TREND MODELS FOR FORECASTING ECONOMIC INDICATORS

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Abstract: This scientific article discusses mathematical methods for using time series and trend models to predict the future state of economic indicators. The relevance of the study is that state and business structures cannot forecast the dynamics of economic growth without accurate mathematical algorithms when making strategic decisions. To solve the problem, a linear trend equation based on the method of least squares (LKS) was used. In the practical analysis section, the dynamics of the volume of industrial production in Uzbekistan over the past 6 years was studied and a precise mathematical forecast was calculated for the future period. The conclusions of the study show that smoothing fluctuations and building linear trend models are the most reliable means of identifying long-term patterns.

Keywords: time series, forecasting, linear trend model, econometrics, least squares method, macroeconomic dynamics, industry size, mathematical modeling.

INTRODUCTION

Planning any large investment project or state budget begins with forecasting the future based on data from previous years. The most scientifically sound and reliable method for doing this is time series analysis.

The main problem raised in the article is related to finding the main direction of development (trend), isolating unexpected, seasonal and random fluctuations in macroeconomic indicators. In practice, many experts rely solely on the average percentage growth in previous years when forecasting. However, this elementary method does not take into account the curvilinear nature of the economic process and, as a result, leads to erroneous forecasts. The relevance of the research is explained by the need to develop reliable forecasting tools using mathematical functions and analytical smoothing. The purpose of the work is to demonstrate an algorithm for linear modeling of economic dynamics based on time series and calculate future volumes in exact numbers using real data.

LITERATURE REVIEW

Time series and their forecasting methodology are an independent branch of mathematical statistics and econometrics. The fundamental foundations of this direction were formed in the 1970s by the ARIMA (Autoregressive Integrated Moving Average) models developed by J. Box (George Box) and G. Jenkins (Gwilym Jenkins). In the works of scientists such as W. Enders (Walter Enders), the application of time series to practical economics was widespread.

The issues of forecasting economic dynamics through time series in Uzbekistan, especially modeling GDP and industrial growth, are found in the works of such economists as M.M. Makhmudov, B.Y. Khodiev. Also, in recent years, "Nowcasting" (short-term forecast) methods have been introduced into our economy by specialists of the Institute of Macroeconomic and Regional Studies (IMRS). This article, based on the above scientific experiments, highlights the linear trend algorithm that is most suitable for application at the enterprise and industry level.

RESEARCH METHODOLOGY

A Linear Trend Model is used to accurately measure how an economic indicator changes over time. The Linear Trend Equation looks like this:

$$Y_t = a + b \cdot t$$

here:

Y_t – t- the actual or expected value of the economic indicator for the year;

t – time index (sequence of observations, $t = 1,2, \dots, n$);

a – initial parameter (point of intersection of the graph with the vertical axis);

b – trend coefficient (the rate at which an indicator changes on average over each time period).

To calculate the unknown parameters □a and □b, the system of equations using the Least Squares Method (LSM) is used. The formulas are as follows:

$$b = \frac{n\sum_{t=1}^{n}(t \cdot Y_t) - \sum_{t=1}^{n} t \sum_{t=1}^{n} Y_t}{n\sum_{t=1}^{n} t^2 - (\sum_{t=1}^{n} t)^2}$$

Once these parameters are found, precise forecast values are obtained by substituting future year indices for t- using the equation.

DISCUSSION AND RESULTS

In order to demonstrate the analytical power of the methodology in economic processes, we study the dynamics of the volume of industrial production of the Republic of Uzbekistan in 2018–2023 (in trillion soums):

Table-1

DYNAMICS AND TREND PARAMETERS OF INDUSTRIAL PRODUCTION VOLUME [1]

Years	**Time index (t)**	**Industry size (Y), trillion soums**	**t·Y**	t^2	Y^2
2018	1	220	220	1	48 400
2019	2	260	520	4	67 600
2020	3	300	900	9	90 000
2021	4	350	1400	16	122 500
2022	5	410	2050	25	168 100
2023	6	480	2880	36	230 400
Jami:	$\sum t = 21$	$\sum Y = 2020$	$\sum tY = 7970$	$\sum t^2 = 91$	$\sum Y^2 = 727000$

Number of observations $n = 6$.

We calculate the coefficient b, which indicates the growth rate, from the sums in the table:

$$b = \frac{6 \cdot 7970 - 21 \cdot 2020}{6 \cdot 91 - (21)^2} = \frac{47820 - 42420}{546 - 441} = \frac{5400}{105} \approx 51.43$$

We find the free part a:

$$a = 336.67 - (51.43 \cdot 3.5) = 336.67 - 180.00 = 156.67$$

Therefore, the empirical trend equation representing Uzbekistan's industrial growth is formulated as follows:

$$\hat{Y}_t = 156.67 + 51.43 \cdot t$$

Forecast results: Mathematical calculations show that the volume of the industry is growing by an average of 51.43 trillion soums annually (along the trend). Now, in order for state bodies to plan the budget for the upcoming years 2024 ($t = 7$) and 2025 ($t = 8$), we calculate the forecast:

$$\hat{Y}_{2024} = 156.67 + 51.43 \cdot (7) = 516.68 \text{ (trln so'm).}$$

$$\hat{Y}_{2025} = 156.67 + 51.43 \cdot (8) = 568.11 \text{ (trln so'm).}$$

CONCLUSIONS AND SUGGESTIONS

Based on the modeling of economic indicators based on time series and the conducted linear trend analysis, the following conclusions were drawn:

1. In an economic environment rich in random crises and seasonal processes, it is a scientific and practical error to make forecasts based on the simple approach of "it

grew by so much percent compared to the previous year." Building linear models using the EKK smoothes out jumps in indicators and clearly establishes a stable growth trajectory.

2. Based on the obtained equation, the forecasts for 2024 and 2025 were determined in the amount of 516.68 and 568.11 trillion soums, respectively. It is suggested that the Ministry of Economy and Finance rely on these fundamental forecast values when planning major budget revenues.

3. Although linear models are ideal for short- and medium-term forecasts, in the long term (10+ years) it is necessary to take into account the changes in the economic situation. For this, economists are advised to master autoregressive (ARIMA) models.

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