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ECONOMETRIC ANALYSIS OF INDUSTRIAL SECTOR DEVELOPMENT AND FORECASTING MODELS

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Abstract. *This study examines the econometric analysis of industrial sector development and proposes forecasting models to assess future growth trajectories. The research focuses on identifying key determinants of industrial performance, including investment inflows, labor productivity, technological intensity, and structural transformation. Using modern econometric techniques, the study evaluates the relationship between industrial output and macroeconomic indicators. Trend analysis, multiple regression modeling, and scenario-based forecasting approaches are applied to estimate short- and medium-term industrial growth prospects. The findings demonstrate that investment intensity, innovation capacity, and structural diversification significantly influence industrial development. The proposed forecasting models provide a reliable analytical framework for evidence-based industrial policy formulation and strategic economic planning.*

Keywords: *industrial development, econometric analysis, forecasting models, structural transformation, industrial output, regression model, investment intensity, productivity growth, economic modeling, scenario analysis*

INTRODUCTION.

Industrial development remains a central driver of economic growth, structural transformation, and long-term competitiveness. In the context of globalization, technological advancement, and increasing market volatility, understanding the determinants of industrial growth has become increasingly important for policymakers and researchers. The industrial sector not only generates value added and employment but also stimulates innovation, export expansion, and productivity improvement. Recent economic fluctuations and global structural shifts highlight the need for evidence-based industrial policy supported by quantitative analysis. Econometric modeling provides a robust methodological framework for assessing the impact of investment, labor productivity, technological progress, and macroeconomic stability on industrial performance. Moreover, forecasting models allow policymakers to anticipate future industrial trends and design adaptive development strategies. Despite extensive literature on industrial growth, there remains a need for integrated econometric approaches that combine structural analysis with forward-looking forecasting techniques. This study aims to fill this gap by developing econometric models that evaluate industrial sector dynamics and generate reliable growth projections.

LITERATURE REVIEW.

Industrial sector development and its econometric assessment have been widely examined within the framework of structural transformation and sustainable growth theories. According to the World Bank, effective industrial policy plays a decisive role in accelerating structural change and enhancing productivity through investment stimulation and technological upgrading [1]. Structural transformation theory suggests that reallocating resources toward higher value-added industries significantly increases overall economic efficiency [2]. OECD studies emphasize that innovation capacity, regional competitiveness, and industrial diversification are key determinants of sustainable industrial growth [3]. Similarly, UNIDO highlights that modernization of industrial infrastructure and integration into global value chains strengthen long-term economic resilience [4]. IMF research further stresses the importance of macroeconomic stability and efficient capital allocation in maintaining industrial expansion [5]. UNCTAD reports confirm that foreign direct investment contributes to technological diffusion and industrial productivity growth [6]. In econometric literature, regression analysis, vector autoregression (VAR), and time-series forecasting models are widely applied to evaluate industrial dynamics and predict sectoral performance [7]. The World Bank's global projections underline the necessity of evidence-based forecasting tools in designing adaptive industrial policies [8]. Alongside international research, Uzbek scholars have made significant contributions to the study of industrial development and regional economic growth. For instance, K. Hakimov examines structural modernization of industry in the context of economic liberalization and emphasizes the importance of diversification in increasing competitiveness [9]. Sh. Mustafakulov analyzes investment efficiency and industrial transformation in Uzbekistan, highlighting econometric modeling as an effective tool for assessing sectoral performance [10]. Furthermore, A. Rasulov focuses on regional industrial policy and the role of innovation in enhancing productivity growth [11], while D. Kadirov studies econometric approaches to forecasting industrial output and regional development trends [12]. Research by M. Yuldashev also underlines the significance of quantitative modeling in evaluating industrial investment returns and long-term economic growth prospects [13]. Despite these valuable contributions, limited research integrates advanced econometric forecasting models with comprehensive industrial policy analysis in a unified framework. Therefore, this study seeks to bridge this gap by combining structural industrial analysis with predictive econometric modeling to provide policy-relevant insights.

RESEARCH METHODOLOGY.

