Post-COVID 2019 sustainable economic development: a new cycle of digital development

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Abstract. The purpose of the work is to simulate sustainable economic development under the influence of the spread of the global pandemic COVID-2019 and its consequences. The work uses such methods of scientific research as classification, problem and comparative analyzes, methods of synthesis and analysis of cause-and-effect relationships, strategy, methods of economic statistics: methods of correlation and regression analyzes, analysis of variance. The study is carried out on the example of the leaders (countries from the top 20) of the World Bank global ranking according to the value of the index of doing business for 2020. Scenarios of sustainable economic development after COVID-2019 are modelled under the influence of digitalization. The scenarios that were written showed that digital technologies can most likely be used to launch a new cycle of digital development. It has been proved that digital technologies, most likely, cannot be used as a countercyclical tool for regulating the market situation, since the scenarios drawn up indicate the absence of regression dependence.

1 Introduction

The relevance of modeling sustainable economic development is associated primarily with the need to analyze the global processes of transformation of society, new challenges and opportunities caused by political, social, economic and new, epidemiological changes that increase the uncertainty of the external environment.

The uniqueness of the period of the COVID-2019 pandemic and the post-pandemic stage of development of the world economy lies in the fact that almost all business entities must, to one degree or another, switch to Industry 4.0 tools. At the same time, a characteristic feature was the fact that the transition to a digital type of business was under the control of governments, and therefore COVID-2019 set a high speed of digitalization of all business processes. The new regulated format of the industrial revolution helps reduce the risks associated with the transition to Industry 4.0 and maximize the benefits.

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In this regard, the problem of managing sustainable economic development in the period after COVID-2019 with the condition of the influence of digital technologies is becoming highly relevant. This process can follow one of two scenarios.

The first scenario assumes the launch of a new business cycle in the post-pandemic period, that is, the acceleration of economic growth rates based on the use of Industry 4.0 technologies. The second scenario is associated with the prospect of using the achievements of Industry 4.0 in business as a countercyclical tool for regulating market conditions, that is, to prevent an economic crisis in the post-pandemic period. Simultaneous implementation of the presented scenarios is difficult, therefore, in the study, they will be considered as alternative.

The aim of the work is to simulate sustainable economic development under the influence of the spread of the global pandemic COVID-2019

2 Materials and methods

The development of industry 4.0 is described in works [1-5] and others. The works of such scientists as [6, 7] and others are devoted to the topic of manifestations and factors of sustainable development of the modern economy. Prospects for improving the practice of making managerial decisions in conditions of economic crises are considered in works [8, 9] and others. The economic aspects of the COVID-2019 pandemic were studied in the works [10-13] and others. The economic analysis of the consequences of decisions on mandatory self-isolation during COVID-2019 was made by Nadrian H. [14]. Bentata Y. [15] investigated the consequences of COVID-2019 and the cyclical nature of economic systems. Certain issues of COVID-2019 have been studied in the literature, in general, scenarios for sustainable economic development under the influence of COVID-2019 and the further development of digitalization are poorly understood and need further elaboration.

Table 1. Statistics of the integral marketing indicator and digital competitiveness in the top 20 countries

Position in the ranking doing business 2020	Country	IMD, Digital Competitiveness Index, rank	Sustainable Development Index, rank				
			2016	2017	2018	2019	Variation, %
			-	-	-	y1	y2
Developed countries (top 10)	New Zealand	86.026	43.6	43.4	43.5	43.6	0.22988506
	Singapore	99.373	8.1	7.9	7.9	7.9	1.4494149
	Denmark	95.225	35.8	35.4	35.5	35.5	0.58528566
	The Republic of Korea	91.297	28.0	27.3	27.3	27.4	1.46783967
	USA	100	18.2	18.1	18.1	18.1	0.31839169
	Great Britain	88.691	39.3	38.3	38.9	39.1	1.29610892
Developing countries (top 20)	Malaysia	82.39	43.7	46.5	46.4	46.6	3.48865375
	UAE	90.295	10.8	10.9	11	11	0.91743119
	Thailand	68.434	72.2	72.6	73.2	73.7	0.69264536
	Russia	70.406	68.7	68.3	68.4	68.5	0.3040408
	China	84.292	52.0	51.0	51.3	51.7	0.99771901
	Turkey	59.793	67.4	67.0	67.3	67.5	0.30961815

For further elaboration, the study uses the methods of regression and correlation analysis. They are used to determine the impact of digitalization, the indicator of which is

the Digital Competitiveness Index, IMD, (x) [16], on the Sustainable Development Index [17] in 2019 (y1), as well as its variation in 2016-2019. (y2).

The study is conducted on 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 [18-20].

- Hypothesis H1: there is a positive relationship between digitalization and the 2019 Sustainable Development Index, i.e. $r(x,y1) > 0$ (in correlation analysis) and their correlation is quite high, that is, $R^2(x,y1) > 50\%$ (in correlation analysis);
  - Hypothesis H2: there is a negative relationship between digitalization and the variation of the Integrated Marketing Indicator in 2016-2019, that is,
 $r(x,y1) < 0$ (in correlation analysis) and their correlation is quite high, that is, $R^2(x,y1) > 50\%$ (in correlation analysis)
- The statistical basis for the study is presented in Table 1.

3 Results and discussion

As a result of the analysis of the data table. 1, the following results of correlation analysis were obtained (Fig. 1). At the same time, in connection with the essence of the studied indicators (reciprocal: IMD: the higher the indicator, the better; Sustainable Development Index: the lower the better), then a negative correlation r indicates a direct relationship between the studied indicators. In the case of researching the relationship between the Digital Competitiveness Index and variation; Sustainable Development Index correlation is interpreted in the traditional sense.

