



Regional Development. Analysis and Forecasting of the Number of Unemployed in the Central Federal District

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Abstract: The market economy is characterized by a number of parameters. One of them is competition in various fields. Which leads to restrictions in jobs and as a result to the appearance of unemployment. The unemployment rate is a rather complex socio-economic phenomenon that forms the attitude not only to local authorities, but also to the activities of the government of the Russian Federation as a whole. The economic aspect plays a very important role in the study of unemployment. However, it is necessary not to forget the various social factors that influence the sustainable development of the unemployment rate. This article is devoted to the study of changes in the main indicators of the level of the unemployed population. The dynamics of the officially registered number of unemployed people aged 15-72 in the entire Central Federal district is analyzed. The article discusses the characteristics of basic and chain indicators, calculated and quantified factors (wages, population, the increase in high-performance workplaces, the cost of a fixed set of consumer goods and services, the age structure of the population above the working age, and net migration) on the basis of which it is possible to investigate the dynamics of changes in the level of unemployed population. The analysis allowed to construct a regression model that reveals the relationship between the wages of workers, population growth in high-performance workplaces, with the cost of fixed set of consumer goods and services, the age structure of population above the working age, migration population growth and growth in the number of unemployed in all regions of the Central Federal district. The paper also makes a forecast of the distribution of the number of unemployed in the district in question for 2021.

1 INTRODUCTION

Economic instability shall be characterized by such a phenomenon as unemployment. Unemployment is a complex, multidimensional socio-economic phenomenon, when a part of the economically active population is not employed in social production, cannot realize their physical and mental abilities with the help of the labor market (the latter is due to the lack of suitable jobs) (Slyunyayeva, 2014). In Russia, the concept of unemployment arose during the transition to a market economy. There have been global changes in the structure of the national economy of the country, which entailed changes in the use of labor resources. The bankruptcy of many organizations led to deterioration of the socio-

economic situation in the country and had an impact on the effectiveness of the usage accumulated production potential, that caused a sharp rise in unemployment among the population. The possibility of population migration to far foreign countries that arose in the new economic conditions led to the loss of a large number of highly qualified specialists, which led to a decrease in the quality of the domestic labor force. While the human resources of the state represent the base - the foundation for ensuring internal political, economic, social and other stability (Sadovnikova and Makhova, 2019). The employment rate of the population and the unemployment rate in the region are the main social factors that form the attitude not only to local authorities, but also to the activities of the federal government as a whole. High

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unemployment rates lead to social tension in society (Abramov and Gavrikov, 2019). Such eminent scientists of economic science as Adam Smith, Karl Marx, Arthur Pigou, David Reckardo, John Maynard Keynes, Jean Baptiste Say, Alfred Marshall (Ramazanova, 2017) were widely engaged in these questions. At the present time, many works are devoted to the study of the unemployment problem in the Russian Federation, such economists as Bogachenko E.D., Kuznetsova O.I., Brusyanina M.S. (Kostikova et al., 2013). They identify the following reasons for unemployment - low effective demand, surplus population and the introduction of new technologies. The authors of the works (Borzenkov, 2012; Bashkirova, 2016) highlight the following reasons for unemployment: an increase in the minimum wage, the introduction of new technologies, an economic downturn and seasonal changes in the level of production in certain sectors of the economy. The author of the work (Mikhal'kevich, 2018) notes that the main reason for the large number of unemployed is high and inflexible downward wages. Although this problem is reflected in the works of foreign and domestic scientists, various measures taken by the Russian Government have not yet led to its solution (Kostikova et al., 2013; Urusova, 2019).

The main types of unemployment include the following:

- Structural - is when the unemployed do not have the necessary qualifications, or live in places that do not allow them to find vacancies. In addition, this type of unemployment is characterized by a discrepancy between the quality and quantity of labor force and the quality and quantity of jobs existing in this state. The main reason for the appearance of this type of unemployment is the changing structure of population consumption. This type of unemployment is long-term.

- Frictional - is a result associated with finding a job and is due to the fact that it takes time for an unemployed person to find a job that he likes. Thus, frictional unemployment characterizes the employee's desire to improve his working conditions. This type of unemployment is short-term.

- Cyclical - is a consequence of the lack of aggregate demand in the phases of recession and depression of the business cycle, when there is a shortage of jobs. Moreover, it does not depend on the qualifications of the employee (Mal'tseva, 2020; Kurakov et al., 2017).

