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Development Of Forecasting Indicators Of Industry Development Trends In The Republic Of Karakalpagistan

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Abstract

Subjects operating in the field of industrial production, which are considered as the driving force of socio-economic development in the Republic of Uzbekistan, are faced with fundamentally new requirements for the development of the industrial sector, in this regard, instead of their traditional interactions, they are consistently moving to digital communications. Despite the fact that a number of works on the problems of innovative development, its social and economic content, and the complex approach to the formation of the innovative development management mechanism have been intensively carried out, there are no complete works on the strategy of increasing the effectiveness of the innovative development management mechanism of the regional industry. This article discusses the issues of analyzing the development of the regional industry in the Republic of Karakalpakstan and forecasting the trends of innovative development of the regional industry.

Key words: region, industry, industrial products, innovation, innovative technologies, correlation analysis, regression analysis, ARIMA model, ARMAX model, lag model

Introduction

During the years of independence, Uzbekistan and its regions underwent great changes in the economic sphere, especially in the industrial sphere. In particular, in 2020-2021, the economic growth is 27.6%, and the share of industry in the GDP structure is also facing big changes. For example, in 2019, the share of industry in the country's GDP was 29.1%, and in 2020, this indicator decreased to 28%. In the next year 2021, this indicator of the industry will be equal to 28.1%, in 2023 its growth will not be observed (28.9%), and in the next year 2024, the share of the industry in the GDP is expected to reach 30.2%. Thus, the share of industry is increasing, and the growth of the share of industry in almost all GNI of some regions has grown faster than the growth of the share of industry in the GDP of the country.

Review of literature on the subject. Scientific study of economic problems in the development of industry in the region and issues of their elimination have always been in the focus of attention of economists-scientists. In particular, foreign economists A. Venables, H. Glenn, P. Krugman, B. Robert, M. Fujita, B. Shaun, M. Enright made a great contribution to the theoretical and practical aspects of this issue, in particular to the issues of the country's industrial policy[1].

[1] Roberts B. National and regional corporate spatial structure / B. Roberts, A. Murray // The Annals of Regional Science. 2002. Vol. 36.; Fujita M., Krugman P., Venables A.J. The Spatial Economy: Cities, Regions and International Trade. - The MIT Press, 2001. P. 384. Enright M. The Geographical Scope of Competitive Advantage // Stuck in the Region? Changing scales for regional identity / Ed. By E. Dirven, J. Grocnewegen and S. van Hoof. Utrecht, 1993. P. 87102. B.Shaun and H. Glenn. Microregionalism and world order: concepts, approaches and implications. London: Palgrave Macmillan, 2003. P. 272.

A.G. Granberg, Yu.A. Gadzhiev, O.G. Dmitrieva, N. Zubarevich, S.V. Kazantsev, I.N. Merenkova, A.N. Nosov, O.I. Panteleeva, among the economists of the CIS countries. D. Sepik, L.A. Serebryakova and others paid special attention to the theoretical issues of regional economic development, increasing the weight of industry in the region, and increasing competitiveness in its industries[2].

In Uzbekistan, the issues of industrial development and its management, forecasting industrial development trends are the subject of scientific interest of economists in this regard. In particular, issues such as analysis of the socio-economic development of regional industrial complexes, comprehensive analysis of regional industrial complexes, territorial placement and management of productive forces, improvement of the methodological basis for increasing the industrial competitiveness of the country's regions, were discussed by Uzbek economists B.K. Qobulov, S.S. Gulomov, T. Shodiev, T.M. Akhmedov, A.M. Kadyrov, B.B. Berkinov, Sh.Kh. Nazarov, A.M. Sodikov, N. Makhmudov, R. I. Nurimbetov, B. S. Kalmuratov, I. It has a wide place in the scientific researches of Umarov and others[3].

The branch and regional structure of the industry of the Republic of Karakalpakstan related to the topic proposed by the above-mentioned scientists was not fully taken into account, as well as the forecasting of the industrial development trends of the region was not carried out.

Research methodology. In the research, induction and deduction, logical approach, space and time, comparative analysis, statistical analysis, empirical evaluation, systematic and situational approach, analysis and synthesis, survey method, as well as economic-mathematical models, statistical and econometric methods of the theory of knowledge were used.

Main part. During our researches, it was confirmed that the development of industry in the Republic of Karakalpakstan is one of the promising directions in strengthening the export potential of the region, ensuring economic stability, increasing the income of the population, and producing products with high added value. As a result, in the following years, special attention is being paid to issues such as industrial development in the region, ensuring efficiency in the field, and modernization of the field.

