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Larysa Zomchak[1]

Rebuilding Through Innovation: Modeling Ukraine's Development Path Among European Economies

[1]Ivan Franko National University of Lviv

Abstract: *The paper examines the theoretical foundations of innovative development of national economies and its impact on international competitiveness. The strengths and weaknesses of Ukraine's innovative development are analyzed in comparison with European countries. A binary logistic regression model is constructed to classify 39 European economies by level of innovation based on the 12 indicators. Using the backward Wald method, four statistically significant predictors were identified. Model diagnostics and interpretation confirm its adequacy and high predictive power (accuracy 92.3%, AUC = 0.922).*

Keywords: *innovation; innovative development; logistic regression; machine learning; classification; global innovation index.*

In the context of globalization and digital transformation, innovative development is a key factor in the economic growth of countries and their competitiveness on the international stage. For Ukraine, which strives for European integration and post-war recovery, the issue of assessing the level of innovative development and identifying its determinants is of particular relevance.

Modern modeling of National Innovation Systems has shifted from static efficiency assessments to dynamic, integrated frameworks. Guan and Chen [1] and Anouze et al. [2] provide the theoretical basis for this by decomposing innovation into knowledge production and commercialization stages, using network-based indices to reevaluate national performance. However, for transition economies like Ukraine, this evolution is constrained by "path dependence" [2], where historical institutional structures create persistent regional disparities. Liao et al. [3] confirm that such technological heterogeneity across 35 European countries directly dictates total factor productivity. In the Ukrainian context, Nosova and Makovoz [4] and Zomchak et al [5] highlight that internal regional imbalances and wartime challenges remain the primary hurdles to national competitiveness. The structural interaction between industrial output and GDP [6] identifies the macroeconomic "levers" necessary for growth. Methodologically, your use of logistic regression aligns with the "integrated approach" of Kovalchuk et al. [7], who advocate for robust statistical classification to identify the specific drivers, such as R&D expenditure and high-tech exports, that allow an economy to transition into a high-innovation cohort.

The aim of the research is to apply the logistic regression method to model and classify the level of innovative development of the national economies of Ukraine and European countries, as well as to identify the main factors that determine it.

The object of the study is the innovative development of national economies. The information base consists of the Global Innovation Index data for 39 European countries. The methodological basis comprises methods of economic analysis, mathematical statistics, and machine learning, specifically binary logistic regression.

The analysis showed that Ukraine ranks 34th among 39 European countries in terms of GII value (31,0 points) [8], which places it in the group of less innovatively developed economies. Among the main factors hindering Ukraine's innovative

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development, the study identified an insufficient volume of R&D funding (only 8 USD per capita, what is 100 times less than in the USA), the absence of targeted state programs to support innovation, underdeveloped innovation infrastructure, and the impact of military actions.

To construct the model, countries were divided into two classes: more innovatively developed (Y is equal one) and less innovatively developed (Y is equal zero). By applying the Wald backward method (9 iterations), 4 statistically significant factors ($p < 0.1$) were selected from an initial set of 12 variables: domestic market size (billion PPP); the number of scientific and technical articles per billion GDP; the share of high-tech exports in total trade (%); and gross domestic expenditure on R&D (% of GDP).

All estimated coefficients within the specified model exhibit positive signs, indicating a direct proportional relationship where an increase in each respective predictor enhances the probability of a country's classification within the high-innovation cohort. Notably, gross domestic expenditure on R&D functions as the most influential determinant (B is 0,451; Exp(B) is 1,569). The empirical robustness and predictive validity of the model are substantiated by a comprehensive suite of diagnostic metrics: the Omnibus test (chi^2 is 44,075 with $p < 0,001$), a Nagelkerke R^2 of 0.903, an overall classification accuracy of 92.3%, an area under the ROC Curve of 0,922, and a Gini index of 0,845.

The constructed logistic regression model is adequate and possesses high predictive characteristics, which allows recommending it for practical application in the classification and forecasting of the level of innovative development of national economies. The results of the study indicate the need to increase public and private investment in R&D, stimulate scientific and technical publication activity, and increase the share of high-tech exports as priority areas for enhancing the innovativeness of Ukraine's economy.

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Zomchak Larysa – candidate of economic sciences, associate professor, Ivan Franko National University of Lviv; email: lzomchak@gmail.com

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