MODELING THE LABOR MARKET STABILITY IN CONDITIONS OF UNCERTAINTY AS A COMPONENT OF STRATEGIC MANAGEMENT

Anatoliy Ostapchuk[1] [0000-0002-5663-5895], Liliia Kustrich[2] [0000-0002-5048-4053], Liudmyla Tranchenko[3] [0000-0003-0900-5484], Oleksandr Botsula[4] [0000-0001-7047-0102], Valentyna Kolmakova[5] [0000-0002-2172-7351], Iryna Patoka[6] [0000-0002-3810-2796]

[1] National University of Life and Environmental Sciences of Ukraine, Kyiv, Ukraine. aostpchuk@ukr.net
[2] Uman National University of Horticulture, Uman, Ukraine, kustrichlilya@gmail.com
[3] Uman National University of Horticulture, Uman, Ukraine, lydatranch@gmail.com
[4] Institute of Agroecology an Environmental Management NAAS, nadya-reznik@ukr.net
[5] Institute of Environmental Economics and Sustainable Development of the National Academy of Sciences of Ukraine, nadya-reznik@ukr.net
[6] Institute of Environmental Economics and Sustainable Development of the National Academy of Ukraine, nadya-reznik@ukr.net

Abstract. The labor market modeling makes it possible to objectively assess its current state and development trends, as well as to make sound management decisions in the field of employment and efficient use of human resources in rural areas. On the basis of the offered mathematical model of the labor market the following is possible: creation of information base and system of labor market monitoring; determination of various parameters of the labor market; providing interested services with information for analysis and forecasting of labor market conditions and trends; analysis of labor consumers; identification of the most desirable professionals in demand; analysis of labor distribution and redistribution in terms of further use in the economy; analysis of the existing system of employment incentives for the employment policy formation; forecasting the labor market, number of jobs and their needs, as well as the level and structure of employment of the population and its migration.

Keywords: labor market, unemployment, management, strategic management, modeling, economy.

I. Introduction

As a result of more than a decade of reforms in Ukraine, a very specific “Ukrainian model” of the labor market has been formed. Its key features are not yet fully understood. Therefore, the Ukrainian labor market is often perceived as an accumulation of anomalies, rather than a holistic and internally coherent system. Moreover, it is not chaotic at all, but follows certain logic, based on the peculiarities of the formed model. Spontaneous interregional and inter-sectoral labor migration, widespread informal employment and informal wages, and at the same time the

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concealed unemployment and mass wage arrears – all these phenomena are nothing more than a kind of adjustment mechanisms of the main labor market actors (employees and employers) to the new conditions of the socio-economic environment.

At the same time, the adaptive possibilities of the labor market are far from limitless. It is noted that the restructuring of the Ukrainian economy in general and the labor market in particular is much slower than in other countries of the former Soviet Union. It is the change in the number and structure of jobs that does not fully meet the requirements of modern reality. In such conditions, the delicate reasonable intervention of the state in the structural formation processes, movement and professional adaptation of labor resources is an inevitable stage of the Ukrainian labor market development.

The most important task of economics is the analysis and forecasting of social and economic processes for purposeful influence on them. Modern science has a wide arsenal of relevant tools, among which a special place is occupied by economic and mathematical modeling, relatively free from subjective ideas and passions. It is economic and mathematical methods and models designed to help understand the current situation in the labor market and choose adequate tools for its regulation.

II. Literature review

Analysis of numerous publications by A. N. Maryuta, N. I. Redina, Yu. A. Dolgorukov [14], R. Grünig, R. Kühn [16], L.N. Serhieieva, A.V. Bakurova [1], I.V. Smolin, devoted to certain aspects of the labor market, shows that research is usually qualitative in nature. Among the methods that allow obtaining quantitative estimates and forecasts, the methods of correlation-regression and cluster analysis are used quite actively. However, such studies are mostly fragmentary. Meanwhile, the instability of the Ukrainian economy requires a systematic approach from the researcher.

It should also be noted that the segmentation of the labor market by region, as well as significant differences in the main indices of regional markets naturally determine the logic of the study, reducing it from the macro level to the meso-level. Thus, the development of a set of economic and mathematical models of analysis and forecasting of labor processes to justify regional plans for social and economic development is an urgent task.

