Innovation as a Factor of Sustainable Development during a Pandemic: Scientific Analytics and Management Perspectives

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Abstract: Sustainable development goals are considered by all countries. However, each country has its own specifics in innovative development. In addition, the current stage of the world economy development is characterized by competition for leadership in world markets, where innovation is the main tool. In this connection, studying the dependence of the country's innovative development and the level of sustainability is relevant. The purpose of this research is to test the hypothesis and scientific analytics of introducing innovations as a factor in the sustainable development of the economy and to identify the prospects for managing this factor in order to maintain sustainability. The methodological apparatus of the research is based on the methods of economic statistics (econometrics), namely the method of variation, methods of correlation and regression analyzes, analysis of variance. The scientific value and novelty is the assessment of prospects for managing innovative development in the context of the sustainable development methodology.

1 INTRODUCTION

The global economy managed to recover from the financial and economic crisis of 2008, but then a new crisis caused by the COVID-2019 pandemic came. In this regard, the problem of sustainable development of the economy at the present time and its prospects are highly urgent. Therefore, there is a need to determine the factors influencing sustainable development.

Features and factors of sustainable development of the modern economy are studied by such scientists as Andronova et al. (Andronova, 2019), Goyal and Sergi (Goyal,2015), Haabazoka (Haabazoka, 2019), Inshakov et al. (Inshakov, 2019), Karanina et al. (Karanina, 2019), Morozova et al. (Morozova, 2019), Petrenko et al. (Petrenko, 2018), Popkova et al. (Popkova, 2014), Popkova et al. (Popkova, 2017), Popkova et al. (Popkova, 2016), Pozdnyakova et al. (Pozdnyakova, 2017), Ragulina et al. (Ragulina, 2019a), Ragulina et al. (Ragulina, 2019b), Sergi (Sergi, 2018), Sergi et al. (Sergi, 2019a), Sergi et al. (Sergi, 2019b), Sozinova et al. (Sozinova, 2021a), Sozinova et al. (Sozinova, 2021b), Tripathi et al.

(Tripathi, 2020), Zavyalova et al. (Zavyalova, 2018), Zhang et al. (Zhang, 2018).

Prospects for improving the practice of making management decisions in conditions of economic crises are considered by Bogoviz et al. (Bogoviz, 2018), Fufacheva et al. (Fufacheva, 2017), Kataeva et al. (Kataeva, 2017), Popkova et al. (Popkova, 2021a), Popkova et al. (Popkova, 2021b), Soboleva et al. (Soboleva, 2017) and others. The issues of introducing innovations are analyzed by Loginov and Karanina (Loginov, 2019), Palkina et al. (Palkina, 2020a), Palkina et al. (Palkina, 2020b), Palkina and Kislitsina (Palkina, 2018), Snigireva et al. (Snigireva, 2017).

The article proposes a hypothesis that the introduction of innovations is an effective factor of sustainable development. The aim of the study is to test the hypothesis and scientific analytics of introducing innovations as a factor of sustainable economic development, and to identify the prospects for managing this factor in order to maintain sustainability.

The scientific value and novelty is an assessment of prospects for managing innovative development in

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the context of sustainable development methodology, and the results of a statistical analysis of depending manifestations of sustainable development on innovative development in countries

2 MATERIALS AND METHODS

The research has studied the example of the leaders (countries from the top 20) of the World Bank global ranking for 2020 according to the value of the index of doing business for 2020.

The methodological apparatus of the research is based on the methods of economic statistics (econometrics), namely:

— the method of analysis of variation, which calculates the arithmetic mean over the sample (x_{mean}), standard (root-mean-square) deviation (s) and coefficient of variation ($V = s/x_{mean}*100\%$) and determines the spread of data (degree of homogeneity) of the sample;

— the method of correlation analysis, with the help of which the correlation coefficient (r) and the coefficient of determination (R^2) are calculated and the interdependence of the variables included in the time series is revealed;

— the method of regression analysis, with the help of which a multiple linear regression model of the form $y=a+b_1*x_1+b_2*x_2+\ldots+b_n*x_n$ is compiled. The values of the coefficients b in this model show how the dependent variable (y) changes when each independent variable changes by 1;

— an analysis of variance, which evaluates the statistical significance of the results of regression analysis by Fisher's F-test (F_{obs} must be greater than F_{tabl}) and Student's t-test (t_{obs} must be greater than t_{tabl}).

