Public Health Efficiency and Country Competitiveness: Empirical Study in Pre-Pandemic and Pandemic Periods

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Abstract

Dramatical fall in economic growth both in terms of COVID-19 pandemic and military threats actualizes the need to identify the drivers and inhibitors of ensuring the country competitiveness. Instead, in the conditions of intense load on the public health system caused by both the challenges of the COVID-19 pandemic and military threats, the definition of these drivers and inhibitors among public health factors is of critical importance. The purpose of this study is to identify the impact of public health factors on the level of the country's competitiveness, as well as the change of these causal patterns in the context of the unfolding of the coronavirus disease (COVID-19). For the empirical implementation of the research goal, several hypotheses have been formed: hypothesis 1 – improving the efficiency of the public health system has a positive effect on the country's competitiveness (both in pre-pandemic and pandemic periods); hypothesis 2 – in the context of the spread of the COVID-19 pandemic, there was an increase in the significance of the influence of public health factors on the level of the country's competitiveness. The study involves the implementation of several stages: 1) formation of an integral index of the country's competitiveness; 2) modelling the impact of public health factors on the level of the country's competitiveness in the pre-pandemic and pandemic periods. Modelling of the influence of public health factors on the level of the country's competitiveness was carried out using panel data regression modelling and the Hausman test in the Stata/SE 14.2 software. The implementation of the theoretical part of the study proved the existence of five contextual clusters of scientific research on ensuring the country's competitiveness in the context of the spread of the coronavirus pandemic. The results of the practical approbation of the developed approach made it possible to partially confirm hypothesis 1 (among the factors characterizing the effectiveness of the public health system, only the birth rate, mortality rate, life expectancy, and number of hospital beds had a statistically significant impact on the country's competitiveness, while neither current nor capital expenditures on health care did not have a significant impact) and to confirm hypothesis 2 (in the context of the unfolding of the pandemic, the influence of relevant public health factors on the country's competitiveness increased).

Key words

competitiveness of the country, coronavirus disease, COVID-19, public health, health care expenditures.

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Introduction

In the conditions of the intensification of globalization and integration processes, the need to ensure the stability of the national economy is becoming more urgent due to the significant intensity and scale of cross-border interaction, the probability and speed of transmission of destructive processes. These processes were quite acutely manifested during the global financial crisis of 2007-2009, when the collapse of several systemically important financial institutions provoked a crisis in the financial and economic sector of a number of countries around the world (Dubina et al, 2020; Titko & Shina, 2017). The experience of the global financial crisis has shown that crisis phenomena are becoming more intense, and their consequences are becoming more large-scale. The negative synergy of the interstate transmission of destructive processes was also intensified during the outbreak of the COVID-19 pandemic, when, against the background of restrictive state interventions aimed at countering the spread of the coronavirus infection, there was a sharp decrease in the level of business activity, which resulted in a catastrophic decrease in the rate of economic growth (Letunovska et al., 2021; Titko et al., 2015; Komańda, 2022). Thus, according to forecasts of experts of the International Monetary Fund (International Monetary Fund, 2022) in 2023, the dynamics of economic growth among the countries of the world will decrease to the level that is the lowest result since 1970. It is also worth noting that in conditions where the intensity of crisis processes and the scale of transmission of destructive shocks is rapidly increasing, it is important to identify the determinants of ensuring the state's competitiveness. At the same time, in the conditions of intense load on the public health system caused by both the challenges of the COVID-19 pandemic and military threats, the identification of drivers and inhibitors of ensuring the state's competitiveness among public health factors is gaining relevance. In addition, an important task is to identify changes in the patterns of ensuring the state's competitiveness, caused precisely by the challenges of the COVID-19 pandemic. All this determines the relevance, purpose and tasks of this research.

1. Literature review

In order to formalize the theoretical basis for ensuring the competitiveness of the state and the determinants that affected it in the conditions of the COVID-19 pandemic, relevant scientific Scopus publications were analysed (Scopus, 2024). In particular, 292 scientific publications were selected for the sample, the title, abstract or keywords of which contain such concepts as "competitiveness" AND "country" AND "COVID-19". So, by processing keywords in publications on a certain issue using the VOSviewer software (VOSviewer, 2024), a visualization map was built, which is presented in Figure 1.

Thus, according to the results of the bibliometric analysis, it is possible to note the existence of several meaningful directions of scientific research in the context of ensuring countries' competitiveness in the conditions of the COVID-19 pandemic, namely:

- red cluster – represents a scientific direction within which researchers are focused on identifying the impact of population employment, trade and the development of various industries on the country's competitiveness;
- green cluster – covers scientific research on the identification of the role of digital technologies, artificial intelligence, economic determinants and economic crises in ensuring the country's competitiveness;

– blue cluster – covers scientific publications on identifying the impact of governance, education, human potential development, labour productivity, as well as the impact of the COVID-19 pandemic and public health on the country's competitiveness;
– yellow cluster – integrates scientific results in the sphere of the impact of the development of commerce, entrepreneurship and management of supply chains in ensuring the country's competitiveness;
– purple cluster – covers scientific papers regarding the role of globalization and tourism in ensuring the country's competitiveness.

