

## ПРОБЛЕМИ ЕКОНОМІКИ

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### MODELING THE IMPACT OF GCI COMPONENTS ON UKRAINE COMPETITIVENESS

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Global competition is growing not only on a products/firms level, but also among countries. There are many approaches to interpretation of a concept of the “country competitiveness”, which in particular means “the state of the country in the global market due to the international division of labor, national conditions and factors of production and its ability to compete effectively in world markets”.

The competitiveness of countries is determined by many factors and is assessed by different approaches and methods. Some of the best known are the methodologies of the Institute for Management Development (IMD) and the World Economic Forum (WEF). Potential investors are guided by them when making decisions about investing in the economy, financial institutions – when evaluating countries as recipients of capital, etc.

The WEF’s Global Competitiveness Index (GCI) is based on 12 groups of over 100 indicators and is regularly adjusted to meet current challenges facing national economies. The latest version – GCI 4.0 – includes: 1. Enabling Environment (1.1. Institutions. 1.2. Infrastructure. 1.3. ICT adoption. 1.4. Macroeconomic stability). 2. Human Capital (2.1. Health. 2.2. Skills). 3. Markets (3.1. Product market. 3.2. Labour market. 3.3. Financial system. 3.4. Market size). 4. Innovation Ecosystem (4.1. Business dynamism. 4.2. Innovation capability). According to GCI 2019, the top five are: Singapore, the United States, Hong Kong, Netherlands and Switzerland, while Ukraine – in the 85th place out of 141 countries. The competitiveness of Ukraine has been deteriorating for the third year in a row. The main regression is in the spheres of: financial systems, healthcare, ICT implementation, macroeconomic stability and innovation opportunities.

Considering those 12 components, the multifactorial regression model for Ukraine competitiveness was designed based on aggregated and standardized GCI indicators of 2009–2017 and 2018–2019. To estimate the parameters of the multifactor regression model, the least squares method and the application “Data Analysis” of the program MS EXCELL were used. The obtained model has been tested.

As a result of modeling, it can be seen that  $x_1$  – institutions indicator and  $x_6$  – indicator of financial market development had the greatest influence on the competitiveness of Ukraine. Thus, they should become the priority areas of the state development and policy.

**Key words:** competitiveness; Global competitiveness index; modeling; correlation-regression analysis; multifactor model.

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### **Formulation of the problem**

With the convergence of national markets of some countries and intensification of globalization processes, competition has been growing not only among producers of products/services, but also among countries. There are many approaches to interpretation of a concept of the “country competitiveness”, which in particular means “the state of the country in the global market due to the international division of labor, national conditions and factors of production and its ability to compete effectively in world markets” [1].

The competitiveness of countries is assessed by different approaches and methods. Some of the best known are the methodologies of the Institute for Management Development (IMD) and the World Economic Forum (WEF). Potential investors are guided by them when making decisions about investing in the economy, financial institutions – when evaluating countries as recipients of capital, etc.

The IMD methodology [2] is based on a large number of indicators (more than 330), thus providing the greatest objectivity and systematic assessments. Almost 2/3 of all data for analysis are statistics of international organizations (UN, WTO, ILO, OECD, IMF, etc.), and the rest are national statistics. According to the IMD competitiveness index 2019, Singapore, Hong Kong, USA, Switzerland and the UAE are in the lead out of 63 countries. Ukraine took 54th place (in 2018 – 60th).

The World Economic Forum’s Global Competitiveness Index (GCI) [3] is based on over 100 indicators and is regularly adjusted to meet current challenges facing national economies. GCI integrates macroeconomic and micro/business aspects of competitiveness. It assesses the set of institutions, policies, and factors that provide sustainable current and medium-term levels of economic prosperity. The Global Competitiveness Index 4.0 framework is:

1. Enabling Environment: 1.1. Institutions. 1.2. Infrastructure. 1.3. ICT adoption. 1.4. Macroeconomic stability.
2. Human Capital: 2.1. Health. 2.2. Skills.
3. Markets: 3.1. Product market. 3.2. Labour market. 3.3. Financial system. 3.4. Market size.
4. Innovation Ecosystem: 4.1. Business dynamism. 4.2. Innovation capability.

According to GCI 2019, the top five are: Singapore, the United States, Hong Kong, Netherlands and Switzerland, while Ukraine – in the 85th place out of 141 countries. In 2018, the United States, Singapore, Germany, Switzerland and Japan were in the top 5, Ukraine was in the 83rd place out of 140 countries. Thus, the competitiveness of our country has been deteriorating for the third year in a row.

