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The Interdependence of the Natural Resource Potential of the Region and its Economic Development

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***Abstract* – A comprehensive assessment of the impact of natural conditions on economic development and, more generally, on the overall development of countries and regions is a very complex topic. Based on the data of the industrial production index and agricultural production index, we will identify the dependence of the region's economic development (on the example of the Chechen Republic) on the above indicators. Identification of this dependence was carried out using correlation and regression analysis. It can be noted that there is a dependence of the average level of economic growth on the natural resource potential, which was calculated based on indicators of industrial and agricultural production. The agricultural production factor has a more serious impact, it is also positive.**

Abstract* – *natural resources, economic development, growth indicators, Chechen Republic

I. INTRODUCTION

The nature of the impact of natural factors undergoes significant changes in the process of historical development and always depends on the needs and capabilities of society at each specific historical stage of development. Several centuries ago, one of the most important factors in the location of Russian settlements was the hydrographic network and water supply sources. Currently, this factor no longer plays such a role. A comprehensive assessment of the impact of natural conditions on economic development and, more broadly, on the overall development of countries and regions is a very complex topic. The relationship between the natural environment and regional development features is most developed in the theories and concepts of geographical determinism, according to which natural conditions (especially climate) determine the development of peoples, differences in the intensity and characteristics of economic activity of individual countries and regions. Another view of the role of natural conditions in people's lives is indefinite (“in” means negation) [1].

The North Caucasus Federal District (NCFD) is a set of territorial-economic systems characterized by a geopolitical and strategic structure formed over a long period of time. The use of all-Russian methods and techniques of regional management, along with ignoring the specifics of development of each subject of the studied macro region, has led to the "stagnation" of the position of the majority of the regions forming the macro region. The reasons for this situation are connected, among other things, with insufficient research on the social, political, economic and ethnocultural characteristics of each region as part of the NCFD, which distorts the vision of development guidelines and leads to ineffective use of management tools.

The macro-region under study is characterized by agricultural specialization, which forms the specifics of the development of the NCFD. However, the paradox is that a high level of employment in agriculture does not stimulate the high productivity of agricultural production, which covers the cause of most social problems in the macroregion associated with poverty, low living standards, low labor productivity, etc. This is the so-called vicious circle of problems .

II. MATERIALS AND METHODS

Assessing the real indicators of labor productivity in various sectors of the economy of the subjects of the NCFD is a difficult task, since a high percentage of the population of the macroregion in the shadow business sector is associated with a surplus of labor, low official wages, inefficient labor market control by responsible authorities, and high the degree of corruption of government, the low level of development of the digital economy [2]. The severity of the employment problem in the regions of the NCFD reflects the tensions in the social sphere of the macroregion. Studying the socio-economic development trends of the subjects of the NCFD over the past 10 years allows them to be grouped. The use of the methodology for assessing the competitiveness of Russian regions was proposed by the Leontief Center [3] (the International Center for Social and Economic Research), which allowed us to identify the competitive potential of the advantages and vulnerabilities of each region in the NCFD (table 1). Among the subjects of the NCFD, according to the results of the study, there was not a single region that received the maximum number of points equal to 5 points.

Consequently, not a single region of the NCFD has the potential to compete with the "leader" regions of the national level. Stavropol Krai and Kabardino-Balkaria can be considered as nominal "leaders" (within the framework of the NCFD), since these regions have taken the highest positions in the ranking and also have a large number of developed factor markets.

The presence of systemic failures in the development of the subjects of the NCFD led to a decrease in the pace of transition from extensive to intensive types of regional management. The main advantages of the regions associated with favorable climatic and natural conditions, demographic situation, and the availability of sufficient labor potential are the main source of well-being, while the intensification of resource use is inherent in a small number of regions of the NCFD.

In the presented analysis of the competitiveness of subjects of the NCFD, the Chechen Republic took fifth place among other regions of the district. Among the presented directions for assessing the potential of the region, the values of indicators in two directions: institutional capacity and natural capital exceed the average values for the region. High dependence on federal funding, the mismatch of the technological equipment of enterprises with modern requirements, and the unattractiveness of the region for investors are weak competitive positions of the constituent entity of the Federation (Figure 1).