Fig. 1. Cross-correlation of the Digital Competitiveness Index with the Sustainable Development Index in developed and developing countries, %

As can be seen from Figure 1, in both developed and developing countries, digitalization has a fairly strong effect on sustainable development (86.97% and 84.58%, respectively). It was found that in developing countries, digitalization increases the level of variation of the Sustainable Development Index (46.56). As you can see, the correlation analysis confirmed the scientific hypothesis about the dependence of sustainable development on digitalization, in connection with which we will conduct further regression analysis.

First, let's analyze the impact of digitalization on the Sustainable Development Index. Consider the regression statistics of the correlation of the dependent variable y1 (Sustainable Development Index) on the factor x (Digital Competitiveness Index, IMD). By

the method of analysis, it was determined (by the coefficient of determination) that the dependence is better described by the linear function $y_1(x) = a_1 + b_1 \cdot x$. The regression statistics of this equation are given in Table. 2.

Table 2. Regression statistics.

Multiple R	0.896247764
R-square	0.803260054
Normalized R-square	0.783586059
Standard error	5.863359925
Observations	12

The calculated value of multiple $R = 0.8962$ suggests that the 89.62% change in the dependent variable Sustainable Development Index is explained by the change in the independent variable Index of Digital Competitiveness, IMD. The normalized (reduced) coefficient of determination (0.7836) characterizes the closeness of the constructed regression to the original data, which contain an “undesirable” random component caused by the “complexity” of the regression equation, determined by the number of equation coefficients. In our case, the R -square and the normalized R -square do not differ significantly (and are 0.8962 and 0.7836, respectively), which positively characterizes the constructed model. The results of analysis of variance are shown in table. 3.

Table 3. Analysis of variance.

	df	SS	MS	F	Significance of F
Regression	1	1403.643	1403.643	40.82852	7.94
Remainder	10	343.7899	34.37899		
Total	11	1747.433			

From table 3 the observed value of the Fisher's F-criterion: $F_{obs} = 7.94$. The tabular value of Fisher's F-test at the significance level $\alpha = 0.05$ and $k_1 = m = 1$ and $k_2 = n - m - 1 = 12 - 1 - 1 = 10$ is $F_{tabl} = 2.156$. Since $F_{obs} > F_{tabl}$ ($15.3 > 2.156$), the equation is considered statistically significant. The calculated coefficients of the regression equation are given in table 4.

Table 4. Calculated coefficients.

	Coefficients	Standard error	t-statistics	P-Value	Lower 95%	Upper 95%
a_1	105.4922887	3.669971	28.74472	6.05E-11	97.31508	113.6695
b_1	-0.508938983	0.07965	-6.38972	7.94E-05	-0.68641	-0.33147

Analysis of the table. 4 allows us to conclude that the obtained model is:

$$y_1 = 105.49 - 0.5089 \times x. \tag{1}$$

The calculated p-value does not exceed 0.05, therefore, the model is statistically significant at the level of $\alpha = 0.05$. Thus, the regression analysis showed that an increase in the Digital Competitiveness Index by 1 point contributes to an increase in the Sustainable Development Index of 0.51 points.

Second, we will analyze the impact of digitalization on the variation of the Sustainable Development Index in a similar way. Consider the regression statistics of the correlation of the dependent variable y_2 (variation of the Sustainable Development Index) on the factor x (Index of Digital Competitiveness, IMD).

The regression statistics of this equation are given in Table 5.

Table 5. Regression statistics

Multiple R	0.167367411
R-square	0.02801185
Normalized R-square	-0.069186965
Standard error	13.03259097
Observations	12

The calculated value of multiple $R = 0.167$ indicates that the change in the dependent variable variation in the Sustainable Development Index by only 16.7% is explained by the change in the independent variable Digital Competitiveness Index, IMD. Further analysis is not useful.

Based on the calculations presented, marketing scenarios were modeled, the results of which are shown in table. 6.

Table 6. Scenarios for sustainable economic development under the influence of digitalization

Scenario characteristic	Accelerating digitalization scenario	Scenario of countercyclical regulation of market conditions
Consequence of the spread of digitalization	Launching a new cycle of digital technologies development	Using digital technologies as a countercyclical tool for market regulation
Independent variable	IMD, Digital Competitiveness Index	
Dependent variable	Sustainable Development Index (y1)	Variation of Sustainable Development Index from 4 years (y2)
Regression dependence	$y1=105.49-0,5089 \times x$	It is not possible to calculate
Consequences of the rise / fall of the explanatory variable	If the independent variable changes by 1%, the dependent variable improves / worsens its performance by 0.51.	–
Conclusion on the script	High probability of scenario realization	Unlikely

As you can see from table. 6, the use of digital technology as a countercyclical tool for market regulation is unlikely. The scenario of launching a new cycle of digital technologies development has a very high likelihood of implementation, in connection with which an increase in the introduction of digital technologies can be expected.

5 Conclusion

As a result of the study, the following conclusions were obtained.

First, digital technologies, most likely, cannot be used as a countercyclical tool for regulating the market situation, since the scenarios written indicate the absence of regression dependence.

Secondly, digital technologies can be used as a tool to launch a new development cycle. The compiled regression model confirms this conclusion. Nevertheless, digital technologies should not be the only measure for the formation of sustainable economic development, since their impact on the variation of the Sustainable Development Index is very small.

Thirdly, developing countries have a more pronounced potential for using digital technologies to form sustainable economic development, since the correlation between the digital competitiveness index and the variation of the Sustainable Development Index is higher for them (46.56% developing countries, 4.56% developed countries).

Thus, digital technologies affect sustainable economic development, possibly changing it, which should be devoted to further research.

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