SJIF Impact Factor 2021: 8.013| ISI I.F.Value:1.241| Journal DOI: 10.36713/epra2016 ISSN: 2455-7838(Online)
EPRA International Journal of Research and Development (IJRD)
Volume: 6 | Issue: 7 | July 2021 - Peer Reviewed Journal

MODELING AND FORECASTING THE DEVELOPMENT OF THE REGIONAL AGRICULTURAL SECTOR BASED ON MULTIFACTORIAL RELATIONSHIPS

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ABSTRACT
The article develops a multivariate econometric model based on the Cobb-Douglas production function, which includes the volume of gross regional agricultural output as an endogenous factor and egzogenic factors that affect the endogenous one. The assessment of the model and carried out its parameters, on the basis of which the forecast determined indicators of the gross regional agricultural output of the Andijan region for 2024.
KEYWORDS: *multivariate analysis, endogenous and exogenous factors, correlation, correlation and regression analysis, gross regional agricultural output, least squares method, regression coefficient, elasticity coefficient, lag expectations, development strategies.*

INTRODUCTION

The basis of statistical analysis of the development of any economic process is to determine what forms of relationships between economic growth and growth factors, which of the factors in this relationship are important and how they differ from other factors.

The interrelationships between economic development and the factors influencing it have the following specific features:

- directions of dependencies;
- temporal features of dependence;
- causality or co-participation of the meaning of dependence, etc. [1].

Today, the outcome indicators of economic processes at the global, macro, meso or micro level and the dependence of factors on them are selected in the form of cost-production in accordance with the degree of influence of factors. Typically, this form of dependence relies on the notion that the outcome factor depends on a single indicator and not many factors. Based on this concept, the economic process is analyzed in a multi-indicator and multi-factor relationship, and the forms of relationships are compared [2].

At the level of regional development of the agricultural sector, the natural-climatic and socio-economic advantages of the regions related to the type of product play an important role as influencing factors.

Within the framework of agrarian reforms, important legal, organizational and economic measures are being taken in our country to develop forms of entrepreneurial activity. In particular, in the Strategy of Agricultural Development of the Republic of Uzbekistan for 2020-2030, the implementation of pilot investment programs to support the development and diversification of entrepreneurship in agriculture, improving the activities of the State Fund for Entrepreneurship Support under the Agency for Small Business and Entrepreneurship Development special attention was paid to [3].

Given the fact that the agricultural sector is one of the main sectors of the economy in the context of the pandemic, which put the world in a difficult economic situation at the end of 2019, the development of economic growth models based on multifactorial models of agricultural development in the regions. is calculated.

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ANALYSIS OF THE RELEVANT LITERATURE

The issues of multifactor analysis and modeling of agricultural production at the meso level have been studied by many local and foreign researchers. In particular, T. Shodiev theoretically and practically studied econometric models of agricultural development [4], R. Alimov studied the peculiarities and laws of economic growth models [2], T. Khakimov theoretically studied mathematical models of economic growth, J. Erkinov [5], A.Asrakulov [6] studied the practical aspects of multifactorial connections in various fields.

Although the above research theoretically studied the macro and meso-factor multivariate analysis of the development of the agricultural sector, to date, the economies of the territorial units of the country have been studied econometrically at the meso-level. level has not been implemented.

ANALYSIS AND RESULTS

The use of costs as a factor of production and the resulting specific relationships between the resulting factor and the factors influencing it are the same for the production model. In the production model, the production process, the factors of production, and the product produced are the basic concepts that are explained on the basis of a purely economic concept. Material and technical indicators are at the heart of the production model in the analysis of product production and factors of production.

Production functions are the modeling of interrelationships such as the volume of output of economic activity, labor and capital expenditure, return on funds, labor productivity. In general, we can give the volume of production in the form of the following function:

$$N = f(F_1, F_2, F_3, \dots, F_n)$$

Where: N - volume of products produced;

$F_{\_1}$, $F_{\_2}$, $F_{\_3}$,…, $F_{\_n}$ - factors influencing production, ie economic growth.