### **Analysis of recent research and publications**

Many Ukrainian and foreign scientists are engaged in research of competitiveness of the countries. The works of S. Linder, F. Liszt, J. Mill, R. Nelson, M. Posner, M. Porter, D. Ricardo, J. Robinson, J. Sachs, P. Samuelson, A. Smith, J. Schumpeter, F. Hayek, E. Heckscher, J. Hicks are widely known. Porter [4] argues that “the only meaningful concept of competitiveness at the national level is national productivity. Competitiveness is the ability of a country’s economy to provide its residents with a high standard of living and employment on a sustainable basis”.

The authors of [5] analyze the competitiveness of various objects, including countries, and the authors of [1] – the competitiveness of our state. L. I. Pronkina, O. M. Gavrish [6] investigate the peculiarities of the formation of state competition policy, the principles of competition policy, T. Khvorost [7] – competitiveness of the domestic economy. V. V. Antoshchenkova [8] argues that a competitive economy requires formation of an innovative ecosystem. Yu. Lupenko and N. Patyka [9] proved that today countries are competitive in international trade when they are actively developing and implementing

innovative technologies. Yu. Polyakova [10] generalizes the principles of interdependence of innovative development and competitiveness, offers organizational and economic tools for integration of Ukraine and the EU in the field of innovation etc. The authors of [11] study the implications of EU membership for the competitiveness of Eastern Europe.

N. Skorobogatova [12] systematizes factors influencing the international competitiveness of countries at the macro and micro levels, emphasizing innovative leadership through the use of Industry 4.0 tools.

Factors of competitiveness of the national economy are considered in [13–14]. Econometric assessment of the impact of business environment factors on a resulting indicator was carried out in [15]. Systematic analysis of competitiveness factors by innovation component was performed by Z. Yurynets [16]. The author used econometric models, ARIMA model, for graphical representation of dynamics of factors.

Despite the significant amount of scientific work on the subject, constant monitoring of Ukraine's position in the world for the formation of measures to improve its international competitiveness remains relevant. In this article, we use modelling to estimate impact of different GCI components on the competitiveness of Ukraine.

### **Setting objectives**

Thus, the **purpose of the article** is to analyze the competitiveness of Ukraine according to GCI and main factors influencing it using economic-mathematical modeling in order to identify ways for its improvement.

### **Main part**

As mentioned above, the position of Ukraine in the GCI 2019 ranking [3] has deteriorated.

In terms of the level of state institutions, Ukraine ranks 104th (in 2018 – 110th), in terms of infrastructure – 57th (similarly to 2018), by the level of technology implementation – 78th (in 2018 – 77th), in terms of macroeconomic stability – 133rd (131st in 2018), 101st in terms of health care (94th in 2018), 44th in terms of education (46th in 2018), by the level of the goods market – 57th (in 2018 – 73rd). According to the state of the labor market, Ukraine ranks 59th (66th in 2018), 136th – in the financial system (117th in 2018), 47th – in the market volume, 85th – in the business dynamics (in 2018 – 86th) and the ability to innovate – 60th place (in 2018 – 58th).

The main regression is in the sphere of financial systems, in which the rating of Ukraine dropped by 19 positions – to 136th place, and in the field of healthcare – by 9 positions, to 101st place. ICT implementation also deteriorated slightly, from 77th to 78th place, macroeconomic stability from 131st to 133rd place, and innovation opportunities from 58th to 60th place.

At the same time, for the second year in a row, the country's positions improved in: goods market – from 73rd to 57th place, labor market – from 66th to 69th place and institutional development – from 110th to 104th place. In addition, Ukraine managed to rise slightly in education level – from 46th to 44th place and the level of business development – from 86th to 85th place.

Table 1 represents dynamics of the most important factors affecting the competitive position of Ukraine: health and basic education; higher education and advanced training; quality of state institutions; infrastructure.

In order to comprehensively assess all indicators of GCI Ukraine competitiveness, the multifactorial regression model was designed in the following form:

$$Y = a_0 + a_1 \times x_1 + a_2 \times x_2 + a_3 \times x_3 + a_4 \times x_4 + a_5 \times x_5 + a_6 \times x_6 + a_7 \times x_7 + a_8 \times x_8 + a_9 \times x_9 + a_{10} \times x_{10} + a_{11} \times x_{11} + a_{12} \times x_{12} + e \quad (1)$$

where  $Y$  – competitiveness of the country (place in the rating);  $a_0, a_1$  – parameters of the multifactor regression model;  $x_1$  – institutions indicator;  $x_2$  – innovation indicator;  $x_3$  – indicator of business sophistication;  $x_4$  – market size indicator;  $x_5$  – indicator of technological readiness;  $x_6$  – indicator of financial market development;  $x_7$  – labor market efficiency indicator;  $x_8$  – indicator of goods market efficiency;  $x_9$  – higher education and training indicator;  $x_{10}$  – indicator of health and primary education;  $x_{11}$  – macroeconomic environment indicator;  $x_{12}$  – infrastructure indicator;  $e$  – model error.