Although there are many types of unemployment, various measures to reduce it need to be considered (Sazhina and Serushkina, 2015):

1. Unemployment benefits payment;
2. Creation of additional jobs;
3. Improving information support of the labor market;
4. Creation of state services for retraining and requalification;
5. Creation of conditions for increasing demand for goods and services;
6. Eliminating factors that reduce labor mobility (Zaval'nyuk, 2016):
7. Creation of conditions for the employment of disabled people, including creation of special jobs for people with disabilities.

Despite significant elaboration of issues related to unemployment, it should be noted that over time, the factors affecting unemployment (Kulentsan and Marchuk, 2019) are constantly changing, which requires constant in-depth study and analysis of these issues.

The relevance of this work lies in the fact that the problem associated with the number of unemployed is one of the main problems in the modern world. Without solving this problem, it is impossible to overcome the economic slack and establish effective economic activity in our country. Therefore, the analysis of such indicators as the wages of workers, the population, the growth of highly productive jobs, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and the migration growth of the population affecting the unemployment rate is an important and key task. As a result, it is necessary to consider the correlation and regression model and the listed factors.

The work analyzes modern approaches to economic and mathematical modeling (Goncharenko, 2011).

Correlation and regression analyzes are among the main statistical methods for processing experimental data (Dolgov, 2013; Kulentsan and Marchuk, 2020; Polozhentseva, 2017).

2 RESEARCH METHODOLOGY

Currently, the correlation analysis technique shall be used to identify the relationship between variables and assess the tightness of the relationship. Regression analysis shall be used to establish the shape and study the relationship between variables. Consider a sample of two variables A and B. The multivariate distribution of variables A and B can be represented as the density of the 2nd normal law of distribution (1):

$$f(A, B) = \frac{1}{2\pi\sigma_A\sigma_B\sqrt{1-\rho^2}} \exp \left[-\frac{1}{2\sqrt{1-\rho^2}} \left(\frac{A-\mu_A}{\sigma_A} \right)^2 - 2\rho \left(\frac{B-\mu_A}{\sigma_A} \right) \left(\frac{A-\mu_B}{\sigma_B} \right) + \left(\frac{A-\mu_B}{\sigma_B} \right)^2 \right] \quad (1)$$

In this case, the probability density is determined by 5 parameters: mathematical expectation ($MA = \mu_A, MB = \mu_B$), variance ($DA = \sigma^2A, DB = \sigma^2B$) and pair correlation coefficient (ρ). This coefficient shows the closeness of the linear relationship between the sampled values of A and B.

$$\rho = M \left[\frac{A-\mu_A}{\sigma_A} \cdot \frac{B-\mu_B}{\sigma_B} \right] \quad (2)$$

Pair correlation coefficient properties:

1. $-1 \leq \rho \leq 1$ - ρ takes values on the segment $[-1; 1]$, and the closer $|\rho|$ to 1, the closer the relationship between features A and B;

2. at $|\rho| = 1$, the correlation between signs A and B is a linear dependence);

3. at $|\rho| = 0$, there is no linear correlation between A and B (but this does not mean the impossibility of a nonlinear relationship between them);

4. $\rho < 0$ indicates the presence of an inverse relationship between variables A and B (as one variable increases, the other decreases);

5. $\rho > 0$ indicates the presence of a direct relationship between variables A and B (as one variable increases (decreases) in one variable, the other also increases (decreases));

6. If all feature values are increased (decreased) by the same number or by the same number of times, then the value of the correlation coefficient will not change (Kulentsan and Marchuk, 2020; Polozhentseva, 2017).

Since it is assumed that the random variable B has a normal distribution with a conditional mathematical expectation $\tilde{B} = \varphi(A_1, A_2, \dots, A_k)$, which is a function of the arguments A_j and a constant variance that does not depend on the arguments σ^2 .

A certain class of functions depending on unknown parameters shall be chosen as the form of dependence. The task of regression analysis is to estimate parameters for a number of independent observations and to test hypotheses for such unknown parameters. The task of regression analysis is to estimate parameters for a number of independent observations and to test hypotheses for such unknown parameters.

The main assumptions of regression analysis of the linear pairwise regression model are as follows:

- the dependent variable B_i is a random variable, and the explanatory variable A_i is not random;
- the mathematical expectation of the disturbance is zero ($M\varepsilon_i = 0$);
- the variance of the dependent variable B_i is constant (for all i) and equal to $D\varepsilon_i = \sigma^2$;
- variables B_i and B_j are not correlated $M\varepsilon_i\varepsilon_j = 0, \forall i \neq j$;
- the dependent variable B_i is a normally distributed random variable.