Thus, a function that represents the relationship between the volume of products produced and the factors affecting it, i.e., the production function, can be expressed by the set correlation equation.

In the construction of economic mathematical models, it is said that there is a linear relationship between economic growth (volume of products produced) and the factors that affect it. This assumption is determined by the proportional net coefficient of economic growth and its interdependence, the coefficient of direct expenditure on production. In linear programming models used in economic growth analysis, the volume of products produced and the consumption of factors (resources) are directly proportional.

The use of linear functions of production allows the creation of mathematical models that are practical and easy to construct. But it is a misconception to say that there will be only a linear relationship between economic growth and its factors. Indeed, while there is a linear relationship between economic growth, raw material and fixed capital expenditure, the relationship between labor and fixed capital expenditure is more complex than linear. The development of economic-mathematical models of economic growth analysis and the use of new methods require a deeper and more accurate study of the relationships between growth and its factors.

In many cases, the nonlinear view of economic growth is as follows:

$$N = a_0 \cdot F_1^{a_1} \cdot F_2^{a_2} \cdot F_3^{a_3} \dots \cdot F_n^{a_n}$$

Using this production function, we can determine the impact of each factor on economic growth. Economic growth rates are of two types, in the form of absolute growth rates and relative growth rates.

For each factor of economic growth, the absolute growth rate of economic growth is determined by obtaining a specific product on any factor from the nonlinear view of growth. For example, for the first factor:

$$\frac{\partial N}{\partial F_1} = a_0 \cdot a_1 \cdot F_1^{a_1-1} \cdot F_2^{a_2} \cdot F_3^{a_3} \dots \cdot F_n^{a_n}$$

It is known that economic growth depends on all its factors. The ratio of the specific derivatives obtained by a factor will be a specific normative indicator of the displacement of these factors.

In addition to the absolute rate of economic growth, the relative rate of growth is also of great economic importance. The relative rate of economic growth is the amount by which the percentage of output changes when the consumption of any factor of growth changes by 1%.

The relative rate of growth is determined by multiplying the absolute rate by the ratio of the product produced by any factor (production resource). Its mathematical form is as follows:

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$$\frac{\partial N}{\partial F_1}\cdot\frac{F_1 N}{N}=\frac{\left(a_0\cdot a_1\cdot F_1^{a_1-1}-F_2^{a_2}-F_3^{a_3}\ldots-F_n^{a_n}\right)\cdot F_n}{N}=\frac{a_0\cdot a_1\cdot F_1^{a_1}-F_2^{a_2}-F_3^{a_3}\ldots-F_n^{a_n}}{a_0\cdot F_1^{a_1}-F_2^{a_2}-F_3^{a_3}\ldots-F_n^{a_n}}=a_1$$

The relative rate of economic growth is called the elasticity of production in terms of factor consumption and is usually denoted by E. This means that for any economic growth factor (resource type), the elasticity of production in terms of factor consumption is as follows:

$$E_i=\frac{\partial N}{\partial F_i}\cdot\frac{F_i}{N}=a_1$$

Thus, if the product function produced as an indicator of economic growth is used, the elasticity of consumption has a constant value for all growth factors and is equal to the corresponding regression coefficients. In other words, regardless of the volume of production, increasing the consumption of u-type growth factor (production resource) by 1% increases the volume of output by a_u%.

The sum of regression coefficients determined by the amount of total elasticity (A) will be important in determining the characteristics of the production functions used in the economic growth analysis.

$$A=a_1+a_2+a_3\ldots+a_n$$

If all the factors of economic growth change k times, the amount of output will be as follows:

$$N'=a_0(kF_1)^{a_1}\cdot(kF_2)^{a_2}\cdot(kF_3)^{a_3}\cdot\ldots(kF_n)^{a_n}=k^{a_1+a_2+a_3\ldots+a_n}\cdot F_1^{a_1}\cdot F_2^{a_2}\cdot F_3^{a_3}\ldots\cdot F_n^{a_n}=k^A\cdot N$$

In this case, the values of A = 1, A> 1 and A <1 can be taken.

