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MODEL OF QUADRATIC PROGRAMMING OF ECONOMIC FACTORS AFFECTING THE COMPETITIVENESS OF SMALL-SCALE AGRICULTURAL ENTERPRISES

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ABSTRACT

Purpose – to form of model of discrete linear, quadratic and general programming of economic factors that effectively take into account the mutual influence of elements of a dynamic series that affect the increase of competitiveness of small agricultural formations.
Methodology – probabilistic statistical analysis, economic-statistical research method.
Originality/value – the proposed model effectively takes into account the mutual influence of the elements of the dynamic series that influence the increase of competitiveness of small agricultural formations, that is, the influence of various economic parameters on each other when they simultaneously manifest themselves. In this case, the forecasting operator is actually trained on the statistical material of the past.
Findings – the proposed model takes into account the mutual influence of the change in all quantitative indicators in the reporting period on the result of each parameter in the prospective period to the greatest extent. Therefore, this model can be directly applied as separate small agricultural formations (peasant (farm) farms, since they occupy the main part of all formations) to increase the competitiveness of domestic agrarian production, and to predict macroeconomic indicators of ensuring and increasing the competitiveness of agricultural enterprises in the conditions of sustainable development of the agroindustrialcomplex. The universality of the model makes it easy to further modify it for use in solving a wide range of economic, production, marketing and financial problems wherever an effective forecast allows to rationalize management decisions and obtain results in the future. Taking into account the fact that in modern agrarian economy in ensuring the country's food security and increasing the competitiveness of agricultural enterprises, the forecast is widely used, it is difficult to estimate the expected social and economic effect.
Keywords – quadratic programming, competitiveness.

INTRODUCTION

The practice of recent years has shown that, despite the steady growth, the overwhelming majority of agricultural units, i.e. number of peasant farms, the level of competitiveness of their products continues to be at a rather low level. This is due to certain difficulties due to the low level of production development, underdeveloped market infrastructure, marketing services, the lack of skills of most farmers in the market conditions, the proper measures are not taken to create cooperatives, the development of logistics services, especially the organization of the service. When choosing the optimal size of peasant farms, the ecological, economic, technological, market, social and other factors of the regions are not fully taken into account, which does not allow them to fully realize their potential.

It is these problems that are largely conditioned by the fact that for the period of existence, peasant (farmer) farms cannot yet produce competitive products, be competitive and become guarantors of the country's food security. Unlike large agricultural enterprises, peasant farms have lower investment activity and manufacturability of production, there is no justified specialization and division of labor.

In the current situation, more effective measures are needed to increase the competitiveness of the agrarian sector. It is necessary to define strategic and tactical goals for the development of small-scale agricultural enterprises, to work out concrete ways to achieve them, and outline priorities for state support.

In this paper, we present a model of quadratic programming of economic factors that effectively take into account the mutual influence of the elements of the dynamic series that affect the competitiveness of small agricultural enterprises. Three methods of simple discrete linear prediction with methods adapted to the economic forecasting of the competitiveness of small agricultural enterprises are presented.

The idea of the work is that the proposed model effectively takes into account the mutual influence of various economic factors of competitiveness when they simultaneously manifest themselves on the object of research.

The base goal is mathematical justification of the choice of priorities for increasing the competitiveness of small agricultural enterprises in the new conditions for the implementation of the Concept of the State Program for the Development of the Agroindustrial Complex of the Republic of Kazakhstan for 2017-2021.

By developing entrepreneurial activity on the basis of private property, small agricultural enterprises, namely peasant (farmer) farms, have a significant influence on the solution of organizational, political and economic problems associated with raising the standard of living of the rural population, reducing poverty and rural unemployment in the country.

The investigations of [1-2], although they are not problems of mathematical modeling, but lead to the fact of fitting real data to prognostic ones. Sources [3], [4-5] describe standard classical methods that do not take into account the multifactorial properties of phenomena or events. Article [3] indicates the need to improve mathematical models of forecasting. Works [6-8] show a low level of estimates of the probabilities of previous mathematical models. In [9] we are talking about the concept of linear prediction, which are useful for complex modeling.

Thus, the analysis of ready mathematical models of economic processes has shown that many of them have completely or partially lost relevance and do not allow obtaining reliable results. With their help it is impossible to model the processes taking place in modern conditions [10-12].

The practical significance of the results of the work is that the proposed model takes into account the mutual influence of the change in all quantitative indicators in the reporting period on the result of each parameter in the prospective period to the greatest extent. Therefore, this model can be directly applied as separate small agricultural formations (peasant (farm) farms, since they occupy the main part of all formations) to increase the competitiveness of domestic agrarian production, and to predict macroeconomic indicators of ensuring and increasing the competitiveness of agricultural enterprises in the conditions of sustainable development of the agro-industrial complex. The universality of the model makes it easy to further modify it for use in solving a wide range of economic, production, marketing and financial problems wherever an effective forecast allows to rationalize management decisions and obtain results in the future. Taking into account the fact that in modern agrarian economy in ensuring the country's food security and increasing the competitiveness of agricultural enterprises, the forecast is widely used, it is difficult to estimate the expected social and economic effect.