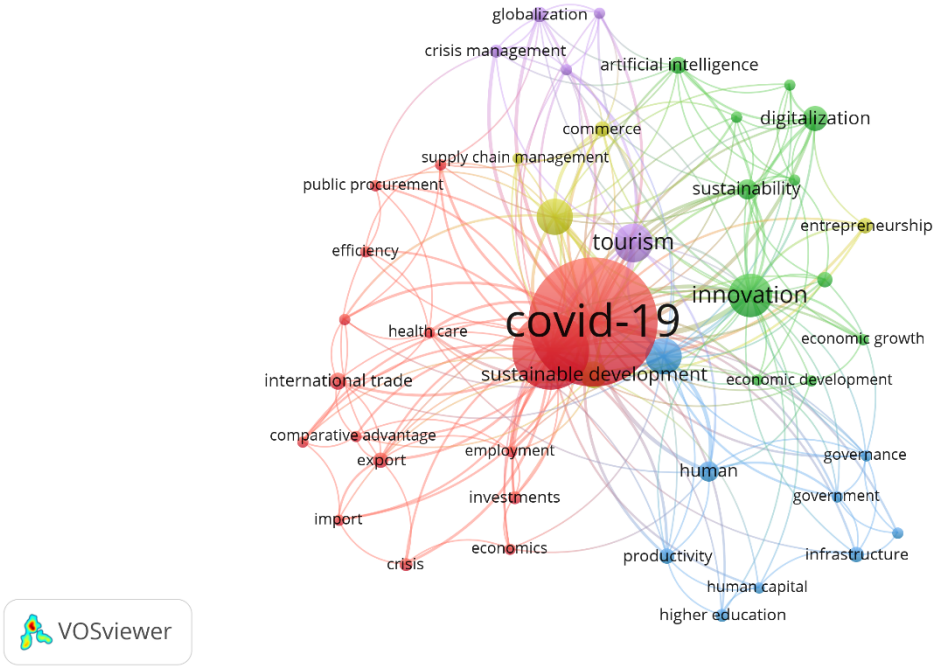

Figure 1. Co-occurrence map of key words in Scopus publication on country competitiveness in terms of COVID-19

Source: created with VOSviewer (VOSviewer, 2024) based on information from Scopus (Scopus, 2024).

According to the results of the bibliometric analysis of Scopus publications, it can be noted that ensuring the country's competitiveness depends on a number of various factors, including both socio-economic and digital determinants. An in-depth analysis of existing publications on relevant issues made it possible to underline more specific scientific results, the general trends of which were revealed during the bibliometric analysis. Thus, a rather popular scientific direction is the study of the impact of education (Çidik et al., 2023), the development of human potential and labour productivity in the context of ensuring the country's competitiveness (Lyulyov et al., 2018; Chygryn et al., 2023; Szczepanska-Woszczyna, Bogaczyk, 2023). The generalization of scientific research proved that investing in the development of human capital, improving qualifications and developing professional competences allows to increase labour productivity, which, in turn, allows to obtain additional competitive advantages in the domestic and foreign markets.

One of the important focuses of scientific research in terms of clarifying social determinants of country's competitiveness is the study of the peculiarities of migration processes. Thus, the analysis of the trends of internal migration of the population allows to balance the urban development of the

territories, to contribute to the reduction of the socio-economic gap between the urban and rural territories due to the use of appropriate regulatory interventions. Instead, the determination of trends in external migration of the population allows taking into account all the risks and opportunities of such a labour flow in the context of ensuring the competitiveness of the national economy (Kwilinski et al., 2022). eAt the same time, the strengthening of globalization and integration processes, taking into account cross-cultural factors and the expansion of export-import operations contribute to the active involvement of the country in foreign economic activity and the opportunities to develop new markets, modernize production technologies and obtain additional competitive advantages (Dacko-Pikiewicz, 2019; Szczepańska-Woszczyna et al., 2022; Dzwigol, 2021).

No less important than socio-demographic parameters are natural resource factors. Thus, countries with a higher level of competitiveness have larger reserves of land resources characterized by good fertility, as well as a larger reserve of natural resources that can be developed for the development of industry (Hussain et al., 2021). However, the presence of rich natural resource potential or, on the contrary, its absence is not an exclusive prerequisite for the presence or absence of a country's competitiveness. Thus, in countries rich in natural resources, in the absence of proper infrastructure and other related prerequisites, there may be a rather mediocre level of competitiveness. Instead, countries that are not rich in natural resources have the opportunity to gain additional competitive advantages due to the effective use of existing potential and its multiplication with the use of innovative technologies. The positive role of innovation in ensuring the country's competitiveness is also confirmed by Hakhverdyan & Shahinyan (2022), Szczepańska-Woszczyna (2018), Szczepańska-Woszczyna et al. (2021), Baltgailis & Simakhova (2022).

