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ECONOMETRIC ANALYSIS OF INDUSTRIAL NETWORK DEVELOPMENT OF NAMANGAN REGION

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Abstract
The article presents an econometric analysis of development trends in the industrial sector of the Namangan region. An econometric model was created based on the parameters of the production function, which represents the dependence of the volume of industrial production on the cost of fixed assets and the number of labor resources, and the reliability of the model was assessed. The efficiency indicators of the model factors and forecasts of industrial production volumes are calculated, conclusions and proposals are presented.
Keywords: Industry, production function, multiplicative model, additive model, correlation coefficients, model reliability criteria, forecasting.

Introduction

The importance of industry is manifested at every stage of the development of society, in the life of mankind. Industry is the driving force behind the development of science, technology and other fields. The development of the country's industrial network causes the creation of the main jobs, the formation of a large part of the gross domestic product, and also helps the development of the general economy.

In the decree of the President of the Republic of Uzbekistan dated January 28, 2022 No. PF-60 "On the development strategy of New Uzbekistan for 2022-2026" it is stated that "Ensure the stability of the national economy of our country and the share of industry in the gross domestic product by continuing the industrial policy aimed at increasing the production of industrial products by 1.4 times", as well as "increasing the regional economy by 1.4 - 1.6 times through the proportional development of regions" [1].

In order to achieve these goals at the level of Namangan region, it is necessary to know the current state of the development level of the industrial network in the region, the laws of growth dynamics, to determine the factors and resource sources that are the basis for development, and to develop measures to change these factors in accordance with the goals. . Production functions (PF), one of the main instruments of econometrics, are widely used in the analysis of production processes and efficient use of resources in the industrial network.

Production functions are a mathematical relationship between the production of a product and the resources used in this process.

From the point of view of econometric analysis, production processes can consist of certain analytical functions or a system of equations and inequalities.

In general, the production function (PF) has the following form:

$$y = f(x_1, x_2, ..x_n) \quad (1)$$

here - *y*-the amount of the produced product; *x*- consumption of resources.

From the set of dependencies, the selection of the PF that corresponds to the nature of the economic process is achieved based on studying the technological, management and several other characteristics of the object being modelled.

Methodology

In the study of PF, it can be used in researching problems such as evaluating the efficiency of some production factors, mutual exchange of factors with other factors, and the development of technology. In most cases, a two-factor multiplicative model in the form of Cobb-Douglas can be used.

$$y = A \cdot K^{\alpha} \cdot L^{\beta},$$

here:-K- the value of the main production funds in the enterprise;

L- labor costs spent on product production at the enterprise;

A, α, β -calculated parameters [2].

Table 1 shows the volume of industrial production of Namangan region, the number of people employed in industry, and the value of fixed assets of the regional industrial network. Based on the data of the statistics department of Namangan region, when constructing the Kobba-Douglas production function based on current prices, taking into account the low reliability of the econometric model when price changes are not taken into account, the price index of industrial products and the growth of industrial products Taking into account all the values expressed in money, they were brought to the values of the year 2022 [3].

For example, the industrial output in 2003 at current prices was 185.3 billion soums, and at the prices of 2022, this indicator will be 1 trillion. 765 billion 901 mln. amounted to soum. The value of the main funds of the regional industrial network at the prices of 2003 is 66 billion. 512 mln. 633 billion soums in 2022 prices. 742 mln. amounted to soum. When creating an econometric model of industrial production based on the Kobba-Douglas production function, all values are based on the indicators of 2022. The number of people employed in industrial production does not change because there is no monetary value.