New trends and patterns of development, problems and contradictions that accompany the formation of the modern labor market require a comprehensive study. Labor market modeling allows preventing future structural imbalances at work, to maintain the correspondence of labor supply and demand, to forecast employment, both in the near future and in the long run.

The application of the self-organization properties to describe economic processes opens up new opportunities for their study. Development of a mathematical model of the labor market self-organization for several sectors of the economy, the model study for stability allows establishing trends in the labor market functioning, to study the market for its stability. The labor market, unlike other types of markets, has the property of stability. However currently the study of the labor market in a market economy for

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stability, analysis of the labor exchange as part of the functional and organizational structure of the labor market, the use of these studies in the formation of social policy are insufficiently studied. The urgency of this study is due to the need to develop a mathematical model that describes the process of the labor market functioning for several sectors of the economy.

The results of the labor exchange activity do not always meet the demands of the labor market at the present stage. The reason is the incompetence of services provision, which hinders the development of the process of focusing on the relevance of the rural population needs. Insufficient information about the state of the labor market does not allow adequately influence the processes taking place in it. There are a number of contradictions related to the differences between the official statistics indices and the real state of the labor market, the capabilities of modern information resources and the lack of technologies for their use in the labor exchange. The proposed method allows determining the stable state of the agricultural labor market. In this research we sought to combine the possibilities of applying modern theory of stability to solve practical problems of assessing the labor market state using a computer.

Theoretical understanding of the problems of K.R. Thomson, N.J. Mathys [22], K.J. Hatten, M.L. Hatten [9], J.M. Higgins [10], G.D. Smith, D.R. Arnold, B.G. Bizzel [18] contradictions, new trends that accompany the formation of the modern labor market, requires a comprehensive study of the whole set of factors that give rise to the specifics of its functional state forms, the laws of its modification and development. The functional and organizational structure of the labor market includes in a developed market economy the following elements: the principles of state policy in the field of employment and unemployment; training system; hiring system, contract system; unemployment fund; retraining system; labor exchanges; legal regulation of employment.

The theory formalization can be completed by developing a set of interrelated mathematical and computer models that allow flexible changes in government policy in the field of employment and unemployment in order to reconcile the effective economic development and social protection of the unemployed population. Domestic science has accumulated some experience in mathematical models development that describe the processes occurring in the labor market O. M. Tranchenko [20], J. Banioniene, L. Dagiliene [2], F. Burstein, C. W. Holsapple (2008), F.X. Diebold (2015), S.O. Dovghyj, P.I. Bidjuk, O.M. Trofymchuk, O.I. Savenkov (2011). In order to forecast the situation in the field of employment and unemployment, the balance models and statistical methods of correlation analysis were used. It is known that regression methods give good results when there are no drastic structural changes in socio-economic development of society. Therefore, no forecast made using these methods could predict, for example, the labor market decline in 1998. The choice of mathematical methods to solve the problem of the labor market self-organization is due to the following aspects: improving the system of collecting information about complex objects (market labor);

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deepening the quantitative analysis of problems in technical, economic and other areas of the agricultural labor market; solution of fundamentally new scientific and practical problems in any sphere of economic activity.

Self-organization is a supercritical phenomenon of the process (system). Most economic processes have the properties of self-organization, and economic objects are examples of complex self-organized systems. The operation of such facilities is due to the fact that they have a certain stability and adaptability to external conditions. Knowledge of the basic laws of self-organization allows us to move to the purposeful design of artificial active environments, the processes of self-organization in which would lead to the formation of the necessary structures (stationary or changing). O. Chygryn (2016) notes that the emergence of structure is a consequence of self-organization. The system behavior is ordered and periodic in a certain range of its parameter values, i.e. it is reproduced over time.

III. Research methodology

Recently, one of the main areas of applied research in this area is fuzzy modeling. Fuzzy modeling is especially useful when there is uncertainty in the description of a socio-economic system or business process that complicates or even eliminates the possibility of using accurate quantitative methods and approaches. In particular, uncertainty may relate to the following aspects of model representations: ambiguity and vagueness of the system boundary description or its individual states, uncertainty of the occurrence of certain events, incomplete understanding of the system due to poorly formalized problems etc. The basis for the implementation of fuzzy modeling methods is fuzzy logic, which describes more the nature, reasoning of human thinking than traditional formal-logical systems.