This study applies a quantitative econometric approach to analyze industrial sector development and construct forecasting models. The methodological framework is based on structural transformation theory and modern industrial growth concepts. First, descriptive and structural analysis is used to assess trends in industrial output, sectoral composition, investment dynamics, and productivity indicators. Second, econometric techniques—primarily multiple regression and time-series analysis—are employed to evaluate the relationship between industrial growth and key determinants such as capital investment, labor productivity, export performance, and technological development. For forecasting purposes, trend extrapolation and scenario-based modeling are applied to estimate short- and medium-term industrial growth prospects. Model reliability is tested using standard statistical diagnostics to ensure robustness and consistency. The empirical base of the research consists of official statistical data and international economic reports. The applied methodology enables a comprehensive assessment of industrial dynamics and provides a reliable analytical foundation for evidence-based industrial policy recommendations.

ANALYSIS AND RESULTS.

Currently, development processes are taking place rapidly in all areas of the world. In particular, the sustainable development of each region directly depends on the effective functioning of priority sectors in its economic structure. The urgent tasks are to solve existing problems in the regions by developing industrial structures, increasing the living standards of the population, and accelerating structural changes at a new stage of economic reforms. The policy of modernization of the economy should be based on the effective use of the rich mineral raw materials, natural and labor resources of the regions. The development of a strategy for the long-term development of industrial structures, especially in the regions with a geographical location, is of great importance for the development of the country. The results of the systematization and analysis of targeted programs aimed at developing the regional economy make it possible to identify the main parameters affecting the development of the economy and its individual industrial sectors. The long-term development strategy developed by the Institute of Forecasting and Macroeconomic Research sets the sustainable growth of the country's economy and increasing the living standards of the population as the main goal. The regional development strategy lists as a priority the gradual reduction of socio-economic disparities between regions through the rapid development of the economy of industrial zones. The main goal is to increase the standard of living of the population living in the industrial zones of the region, expand the service sector, and reduce environmental problems. The components of the industrial structures of the region include the natural resource extraction industry, metallurgy, chemistry and petrochemicals, forest and wood processing, building materials, pharmaceuticals, light and food industries, microbiology, and paper industries. In order to assess the dynamics of the development of these industries and determine their future growth trends, it is advisable to use econometric approaches. In this regard, it was found necessary to use trend models to assess the development processes of the region's industrial sectors. Trend models allow to determine the dynamics of changes in economic indicators over time and to forecast future development rates. If the volume of industrial production is considered as a function of time, in general terms:

$$Y_t = f(t)$$

where Y_t is the network production volume, t is the time indicator.

The trend models were constructed using the method of least squares (MLS). This method is based on minimizing the sum of squared errors in determining the regression parameters:

$$\sum_{t=1}^{n}(Y_t - \hat{Y}_t)^2 \rightarrow \min$$

Linear trend model If the development of industrial sectors is expressed in a linear form:

$$Y_t = a + bt$$

where: a— initial level, b— average annual growth rate.

If b>0, it is determined that the industry has a growth trend.

Exponential trend model Due to the accelerating nature of growth in some industries, an exponential model was used:

$$Y_t = ae^{bt}$$

or in logarithmic form:

$$\ln\, Y_t = \ln\, a + bt$$

This model allows us to determine the growth rate in percentages. Here, b represents the average annual growth rate of the industry.

n-index (multifactor) trend model Taking into account the fact that several factors affect the development of industrial sectors, a multifactor regression model was also developed:

$$Y_t = a + b_1X_{1t} + b_2X_{2t} + \ldots + b_nX_{nt}$$

where: X_it— investments, labor resources, energy consumption and other factors. Through this model, the impact of each factor on industrial development was quantitatively assessed. Thus, the use of trend models in assessing the dynamics of the development of regional industrial sectors allows us to identify changes in the industrial structure, calculate growth rates and form forecast indicators for the future. The use of the least squares method ensures the reliability of model parameters and increases the accuracy of forecast results. Therefore, we found it necessary to use trend models in assessing the development processes of regional industrial sectors. We created trend models for the development of each of the regional industrial sectors in the form of n-exponential and exponential. For this, we used the least squares method to generate trend models of the process.