At the current stage of the development of global economic relations, the competitiveness of the national economy is significantly determined by environmental factors (Panchenko et al., 2021), because only countries that constantly introduce eco-innovations and use a wide range of environmental protection technologies have prospects for sustainable development, and therefore for the growth of the country's competitiveness (Chen et al., 2023; Dzwigol et al., 2023; Kwilinski et al., 2023; Titko et al., 2013; Veckalne & Tambovceva, 2023; Spicka, 2018; Spicka et al., 2019). Reducing the level of energy dependence is also one of the main prerequisites for ensuring the national security of the state and the competitiveness of the national economy. In particular, reducing the level of energy dependence can be achieved through the active development of renewable energy (Ziabina, & Pimonenko, 2020; Ziabina, Y., Pimonenko et al., 2021; Ortina, et al., 2023).

The development of the institutional environment is also defined by scientists as an important prerequisite for ensuring the country's competitiveness, since even under good initial conditions, the lack of good governance (corruption, instability of legislation, etc.) can lead to irrational use and waste of existing potential (Dzwigol, 2019; Dzwigol, 2023; Szczepańska-Woszczyna, Kurowska-Pysz, 2016). Among the micro-level determinants of ensuring business and economic competitiveness, the use of digital technologies (Ortina et al., 2023) and artificial intelligence to optimize business processes and production technologies is gaining importance (Chygryn et al., 2022; Tambovceva et al., 2020; Wang et al., 2022; Us et al., 2021; Melnychenko, 2019; Miśkiewicz, 2019; Trushkina et al., 2020; Trzeciak et al., 2022; Zhanibek et al., 2022; Grebosz-Krawczyk & Siuda, 2022; Seržantė & Pakalka, 2022; Di Sabato & Kozáková, 2023). It is worth noting that the implementation of digital technologies is impossible without significant investments (Kostiukevych et al., 2020), which is also determined in numerous studies (Moskalenko et al., 2022a; Lyulyov & Moskalenko, 2020; Szczepańska-Woszczyna, Gatnar,

2022). At the same time, there is a lack of scientific research aimed at determining the role of public health factors in ensuring the country's competitiveness both in the conditions of the COVID-19 pandemic and in the pre-pandemic period (Letunovska et al., 2022), which determines the need for further research in this direction.

2. Methodology

The purpose of this study is to determine the impact of public health factors on the level of the country's competitiveness, as well as the change of these causal patterns in the context of the spread of the coronavirus pandemic. Thus, for the empirical implementation of the research goal, several hypotheses were formed:

Hypothesis 1: improvement of the efficiency of the public health system has a positive effect on the country's competitiveness (both in pre-pandemic and pandemic periods);

Hypothesis 2: in the conditions of the spread of the COVID-19 pandemic, there was an increase in the significance of the influence of public health factors on the level of the country's competitiveness.

In order to test the proposed hypotheses, an array of statistical data was formed for a geographical sample of 15 European countries with common trends in socio-economic development (Albania, Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Serbia, Slovakia, Slovenia and Ukraine). The time period of the study covers both pre-pandemic and pandemic periods (2000–2022).

2.1 Formation of the country's competitiveness index

Taking into account the fact that there are no comparable international ratings or indices that allow to assess the state of the country's competitiveness on a single scale both in the pre-pandemic and pandemic periods (the latest report, in which it is presented the results of the Global Competitiveness Index from World Economic Forum, have been published in 2020 (Schwab, Zahidi, 2020), while the results of the World Competitiveness Ranking from the International Institute for Management Development (IMD, 2024) cover only 2019-2023), the it was developed own country competitiveness index, taking into account the basic methodological aspects of both indicated indices.

In particular, 18 indicators were initially selected to assess the level of the country's competitiveness: Agricultural land (% of land area) (Agr_L); Control of Corruption: Estimate (CC); Government Effectiveness: Estimate (GE); Regulatory Quality: Estimate (RQ); Political Stability and Absence of Violence/Terrorism: Estimate (PS); Current account balance (% of GDP) (CAB); Employment to population ratio, 15+, total (%) (Empl); Foreign direct investment, net inflows (% of GDP) (FDI); GDP growth (annual %) (GDPg); General government final consumption expenditure (% of GDP) (GGFCE); Gini index (Gini); Gross fixed capital formation (% of GDP) (GFCF); Inflation, consumer prices (annual %) (CPI); New business density (new registrations per 1,000 people ages 15-64) (Bus); Portfolio investment, net (BoP, current US$) (Portfolio); Tax revenue (% of GDP) (Tax_rev); Trade (% of GDP) (Trade); Total reserves in months of imports (Res). The statistical array of the above indicators for 15 European countries for 2000-2022 was formed from the collections of the World Bank Group (World Bank DataBank, 2024).