Calculations are performed using automation tools based on standard functions ("AVERAGE", "STANDARDDEVAL") of the "Data Analysis" function of the Microsoft Excel computer program. Statistical materials of the Sustainable development index Global Innovation index (2020), World Economic Forum (The global competitiveness report 2019) are the information and empirical base of the study.

Using the method of regression analysis, firstly, the authors have determined the dependence of the manifestations of sustainable development, highlighted in the content analysis of the literary sources The Global Innovation Index (GII) (2020) by constructing regression curves. Secondly, a multifactorial model of the regression dependence of sustainable development in the country on the selected potential factors has been built (Table 1).

Table 1: Statistics for correlation and regression analyzes in the top 20 countries.

Position in the ranking doing business 2020	Country	The Global Innovation Index, points 1–100 x	Manifestations of sustainable development				
			Global Competitiveness Index 4.0, points 1–100 y1	Economic growth rate, % y2	GDP per capita 2020, PPP$ y3	GDP per capita 2019, PPP$ for reference, for calculation x2	Sustainable Development Index, points 1–100 y4
The developed countries (top 10)	New Zealand	26	76,7	-10,94	35 744,00	40 135,40	43,6
	Singapore	8	84,8	-10,23	90 080,20	100 344,70	7,9
	Denmark	6	81,2	-9,75	47 040,40	52 120,50	35,5
	The Republic of Korea	10	79,6	-5,54	39 059,70	41 350,60	27,4
	USA	3	83,7	-9,2	56 844,30	62 605,60	18,1
	Great Britain	4	81,2	-10,55	40 881,30	45 704,60	39,1
Developing countries (top 20)	Malaysia	33	74,6	-6,98	28 705,90	30 859,90	46,6
	UAE	34	75	-12,63	60 618,60	69 381,70	11
	Thailand	44	68,1	-8,72	17 778,80	19 476,50	73,7
	Russia	47	66,7	-11,58	25 878,70	29 266,90	68,5
	China	14	73,9	-5,98	17 027,50	18 109,80	51,7
	Turkey	51	62,1	-11,73	24 675,50	27 956,10	67,5
Average	-	23,33	75,63	-9,49	40 361,24	44 776,03	40,88

Source: compiled by the authors based on materials (Globalinnovationindex.org, 2020; Weforum.org, 2019; Wipo.int, 2019; Sustainabledevelopmentindex.org).
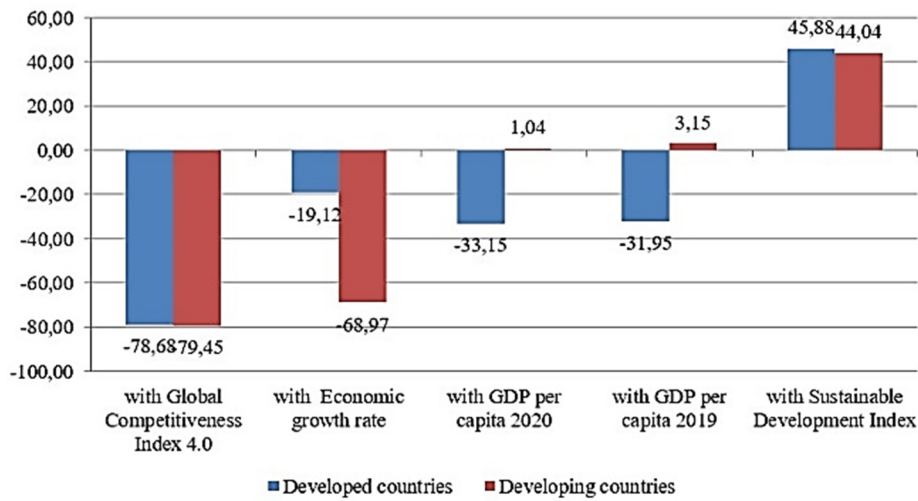
Source: compiled by the authors.