In order to find the unknown parameters A, α, β in the model (2) given above, it is first necessary to transform the model from a level representation to a linear representation. For this, it is necessary to logarithmize the left and right sides of the model (2). As a result of logarithmization, we get the following linear additive model:

$$\ln y = \ln A + \alpha \ln K + \beta \ln L,$$

It can be seen from the logarithmic model (3) that it has become a linear additive model. We use the "method of least squares" to find the unknown parameters in the model. That is, the essence of the "method of least squares" is that the sum of the squares of the difference between the calculated values of the function and its actual values should be the minimum.

$$F(x) = \sum (y_{\text{тм}} - f(x))^2 \rightarrow \min$$

Table 1

The volume of production, the value of fixed assets and the number of employees in the industry of Namangan region during 2003-2022

years	The volume of regional industrial output, at current prices. (billion soums)	People employed in industry (thousands)	Value of fixed assets of industrial production, at current prices (billion soums)	Growth rate of production of industrial products of Namangan region, in percent	The volume of industrial production of the region, at the price of 2022. (billion soums)	The value of industrial production fixed assets, at 2022 prices (billion soums)
2003	185,3	78,9	66,512	113,3	1765,901	633,742
2004	242,8	80,1	78,604	113,0	1995,468	645,979
2005	330,5	84,6	86,184	114,0	2274,834	593,205
2006	309,5	88,5	103,428	108,6	2470,469	825,576
2007	368,3	88,2	124,482	107,1	2645,873	894,281
2008	472,7	93,6	164,694	110,7	2928,981	1020,490
2009	593,7	93,7	227,610	114,8	3362,470	1289,088
2010	1000,7	98,9	302,448	122,1	4105,576	1240,855
2011	1358,1	99,6	387,612	114,8	4713,201	1345,183
2012	1615,6	103,7	490,902	110,9	5226,940	1588,212
2013	1892,1	108,1	602,568	111,1	5807,131	1849,369
2014	2315,2	112,8	729,624	113,1	6567,865	2069,831
2015	2861,8	117,2	909,618	114,4	7513,637	2388,196
2016	3475,7	121,7	1191,288	113,0	8490,410	2910,068
2017	4615,5	126,5	1581,462	114,7	9738,500	3336,815
2018	6586,6	131,2	1215,312	113,8	11082,413	2044,827
2019	8818,1	135,9	2596,624	110,4	12234,984	3602,744
2020	11011,9	137,7	10770,903	115,3	14106,937	13798,201
2021	14695,1	145,5	12625,121	118,2	16674,400	14325,589
2022	18241,8	151,3	15348,194	109,4	18241,793	15348,194

Source: www.namstat.uz Compiled by the author based on the data of the Namangan Region Statistics Department [4]

(3) to find the unknown parameters in the model, a "system of normal equations" of the following form is created

$$\begin{cases} n\cdot\ln A+\alpha\cdot\sum\ln K+\beta\cdot\sum\ln L=\sum\ln y \\ \ln A\cdot\sum\ln K+\alpha\cdot\sum(\ln K)^2+\beta\sum\ln L\cdot\ln K=\sum\ln y\cdot\ln K \\ \ln A\cdot\sum\ln L+\alpha\cdot\sum\ln L\cdot\ln K+\beta\cdot\sum(\ln L)^2=\sum\ln y\cdot\ln L \end{cases}$$

As a result of solving this system of equations, unknown parameters A,α,β in model (3) are determined.

We will use data from 2003-2022 to determine the production efficiency of the industrial sector, which is one of the main sectors of the Namangan region, and the impact of resource consumption on the gross output of the industrial sector. The logarithmic values of the factors are presented in Table 2 below.

Table 2

The main indicators in the industrial sector of Namangan region Dynamics in 2003-2022

years	Production volume of the industrial network, bln. soum. Ln Y	The value of the main funds of the industrial network, billion soums. Ln K	The number of people employed in the industry, thousand people. Ln L	years	Production volume of the industrial network, bln. soum. Ln Y	The value of the main funds of the industrial network, billion soums. Ln K	The number of people employed in the industry, thousand people. Ln L
2003	7,476416	6,451642	4,368181	2013	8,666842	7,5226	4,683057
2004	7,598634	6,470768	4,383276	2014	8,789944	7,635222	4,725616
2005	7,729662	6,38554	4,437934	2015	8,924475	7,778294	4,763882
2006	7,812163	6,716081	4,483003	2016	9,046693	7,975932	4,801559
2007	7,880756	6,796019	4,479607	2017	9,183842	8,112772	4,840242
2008	7,98241	6,928038	4,53903	2018	9,313115	7,623068	4,876723
2009	8,120431	7,161691	4,540098	2019	9,412055	8,189451	4,911919
2010	8,320101	7,123556	4,594109	2020	9,554422	9,532293	4,925077
2011	8,458123	7,204286	4,601162	2021	9,72163	9,569803	4,980176
2012	8,561581	7,370364	4,641502	2022	9,811471	9,638753	5,019265

Source: author's development based on the data of the Namangan region statistics department

Before creating the PF for the industrial sector of Namangan region, we will check whether the data obeys the law of normal distribution. For this, we calculate the descriptive statistics of all factors included in the model.

