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Ecologically Responsible Entrepreneurship and Its Contribution to the Green Economy's Sustainable Development: Financial Risk Management Prospects

Vladimir S. Osipov [1,2,*], Yuriy A. Krupnov [3], Galina N. Semenova [4,5] and Maria V. Tkacheva [6]

1 Department of Asset Management, Moscow State Institute of International Relations (MGIMO University) of the Ministry of Foreign Affairs of the Russian Federation, 119454 Moscow, Russia
2 Department of Global Economics and Management of External Economic Activities, Lomonosov Moscow State University, 119991 Moscow, Russia
3 Institute of Economic Policy and Economic Security, Financial University under the Government of the Russian Federation, 125167 Moscow, Russia; yakrupnov@fa.ru
4 Department of Accounting and Taxation, Plekhanov Russian University of Economics, 115093 Moscow, Russia; semenova.gn@rea.ru
5 Department of Economics, Moscow Region State University, 141014 Mytishchi, Russia
6 Department of Economic Security and Accounting, Voronezh State University, 394018 Voronezh, Russia; tkacheva_mv@econ.vsu.ru
* Correspondence: vs.ossipov@gmail.com

Abstract: This paper's goal is to develop a scientific methodology of financial risk management of ecologically responsible entrepreneurship for the sustainable development of the green economy. The originality of this paper is due to the fact that, for the first time, the financial risks of the green economy are considered through the prism of its sustainability. The paper's novelty is due to the modelling and quantitative measuring of the impact of the COVID-19 pandemic and the financial and economic crisis on the financial risks to the green economy's sustainability, in addition to the development of precise quantitative recommendations for financial risk management of the green economy. This enables an increase in its sustainability and reduces ecological disproportion in regions of the world (reducing the differences in the green economy's sustainability among regions of the world through the management of green investments). The paper's contribution to the literature consists of specifying the theory of financial risks to the green economy. According to the specified fundamental provisions of this theory, the essence of the process of green economy development is clarified (the "black box" is opened) as the increase in its contribution to sustainable development. As the indicator of achieving this development, an increase in the green economy's sustainability is offered. A new source of achieving the goal is proposed, consisting of a financial risk management of ecologically responsible entrepreneurship based on (private) green investments.

Keywords: financial risk management; ecologically responsible entrepreneurship; sustainable development; green economy

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1. Introduction

The COVID-19 pandemic and crisis caused high financial risks to sustainable development, which is noted in many works (Dzau and Balatbat 2020; Kwon and Kim 2021; Tsani et al. 2021; Tsao et al. 2021). The financial risks to sustainable development include accessibility, sufficiency, and the absence of a deficit for financing sustainable development. The green economy occupies a central place in the system of the Sustainable Development Goals (SDGs). The UN concept of sustainable development is based on the noosphere study (Lapo 2001), the key idea of which is the harmonization of socio-economic processes, systems and relations with the environment, which transforms resources (inanimate object of economic activities) into animate (with own interests) subjects (Shoshitaishvili 2021). It is

no coincidence that the SDGs concerning ecology (preservation of biodiversity, fight against climate change, etc.) are many and dominate, by their number, in the general structure of the SDGs.

Thus, when studying sustainable development, it is expedient to pay special attention to the green economy. In modern economic practice, this is reflected in the fact that ecological responsibility is distinguished as a special direction of corporate social responsibility, which supports the establishment and development of the green economy (Pyka and Nocoń 2021; Jonsdottir et al. 2021). Due to this, the impact of the COVID-19 pandemic and crisis on the financial risks of the green economy is not defined (which is a research gap).

Financing and financial risks (accessibility, sufficiency, and the absence of a deficit of financing) and their reduction (through an increase in financing) are assigned an important role during the research and management of sustainable development (Chen and Zhao 2021; Liu et al. 2021; Miralles-Quirós and Miralles-Quirós 2021; Wang and Wang 2021). However, financial risks to green economy development are not sufficiently elaborated at the level of fundamental science, as they are considered in isolation from sustainable development.

Existing works (Goenka et al. 2021; Lin et al. 2021; Wang et al. 2021) note progress in the development of the green economy amid the COVID-19 pandemic due to the lockdown. The works (Ngo et al. 2021; Taghizadeh-Hesary et al. 2021; Tan et al. 2021; Tu et al. 2021) note a reduction in the volume of financing for the green economy due to the COVID-19 financial and economic crisis. However, the consequences of the pandemic for the sustainability of the green economy—its financial risks—are still unclear (this is another research gap), which reduces the effectiveness of their management in the practice of ecologically responsible entrepreneurship.