Figure 1: Correlation analysis of depending manifestations of sustainable development on innovative development.
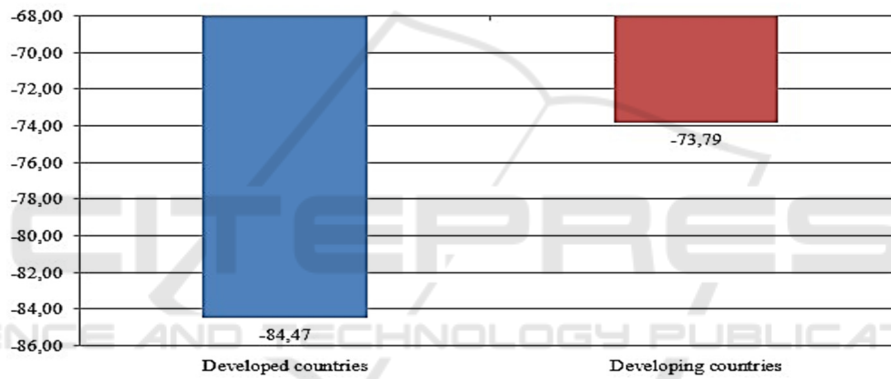
Source: compiled by the authors.

Figure 2: Correlation analysis of the dependence of the Global Competitiveness Index 4.0 and Sustainable Development Index.

3 RESULTS AND DISCUSSION

Based on the data in Table 1, the following results of correlation analysis were obtained (Fig. 1). At the same time, the indicators of the Global Innovation Index and Global Competitiveness Index 4.0 are measured in points, but they are reciprocal. Since, in accordance with their methodology, The Global Innovation Index varies from 1 to 100, the closer to 1, the better the innovative development of the country, and in accordance with the methodology for calculating the Global Competitiveness Index 4.0, the closer the country's indicator is to 100, the better. Similarly, the indicators of Economic growth rate, GDP per capita are reciprocal in relation to The Global Innovation Index.

As can be seen from Fig. 1, the top 10 and top 20 countries are influenced by innovative development on the level of the country's competitiveness (78.68% and 79.45%, respectively) and the average impact on the overall sustainable development index (45.88% and 44.04% respectively). Innovative development has a rather weak effect on the country's GDP, which is proved by the analysis of studied years (2020 and 2019).

In addition, the high level of correlation between the indicators of the Global Competitiveness Index 4.0 and the Sustainable Development Index (Fig. 2), which indicates the need for regression analysis with the Sustainable Development Index, should be noted.

As it can be seen, the correlation analysis partially confirmed the scientific hypothesis about depending

manifestations of sustainable development identified in the content analysis on the innovative development of the country. Three of the four manifestations of sustainable development depend on innovative development: Global Competitiveness Index 4.0, Economic growth rate (only in developing countries) and Sustainable Development Index. GDP per capita showed a weak connection with innovative development, and therefore we exclude it from further regression analysis.

Firstly, let us consider the regression statistics of the correlation of the dependent variable y_1 (Global Competitiveness Index 4.0) on the factor x (indicators of the Global Innovation Index). By the method of analysis, it is determined (by the coefficient of determination) that the dependence is better described by the linear function $y_1(x)=a_1+b_1*x$. The regression statistics of this equation are given in Table 2.

Table 2: Regression statistics.

Regression statistics	
Multiple R	0,928544784
R-square	0,862195415
Normalized R-square	0,848414957
Standard error	6,998923948
Observations	12

Source Developed and compiled by the authors.

The calculated multiple R = 0.9285 suggests that the 92.85% change in the Global Competitiveness Index 4.0 is due to the change in the Global Innovation Index. The normalized coefficient of determination (0.8484) characterizes the closeness of the constructed regression to the original data. In our case, the R-square and the normalized R-square do not differ significantly (0.8622 and 0.8484, respectively), which positively characterizes the constructed model. The results of analysis of variance are shown in Table 3.

According to Table 3, the observed value of the F-Fisher criterion: F_{obs} = 2.4. Tabular value F_{tabl} is 2.156. Since $F_{obs} > F_{tabl}$ (2.4 > 2.156), the equation is considered statistically significant. The calculated coefficients of the regression equation are given in Table 4.

Analysis of Table 4 allows to conclude that a model $y_1=201,528-2,356 * x$ is obtained. The calculated p-value does not exceed 0.05, therefore, the model is statistically significant at the α = 0.05 level. To assess the statistical significance of the regression coefficient, let us analyze the observed value of the Student's t-test: 3.912 (for the coefficient b_1). For a given level of significance (α = 0.05) and n-2 = 12-2 = 10 degrees of freedom, the tabular value of the t-criterion: t_{tabl} = 2.228. Since t_{obs} of each regression coefficient is greater than t_{tabl}, then we recognize the statistical significance of the regression coefficients.