If A = 1, then multiplying the cost of production by a factor of k will also increase the quantity of products produced by a factor of k, which means that economic growth will increase by the same amount.

If A> 1, a k-fold increase in production costs will result in a k-fold increase in the amount of product produced, leading to a k-fold increase in economic growth.

If A <1, a multiplier of production costs provides a k-fold increase in output, which means that economic growth is reduced by a factor of k.

In addition to the elasticity of production costs in economic growth analysis, there is also a differentiated growth rate that shows the change in the amount of output produced when we multiply the consumption of any factor by one and other factors remain unchanged.

The general method of production factors of analysis is a method of showing how much the quantity of a product changes by 1% change of all factors at the same time.

The elasticity of the reciprocal exchange is determined by the change in the differentiated growth of the factors by 1%.

At the current stage of socio-economic development, the following production functions are often used for factor econometric analysis:

1. Cobb-Douglas production function.
2. The constant elasticity of factors of production is a function of reciprocity (Errow-Cheneri, Minxasa and Solou functions).
3. The function of factors involved in the production of a constant amount (Bruno function).

Production functions were first studied in practice by Ch. Cobb and P. Douglas on the basis of statistics on the U.S. light industry, who proposed the following production function:

$$N=a_0\cdot L^{\alpha}\cdot K^{\beta}$$

Where N is the quantity of product produced;

L is the amount of labor;

K - fixed capital.

At the beginning of the parameters of the equation is assumed a + b = 1. Under this condition, an increase in output leads to the conclusion that economic growth is accompanied by a quantitative increase in labor and capital.

In some industries (energy, metallurgy) the increase in the size of enterprises, increase in labor and capital expenditures has a positive effect, while in many other industries (agriculture, trade, light industry) the expansion of labor and capital expenditures leads to a decrease in efficiency after certain limits. If the condition a + b = 1 is set in determining the parameters of production functions, the network and network groups are divided by the coefficient of elasticity indicating the efficiency of production expansion, if a + b> 1, there is efficiency, if a + b = <1, production an increase in the size of enterprises leads to a decrease in efficiency.

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In addition to increasing the volume of production resources, similar factors will play an important role in economic growth, such as improving equipment and technology, improving the skills of workers, proper organization and management of production.

The results of scientific and technological progress are more widely reflected in the function of the constant elastic interaction of factors of production (Errow-Cheneri, Minxasa and Solou) than other functions.

$$N = a_0 e^{\lambda t}[\delta h^{-p} + (1-\delta)\cdot K^{-p}]^{-\frac{h}{p}}$$

Here h is the total benefit from the factors of production.

The parameter values in the Bruno function, in which the factors are present in a constant amount of production, correspond to the parameter values in the Cobb-Douglas function.

$$N = a_0 \cdot L^{\alpha} \cdot K^{\beta} - mh$$

M in this function is a parameter of imbalance, the value of which represents the extent of the imbalance in the "market" of labor and capital, ie the difference in demand for labor and capital.

Three variants of the above function have been developed by Bruno. All options emphasize that the average productivity of labor is linearly related to wages, and the mathematician gives the following:

$$\frac{N}{h} = cw + d$$

In the first variant of the function, the differentiated productivity of labor and the productivity of fixed assets are determined by the value of one factor of production, and the function takes the following form:

$$N = a_0 \cdot L^{\alpha} \cdot K^{\beta} - mL$$

$$a_1 = \frac{1}{c};\ m = \frac{d}{(c-1)}$$

The second variant of the function of factors participating in production in constant quantities is expressed by Bruno in the following form for a situation where there is no equilibrium in the capital market, the differentiated yield of fixed assets does not correspond to the percentage of rates imposed on it:

$$N = a_0 \cdot h^{\alpha} \cdot K^{\beta} - mL$$

In the econometric analysis of socio-economic development processes, taking into account the above-mentioned multifactorial production functions and the widespread use of their derivative functions, we identify econometric models in the form of multifactorial production functions of the agricultural sector of Andijan region. The identifiable models will help to determine the target forecast indicators for the medium and long term on the basis of determining the direction of management of the factors influencing the development of the agricultural sector of the region and to identify the necessary measures to ensure these indicators.