With the effective use of innovative technologies, high-speed growth of the industry is ensured. For example, in 2000-2022, the value of industrial products grown in Uzbekistan at constant prices increased by 3.0 times, while in the Republic of Karakalpakstan this indicator was 4.3 times. That is, it had an almost 1.4 times higher growth rate. In this period, the average growth rate of industrial production in Uzbekistan was 5.4 percent, while in the Republic of Karakalpakstan it was 7.2 percent.

[2] Granberg A.G. Basic regional economy. M.: GU VShE, 2003. - 52 p.; Gadjiev Yu.A. Zarubezhnye novye teorii regionalnogo rosta i razvitiya //"Korporativnoe upravlenie i innovatsionnoe razvitiya Severa". Vestnik Syktyvkarskogo gosudarstvennogo universiteta. 2008 #2; Dmitrieva O.G. Regional economic diagnosis. SPb.: Izd-vo SPb. University of Economics and Finance, 1992.; Zubarevich N. Institute of Regional Development // Expert portal Vysshey shkoly ekonomiki "Otkrytaya ekonomika" - OPEC.ru; Kazantsev SV. Potentsial ekonomiki regionov Rossii kak osnova ix vnutrenney konkurentosposobnosti // Region, 2004, #1; Merenkova I.N. Diagnostika urovnya razvitiya selskikh territoriy // "Regionalnaya ekonomika: teoriya i praktika", 2010, #24; Nosov A.K. Management of interrelationships and regional cluster structure, connected supply chains // "Logistics and management of supply chains", 2009, #6; Panteleeva A.P. Application of indicators of sustainable development at regional and municipal levels // "Regional economy: theory and practice", 2010. #22; Sepik D. Indicatory konkurentosposobnosti regionsov: evropeysky podkhod //"Region: economics and sociology", 2005, #2; Serebryakova L.A. Methody otsenki urovnya sotsialno-ekonomicheskogo razvitiya regionov // Vestnik SevKavGTU, series "Economics", 2003, #3.

[3] Gulyamov S.S. Modelirovanie sotsialno-ekonomicheskogo razvitiya territorialno-promyshlennyx kompleksov. T.: Science, 1980. - 194 p.; Akhmedov T.M. perspectivnogo planirovaniya», application of mathematics and economic research, M. Mysl, 1965; Gulyamov S.S., Abdullaev A.M. i dr. National economic forecasting and modeling. / Pod ed. akad. OS. Gulyamova. - T.: Science and technology, 2007; Shodiev T.Sh. Problemy modelirovaniya razvitiya selskogo hozyaystva (na primere Uzbekistana): dis.dok.ekon.nauk.-T.: TGEU, 1988. -380 p.; Khodiev B.Yu., Berkinov B.B., Kravchenko A.N. Enjoy the pleasure of business. Ukuv kullanma./ I.f.d., under the editorship of Prof. B.Yu. Khodiev.-Tashkent: Fan, 2006. -228 p;; Gulyamov S.S, Salimov B.T. Modelirovanie ispolzovaniya i razvitiya proizvodstvennogo potensiala regiona. N. Makhmudov. Forecasting socio-economic processes. Do not use. - T.: "Iktisodiet", 2012; Rasulev D.M. Vveedenie v dynamika obshchego ekonomicheskogo ravnovesiya. Uchebnoeposobie.-Tashkent. izd. TGEU, 2006. -S-88. Kadyrov A. M. "Innovative potential development of promyshlennyx predpriyati republic v usloviyax rynka". Scientific and practical conference "Novoe kachestvo ekonomicheskogo rosta: innovation, konkurentosposbnost, investitsii".-T., April 23, 2008; Umarov I., Saidkarimova S., Oblokhlova Sh.. Analysis of indicators of innovative potential of industrial enterprises// "Economics and innovative technologies" scientific electronic journal. 2015 year. 4 issues, July-August. Kalmuratov B.S. Strategy for improving the efficiency of the mechanism of managing innovative development of the regional industry. Doctor of Economic Sciences (DSc) thesis abstract - N.: 2023,-37

However, the results of the above-mentioned analysis do not provide an opportunity to draw sufficient conclusions regarding industrial development and its stability in the region. Taking this into account, we would like to focus on the descriptive statistical indicators determined on the basis of the data of 2000-2022 (Table 1).