That is why the use of mathematical methods to represent fuzzy information allows developing such models that most adequately reflect various aspects of uncertainty that is constantly present in complex economic systems. The problem of macroeconomic forecasting in market economies has a number of features:

1) essential instability of economic processes;

2) uncertainty and unreliability of initial data on a number of microeconomic indices;

3) limited data samples (short samples).

These circumstances do not allow the application of traditional methods of regression and variance analysis for macroeconomic forecasting and urgently require the development of fundamentally new approaches and methods, in particular, use the ideas of artificial intelligence. Among the promising areas in the field of artificial intelligence are fuzzy neural networks (FNN). Fuzzy neural networks, in contrast to conventional neural networks, allow the use of a priori information from experts in the form of fuzzy inference rules: «IF-THEN».

In addition, they make it possible to work in conditions of incomplete and unreliable information, when the values of a number of initial indices are set at

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intervals, as well as when some of them are qualitative and are described as linguistic variables (small, medium, large etc.). The accumulated arsenal of teaching methods designed for conventional neural networks, including the gradient method and gradient-related method, is used for FNN teaching.

As a rule, in a state of unstable economy, characterized by frequent changes in socio-economic conditions, management decisions are made in the uncertainty, as a result of which the task of planning economic activity and forecasting its results is one of the most complex and ambiguous. There are a number of classical methods of forecasting economic indices, which are based on the mathematical statistics apparatus, among which are methods of analysis and time series modeling, methods of multidimensional regression analysis. The peculiarity of these methods is the need for a clear specification of the developed models, and besides, additional difficulties for the use of these methods creates the unstable nature of the studied economic processes.

A promising direction in the field of forecasting is the use of artificial neural networks and fuzzy neural networks. The principle of the neural network is that the available data set constructs the relationship between input and output system variables, while in the process of network study the parameters (weight) of the resulting functional relationships adjust (usually, detection and definition of this dependence is not possible in force of the above reasons). The neural network model is positioned as a “black box” due to the fact that the internal algorithm for its configuration is not “transparent”, and the results and relationships are difficult to interpret.

Fuzzy neural networks or hybrid networks are designed to combine the benefits of neural networks and fuzzy inference systems. On the one hand, they allow developing and presenting models of systems in the form of rules of fuzzy products, which have clarity and simplicity of meaningful interpretation. On the other hand, neural network methods are used to develop fuzzy product rules, which is a more convenient and less time-consuming process for systems analysts. A hybrid network is a multilayer neural network of special structure without feedback, which uses normal (not fuzzy) signals, weights and activation functions, and the execution of the summation operation is based on the use of a fixed T-rate. The values of input, output and weights of the hybrid neural network are real numbers from the segment [0, 1].

The basic idea behind the hybrid network model is to use an existing date sample to determine the parameters of membership functions that best fit some fuzzy inference system. In this case, known procedures for neural networks study are used to find the parameters of membership functions.

In the Fuzzy Logic Toolbox package of the MATLAB system, hybrid networks are implemented in the form of the so-called adaptive neuro-fuzzy inference system ANFIS. On the one hand, the hybrid network ANFIS is a neural network with a single output and multiple inputs, which are fuzzy linguistic variables. In this case, the terms of the input linguistic variables are described by the membership functions standard for

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the MATLAB system, and the terms of the output variable are represented by a linear or constant membership function.

On the other hand, the hybrid network ANFIS is a fuzzy output system FIS type Sugeno zero or first order, in which each of the rules of fuzzy productions has a constant weight equal to 1. In the Fuzzy Logic Toolbox package of MATLAB system the hybrid networks are implemented in the form of adaptive neural systems of fuzzy-inferent ANFIS output. Also the development and research of hybrid networks is possible:

- in the interactive mode with the help of a special graphic editor of adaptive networks, called ANFIS editor;
- in command line mode by entering the names of the corresponding functions with the necessary arguments directly into the command window of the MATLAB system.

The ANFIS editor allows to create or download a specific model of an adaptive neuro and fuzzy inference system, perform its training, visualize its structure, change and adjust its parameters, as well as use a customized network to obtain fuzzy inference results.