$$\boldsymbol{Y_x = a_0 + a_1x + a_2x^2 + \cdots + a_kx^k}$$

To create a trend model, you need to do the following:

$$\boldsymbol{F = \sum(Y - Y_x)^2 \rightarrow min}$$

yoki $\boldsymbol{F = \sum\left(Y - a_0 - a_1x - a_2x^2 - \cdots - a_kx^k\right)^2 \rightarrow min}$ If we can derive a special derivative from this, we obtain the following system of equations.

$$\begin{cases} \sum Y = a_0 n + a_1 \sum x + a_2 \sum x^2 + \cdots + a_k \sum x^k \\ \sum Yx = a_0 \sum x + a_1 \sum x^2 + a_2 \sum x^3 + \cdots + a_k \sum x^{k+1} \\ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \\ \sum Yx^k = a_0 \sum x^k + a_1 \sum x^{k+1} + a_2 \sum x^{k+2} + \cdots + a_k \sum x^{2k} \end{cases}$$

$\boldsymbol{Y_x = a_0 e^{a_1 x}}$ tr To create a trend model, we need to do the following:

To do this, we take the natural logarithm of both sides of the equation.

$$\boldsymbol{\ln Y_x = a_1 x + \ln a_0}$$

$\boldsymbol{F = \sum(\ln Y - \ln Y_x)^2 \rightarrow min}$ yoki$\boldsymbol{F = \sum(\ln Y - \ln a_0 - a_1 x)^2 \rightarrow min}$ If we can derive a special derivative from this, we obtain the following system of equations.

$$\begin{cases} \sum(\ln Y) = n \ln a_0 + a_1 \sum x \\ \sum(x \ln Y) = (\ln a_0) \sum x + a_1 \sum x^2 \end{cases}$$

We evaluate the results obtained using the following evaluation criteria:

Fisher's F-test is used to assess the "significance" of a regression equation. The value of Fisher's F-test is related to the coefficient of determination as follows:

$$F_{haqiqiy} = \frac{r_{xy}^2}{1 - r_{xy}^2} \cdot (n-2), \quad \text{n} \geq 3.$$

If (five percent significance level) and degrees of freedom and , then the Fisher distribution of random variables is given in the tables with the Fisher's sign table value - is found. If this inequality is true, the regression equation is considered statistically significant. The errors in constructing the regression equation are also affected by random errors in calculating the parameters and in the equation and the correlation coefficient -. Therefore, the standard errors in calculating the parameters and are determined. The random error of the regression coefficient is determined by the following formula:

$$m_b = \sqrt{\frac{\sum(y - y_x)^2 / (n-2)}{\sum(x - \bar{x})^2}}.$$

The random error of the parameter of the regression equation is determined by the following formula:

$$m_a = \sqrt{\frac{\sum(y - y_x)^2}{n-2} \cdot \frac{\sum x^2}{n \cdot \sum(x - \bar{x})^2}}.$$

The random error of the linear correlation coefficient is determined based on the formula:

$$m_r = \sqrt{\frac{1 - r^2}{n-2}}$$

The statistical significance of the parameters of the regression equation can also be assessed using the Student's t-test (the number of degrees of freedom and, if any, the tabular values of the symbol are found in the Student's distribution table). It calculates the following;

$$t_a = \frac{a}{m_a}, \quad t_b = \frac{b}{m_b}, \quad t_r = \frac{r_{xy}}{m_r}.$$

If the actual values of a characteristic are found to be greater than its table value (i.e. , ,) and the parameters are considered statistically significant. We designated each service sector as Y, and we generated trend models by relating the values obtained as a result of observations to the time factor t. Based on statistical data (2016-2025), several variants of trend models for each service sector were generated, and after evaluating them with evaluation criteria, we selected the optimal models. One of the main industrial structures of the region is the oil and oil refining industry, the trend models of which are shown in Figure 3.2.1. As you can see, several models have been created based on the trend of change in the oil and oil refining industry, of which we have selected a regression equation of the form Y1Aaax= 2.182t2 - 4.524t + 10.49 when R^2 = 0.996, Fhisob=3237, thisob=56.89 (when tjad=2.1314, Fjad=2.4034). Adequate regression equations have also been created among other trend models, but currently, taking into account the growth in the volume of the oil and oil refining industry and the reforms being carried out, we have selected a quadratic regression equation from the trend models.