To perform a comparative analysis, indicators were calculated for the Republics of Uzbekistan and Karakalpakstan. In order to assess the degree of stability of various fluctuations in the development of the industry, the mean square deviation index is presented. However, taking into account the existence of economies of scale between the two regions under comparative analysis, a standard indicator was calculated and we found it appropriate to use it.

Table 1

Indicators for assessing sustainability in industrial development (based on data from 2000-2022)[4]

	Ўзбекистон республикаси	Қорақалпоғистон республикаси
Mean squared deviation	1294,3	57,5
Maximum value	5971,4	192,5
Minimum value	1888,9	36,8
Variation width	4082,5	155,7
The ratio of the width of variation to the standard error	3,2	2,7

This standard deviation is determined by dividing the variation width by the mean square deviation. According to the results, the ratio of both indicators in the Republic of Uzbekistan is 3.2 units, while in the Republic of Karakalpakstan it is 2.8 units. It can be seen that during the period of the analysis, the stability of the industry in the Republic of Karakalpakstan was high.

However, on the other hand, it is observed that the share of industrial production in the region decreased in the next four years. In particular, in 2018 it reached the highest value, i.e. 4.6, and as a result of the decrease in the following years, it decreased to 3.2 percent by 2022 (Fig. 1).

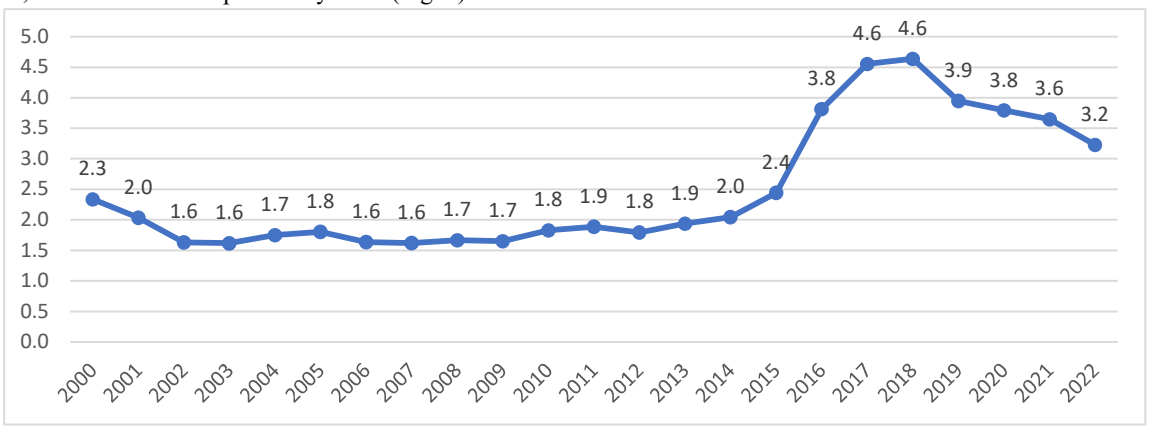


Figure 1. The share of the Republic of Karakalpakstan in the production of industrial products (in percent).[5]

According to the trend, the share of the Republic of Karakalpakstan in the production of industrial products corresponds to the period after 2016, that is, in 2015, it was 2.4 percent, slightly increased from the level of 2000, and high growth rates were ensured in the next period. However, after 2019, a downward trend was observed.

In the origin of the above-mentioned changes, the influence of the organization of activities in industrial enterprises and the level of use of existing opportunities was considered on the basis of correlational analysis. Taking into account the availability of data on the period of changes and the number of industrial enterprises, the analysis was carried out on the basis of the data of 2013-2022 (Table 2).

[4] Source: development of authors
[5] Source: development of authors

Table 2
Correlation analysis results[6]

	REGIN	*ACIN*	*NACIN*	*NEWIN*	*CLOIN*	*REGINSB*	*ACINSB*	*NACINSB*	*NEWINSB*	*CLOINSB*	*INDQQ*	*HSDNI*
REGIN	1,00											
ACIN	1,00	1,00										
NACIN	0,35	0,28	1,00									
NEWIN	0,94	0,95	0,11	1,00								
CLOIN	0,62	0,60	0,56	0,44	1,00							
REGINSB	1,00	1,00	0,35	0,94	0,62	1,00						
ACINSB	1,00	1,00	0,28	0,95	0,59	1,00	1,00					
NACINSB	0,35	0,29	1,00	0,12	0,57	0,35	0,29	1,00				
NEWINSB	0,94	0,95	0,11	1,00	0,44	0,94	0,95	0,12	1,00			
CLOINSB	0,63	0,60	0,56	0,45	1,00	0,62	0,60	0,56	0,45	1,00		
INDQQ	0,79	0,82	-0,21	0,84	0,38	0,79	0,82	-0,20	0,84	0,39	1,00	
INDSH	0,28	0,33	-0,67	0,45	-0,05	0,28	0,33	-0,66	0,45	-0,04	0,80	1,00

