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ANALYSIS OF GROSS REGIONAL PRODUCT DYNAMICS IN UKRAINE: A MULTIFACTOR REGRESSION APPROACH

The analysis of gross regional product (GRP) dynamics in Ukraine has gained particular relevance amidst ongoing reforms and decentralization of power. To identify key drivers of economic growth at the regional level, the application of economic-mathematical methods and models is deemed appropriate. The findings of such research can inform the development and evaluation of effective state policies aimed at stimulating economic activity in regions and reducing regional disparities.

This research investigates the determinants of Gross Regional Product (GRP) in Ukraine using a multifactor linear regression model, building upon existing quantitative analyses of the Ukrainian economy. While paper [1] examined service exports and papers [2, 3] applied ranking and autoregressive methods to regional labor markets and food prices respectively, this study focuses specifically on GRP drivers across regions. Authors of [5] used regression for small business development in one region, whereas this paper employs a similar method for a broader regional GRP analysis, emphasizing the crucial step of addressing multicollinearity for reliable results, a methodological concern highlighted for accurate economic interpretation.

Gross regional product (GRP) is traditionally considered a crucial indicator of a region's economic development. This study aims to comprehensively analyze the dynamics of GRP across the regions of Ukraine by developing a multifactor linear regression model. *This research endeavors to identify and quantitatively assess the impact of the following determinants:*

- x1 – capital investments;
- x2 – employed population;
- x3 – regional exports;
- x4 – regional imports;
- x5 – number of active enterprises in the region.

Statistical data for analyzing the economic state of Ukraine's regions were collected from the website of the State Statistics Service of Ukraine [6].

Methodological Considerations

When constructing such a model, it is crucial that the parameter estimates adequately reflect the influence of each factor on the resultant variable. Incorrect parameters can lead to erroneous economic interpretations of the results.

Multicollinearity, a phenomenon where several factors are linearly interdependent, implying an influence of factors on each other, can lead to biased parameter estimates. Therefore, it is essential to test the initial model for multicollinearity before determining its parameters.

The Ferrara-Glauber algorithm represents a comprehensive approach to testing a model for the presence of multicollinearity. It involves three main stages:

- testing the system of independent variables for multicollinearity.
- testing each individual factor for multicollinearity with other factors.
- testing pairs of factors for multicollinearity.

For the first stage, it is necessary to normalize the factor variables, determine the correlation matrix and its determinant, and calculate the empirical value of the chi-squared (χ^2) criterion using the formula:

$$X_{em}^2 = - \left(n - 1 \cdot \frac{1}{6} (2k + 5) \right) \cdot \ln|R|,$$

where: n is the number of observations, k is the number of independent variables, and R is the correlation matrix.

For the analyzed model, $\chi_{emp}^2 = -41.6$, while the critical value $\chi_{crit}^2 = 23.2$. The absolute critical value exceeds the empirical value, indicating the presence of dependence within the system of factor variables.

Subsequently, each factor was tested for its relationship with all other factors using the F-criterion:

For the studied model, $F_1 = 56.5$, $F_2 = 75.3$, $F_3 = 22$, $F_4 = 29.1$, $F_5 = 112.1$, with $F_{crit} = 14$. As all empirical F-values are greater than the critical value, each factor variable is multicollinear with some others.

The final stage of the Ferrara-Glauber algorithm involves testing pairs of factors for multicollinearity using the t-statistic. The critical value of the t-statistic is 2.89. The empirical values exceeded the critical value in two instances, indicating a strong interrelationship between capital investments and exports, and between the employed population and the number of active enterprises. Thus, the Ferrara-Glauber algorithm also confirms the presence of multicollinearity in the model.

The strongest correlation was observed between the variables x_2 (employed population) and x_5 (number of active enterprises), with a correlation coefficient of 0.96. Furthermore, variable x_5 exhibited a strong correlation (greater than 0.8) with two other variables, while x_2 had a strong correlation with only one. The application of the Ferrara-Glauber algorithm also yielded the highest F-statistic and t-statistic values for variable x_5 . Additionally, the Variance Inflation Factor (VIF) was calculated, with the highest value ($VIF = 24.6$) also associated with variable x_5 . Therefore, in the first iteration, the factor variable x_5 (number of active enterprises) was chosen for removal.

This choice can also be justified from an economic perspective: employment encompasses not only the production sector but also services and non-profit industries, which also make a significant contribution to GRP. The number of active enterprises may not fully reflect these sectors, leading to an underestimation of their contribution to GRP.

After the first iteration, multicollinearity still persisted (a strong interrelationship existed between capital investments and all other factors). Although capital investments have a relatively strong relationship with GRP, it was decided to eliminate this factor as it depends on all other studied factors, leading to an inadequate reflection of the model parameters. Following the exclusion of capital investments, multicollinearity was finally eliminated (none of the pairwise correlation coefficients exceeded 0.8, the coefficient of determination was 0.95, and all model parameters were statistically significant).

The regional economic development model after eliminating multicollinearity takes the following form:

$$y = -24766.7 + 232.8x_2 + 17.4x_3 + 13.2x_4,$$

where: y – GRP, X_2 – employed population; X_3 – regional exports; X_4 – regional imports; $\beta_0, \beta_2, \beta_3, \beta_4$ – estimated parameters; ϵ – error term.

This model suggests that the GRP of a region in Ukraine is positively influenced by the size of its employed population, the volume of its exports, and the volume of its imports. The coefficients quantify the estimated magnitude of these impacts, holding other factors constant. A larger employed population, higher exports, and even higher imports (likely due to their role in production and consumption) are all associated with a higher Gross Regional Product according to this specific regression model.

Gross regional product (GRP) is a fundamental indicator of a region's economic well-being, especially in the context of global economic challenges and regional disparities. Utilizing multifactor linear regression applied to data from the State Statistics Service of Ukraine for 2021, this study aimed to gain a deeper understanding of how key factors such as capital investments, employment, foreign trade, and entrepreneurship influence the economic development of Ukraine's regions. The results of this research are relevant for the development of effective regional policies aimed at stimulating economic growth and balanced development.

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ПЕРЕВАГИ ТА РИЗИКИ ВИКОРИСТАННЯ КРИПТОВАЛЮТНИХ АКТИВІВ ЯК ФІНАНСОВОГО ІНСТРУМЕНТУ

Дослідження криптовалют як фінансових інструментів є надзвичайно важливим і актуальним, оскільки воно дає змогу оцінити їхній вплив на світову економіку, виявити переваги й недоліки, визначити ефективні механізми регулювання та захисту інвесторів, а також окреслити перспективи подальшого розвитку цього інноваційного сегмента. Ідея створення криптовалюти полягала в кардинальній трансформації чинної фінансової системи. Проте, як і будь-яка новаторська технологія, вона має свої ризики й обмеження. На даний момент криптовалюти не становлять серйозної загрози для фінансової стабільності: обсяги їх використання та торгівлі залишаються невеликими, а поширення – обмеженим. Однак подальший розвиток криптовалютного ринку потребує посиленого контролю та регуляторної уваги, оскільки в перспективі він може набувати більшого значення і впливу на глобальну економіку. На сьогодні, стрімке зростання криптовалютного сектору створює нові як можливості, так і виклики для фінансової системи та економіки загалом. У зв'язку з цим доцільно проаналізувати ключові переваги та потенційні ризики використання криптовалютних активів як фінансового інструменту (рис. 1).