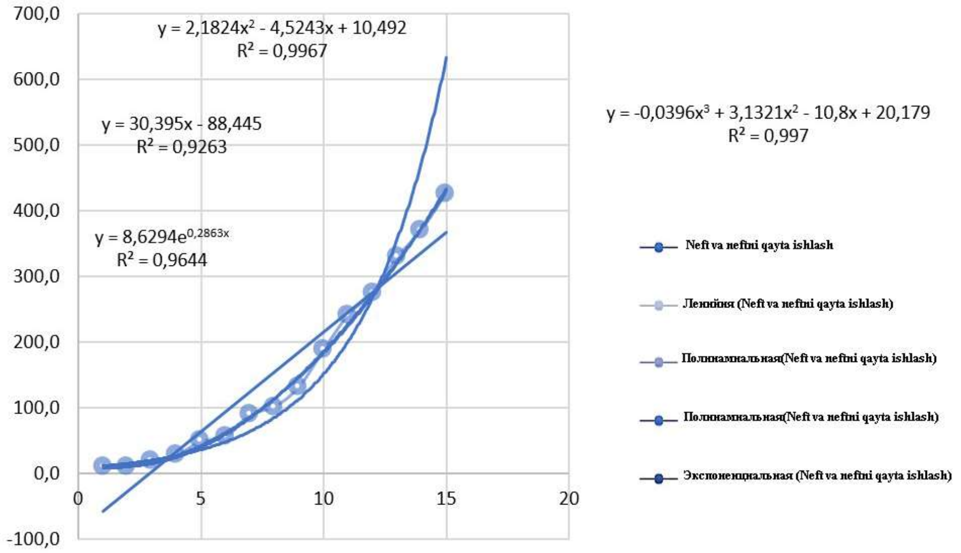

Fig 1. Oil refining

Another branch of the regional industrial structure is the electric power industry, and its trend models are shown in Figure 3.2.2. Here, several models were created depending on the trend of the industrial sector, from which we selected a regression equation of the form Y1YjOx=0.352t3-6.401t2+34.43t-30.45 when R^2=0.920, Fhisob=149.5, thisob=12.23 (when tjad=2.1314, Fjad=2.4034). We could have chosen a regression equation of the form Y2YjOx=0.014t4-0.123t3-1.397t2+15.23t-10.7 when R^2=0.923, Fhisob=155.83, thisob=12.48 (when tjad=2.1314, Fjad=2.4034), but since the reforms being carried out in this area at the present time correspond to changes in the third-order regression equation, we considered the trend model of the first form adequate.