Here, REGIN is the number of industrial enterprises and organizations registered in the Republic of Karakalpakstan; ACIN – the number of active industrial enterprises and organizations in the Republic of Karakalpakstan; NACIN - the number of inactive industrial enterprises and organizations in the Republic of Karakalpakstan; NEWIN - the number of newly established industrial enterprises and organizations in the Republic of Karakalpakstan; CLOIN - the number of closed industrial enterprises and organizations in the Republic of Karakalpakstan; REGINSB – the number of small business entities registered in the industrial sector in the Republic of Karakalpakstan; ACINSB - the number of small business entities active in the industrial sector in the Republic of Karakalpakstan; NACINSB - the number of small business entities inactive in the industrial sector in the Republic of Karakalpakstan; NEWINSB - the number of newly established small business entities in the industrial sector in the Republic of Karakalpakstan; CLOINSB - the number of small business entities whose activity in the industrial sector in the Republic of Karakalpakstan has been terminated; INDQQ - volume of industrial products produced in the Republic of Karakalpakstan billion soums; INDSH - the share of the Republic of Karakalpakstan in the production of industrial products (in percent).

From the results of the correlation analysis, it was found that the number of industrial enterprises and organizations registered in the region is strongly related to the manufactured industrial products, but it can be observed that there is almost no correlation with the share of the region in the production of industrial products. The same situation can be observed with the number of active industrial enterprises.

If the change in the number of inactive industrial enterprises has a weak and negative effect on the manufactured industrial products, the opposite and higher effect was found with the share of the manufactured industrial products. From this, it can be noted that the change in the number of non-performing enterprises is the cause of the negative results in the share. The correlation coefficient expressing the effect of the number of newly established industrial enterprises and organizations on the volume of output has the highest value, while the effect on the share was also found to be sufficiently high. It should be noted that the number of closed industrial enterprises and organizations has a weak but positive effect on the volume of production. It was proved that there is a negative but insignificant effect on the share. The effect of the change in the number of small business entities in the industry on the manufactured product and its share is almost the same as the change in the total number of industrial enterprises. There is a positive correlation between the volume of manufactured industrial products and their share, that is, the correlation coefficient is 0.80.

According to the results of the correlational analysis, it can be noted that the development of industrial enterprises in the region and the support of innovative processes in them, as well as ensuring competitiveness, remain low compared

[6] Source: development of authors

to other regions in the following years. As a result, the share impact of defunct and active industries remains negligible. Taking this into account, a regression analysis was carried out in order to determine the quantitative values of their effect on the industrial products produced and the region's share in the production of industrial products (Table 3).

In order to justify the adequacy of the initially developed models, we will pay attention to the mentioned criteria and their threshold indicators. Initially, the Student's criterion was cited to justify the adequacy of the coefficient determined based on the model, and we did not find it permissible to quote it due to the fact that the values determined in all models are much higher than the threshold value. In addition, the probability indicators justify the adequacy of the coefficients.

Table 3

Regression analysis results[7]