DISCRETE QUADRATIC PREDICTION

Here are three ways of simple discrete linear prediction. The methods outlined below can be used not only in economic forecasting, but also in forecasting earthquakes, weather, etc.

Let's $t_{n-1}, t_{n-2}, t_{n-3},..., t_{n-l},...$ is a decreasing sequence of time units $t_{i+1}-t_i= t_i-t_{i-1}$, and are determined respectively at each time point of the vector $b_{n-1}, b_{n-2}, b_{n-3},..., b_{n-l},...$, where $b_j=(b_{j,1},...,b_{j,k})$ is a k-dimensional vector indicator of the economic state at the t_j-th time moment. We denote by $\mathbf{h}(t)=(h_1(t), h_2(t),...,h_q(t))^T$ is the vector-column of cosmic indicators at time t. Suppose that $q \geq n$, (this does not detract from the generality). We introduce a rectangular matrix X consisting of k rows and q columns, where

$$\begin{cases} \mathbf{X} \cdots \mathbf{h}(t_{n-k}) = \mathbf{b}_{n-k}, \\ k = 1,\dots,l. \end{cases} \tag{2.1}$$

Equation (2.1) is algebraic. According to [8-10], this system always has a solution (possibly infinitely many) for sufficiently large q.

You can slightly modify the linear prediction problem by adding a few more parameters to the vector b (i). The main reason for the addition of such parameters is a essential dependence of more accurate prediction on these parameters (see [1]). For this reason, we now consider the case where the prediction $\mathbf{b}_{n-i}$ is sought as a polynomial not higher than the second power of the vector b (i + 1). We call this problem the problem of quadratic prediction. We define the vector b(i) as follows:

$$\mathbf{b}(i) = \left(b_{n-i,1},\dots,b_{n-i,k}, b_{n-i-1,1},\dots,b_{n-i-1,k},\dots,b_{n-i-l+1,1},\dots,b_{n-i-1+1,k}, a_{kl+1,i},\dots,a_{C_{kl}^2+kl,i}\right)$$

where the numbers $a_{kl+1,i},\dots,a_{C_{kl}^2+kl,i}$ are defined as all possible products of two elements from the collection:

$$\left\{b_{n-i,1},\dots,b_{n-i,k}, b_{n-i-1,1},\dots,b_{n-i-1,k},\dots,b_{n-i-l+1,1},\dots,b_{n-i-1+1,k}\right\}$$

The length of the vector b (i) is $C_{kl}^2 + 2kl$, where

$$C_p^q = \frac{p!}{q!(p-q)!}.$$

For example, for i = 3 and k = l = 2, we have

$$\mathbf{b}_2 = \begin{pmatrix} b_{2,1} \\ b_{2,2} \end{pmatrix}, \mathbf{b}_1 = \begin{pmatrix} b_{1,1} \\ b_{1,2} \end{pmatrix}$$

and

$$\mathbf{b}(3) = \left(b_{2,1}, b_{2,2}, b_{1,1}, b_{1,2}, (b_{2,1})^2, (b_{2,2})^2, (b_{1,1})^2, (b_{1,2})^2, b_{2,1}b_{2,2}, b_{2,1}b_{1,1}, b_{2,1}b_{1,2}, b_{2,2}b_{1,1}, b_{2,2}b_{1,2}, b_{1,1}b_{1,2}\right).$$

The length of this vector is

$$C_{2\cdot 2}^2 + 2 \cdot 2 \cdot 2 = 14.$$

For the further research it will be convenient to assume that the squares in the vector b (i) $\left\{(b_{n-i,1})^2,\dots,(b_{n-i-1+1,k})^2\right\}$ are in the vector b (i) immediately after the element $b_{n-i-l+1,k}$, as in the example considered for i = 3 and k = l = 2, and then all the other elements in a certain sequence. Next, we look for a matrix X having k rows and

$$C_{kl}^2 + 2kl$$

columns from the system

$$\begin{cases} \mathbf{b}_{n-i} = \mathbf{X} \cdot \mathbf{b}(i+1), \\ i = 1,\dots,C_{kl}^2 + 2kl. \end{cases} \tag{2.2}$$

It would be possible to solve system (2.2) in the same way as in the case of linear prediction, but we can represent the system (2.2) in a different form, which will be useful in questions of parallelization (see [2]).For this we denote by $\mathbf{x}^j$ (j=1,...,k)- a vector composed of the j-th row of the matrix X: $\mathbf{x}^j = \left(x_{j,1},\dots,x_{j,C_{kl}^2+2kl}\right)$

Then the system (2.2) can be rewritten in the following form

$$\begin{cases} \mathbf{B}_j \mathbf{x}^j = g_j, \\ j = 1,\dots,k. \end{cases}$$

where $\mathbf{B}_j$ - a square matrix of order $C_{kl}^2 + 2kl$.

Algorithms for linear and quadratic prediction were presented in [1]. An example of the application of discrete linear prediction to the competitiveness of agricultural enterprises with the number of indicators k = 24 is considered. According to the annual statistics for 2012-2016 for all indicators k = 24, a sample implementation representing the relative errors of the actual data to the prognostic values was formed.