The formation of the integrated index of the country's competitiveness involves the implementation of several consecutive procedures. First, all indicators must be brought to a comparable measurement, because they have different units of measurement. Considering the existence of negative values for some indicators, it is first necessary to transform all data into non-negative values by adding to all

current values of the indicators the largest absolute negative value of the indicator. After bringing all indicators for non-negative values, they must be brought to a comparable form, taking into account the nature of their influence on the future integral indicator. Considering the existence of zero values among the values of the individual indicators, the application of the simplest approaches to normalization is impossible, and therefore the normalization will be carried out using combination of the natural normalization and Savage normalization. Thus, among the entire set of individual indicators for assessing the country's competitiveness, only two – the Gini index and Inflation, consumer prices (annual %) – are inhibitors, that is, their increase leads to a deterioration of the country's competitiveness. Normalization of inhibitor indicators will be carried out using Savage normalization according to the formula:

$$cci_n = \frac{cci_{max} - cci_i}{cci_{max} - cci_{min}} \quad (1)$$

where cci_n is the value of the individual indicator for assessing the country's competitiveness after the normalization procedure; cci_i – the value of the individual indicator of the country's competitiveness, which is normalized; cci_{min} – the minimum value of the individual indicator of the country's competitiveness; cci_{max} – the maximum value of the individual indicator of the country's competitiveness.

The remaining individual indicators of the country's competitiveness have a positive effect on the integrated indicator, so their normalization will be carried out using natural normalization according to the formula:

$$cci_n = \frac{cci_{max} - cci_{min}}{cci_i - cci_{min}} \quad (2)$$

where cci_n is the value of the individual indicator for assessing the country's competitiveness after the normalization procedure; cci_i – the value of the individual indicator of the country's competitiveness, which is normalized; cci_{min} – the minimum value of the individual indicator of the country's competitiveness; cci_{max} – the maximum value of the individual indicator of the country's competitiveness.

After bringing the indicators to a comparable form, all the values of the individual indicators of the country's competitiveness will be in the range from 0 to 1, where a higher value of the indicator is characterized by a better influence on the integrated indicator. Since the preliminary selection of indicators for assessing the country's competitiveness was carried out using an expert-monographic approach, it is advisable to check the indicators for the existence of internal consistency. Cronbach's alpha test in Stata/SE 14.2 software was used for this purpose. As it is mentioned in Stata manual (Stata, 2023) "Cronbach's alpha assesses the reliability of a summative rating scale composed of the variables (called items) specified". If the results of the test determine an individual indicator that worsens the internal consistency of the indicators, then they will be eliminated. At the next stage, it is necessary to determine the weighting coefficients of the contribution of each of the individual indicators of the country's competitiveness to the integrated indicator. To perform the task, the principal

component analysis in the Stata/SE 14.2 software will be applied. This process involves the implementation of several sequential procedures, namely:

– selection of the minimum number of principal components, the eigenvalues of which will be used to identify the importance of the contribution of individual indicators to the integral. When choosing the number of principal components, both graphic and analytical approaches will be used. Thus, according to the graphical approach, a graph of the scree plot will be constructed using the Stata software, based on which the number of principal components is selected, at which the intensity of the decrease of the eigenvalues of the principal components slows down. In addition, the correctness of this choice will be checked using an analytical approach, since, as a rule, the number of principal components characterizing more than 70% of the total variation of variables is chosen;
– determining the ranks of individual indicators of the country competitiveness according to the Fishburne approach. On the basis of averaging the absolute eigenvalues of individual indicators from the principal components selected at the previous stage, the indicators are assigned ranks. If the difference between the levels of averaged absolute eigenvalues of individual indicators is not significant, then the indicators are assigned the same rank;
– determination of the weight coefficients of individual indicators for assessing the level of country competitiveness by the ratio of the rank of the individual indicator to the total sum of ranks.

At the final step of this stage, the country's competitiveness index is determined by adding the multiplications of the actual normalized values of individual indicators to their weighting coefficients.