№	Model	t-statistics	R^2	MAPE	DW	Elasticity
1	$INQQ = REGIN^{0.65}$	b_1=61,25	0,99	4,3	0,61	0,65
2	$INQQ = ACIN^{0.66}$	b_1=68,63	0,99	3,9	0,72	0,66
3	$INQQ = NACIN^{1.02}$	b_1=17,91	0,97	14,9	0,39	1,02
4	$INQQ = NEWIN^{0.82}$	b_1=44,26	0,99	5,2	0,76	0,82
5	$INQQ = CLOIN^{0,99}$	b_1=28,51	0,99	9,5	1,43	0,99
6	$Ln(INQQ) = 0{,}13 * REGINBB$	b_1=7,08	0,85	27,69	0,69	-
7	$Ln(INQQ) = 0{,}14 * ACINBB$	b_1=7,16	0,85	26,87	0,73	-
8	$Ln(INQQ)_t = 0{,}18 * NACINBB + 1{,}00 * Ln(INQQ)_{t-1}$	b_1=2,16 b_2=88,66	0,99	1,52	-	-
9	$Ln(INQQ) = 2{,}34 * CLOINBB$	b_1=2,27	0,36	72,97	0,60	-
10	$INDSH = 0{,}45 * Ln(REGIN)$	b_1=11,83	0,94	25,66	0,47	
11	$INDSH = 0{,}45 * Ln(ACIN)$	b_1=12,13	0,94	25,04	0,48	
12	$INDSH = 0{,}70 * Ln(NACIN)$	b_1=7,97	0,88	36,61	0,36	
13	$INDSH = 0578 * Ln(CLOIN)$	b_1=13,14	0,95	22,78	0,54	
14	$INDSH = 0{,}68 * Ln(CLOIN)$	b_1=10,12	0,92	30,78	0,56	
15	$INDSH = 0{,}09 * REGINBB$	b_1=5,60	0,78	47,62	0,50	
16	$INDSH = 0{,}09 * ACINBB$	b_1=5,67	0,78	47,88	0,52	

The Durbin-Watson criterion is also mentioned in order to solve the problem of autocorrelation in the models. Due to the absence of a free term in all models, we present the criterion of Durbin-Watson indicators, which is suitable for this situation. If the number of factors in the model is one, then DW(positive)=0.63, DW(negative)=2.84, and due to the fact that two factors were obtained in the eighth model, threshold values were also calculated for this case, i.e. DW(positive)=0.46 , DW(negative)=2.45.

In our first model, all criteria are in demand, but the Durbin-Watson statistic shows that there is a positive autocorrelation. In general, the coefficient of elasticity is 0.65, which represents the positive effect of the increase in the number of registered industrial enterprises and organizations. The same situation can be observed in the results of the model developed to express the effect of the number of active industrial enterprises and organizations, but unlike the above, in this case the Durbin-Watson statistic has a high value compared to the threshold indicator and shows that there is no autocorrelation problem. That is, a one percent increase in the number of active industrial enterprises and organizations leads to an increase in the volume of manufactured goods by 0.66 percent.

The coefficient of elasticity determined by the number of inactive industrial enterprises and organizations is the highest and has a positive value. Basically, this indicator is required to have a negative value. There is an autocorrelation problem with the results of the criteria for justifying the adequacy of the model. The results of this model do not allow for conclusions due to the fact that they are different from the results of the correlation analysis and there is an autocorrelation problem.

The coefficients of elasticity determined by the number of newly established and terminated industrial enterprises and organizations are equal to 0.82 and 0.99, respectively. All criteria justifying the adequacy of these models are also in

[7] Source: development of authors

demand. A positive and high correlation between the finished industrial enterprises and the volume of produced products indicates that there are problems in the activity of enterprises in the industrial sector.

The importance of small and large business in the development of industry and innovative processes in the industry is unique. Therefore, the effects of small and large industrial enterprises on the produced industrial products were also considered separately. Only, the results of the regression analysis performed on small businesses had the same value as the coefficients of elasticity determined on total industrial enterprises and organizations. Therefore, the main attention was paid to the effect of the change in the number of large business entities on the volume of manufactured industrial products.

The fact that the number of large industrial enterprises is relatively unchanged causes the value to be zero for some years, so it was not possible to logarithmize them and use the rank function. A log-lin model was used instead. If the coefficient determined by this model is multiplied by 100, a one-percent change in the independent variable will allow us to determine how much the independent variable will increase. An increase in the number of registered large industrial enterprises by one unit increases the volume of manufactured industrial products by 13 percent, and the coefficient determined by large industrial enterprises was 14 percent. According to the results of the impact assessment of the number of inactive large industrial enterprises, it was found that there is an autocorrelation problem. According to the results of its elimination, the determined coefficient has a positive value.

A linear model was used to estimate the effects of changes in the number of enterprises on the region's share in the production of industrial products. That is, it makes it possible to calculate the percentage change of one unit in the number of enterprises. However, it can be observed that there is an autocorrelation problem in all models.

Taking into account the above, within the framework of the available opportunities, the forecast values of the production of industrial products in the following years were developed on the basis of various models. A graphical method was used to select the type of model and it was determined that the use of a lag model was appropriate. The graph shows that in 2016 there was a sharp increase in the volume of production of industrial products in the region, that is, an increase of 64.5% compared to the previous year. Therefore, a dummy variable was used to account for the effect of this change. In this factor, zero was given for all years, only in 2016 one was put. As a result, the developed lag model had the following form.

$$INDQQ_t = 49{,}81 * D + 0{,}66 * t + 0{,}96 * INDQQ_{t-1}$$

In order to justify the adequacy of this model for the development of forecast values, the necessary criteria were mentioned (Table 4).