3 RESEARCH RESULTS AND DISCUSSION

To analyze in this work the number of unemployed aged 15-72 years, we considered the following regions - Belgorod, Bryansk, Vladimir, Voronezh, Ivanovo, Kaluga, Kostroma, Kursk, Lipetsk, Moscow, Oryol, Ryazan, Smolensk, Tambov, Tverskaya, Tula, Yaroslavl and Moscow. The considered areas differ in many respects, however, we hope that the considered approach can be universal when studying the problem of unemployment, regardless of the region of the Russian Federation. In our work, we analyzed the influence of employee wages, population size, growth in highly productive jobs, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration growth of the population on the growth rate of the number of unemployed in all regions of the Central Federal District. Based on the assessment of the tightness of the relationship between the studied parameters (Table 1) and the rated values of the significance level and the Student's test ($p = 0.05; t_{tab} = 2.045$), it can be argued that some coefficients were insignificant. As a consequence, these factors must be excluded from the list of dependent variables for the study areas.

An assessment of the data obtained indicates that in the Belgorod region, among the parameters under consideration, the largest influence on unemployment is exerted by the population size and the increase in highly productive jobs. For the Belgorod region, the value of the correlation coefficient is $r = 0.961$, in the case of paired regression, the coefficient of determination is equal to the square of the correlation coefficient, $R^2 = 0.924$. Its value suggests that 92.4% of changes in wages of workers, population size, increase in high-productivity jobs, the cost of a fixed set of consumer goods and services, and migration population growth are explained by regression, and

7.6% - by the influence of other factors. The t-statistic criterion used to assess the statistical significance indicates that the equations obtained for the Central Federal District in Table. 1 are highly significant. The parameter - the age composition of the population over the working age - turned out to be insignificant for the Belgorod region. In the Bryansk region, the results showed that unemployment is most influenced by the size of the population and the age composition of the population over the working age. For this region, 93.4% of changes in workers' wages, population size, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration growth of the population is explained by regression, and 6.6% - by the influence of other factors. The parameter, the growth of highly productive jobs, turned out to be insignificant for this area. In the Vladimir and Voronezh regions, the situation is as follows, unemployment is most influenced by the size and age composition of the population. For the Vladimir region, 79.4% of changes in the wages of workers, the population size, the increase in high-productivity jobs, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration population growth are explained by regression, and 20.6% - by the influence of other factors. For the Voronezh region, 76.0% of the change in wages of workers, the population size, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration growth of the population is explained by regression, and 24.0% - by the influence of other factors. In the Voronezh region, the parameter turned out to be insignificant - the increase in highly productive jobs. In the Ivanovo region, the results showed that the number of unemployed is most influenced by the age composition and population, as well as the increase in highly productive jobs. For the this region, 72.5% of changes in the wages of workers, the population size, the increase in high-productivity jobs, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration population growth are explained by regression, and 17.5% - by the influence of other factors. In the Kaluga region, the situation is as follows, unemployment is mainly influenced by the size and age composition of the population. In this area, 80.7% of the change in the studied parameters is explained by regression, and 19.3% - by the influence of other factors. At the same time, despite the fact that in the Kostroma and Kursk regions, the obtained equations (Table 1) also have a high degree of

significance (p-level significance level <0.05), in this case, the growth of workers' wages and population growth is very well have little effect on reducing the unemployment rate. In the studied regions, 87.2% and 88.1% of the changes in the studied parameters are explained by regression, and 12.8% and 11.9% are explained by the influence of other factors, respectively. The parameters turned out to be insignificant in these areas - the growth of highly productive jobs and the cost of a fixed set of consumer goods and services. In the Lipetsk region, the results showed that the factors under consideration have a weak influence on the number of unemployed ~ 29.6%, and 70.4% are influenced by other factors. In the Moscow, Oryol and Ryazan regions, unemployment is most influenced by the size of the population and the age composition of the population over the working age. For these regions, 83.6%, 88.5%, 91.4% of changes in the wages of workers, the population size, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration population growth are explained by regression, and 12, 4%, 11.5%, 8.6% - by the influence of other factors, respectively. In the Moscow and Ryazan regions, the parameter turned out to be insignificant - the increase in highly productive jobs, in the Oryol region - the cost of a fixed set of consumer goods and services. In the Smolensk and Tver regions, the data obtained showed that the parameters under consideration have a weak effect on the number of unemployed ~ 39.1% and 28.6%, respectively, and 60.9% and 71.4% are influenced by other factors, respectively. In the Tambov region, the number of unemployed is mainly influenced by the following factor - the age structure of the population over the working age. In this area, 78.0% of the change in the studied parameters is explained by regression, and 22.0% - by the influence of other factors. In the Tula region, the results showed that unemployment is most influenced by the size of the population and the age composition of the population. For this region, 84.9% of changes in workers' wages, population size, the cost of a fixed set of consumer goods and services, the age composition of the population over the working age and migration growth of the population is explained by regression, and 15.1% - by the influence of other factors. The parameter, the growth of highly productive jobs, turned out to be insignificant for this area. For the Yaroslavl region and Moscow, the data obtained showed that the unemployment rate, changes of the wages of workers, the population size, the growth of highly productive jobs, the cost of a fixed set of consumer goods and

