ECONOMIC ANALYSIS OF INDUSTRIAL PRODUCT GROWTH RATE BASED ON PANEL MODELS BY REGION

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ABSTRACT

The article comprehensively studies the trends in the development of industrial infrastructure in our country and the possibilities of increasing its contribution to GDP. In this regard, the 6-year dynamics of 15 types of indicators affecting the growth rate of industrial output were selected as panel data, parameter values were determined for 4 different models, and their economic content was explained.

Introduction

In the context of the large-scale reforms being implemented in our country, at the current stage of forming a green economy in the development of New Uzbekistan, it is of urgent importance to improve the mechanisms for increasing industrial potential, including continuous monitoring of the level of economic potential of regions and industrial sectors, adopting modernization programs aimed at increasing industrial potential, and developing targeted strategies in this regard. The development of the industrial sector is of great importance for the economy of Uzbekistan. Looking at the preliminary results of 2023, our country's gross domestic product increased by 6.0 percent (5.7% in 2022), and the volume of value added in industry increased by 6.0 percent (5.2% in 2022). The intensity of growth in the industrial sector increased by 0.8 percentage points compared to 2022. The share of industry in GDP was 26.1 percent and ranked second after the service sector in terms of value added.

The manufacturing industry, the main driver of industrial growth in the regions, demonstrated the best pace of structural change. Product output in this sector increased by 6.7 percent, 0.7 percentage points higher than the average growth index for the industry as a whole.

The issues of analyzing, assessing, modeling, constructing inter-sectoral balance and optimization models of socio-economic processes, including industrial development, and forecasting economic growth were studied by foreign scholars Tianshu Fang (2021). In particular, in economics and econometrics, the Cobb-Douglas model is a special functional form of the production function, which is widely used to express the technological relationship between the volume of two or more inputs (especially capital and labor) and the volume of production. According to the Solow model, which describes exogenous growth, long-term economic growth is achieved through capital accumulation, labor force or population growth, and labor productivity growth, which is mainly associated with technological progress. Mukhlis (2017) paid special attention to industrial agglomeration, emphasizing that its presence contributes to economic growth and reducing regional inequalities between regions. Oytun and Muharrem (2014) proved in their scientific work that an increase in labor productivity in production leads to a long-term unemployment rate. A number of studies have been conducted by scientists in our country to assess the potential of industrial production. In particular, Mamadjonov (2018), Khomidov (2017), Mahmudov (2019) and others studied the role of the industrial sector in the national economy and the ways of sustainable development, and developed relevant proposals and recommendations.

Several research methodologies and methods were selected in the preparation of the scientific article. In particular, general-logical (induction, deduction, analysis and synthesis, analogy, generalization) and special-scientific (comparison, grouping, correlation and regression analysis and economic-mathematical) methods were used. The formed panel data were modeled using modern software used in applied econometrics, in particular, using the "Stata" program.

Panel data is a set containing statistical information about several objects in a row over several time periods. From the point of view of regression analysis, the use of panel data increases the size of the sample under consideration, which makes it possible to increase the efficiency of estimating the parameters of the regression model: Y_{it},i=1,..,N , t=1,..,T sample size N*T.

If there are no significant differences between the objects in the sample set, it is possible to build a regression on this panel (pooled regression). In the POLSE (Pooled OLS) method, the table is treated as a cross-section using the least squares method. That is, the individual characteristics of the regions (objects) are not taken into account, and the parameter values in the regression equation represent the change in the regions as a whole, its analytical form is as follows:

$Y_{iy}=a+X_{it}*B+U_{it}$

This is the most restrictive model of panel data and is not widely used in practice. In the fixed effects model (FE), each entity has its own intercept α, and individual effects occur at different intercept times and have the same adaptive parameters:

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a= Yiy -Xit*B

In other words, individual specific effects are the residual variation that cannot be explained by the factor variables (regressors). The essence of the random effects model (RE) is that it assumes that the individual specific effects in the panel data are distributed independently of the regressors. In this model, the objects have the same adaptive parameters and also satisfy the condition of uniform error (randomness):

$Y_{iy}=a+X_{it}*B+U_{it}$

$E_{it}=a_i-e_{it}$

Here, Rho is the intergroup correlation of the error. Rho is the fraction of the variance in the error caused by individual effects. If individual effects have idiosyncratic error (unexplained, random), the value of Rho approaches 1. When processing panel data, all the indicators collected are first logarithmized, and to simplify the calculations, the following variation results are determined for them:

- Overall variation: the difference between the average over time and across objects is found for each object (x_{it} - $\bar{x}$);
- Between variation: for each object, the difference between the mean across time and objects is found from the group mean ($\bar{x}i$ - $\bar{x}$);
- Within variation: the difference between the group mean for each object is found(xit - $\bar{x}i$).