Table 4

Results of the selected lag model for calculating forecast values of industrial products produced in the Republic of Karakalpakstan[8]

Model 17: OLS, using observations 2001-2022 (T = 22)

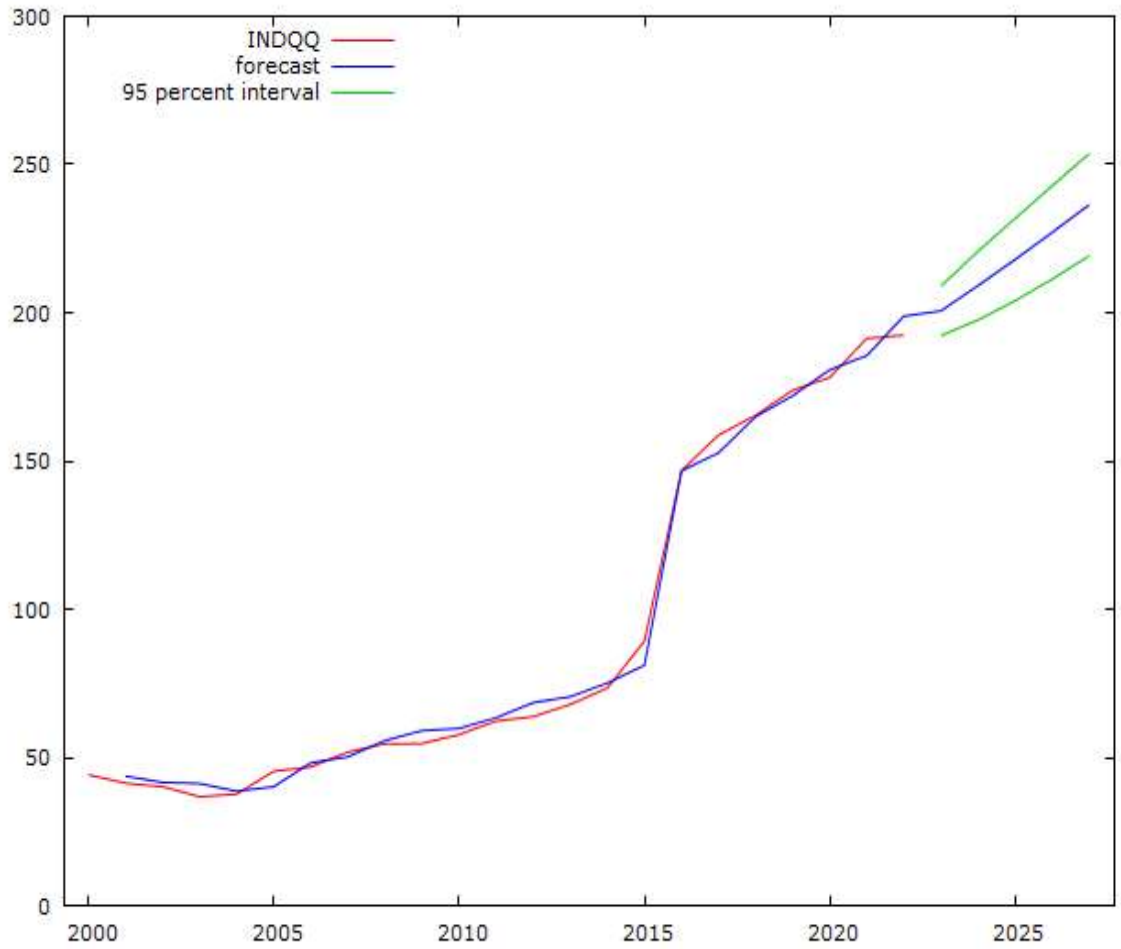
Dependent variable: INDQQ

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
D	49.8095	4.28928	11.61	<0.0001	***
time	0.667792	0.266710	2.504	0.0216	**
INDQQ_1	0.959075	0.0365507	26.24	<0.0001	***

Mean dependent var	92.25911	S.D. dependent var	57.97143
Sum squared resid	302.8566	S.E. of regression	3.992470
Uncentered R-squared	0.998825	Centered R-squared	0.995709
F(3, 19)	5385.463	P-value(F)	5.27e-28
Log-likelihood	−60.06103	Akaike criterion	126.1221
Schwarz criterion	129.3952	Hannan-Quinn	126.8931
rho	−0.115747	Durbin's h	−0.551062

The mentioned criteria justify the appropriateness of using the developed model. Also, we can see from the graph presented in Figure 2 that the estimated indicators based on the model and the actual indicators almost overlap.