services, the age composition of the population over the working age and migration growth of the population, has little effect.

Based on the data obtained over the past 30 years, regression models were built for the Central Federal District, revealing the relationship between the wages of workers (X_1), the size of the population (X_2), the increase in highly productive jobs (X_3), the cost of a

fixed set of consumer goods and services (X_4), the age composition of the population over the working age (X_5), the migration growth of the population (X_6) and the growth rate of the number of unemployed (Y) in all regions of the Central Federal District (Table 3). In general, the regression model can be written as follows: $\hat{Y} = b_0 + b_1 \cdot X_1 + b_2 \cdot X_2 + b_3 \cdot X_3 + b_4 \cdot X_4 + b_5 \cdot X_5 + b_6 \cdot X_6$.

Table 1: Regression model describing the relationship between the unemployment rate and the factors under consideration in the Central federal district.

Belgorod region	$Y = -54.41 + 0.003 \cdot X_1 + 0.72 \cdot X_2 - 0.087 \cdot X_3 - 0.003 \cdot X_4 - 0.001 \cdot X_6$
Bryansk region	$Y = -597.676 - 0.01 \cdot X_1 + 0.489 \cdot X_2 + 0.008 \cdot X_4 - 0.275 \cdot X_5 - 0.002 \cdot X_6$
Vladimir region	$Y = -3971.02 - 0.001 \cdot X_1 + 2.07 \cdot X_2 + 0.2 \cdot X_3 + 0.01 \cdot X_4 - 1.4 \cdot X_5 + 0.01 \cdot X_6$
Voronezh region	$Y = 4301.6 - 0.009 \cdot X_1 - 2.753 \cdot X_2 + 0.002 \cdot X_4 - 4.668 \cdot X_5 + 0.003 \cdot X_6$
Ivanovo region	$Y = 46.247 - 0.001 \cdot X_1 - 0.251 \cdot X_2 - 0.033 \cdot X_3 - 0.002 \cdot X_4 + 1.149 \cdot X_5 - 0.008 \cdot X_6$
Kaluga region	$Y = -464.761 - 0.001 \cdot X_1 + 0.585 \cdot X_2 - 0.035 \cdot X_3 + 0.001 \cdot X_4 + 0.592 \cdot X_5 - 0.001 \cdot X_6$
Kostroma region	$Y = 205.949 - 0.003 \cdot X_1 - 0.068 \cdot X_2 - 0.399 \cdot X_5 + 0.003 \cdot X_6$
Kursk region	$Y = -133.01 + 0.001 \cdot X_1 + 0.225 \cdot X_2 - 0.458 \cdot X_5 - 0.001 \cdot X_6$
Lipetsk region	$Y = -126.992 - 0.002 \cdot X_1 - 0.001 \cdot X_6$
Moscow region	$Y = -2626.49 + 0.001 \cdot X_1 + 2.55 \cdot X_2 + 0.001 \cdot X_4 + 2.99 \cdot X_5 - 0.001 \cdot X_6$
Oryol region	$Y = -1091.05 - 0.008 \cdot X_1 + 0.83 \cdot X_2 + 0.05 \cdot X_3 + 0.59 \cdot X_5 - 0.007 \cdot X_6$
Ryazan region	$Y = -616.668 - 0.002 \cdot X_1 + 0.46 \cdot X_2 + 0.005 \cdot X_4 + 1.067 \cdot X_5 - 0.003 \cdot X_6$
Smolensk region	$Y = -244.868 + 0.001 \cdot X_1 + 0.257 \cdot X_2 - 0.161 \cdot X_3 + 0.003 \cdot X_4 + 0.009 \cdot X_5 - 0.002 \cdot X_6$
Tambov region	$Y = 1146.007 - 0.002 \cdot X_1 - 0.385 \cdot X_2 - 0.014 \cdot X_3 + 0.002 \cdot X_4 - 1.823 \cdot X_5 + 0.002 \cdot X_6$
Tver region	$Y = 18.979 - 0.002 \cdot X_1 + 0.002 \cdot X_2 + 0.027 \cdot X_3 + 0.004 \cdot X_4 - 0.025 \cdot X_5 + 0.001 \cdot X_6$
Tula region	$Y = -2777.26 - 0.01 \cdot X_1 + 1.65 \cdot X_2 + 0.007 \cdot X_4 + 2.16 \cdot X_5 + 0.008 \cdot X_6$
Yaroslavl region	$Y = 180.828 + 0.006 \cdot X_1 + 0.133 \cdot X_2 - 0.024 \cdot X_3 + 0.002 \cdot X_4 - 1.024 \cdot X_5 - 0.005 \cdot X_6$
Moscow	$Y = -559.799 - 0.001 \cdot X_1 + 0.101 \cdot X_2 - 0.01 \cdot X_3 + 0.014 \cdot X_4 - 0.225 \cdot X_5 + 0.001 \cdot X_6$