2.2 Modelling the influence of public health factors on the level of the country's competitiveness in the pre-pandemic and pandemic periods

To test hypothesis 1 regarding the positive impact of improving the public health system efficiency on the country's competitiveness in the pre-pandemic and pandemic periods, panel data regression models in the Stata/SE 14.2 software will be built, and the model specification (fixed or random effects) will be determined using the Hausman test. To determine causality in the pre-pandemic period, a model will be built only for the period 2000-2019. Instead, the following indicators will be chosen as factor variables: Birth rate, crude (per 1,000 people) (Birth); Capital health expenditure (% of GDP) (CHE); Current health expenditure (% of GDP) (CurHE); Death rate, crude (per 1,000 people) (Death); Hospital beds (per 1,000 people) (Beds); Life expectancy at birth, total (years) (Life). In turn, to determine the impact of public health factors on country's competitiveness during the pandemic period, two additional variables will be added – total COVID-19 cases, per million cumulative and total COVID-19 death, per million cumulative. The modelling period is 2020-2022. In order to test hypothesis 2 about the impact of public health factors on the level of the country's competitiveness increase during the COVID-19 pandemic period, the strength and direction of the relationship between the relevant independent and dependent variables in the model for the pre-pandemic and pandemic periods will be compared.

3. Research results

3.1 Formation of the integrated index of the country's competitiveness

After normalization of 18 selected individual indicators of country's competitiveness measurement using the Savage formula (formula 1) and natural normalization (formula 2), all indicators are in the range from 0 to 1. In order to check the internal consistency of the indicators, the Cronbach's alpha test was applied, the results of the first iteration of which are presented in Table 1.

Table 1. Cronbach's alpha test results (1st iteration)

Item	Item-test correlation	Item-rest correlation	Average interitem correlation	Alpha
Agr_L	0.5365	0.4462	0.1815	0.7904
CC	0.8518	0.8147	0.1615	0.7660
GE	0.8602	0.8251	0.1610	0.7653
RQ	0.8151	0.7701	0.1638	0.7691
PS	0.7184	0.6548	0.1700	0.7768
CAB	0.3979	0.2940	0.1903	0.7998
Empl	0.3104	0.2006	0.1959	0.8055
FDI	0.2451	0.1322	0.2000	0.8096
GDPg	0.3099	0.2001	0.1959	0.8055
GGFCE	0.3567	0.2498	0.1929	0.8025
Gini	0.4382	0.3377	0.1878	0.7972
GCF	0.2065	0.0924	0.2025	0.8119
CPI	0.4332	0.3322	0.1881	0.7975
Bus	0.6183	0.5387	0.1763	0.7844
Portfolio	0.1356	0.0200	0.2070	0.8161
Tax_rev	0.1470	0.0315	0.2063	0.8154
Trade	0.7163	0.6524	0.1701	0.7770
Res	0.5425	0.4529	0.1811	0.7899
Test scale			0.1851	0.8035

Source: authors' calculations in Stata/SE 14.2 software.

After the first iteration, the "Portfolio" variable was eliminated, after the second iteration – the "Tax_rev" variable, after the third – the "GCF" variable. This made it possible to increase the internal consistency of indicators from 0.8035 to 0.8478. Further removal of indicators led to worthening of the test results. Thus, for the formation of the country's competitiveness index, it is advisable to choose 15 of the 18 individual indicators that were primarily selected.

At the next stage, the principal component analysis was used, the results of the first stage of which are presented in Table 2 and Figure 2.

Table 2. Results of Principal Component Analysis

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	5.3387	3.4305	0.3559	0.3559
Comp2	1.9082	0.4178	0.1272	0.4831
Comp3	1.4904	0.2113	0.0994	0.5825
Comp4	1.2791	0.2168	0.0853	0.6678
Comp5	1.0623	0.2790	0.0708	0.7386
Comp6	0.7833	0.0888	0.0522	0.7908
Comp7	0.6945	0.1589	0.0463	0.8371
Comp8	0.5355	0.0427	0.0357	0.8728
Comp9	0.4929	0.0353	0.0329	0.9057
Comp10	0.4576	0.1207	0.0305	0.9362
Comp11	0.3369	0.0379	0.0225	0.9586
Comp12	0.2990	0.1235	0.0199	0.9786
Comp13	0.1755	0.0803	0.0117	0.9903
Comp14	0.0952	0.0443	0.0063	0.9966
Comp15	0.0509	.	0.0034	1.0000

Source: authors' calculations in Stata/SE 14.2 software.

The combination of graphic (Figure 2) and analytical (Table 2) approaches allowed us to determine that it is optimal to choose 6 principal components, which together explain 79.08% of the total variation of factors.

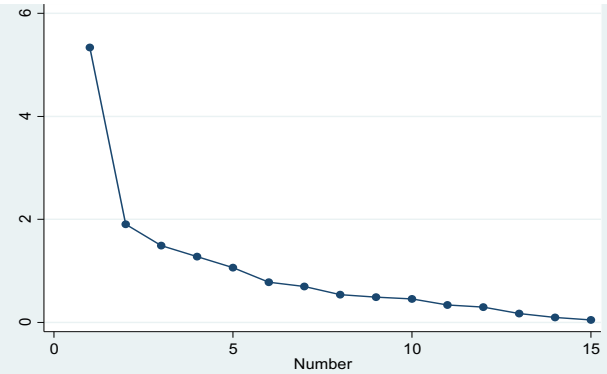

Figure 2. Scree plot of eigenvalues after Principal Component Analysis
Source: authors' calculations in Stata/SE 14.2 software.