[8] Source: development of authors



2 pictures. Estimated values of industrial products produced in the Republic of Karakalpakstan based on the lag model

Taking these into account, forecast values for the next five years were developed (Table 5).

Table 5

Forecast results calculated based on the developed lag model[9]

Years	Prognosis	Growth rate	Standard error	95 percent confidence interval
2023	200,604	104,2	3,99247	(192,247, 208,960)
2024	209,089	104,2	5,53188	(197,510, 220,667)
2025	217,894	104,2	6,63988	(203,997, 231,792)
2026	227,007	104,2	7,51618	(211,276, 242,739)
2027	236,415	104,1	8,24035	(219,168, 253,662)

From the results of the calculated forecast, it is known that in the next five years, stability will be ensured in the growth rate of industrial products, with an average growth rate of 4.2 percent, and by 2027, the real value of manufactured industrial products will be 236.4 billion soums. This means 1.23 times more than in 2022.

Considering the type of data being used for forecasting, an appropriate ARIMA model was developed. According to the results of the UNITROOT test, the second-order difference of the data is stationary, according to the results of the correlogram, it was determined that it is appropriate to use the model in the form of ARIMA (0 2 1). As a result, the model had the following appearance.

[9] Source: development of authors

$$(1-L)^2 INDQQ_t = -0{,}72 * (1-L)^2 \varepsilon_{t-1}$$

This model and its coefficients are adequate according to the criteria presented in Table 6, justifying its use in drawing conclusions and calculating prognostic indicators.

Table 6

Results of the ARIMA (0 2 1) model selected to calculate forecast values of industrial products produced in the Republic of Karakalpakstan[10]

Model 6: ARIMA, using observations 2002-2022 (T = 21)

Dependent variable: (1-L)^2 INDQQ

Standard errors based on Hessian

	Coefficient	*Std. Error*	*z*	*p-value*	
theta_1	−0.721894	0.248128	−2.909	0.0036	***

Mean dependent var	0.191351	S.D. dependent var	14.74974
Mean of innovations	1.817169	S.D. of innovations	12.51745
R-squared	0.957538	Adjusted R-squared	0.957538
Log-likelihood	−83.23547	Akaike criterion	170.4709
Schwarz criterion	172.5600	Hannan-Quinn	170.9243

		Real	*Imaginary*	*Modulus*	*Frequency*
MA					
	Root 1	1.3852	0.0000	1.3852	0.0000

Forecast values for the next five years were calculated based on the ARIMA (0 2 1) model developed based on the results of the analysis mentioned above (Table 7).

Table 7

Forecast results calculated based on the developed ARIMA (0 2 1) model [11]

For 95% confidence intervals, z(0.025) = 1.96

Years	Prognosis	Growth rate	Standard error	95 percent confidence interval
2023	201,065	104,5	12,5175	(176,531, 225,599)
2024	209,677	104,3	20,3136	(169,863, 249,491)
2025	218,29	104,1	28,1444	(163,128, 273,452)
2026	226,902	103,9	36,3224	(155,712, 298,093)
2027	235,514	103,8	44,9278	(147,458, 323,571)

According to the forecast results calculated on the basis of the ARIMA (0 2 1) model, the growth rate in 2023 will be 4.5 percent compared to the previous year. However, it will tend to decrease by 0.2 percent in the following years, and by 2027, the growth rate will be 3.8 percent compared to the previous year. In general, it will increase by 1.22 times compared to 2022 and will have almost the same value as the previous forecast results.

The results of both predictions have almost the same value and both of them can be used, but from the point of view of reliability and stability, we can suggest using the lag model. However, the relatively small standard error of this model ensures that the 95 percent confidence interval is also small and the confidence level is relatively high.

In recent years, the share of the Republic of Karakalpakstan in the production of industrial products has been ensured, albeit at an insignificant level. Stability in the developed forecast results serves to justify this positive result. For this reason, the following model was developed to calculate the forecast values of the region's share in the production of industrial products.

$$(1-L)^2 INDSH_t = -1 * (1-L)^2 \varepsilon_{t-2} + 0.33 * D$$

The full results of this model are presented in Table 8, and all criteria and their values support the adequacy of

[10] Source: development of authors

[11] Source: development of authors

the model and its coefficients.