According to data on per capita incomes in the Chechen Republic, the region, starting in 2000, has moved to the development stage based on increasing the efficiency of using its resource potential, however, the indicators are lower than the national average.

The dynamics of agricultural and industrial production in the region are heterogeneous (Figure 2), especially with regard to the agricultural sector of the Chechen Republic, where, despite the increase in the efficiency of using production factors, labor productivity remains low. This put the Chechen Republic on the list of outsiders among the regions of the NCFD, since in this region the efficiency of agricultural land use is much lower than the national average.

If in the Chechen Republic this situation may be associated with low labor productivity, then in the Stavropol Krai the situation in agriculture is associated with terrain features and climatic specifics, which requires the region to use innovative technologies to increase the efficiency of optimal production in agriculture.

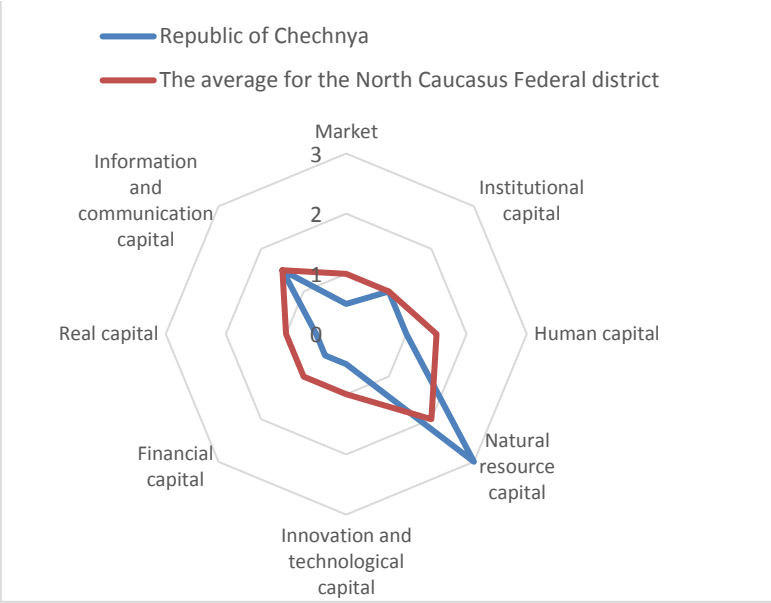

Fig. 1. Competitiveness of the Chechen Republic potential in the NCFD framework [4]

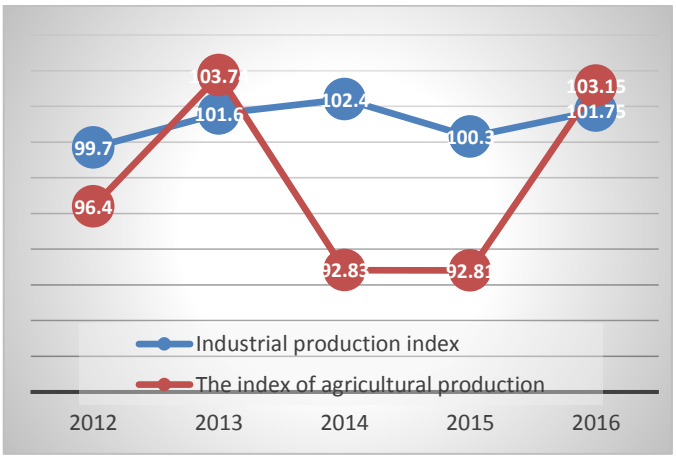

Fig. 2. Indicators of agricultural and industrial production of the Chechen Republic in 2012–2016, % [5]

Progressive production methods in agriculture and industry of the regions of the NCFD are being introduced very slowly, which is mainly due to the lack of investment for the implementation of innovative ideas, the creation of innovative infrastructure and the necessary level of knowledge in the field of innovation. According to 2016, the share of innovative products in the structure of the GRP of the Chechen Republic amounted to 0.2, which indicates the inefficiency of innovative activity in the region [6].

