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THE MULTI-FACTORIAL REGRESSION MODELS FOR STUDYING THE ECONOMIC EFFICIENCY OF LAND CONSOLIDATION IN THE REPUBLIC OF MOLDOVA

Anatol RACUL, Dragoş CIMPOIEŞ

The State Agrarian University of Moldova, 44 Mirceşti, 2049, Chişinău, Republica Moldova,
E-mail: racul@rambler.ru, dcimpoies@uasm.md

Corresponding author: racul@rambler.ru

Abstract

The purpose of this paper is to study the economic efficiency of the autumn wheat with the help of the multi-factorial regression models. Assessing the elasticity coefficient of production factors in the agrarian sector of the Republic of Moldova gives the possibility to define the criteria for optimizing the land consolidation. By means of these assessment methods we can appreciate the existence, direction and the degree of interrelatedness between the economic processes. We can also measure the degree of variation of endogenous characteristics under the influence of the exogenous characteristics in growing autumn wheat in the district of Făleşti, the Republic of Moldova.

Keywords **:** *land consolidation, econometric models, autumn wheat*

INTRODUCTION

Since 1991 Moldova has carried out a wide range of radical reforms affecting its social and economic system. The reforms have been aimed at the creation of political, legal and economic foundations for a market economy based predominantly on the private sector. Within this general framework, agrarian reform proceeded in the following main directions:

- mass privatization of agricultural land, culminating in physical distribution of land plots and issue of land titles to individual owners;
- transformation of traditional collective and state farms into new forms of market-oriented organizations.

Over 1 million residents became landowners as a result of this process, which ended between 1998 and 2000. Many of them used their privately owned land to establish independent family farms, while others entrusted their land to managers of newly created corporate farms (partnerships, limited liability companies, agricultural cooperatives, joint stock companies, etc.) [1].

As of today, 50% of agricultural land in Moldova is used by individual producers and the rest is managed by corporate farms. This is in stark contrast to the pre-reform situation, when individuals cultivated 2% of agricultural land and 98% was controlled by collective and state farms. Ensuring the long-term viability and sustainability of the new farming structure in Moldova is a national priority.

Meanwhile, the progress in land privatization does not led to the individualization of agriculture. Half of agricultural land in Moldova is farmed by the corporate sector. Although this is a positive result, comparing with other transition countries like Russia and Ukraine, it is far from being satisfactory, while compared with market economies, where the share of corporate farms in the total area of agricultural land is much smaller [4].

The need for studying the economic efficiency of producing autumn wheat and also the reserves for increasing this efficiency requires the identification of the causal links between the factors which influence the indicators for the results in order to fundament decisions or make forecasts with respect to these factors in the future. In this way, the relations between the result indexes and the factors which influence the efficiency of the autumn wheat production can be brought together in the analysis of regression and

correlation. Here we study the dependence between the result variable (characteristic) ***y*** and one or more independent variables (characteristics) ***x***. The result characteristic ***y*** is also called the endogenous characteristic, dependent or effect, and the independent characteristic ***x*** – factorial, exogenous or causal [2].

Although a lot of studies have been conducted in both developed and developing countries, including countries in transition regarding the place of individual farms in agriculture, the main questions addressed by local policy makers and researches still concern whether there is a clear superiority of one organisational form, namely family farms, over corporate structures and the nature of the relationship between size and farm efficiency, being strong advocates of the economy of scale. Such an approach may cause a serious impact on the country's agricultural policy and different strategic plans regarding agricultural and rural development.

Agricultural reforms led to the existence of a reduced number of large corporate farms - at one pole, and a large number of small and very small peasant (family) farms and rural households – at another one. Almost do not exist the so-called "medium-sized" family farms, the main organization form in market economies' agriculture [4]. At the same time, the relationship between the organization form and farm size is not always the same. Usually, family farms are small farms, but some of them fall in the category of large farms. A similar picture is observed with corporate farms, which are typically large, but not all of them.

MATERIAL AND METHODS

In the case of regression analysis we describe the way that a dependent variable evolves depending on the modification of one or more causal variables, therefore $y = f(x_i)$. The analysis of this correlation aims at establishing the degree in which the causal variable influences the modification of the effect variable [3].

There are several criteria for establishing the independences: the relation type (functional or stochastic); the number of characteristics (simple or multiple); the direction of the relation (direct or inverse); the function's form (linear or non-linear) and according to the way of manifestation in time (synchronous or non- synchronous).

When determining the production functions in agriculture, in the basis of the qualitative economic analyses, we specify:

- the essential phenomena taken into account (two of them), out of which one is "cause" and the other one is "effect"
- the hypothesis describing the independence between the two phenomena is shown by one single relation;
- the form of the relation is linear;
- in the case of linear relation, the model obtains the formula

$$y_x = a_0 + a_1 x,$$

where

y_x – dependent variable, effect or endogenous;

x – independent variable, causal or exogenous;

a_0 – free coefficient;

a_1 – regression coefficient, which shows the modification of y after the unitary modification of x.

