

Justification of Promising Areas of Development and State Support of Agricultural Industry Using the Cobb-Douglas Model

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Abstract — The agricultural industry of many countries is traditionally supported by government in order to ensure food security and maintain good public health. According to the authors of the article, state support is often provided without a formal statistical assessment of the consequences of such investments, without counting and justification of the increase in output in the subsidized industry due to state support. The authors constructed a model of the production function, which can be used to predict the development of agriculture, and assess the increase in output as a result of state support. In addition, this model can be used to forecast output in the context of a demographic reduction of workers involved in agriculture.

Keywords — *agro-industrial complex, agriculture, Cobb-Douglas model, production function, Kursk region, government support, government regulation.*

I. INTRODUCTION

The agro-industrial complex and its basic branch – agriculture are one of the most important system-forming spheres of the economy of the Kursk region. Its development determines the formation of the agri-food market, the labor and settlement potential of rural areas and ensures food and economic security of the region. Agriculture occupies a significant share in the structure of the gross regional product (GRP) of the Kursk region. The share of agriculture in the structure of GRP in 2018 was 18.1 % (for comparison, the share of manufacturing was 16.9 %). Moreover, in the long-term retrospective, the share of agriculture in the economy of the Kursk region is slowly but almost continuously growing.

The modern agricultural industry is a complex, multi-specialized system. It includes various branches of crop production, animal husbandry, as well as partial processing and storage, while it includes both large and largest complexes, as well as medium and small enterprises, peasant farms and households.

Worldwide the agricultural industry is considered to be strategic, forming national security, affecting the health and well-being of the population. This circumstance, as well as the risk component of the agricultural sector, which in many respects depends on the climatic circumstances of the particular production season, determine the special situation of the agricultural sector and form the protectionist policy of the state. For example, in the European Union, 42.5 % of the

budget of 166 billion Euros is allocated to ensure a common agricultural policy of the European Union, the development of rural territories and environmental concerns¹. This is apart from the high level of support of each of the countries.

In the Russian Federation in 2019, state support alone in the amount of 318 billion rubles was provided from the federal budget in the framework of the State Program for the Development of Agriculture². The task of this research was to clarify the relationship between investment in the industry and agricultural output.

The subject and purpose of this research were to build a production function by the type of economic activity in agriculture for enterprises of the Kursk region. In order to build the production function, the methods of correlation and regression analysis were used, followed by the study of model adequacy. In further studies, we plan to use the production function model to plan output growth by type of economic activity in “agriculture”, as well as to assess the balance of scheduled documents, development strategies of the Kursk region according to the factors “investment – output growth” and justification of suggestions for the enhancement of state support mechanism and directions of state regulation.

II. RESULTS AND DISCUSSION

Nowadays certain positive trends are observed in the development of the industry: gross agricultural output is growing despite the unfavorable conditions of individual years, the financial and economic conditions of agricultural organizations are improving, large agricultural enterprises are developing, the share of regional agricultural products is growing, which is being sold at the consumer market.

The dynamics of agricultural production (in actual current prices in millions of rubles) and production indices (in comparable prices, as a percentage of the previous year) in various categories of farms in the Kursk region are presented in Figure 1.

¹https://ru.wikipedia.org/wiki/%D0%91%D1%8E%D0%B4%D0%B6%D0%B5%D1%82_%D0%95%D0%B2%D1%80%D0%BE%D0%BF%D0%B5%D0%B9%D1%81%D0%BA%D0%BE%D0%B3%D0%BE_%D1%81%D0%BE%D1%8E%D0%B7%D0%B0

²https://www.minfin.ru/common/upload/library/2020/03/main/Ispolnenie_FB_RF_za_2019_god_predv.itogi.pdf