The development of the human potential of the regions of the NCFD is primarily determined by financial investments in science and education. By this indicator, the Chechen Republic is a leader among other subjects of the NCFD, as the region is actively engaged in activities related to the restoration of educational activities at the same level. While in the Russian Federation the average share of expenses related to science and education is 4 %, in the Chechen Republic this indicator is about 15 %.

The institutional structure of the Chechen Republic in recent years has undergone changes related to the provision of benefits and incentives to companies investing resources to invest in a priority and strategically oriented sector of the regional economy.

Since 2014, work has been actively underway to create free economic zones of industrial, transport and recreational types that can bring the economy of the region to a new level of development [7].

3. Studies of the place and role of the socio-economic situation of the Chechen Republic in the NCFD.

Summarizing the results of a study of the place and role of the socio-economic situation of the Chechen Republic in the NCFD, we can present a SWOT matrix of the region's competitive positions (table 1).

Under the current conditions, the development prospects of the Chechen Republic are associated with the creation of prerequisites for maximizing the socio-economic potential of the region and creating conditions for interregional clustering in the field of innovation, transport, logistics, investment, etc. Prospects are based on cooperation between business and the state, which will create new economic structures of a "metaregional level" [9] with the aim of using the competitive advantages and capabilities of each region of the North-Caucasian Federal District.

TABLE I. SWOT MATRIX OF THE CHECHEN REPUBLIC COMPETITIVE POSITIONS

Strengths	**Weaknesses**
Low investment activity in the region and attractiveness for investors. The use of extensive methods in the production of goods and services Poor quality of life Low quality management in the field of marketing and enterprise management Production, mainly with low added value Imperfection of the legal framework related to the protection of the rights and interests of the business community, citizens	1. The flexibility of business processes 2. The revitalization of processes associated with the development of new technologies 3. The presence of a favorable business environment 4. The presence of dialogue between business and government 5. Streamlining budget spending planning 6. Orientation of regional costs to innovative projects 7. The presence of confidence in the authorities on the part of the population and business communities
Threats	**Opportunities**
1. Reduced productivity in sectors of the economy due to the lack of conditions for the modernization of production 2. Increased dependence on the federal government in financial matters 3. Migration of economically active population 4. The decline in the quality of life in the region 5. Growth in unemployment, labor surplus 6. The growth of environmental issues	1. Increasing the level of employment in the region through the development of rural and mountainous areas 2. Creating conditions for the development of priority economic specializations of municipalities in the region 3. Infrastructure development to support innovation and investment 4. Creation of the most favorable conditions for interregional cooperation in the NCFD 5. Development of priority areas of specialization in the region and their localization in the zone of advanced economic growth 6. Development of tourism and recreation

Based on the data of the industrial production index and agricultural production index, we will identify the dependence of the region's economic development (on the example of the Chechen Republic) on the above indicators. Identification of this dependence was carried out using correlation and regression analysis. The source data are presented in table 2.

TABLE II. INPUT DATA FOR CORRELATION AND REGRESSION ANALYSIS, 2012–2016 [10]

Period	**Group of the Chechen Republic, billion rubles**	**Industrial Production Index, X1**	**Agricultural Production Index, X2**
2012	102,289	99,7	96,4
2013	122,403	101,6	103,7
2014	142,942	102,4	92,83
2015	154,401	100,3	92,81
2016	166,711	101,75	103,15

We define the vector of estimates of the regression coefficients. According to the least squares method, vectors are obtained from the expression: s = (XTX) – 1XTY

Add one column to the variable matrix xj:

1	99.7	96.4
	101.6	103.7
1	102.4	92.83
1	100.3	92.81
1	101.75	103.15

Matrix Y =

102.289
122.403
142.942
154.401
166.711

Matrix X^T

1	1	1	1	1
99.7	101.6	102.4	100.3	101.75
96.4	103.7	92.83	92.81	103.15

Multiply Matrices, (X^TX)

$X^T X =$

5	505,75	488,89
505,75	51161,563	49457,148
488,89	49457,148	47917,678

In the matrix (XTX), the number 5 lying at the intersection of the 1st row and the 1st column is obtained as the sum of products of the elements of the 1st row of the XT matrix and the 1st column of the matrix X.