Based on the fact that the factors included in the model obey the normal distribution, we determine the connections between them. For this, we calculate correlation coefficients between factors.

Using the Eviews program, we calculate correlation coefficients between factors (Table 3).

Table 3

Correlation matrix

Probability	LNY	LNK	LNL
LNY	1		
LNK	0,931838	1	
LNL	0,997163	0,929371	1

Source: Developed by the author based on Eviews 9 software

If we analyze the correlation matrix between the factors, we can see the following. First of all, we will analyze private correlation coefficients. Specific correlation coefficients are the correlation between the outcome factor (lnY) and each influencing factor (lnK, lnL). There is a close direct relationship between the value of the gross product of the industrial sector of Namangan region (lnY) and the value of the fixed assets of the industrial sector (lnK) (0.931838). It can be seen that there is a strong positive relationship (0.997163) between the value of the gross product of the regional industrial sector (lnY) and the number of people employed in the industrial sector (lnL).

In addition, in the data of Table 3, pairwise correlation coefficients were calculated between the factors. Pairwise correlation coefficients are associations between the influencing factors (ie, lnK and lnL).

From the data in Table 3, it can be seen that there is a strong positive relationship between the value of fixed assets of the industrial sector (lnK) and the number of persons employed in the industrial sector (lnL) (0.929371).

From the results of the correlation analysis, it can be seen that there are correct and close relationships between the researched factors of the production of the industrial sector in Namangan region. Therefore, the existence of relationships between factors is the basis for creating the Cobb-Douglas PF according to the indicators of the production of the industrial network.

The calculated parameters of the Cobb-Douglas PF for the production of the industrial sector of the Namangan region are as follows (Table 4):

Table 4

Calculated parameters of Cobb-Douglas PF

Variable	Coefficient	Standard error	t-sstatistics	Ehtimollik
LNK	0.027553	0.035764	2.770406	0.4516
LNL	3.496115	0.176614	19.79527	0.0000
C	-7.952436	0.582468	-13.65300	0.0000
R-squared	0.994525	The mean of the dependent variable		8.618238
Smoothed R-squared	0.993881	The standard deviation of the dependent variable		0.738284
Smoothed R-squared	0.057753	Akaike information criterion		-2.727813
The sum of squared residuals	0.056701	Schwarz criterion		-2.578453
The value of the similarity function	30.27813	Hannan-Quinn criterion		-2.698656
F-statistics	1543.980	Darbin-Watson statistics		1.329345
Probability (F-statistic)	0.000000			

Source: Developed by the author based on Eviews 9 software

Based on Table 4, the production function of the industrial sector of Namangan region looks like this:

$$\ln \hat{y} = \ln(-7{,}9524) + 0{,}0275 \ln K + 3{,}4961 \ln L \qquad (7)$$
$$(13{,}6530) \qquad (2{,}7704) \qquad (19{,}7952)$$

$R^2 = 0{,}9945$; $F_{хисоб} = 1543{,}980$.

So, we determined the values of the unknown parameters A, α, β of the linear PF (7). Now, by powering the left and right sides of the model (7) (powering is the opposite of logarithmization), we make it look like a power function. In this case, all logarithms disappear, the coefficients in front of the variables are transferred to the degree indicators of the variables, and the additive model in the form of sum (7) and the multiplicative model in the form of multiplication (8) are changed. That is:

$$y = 0{,}00035 \cdot K^{0{,}0275} \cdot L^{3{,}4961} \quad (8)$$

$R^2 = 0{,}9945$; $F_{хисоб} = 1543{,}980$.