Table 1

**Position of Ukraine in the GCI competitiveness rankings in 2008–2019  
in terms of its main indicators \***

Evaluation indicators	Years											
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Higher education and advanced training	43	46	46	51	47	43	40	34	33	35	46	44
Infrastructure	79	78	68	71	65	68	68	69	75	78	57	57
Health and basic education	60	68	66	74	62	62	43	45	54	53	94	101
Quality of institutions	115	120	134	131	132	137	130	130	129	118	110	104
Place in the rating	72	82	89	82	73	84	76	79	85	81	83	85
Number of countries	134	133	139	142	144	148	144	140	138	137	140	141

\* Systematized by the authors according to the 2008–2019 reports of the World Economic Forum [3].

In order to estimate the parameters of the multifactor model, an input data were aggregated and standardized (Table 2, Table 3). The main GCI indicators 2009–2017 were calculated using a scale from 1 to 7 points, where – 1 is the lowest result and 7 is the highest. However, over the last two periods (2018–2019), the methodology of the GCI 4.0 has changed and ranking of countries is now based on a 100-point system. To form a multifactor regression model, the data for 2018–2019 were converted into a 7-point scale by calculating the total coefficient. Accordingly, the total coefficient for points converting is  $100/7 = 14.28$  points.

Table 2

**Input data for building a multifactor model of Ukraine's competitiveness**

Years	Y	$x_1$	$x_2$	$x_3$	$x_4$	$x_5$	$x_6$	$x_7$	$x_8$	$x_9$	$x_{10}$	$x_{11}$	$x_{12}$
2009	82	3,1	3,4	4	5,4	4,4	3,7	4,6	3,6	3,4	4,7	3,6	3,2
2010	89	3	3,8	3,2	5,7	4,6	3,5	4,5	3,3	3,4	4,5	3,5	3,1
2011	82	3	3,9	4,2	5,6	4,6	3,6	4,4	3,4	3,5	4,5	3,5	3,1
2012	73	3,1	4,1	4,4	5,8	4,7	3,8	4,4	3,5	3,6	4,6	3,7	3,2
2013	84	3	4,1	4,2	5,8	4,7	3,8	4,2	3,5	3,3	4,6	3,7	3
2014	76	3	4,2	4,1	6,1	4,9	4	4,1	3,5	3,5	4,6	3,7	3,2
2015	79	3,1	4,1	3,1	6,1	5	4	4,3	3,2	3,4	4,5	3,7	3,4
2016	85	3	3,9	3,2	6	5,1	4	4,2	3	3,6	4,4	3,6	3,4
2017	81	3,2	3,9	3,5	6	5,1	4	4	3,1	3,8	4,5	3,7	3,4
2018	83	3,24	4,9	3,91	5,04	4,82	4,17	4,17	3,41	3,57	4,39	3,87	2,73
2019	85	3,37	4,95	4,05	4,59	4,92	4,29	4,29	2,96	3,63	4,41	3,4	2,8

\* Aggregated by the authors according to the 2008-2019 reports of the World Economic Forum [3].

To estimate the parameters of the multifactor regression model, the least squares method and the application “Data Analysis” of the program MS EXCELL were used. The following model was obtained:

$$Y = 1,08 + 4,29 \times x_1 - 0,15 \times x_2 + 0,27 \times x_3 + 1,9 \times x_4 + 0 \times x_5 + 5,3 \times x_6 - 0,75 \times x_7 - 2,9 \times x_8 - 0,72 \times x_9 + 0 \times x_{10} - 3,17 \times x_{11} - 3,58 \times x_{12} + e \quad (2)$$

The statistical indicators of the quality of the obtained model are the coefficient of determination  $R_2$ , Fisher's  $F$ -test and the standard error of the model. According to the obtained data, the coefficient of determination  $R_2$  is 1.

In order to obtain reliable results, the independent factors of the model were tested for multicollinearity according to the Farrar–Glauber test. As a result, the criterion  $\chi$  proved that multicollinearity in the standardized input data is absent.