Economic sanctions, the crisis, restrictions on access to the global market have led to the fact that our country has already learned to live in difficult economic conditions. However, new unfavorable conditions that have seized the whole world, such as the coronavirus infection COVID-2019 and the collapsed oil price in the oil market, may lead to an increase in the number of unemployed in the Russian Federation and in particular in the Central Federal District. Therefore, it is very important to make a forecast of the distribution of the number of

unemployed in the considered district. Further, applying the rated estimates, we obtained the final forecast of the distribution of the number of unemployed in the Central Federal District for 2020. The obtained calculations (Table 2) showed that the average error of the predicted data for the period - 2017 is 4.6% and for 2019 - 6.1%, such results indicate that the considered correlation and regression analysis, the number of unemployed, predicts well the observed values.

Table 2: Results of the final forecast distribution of the number of unemployed in the Central federal district.

Region	Number of unemployed, thousand people			Forecast of the number of unemployed, thousand people			Forecasted data error	
	2017	2019	2021	2017	2019	2021	2017	2019
Belgorod region	32.1	31.9	-	33.1	34.1	37.2	3.1	6.9
Bryansk region	27.0	22.5	-	28.5	22.9	26.3	5.6	1.8
Vladimir region	35.3	29.0	-	34.4	30.8	33.4	2.5	6.2
Voronezh region	51.2	41.9	-	53.4	42.8	50.1	4.3	2.1
Ivanovo region	25.4	19.5	-	26.1	21.3	24.3	2.8	9.2
Kaluga region	21.6	19.8	-	23.5	20.6	22.6	8.8	4.0
Kostroma region	17.3	12.6	-	18.0	14.2	19.3	4.0	12.7
Kursk region	23.5	22.5	-	25.0	23.2	24.2	6.4	3.1

Table 2: Results of the final forecast distribution of the number of unemployed in the Central federal district (cont.).

Region	Number of unemployed, thousand people			Forecast of the number of unemployed, thousand people			Forecasted data error	
	2017	2019	2021	2017	2019	2021	2017	2019
Lipetsk region	23.1	22.3	-	22.6	23.9	24.9	2.2	7.2
Moscow region	130.3	113.9	-	134.1	118.2	130.5	2.9	3.8
Oryol region	24.6	18.5	-	25.6	20.3	24.5	4.1	9.7
Ryazan region	22.0	21.1	-	23.1	22.6	26.3	5.0	7.1
Smolensk region	29.8	25.3	-	31.2	26.8	32.5	4.7	5.9
Tambov region	22.5	19.6	-	23.6	21.3	23.9	4.9	8.7
Tver region	31.0	26.7	-	33.0	28.6	30.9	6.5	7.1
Tula region	30.7	29.9	-	32.1	30.9	33.2	4.6	3.3
Yaroslavl region	44.1	35.0	-	45.9	37.2	42.9	4.1	6.3
Moscow	99.6	99.5	-	106.1	104.1	110.4	6.5	4.6
mean error of forecasted data, %							4.6	6.1

4 CONCLUSIONS

Thus, in this work, a forecast of the distribution of the number of unemployed in the regions of the Central Federal District for 2021 is made and the average error of the predicted data is rated. The obtained results of the regression model showed that in these regions there is a tendency for the disproportion of regional development. These results indicate that a new regional policy is needed in the Central Federal District, which will make it possible to implement and find solutions to reduce the number of unemployed. This can be achieved by developing new socio-economic mechanisms, thanks to which the considered regions of the Central Federal District will be able to more fully realize and sustainably develop their economic, cultural, educational, industrial and scientific and technical potential.

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