Additionally, the existing literature (Blazovich et al. 2013; da Silva et al. 2019; D'Orazio and Popoyan 2019; Gao et al. 2021; Streimikiene and Kaftan 2021) considers the financial risks of the green economy formally, with only a generalized formulation that is narrowed down to the reduction in financing; the structure of financing is not defined (which is a research gap). The studies (Afonso 2021; Černìnko et al. 2021; Govinda Rao 2021; King et al. 2021; Lalvani and Karni 2021) state that the COVID-19 pandemic and financial and economic crisis influenced government finances to a larger extent, compared to corporate finances. Therefore, an important issue is the role of corporate finances ("private" green investments) in the financing of the green economy, since this is the key to determining financial risks to the green economy amid the COVID-19 pandemic and crisis.

All three mentioned research gaps are filled by this paper, which aims to develop a scientific methodology of financial risk management of ecologically responsible entrepreneurship for the green economy's sustainable development. The authors set four research questions (RQ) that define the logic and structure (tasks) of this paper.

RQ_1: How is the green economy's sustainability understood, how is it measured, and what is it at present?

To answer this research question, the authors developed a proprietary concept of green economy sustainability, which is treated as the contribution of the green economy to implementing the SDGs. Additionally, the authors developed a proprietary methodology of measuring green economy sustainability, which is approbated on the example of the modern world economy. The hypothesis H_1 was tested: green economy sustainability is different depending on the regions of the world.

RQ_2: What was the impact of the COVID-19 pandemic and financial and economic crisis on the financial risks of the green economy's sustainability? To answer this research question, research was performed dynamically: the change in green economy sustainability in 2020 compared to 2019 was assessed. Using the works of Bouri et al. (2021) and Morelli and Petrella (2021), the hypothesis H_2 was tested: the COVID-19 pandemic and financial and economic crisis increased the financial risks of the green economy, reducing

its sustainability and causing the growth of ecological disproportion in regions of the world (growth of disproportions in green economy sustainability among regions of the world).

RQ_3: How could we reduce the negative impact of the COVID-19 pandemic and financial and economic crisis on the financial risks of the green economy's sustainability? To answer this research question, this paper assessed the dependence of the manifestations (that reflect the results of the development of the green economy—green trade, green employment and green innovation—on the financing factor: green investment, which characterises the level of financial risks and the effectiveness of risk management. The following hypothesis H_3 was proposed and tested: the increase in green investments allows reducing financial risks to the green economy, raising its sustainability and reducing ecological disproportion in regions of the world (reducing the disproportions in green economy sustainability among regions of the world).

The originality of this paper lies in the fact that, for the first time, the financial risks to the green economy are considered through the prism of its sustainability. The paper's novelty is due to the modelling and quantitative measuring of the impact of the COVID-19 pandemic and financial and economic crisis on the financial risks to green economy sustainability, as well as the development of precise quantitative recommendations for financial risk management of the green economy, which enables an increase in its sustainability and reduces ecological disproportion in regions of the world (reducing the differences in green economy sustainability among regions of the world through the management of green investments.

2. Theory

This paper uses the framework of the theory of the green economy financial risks. This theory treats the green economy as a system (totality) of economic practices that contribute to environmental protection. The fundamental provisions of this theory are systematised in Figure 1.

