ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Economic and mathematical modeling of personnel risks in the rural labor market

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ABSTRACT

Transformations of the agrarian economy predetermine the formation and development of the rural labor market, and together with it generate scientific problems related to the study and measurement of personnel risks. Adequate economic and mathematical assessment of labor risks is the most important prerequisite for effective management of the labor force in the agrarian sector and improving the quality of its use in the rural economy. The modeling of risks in the labor market is associated with the alleged underutilization of the workforce due to the availability of able-bodied individuals released from organizations and enterprises, the growth in the number of unemployed and increasing the number of unemployed, and the duration of unemployment. In addition, personnel risks are caused by the inefficient functioning of district municipal employment services, probable labor and material losses due to the fault of managers and specialists of enterprises. At the same time, the degree of risk is expressed in a multiplicative way, depending on the expected damage and the likelihood that it will occur. In this connection, the issues of economic, mathematical and statistical modeling of these processes become especially topical. The article substantiates the scientific approach to the modeling of the rural labor market, taking into account the cyclical nature of its functioning, including the calculation of risks from underutilization of the workforce, the unemployment rate, and the decline in the efficiency of labor activity.

Keywords: personnel risks, cyclicity, rural labor market, municipal territories, unemployment, development, economic and mathematical modeling

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ISSN: 0975-8585

INTRODUCTION

Personnel risks in the rural labor market are determined by a complex of numerous factors and conditions that negatively affect the effectiveness of the use of labor. Methodically, they can be classified into economic and organizational, internal and external, objective and subjective [1]. First of all, they include: an increase in the number of unemployed and migrants in the region; decrease in the effectiveness of the functioning of municipal employment services; lack of professional skills in the labor market, including among young people [6]; strengthening of processes of social and economic instability; the absence of a flexible employment policy in the labor market; the limitation of the number of vacancies, including the lack of jobs in rural areas.

On the other hand, there are certain positive determinants that reduce risks in the rural labor market [4]. These include a high level of skill in the workforce; increase in demand for some scarce occupations and specialties; the developed market of alternative kinds of labor activity; an effective system of employment in the region; development of the system of additional education and retraining of personnel [7-15]. These and other problems pose specific tasks for the theory, methodology and applied aspects of the formation and regulation of the labor market in rural areas. Particular importance is given to economic and mathematical modeling as an important tool for effective scientific research [2, 5, 8].

MATERIALS AND METHODS

Some authors [3, 7] reasonably state that in the regional labor market all its main components are subject to seasonal cyclical fluctuations: the number of employed and unemployed, the number of people applying for employment in the employment service and the number of temporarily unemployed persons, the number of people employed in public paid jobs and number of persons directed to vocational training, etc.

In this regard, the author's methodical approach to the statistical assessment of personnel risks is based on the economic and mathematical modeling of the main parameters of the regional labor market, taking into account the seasonality (cyclicity) of labor processes.

Cyclic (seasonal) processes can most adequately be approximated by trigonometric functions. Therefore, it is recommended to develop appropriate economic and mathematical models that take into account the seasonal fluctuations of different employment processes and labor force unemployment in the regional labor market (1). In this case, specific calculations can be made on the basis of the relevant statistics of municipal employment services in the region.

As an analytical form of the seasonal wave of labor market components, we recommend using the Fourier equation of the following form (1):

$$Y_t = a_0 + \sum_{k=1}^{m} (a_k \cos kt + b_k \sin kt) \qquad (1)$$

This model (1) is a Fourier series,

Where is t - the conditional time, expressed in radian measure, varies from 0 to 2π in increments of π/6.

By k = 2 (the so-called coefficient of the degree of accuracy of the harmonic of a trigonometric polynomial), the equation takes the form (2), which is acceptable for carrying out adequate practical calculations:

$$Y_t = a_0 + a_1 \cos t + b_1 \sin t + a_2 \cos 2t + b_2 \sin 2t \qquad (2)$$

The parameters of the above model can be calculated as follows (3):

$$a_0 = \sum y / n; \qquad a_k = 2\sum y \cos kt / n; \qquad b_k = 2\sum y \sin kt / n \qquad (3)$$

ISSN: 0975-8585

In accordance with the presented methodology, seasonal labor market development models for the near future can be obtained in order to form an effective employment policy in the region and regulate labor processes in the territory.

