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MODELING AND FORECASTING THE NUMBER OF THE EMPLOYED IN AGRICULTURE IN RUSSIA UNTIL 2020

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Abstract

The purpose of this study is to assess the impact of individual areas of the agrarian policy on changes in the parameters of agricultural employment in the Russian Federation. The paper presents a quantitative analysis of the dependence of employment in the Russian agriculture from the changes in production volumes and dynamics of investments in fixed assets set out in the State Program for Agricultural Development and Regulation of the Markets for Agricultural Products, Feedstock and Food for 2013-2020. The authors carry out predictive modeling of the number of the employed in the Russian agriculture using the parameters of development of the agriculture laid down in the state program and assess the social-economic consequences of the current agrarian policy for the sphere of agricultural employment in Russia. The results show that if the targets set out in the State Program for Agricultural Development are attained, by 2020 the agriculture's need for labor will drop by 2.4-5.5%, and the degree and rate of this reduction will depend on the trends that will prevail in the forecast period. Decrease in the number of agricultural workers due to technological modernization reasons could be offset by creating new agricultural and non-agricultural jobs. These new segments of employment could include organic agriculture, biofuel production, deep processing of agricultural products and development of the production, transport, financial and social infrastructures and services. Intensive development of primary, secondary and deep processing of agricultural products could give impetus to both rural communities and small towns. The results of this study could be used in rural development strategies.

Key words: *agricultural employment, forecasting, modeling, state agricultural programs*

Introduction

The agro-food complex and its key branch – agriculture – form the basis of the Russian agrarian economy, ensuring food security, on the one hand, and shaping the rural employment and settlement pattern, on the other hand. The growing global demand for quality food and agricultural products urges the Russian agro-food complex to expand its production. In view of this, the Government of RF approved the State Program for Agricultural Development and Regulation of the Markets for Agricultural Products, Feedstock and Food for 2013-2020 by a special decree. According to this Program, the major priorities are to ensure food independence of the country, modernize the agrarian economy through the use of modern technology, create conditions for sustainable development of rural areas, increase the employment rate, and improve the quality of life of the citizens [State Program, 2012]. Agrarian policies are one of the factors of forming long-term agricultural employment trends. It is therefore important to know how the agrarian sector's demand for labor will change, if the tasks set out in the Program are fulfilled. This question can be answered through analyzing the key trends on the basis of medium-term forecasting, which allows expand the time horizon for the social-economic analysis of agrarian policy achievements.

The purpose of the study is to perform forecast modeling of agricultural employment with taking into account the changes in agricultural production and investment in fixed assets set out in the State Agriculture Development Program for 2013-2020. The object of our forecasting is the number of the population employed in agriculture, hunting and forestry in RF (hereinafter – the number of the employed in agriculture). The methodological basis of the medium-term forecasting is the modeling that describes the system of interrelationship and interdependence of the key parameters. Since the demand for labor is derived, we made an econometric assessment of the dependence of agricultural employment from changes in production and investments in fixed assets. Forecast modeling is an important research tool, allowing evaluate the decisions made, identify the risks, opportunities and problems that are difficult to detect by a retrospective analysis (Ksenofontov, 2002).

Medium-term forecasting of the number of the employed in agriculture until 2020 enables to:

- Identify the different degree of impact of individual social-economic parameters on the dynamics of agricultural employment;
- Trace the adaptation of the rural employment sphere to the new conditions of technological and social-economic development, changes in the situation with investments and production growth;
- Assess the social-economic consequences of implementing the priority agrarian policy measures for the sphere of rural employment;

Materials and methods

Our forecasting of agricultural employment until 2020 is based on analyzing the trends and relationships of the number of workers on the one hand, and the volumes of production and investment in fixed assets, on the other hand. For the forecasting purposes we used econometric models of employment in economic sectors that establish relationships between its dynamics and basic economic parameters. When modeling, as explanatory variables we selected the parameters, whose forecast values are set out in the State Program for Development of the Agriculture until 2020: the gross value added (GVA) and the amount of investments in fixed assets. The data for our forecast calculations was obtained from official publications of the Federal State Statistics Service (Rosstat) [Rosstat, 2012].