Results

The coefficient of 0.00035 in PF (8) compiled for the industrial sector of Namangan region shows the influence of factors not taken into account. The coefficient of 0.0275, calculated on the value of the main funds of the industrial sector in the province, is the coefficient of elasticity. shows. An increase in the number of people employed in the industrial sector of the region by one percent indicates an average increase of the gross product of the industrial sector in the region by 3.4961 percent. If we pay attention to the coefficients of elasticity of each factor in the model, in the creation of the gross product of the industrial sector in Namangan region, the fixed assets of the industrial sector make up 0.78 percent, and those employed in industrial production make up 99.22 percent. This shows that 99.22 percent of the development of the industrial sector in Namangan region is mainly due to extensive factors (increasing the number of people employed in the production of the industrial sector). This requires the transition to the path of intensive development of the industrial sector in the region.

We use Fisher's F-criterion to check whether the production function (8) compiled for the industrial sector of Namangan region corresponds to the studied process or is statistically significant.

According to the number of observations and the number of factors, it can be determined that the value of the F-criterion in the table is equal to 3.52. Table 4 shows the calculated value. From this it turned out that $F_{\text{hisob}} > F_{jadval}$, , i.e $F_{\text{hisob}} = 1543{,}980 > F_{\text{jadval}} = 3{,}52$

Therefore, the structured production function is statistically significant, as it directly determines the state of the gross product of the industrial sector in Namangan region. In addition, with the help of this model, it is possible to forecast the gross product of the industrial sector of Namangan region for future periods.

To check the complete adequacy of the structured production function (8), we will check the reliability of the factors involved in it.

Student criteria values are as follows in Table 4:

$t_{\ln K} = 2{,}7704$ prob $= 0{,}4516$; $t_{\ln L} = 19{,}7952$ prob $= 0{,}0000$;

To check the reliability of these calculated parameters, we refer to the Student distribution table. If $t_{\text{hisob}} > t_{\text{jadval}}$ it is, then the regression coefficients are called reliable, otherwise they are called unreliable. According to the student distribution table, it is equal to $t_{\text{jadval}} = 2{,}1098$ 95% accuracy. As long as all the factors in the constructed (8) production function meet the requirement (the accuracy probability of these factors $\alpha = 0{,}05$ is less than 0.05).

When checking the presence of autocorrelation in the model, we find tabular values of the Darbin-Watson criterion. The lower value ($DW_L = 1{,}13$) and upper value ($DW_U = 1{,}31$) of the Darbin-Watson criterion in the table are equal.

Therefore, the calculated value of the Darbin-Watson criterion ($DW_X = 1{,}3293$) is greater than its lower ($DW_L = 1{,}13$) and upper ($DW_U = 1{,}31$) values in the table. This shows that there is no autocorrelation in the residuals of the resulting factor.

Cobb-Douglas graded production function based on the gross product of the industrial sector of Namangan region and its influencing factors and all its calculated parameters Fisher's F-criterion, Student's t-criterion and Darbin-Watson DW-criterion it fully met the requirements for all criteria and (8) the model can be used in the analysis and forecasting of the gross product of the industrial sector of Namangan region.

Three types of inertial, optimistic and pessimistic scenarios for the development of the regional industry for 2023-2030 have been developed (Table 5).

Table 5

Namangan region industrial branch of industrial production forecast indicators according to the value of fixed assets and the number of jobs in the industry