In studying the efficiency of autumn wheat production, this equation is used only when the determined result indexes depend greatly on one single factor. However, during actual production the result indexes are influenced by a series of factors, and consequently in practice we use the multi-factorial model more often, since it offers us the possibility to make a quality evaluation of the shape and the intensity of the relation between the result (y) and the factors $x_1, x_2, x_3 \ldots x_n$ which influence it. In this case, the equation of the relation becomes:

$$y_{x_1 x_2 \ldots x_n} = a_0 + a_1 x_1 + a_2 x_2 \ldots + a_n x_n$$

where

a_0 – free coefficient;

$a_1, a_2 \ldots, a_n$ – regression coefficients, which show the average change with one unit of the

endogenous characteristic x_i, on the condition that the influence of other factors in the regression's model has been taken into account and set at a medium level.

$x_1, x_2, ..., x_n$ –independent variables, which influence the result.

The regression coefficients in the complex equation are not comparable because of the different measurement units. In order to identify the priority of the factors we determine the standardized regression coefficients: elasticity coefficients and β-coefficients.

Elasticity coefficients are determined according to the following formulas:

$$Э_1 = a_1 \frac{\overline{x_1}}{\overline{y}},\ Э_2 = a_2 \frac{\overline{x_2}}{\overline{y}} \text{ etc.}$$

They show with how many percents the resulting characteristic will be modified, if the factor characteristic is modified with 1 %.

β -coefficients are determined as follows:

$$\beta_1 = a_1 \frac{\sigma x_1}{\sigma y},\ \beta_2 = a_2 \frac{\sigma x_2}{\sigma y} \text{ etc.,}$$

where

$\sigma x_1, \sigma x_2, ..., \sigma x_n$ – average square deviation of the factors $x_1, x_2, ..., x_n$.

σy – square deviation of the result y.

Average square deviations are determined according to the following formulas:

$$\sigma x_i = \sqrt{\frac{\sum x_i^2}{n} - (\overline{x_i})^2},$$

$$\sigma y = \sqrt{\frac{\sum y_i^2}{n} - (\overline{y})^2}$$

where i = 1 ... n .

The value of the β-coefficient shows with how many average square deviation **y** will be modified if x_i is modified with only one average square deviation.

The correlation coefficient of multiple relations (R) shows the qualitative relation between the endogenous and the exogenous characteristics. The more this coefficient's value comes closer to 1, the more complete (high) is the correlative relation between the characteristics.

The determination coefficient $D = R^2$ shows the resulting index variation part (y) under the influence of the factorial indexes studied ($x_1, x_2, ..., x_n$).

The partial determination coefficients are calculated according to the formula:

$$d_i^2 = r_{yx_i} \cdot \beta_i$$

which determines the individual signification of each factor included in the model [5].

In the sum of the partial determination coefficients is included the multiple determination coefficient:

$$\sum_{i=1}^{n} d_i^2 = R^2$$

RESULTS AND DISCUSSIONS

The analysis of the multiple regression and correlation gives us the possibility to point out the factors, whose modification brings about enormous possibilities of altering the result characteristic. In multi-factorial models, in order to determine the priority of certain factors, we can arrange them according to the coefficients determined above ($Э_i$; β_i, d_i^2), and afterwards we will determine the average level of influence of those factors over the result.

In elaborating the models which reflect the phenomena of economic efficiency in producing autumn wheat and in selecting the factors of these models we have taken into consideration the following restrictions:

- characteristics which present functional interrelations haven't been included in the models;
- in the equation of the relation were included factors which influence the result directly;
- for each characteristic included in the model there have been performed no less than 10 observations;
- in the case of the factorial (exogenous) characteristics which are closely interrelated (that means there are collinear relations) only one factor has been included in the equation of the relation

(only the factor which is more closely related to the result).

When elaborating the relatively multi-factorial models, in order to establish the factors' influence on modifying the indicators of the economic efficiency of the autumn wheat production, the following effect (endogenous, resulting) characteristics have been examined:

y_1 – unit cost of 1 q autumn wheat, MDL

y_2 – autumn wheat profitability level, %.