Multiply Matrices, (X^TY)

$X^T Y =$

688,746
69720,883
67349,353

Find the inverse matrix, $(X^TX)^{-1}$

$(X^T X)^{-1} =$

2072,154	-20,692	0,216
-20,692	0,215	-0,0111
0,216	-0,0111	0,00927

Regression coefficient estimates vector

$Y(X) =$

2072,154	-20,692	0,216	*	688,746	=	-983,203
-20,692	0,215	-0,0111		69720,883		11,617
0,216	-0,0111	0,00927		67349,353		-0,554

Regression equation (estimation of the regression equation) $Y = -983.2025 + 11.6172X_1 - 0.5539X_2$

Matrix of pair correlation coefficients R:

Number of experimental observation n = 5. The number of independent variables in the model is 2, and the number of regressors, taking into account a unit vector, is equal to the number of unknown coefficients. Given the sign of Y, the dimension of the matrix becomes 4. The matrix of independent variables X has dimension (5 x 4). Matrix A consists of Y and X.

1	102.289	99.7	96.4
1	122.403	101.6	103.7
1	142.942	102.4	92.83
1	154.401	100.3	92.81
1	166.711	101.75	103.15

Transposed Matrix

1	1	1	1	1
102.289	122.403	142.942	154.401	166.711
99.7	101.6	102.4	100.3	101.75
96.4	103.7	92.83	92.81	103.15

Matrix X^TX.

5	688.746	505.75	488.89
688.746	97510.176	69720.883	67349.353
505.75	69720.883	51161.563	49457.148
488.89	67349.353	49457.148	47917.678

The resulting matrix has the following correspondence:

$\sum n$	$\sum y$	$\sum x_1$	$\sum x_2$
$\sum y$	$\sum y^2$	$\sum x_1 y$	$\sum x_2 y$
$\sum x_1$	$\sum y x_1$	$\sum x_1^2$	$\sum x_2 x_1$
$\sum x_2$	$\sum y x_2$	$\sum x_1 x_2$	$\sum x_2^2$

Find the pair correlation coefficients.

$$r_{xy} = \frac{\overline{x \cdot y} - \overline{x} \cdot \overline{y}}{s(x) \cdot s(y)}$$

$$r_{yx_1} = \frac{13944.177 - 101.15 \cdot 137.749}{0.995 \cdot 22.961} = 0.475$$

$$r_{yx_2} = \frac{13469.871 - 97.778 \cdot 137.749}{4.796 \cdot 22.961} = 0.00935$$

$$r_{x_1x_2} = \frac{9891.43 - 97.778 \cdot 101.15}{4.796 \cdot 0.995} = 0.248$$

Знаки x и y	$\sum x_i$	$\overline{x} = \frac{\sum x_i}{n}$	$\sum y_i$	$\overline{y} = \frac{\sum y_i}{n}$	$\sum x_i * y_i$	$\overline{xy} = \frac{\sum x_i y_i}{n}$
Для y и x_1	505.75	101.15	688.746	137.749	69720.883	13944.177
Для y и x_2	488.89	97.778	688.746	137.749	67349.353	13469.871
Для x_1 и x_2	488.89	97.778	505.75	101.15	49457.148	9891.43

Discrepancy and standard deviations.

Знаки x и y	$D(x) = \frac{\sum x_i^2}{n} - \overline{x}^2$	$D(y) = \frac{\sum y_i^2}{n} - \overline{y}^2$	$s(x) = \sqrt{D(x)}$	$s(y) = \sqrt{D(y)}$
Для y и x_1	0.99	527.193	0.995	22.961
Для y и x_2	22.998	527.193	4.796	22.961
Для x_1 и x_2	22.998	0.99	4.796	0.995

Matrix of pair correlation coefficients R:

-	y	x_1	x_2
y	1	0.4747	0.00935
x_1	0.4747	1	0.2483
x_2	0.00935	0.2483	1

1. Analysis of multicollinearity based on the matrix of correlation coefficients.

If the matrix rxjxi> 0.7 has an inter-factor correlation coefficient, then in this model of multiple regression multicollinearity is observed. In our case, all pair correlation coefficients |r| <0.7, this indicates the absence of multicollinearity factors.