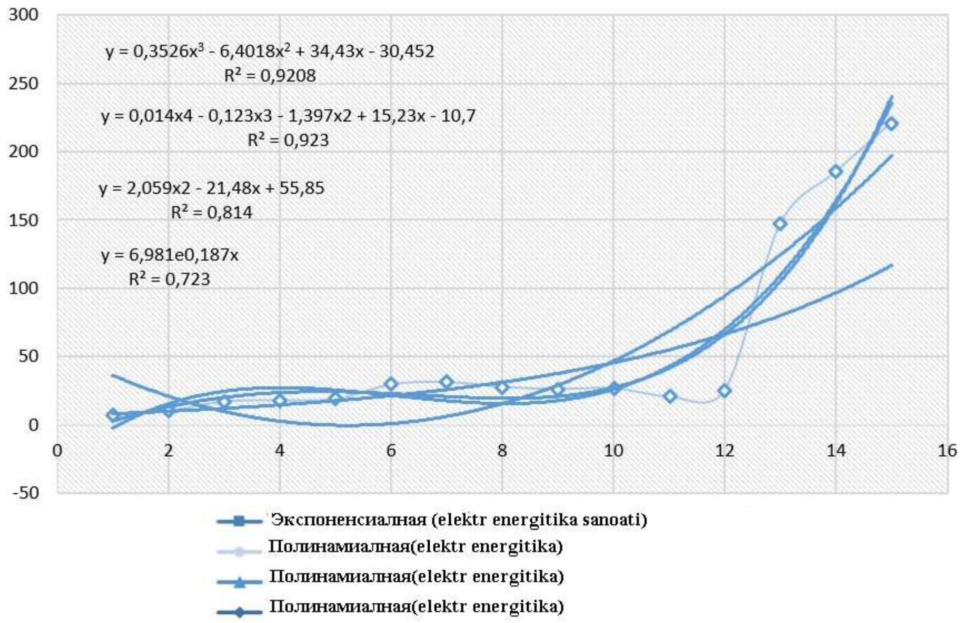

Fig 2. Electric power industry

As above, we have created trend models for the growth trend of production in the electric power industry in the region, which can be seen in Table 3.2.2. Also, several trend models have been created for the electric power industry of the region, and after evaluating them according to the evaluation criteria, the trend model that gave good results was selected, and adequate regression equations were selected based on the reforms currently underway. We have selected trend models of various types for the electric power industry, because in each case the equation was considered adequate. However, we believe that it is appropriate to analyze the selected regression equations for optimality, taking into account the social reforms currently

Table 1.

Analyzing industries

Industries	Regression equations	F-criterion	t-criterion
Production in the regional industry	$\mathbf{Y_1 = 2{,}175x^3 - 6{,}305x^2 + 60{,}65x + 159{,}6}$ $R^2 = 0{,}999$	12987	113,96
	$Y_2 = 165{,}6e^{0{,}256x}$ $R^2 = 0{,}997$	4320,33	65,73
Coal industry	$\mathbf{Y_1 = 2{,}182x^2 - 4{,}524x + 10{,}49 R^2 = 0{,}996}$	3237	56,89
	$Y_2 = 8{,}629e^{0{,}286x}$ $R^2 = 0{,}964$	348,11	18,66
Gas industry	$\mathbf{Y_1 = 12{,}39e^{0{,}271x}}R^2 = 0{,}984$	799,5	28,28
	$Y_2 = 0{,}611x^3 - 8{,}795x^2 + 47{,}71x - 38{,}47$ $R^2 = 0{,}993$	1844,14	42,94
Metallurgical industry	$\mathbf{Y_1 = 33{,}15e^{0{,}264x}}R^2 = 0{,}994$	2153,67	46,41
	$Y_2 = 0{,}835x^3 - 8{,}302x^2 + 47{,}66x - 7{,}958$ $R^2 = 0{,}986$	915,57	30,26
Chemical and petrochemical industry	$\mathbf{Y_1 = 0{,}352x^3 - 6{,}401x^2 + 34{,}43x - 30{,}45}$ $R^2 = 0{,}920$	149,5	12,23
	$Y_2 = 0{,}014x^4 - 0{,}123x^3 - 1{,}397x^2 + 15{,}23x - 10{,}7$ $R^2 = 0{,}923$	155,83	12,48
Forestry, wood processing	$\mathbf{Y_1 = 14{,}36x^2 - 73{,}76x + 178{,}9}R^2 = 0{,}997$	4320,33	65,73
	$Y_2 = 57{,}36e^{0{,}257x}$ $R^2 = 0{,}987$	987	31,42
Paper industry	$\mathbf{Y_1 = 1{,}426x^2 - 7{,}255x + 16{,}34}R^2 = 0{,}996$	3237	56,89
	$Y_2 = 4{,}866e^{0{,}271x}$ $R^2 = 0{,}990$	1287	35,87
Building materials	$\mathbf{Y_1 = 4{,}874e^{0{,}260x}}R^2 = 0{,}975$	507	22,52
	$Y_2 = 0{,}138x^3 - 1{,}910x^2 + 12{,}83x - 10{,}59$ $R^2 = 0{,}993$	1844,14	42,94
Glass and porcelain industry	$\mathbf{Y_1 = 0{,}041x^3 - 0{,}560x^2 + 4{,}008x - 2{,}331}$ $R^2 = 0{,}985$	853,67	29,22
	$Y_2 = 2{,}319e^{0{,}232x}$ $R^2 = 0{,}973$	468,48	21,64
Microbiology industry	$\mathbf{Y_1 = 5{,}641e^{0{,}241x}}R^2 = 0{,}994$	2153,67	46,41
	$Y_2 = 0{,}048x^3 + 0{,}133x^2 - 0{,}344x + 9{,}131$ $R^2 = 0{,}997$	4320,33	65,73
Printing	$\mathbf{Y_1 = 1{,}565x^2 - 6{,}093x + 10{,}31}R^2 = 0{,}983$	751,71	27,42
	$Y_2 = -0{,}041x^3 + 2{,}570x^2 - 12{,}73x + 20{,}56$ $R^2 = 0{,}984$	799,5	28,28
Light industry	$\mathbf{Y_1 = 1{,}537x^2 - 6{,}5x + 22{,}30}R^2 = 0{,}992$	1612	40,15
	$Y_2 = 10{,}44e^{0{,}225x}$ $R^2 = 0{,}989$	1168,82	34,19
Food industry	$\mathbf{Y_1 = 0{,}096x^3 - 1{,}866x^2 + 11{,}61x - 8{,}082}$ $R^2 = 0{,}956$	282,45	16,81
	$Y_2 = 5{,}447e^{0{,}149x}R^2 = 0{,}885$	100,04	10,00