Years	Production volume of the industrial network, bln. soum. Ln Y	The value of the main funds of the industrial network, billion soums Ln K	The number of people employed in the industry, thousand people. Ln L	Production volume of the industrial network, bln. soum. Y	The value of the main funds of the industrial network, billion soums K	The number of people employed in the industry, thousand people. L
LnY= -7.95243630519+0.0275526511365*LnK+3.49611515781*LnL						
An optimistic scenario LnK=6,1036*e0.203*t ; R2=0,8982; LnL= 0,0003*t2+0,0289*t+4,3396; R2=0,9965						
2023*	10,0612	9,348153	5,0788	23416,584	11477,602	160,581
2024*	10,21262	9,53986	5,1206	27244,839	13902,995	167,436
2025*	10,36625	9,735498	5,163	31768,961	16907,248	174,688
2026*	10,52208	9,935148	5,206	37126,225	20643,337	182,363
2027*	10,68012	10,13889	5,2496	43482,907	25308,419	190,490
2028*	10,84038	10,34682	5,2938	51040,785	31157,653	199,099
2029*	11,00285	10,559	5,3386	60045,181	38522,661	208,221
2030*	11,16754	10,77554	5,384	70794,911	47836,303	217,892
Inersion ssenariy LnK=0,1577*t+5,9532; R2=0,8645; LnL= 0,0343*t+4,32; R2=0.9951						
2023*	9,9235	9,2349	5,0403	20403,850	10248,637	154,516
2024*	10,0477	9,3926	5,0746	23103,530	11999,257	159,908
2025*	10,1720	9,5503	5,1089	26160,411	14048,909	165,488
2026*	10,2963	9,7080	5,1432	29621,754	16448,672	171,263
2027*	10,4205	9,8657	5,1775	33541,076	19258,350	177,239
2028*	10,5448	10,0234	5,2118	37978,972	22547,963	183,424
2029*	10,6690	10,1811	5,2461	43004,056	26399,491	189,825
2030*	10,7933	10,3388	5,2804	48694,021	30908,917	196,448
Pessimistic ssenariy LnK=0,9953*Ln(t)+5.5025; R2=0.6496; LnL=4,2121*t0,0493; R2=0.8533						
2023*	9,3934	8,5327	4,8942	12009,374	5078,205	133,517
2024*	9,4340	8,5790	4,9055	12506,529	5318,861	135,026
2025*	9,4729	8,6233	4,9162	13001,892	5559,466	136,487
2026*	9,5101	8,6656	4,9266	13495,589	5800,022	137,903
2027*	9,5459	8,7062	4,9365	13987,731	6040,530	139,279
2028*	9,5804	8,7453	4,9460	14478,418	6280,994	140,616
2029*	9,6137	8,7828	4,9552	14967,741	6521,414	141,917
2030*	9,6457	8,8190	4,9641	15455,784	6761,792	143,185

Source: Author development

Analysis

Based on the above-mentioned opinions, we calculate the efficiency of the factors used in the production of the industrial network of Namangan region. For this, we use average and finite indicators [2].

First, we calculate the average efficiency indicators of each influencing factor - the average fund return and the average labor productivity. Then we calculate the marginal efficiency indicators of the same factors.

In the production of the industrial network of Namangan region:

- average fund return:

$$\frac{y}{K} = 0,00035 \cdot K^{0,0275-1} \cdot L^{3,4961} = 0,00035 \cdot K^{-0,9725} \cdot L^{3,4961} = 0,00035 \cdot \frac{L^{3,4961}}{K^{0,9725}}$$

- average labor productivity:

$$\frac{y}{L} = 0,00035 \cdot K^{0,0275} \cdot L^{3,4961-1} = 0,00035 \cdot K^{0,0275} \cdot L^{2,4961}$$

In the production of the industrial network of Namangan region:

- closed-end fund return:

$$\frac{\partial y}{\partial K} = 0,00035 \cdot 0,0275 \cdot K^{0,0275-1} \cdot L^{3,4961} = 0,000009625 \cdot K^{-0,9725} \cdot L^{3,4961} = 0,00025 \cdot \frac{L^{3,4961}}{K^{0,9725}}$$

- limited labor productivity:

$$\frac{\partial y}{\partial L} = 0,00035 \cdot 3,4961 \cdot K^{0,0275} \cdot L^{3,4961-1} = 0,0012236 \cdot K^{0,0275} \cdot L^{2,4961}$$

The dynamics of the average and marginal values of the resources used in the industrial network of Namangan region in 2003-2022 are presented in Table 6.

