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ECONOMIC AND MATHEMATICAL MODELING REASONS FOR DIFFERENTIATED DEVELOPMENT OF PANDEMIC IN UKRAINE

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As of October 30, 2020, the level of vulnerability of the population to COVID-19 in Ukraine, namely the number of infected/dead, is the highest in Kharkiv (37180/51) and Lviv regions (30236/876) and the lowest level in the Kirovohrad region (2610/92) and Kherson (4153/85). What exactly caused such differentiation? The question of the negative effects virus COVID-19 has changed the vector of scientific interests of many scientists. Economists' goal is a find quick way to overcome the economic crisis, by reason of total quarantine and search the cause-and-effect relationships between the different spread of the disease within country. The pandemic is destroying the economy due to many companies' bankruptcy and high level the unemployment rate [11]. Researchers [10; 13] considered factors that may contribute to economic development. In [6], economic the crisis is studied as one of the elements increase of terrorism, so the impact of a pandemic may have preliminary consequences worldwide. The authors [1] learn indicators that can positively affect economic growth, which is a topical issue given the pandemic's negative effects on the world economy. High-quality state regulation of business [19], increasing the efficiency of workers [18], socially responsible public investment system [20] , increasing foreign investment [17] is the driving force in overcoming the pandemic. The medical sphere state now occupies great attention in the scientific community [3; 12; 15]. Researchers [2; 5;16] have paid sufficient attention to health workers' quality of life and motivation to work. The search for environmental factors, which has impact on the overall development of the country's economy [9], and in [4] sufficient attention was paid to the need to introduce "clean industry". The issue of an innovative approach to information data as one of the aspects of providing economic benefits for the rapid overcoming of the pandemic's crisis consequences is relevant [7; 14]. So, the problem of finding causes of various effects of pandemics in the regions is relevant. As regresants, we use data on the regions of Ukraine (1.10.2020) on the incidence of COVID-19 and the number

of deaths caused by the COVID-19. We chose the composition of the population of Ukraine, the state of health care, the ecological state of the region, investment in environmental protection, gross regional product, household income, migration.

Stage 1. Multicollinearity testing using the Farrar-Glober algorithm for input data. Thus, we withdrew from the study some indicators and reduced the number of indicators from 22 to 16.

Stage 2. Let us construct a multiple regression model to estimate the significance of the coefficients. After performing a preliminary analysis of the linear regression model, we obtained a satisfactory result. So, that we will apply logarithmization of indicators.

Stage 3. Construction of nonlinear multiple regression of the form:

$$lny = a_0 + a_1 lnx_1 + a_2 lnx_2 + \cdots + a_{16} lnx_{16} \quad (1)$$

Using the MLS, we calculated the coefficients for each regression. For "Mortality" coefficient of determination: R2= 0.86; Fisher's test F = 3.71. For "Incidence" R2 = 0.89; F = 3.86. We conclude that the coefficient of determination is statistically significant, and indeed there is a relationship between the dependent variable and 16 independent variables. The most significant for the number of deaths (S) from COVID-19 were: the people of Ukraine, 64+ (P); declarations (D); emissions of pollutants (E); household income (I); number of arrivals (M):

$$lnS = -3{,}1\ ln\ ln\ P\ + 1{,}3lnD - 1{,}2lnE + 1{,}4lnI + 0{,}9lnM + 26{,}3 \quad (2)$$

The most significant for the number of infected COVID-19 (01.10.2020) were the following indicators: the number of arrivals (M),% of wage arrears (W), air pollutant emissions (E), the number of doctors (L), the population of Ukraine,64+ (D) result (3):

$$lnY = -1{,}1\ ln\ ln\ D\ + 2{,}1lnL - lnE + 1{,}8lnW + 1{,}3lnM - 1 \quad (3)$$

Stage 4. Let's check the connection between random deviations and residual values in other observations - that is, the presence of autocorrelation. To test, apply the Darbin-Watson test.After performing the calculation, we obtained DW1 = 2.03 (DW1 = 1.3). The obtained result within acceptable limits, which means that autocorrelation of residues doesnot exist.

Stage 5. We analyze residues' dependence on the variables included in the final model to determine the presence of heteroskedasticity using the Spearman test. All values are more significant than critical - the rank correlation is insignificant, so there is no heteroskedasticity in the model.

Both constructed spatial logarithmic models have high indicators of quality, adequacy, and closeness of the dependent variable's connection with independent ones, so the results can be used to find a method to slow down the spread of the virus in the regions, and to develop anti-epidemiological measures.

Thus, among the considered factors of development of the regions, those

that determine the region's vulnerability to the COVID-19 pandemic have been identified. Namely, the migration movement of the population, which has a positive impact on the number of deaths and morbidity. Therefore, we believe that closing the country's borders really helps slow down the spread of the virus. Also significant is the region's ecological state, the development of the health sector, and households' well-being. The study results may be useful in creating road maps of particular regions to overcome epidemiological influences. This work is carried out within the taxpayer-funded researches: No. 0118U003574 “Cybersecurity in the banking frauds enforcement: protection of financial service consumers and the financial and economic security growth in Ukraine”.

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