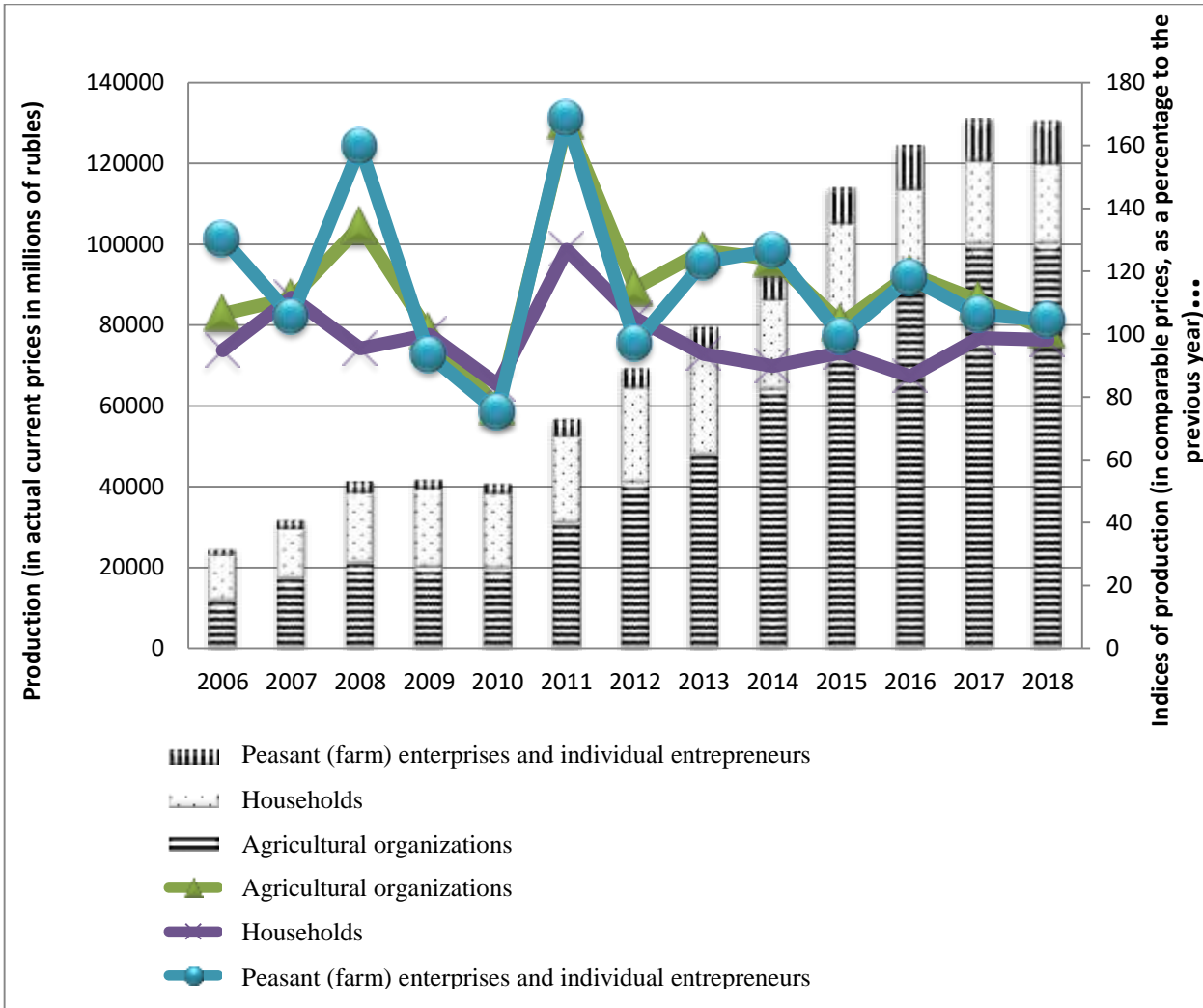


Fig. 1. Dynamics of agricultural production (in actual current prices in millions of rubles) and production indices (in comparable prices, as a percentage of the previous year) in the Kursk region

In general, the figure shows the positive growth dynamics of production the analyzed period from 24,158 million rubles in 2006 to 130.9 million rubles in 2017. At the same time, this significant growth was not stable and dynamic. In 2009, the increase was relatively small, and in 2010 and 2018 there was a decrease of 928.9 million rubles and 520.0 million rubles, respectively.

