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“QURILISHDA YASHIL IQTISODIYOT, SUV VA ATROF-MUHITNI ASRASH TENDENSIYALARI, EKOLOGIK MUAMMOLAR VA INNOVATSION YECHIMLAR” MAVZUSIDAGI RESPUBLIKA MIQYOSIDAGI ILMIY-AMALIY KONFERENSIYA TASHKILIY QO‘MITASI

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Multivariate regression model for factors affecting natural gas production in the Republic of Uzbekistan

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Abstract: This article examines the relationship between natural gas production in Uzbekistan and the factors affecting it — domestic consumption, export volume, export income and international gas prices. A multivariate linear regression model was built to estimate the effects of these variables based on 20 years of data. Correlation analysis showed strong correlation between several indicators, while VIF analysis eliminated the multicollinearity problem. The final model was statistically evaluated for reliability using t-tests and F-tests. Through the results, factors were identified that significantly affect the volume of gas production. The conclusions drawn from these results help policymakers optimize resource management and export strategies.

Keywords: correlation matrix, multicollinearity, degree of significance, critical value, correlation coefficient, predictor, regression

1. Introduction

The industry of Uzbekistan is one of the most important sectors of the country's economy, its development is of great importance not only in domestic energy supply, but also in generating income through exports. Over the past 20 years, natural gas prices, production volumes, domestic consumption and exports have significantly affected the stability and financial condition of the Uzbek economy.

Natural gas prices vary depending on global market conditions and directly shape Uzbekistan's export revenues. Also important factors affecting the size of these revenues are the volume of natural gas production and domestic consumption. The study of the complex relationships between these factors and the identification of trends that developed in 2005-2024 are of great scientific and practical importance.

2. Objects and methods of research

In this study, the change in income from the export of natural gas based on the indicators of the price of natural gas, the volume of production, domestic consumption and export is analyzed using a regression model constructed by the methods given in [1] - [5]. This approach will help understand the economic dynamics of the gas sector in Uzbekistan, as well as shape further policies and strategies.

Below are the data on natural gas production in Uzbekistan in 2005-2024 and the factors affecting it.

Y	X_1	X_2	X_3	X_4
59,2	48,5	14,0	1200	8,69
59,7	49,0	15,2	1300	6,73
66,2	53,1	16,8	1400	6,97
63,2	51,0	17,6	1500	8,86
61,4	49,6	14,5	1350	3,95
58,8	48,0	13,2	1500	4,39
57,2	47,5	12,0	1600	4,00
56,3	47,0	11,5	1700	2,75
55,0	46,5	10,8	1800	3,73
56,0	48,0	10,0	1900	4,37
57,7	50,3	9,5	2000	2,61
56,4	49,8	8,7	1390	2,52
56,5	50,0	8,0	2420	2,99
59,1	52,0	7,5	2260	3,15
53,8	50,5	6,8	478	2,57
49,7	48,0	5,5	717	2,03
53,5	50,0	4,8	911	3,89
51,7	49,0	3,7	530	6,45
46,7	48,5	1,7	628	2,57
59,2	48,5	14,0	1200	8,69

Here

Y – natural gas production (billion m^3)

X_1 – natural gas consumption (billion m^3)

X_2 – natural gas export (billion m^3)

X_3 – income from natural gas exports (mln USD)

X_4 – Henry Hub Annual Natural Gas Price Averages ($/MMBtu).

The main purpose of building the model is to determine which of the listed factors, such as natural gas consumption, natural gas exports, annual average natural gas prices, income from natural gas exports, will have a greater impact on natural gas production and choose the best model.

The correlation matrix is a square table showing correlation coefficients between multiple variables. It is used to assess how each variable relates to their heads. Correlation value -1 to + 1

+ 1 - strong positive dependence

No dependency on 0

-1 - strong negative dependence

3. Results and their discussion

¤	y¤	x1¤	xx2¤	x3¤	x4¤
y¤	1,00000	0,49383	0,89911	0,48297	0,56213
x1¤	0,49383	1,00000	0,14330	0,07886	0,21427
x2¤	0,89911	0,14330	1,00000	0,36829	0,61621
x3¤	0,48297	0,07886	0,36829	1,00000	0,08716
x4¤	0,56213	0,21427	0,61621	0,08716	1,00000