Values of the indicators measured in monetary terms (gross value added and investment) were revalued by direct deflation in prices in 2010. The amount of investment in fixed assets was included in the model with a retarded one-year lag. The resulting dynamic series of the selected indicators were logarithmed and used in the construction of our econometric models. The initial data for the analysis is presented in Table 1.

Table 1 – Initial data for econometric calculations

Year	Number of the employed in agriculture, thousand people	Investments in fixed assets, billion RUR	Gross value added, billion RUR
1998	8963	188,9	322262
1999	8738	147,9	431853
2000	8996	130,9	496806
2001	8509	137,3	606362
2002	8229	160,8	692006
2003	7796	189,3	835448
2004	7430	190,4	861598
2005	7381	213,5	933770
2006	7141	233,7	1332368

2007	6925	334,2	1397157
2008	6675	441,9	1482188
2009	6733	436,6	1633300
2010	6656	341,0	1473237
2011	6583	303,8	1706008
2012	6515	336,6	1625826

A retrospective analysis showed that the number of the employed in agriculture, forestry and hunting had been on the decline, having dropped by 27.3% (1998-2012). The amount of gross value added, calculated in comparable prices, was augmenting, with the exception of 2010 – a year of abnormal weather conditions. The amount of investment in fixed assets, in comparable prices, was on the steady rise until the 2008 crisis: the global financial-economic crisis was one of the causes for this parameter to decrease between 2009 and 2012. Nevertheless, during the entire reporting period the amount of investment in fixed assets generally grew. Thus, the growth of the selected factors of agricultural development between 1998 and 2012 is accompanied by a decrease in the number of population engaged in this activity. The anticipated dynamics of these parameters of agricultural development in 2013-2020 set out in the State Program is presented in Table 2.

Table 2 – Forecasted parameters of agricultural development, % of the previous year [State Program]

#	Parameters	2015	2016	2017	2018	2019	2020
1	Agricultural production index for all categories of farms (in comparable prices)	102,7	103,1	101,9	101,9	101,9	101,9
2	Index of physical volume of investment in agricultural fixed assets	104,2	104,3	104,5	104,8	104,9	105,0

It is assumed that the factors determining the development of agriculture in Russia include increasing global demand for food, increasing internal and external demand for quality food, increasing the export potential of regional agriculture and food industry in Russia, the implementation of the import substitution strategy based on domestic demand, household incomes, quality and environmental safety of food, increasing demand for biofuels, and the expansion of non-food use of agricultural raw materials. In addition, the most important factors are the introduction of innovative technologies, modernization of machinery and equipment in agriculture and food processing industry, and the growth of labor productivity. The predicted growth of agricultural investments will expand the use of modern technologies. It should be emphasized that the projected rate of growth of labor productivity is higher than the rate of growth of production, which means that the demand for agricultural labor will inevitably drop. Many leaders of enterprises today keep excessive number of workers to maintain social stability, because the number of jobs in rural areas is limited. But this leads to lower productivity of labor and reduces its motivation. This paper represents one of the stages of studying the impact of economic policy measures on the parameters of employment in the Russian agriculture (Blinova and Bylina, 2011).

Results and discussion

For the purposes of our study we built multifactor and single-factor models characterizing the dependence of the number of the employed in agriculture, forestry and hunting on each of the factors separately and their combinations. Statistical parameters of the obtained models are presented in Table 3. The forecasting capabilities of our models were checked by making a retrospective forecast with the use of existing dynamic data (1998-

2012). The following abbreviations are used: L – number of the employed in agriculture and forestry; Y – gross value added (GVA); I – investments in fixed assets of the industry.

Table 3 – Statistical evaluation of regression dependencies of agricultural employment on the parameters of development of the Russian agriculture

Model 1

Variable	Coefficient	Std. Error	t-Statistic	Sig.
Const	11,87	0,189	62,71	1,59E-17
Ln Y	-0,215	0,014	-15,6	8,52E-10

R-squared	Adjusted R-squared	Std. Error of the Estimate	F Change	Sig. F Change
0,949	0,945	0,028	243,26	8,524E-10

Durbin-Watson statistic	Std. Deviation Predicted Value	Sum of Squares Residual	Average relative error, %
1,27	0,116	0,010	1,86

Model 2

Variable	Coefficient	Std. Error	t-Statistic	Sig.
Const	10,347	0,191	54,30	1,03E-16
Ln I	-0,261	0,035	-7,49	4,54E-06

