

## Forecasting economic growth by multi-factored model



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**Abstract:** The article is devoted to modeling and forecasting economic growth. Effects of labor force, capital and innovation costs, the coefficient of elasticity, the results of regression and correlation analysis is shown.

**Keywords:** Tourism, correlation, time series, regression analyze, model, forecasting.

### Introduction

Economic growth and sustainable economic growth are the main factors in solving the socio-economic problems and welfare of the country. President of the Republic of Uzbekistan Shavkat Mirziyoev in his Address to the Oliy Majlis on December 28, 2018, highlighted the key priorities for the development of our country in 2019 and emphasized the importance of macroeconomic stability and economic growth as following: "First, we must ensure macroeconomic stability and high economic growth rates. In the transitional period, it is important to keep statistics on the economy and to accurately assess the economic potential of the state. It will help to achieve an objective assessment of GDP" [1].

Gradual implementation of economic reforms and well-thought-out monetary and credit policy provide broad opportunities and favourable conditions for entrepreneurship in all sectors and areas, ensure macroeconomic stability and high rates of economic growth.

An in-depth analysis of the progress of the past, the growing competition on the world stage requires the development and implementation of fundamentally new approaches and principles for more sustainable and dynamic development of our economy.

The key factor of achieving high results is an analysis of the progress made over the years of independence, the well-defined goal of further deepening economic reforms and accelerating the country's development.

The third priority of the Strategy of Action for the five priority areas of development of the Republic of Uzbekistan in 2017-2021, called the further development and liberalization of the economy, and according this the first main aim is to maintain macroeconomic stability and maintain high economic growth rates [2].

The importance of developing an econometric model and forecasting GDP growth in the near future, achieving objective estimates of GDP, macroeconomic stability and high economic growth rates, changing its timings, and regression and correlation analysis on the factors influencing high GDP substantiates the actuality of the research topic.

### Analysis of literature

Modeling and forecasting of economic processes has been carried out by many economists, and this process is still relevant today.

Hodiev B., Shodiev T., Berkinov B. showed the tendency changing indicators of complex social phenomena is only by one or another equation or line of trend, and in

practice the use of linear, parabolic, hyperbolic, exponential, logarithmic and logistic types of time series trends. They also gave a description of the models and gave an idea of how to calculate the trend [3].

Z.M.Mamaeva showed in details the use of the Foster-Stewart method for determining the trend in time series, the way to determine the quality of the model based on the time series, the statistical content of the regression equations and parameters, the quality of the trend models, expressed rules of the Student's T-criterion, Fisher's F-rate, and Darbon-Watson's d-criterion outline the use of theoretical indicators in the table, working out model and forecast [4].

Allen L. Webster shows the need to use linear regression by creating slippery lines in softening time lines, exponential softening and the use of linear trend equations and exponential alignment and linear trend equations [5].

Indian Dr. Amit Kundu examines the link between economic growth and government spending in 1961-2014 on a time-series basis, and proves the long-term link. Research with the VAR model shows that costs do not supply economic growth. Government spending does not affect short-term economic growth at all [6].

Studying economical growth in time line base, Indian scientists Aruna Kumar Dash, Aviral Kumar Tiwari, Pradeep Kumar Singh analysed factors affecting the economic growth of the country in 1973-2013, economic processes in the sectors. Using ARDL model scientists showed that the development of tourism in the country influences economical growth for short and long period. Creating opportunities for tourism development in the country is a prerequisite for economic growth [7].

#### **Methodology of research**

Gross domestic product is a commodity that is estimated at market prices of goods and services produced during the year for final use by economic resident units in the economic territory of the country and is a key indicator of the system of national accounts. Quantity increase in production, and the growth of the GDP ratio to the average population means macroeconomic growth.

If the rate of economic growth is completely different from last year's GDP, the rate of economic growth is calculated as a percentage of the GDP for the current year. Quantitative changes in economic growth mean quantitative changes in products and services produced at the national level, and changes in the quality of economic growth mean consumption of goods at the level of consumer demand.

Whereas the gross domestic product depends on natural and labor resources, capital, relative economic growth rates, growth rates and rates depend on the use of resources, the net investment, the use of scientific and technological development in production, ie the introduction of innovative technologies and technologies in production.

The study investigated multivariate linear modelling and forecasting, which is considered to be the simplest model of multi-factor modelling and forecasting, and developed a forecast for GDP variability and possible quantities.

Multi-factored straight lined model has the following formula:

$$y = a_0 + \sum_{i=1}^n a_n x_n \text{ ёки } y = a_0 + a_1 x_1 + a_2 x_2 + \dots + a_n x_n \text{ (4);}$$

Here: y - result, an arbitrary variable;

$a_0, a_1, a_2, \dots, a_n$  – parameters of regression equation;

$x_1, x_2, \dots, x_n$  – factors, free variables.