IV. Results

The purpose of mathematical modeling of the labor market is to obtain objective data that will ensure the effectiveness of its operation. Creating models of the agricultural labor market provides a choice of the optimal strategy of economic management, which allows preventing future imbalances in rural labor, to maintain compliance with labor supply and demand. Modeling of the agricultural labor market makes it possible to objectively assess its current state and trends, allows to make informed management decisions in the field of employment and efficient use of human capital.

Depending on the desired goal, a specific mathematical model allows you to answer various questions about the labor market functioning. For example, it is possible to create an information base and system for labor market monitoring, to determine various labor market parameters, to analyze the distribution and redistribution of labor, to predict the level and structure of employment and migration.

However, in the conditions of the economic crisis, the model parameters change so unpredictably (they speak of perturbations of the initial parameters of the model), that even stochastic methods give rather approximate forecasts. Balance models and statistical methods of correlation analysis were mainly used to forecast the situation on the agricultural labor market. But it is known that regression methods give good results in cases where there are no drastic structural changes in the socio-economic development of society. Therefore, no forecast obtained using these methods in a crisis can adequately predict the situation in the labor market. We propose a method for determining the agricultural labor market stability by developing an analytical dynamic model, which consists of a system of differential equations. However, the system of equations itself is not solved in such a way that the exact solution, firstly, cannot always

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be found, and secondly, even its finding is very difficult to analyze. Therefore, we do not propose to solve this system of differential equations, but to study their stability. The stability of the model is determined by considering the roots of the characteristic polynomial of the proposed system of differential equations. Thus, the study of the labor market in a market economy for stability will predict the trend of unemployment with the disturbance of the initial state of the market.

When applying the ideas of the self-organization theory O. Chygryn (2016) uses nonlinear differential equations as a basic mathematical apparatus. The model of self-organization of the separate branch of labor market which allows predicting probability of development of events in the market is offered. The model assumes that during this period the number of employees will change to

$$dN_1(t) = \left(N_2(t)W_1(t) - N_1(t)W_2(t)\right)dt, \quad (1)$$

Where $N_1(t)$ – the total number of specialists employed in the industry at present, $N_2(t)$ – the number of potential workers who can be hired and are currently unemployed, $N = N_1(t) + N_2(t) = const$ – labor market capacity of the industry, $W_1(t)dt$ – the probability that an unemployed specialist can find a job in the specialty in a certain period of time from t to $t + dt$, $W_2(t)dt$ – the probability of employee dismissal in a certain period of time from t to $t + dt$.

In the model, equation (1) is reduced to a differential equation with constant coefficients, from which two solutions are obtained. And of the two stationary solutions, only one will be stable. From an economic point of view, this means that in this state with a certain level of employment with slight deviations from this level, the system will eventually return to its original state. In contrast to the state of equilibrium, the state with the second level of employment is nonequilibrium, because even a slight deviation from this level will lead to the transition of the system to another steady state. This result is fully confirmed by economic considerations, as the nonequilibrium state corresponds to the mode of operation of the industry with the use of additional resources. Hereinafter a system of differential equations with constant coefficients is considered:

$$\frac{dx}{dt} = Ax(t) \quad (2)$$

Where A is matrix of constant coefficients of the system of equations (2).

In linear algebra, it is proved that for the stability of the solution of the system of equations (2) it is necessary and sufficient that all eigenvalues k_i of the matrix A satisfy the condition $\mathrm{Re}\, k_i \le 0$, i.e. the real part of all eigenvalues is not positive. The results can be summarized in case of two, three or more sectors of the economy.