The structure of production growth shows that this increase occurred in all categories of farms, but the production in agricultural organizations most significantly increased – from 11568.4 million rubles in 2006 to 99993.6 million rubles in 2018, or by 82933, 3 million rubles (almost 9 times), while production in households increased from 11260.7 million rubles to 19502.1 million rubles, or by 7280.5 million rubles (1.7 times), and the production of peasant farms and individual entrepreneurs increased by 8714.4 rubles.

This dynamics led to the increase in the share of agricultural organizations in the agrarian sector of the Kursk region from 47.9 % in 2006 to 76.7 % in 2018 with a significant decrease in the share of households. If in 2006 they

produced almost half of all products (46.6 %), then in 2018 the produced only 15.0 %. The share of peasant farms and individual entrepreneurs also increased from 5.5 % in 2006 to 8.3 % in 2018, but their production volumes and market share were two times lower than households.

This dynamics allows drawing a conclusion about the development of the agricultural sector in the Kursk region along the path of industrialization with a concentration of production in agricultural organizations with the decrease in the role but still high production volumes in households with the simultaneous low-speed development of peasant farms. These trends are manifested both in crop production and in animal husbandry. Moreover, in the livestock industry they are more pronounced due to the specifics of the organization of production.

The decelerating growth rates in the agricultural sector revealed during the statistical analysis are aggravated by a number of problems that need to be addressed to ensure the strategic long-term development of the agro-industrial complex. They include the low level of technical and

technological equipment of agricultural organizations, limited access to retail sales in the context of increasing monopolization of retail chains, the need to maintain the pace of socio-economic development of rural areas in order to prevent the outflow of the population and to retain young specialists in villages, insufficient readiness of agricultural producers to carry out activities in the context of harmonization of domestic and world technological standards for the production and processing of agricultural products [1].

It is necessary to note that although growth since 2000 is based largely on new technologies because it is associated with high growth rates of labor productivity in agricultural enterprises (4–5 % per year), however, the technological level in many sectors remains low, significantly lower than in developed countries.

As it was noted in the introduction, the purpose of this work is to build a production function for agricultural enterprises of the Kursk region. This research was carried out on the basis of classical economic theory. To ensure the effective organization of the production process and stable development of the agricultural sector, the certain amount of production factors are necessary. In order to analyze this dependence, we used production functions – these are regressive models showing the relations between the amount of manufactured products and the amount of resources used.

The construction and interpretation of production functions, that is, the identification of actual relations in production, is one of the most important econometric tasks. The model of the production function can have a different form. The most famous and frequently used form is the Cobb-Douglas Model. This model can be modified, new factors can be added or the original ones can be modified.

The choice of this function in the framework of this research is also reasoned by the fact that the main part of the problems in the development of the industry and decisions made at the state level for its support and development are somehow related to capital and labor factors [8]. In the classic version, the formula is as follows:

$$Y = A * K^a * L^b \quad (1)$$

where Y – output, that is, gross domestic product, gross regional product (when constructing a function at the regional level), or gross value added (GVA), if we are talking about some industry or a type of economic activity (FEA);

K – capital factor, i.e. fixed assets;

L – labor force factor, usually measured as the number of employees;

A – technological coefficient

a and b – model parameters, coefficients characterizing the influence of capital and labor factors.

The technological coefficient, parameters a and b are selected during the construction of the production function based on the used statistical data.

In scientific sources there is no data on models of production functions in the Russian Federation earlier than

before the beginning of the 2000s. We explain this fact by the lack of relevant information which could be used to build economic models in the 90s of the 20th century, and, possibly, the insufficient relevance of such tasks for that time. Such studies appeared in the middle of the first decade of the 21st century [4], when it became possible to trace the dynamic series after market reforms.

According to the research of our colleagues conducted in the years 2010–2012 in the Kursk region, the type of activity of agriculture at that time showed contradictory results that were poorly theoretical.