Table 8

Results of the ARMAX model selected for calculating the forecast values of the share of the Republic of Karakalpakstan in the production of industrial products[12]

Model 4: ARMAX, using observations 2002-2022 (T = 21)

Dependent variable: (1-L)^2 INDSH

Standard errors based on Hessian

	Coefficient	*Std. Error*	*z*	*p-value*	
theta_2	−1.00000	0.236047	−4.236	<0.0001	***
D	0.329734	0.0604170	5.458	<0.0001	***

Mean dependent var	−0.005433	S.D. dependent var	0.399147
Mean of innovations	0.045929	S.D. of innovations	0.253780
R-squared	0.951394	Adjusted R-squared	0.948836
Log-likelihood	−3.442037	Akaike criterion	12.88407
Schwarz criterion	16.01764	Hannan-Quinn	13.56414

		Real	*Imaginary*	*Modulus*	*Frequency*
MA					
	Root 1	-1.0000	0.0000	1.0000	0.5000
	Root 2	1.0000	0.0000	1.0000	0.0000

Using the selected ARMAX model, the forecast values of the share of the Republic of Karakalpakstan in the production of industrial products in the following years were determined, and the obtained results were as follows (Fig. 3).

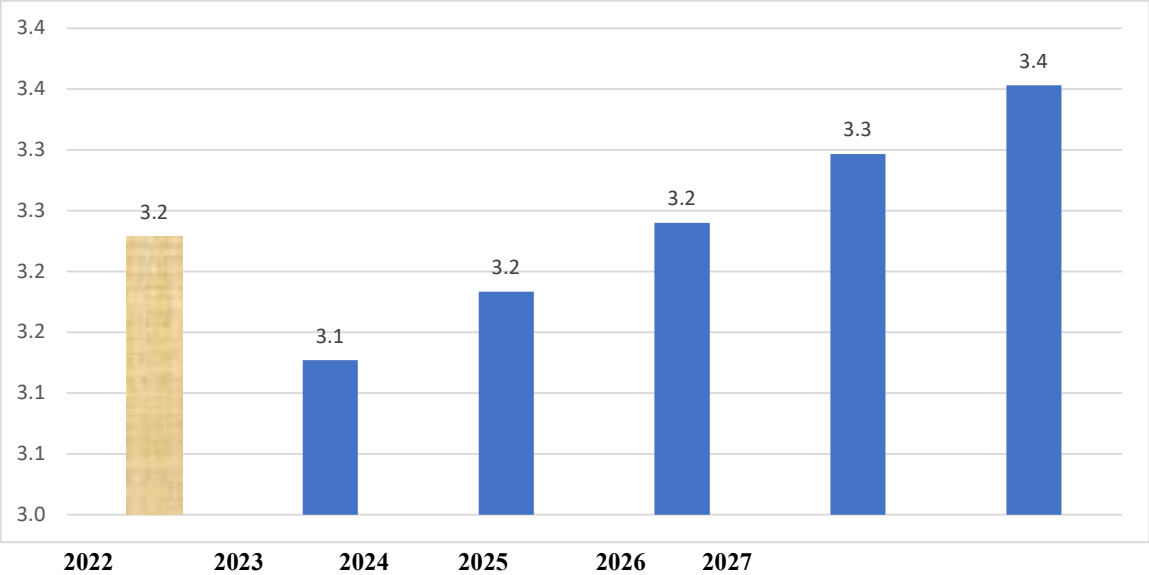


Figure 3. Forecast values of the share of the Republic of Karakalpakstan in the production of industrial products

It is known from the results of the calculated forecast that the share will decrease by 0.1 percent in 2023, but the rate of growth will be observed gradually in the following years. As a result, by 2027, the share of the Republic of Karakalpakstan in the production of industrial products will reach 3.4%.

Conclusion

In general, in the following years, a stable increase in the production volume and share of industrial products will be ensured in the Republic of Karakalpakstan. Because the decline in recent years was caused by the unstable trend of changes in the number of enterprises and the volume of production of industrial products. It is known from the results of

[12] Source: development of authors

correlational analysis that there are problems in organizing the activities of enterprises. In our opinion, increasing the efficiency of industrial enterprises in the region by introducing innovative technologies will serve to achieve the stated results.

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