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In this paper, we consider the labor market of Ukraine in rural areas. Conventionally, all working rural able-bodied residents can be divided into two groups. Some people work in agriculture, others in industrial production (in villages or in nearby cities). Thus, to develop a mathematical model, we can consider two "branches": "agriculture" and "industry". Let's mark:

$N_1^1(t)$ - the total number of rural residents working in agriculture at the time;

$N_1^2(t)$ - the total number of rural residents working in industrial production at the time;

$N_2^1(t)$ - the number of potential workers living in rural areas who may be employed in agriculture and are currently unemployed;

$N_2^2(t)$ - the number of potential workers living in rural areas who can be employed in industrial production and are currently unemployed;

$\sum_{i=1}^{2}\sum_{j=1}^{2} N_j^i(t) = N = const$ the labor market capacity of rural residents;

$W_1^{(1,1)}$ - the probability that the unemployed, whose last place of work was agriculture, gets a job in agriculture for a period of time from t to $t+dt$;

$W_1^{(1,2)}$ - the probability that the unemployed, whose last place of work was agriculture, gets a job in industrial production for a period of time from t to $t+dt$;

$W_1^{(2,1)}$ - the probability that the unemployed, whose last place of work was industrial production, gets a job in agriculture for a period of time from t to $t+dt$;

$W_1^{(2,2)}$ - the probability that the unemployed, whose last place of work was industrial production, gets a job in industrial production for a period of time from t to $t+dt$;

$W_2^{(1)}$ - the probability of dismissal of an agricultural specialist for a period of time from t to $t+dt$;

$W_2^{(2)}$ - the probability of dismissal of an agricultural specialist for a period of time from t to $t+dt$.

It is important to note that in the general case $\sum_{i=1}^{2} W_1^{(i,j)} \neq 1,\ j=1,2$

Let us assume that at the initial time point $t=0$ the number of professionals employed in agriculture and living in rural areas is equal to $N_{10}^{(1)}$, the number of professionals employed in industry and living in rural areas $N_{10}^{(2)}$, the number of potential workers living in rural areas who can be employed in agriculture and for the period of time t are unemployed is equal $N_{20}^{(1)}$, the number of potential workers living in

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rural areas who can be employed in industry and for the period of time t are unemployed – $N_{20}^{(2)}$

Hence, $N_1^{(i)}(0)=N_{10}^{(i)},\ N_2^{(i)}(0)=N_{20}^{(i)},\ i=1,2.$ (3)

According to the introduced notations, we obtain a system of differential equations with given initial conditions (3), which describes the dynamics of labor redistribution in rural areas:

$$\frac{dN_1^{(1)}(t)}{dt}=-N_1^{(1)}(t)W_2^{(1)}+N_1^{(2)}(t)W_2^{(2)}-N_2^{(1)}(t)W_1^{(1,1)}+N_2^{(2)}(t)W_1^{(2,1)},$$

$$\frac{dN_1^{(2)}(t)}{dt}=N_1^{(1)}(t)W_2^{(1)}-N_1^{(2)}(t)W_2^{(2)}+N_2^{(1)}(t)W_1^{(1,2)}-N_2^{(2)}(t)W_1^{(2,2)}, \quad (4)$$

$$\frac{dN_2^{(1)}(t)}{dt}=N_1^{(1)}(t)W_2^{(1)}+N_1^{(2)}(t)W_2^{(2)}-N_2^{(1)}(t)\left[W_1^{(1,1)}+W_1^{(1,2)}\right]+N_2^{(2)}(t)W_1^{(2,1)},$$

$$\frac{dN_2^{(2)}(t)}{dt}=N_1^{(1)}(t)W_2^{(1)}+N_1^{(2)}(t)W_2^{(2)}+N_2^{(1)}(t)W_1^{(1,2)}-N_2^{(2)}(t)\left[W_1^{(2,1)}+W_1^{(2,2)}\right].$$

Let us assume that the probabilities $W_1^{(i,j)}$, $W_2^{(i)}$ are constant values, $i,j=1,2$. This assumption is quite acceptable from an economic point of view. For example, you can find their average values for the current year and count. If we take into account that the unemployed of the i-th branch can apply for the position of an employed specialist of this branch only under the condition of dismissal of the job, i.e. dismissal of the i-th branch worker, the system of differential equations (4)will look like hat:

$$\frac{dN_1^{(1)}(t)}{dt}=-N_1^{(1)}(t)W_2^{(1)}-N_2^{(1)}(t)W_1^{(1,1)}+N_2^{(2)}(t)W_1^{(2,1)},$$

$$\frac{dN_1^{(2)}(t)}{dt}=-N_1^{(2)}(t)W_2^{(2)}+N_2^{(1)}(t)W_1^{(1,2)}-N_2^{(2)}(t)W_1^{(2,2)}, \quad (5)$$

$$\frac{dN_2^{(1)}(t)}{dt}=N_1^{(1)}(t)W_2^{(1)}+N_1^{(2)}(t)W_2^{(2)}-N_2^{(1)}(t)\left[W_1^{(1,1)}+W_1^{(1,2)}\right],$$

$$\frac{dN_2^{(2)}(t)}{dt}=N_1^{(1)}(t)W_2^{(1)}+N_1^{(2)}(t)W_2^{(2)}-N_2^{(2)}(t)\left[W_1^{(2,1)}+W_1^{(2,2)}\right].$$