2. Ridge regression.

The most detailed indicator of problems associated with multicollinearity is the coefficient of variance increase, defined for each variable as:

$$VIF(b_j)=\frac{1}{1-R_j^2}$$

where R2 is the multiple determination coefficient in the regression of Xj on another X.

Multicollinearity will be indicated by a VIF of 4 or higher for at least one j.

$$VIF(b_1)=\frac{1}{1-0.2483^2}=1.07$$

Since VIF (b) 1 ≥ 4, this indicates the multicollinearity of factors x1, x2 and the need to exclude one of them from further analysis.

The poverty criterion is absolutely the high value of the ratio λmax / λmin of the maximum and minimum eigenvalues of the matrix XTX – the so-called indicator conditions. This ratio also gives an indication of the severity of multicollinearity problems: a conditionality indicator in the range from 10 to 100 indicates moderate collinearity, more than 1000 indicates very serious collinearity.

The regression model on a standard scale assumes that all the values of the studied characteristics are translated into standards (standardized values) according to the formulas:

$$t_j=\frac{xj_i-\overline{xj}}{S(x_j)}$$

where ji is the value of the variable j in the 1st observation.

$$t_y=\frac{y_i-\overline{xj}}{S(y)}$$

Thus, the beginning of each standardized variable is combined with the average value, and its standard deviations are taken as the unit of change.

If the relationship between the variables on a natural scale is linear, then the change in the origin and unit of measurement of this property will not be violated, so standardized variables will be connected by a linear relationship:

$$t_y = \sum\beta_j t_{xj}$$

To evaluate β-coefficients, OLS is used. In this case, the system of normal equations will look like:

$$r_{x1y}=\beta_1+r_{x1x2}\bullet\beta_2 + ... + r_{x1xm}\bullet\beta_m$$
$$r_{x2y}=r_{x2x1}\bullet\beta_1 + \beta_2 + ... + r_{x2xm}\bullet\beta_m$$
$$...$$
$$r_{xmy}=r_{xmx1}\bullet\beta_1 + r_{xmx2}\bullet\beta_2 + ... + \beta_m$$

For our data (we take from the Matrix of pair correlation coefficients):

$$0.475 = \beta_1 + 0.248\beta_2$$
$$0.00935 = 0.248\beta_1 + \beta_2$$

This system of linear equations is solved by the Gauss method: β1 = 0.503; β2 = -0.116;

Equation sought on a standardized scale: ty=ß1tx1+ß2tx2

The calculation of β-coefficients can be carried out according to the formulas:

$$\beta_1=\frac{r_{yx1}-r_{yx2}r_{x1x2}}{1-r_{x1x2}^2}=\frac{0.475-0.00935\cdot0.248}{1-0.248^2}=0.503$$
$$\beta_2=\frac{r_{yx2}-r_{yx1}r_{x1x2}}{1-r_{x1x2}^2}=\frac{0.00935-0.475\cdot0.248}{1-0.248^2}=-0.116$$

The standardized form of the regression equation:

ty = 0.503x1 -0.116x2

The B-coefficients found from this system make it possible to determine the values of the regression coefficients on a natural scale by the formulas:

$$b_j=\beta\cdot\frac{S(y)}{S(x_j)}$$
$$a=\overline{y}-\sum b_j\cdot\overline{x_j}$$

Let us move on to the statistical analysis of the regression equation: checking the significance of the equation and its coefficients, studying the absolute and relative approximation errors

For an objective assessment of variance, we perform the following calculations:

Unbiased error ε = Y-Y (x) = Y-X*s (absolute error of approximation)