GENERAL DISCRETE QUADRATIC PREDICTION

Here are three ways of simple discrete linear prediction. Let t_{n-1}, t_{n-2}, t_{n-3},..., t_{n-l},... - decreasing sequence of time units $t_{i+1}-t_i= t_i-t_{i-1}$, and are determined respectively at each time point of the vector b_{n-1}, b_{n-2}, b_{n-3},..., b_{n-1},..., where $b_j=(b_{j,1},\dots,b_{j,k})$ is a k-dimensional vector indicator of the economic state in t_j moment of time.

We denote by $\mathbf{h}(t)=(h_1(t), h_2(t),\dots, h_q(t))^T$ - vector-column of cosmic indicators at time point t. Suppose that $q \geq n$.

We introduce a rectangular matrix X, consisting of k rows and q columns where

$$\begin{cases} \mathbf{X} \cdots \mathbf{h}(t_{n-k}) = \mathbf{b}_{n-k}, \\ k = 1,\dots,l. \end{cases} \tag{3.1}$$

Equation (1) is algebraic. This system always has a solution (possibly infinitely many) for reasonably larger q.

It is possible to slightly modify the next linear prediction of several more parameters into the vector $\mathbf{b}(i)$. The reason for adding such parameters is when the more accurate prediction depends on these parameters (see [1]). For this reason, we now consider the case where the prediction $\mathbf{b}_{n-i}$ is sought as a polynomial not higher than the second power of the vector $\mathbf{b}(i+1)$. This task is based on quadratic prediction. We define the vector $\mathbf{b}(i)$ as follows:

$$\mathbf{b}(i) = \left(b_{n-i,1},\dots,b_{n-i,k}, b_{n-i-1,1},\dots,b_{n-i-1,k},\dots,b_{n-i-l+1,1},\dots,b_{n-i-1+1,k}, a_{kl+1,i},\dots,a_{C_{kl}^2+kl,i}\right)$$

The length of the vector b (i) is $C_{kl}^2 + 2kl$, where

$$C_p^q = \frac{p!}{q!(p-q)!}.$$

For example, for i = 3 and k = l = 2, we have

$$\mathbf{b}_2 = \begin{pmatrix} b_{2,1} \\ b_{2,2} \end{pmatrix}, \mathbf{b}_1 = \begin{pmatrix} b_{1,1} \\ b_{1,2} \end{pmatrix}$$

And

$$\mathbf{b}(3) = \left(b_{2,1}, b_{2,2}, b_{1,1}, b_{1,2}, (b_{2,1})^2, (b_{2,2})^2, (b_{1,1})^2, (b_{1,2})^2, b_{2,1}b_{2,2}, b_{2,1}b_{1,1}, b_{2,1}b_{1,2}, b_{2,2}b_{1,1}, b_{2,2}b_{1,2}, b_{1,1}b_{1,2}\right).$$

The length of this vector is

$$C_{2\cdot 2}^2 + 2 \cdot 2 \cdot 2 = 14.$$

For the future it will be convenient to assume that the squares in the vector

$$\mathbf{b}(i) \ \left\{(b_{n-i,1})^2, ..., (b_{n-i-1+1,k})^2\right\}$$

are in the vector b (i) immediately after the element $b_{n-i-l+1,k}$, as in the example considered for i = 3 and k = l = 2, and then all the other elements in a certain sequence. Next, we look for a matrix X having k rows and $C_{kl}^2 + 2kl$ columns from the system

$$\begin{cases} \mathbf{b}_{n-i} = \mathbf{X} \cdot \mathbf{b}(i+1), \\ i = 1, ..., C_{kl}^2 + 2kl. \end{cases} \tag{3.2}$$

It would be possible to solve system (3.2) in the same way as was the case with linear prediction, but it is possible to represent system (3.2) in a different form, which will be useful in questions of parallelization (see [1]). For this we denote by $\mathbf{x}^j$ (j=1,...,k)- a vector composed of the j-th row of the matrix X:

$$\mathbf{x}^j = \left(x_{j,1}, ..., x_{j,C_{kl}^2+2kl}\right)$$

Then system (2) can be rewritten in the following form

$$\begin{cases} \mathbf{B}_j \mathbf{x}^j = g_j, \\ j = 1, ..., k. \end{cases}$$

where $\mathbf{B}_j$- square matrix of $C_{kl}^2 + 2kl$ order.

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ТҮЙІН

Осы мақалада шағын агроөнеркәсіптік кәсіпорындардың бәсекеге қабілеттілігіне әсер ететін динамикалық сериялардың элементтерінің өзара әсерін ескеретін экономикалық факторлардың шаршы бағдарламаларын ұсынамыз. Шағын ауыл шаруашылық кәсіпорындарының бәсекеге қабілеттілігін экономикалық болжауға бейімделген әдістермен қарапайым дискретті сызықтық болжаудың үш әдісі ұсынылған.

РЕЗЮМЕ

Представлена модель квадратичного программирования экономических факторов, эффективно учитывающих взаимное влияние элементов динамического ряда, влияющих на повышение конкурентоспособности мелких сельхозформирований.