R-squared	Adjusted R-squared	Std. Error of the Estimate	F Change	Sig. F Change
0,812	0,798	0,054	56,2	4,54E-06

Durbin-Watson statistic	Std. Deviation Predicted Value	Sum of Squares Residual	Average relative error, %
0,69	0,107	0,038	3,5

Model 3

Variable	Coefficient	Std. Error	t-Statistic	Sig.
Const	11,609	0,178	65,18	1,13E-16
Ln Y	-0,164	0,027	-2,86	0,014
Ln I	-0,078	0,021	-7,92	4,18E-06

R-squared	Adjusted R-squared	Std. Error of the Estimate	F Change	Sig. F Change
0,970	0,965	0,022	192,65	7,59E-10

Durbin-Watson statistic	Std. Deviation Predicted Value	Sum of Squares Residual	Average relative error, %
1,40	0,118	0,006	1,58

Model 1 has a sufficiently high quality of approximation determined by the coefficient of determination: the resulting model describes 94.5% of the variation of the independent variable. The value of the Fisher’s F-criterion that characterizes the reliability of the regression equation as a whole is also very high, amounting to 243.26, and the probability of obtaining this value by chance does not exceed the acceptable level of significance of 5%. The standard deviation of the estimation that characterizes the deviation of the residuals from the approximating line is significantly below the standard deviation of the dependent variable, which also indicates a fairly high quality of the model. The coefficients of the obtained dependency are statistically significant at the 5% level by the Student’s test, as the r-values are close to zero. The values of t-statistics for the variables point at the importance of these parameters in the model. According to the retrospective forecast made with the model, between 1998 and 2012, with a real 4-times growth of production, the calculated number of the employed in agriculture and forestry dropped by 29.3%, which is by 2% higher than the actual data. Thus, this model can be considered adequate.

The parameters of Model 2 show a much worse quality of approximation. The value of the Fisher’s F-criterion is much lower, the Durbin-Watson coefficient is quite low, and the average relative error is much higher.

Model 3 has the best quality of approximation, as evidenced by its statistical characteristics. The reduction of the number of the employed calculated with Model 3 in the reviewed period differs from the actual reduction by 1.1%.

So, Models 1 and 3 are the most appropriate for forecasting. Nevertheless, to make our forecasting of the number of the employed in the Russian agriculture more informative, we used all our models.

The forecast modeling made it possible to (1) assess the quantitative relationship between the number of the employed in agriculture and the parameters of growth of production and investment in fixed assets; (2) measure the degree of closeness of the connection between the effective and the factor variables; (3) identify the form of this connection and analyze the aggregate impact of the factor variables. The results show that agricultural employment is likely to reduce, and the scope and rate of this reduction will depend on the trends that will prevail over the forecasting period. According to our estimates, between 2012 and 2020 the decrease in the number of the employed in agriculture and forestry will make: 2.4% in Model 1 describing the dependency of the number of the employed on the amount of production; 5.5% in Model 2 depicting the dependency of the number of the employed on the amount of investments in fixed assets; 3.9% in Model 3 representing the dependency of the number of the employed on the amount of production and the amount of investments in agricultural fixed assets. It should be mentioned that with the introduction of modern agricultural technologies the demand for skilled labor will increase, accompanied with a decrease in the contribution of those economic activities that do not require professional education and skills. The forecasted dynamics of the number of the employed in agriculture and forestry is presented in Figure 1. We have not estimated the impact of labor productivity growth, however, its endogenous impact causing the number and fraction of the employed in agriculture to reduce is embodied in investments in new technologies. If, during the forecasting period, the rates of labor productivity growth lag behind the amounts of production, the demand for labor may grow. If the rates of growth of production and labor productivity are more or less similar, the number of the employed in agriculture is likely to remain on the same level.