A multifactor analysis of changes in the volume of regional agricultural production in Andijan region under the influence of key production factors (resources) to the indicator, which is considered an endogenous factor.

Determining the volume of output generated by the regional agricultural sector as the peak of the production function, ie the output factor, the following factors were selected based on expert analysis conducted by the Andijan Regional Department of the Ministry of Economic Development and Poverty Reduction and the Andijan Regional Statistics Department. indicators were selected (Table 1):

X_1 - the volume of investments in the regional economy;

X_2 - the number of people engaged in agriculture in the region;

X_3 is the area under agricultural crops in the area.

Table 1
Indicators of the volume of regional agricultural production and factors influencing its change

Years	The volume of regional agricultural production, bln. sum (*Y*)	The volume of investments in the regional economy, bln. sum (X_1)	Number of people employed in the region's agriculture, thousand people (X_2)	Agricultural area of the region, thousand ha (X_3)
2010	27126,8	16463,7	949,7	1711,4
2011	35196,3	19500,0	1199,6	2264,8
2012	44386,0	24455,3	1490,7	2831,6
2013	55872,8	30490,1	1847,4	3142,1
2014	68032,1	37646,2	2211,9	3601,3
2015	78530,4	44810,4	2509,0	4805,2
2016	97050,0	51232,0	3047,3	5503,5

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2017	118811,0	72155,2	3668,3	6227,8
2018	150889,8	124231,3	4578,5	7300,2
2019	190356,0	189924,3	5768,2	8963,7

If we consider the essence of the indicators of endogenous factor and exogenous factor influencing it, the factors influencing it are divided into those with a close relationship to the model in the form of a production model based on indicators of capital, labor and land resources. The data in the form of the above time series were analyzed using EViews10 software in order to identify the changing trends occurring on the basis of a combination of isolated key endogenous and exogenous factors.

The parameters identified in the regression analysis using the Eviews10 software package, as well as the importance of the model, were assessed using key evaluation indicators calculated by the program (Table 2).

The analysis performed on the basis of the software package shows that the correlation of the resulting factor with the influencing factors in the set is r = 0.9803, the coefficient of determination is R2 = 0.9705. This suggests that there is a high density correlation between the influencing factors and the resulting factor, and that the residues are also closely related as the difference between the calculated values and the real values.

The significance and quality of the parameters of the econometric model constructed using the values of the indicators shown in the table are evaluated (Table 2).

Table 2

The relationship properties of the factors and the main indicators of the quality of the structured factor model

Dependent Variable: **Regional agricultural production volume, *Y***
Method: Least Squares
Date: 10/16/20 Time: 20:08
Sample: 2010 2019
Included observations: 10

Variable	Coefficient	Std. Error	t-Statistic	Prob.
The volume of investments in the regional economy X_1	2.895378	0.235914	12.27301	0.0000
Number of people employed in regional agriculture X_2	38.62627	9.455394	4.085104	0.0065
The area under agricultural crops X_3	2218.613	2451.487	0.905007	0.4003
A value that takes into account the influence of random factors *C*	-536750.2	564194.2	-0.951357	0.3782

R-squared	0.980307	Mean dependent VAR	10796.40
Adjusted R-squared	0.970461	S.D. dependent VAR	7056.308
S.E. of regression	1212.762	Akaike info criterion	17.32836
Sum squared resid	8824745.	Schwarz criterion	17.44940
Log likelihood	-82.64181	Hannan-Quinn criter.	17.19559
F-statistic	99.56063	Durbin-Watson stat	1.761604
Prob(F-statistic)	0.000017		

For the endogenous factor in the identified model, the value of the Fisher criterion is 99.56, and its value is 0.000017. It can be seen that the structured trend model can be applied in practice in terms of importance.