The system of differential equations (5) with the initial conditions (3) is an analytical model that describes the dynamics of the labor market in rural areas. The probabilities that are included in the system as constant coefficients can be estimated when analyzing the statistics. The solution of this system of equations does not provide additional information about the state of the labor market at present, but the phenomenological parameters included in the proposed mathematical model open up the opportunities to study the influence of objective and subjective factors on the

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dynamics of unemployment in rural areas without a detailed consideration of these factors. Since any mathematical model cannot take into account all the factors, and therefore always has an error, one of the important procedures in modeling is the study of stability.

An important aspect of any economic system is its stability. A system is stable if it maintains a tendency to move to the state that best meets the purpose of the system, the goal of maintaining quality without changing or slightly changing the system structure on a given set of resources (for example, on a time interval). From an economic point of view, the stability of the model (5) means that in the state with the level of employment (3) with slight deviations from (3) the system will eventually return to its original state. If the model (3), (5) is unstable, then even small changes (3) will inevitably lead to a different ratio of the number of unemployed and working people in rural areas.

Let us investigate model (3), (5) for stability. The typical polynomial of the matrix of coefficients of system (5) is stable if and only if its roots k_j ($j=1,...,4$) have a negative real part, i.e. correspond to the statement $\mathrm{Re}\,k_j<0$. Let us mark the matrix of system (5) coefficients by W.

The matrix of coefficients has the following form:

$$W=\begin{pmatrix} -W_2^{(1)} & 0 & -W_1^{(1,1)} & W_1^{(2,1)} \\ 0 & -W_2^{(2)} & W_1^{(1,2)} & -W_1^{(2,2)} \\ W_2^{(1)} & W_2^{(2)} & -W_1^{(1,1)}-W_1^{(1,2)} & 0 \\ W_2^{(1)} & W_2^{(2)} & 0 & -W_1^{(2,1)}-W_1^{(2,2)} \end{pmatrix}$$

Let's make the standard equation of matrix W:

$$\det(W-kE)=0, \tag{6}$$

where E – unit size matrix 4×4. Equation (6) is equivalent to equation

$$P_n(k)=a_0+a_1k_1+a_2k^2\ldots+a_nk^n=0,\ a_n=1. \tag{7}$$

Direct calculation of eigenvalues of the standard equation of the coefficient matrix of system (5) is a rather labor-intensive process that requires a lot of time. And with increasing polynomial degree (7) increases the deviation of the results. Therefore, to solve the problems of mathematical modeling of the agricultural labor market, you can use different application packages, such as: Excel spreadsheets, MathCad integrated environment, Maple computing environments, MatLab, mathematical system Mathematica. To find the roots of the standard equation, we used the MathCad environment.

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Direct calculation of standard polynomial coefficients a_i requires a lot of mathematical operations. Special methods have been developed for the deployment of the standard matrix determinant, which does not require its direct calculation. In this work, we used the interpolation method. After calculating the standard polynomial a_i coefficients, the eigenvalues were found using Newton's method.

The MathCad integrated environment allows to find the standard polynomial eigenvalues without time-consuming calculations. The built-in *eigenvals* function finds all the roots k_i of the standard equation. Analysis and data processing allowed estimating the probabilities that are included in the proposed analytical model. Based on the data of 2018, we obtained the following values:

$$W_1^{(1,1)} = 0.12,\ W_1^{(1,2)} = 0.02,\ W_1^{(2,1)} = 0.04,\ W_1^{(2,2)} = 0.07,$$
$$W_2^{(1)} = 0.13,\ W_2^{(2)} = 0.19. \quad (8)$$

The fragment of a working document of the MathCad integrated environment for finding the eigenvalues k_i of a standard polynomial are given below:

$W21 := 0.13 \qquad W22 := 0.19$

$W111 := 0.12 \qquad W112 := 0.02 \qquad W121 := 0.04 \qquad W122 := 0.07$

$$w := \begin{pmatrix} -W21 & 0 & -W111 & W121 \\ 0 & -W22 & W112 & -W122 \\ W21 & W22 & -W111 - W112 & 0 \\ W21 & W22 & 0 & -W121 - W122 \end{pmatrix}$$

$$w = \begin{pmatrix} -0.13 & 0 & -0.12 & 0.04 \\ 0 & -0.19 & 0.02 & -0.07 \\ 0.13 & 0.19 & -0.14 & 0 \\ 0.13 & 0.19 & 0 & -0.11 \end{pmatrix} \qquad E := \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

$Wj(n) := w - E \cdot n \qquad size := rows(w)$

$l\_r(a,b) := |Wj(a+1)| - (a+1)^{size} \qquad Ml\_r := matrix(size, 1, l\_r)$

$$Ml\_r = \begin{pmatrix} 0.728 \\ 5.154 \\ 16.701 \\ 38.788 \end{pmatrix}$$

$l\_l(a,b) := (a+1)^{size-1-b} \qquad Ml\_l := matrix(size, size, l\_l)$

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$$Ml\_l = \begin{pmatrix} 1 & 1 & 1 & 1 \\ 8 & 4 & 2 & 1 \\ 27 & 9 & 3 & 1 \\ 64 & 16 & 4 & 1 \end{pmatrix}$$

a := lsolve(Ml_l, Ml_r)

$$a = \begin{pmatrix} 0.57 \\ 0.14 \\ 0.017 \\ 7.558 \times 10^{-4} \end{pmatrix}$$

$$P(\lambda) := \lambda^4 + a_0\lambda^3 + a_1\lambda^2 + a_2\lambda + a_3$$

$$P(\lambda) \rightarrow 0.016746\cdot\lambda + 0.14\cdot\lambda^2 + 0.57\cdot\lambda^3 + \lambda^4 + 0.00075582$$

k := eigenvals(w)

$$k = \begin{pmatrix} -0.143 + 0.139i \\ -0.143 - 0.139i \\ -0.107 \\ -0.178 \end{pmatrix}$$

V. Conclusion

As can be seen from the solution, all four roots k_i have a negative real part. This means that the mathematical model (3), (5) with probabilities (8), characterizing the state of the labor market in rural areas at the end of 2018 will be stable. This indicates the fact that the labor market will be in equilibrium. From an economic point of view, this means that relatively small deviations from the unemployment rate at the end of 2018 and a slight redistribution of the employment structure of rural residents in the next 2019 will not lead to a significant increase in unemployment. The ratio between the employment rate and the unemployment rate in rural areas in 2019 will not deviate much from the value in 2018. It can be assumed that there will be a decrease in unemployment.

As part of the processes of further formation and development of Ukrainian labor potential, a number of internal threats and risks that undermine the foundations of national security are becoming increasingly apparent. The essence of these threats and risks is as follows: deepening the qualitative non-compliance of the national labor force

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with the requirements of the post-industrial-oriented model of Ukrainian economy of the future; deterioration of labor supply of certain sectors of Ukrainian economy; replacement of national emigrants by immigrants – carriers of other labor behavior models; polarization of labor inequality and its strengthening; blurring of national centers of intellectual and cultural capital concentration; excessive prevalence of informal employment and self-employment in potentially promising economic activities.

To prevent these threats, it is necessary to take a number of organizational and economic urgent measures in the following priority areas: intensive development of technologically complex and intellectually rich industries; increasing the national workforce quality; prevention of stagnant forms of unemployment; introduction of stricter control over labor immigration to the territory of Ukraine; mitigating the labor inequality polarization by improving the system of incentives for certain types of work.

The efforts of the state and various institutions of civil society should create a moral and psychological climate in the country, where every citizen would be ready for permanent training, and if necessary would poise for change professions, i.e. for the full need to improve his professional skills during working life. A significant problem that hinders the harmonization of the professional qualification structure of the labor market is the lack of information felt by both the employers and authorized government agencies.

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