On the basis of the obtained parameters of the economic-mathematical model (2), the HR risk model (4) can be calculated and economically justified in the following:

$$R = p\,(B \cdot k_1 + N \cdot k_2 + U \cdot k_3 + Z \cdot k_4)\,, \qquad (4)$$

Where is *R* – cost estimation of expected risk in the labor market, million rubles;
p – value of gross regional product per capita, thousand rubles;
B – number of registered unemployed in the region, people;
N – number of unemployed who applied for employment in the municipal employment services, people;
U – persons subject to release in connection with the reorganization of enterprises and organizations, persons;
Z – number of people working in part-time employment, people.
k_1, k_2, k_3, k_4 – the degree of probability of the corresponding event, determined by expert means.

The author's scientific approach to assessing and reducing personnel risks in the rural labor market is based on the following principles: the priority of an effective system of employment and risk management in the system of regional employment; accounting for a sound balance of supply and demand for labor; constant development of the market for alternative types of employment in rural areas; the effectiveness of the system of additional education and retraining.

RESULTS AND DISCUSSION

The proposed methodology of economic and mathematical modeling of cyclic processes on the rural labor market was tested on the example of 26 municipal districts of the Stavropol Territory.

The following seasonal labor market development models were obtained (5) - (10).

$$Y_1 = 14761{,}4 - 382{,}3\cos t + 178{,}4\sin t - 191{,}5\cos 2t - 683{,}9\sin 2t \quad (5)$$
$$Y_2 = 7856{,}3 - 187{,}1\cos t + 164{,}2\sin t - 83{,}3\cos 2t - 586{,}1\sin 2t \quad (6)$$
$$Y_3 = 402{,}5 - 0{,}69\cos t + 181{,}7\sin t - 197{,}4\cos 2t - 88{,}4\sin 2t \quad (7)$$
$$Y_4 = 652{,}4 - 6{,}7\cos t + 81{,}5\sin t - 10{,}3\cos 2t - 76{,}2\sin 2t \quad (8)$$
$$Y_5 = 273{,}4 - 17{,}6\cos t + 13{,}2\sin t - 19{,}1\cos 2t - 60{,}7\sin 2t \quad (9)$$
$$Y_6 = 221{,}6 - 77{,}6\cos t + 80{,}3\sin t - 4{,}12\cos 2t - 91{,}5\sin 2t \quad (10)$$

Where are:

Y_1 – registered number of unemployed able-bodied people;
Y_2 – unemployed (receiving unemployment benefits);
Y_3 – employed in public paid work;
Y_4 – number of people sent for vocational training;
Y_5 – who have completed vocational training;
Y_6 – employed by the employment service.

The study of the presented models showed that during the last three years the length of the wave characterizing the number of job seekers by the employment service is on average 3.8 months, the recurrence of registration of the unemployed is 1.3 months, the periodicity of those sent for vocational training is 4.2 months and the amplitude of cyclicality employed in public works ranges from 3 to 6 months. The use of this information will allow more targeted management of labor processes in the regulated labor market.

ISSN: 0975-8585

The developed seasonal models were subsequently used for predictive calculations and study of trends in the development of labor processes in the short term on the regional labor market in the region, in the context of months and quarters of the year (Table 1).

Table 1: Forecasting the number of major categories in the rural labor market in the region, thousand people

Indicators	Months 2018 r.											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Unemployed	4,3	4,3	4,3	4,3	4,5	4,5	4,5	4,7	4,7	4,5	4,3	4,7
Employed by community service	0,6	0,7	0,9	1,3	1,5	1,5	1,5	1,3	0,8	0,4	0,2	0,3
Number of people sent for vocational training	1,7	1,7	1,7	1,6	1,5	1,3	1,2	1,0	1,0	1,2	1,3	1,5
	Months 2019 r.											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Unemployed	4,2	4,2	4,2	4,2	4,4	4,4	4,4	4,6	4,6	4,4	4,2	4,0
Employed by community service	0,6	0,7	0,8	1,4	1,5	1,6	1,6	1,5	1,2	0,9	0,7	0,5
Number of people sent for vocational training	1,7	1,9	1,8	1,7	1,6	1,5	1,4	1,2	1,3	1,3	1,5	1,6

The use of this information will allow the regional bodies of the employment service to make certain adjustments to the employment program in the region and, accordingly, to more quickly manage the process of employment, the training of unemployed people, the regulation of paid public works, as well as to plan the necessary funds in time for the payment of unemployment benefits.