Table 6

The dynamics of average and marginal values of resources used in the industrial network of Namangan region in 2003-2022

Years	Average fund return, y/y	Average labor productivity, y/L	Fixed fund return, dy/dK	Marginal labor productivity, dy/dL
2003	2,786466	22,38151	0,8553	5,670787
2004	3,089058	24,91221	0,8933	5,712818
2005	3,834819	26,88929	1,150225	5,829857
2006	2,99242	27,9149	1,052466	6,01757
2007	2,958661	29,99856	0,978845	6,027283
2008	2,870171	31,29253	1,084617	6,205651
2009	2,608409	35,88549	0,907866	6,261485
2010	3,308668	41,5124	1,126152	6,387625
2011	3,503761	47,3213	1,088451	6,423601
2012	3,291084	50,40444	1,101197	6,562085
2013	3,140061	53,71999	1,128884	6,700453
2014	3,173141	58,22575	1,190681	6,832313
2015	3,146156	64,10953	1,213948	6,960386
2016	2,917598	69,76508	1,193006	7,099405
2017	2,918502	76,98419	1,222544	7,2271

Years	Average fund return, y/y	Average labor productivity, y/L	Fixed fund return, dy/dK	Marginal labor productivity, dy/dL
2018	5,419732	84,46961	1,728357	7,206728
2019	3,396018	90,02932	1,413905	7,423463
2020	1,022375	102,4469	0,422632	7,761874
2021	1,163959	114,6007	0,58629	7,907943
2022	1,18853	120,567	0,669689	8,021203

Source: developed by the author based on the data of the statistical office of Namangan region

Conclusions and suggestions

From the data of Table 6, it can be seen that the values of the average and finite fund return indicators are decreasing between 2003 and 2022. This indicates that the basic funds are not updated in time in the industrial sector of Namangan region, and new techniques and technologies are not sufficiently introduced into the industrial sector (Fig. 2).However, despite this, the share of people employed in the production of the industrial sector of Namangan region is increasing. This indicates that the industry is still developing extensively.

It can be seen from the data of Table 6 that the average fund return growth rate decreased between 2018 and 2021. However, it can be seen that the average labor productivity has grown at a high rate.

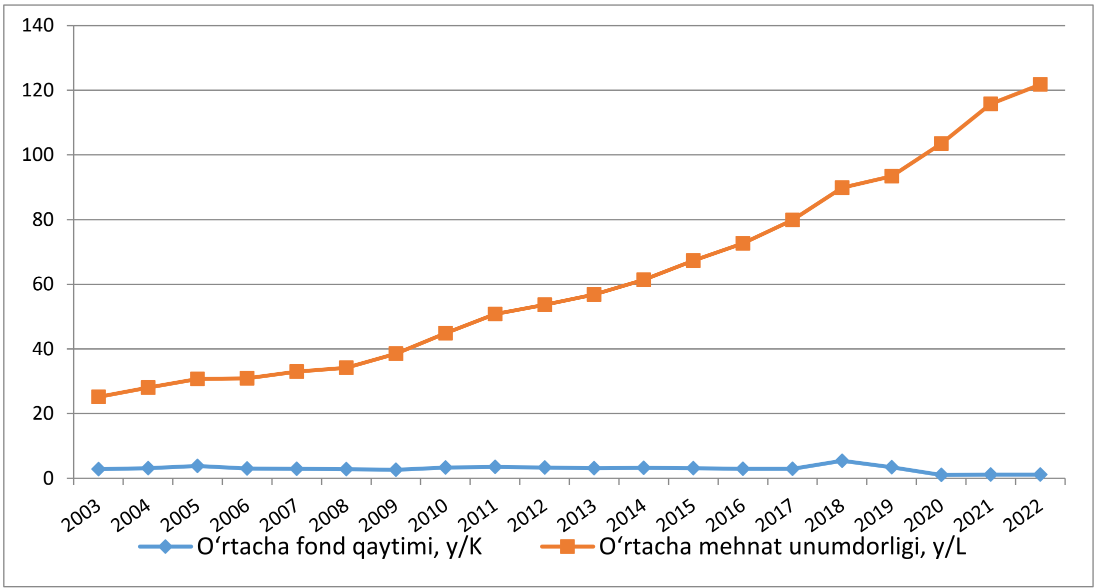

Figure 2. Values of average capital return and average labor productivity in the industrial sector of Namangan region

Source: Author development

The marginal indicators of the use of resources in the industrial sector (i.e., the consumption of additional resources for the additional production of one unit of industrial product), especially in terms of the main funds of the industrial sector, will increase in 2018-2021. does not have a tendency to change (Fig. 3).