We create a result and a matrix of factors to identify the key factors influencing GDP (Table 3). Investments in fixed assets in GDP, employment rates, and innovation costs have a higher impact than other factors, suggesting that the interconnection of factors is lower than the result. It is known that the coefficient of determination is in the range of 0–1.0, and the value is close to 0, which means that the link is weak and about 1.0 is the high degree of bond.

At the same time, we can identify 5-10 factors affecting GDP with a high correlation to GDP, ie, with a coefficient of determination greater than 0.5, and we take into account that the ratio below 0.5 is poor.

The elastic coefficients are used to study the effect of the factor on the results using the regression equation. This coefficient represents the average percentage change in the sign ( $\Theta$ ):

$$\Theta = a_i * \frac{\bar{x}}{\bar{y}} \quad (6);$$

Here:  $\Theta$ -coefficient of elasticity;

$a_i$  – parameter of regression equation;

$\bar{x}$  – average sum of factor;

$\bar{y}$  – average sum of result.

### Analysis and results

The gross domestic product of the Republic of Uzbekistan has been growing steadily over the years, and the contribution of various sectors in the GDP has been changing at different levels across the country. (Table 1).

Table 1.

### Changes in the Gross Domestic Product of the Republic of Uzbekistan and the Share of Sectors by Years

Year	GDP current price, mln sums	Share of sectors, %				Net tax , %
		Industry	Agriculture	Building	Service	
2000	3 255,6	14,9	26,8	7,5	36,4	14,4
2001	4 925,3	14,3	29,0	6,7	36,6	13,4
2002	7 450,2	14,2	30,1	6,0	37,2	12,5
2003	9 844,0	14,2	30,2	5,8	37,3	12,5
2004	12 261,0	14,5	30,1	4,9	37,9	12,6
2005	15 923,4	15,8	28,6	4,5	37,4	13,7
2006	21 124,9	17,1	26,8	4,5	37,6	14,0
2007	28 190,0	20,7	25,0	4,9	38,4	11,0
2008	38 969,8	22,1	24,1	5,1	39,5	9,2
2009	49 375,6	24,0	21,7	5,5	39,3	9,5
2010	62 388,3	22,3	19,4	5,6	43,3	9,4
2011	78 764,2	24,0	18,0	7,0	44,0	7,0
2012	97 929,3	24,0	17,5	6,8	49,0	2,7
2013	120 861,5	24,2	16,8	4,0	53,0	2,0
2014	145 846,4	26,0	16,4	3,8	44,3	9,5
2015	171 808,3	26,2	17,4	4,2	42,9	9,3
2016	199240,0	23,3	28,8	5,7	39,0	11,2
2017	249136,4	14,9	26,8	7,5	36,4	14,4
2018	407514,5	14,3	29,0	6,7	36,6	13,4

**Source: information of State statistics committee of the Republic of Uzbekistan.**

The share of agriculture and services in GDP is high, while the share of industry and construction products has been increasing over the years.

We have not elaborated on the above methods, as the trend equations based on the time series are approximated by extrapolation smoothing, average sliding, and extending the studied period. In time-based forecasting of economic indicators, a more in-depth analysis of changes in economic processes over time, and the impact of time only on the development of forecasts for future years. The key factors influencing the size of the indicator in modelling and forecasting on the basis of factor analysis of the reasons for quantitative changes in economic indicators and future forecast of the indicator under the influence of these factors will be studied.

According to many scientists, capital and labour are the main factors influencing GDP. In addition to these factors, the study also takes into account the cost of innovation, which has had a significant impact on economic growth in recent years (Table 2.).

**Table 2.**

**The degree of linkage of factors affecting GDP**

	GDP	Investment to main amount	Number of sectors	Expense of innovation
GDP	1,000			
Investment to main amount	0,999	1,000		
Number of sectors	0,899	0,877	1,000	
Expense of innovation	0,946	0,933	0,940	1,000

**Source: Prepared by author's researches.**

Table 2 presents the multivariate linear regression equation based on the above factors, given the high impact of changes in GDP on capital investment, number of jobs, and innovation costs on other factors.

When the regression equation was developed based on the change in outcome and factor values for the period 2008-2018, a linear regression equation was generated as follows.

$$y_{YalM} = -106027,82 + 3,46x_1 + 10,03x_2 + 0,62x_3 \quad (5);$$

If you note, the influence of a sectors is inversely related ( $a_0=-106027,82$ ), This means that the change in GDP will have a significant impact on the correct investment in fixed assets, the number of employees and the costs of innovation. These factors, which have a high impact on GDP growth, and the dramatic increase in investment in fixed assets in recent years, are contributing to high GDP growth. (Table 3).