In addition, economic and mathematical modeling has made it possible to establish the quantitative dependence of the level of rural unemployment on the most significant factors affecting it - population density, the proportion of workers released from enterprises and organizations and the degree of employment of labor. In general, these factors for 2015-2017 on average, 79.4% determine the variation (change) of the dependent trait. Moreover, with an increase in the proportion of employment-based employment by 10%, the number of rural unemployed (based on 10 thousand hectares of agricultural land) is reduced by an average of 12.9%.

At the same time, it is this factor with a fixed value of the other that accounts for more than 36.3% of the variation in unemployment across the regions of the region and are decisive. The other two have a direct impact on the unemployment rate, which is determined by 14.8 and 21.7%, respectively.

At the same time, regression coefficients of correlation models indicate that with an increase in the relative density of those released from enterprises and organizations by only 1%, the number of unemployed per 100 hectares of agricultural land increases on average by 253 - 317 people. (depending on the agrarian zone of the region), and with an increase in the proportion of employed by the employment service by 10% - respectively, is reduced by 134-157 people.

This circumstance predetermined the development of measures and proposals for more effective management of the labor force in the region.

The analysis and practical use of models (5) - (10) allowed to substantiate the fact that the personnel risks in the rural labor market in the region in 2018-2019. the following categories of the economically active population may be affected:

1) unemployed registered with the employment service, including:

- young people under the age of 30 (26-27% of the number of registered unemployed) and women (69-71%);
- residents of mono-profile cities (settlements) and rural areas (70-73%);
- the above categories, which are registered for more than 1 year (3-4%);
- having a predominantly basic general education or not having it (8-14%);

2) applying to the State Employment Service for assistance in finding a suitable job:

- citizens of pre-retirement age and invalids (3-4%);
- migrants (0.1%);
- Persons seeking to resume work after a long (more than a year) break in work (2-3% of the number of applicants).

In accordance with the model (4), in 2018-2019 gg. the projected financial losses from personnel risks in the rural labor market in the region may amount to more than 3.2 billion rubles.

In order to reduce risks in the labor market, the following activities are recommended:

- Creation of an interdepartmental headquarters under the regional state employment service for employment issues and ensuring a stable situation in the labor market;
- enabling regional government bodies to develop and implement systems for adapting the population to the risk situation;
- introduction and implementation of the economically sound strategy and tactics of the risk management system in the regional labor market;
- development of regional employment programs, taking into account the rationale for personnel risks;
- additional training as an opportunity to reduce crisis risks to a minimum and increase their competitiveness and labor costs in the labor market;
- Improvement of the system of risk prevention in the labor market, including through the development and implementation of social employment and unemployment cards, as well as on the basis of the construction of municipal cards of personnel risks. This will allow systematizing the risks in the labor market by the factors of their occurrence, objects, types, as well as the magnitude of material and labor losses.

CONCLUSIONS

The economic-mathematical study of seasonal fluctuations of the dynamic series has found its methodical and practical application in the study of the rural regional labor market. It is necessary to take into account the following main provisions of the mechanism for the optimal functioning of employment cycles in the regional labor market:

1. Cyclic seasonal changes in the labor market are an integral part of economic cycles. At the same time, there is a process of mutual influence of undulating phenomena in the economy on the seasonality of employment, the employment of the population, the scale and level of unemployment. Seasonality of employment is due to all sorts of exogenous and endogenous factors, as well as specific conditions for the development of the region. These factors, except those indicated, can be: social, demographic, migration, ethnic, psychological, etc.
2. In the labor market simultaneously, a diverse set of employment cycles coexist, interact and function, characterized by both a different wavelength and its constantly changing amplitude. This should be taken into account when developing measures to regulate the labor market, taking into account the methodology for calculating staff risks.
3. In developing measures to mitigate and prevent personnel risks in a single cycle of seasonal transformations, it should be considered: employment and unemployment; demand for labor and its supply; number of employed and unemployed; the labor market and the job market; regionalization and globalization of the labor market; its autonomy and openness, the level of inflation and unemployment; the amount of unemployment benefits and average wages, and so on.

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