The increase in investments by type of economic activity in agriculture at that time did not correlate well with the increase in its gross value added, and in some cases showed a negative correlation. The production function, calculated according to dynamic indicators on the basis of investment growth, number and GVA with a good degree of model reliability, had the following form:

$$Q_y = X_k^{-0.173} * X_l^{1.193} \quad (2)$$

where Q_y – the growth rate of gross value added by type of economic activity in “agriculture”

X_k – investment growth rate per year;

X_l – growth rate of employees in the agricultural sector.

As it can be seen from the values in the formula, the author did not construct the classical production function on the absolute values of the data. The production function was built on the basis of a dynamic series according to the method proposed by Kolemaev [3]. It was not possible to build the production function on absolute data for the industry as a whole (in the absence of a base for enterprises). This was because of the lack of panel databases on agricultural enterprises at that time and the need to use the dynamic series for the industry as a whole, with a deflation indicator of the value of fixed assets.

Parameter A (from formula 1) at that time showed three- and four-digit values and overlapped the action and influence of capital and labor factors. The accuracy of the model was not high, and the explanatory possibilities of such a model were small. That is why the authors were forced to modify the model, which in this case did not lose its economic meaning, at the same time, parameter A was removed from the formula.

As it can be seen from formula 2, the factors coefficients look very unusual (at that time, the statistical series was limited to 2004–2011). The increase in gross value added depended entirely on the number factor, and the coefficient was more than 1. This means that the increase in the number of employees by 1 percent brought the increase in GVA from agriculture by more than 1 percent. At the same time, there was a negative dependence of the growth of investments and GVA. In our opinion, it can be explained by the following circumstances.

The implementation of four national projects started on January 1, 2006, which included the project “Development of the agro-industrial complex”. The purpose of these programs

was to concentrate budgetary and administrative resources in the main areas of socio-economic development of the Russian Federation, which should lead to the increase in the quality of life of Russian citizens. The amount of project financing only in 2006-2007 was 34.9 billion rubles (at prices of that period, which are comparable to 120-130 billion of current prices).

The increase in investment in those years was 43 % and 32 % in comparable prices for 2006 and 2007, respectively [7]. It could be described by the term “refinancing”. The industry could not respond to such a significant increase in investment by an instant increase in GVA, since there was some lag in the development and implementation of new equipment and technology. The agricultural sector in this regard, due to the nature of the crop and livestock production being created, the means of production used and the technological processes, has specific and sufficiently long production cycle.

The research statement of our study is that the production function by type of activity in agriculture undergone significant changes, acquired a normal form (without negative factor coefficients) and can be used to analyze and forecast changes in GVA and production volume, that is, to act as the tool for analysis, planning and forecasting.

Using modern databases, we can perform research at a qualitatively new level and using panel data from agricultural enterprises we can calculate a number of production functions in dynamics.

The research was carried out on the basis of the statistical base on agricultural enterprises of the Committee of the agro-industrial complex of the Kursk region. After the removal of zero values in the parameters of economic entities, it included:

- 196 agricultural enterprises of the Kursk region in 2016;
- 201 agricultural enterprises in 2017;
- 214 agricultural enterprises in 2018.

It is necessary to note that the Kursk region is represented by a wide range of agricultural organizations producing a wide range of agricultural products, which gives a sufficient representativeness of the sample of agricultural enterprises in the region for the application of statistical analysis methods, including the construction of the production function. The change in the number of enterprises is reasoned by the fact that not all agricultural enterprises reported on their activities for all three years.

As the resulting (dependent) factor, we took the revenue of agricultural enterprises, as independent, explanatory factors we took the number of employees and the average annual value of fixed assets (initial). In the research process, the residual value of fixed assets was also used, but the calculations reflected similar results, so they were not presented.

The calculation results of the production function for three years are shown in Table 1.