Based on the above models, and depending on which variation method is used, panel data are estimated using 5 different estimators:

1. The Pooled OLS estimator uses between and within variances to estimate parameters, and as its name suggests, estimates them using the OLS method:

$y_{it}= \alpha + x_{it} \beta + (\alpha_i-\alpha+e_{it})$

2. The between estimator uses between variation, that is, the group average values of all indicators are found and the difference from the total average is determined, where the number of observations is N.:

$\bar{y}_l= \alpha + \bar{x}_i \beta + (\alpha_i-\alpha+\bar{e}_i)$

3. Within estimator or fixed effects estimator uses within variation, that is, in this case, the group average of each object is first determined and subtracted from the corresponding objects, in which case the results obtained resemble dummy data. The disadvantage of this estimator is that the effect of time-independent variables is lost:

$y_{it}-\bar{y}_l=(x_{it}-\bar{x}_i)\beta+(e_{it}-\bar{e}_i)$

4. In the first-differences estimator, the objects are compared with the values of the previous period and the difference is determined, so the number of observations is reduced to one for each object: N(T-1). FDE interprets the table as a time series. The disadvantage of this estimator is that, like FEE, it does not allow for the influence of time-independent variables:

$y_{it}-y_{i,t-1}=(x_{it}-x_{i,t-1})\beta+(e_{it}-e_{i,t-1})$

5. Random effects estimator, in which individual specific effects are assumed to be error (randomness). The REE estimation method is performed in the same way as FEE, except that it takes into account the random mean rather than the group mean, i.e. λ the model is selected based on the error taking on average 0 and 1. The model can be described as follows:

$$y_{it} - \hat{\lambda}\,\bar{y}_i = (1-\hat{\lambda})\mu + (x_{it} - \hat{\lambda}\,\bar{x}_i)'\,\beta + \nu_{it}$$

$$\nu_{it} = (1-\hat{\lambda})\,\alpha_i + (e_{it} - \hat{\lambda}\,\bar{e}_i)$$

$$\lambda = 1 - \sigma_e / \sqrt{\sigma_e^2 + \sigma_\alpha^2}$$

If the $\hat{\lambda}$ is on average 0, the panel table is estimated using pooled OLS, if the $\hat{\lambda}$ is on average 1, the panel table is estimated using FEE.

In our research, we selected the growth rates of production of processing industry products as the main indicator determining the regional industrial production potential, and we developed Panel data that affect the change in this indicator.

Factors affecting the growth rates of production of processing industry products 15 indicators were compiled by the author based on the data of the Statistics Agency for the period from 2019 to 2025 and divided into three groups: main indicators, positive and negative indicators. It should be noted that the scope of influence of these indicators was considered theoretically acceptable only, so they were included in the relevant groups.

(Table 1)

Econometric analysis of industrial output growth rates based on panel models [1]

№	Indicators	POLS modeli	FDE modeli	FEE modeli	REE modeli
1	Number of operating KTS	0,057 -	-0,006	0,011	0,057
2	Construction work	0,057	0,134	0,095	0,057
3	Investments in fixed capital	-0,000	-0,019	-0,018	-0,000
4	Population density	0,006	1,743	0,910	0,006
5	Volume of agricultural products (services)	-0,000	-0,099	-0,058	-0,000
6	Share of enterprises and organizations connected to the Internet	0,070	0,042	0,031	0,070
7	Volume of services provided	-0,084	-0,275	-0,198	-0,084
8	Employment rate	1,467	1,581	1,198	1,467
9	Economic activity rate of the population	-1,254	-1,139	-0,790	-1,254
10	Real total income per capita	-0,104	-0,155	0,044	-0,104
12	Number of employees in legal entities operating in the ICT sector	-0,018	-0,016	-0,014	-0,018
13	Retail trade	0,259	0,296	0,259	0,259
14	Electricity ICH	-0,004	-0,006	-0,006	-0,004
15	Labor productivity	0,864	0,920	0,895	0,864

All indicators were converted to logarithms, and based on their values, Panel models were developed using the STATA program (Table 1)

In this case, the influencing indicators are classified as follows:

[1] O‘rganishlar natijasida muallif ishlanmasi

1) Main indicators: labor productivity, investments in fixed capital, number of small businesses, volume of services provided, employment rate, retail trade, foreign investment, electricity;

2) Positive influencing indicators: construction work, population density, volume of agricultural products, share of enterprises and organizations connected to the Internet, level of economic activity of the population, real total income per capita, ACT activity, drinking water, gas networks, average monthly pension, immigrants;

3) Negative influencing indicators: refinancing rate, exchange rate, number of crimes, immigrants.

Table 1 presents the regression coefficients of the Panel POLS, FDE, FEE, REE econometric models, based on which we can describe the economic content of the relationship. For example, in the POLS model, employment is equal to 1.467, that is, a one percent increase in employment leads to an increase in the growth rate of industrial production in the regions by 1.47%. Or another important factor is, of course, labor productivity, and when labor productivity growth rates increase by one percent in an intensive way, an increase in the growth rate of industrial production in the regions by 0.86% is ensured.

Conclusions and proposals.

In order to increase the growth rate of the processing industry in our country, it is necessary to stimulate the factors influencing it. In particular, it is possible to increase labor productivity by introducing new types of raw materials and fuel, material resources, introducing highly efficient modern technologies, accelerating the production process, improving the use of fuel and energy, materials, raw materials, equipment, organizing production on the basis of cooperation and specialization. Or we can increase the level of employment by forming modern professional and entrepreneurial skills, training in professions recognized by the world community. Ultimately, these listed factors will contribute to a high growth rate in industrial production.

It is appropriate to express the results of the issue of optimizing the development of infrastructure of processing enterprises in the following forms. In particular,

- mathematical models: this allows you to express a complex economic and social process in the form of equations describing variables and their relationships;
- analysis graphics: this allows you to visually observe quantitative data.
- descriptive tables and graphs: this allows you to visually convey descriptive data in an orderly, graphic organizer.

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