From this table it can be seen that in our question the correlation coefficients between Y (natural gas production) and X_1 (natural gas consumption), X_2 (natural gas export), X_3 (natural gas export income) and X_4 (annual average natural gas prices) are $r_{YX_1} = 0{,}49383$, $r_{YX_2} = 0{,}89911$, $r_{YX_3} =$

0,48297, $r_{YX_4} = 0{,}56213$. Therefore r_{YX_1}, r_{YX_3} and r_{YX_4} are "good" predictors; r_{YX_2}strongly correlating

We analyze multicollinearity. The correlation coefficient between X_1 and X_2 was $\boldsymbol{r_{X_1X_2} = 0,14330}$. Under the conditions of multicollenniality, the conditions $\boldsymbol{r_{YX_1} \geq r_{X_1X_2}}$ and $\boldsymbol{r_{YX_2} \geq r_{X_1X_2}}$ will be met. According to preliminary data, multicollinearity does not exist. However, if look to $\boldsymbol{r_{X_2X_4}}$, the X_2 and X_4 are in a dubious position. This situation is clarified during the T-test, F-test and *VIF*-test. The *VIF*-test is performed for suspicious predictors. If there is a "dependency," we may not include this predictor in the model since it affects *Y* through another subject.

$$VIF_j = 1/(1 - R_j^2).$$

The decisive rule: if $VIF_j < 5$, then the *i* th predictor is left in the model considered verified, otherwise he will have to exclude the predictor or other strongly correlating predictor from the model.

The following model is proposed

$$Y = (X_1, X_2X_3, X_4)$$

The regression equation is

$Y = -2{,}14 + 0{,}989X_1 + 0{,}7813X_2 + 0{,}001426X_3 + +0{,}059X_4$Results of the *VIF*-test:

Term	*VIF*
X_1	1,06
X_2	2,27
X_3	1,44
X_4	2,05

Because $VIF(X_1) = 1{,}06, VIF(X_2) = 2{,}27, VIF(X_3) = 1{,}44$and $VIF(X_3) = 1{,}44$ since these values are less than 5, we leave them in the model and see the T-test. Information obtained through the Minitab program.

Term	T-Value
Constant	-0,33
X_1	7,42
X_2	10,65
X_3	3,06
X_4	0,40

We build a hypothesis for the T test. Our hypothesis consists of a null and double alternative hypothesis:

$$H_0: \beta_j = 0;$$
$$H_1: \beta_j \neq 0.$$

We find critical value *t* for degree of significance $\alpha = 0{,}025$:

$$t_{kr} = t_{\alpha/2}(n-k) = t_{0{,}025}(36) = 2{,}339061$$

$|t_i| > t_{\alpha/2}(n-k)$ the X_1,

According to the condition
X_2, X_3 pass the t-test, but X_4 does not satisfy this condition, so the X_4 did not pass the t-test. Critical point for F-testing found in Fisher distribution table

$$F_{kr} = F_\alpha(k-1; n-k) = F_{0{,}05}(3; 36) = 2{,}866266;$$

And the estimated sample value *F* is $\boldsymbol{F = 150,21}$.

According to the decisive rule: because $F > F_{kr}$, the model passes the F-test.

4. Conclusions

According to the results of the study, the multidimensional regression model, built on the basis of data collected on the gas industry of Uzbekistan for 2005-2024, acquired the following form:

$$Y = -2{,}48 + 0{,}999X_1 + 0{,}8018X_2 + 0{,}001344X_3$$

Analysis of the model shows that the greatest impact on natural gas production volumes is exerted by internal consumption (X_1) with a coefficient of 0.999. This suggests that gas production will be aimed primarily at meeting domestic needs. The impact of exports (X_2) is also important and makes a significant positive contribution to production. Export revenues (X_3) have a smaller but positive impact on production volumes. In addition, based on the analysis, global prices (X_4) were not included in the final model due to the lack of a statistical value. VIF and T - tests showed model robustness and no significant multicollinearity between predictors. The results of the F-test confirmed that the model as a whole is sensitive. Overall, this model can play an important role in shaping Uzbekistan's natural gas export strategy. You can optimize production by managing domestic consumption and export in a balanced manner. The results of the study create the scientific basis for making effective decisions when planning energy policy and achieving economic stability.

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