According to the data in Table 3, it can be noted that among the indicators for assessing the level of country's competitiveness, the most significant are Foreign direct investment, net inflows (% of GDP) and General government final consumption expenditure (% of GDP). In turn, the least influential are control of corruption, government efficiency and regulatory quality.

Table 3. Results of identification of weighting coefficients

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Av_comp	Rank	Weight
Agr_L	0.2422	0.4156	0.0846	0.0129	0.1961	0.1193	0.1785	3	0.0417
CC	0.3982	0.1489	0.0088	0.074	0.0309	0.0053	0.1110	1	0.0139
GE	0.4047	0.1061	0.0571	0.0312	0.0207	0.0475	0.1112	1	0.0139
RQ	0.3856	0.1345	0.0382	0.0246	0.0076	0.1113	0.1170	1	0.0139
PS	0.3503	0.1609	0.0057	0.2534	0.1556	0.1006	0.1711	2	0.0278
CAB	0.1817	0.3077	0.3934	0.1903	0.1165	0.014	0.2006	5	0.0694
Empl	0.1108	0.4176	0.3885	0.0409	0.2241	0.3895	0.2619	8	0.1111
FDI	0.0030	0.0900	0.1997	0.199	0.8279	0.3483	0.2780	9	0.1250
GDPg	0.0213	0.2216	0.5717	0.2382	0.0225	0.5117	0.2645	8	0.1111
GGFCE	0.1488	0.0765	0.3913	0.4876	0.1693	0.4045	0.2797	9	0.1250
Gini	0.1662	0.5056	0.0228	0.2088	0.1292	0.01	0.1738	3	0.0417
CPI	0.1857	0.0601	0.1425	0.6206	0.1755	0.1463	0.2218	6	0.0833
Bus	0.2604	0.107	0.1758	0.3242	0.2928	0.3389	0.2499	7	0.0972
Trade	0.3061	0.2771	0.1395	0.0674	0.1557	0.2091	0.1925	4	0.0556
Res	0.2368	0.2649	0.3022	0.1352	0.0117	0.2868	0.2063	5	0.0694

Source: authors' calculations in Stata/SE 14.2 software

Taking into account the weighting factors defined in Table 3, the country's competitiveness index was calculated, the dynamics of which are presented at Figure 3. According to the results of the analysis of the dynamics of the countries' competitiveness index for 15 European countries for 2000-2022, it can be noted that the level of this indicator ranges from 0.32 to 0.62 with the maximum value of the indicator – 1. In particular, the Czech Republic and Estonia belong to the countries with the highest level of competitiveness. The group of countries catching up to the leaders is formed by Bulgaria, Croatia, Hungary, Latvia, Lithuania, Moldova, Poland, Romania, Slovakia and Slovenia. The rest of the countries have a below-average level of country competitiveness. In addition, it is worth noting that for most of the countries in the sample, the trend of the change in the level of the indicator is gentle and mostly upward (with a slight drop during the coronavirus pandemic). However, for Hungary and Moldova, the drop in the level of competitiveness after 2020 is more critical. On the other hand, the level of competitiveness of Ukraine during the studied period decreased critically twice – after the

global financial crisis and after the start of military invasion to Ukraine. However, the COVID-19 pandemic did not have such a dramatical effect on Ukraine's competitiveness.