Therefore, the conducted research and the analysis of the parameters of the Cobb-Douglas production function compiled for the industrial sector (9) show that diversification of the industrial sector in Namangan region, development based on innovative technologies, and effective management of the industrial sector it is necessary to produce a new model and a new concept of innovative development.In 2023-2030, according to the inertial scenario calculated according to the forecast of the volume of production of industrial

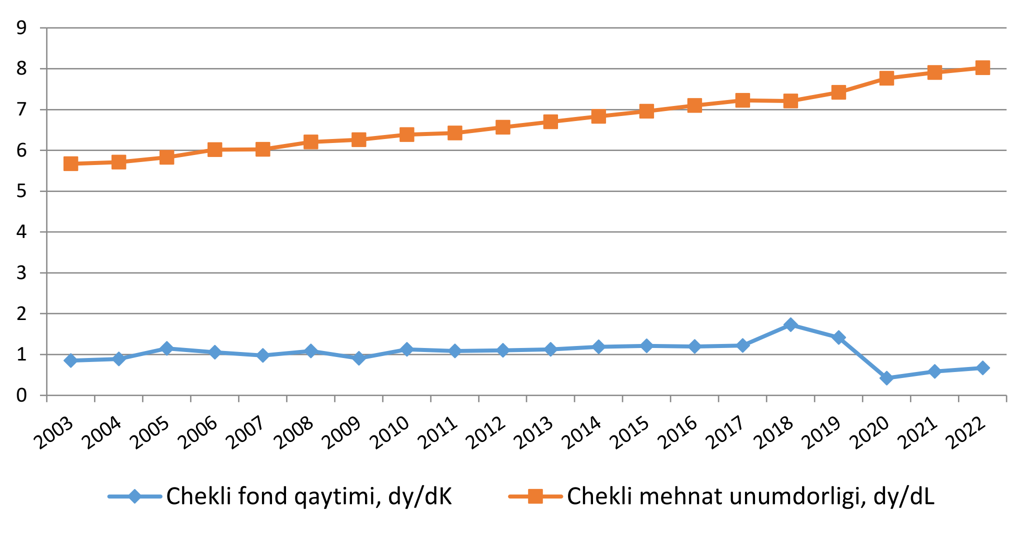

Figure 3. Values of marginal capital return and marginal labor productivity in the industrial sector of Namangan region

Source: Author development

products in Namangan region, the average growth index of the main funds in the industry network is 1,154 times, the average growth of the employed It is observed that the indicator is 1,046 times, and the average growth rate of technological innovation costs included in the industry is 1,182 times; according to the optimistic scenario, the average growth rate of the main funds in the Industry network is 1,091 times, the average growth rate of the employed is 1,033 times, and the average of the technological innovation costs included in the industry network the growth rate is expected to be 1,130 times; in the pessimistic scenario, the average decrease in fixed assets in the industry is 0.09%, the average decrease in employment is 0.006%, and the average decrease in technological innovation expenditures in the industry is 0.02%. it is being observed that it will organize

That is, in the inertial and optimistic scenarios, the joint growth, compared to the pessimistic scenario, more active, innovative costs are observed to increase in a short period of time (2,312 times). (This is obtained by adding 1.130 in inertial to 1.182 in optimistic)

List of used literature

1. Decree of the President of the Republic of Uzbekistan dated January 28, 2022 No. PF-60 "On the development strategy of New Uzbekistan for 2022-2026" / National database of legislative information of the Republic of Uzbekistanhttps://lex.uz/uz/docs/-5841063#-5843873..

2. Ishnazarov A. and others "Basics of Econometrics". Study guide. TDIU-2019, pp. 147-149.

3. Bagayev H.N. Statistical evaluation of the influence of production infrastructures on the volume of industrial products of Navoi region. Scientific electronic journal: "Uzbekistan statistical bulletin", 2022, issue 2 http://www.statmirror.uz/en/arxiv/249-2022-22

4. http://www.namstat.uz data of Namangan Region Statistics Department