In the case of the first mathematic model, there have been included measurable factors which have a significant influence on the unit cost of 1 q of autumn wheat:

x_1 – direct labor consumption per ha, persons-hours

x_2 – quantity of fertilizer used per ha, kg, etc.

x_3 – level of mechanization of the laboring processes, %

x_4 – specialization level, % (according to the structure of the income obtained after selling the agricultural products)

x_5 – materials consumption per ha of autumn wheat, MDL

x_6 – no. of combines used per 100 wheat ha, units

x_7 – autumn wheat productivity, q/ha

After processing the information with the help of least – squares regression techniques we have obtained the following equation:

$$y_{x_1,x_2...x_7} = -13,05 - 0,398x_1 - 0,175x_2 + 1,294x_3 + \\ + 0,607x_4 - 0,003x_5 - 10,409x_6 - 0,227x_7 \cdot$$

The regression coefficients of this equation show that the unit price of 1 q of autumn wheat decreases:

- when direct labor consumption is modified with 1-person-hour, ***y*** decreases with 0.398 MDL;
- when the quantity of fertilizer used per ha is modified with 1 kg, the 1 q cost decreases with 0.175 MDL;
- when the level of mechanization of the laboring processes is modified with 1 %, ***y*** increases with 1.29 MDL;
- when the specialization level is modified with 1 %, ***y*** increases with 0.607 MDL;
- when the materials consumption per ha of autumn wheat is modified, the cost decreases with 0.003 MDL;
- when the factor "no. of combines used per 100 wheat ha, units" is modified, the cost decreases with 10.41 MDL;
- when the autumn wheat productivity is modified, the cost decreases with 0.227 MDL. (In all these cases, the condition at work is that the other factors remain at a medium level.)

The multiple correlation coefficient R = 0.648 demonstrates the fact that between the unit cost of 1 q of autumn wheat and the exogenous factors included in the model there is a remarkable connection. The multiple determination coefficient $D = R^2 = 0.4204$ shows that the variation of the unit cost of 1 q of wheat is influenced buy the factors included in the model at a rate of 42.04%.

In order to determine the influence of the various factors in obtaining the result characteristic we determine the elasticity coefficients, the β-coefficients and the partial determination coefficients [7].

a) Elasticity coefficients:

- for x_1 (direct consumption of labor on 1 ha, persons-hours)

$$Э_1 = -0,398 \cdot \frac{42,305}{82,317} = -0,205;$$

- for x_2 (quantity of fertilizer used per ha, kg, etc.)

$$Э_2 = -0,1748 \cdot \frac{50,529}{82,317} = -0,107;$$

- for x_3 (level of mechanization of the laboring processes, %)

$$Э_3 = -1,2935 \cdot \frac{96,049}{82,317} = -1,509;$$

- for x_4 (specialization level, %)

$$Э_4 = -0,6073 \cdot \frac{24,024}{82,317} = -0,177;$$

-for x_5 (materials consumption per ha of autumn wheat, MDL)

$$Э_5 = -0,0030 \cdot \frac{2303,805}{82,317} = -0,084;$$

- for x_6 (no. of combines used per 100 wheat ha, units)

$$Э_6 = -10,4089 \cdot \frac{0,46}{82,317} = -0,053;$$

- for x_7 (autumn wheat productivity, q/ha)

$$Э_7 = -0,2266 \cdot \frac{29,0}{82,317} = -0,080.$$

The elasticity coefficients prove that:

- when direct labor consumptions are modified with 1%, the average unit cost will alter with 0.205 %;
- when the quantity of fertilizer used per ha is modified with 1%, the average unit cost will alter with 0.107 %;
- when the level of mechanization of the laboring processes is modified with 1 %, the unit cost – with 1.509 %;
- when the specialization level is modified with 1 %, the average unit cost – with 0.177 %;
- when the materials consumption per ha of autumn wheat is modified, the average unit cost – with 0.084 %;
- when the no. of combines used per 100 wheat ha is modified with 1%, the average unit cost – with 0.053 %;
- when the autumn wheat productivity is modified with 1%, the average unit cost – with 0.083 %;

b) We determine the β-coefficients according to the formula:

$$\beta_i = \alpha_i \frac{\sigma x_i}{\sigma y}$$

First of all, we shall determine the average square deviations for y, x_1, x_2 ... x_7:

$$\sigma y = \sqrt{\frac{278651}{41} - (82,317)^2} = 4,504$$

$$\sigma x_1 = \sqrt{\frac{73689,27}{41} - (42,305)^2} = 2,754$$

$$\sigma x_2 = \sqrt{\frac{108406,79}{41} - (50,529)^2} = 9,534$$

$$\sigma x_3 = \sqrt{\frac{378304}{41} - (96,049)^2} = 1,232$$

$$\sigma x_4 = \sqrt{\frac{24769}{41} - (24,024)^2} = 5,193$$

$$\sigma x_5 = \sqrt{\frac{219627704}{41} - (2305,805)^2} = 200,091$$

$$\sigma x_6 = \sqrt{\frac{7,3296}{41} - (0,416)^2} = 0,075$$

$$\sigma x_7 = \sqrt{\frac{34975}{41} - (29)^2} = 3,417.$$

Therefore,

$$\beta_1 = -0,398 \cdot \frac{2,754}{4,504} = -0,243$$

$$\beta_2 = -0,1748 \cdot \frac{9,534}{4,504} = -0,370$$

$$\beta_3 = 1,2935 \cdot \frac{1,232}{4,504} = 0,354$$

$$\beta_4 = 0,6073 \cdot \frac{5,193}{4,504} = 0,700$$

$$\beta_5 = -0,003 \cdot \frac{200,091}{4,504} = -0,133$$

$$\beta_6 = -10,4089 \cdot \frac{0,075}{4,504} = -0,173$$

$$\beta_7 = -0,2266 \cdot \frac{3,471}{4,504} = -0,175$$

β -coefficients show that:

- if the direct labor consumptions per ha are modified to the size of its average square deviation (with σ_1), then the unit cost will modify with 0.243 σ_y;
- if the quantity of fertilizer used per ha is modified to the size of its average square deviation (with σ_2), then the unit cost will modify with 0.370 σ_y;
- if the level of mechanization of the laboring processes is modified to the size of its average square deviation (with σ_3), then the unit cost will modify with 0.354 σ_y;
- if the specialization level is modified to the size of its average square deviation (with σ_4), then the unit cost will modify with 0.700 σ_y;
- when the materials consumption per ha of autumn wheat is modified to the size of its average square deviation (with σ_5), then the unit cost will modify with 0.133 σ_y;,
- if the no. of combines used per 100 wheat ha is modified to the size of its average square deviation (with σ_6), then the unit cost will modify with 0.173 σ_y;
- if the autumn wheat productivity is modified to the size of its average square

deviation (with σ_7), then the unit cost will modify with 0.175 σ_y.

The results of the comparative analysis regarding the factor's influence will be presented by means of the table above.

As we can notice on the basis of all the coefficients we have calculated and of the determination of the average level of the factor's influence we can thus prove the priority of the x_3 factor – level of mechanization of the laboring processes, %, and of x_4 – specialization level. To conclude, we will claim that the highest priorities on modifying the unit cost per q of autumn wheat is due to the complete mechanization of the technological processes and to the enterprise's focus on producing this culture [6].

Table 1. Factor's influence on the unit cost

N	Factors	Coefficients value		
		Эi	βi	d_i^2
1	x_1 - Direct labor consumptions per ha, persons-hours	-0,205	-0,243	0,008
2	x_2 - Quantity of fertilizer used per ha, kg, etc.	-0,107	-0,370	0,007
3	x_3 - Level of mechanization of the laboring processes, %	1,509	0,354	0,073
4	x_4 - Specialization level, %	0,177	0,700	0,293
5	x_5 - Materials consumption per ha of autumn wheat, MDL	-0,084	-0,133	0,000 3
6	x_6 - No. of combines used per 100 wheat ha, units	-0,053	-0,173	0,047
7	x_7 - Autumn wheat productivity, q/ha	-0,080	-0,175	-0,011

In the case of the mathematic model of studying the profitability of the autumn wheat (y_2) the following factors have been included:

x_1 – no. of combines used per 100 wheat ha, units

x_2 – the production cost of 1 q, MDL

x_3 –autumn wheat productivity, q/ha

x_4 – specialization level, %

x_5 – merchandise production level:

$$Yx_1, x_2 \dots x_5 = -32.49 + 6.96\, x_1 + 0.57\, x_2 + +0.019\, x_3 - 0.32\, x_4 - 0.0225\, x_5$$

The regression coefficients prove that the profitability level increases:

- with 6.96 %, when the no. of combines used per 100 wheat increases with one unit *y*;
- with 0.57 %, when the production cost increases with 1 MDL;
- *y* increases with 0.019 %, when the autumn wheat profitability increases with 1 q/ha;
- when the specialization level is modified, the result alters with 0.32 %;
- when the merchandise production level is modified with 1 %, the profitability level increases with 0.02 %.

The coefficient R = 0.79 of the multiple correlation proves that there is a very close relation between the level of the autumn wheat profitability and the exogenous factors included in the model. The multiple determination coefficient R^2 = 0.6246 shows that the variation of the autumn wheat profitability level is influenced by factors included in the model at 62.46 %.

Thus it is proved the priority of the x_1 factor "No. of combines used per100 wheat ha" and x_2 "Production price of 1 q".

CONCLUSIONS

In conclusion, we may claim that the method of correlation and regression can solve the following tasks:

1. Appreciate the existence, direction and the degree of interrelatedness between the economic processes;
2. Measure the degree of variation of endogenous of effect characteristics (Y) under the influence of the exogenous characteristics or (X);
3. Calculate the total change of the result characteristic under the influence of one or more factors of influence.

4.The study of the economic efficiency of the autumn wheat with the help of the econometric models gives the possibility to define the criteria for optimizing the land consolidation in the agrarian sector of the Republic of Moldova.

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