As a result of modeling, it can be seen that  $x_1$  – institutions indicator and  $x_6$  – indicator of financial market development had the greatest influence on the competitiveness of Ukraine. Thus, they should become the priority areas of development.

There is a direct relationship between the level of development of institutions and the rate of economic growth. However, there is also the so-called “base effect” (“limits of technological progress”), which indicates that the impact of the quality of institutions on economic growth is higher in developing countries than in developed ones.

The quality of institutions also significantly affects the use of financial resources. The increase in the amount of financial resources that are invested in the economic system and contribute to its growth is typical when property rights are protected, there is an effective judicial system, the state is accountable to civil society institutions, and so on. Otherwise, institutions (including financial) are not developed or function with certain complications.

Ukraine is extremely far from the leading positions in the quality of institutions (Table 1), as the state institutions are too bureaucratic and are not trusted by citizens. However, as the consequence of European integration processes of Ukraine in accordance with the ratification of the EU-Ukraine Association Agreement in 2016 it has been improving. After all, the institutions must meet all the requirements of the European Union.

In a democratic state, civil society through its institutions actively influences the development of policy by government institutions, controls their public activities aimed at its implementing, encouraging and forcing officials to serve people. In this context, the issue of providing public authorities of Ukraine with effective forms of their interaction with the society is extremely important. It is an important factor in creating conditions for citizens' participation in the formation and implementation of public policy, public control and strengthening public confidence in state authorities and bodies [17].

### **Conclusions**

International competitiveness of countries is determined by many factors that form a full, economically sound position of the country among others. At the present stage of development in the context of globalization and a high level of competition, research and analysis of Ukraine's international position, in particular according to the WEF Global Competitiveness Index, becomes significantly relevant. It makes possible to determine the pace of development and efficiency of priorities of the national economy, etc.

We analyzed the impact of key factors according to the GCI methodology on the competitiveness of Ukraine by forming a multifactor regression model. Evaluation of its parameters showed that the indicators of financial market development and quality of institutions have the greatest impact on Ukraine's competitiveness. Thus, in order to increase the level of competitiveness, the state should strengthen its macroeconomic indicators, promote economic development, but with a key emphasis on the quality of state institutions, their independence, as well as the sustainable development of the financial market.

### **Prospects for further research**

Two identified crucial for Ukraine's competitiveness factors (financial market development and quality of institutions) may be the subject of further research, in particular – ways to improve those indicators in the nearest decade.

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## МОДЕЛЮВАННЯ ВПЛИВУ СКЛАДОВИХ GCI НА КОНКУРЕНТОСПРОМОЖНІСТЬ УКРАЇНИ

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Глобальна конкуренція зростає не лише на рівні продуктів/фірм, а й серед країн. Конку- рентоспроможність країн визначається багатьма факторами та оцінюється за різними підходами та методами. Одними із найвідоміших є методології Інституту розвитку менеджменту (IMD) та Всесвітнього економічного форуму (WEF). Індекс глобальної конкурентоспроможності ВЕФ ґрунтується на 12 групах із понад 100 показників. Остання версія (GCI 4.0) охоплює: 1. Сприят- ливе середовище (інституції; інфраструктура; прийняття ІКТ; макроекономічна стабіль- ність). 2. Людський капітал (здоров'я; навички). 3. Ринки (товарний ринок; ринок праці; фінан- сова система; розмір ринку). 4. Інноваційна екосистема (динамічність бізнесу; інноваційні мож- ливості). За даними GCI 2019, Україна на 85-му місці із 141 країни. Конку- рентоспроможність України погіршується вже третій рік поспіль. Основний регрес відбувся у сферах: фінансової системи, охорони здоров'я, упровадження ІКТ, макроекономічної стабільності та інноваційних можливостей.

На основі цих 12 компонентів розроблено багатофакторну регресійну модель їх впливу на конкурентоспроможність України на основі агрегованих і стандартизованих показників GCI 2009–2019 рр. Для оцінювання параметрів моделі використано метод найменших квадратів і додаток "Аналіз даних" програми MS EXCELL. Отриману модель протестовано.

У результаті моделювання виявлено, що на конкурентоспроможність України найбільше вплинули показники інституцій та розвитку фінансового ринку. Отже, вони повинні стати пріоритетними напрямками розвитку та політики держави.

Ключові слова: конкурентоспроможність; Індекс глобальної конкурентоспроможності; мо- делювання; кореляційно-регресійний аналіз; багатофакторна модель.