Model quality was assessed using the Akiake information criterion (17.33), the Schwartz criterion (17.45), and the Hannan-Quinn criterion (17.19) using the software package. The value of these criteria also indicates that a trend model can be applied.

The Darbin-Watson (DW) criterion, which allows to determine the presence of autocorrelation or multicollinearity in a structured econometric model, is 1.76, and given that the optimal limit is around 2.0, the quality of the model is relatively high, i.e., the autocorrelation rate is low.

Using the software package EViews10, we form a trend of change in the volume of products produced by the regional agricultural network of Andijan region in 2010-2019 within the limits of ± 2 statistical error and evaluate the indicators that reflect the importance of this trend (Figure 1).

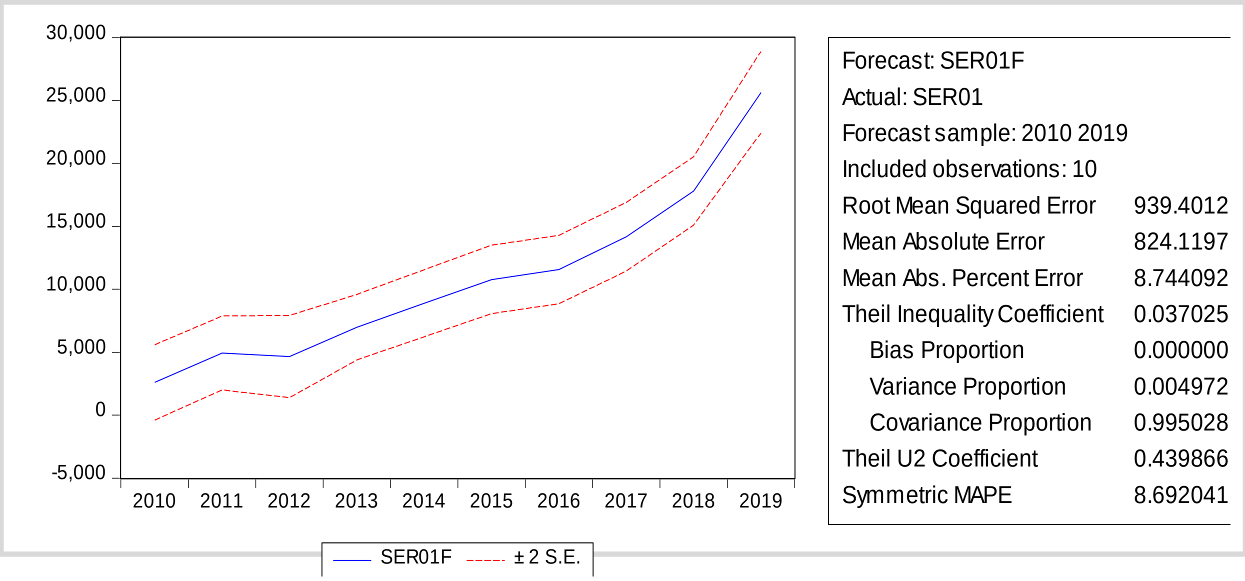

Figure 1. Changes in the volume model of production produced by the regional agricultural sector of Andijan region for 2010-2019 within ± 2 statistical errors

The figures shown in the figure reflect the importance and adequacy of the structured model. In particular, the Teil inequality coefficient is 0.037, the Teil U2 coefficient is 0.44, the Bias ratio is 0, the variation ratio is 0.005, the covariance ratio is 0.995 and the symmetric MAPE is 8.69, indicating that the structured model is in the required range. In particular, given that the limit for symmetric MAPE is up to 10, it can be seen that the approximate error rate is smaller than the specified limit, i.e., MAPE: 8.69 <10.