Flour, cereal and feed industry	$\mathbf{Y_1 = 9{,}230e^{0{,}231x}}$ $R^2 = 0{,}989$	1168,82	34,19
	$Y_2 = 1{,}546x^2 - 7{,}199x + 22{,}49$ $R^2 = 0{,}984$	799,5	28,28

Based on the developed trend models, the development process of industrial sectors for the period 2016–2025 was forecasted (Table 3.2.2). Linear and exponential trend models were used in the forecasting, and the parameters were determined based on the least squares method. According to the results obtained, the volume of production in the industrial structures of the region, when analyzed at 2016 prices, is expected to increase by 1.94 times in 2020 compared to 2016, and by 3.12 times by 2025. This indicates a stable growth trend in the industrial structure. While the region's manufacturing industry sector has seen a 2.18-fold increase compared to 2016 by 2020, according to the forecast for 2025, it is expected to increase by 3.67 times compared to 2016. This confirms the leading position of the manufacturing sector in economic growth. The gas industry has seen a 2.34-fold increase in 2020 compared to 2016. According to the results of the trend model, it is projected to increase by 3.85 times compared to 2016 by 2025. This growth is explained by investment activity in the energy and gas-chemical sectors. The gas industry is also expected to grow by 1.64 times in 2025 compared to 2020. This indicates that the growth rate is relatively stabilizing. The building materials industry recorded a 1.76-fold increase in 2020 compared to 2016, and by 2025 it is projected to increase by 2.98 times compared to 2016. This indicator is associated with an increase in the volume of regional infrastructure and investment projects. In the chemical industry, a 3.41-fold increase is expected by 2025 compared to 2016. This is explained by the export potential of the sector and deep processing processes. In general, the results of trend models show that a stable and accelerating growth trend will remain in the region's industrial sectors between 2016 and 2025. The highest growth is expected to be observed in the manufacturing and gas industry sectors. The main drivers will be the volume of investments, technological modernization and infrastructure development.

CONCLUSION

The findings of this study confirm that industrial sector development plays a fundamental role in ensuring sustainable economic growth. The econometric analysis demonstrates a strong relationship between industrial output and key determinants such as investment intensity, productivity growth, export performance, and technological advancement. These factors significantly influence the pace and stability of industrial expansion. The results also indicate that structural diversification and modernization of the industrial sector enhance resilience against external shocks and improve long-term competitiveness. Forecasting models applied in the study reveal that consistent investment in innovation and efficient capital allocation can substantially accelerate industrial growth in the medium term. Overall, the integration of econometric analysis with forecasting techniques provides a reliable analytical framework for designing evidence-based industrial policies. Strengthening industrial diversification, improving technological capacity, and enhancing investment efficiency are essential for sustaining long-term economic development and structural transformation.

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