Y	Y(x)	ε = Y - Y(x)	ε^2	$(Y-Ycp)^2$	|ε : Y|
102.289	121.637	-19.348	374.345	1257.426	0.189
122.403	139.666	-17.263	298.018	235.506	0.141
142.942	154.981	-12.039	144.935	26.965	0.0842
154.401	130.596	23.805	566.686	277.282	0.154
166.711	141.713	24.998	624.879	838.786	0.15
			2008.863	2635.965	0.719

Average approximation error

$$A=\frac{\sum|\epsilon:Y|}{n}\cdot100\,\%=\frac{0.719}{5}\cdot100\,\%=14.37\,\%$$

The variance estimate is:

$$s_e^2=(Y-Y(X))^T(Y-Y(X))=2008.863$$

Objective assessment of variance:

$$s^2=\frac{1}{n-m-1}\cdot s_e^2=\frac{1}{5-2-1}\cdot2008.863=1004.4313$$

Estimation of standard deviation (Standard error for estimating y):

$$S=\sqrt{S^2}=\sqrt{1004.4313}=31.693$$

Find an estimate of the covariance matrix of the vector k = $S^2 \bullet (X^TX)^{-1}$

k(x) = 1004.43	2072,154	-20,692	0,216	=	2081336,704	-20784,188	216,662
	-20,692	0,215	-0,0111		-20784,188	216,248	-11,14

0,216	-0,0111	0,00927	216,662	-11,14	9,309

The variance of the model parameters is determined by the relation S2 i = Kii, i.e., these are elements lying on the main diagonal.

$$S_{b0} = \sqrt{2081336.704} = 1442.684$$
$$S_{b1} = \sqrt{216.248} = 14.705$$
$$S_{b2} = \sqrt{9.309} = 3.051$$

Multiple Correlation Index

$$R = \sqrt{1 - \frac{s_\varepsilon^2}{\sum(y_i - \overline{y})^2}} = \sqrt{1 - \frac{2008.863}{2635.97}} = 0.4878$$

The multiple correlation coefficient can be determined through the matrix of pair correlation coefficients:

$$R = \sqrt{1 - \frac{\Delta_r}{\Delta_{r11}}}$$

where on Δ is the pair correlation coefficients matrix determinant; Δr11 is the correlation matrix determinant.

Δ_r =	1 0,475 0,00935 0,475 1 0,248 0,00935 0,248 1	= 0.715
Δ_{r11} =	1 0,248 0,248 1	= 0.938

Multiple correlation coefficients

$$R = \sqrt{1 - \frac{0.715}{0.938}} = 0.4878$$

A similar result is obtained by other formulas:

$$R = \sqrt{1 - (1 - r_{yx1}^2)(1 - r_{yx2|x1}^2)}$$
$$R = \sqrt{1 - (1 - 0.475^2)(1 - 0.127^2)} = 0.4878$$

The connection between the attribute Y and the coefficients Xi is average

Coefficient of determination $R^2 = 0.4878^2 = 0.2379$

A more objective assessment is the adjusted coefficient of determination:

$$\overline{R}^2 = 1 - (1 - R^2) \cdot \frac{n-1}{n-m-1}$$
$$\overline{R}^2 = 1 - (1 - 0.2379) \cdot \frac{5-1}{5-2-1} = -0.524$$

The closer this coefficient is to unity, the more the regression equation explains the behavior of Y.

A new model of explanatory variables is added as long as the adjusted coefficient of determination increases.

As a result of the calculations, the multiple regression equation was obtained: Y = -983.2025 + 11.6172X1-0.5539X2. An economic interpretation of the model parameters is possible: an increase in X1 by 1 unit. this leads to an increase in Y by an average of 11.617 units .; an increase in X2 by 1 ISM unit leads to a decrease in Y, on average, by 0.554 units.

III. Conclusion

Thus, as a result of the calculations, we can conclude that there is a dependence of the average level of economic growth on the natural resource potential. In addition, the agricultural production factor has a more serious impact, it is also positive.

In order to predict development trends, in the future it will be possible to analyze the presence of dependence by assessing a larger number of factors using the tools of autocorrelation and autoregression. This will be laid in promising areas for further research in the paradigm of dependence of the potential of natural resources and the level of development of the economy of the territory.

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