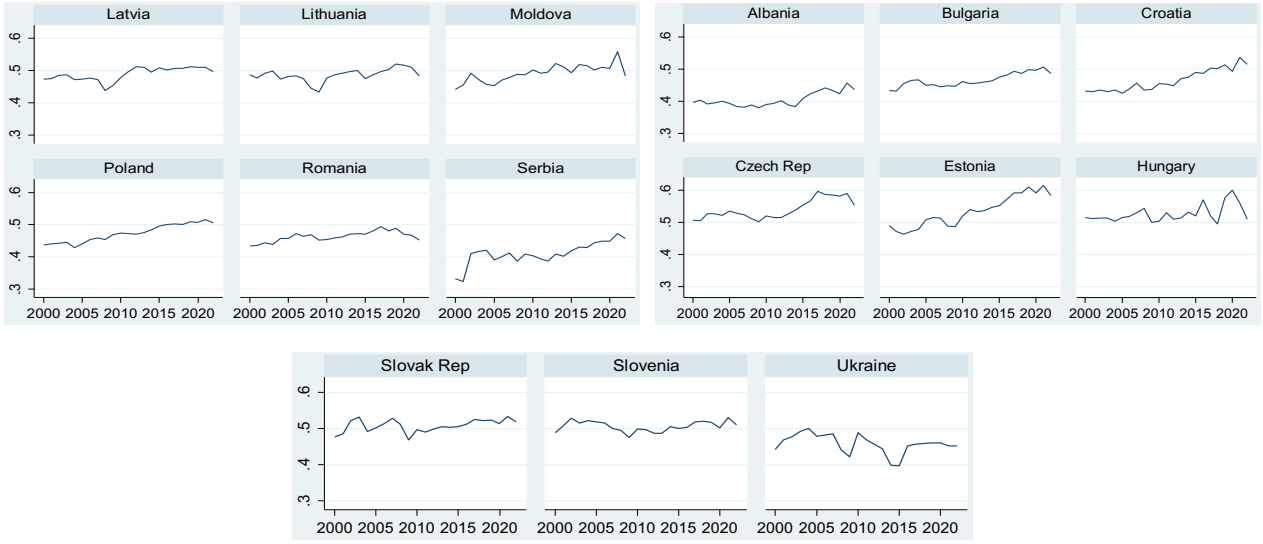

Figure 3. Dynamic of Country Competitiveness Index in 15 European countries in 2000–2022
Source: authors' calculations in Stata/SE 14.2 software.

3.2. Modelling the influence of public health factors on the level of the country's competitiveness in the pre-pandemic and pandemic periods

Before the regression analysis, the descriptive statistics of all variables might be performed (Table 4).

Table 4. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max	Variable	Obs	Mean	Std. Dev.	Min	Max
Agr_L	345	0.48	0.26	0	1	Portfolio	345	0.65	0.09	0	1
CC	345	0.45	0.22	0	1	Tax_rev	345	0.53	0.20	0	1
GE	345	0.55	0.27	0	1	Trade	345	0.50	0.19	0	1
RQ	345	0.56	0.23	0	1	Res	345	0.36	0.21	0	1
PS	345	0.72	0.18	0	1	CCI	345	0.48	0.05	0.32	0.62
CAB	345	0.60	0.16	0	1	Birth	345	10.19	1.39	6.97	17.08
Empl	345	0.40	0.16	0	1	CHE	345	0.29	0.18	0	0.93
FDI	345	0.30	0.06	0	1	CurHE	345	6.83	1.29	4.21	13.68
GDPg	345	0.75	0.11	0	1	Death	345	12.33	2.39	5.8	20.18
GGFCE	345	0.30	0.10	0	1	Beds	345	6.22	1.36	2.88	9.4
Ginny	345	0.69	0.19	0	1	Life	345	74.52	3.07	66.42	81.53
GCF	345	0.44	0.18	0	1	Covid_cases	45	116524.99	100046.39	20309.83	456046.03
CPI	345	0.94	0.09	0	1	Covid_death	45	1415.93	766.54	176.46	3447.24
Bus	345	0.15	0.15	0	1						

Source: authors' calculations in Stata/SE 14.2 software.

To test hypothesis 1 regarding the positive impact of improving the efficiency of the public health system on the country's competitiveness in the pre-pandemic and pandemic periods, panel data regression models were built. The Hausman test made it possible to confirm that in the context of determining the impact of public health factors on the country's competitiveness in the pre-pandemic period, the model with fixed effects is more effective (Table 5).

Table 5. Regression results on relationships between Country Competitiveness Index and public health determinants for 15 European countries in 2000-2019 (fixed effects model)

CCI	Coef.	St. Err.	t-value	p-value	95% Confidence Interval		Sig
Birth	-0.0026221	0.0015224	-1.72	0.086	-0.01	0	*
CHE	0.0002827	0.0085871	0.03	0.974	-0.02	0.02	
CurHE	0.0009131	0.0017653	0.52	0.605	0	0	
Death	- 0.0071334	0.0022374	3.19	0.002	0	0.01	***
Beds	0.0055396	0.0022591	2.45	0.015	0	0.01	**
Life	0.0093725	0.0009197	10.19	0.000	0.01	0.01	***
Constant	-0.3199525	0.073868	-4.33	0.000	-0.47	-0.17	***
F-test		29.206		Prob > F		0.000	
Akaike crit. (AIC)		-1516.013		Bayesian crit. (BIC)		-1490.087	

Note: *** p<.01, ** p<.05, * p<.1

Source: authors' calculations in Stata/SE 14.2 software.

On the other hand, to detect the same cause-and-effect relationship during the pandemic pandemic, both models confirmed their effectiveness, but the model with fixed effects is also more reliable (Table 6).