According to investment elastic coefficient to main amount is 0,844 ( $3,4*36509/147447$ ), by sectors is 0,849 ( $10,03*12469/147447$ ), for innovative expence is 0,027 ( $0,62*6332/147447$ ) when investment to main amount is increased to one billion sums, when GDP is increased to additional 844 mln sums, sectors to one thousand people, GDP reaches up to 849 mln sums, when innovation expence increased to 1,0 billion sums, GDP increases to 27,0 mln sums.

Because the model's quality and accuracy are positive, we used regression equations with zero error values, first of all, to determine the forecasted possible quantities of the factors over the next five years, with the coefficient of determination based on Table 4 data:

Table 3.

## Characteristics of multi-factored straight lined model of GDP

Years	t	GDP, billion sums	Multi- factored forecast of GDP, billion sums	Investment to main amount, $x_1$ , billion sums	Sectors, $x_2$ , thousand people	Expencc of innovation, $x_3$ , billion sums
2008	1	38969,8	37184,4	9555,9	11035,4	521,5
2009	2	49375,6	50935,2	12531,9	11328,1	333,7
2010	3	62388,3	64194,0	15338,7	11628,4	264,4
2011	4	78764,2	76680,3	17953,4	11919,1	372,6
2012	5	97929,3	97040,3	22797,3	12223,8	311,9
2013	6	120861,5	121121,0	28694,6	12523,3	4634,2
2014	7	145846,4	147206,6	35233,3	12818,4	3757,4
2015	8	171808,3	172371,4	41670,5	13058,3	5528,3
2016	9	199325,1	203144,8	49770,6	13298,4	2571,4
2017	10	249136,4	243702,0	60719,2	13520,3	4162,3
2018	11	407514,5	408339,2	107333,0	13800,0	5283,7
2019	12		<b>424365,8</b>	<b>110376,7</b>	<b>14130,8</b>	<b>20049,9</b>
2020	13		<b>505883,7</b>	<b>132726,4</b>	<b>14407,8</b>	<b>24200,3</b>
2021	14		<b>597034,5</b>	<b>157810,4</b>	<b>14684,8</b>	<b>28858,4</b>
2022	15		<b>698182,1</b>	<b>185731,7</b>	<b>14961,9</b>	<b>34043,5</b>
2023	16		<b>809676,4</b>	<b>216590,2</b>	<b>15238,9</b>	<b>39774,0</b>
Regression equation		$y_{Y_{aIM}} = -126304 + 3,46x_1 + 11,82x_2 + 0,03x_3$		$y_{inv} = 9490,17 + 202,2t^{2,5}$	$y_{band} = 10806,2 + 277,0t$	$y_{inn} = 1315,0 + 37,6t^{2,5}$
Coefficient of approximation, %		<b>1,81</b>	<b>11,37</b>	<b>0,29</b>	<b>12,33</b>	
Coefficient of determination		<b>0,99</b>	<b>0,93</b>	<b>0,99</b>	<b>0,98</b>	

Source: Worked out on the base of information of State statistics committee of the Republic of Uzbekistan.

The model of investment sum according timeline to main amount:

$$y_{investitsiya} = 9490,17 + 202,2t^{2,5} \quad (7);$$

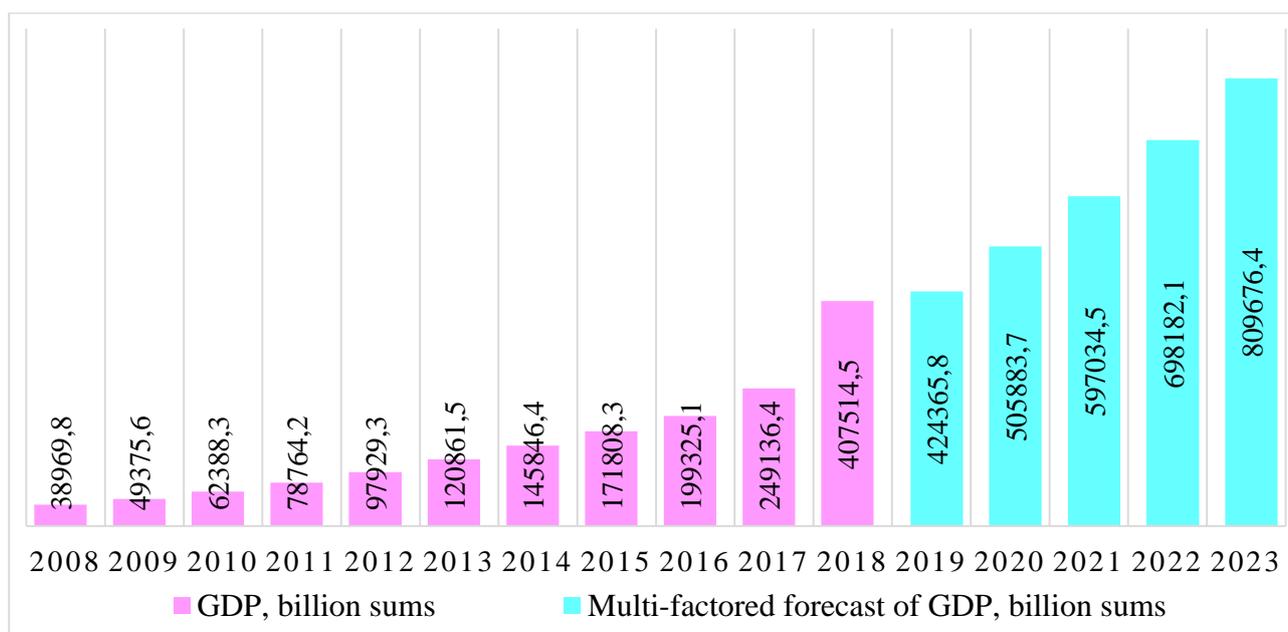
Sectors sum change model on timeline:

$$y_{band} = 10806,2 + 277,0t \quad (8);$$

Model of innovative expence sums o timeline:

$$y_{inn} = 1315,0 + 37,6t^{2,5} \quad (9);$$

Instead of the time factor (t) in the above-linear double regression equation we placed the sum from table 4, after accounting GDP factors forecast sum for 2019-2023, we have worked out GDP multi-factored straight lined regression equation on the base of GDP forecast ушбу даврга мўлжалланган ЯИМнинг кўп омилли тўғри чизиқли регрессия тенгламаси асос (Picture 1).



**Picture 1. Forecast data on GDP based on time series and multivariate linear regression equation.**

**Source:** Worked out by the author on the base of Uzbekistan state statistics committee materials.

Even nineteen years of nominal GDP with no autocorrelation used as a database in the study of time series modeling, as the model based on the multivariate linear regression equation is more accurate than the one based on the time series model, it can be seen from the data in Figure 1 that the forecast data for this model for 2019-2023 is growing comparatively with previous periods of GDP.

According to the multivariate linear regression projections, GDP is expected to be 809,676.4 billion sums in 2023 and 768273.5 billion soums in the forecasted model based on time series.

The projected data is based on the market value of GDP for 2008-2018, and the impact of price changes has not been taken into consideration. The rising inflation rate in recent years may lead to an artificial increase in GDP, and the model and forecast data based on that data may be different from the real situation. In our next research, we will also take into consideration the problem of developing a model and forecasting of fixed price GDP.

### Conclusion and offers

Given that quantitative and qualitative changes in gross domestic product are a key factor in the welfare of the population, in recent years a model and forecast of GDP changes have been developed based on time series and multivariate linear regression equation.

Although studies show that the nominal GDP doubles in the next five years on both models, the multivariate linear model and the predicted data based on it show the accuracy of the time series model and the prediction data, and it is efficient to develop multivariate model and forecast data in situations where time series data are available.

In the process of developing models and forecasts based on time series, it is necessary to make sure that the autocorrelation, that is, the year data, is not interconnected.

In the development of a multidimensional model, it is necessary to develop a correlation matrix in selecting the factors and, consequently, to consider the factors with the highest coefficient of determination. In the development of the multivariate model, the development of multiple models and the coefficient of approximation are the lowest, if the same value is the same or similar across different models, You will need to select a model that meets Fisher's F-criterion and Student's T-criteria.

### **References**

1. Decree of the President of the Republic of Uzbekistan dated February 7, 2017 No UP-4947 "On the Strategy of Action for the Five Priority Areas for the Development of the Republic of Uzbekistan in 2017 - 2021 years" Source: [www.lex.uz](http://www.lex.uz)
2. Address of The President of the Republic of Uzbekistan Shavkat Mirziyoyev to the Oliy Majlis of Uzbekistan on December 28, 2018. Source: [www.prezident.uz](http://www.prezident.uz)
3. Ҳодиев Б. Шодиев Т, Беркинов Б. Эконометрика. Ўқув қўлланма, Т.: Иқтисодиёт, 2018. -175 б.
4. Мамаева З.М. Введение в эконометрику. Учебное пособие, Нижний Новгород.: Нижегородский госуниверситет, 2010.– 72 стр.
5. Allen L.Webster. Applied Statistics for Business and Economics.USA, Bredley University. 1995. -1047 p.
6. Dr. Amit Kundu "Economic Growth & Government Expenditure in Pakistan - A Time Series Analysis", Indian Journal of Economics, 389, Vol. XCVIII October 2017.
7. Aruna Kumar Dash, Aviral Kumar Tiwari, Pradeep Kumar Singh "Tourism and Economic Growth in India: An Empirical Analysis" Indian Journal of Economics, 392, Vol. XCIX July 2018.