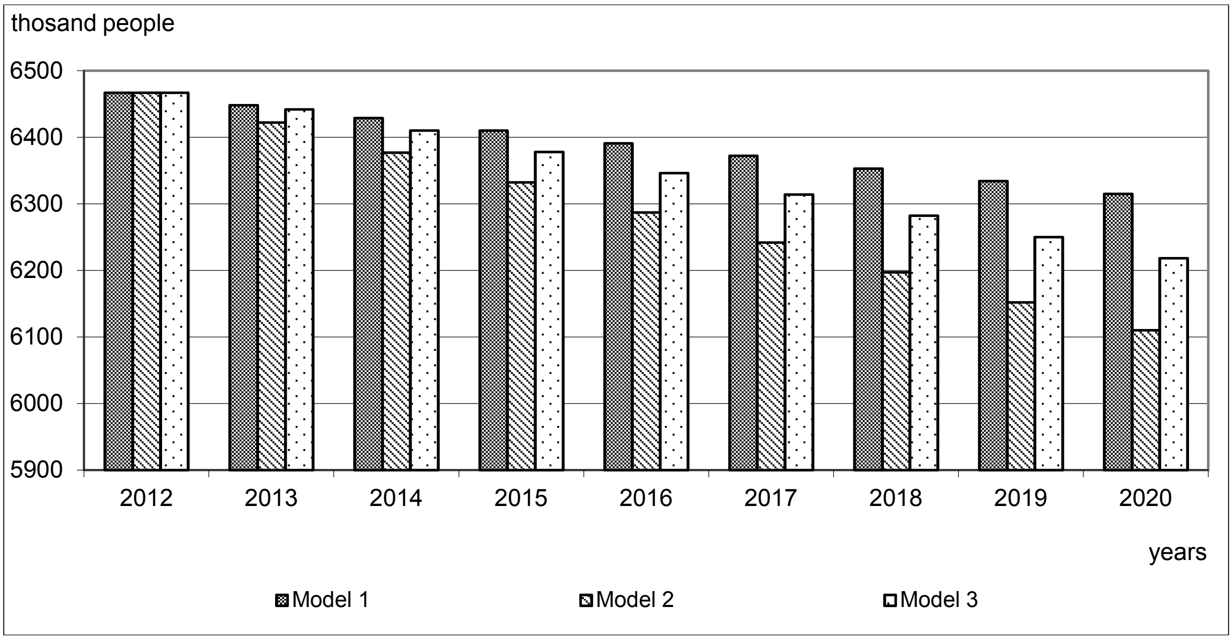

Fig. 1 – Forecast of the number of the employed in the agriculture and forestry of RF

The introduction of labor-saving technologies leads to elimination of inefficient and low paid jobs and reduction of redundant and informal employment that exerts inflationary pressure on the agrarian economy. At the same time, in the short term there may be an increase in rural unemployment, which is more durable than urban unemployment, thus creating the background for social tension. Particular attention should be paid to the fact that the aforementioned public policy measures are being implemented in the conditions of Russia's membership in the World Trade Organization (WTO), which bears additional risks of job losses and employment decline.

To our opinion, an important strategic task is to diversify the agrarian economy through promoting non-agricultural activities, creating an up-to-date production and social infrastructure and improving the functional diversity of rural areas. The role of non-agricultural employment in rural development was discussed by many authors (Bezemer and Davis, 2003, Davis, J.R., Bezemer, D.J., et al., 2004 and others). Responding to the new challenges facing the agricultural sector of Russia implies (1) consolidation of the agricultural policy's social functions and (2) diversification of the employment pattern and sources of income of the population to facilitate sustainable rural development.

Conclusion

An important tool for system analysis of rural employment is the medium-term forecast of the number of agricultural workers reflecting the outcome in particular areas of the public agricultural policy. Forecast modeling allows assess the possible social implications of agrarian policy for the sphere of employment, compare the different options of influence and provide sound advice on choosing the most efficient development strategy. The forecast assessment we made specifies and clarifies the nature of the interrelationship between the dynamics of agricultural employment in the medium term and some individual economic parameters reflecting the directions of the agrarian transformations outlined in the State Program for Agricultural Development and Regulation of the Markets for Agricultural Products, Feedstock and Food for 2013-2020. It is shown that despite the increase in production and investment in agricultural fixed assets projected in the State Program until 2020, if labor productivity grows, the demand for labor may still decrease by 2.4% - 5.5%. To our opinion, it is essential to increase the role of non-agricultural employment and expand the range of recreational, touristic, environmental, social, ethnic and cultural functions of the countryside, which will allow diversify the sphere of application of labor and make the rural areas more attractive for both business and households.

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