Table 6. Regression results on relationships between Country Competitiveness Index and public health determinants for 15 European countries in 2020-2022 (fixed effects model)

CCI	Coef.	St.Err.	t-value	p-value	95% Confidence Interval		Sig
Birth	-.0135534	.0166119	-0.82	0.423	-.05	.02	
CHE	.0137972	.0675853	0.20	0.840	-.13	.15	
CurHE	.0080856	.0063033	1.28	0.213	0	.02	
Death	-.0138065	.0069723	1.98	0.060	0	.03	*
Beds	-.0195758	.0089599	-2.18	0.040	-.04	0	**
Life	.0172587	.0086432	2.00	0.058	0	.04	*
Covid_cases	-1.80e-08	4.59e-08	-0.39	0.698	0	0	
Covid_death	5.94e-06	5.42e-06	1.10	0.285	0	0	
Constant	-.81	.64	-1.26	0.222	-2.14	.53	
F-test		1.937		Prob > F		0.064	
Akaike crit. (AIC)		-249.407		Bayesian crit. (BIC)		-233.147	

Note: *** p<.01, ** p<.05, * p<.1

Source: authors' calculations in Stata/SE 14.2 software

Thus, according to the simulation results, it was established that for the studied 15 European countries in the pre-pandemic period (2000-2019), the relevant public health factors for ensuring country competitiveness are: a decrease in the mortality rate (a decrease in the independent variable by 1 unit leads to an increase in the Country Competitiveness Index by 0.007 units), an increase in the number of hospital beds (an increase in the factor indicator by 1 unit causes an increase in the effective indicator by 0.006 units) and life expectancy (an increase in the independent variable by 1 year causes an increase in the effective indicator by 0.009 units). Moreover, the influence of the rest public health factors are insignificant. Specifically, an increase in both current and capital expenditures on health care does not have a statistically significant effect on the performance indicator.

In turn, the modelling of the impact of public health factors on the Country Competitiveness Index during the pandemic proved the relevance of practically the same set of determinants, but the direction of their influence is somewhat different. In particular, it was determined that the country's

competitiveness is inhibited by an increase in the mortality rate (a decrease in the independent variable by 1 unit leads to an increase in the Country Competitiveness Index by 0.014 units) and the number of hospital beds (an increase in the factor indicator by 1 unit leads to a decrease in the effective indicator by 0.019 units), and the driver is an increase in life expectancy (an increase in the independent variable by 1 year causes an increase in the performance indicator by 0.017 units).

Conclusions

Thus, on the basis of the conducted research results, it was partially confirmed hypothesis 1, since the significance of certain public health factors on the country's competitiveness, in particular, such as the birth rate and mortality rate, life expectancy and number of hospital beds was confirmed. However, the significance of the impact in the context of strengthening the country's competitiveness of such factors as the growth of current and capital expenditures on health care was not confirmed. At the same time, on the basis of the second model, hypothesis 2 was also fully confirmed. It is confirmed that during the COVID-19 pandemic, there was an increase in the significance of the influence of those public health factors, the relevance of which influence on the level of the country's competitiveness was confirmed in the pre-pandemic period. Thus, the strength of the negative impact of an increase in the mortality rate on country's competitiveness increased from 0.007 to 0.014 units, the strength of the positive effect of the increase in the life expectancy on the performance indicator increased from 0.009 to 0.017 units. The influence of the increase in the number of hospital beds also increased from 0.006 to 0.019 units. However, in the pre-pandemic period, this effect was positive, while during the pandemic, it turned into a negative one. It is also worth emphasizing two special points. First, it was established that in the pre-pandemic period, the increase in the birth rate had a negative impact on the country's competitiveness, which may be due to the increase in the load on both the social security system and the health care system, which increases state expenditures, diverting financial resources from investments in sustainable economic growth. Secondly, during the COVID-19 pandemic, the direction of the influence of the increase in the number of hospital beds on the level of the country's competitiveness changed from positive to negative. This can also be explained by the excessive load on the system of financial support of the health care system, which also diverts financial resources from more productive areas. These conclusions are also confirmed by the lack of statistical significance of the impact of the growth of current and capital healthcare expenditures on the country's competitiveness.

Thus, it can be concluded that the country's competitiveness both in crisis conditions (the unfolding of the coronavirus pandemic) and in a more stable period (pre-pandemic period) depends on the efficiency of the health care system, which is manifested in a decrease in the mortality rate and an increase in life expectancy. However, the increase in the number of hospital beds as a factor of the infrastructural capacity of the public health system has different effects on the country's competitiveness in crisis and stable conditions. Thus, in stable conditions, this public health factor has a positive effect, and in crisis – when the load on the health care system is excessive – it becomes negative. Taking into account the above, it can be noted that in order to ensure the country's competitiveness, it is advisable to create favourable conditions for ensuring the health of the population in periods of stability, while forming a margin of safety for more volatile periods.

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