We see from the table, that the type of production function for agriculture has fundamentally changed. We can not compare the constant value that characterizes the combined

effect of all factors unaccounted for in the model on the resulting indicator. In model (2), such a constant value is simply absent, which is the specificity of the calculation of the production function based on growth. However, the value of the constant value of function of 2016–2018 is quite acceptable. With an average revenue of enterprises of 502.6 million rubles in 2018, only 11.12 % is determined by the factors not taken into account in the model, and 89.9 % depend on factors of labor and capital.

TABLE I. PRODUCTION FUNCTION FOR AGRICULTURAL ENTERPRISES OF THE KURSK REGION

Year	Production function	R ²	\hat{F}	Value		$\bar{E}_{rel.}\%$
				α	β	
2016	$Y=29.9*K^{0.47}*L^{0.56}$	0,92	507,2	6,80	10,07	4,72
2017	$Y=77.9*K^{0.40}*L^{0.70}$	0,93	605,1	9,22	12,45	4,95
2018	$Y=55.7*K^{0.44}*L^{0.65}$	0,92	609,6	9,38	10,79	4,98

All the coefficients of the models are significant, the proportion of the rest in the forecasted values does not exceed 4.98 %.

We should pay due attention to the coefficients α for the capital factor and β for the labor factor. The sum of the coefficients α and β in all three models is slightly greater than zero. This shows that the function is no longer linearly homogeneous and does not demonstrate constant returns when the scale of production is changed. With the increase of both factors by 1 %, the revenue of agricultural enterprises increases by more than 1 %, which indicates the beginning of the transition of the agrarian sector to intensive growth, when the growth of system factors gives a total larger increase in the resulting indicator. It is clear that over the years there is some variability in the parameters of the production function.

The trends revealed during the modeling of the production function make allow substantiating both promising management decisions at the level of economic entities and the recommended methods and mechanisms of state regulation and as well as adjusting state regulation programs.

This production function allows scientific substantiation of the change in the priorities of investments in human capital due to their greater significance. Moreover, the general significance during the analyzed period increases. If the coefficient β at the labor factor exceeded the coefficient α at the capital factor in 2016 by 0.09, then in 2017 the difference was 0.3, and in 2018 it was 0.21. This suggestion is especially relevant in view of the fact that the modern state support system is aimed primarily at investments in fixed assets.

III. CONCLUSION

According to the results of the research we can conclude that the economic transformations in the agrarian sector of the Kursk region formed the growth of production potential, but the further effective development of the industry will be determined, first of all, by the development of human capital and the comprehensive development of rural territories as a source of labor resources.

The regression coefficients in the model can be represented as elasticity coefficients, used to directly assess the influence

of factors on the dependent variable value. We see that the role of the investment factor and the factor of capital equipment is quite large. Although the influence of this factor is still less than the number of employees, the coefficient of elasticity for all three years is more than 0.4. It is logical to assume that in the future, with the transition to industrial management methods, the introduction of innovations and digitalization of many processes, the role of capital will increase. Nowadays agricultural enterprises may face a shortage of labor. The decrease of the economically active population in rural areas will also aggravate the current situation.

Along with the improvement of the quality of life, the need to concentrate the efforts of the state on the training of specialists for the agricultural sector becomes obvious. Nowadays existing agricultural enterprises are experiencing a shortage of personnel, and with the decrease of the economically active population in rural areas and the unwillingness of young specialists to work in the agricultural sector in the future, this problem will intensify. Primarily, there is a shortage of agronomists, livestock specialists, and veterinarians. The main reasons why it is difficult to find workers for these positions are related to the low reputation of rural life among the population and especially young people, as well as to the low level of wages. At the level of agricultural organizations, it is also advisable to pay more attention to personnel issues, as a priority in the development of organizations.

Taking into account that the development of the agro-industrial complex is being performed under the conditions of complex geopolitical problems, sanctions and the need to ensure accelerated competitive import substitution, as well as the increase of the export potential of products, food security issues can also be adjusted in accordance with the obtained results. The justification of the suggestion using the proposed production function will make it possible to solve industrial and social problems that have accumulated in the industry and ensure dynamic and effective development of agriculture, improving the living standards in rural areas and the level of self-production of grocery in the region.

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