Thus, the regression analysis has shown that the growth of innovative development by 1 point contributes to the growth of the Global Competitiveness Index 4.0 2.35 points (the indicators are reversed).

Secondly, let us consider the regression statistics of the correlation of the dependent variable y_2 (Economic growth rate) on the factor x (Global Innovation Index indicators) in developing countries. The analysis is carried out in a similar way, we present only the results of the study.

Table 3: Analysis of variance.

	df	SS	MS	F	Value F
Regression	1	3064,817	3064,817	62,56653	2,4
Remainder	10	489,8494	48,98494		
Total	11	3554,667			

Source Developed and compiled by the authors.

Table 4: Calculated coefficients.

	Coefficients	Standard error	t-statistics	P-value	Low 95%	High 95%
a_1	201,5286045	22,61855	8,909882	4,53E-06	151,1313375	251,9259
b_1	-2,356041488	0,29786	-7,9099	1,3E-05	-3,01971451	-1,69237

Source Developed and compiled by the authors.

The resulting model is: $y_2=5,11-3,34 * x$. The regression analysis has shown that the growth of innovative development by 1 point contributes to the growth of the Economic growth rate in developing countries by 3.34 points (the indicators are reversed).

Thirdly, let us consider the regression statistics of the correlation of the dependent variable y_4 (Sustainable Development Index) on the factor x (Global Innovation Index indicators). The analysis is carried out in a similar way, we present only the results of the study.

The resulting model is: $y_4=0,79+0,55 * x$. Regression analysis has shown that the growth of innovative development by 1 point contributes to the growth of the Sustainable Development Index by 0.55 points.

Based on the presented results of correlation and regression analyzes, the authors present the prospects for managing innovative development, the results of which are shown in Table 5.

Table 5 proves the hypothesis that innovative development stimulates sustainable development.

Statistical calculations have proved that there are two forms of manifestations of sustainable development, which are influenced by the innovative development of countries (countries from the top 20) of the World Bank's global ranking for 2020 according to the value of "doing business" index - Global Competitiveness Index 4.0 and Sustainable Development Index. Developing countries are characterized by an impact on the third form of manifestation of sustainable development - Economic growth rate. The direct results of the innovative development of countries are an increase in the country's rating in terms of key indicators characterizing sustainable development.

A debatable issue in the context of this research is the impact of innovative development on such manifestations of sustainable development as Economic growth rate in the top 10 countries of the World Bank global ranking for 2020 by the value of "doing business" index and GDP per capita, which will be further studied.

Table 5: Prospects for managing innovative development for sustainability.

Indicators	Manifestations of sustainable developmentя			
	Global Competitiveness Index 4.0, y_1	Economic growth rate, y_2	GDP per capita, y_3	Sustainable Development Index, y_4
Independent variable	Global Innovation Index, x			
The relationship between variables	reverse	reverse	reverse	direct
Assessment of depending manifestations of sustainable development on cluster development	high (correlation is 78,68% and 79,45%)	high correlation among developing countries (correlation 68.97), weak connection among developed countries (correlation 19.12%)	medium and weak connection (correlation 33.15% and -1.04%)	average (correlation 45.88% and 44.04%)
Regression dependence	$y_1=201,528-2,356 * x$	Developing countries only: $y_2=5,11-3,34 * x$	Weak closeness of the constructed regression to the original data	$y_4=0,79+0,55 * x$
Consequences of the rise / fall of the independent variable	If the independent variable changes by 1%, the dependent variable improves / worsens its performance by 2.36.	In developing countries if the independent variable changes by 1%, the dependent variable improves / worsens its performance by 3.34.	-	If the independent variable changes by 1%, the dependent variable improves / worsens its performance by 0.55.
Conclusion on the prospects for management	The country's innovative development is an important element that stimulates global competitiveness	The innovative development of developing countries is an important element in stimulating global competitiveness. It is not possible to assess the prospects for innovative development of developed countries due to the weak relationship between indicators	It is not possible to assess the prospects due to the weak relationship between the indicators	Innovative development is an essential element for stimulating sustainable development

Source: compiled by the authors.

4 CONCLUSIONS

The research is theoretically significant as its results and authors' conclusions contribute to the development of the concept of sustainability. The scientific value and novelty is an assessment of the prospects for managing innovative development in the context of sustainable development methodology, as well as the results of a statistical analysis of depending manifestations of sustainable development on innovative development in countries.

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