Based on the trend models identified using the software package, the prospects for changes in the volume of regional agricultural production in 2020-2024 and a list of the most suitable models for their calculation are given (Table 3).

Using the identified data, a multi-factor econometric model of the volume of output created in the agricultural sector of the regional economy under the influence of factors affecting it was developed. According to him, representing this process

$y = 2{,}895 \cdot x_{1} + 38{,}626 \cdot x_{2} + 2218{,}613 \cdot x_{3} - 536750{,}24$ (1)

(1) -regression equation was constructed.

The reliability and adequacy of the constructed model should be checked on the basis of several criteria to ensure the accuracy of the results. Due to the low level of autocorrelation in the identified trend and the fact that it meets the requirements on other criteria, the above-defined regression equation (1) - was found to be reliable and proved to be adequate.

Using a multifactor econometric model, the graph shows the values of changes in the volume of regional agricultural production in the medium term, ie in 2020-2024 (Figure 2).

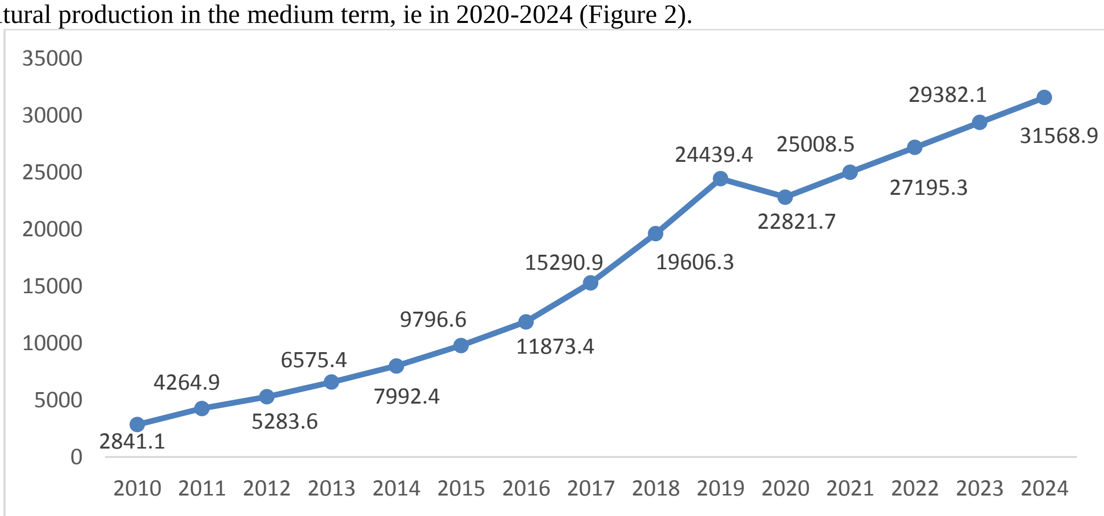

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Figure 1. Forecast indicators of regional agricultural volume of Andijan region (billion uzbek soums)

Based on the coefficients of the variables in the constructed model, we will be able to estimate how much the value of the resulting factor changes at the expense of an added unit of the value of each factor. In particular, the volume of regional agricultural production increased by 2.9 soums for an additional 1 soum of investments in the regional economy, the increase in the number of people employed in agriculture in the region by 38.6 billion soums. soums, an increase in the area of agricultural crops in the region by 1,000 hectares amounted to 2,218.613 bln. soums.

Based on the above factor links, we have developed a development scenario based on the impact of the most important indicators in the development of the regional agricultural sector of Andijan region on the gross output of the regional agricultural sector.

The use of trends identified in the process of strategic planning of agricultural development of Andijan region will allow optimizing the efficiency per unit of resource with the correct distribution of the amount of resources invested in regional agriculture.

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