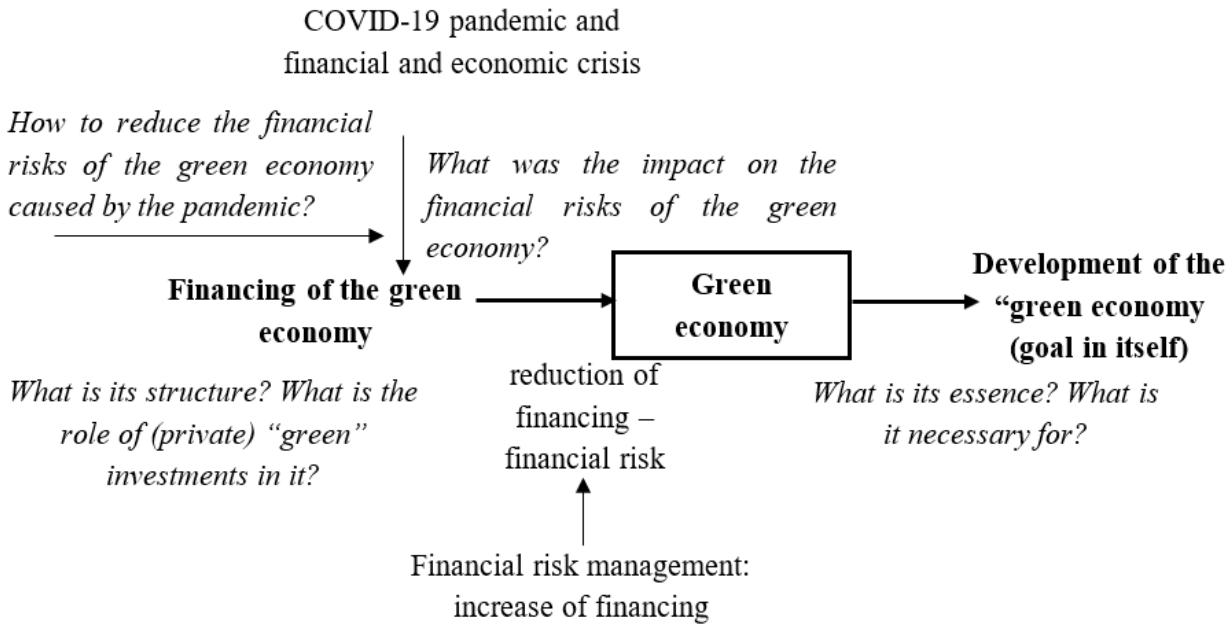

Figure 1. The fundamental provisions of the existing theory of financial risks of the green economy and the gaps in it. Source: authors.

As shown in Figure 1, there are more questions than answers in the existing theory of financial risks to the green economy. The process of green economy development is a "black box". At the input, there is the financing of the green economy. Existing studies (Gün and Kutlu 2021; Jinru et al. 2021; Sriyono and Proyogi 2021; Trippel 2020) have noted

a significant impact on financing for green economy development. However, the structure of this financing, in particular the role of (private) green investments, remain unclear (research gap).

At the output of the "black box", there is the development of the green economy. The goal of management is—from the positions of state regulation—the development of the green economy (Abid et al. 2021; Asongu and Nnanna 2021). A drawback of the existing formulation of the goal is the obscureness of the reason, due to which the green economy's development is necessary (it is a goal in itself) (He and Kim 2021; Jones and Bi 2020; Mach et al. 2021).

Though it is supposed that a green economy must contribute to the improvement of the environment, this is not reflected in the implementation of the considered theory in practice. Thus, reports on corporate social responsibility and official statistical bodies provide only indicators of the green economy (e.g., number of created green jobs or number of implemented green innovations), without including the consequences for the environment (Lăzăroiu et al. 2020; Rogulenko et al. 2021).

An indicator of achieving the goal is the increase in green economy indicators (green investment, green trade, green employment and green innovation) (Nadanyiova et al. 2020). Therefore, this very set of sub-indicators (assigned to one level—result) is given during detalization of the indicator "Green Economic Opportunities" in the reports from the Global Green Economic Institute (2021a, 2021b) for 2019–2020. Other indicators of this report go beyond the bounds of the economy and belong primarily to environmental protection. That is why the set of the indicator "Green Economic Opportunities" (and, accordingly, the set of its sub-indicators) is the manifestation of the green economy.

Based on the noosphere teaching (Lapo 2001), it is possible to expect that results in the sphere of the green economy (at the output) must contribute to sustainable development. Therefore, the existing literature reflects the essence of the results of the green economy development only formally. The issues of the essence and purpose of the development of the green economy remain open (research gap).

The essence of financial risks consist of the reduction in financing of the green economy (Chiang 2021; Hagspiel et al. 2021; Mezghani et al. 2021; Nagy et al. 2021; Yang et al. 2021; Zhao et al. 2021). Accordingly, the approach to financial risk management implies an increase in green economy financing (Arcese et al. 2020; Baggio and Valeri 2020; Elmo et al. 2020; Essaber et al. 2021; Mensi et al. 2022; Valeri 2021).

The work of the considered "black box" is influenced by the COVID-19 pandemic and financial and economic crisis. Existing publications (Ruiz 2020; Ruiz and Stupariu 2021) note the reduction in green economy financing due to the emergence of a large deficit in the national budget's resources under the crisis conditions. At that, aspects of green economy financing under the conditions of the COVID-19 pandemic and financial and economic crisis from the positions of (private) green investments remain poorly studied in the existing literature. The issues of the impact of the COVID-19 pandemic and financial and economic crisis on financial risks of the green economy, and the reduction of financial risks of the green economy, which were caused by the pandemic, remain open (research gap).

Thus, a critical analysis of the existing theory of financial risks to the green economy demonstrated its multiple drawbacks, inaccuracies and contradictions. Due to these drawbacks, though the essence of the green economy is clearly specified by its existing theory, the causal connections between the emergence of financial risks of the green economy are unknown, as are the perspectives (levers) of financial risk management. These drawbacks are dealt with in this paper by specifying the causal connections between the financing of the green economy and the perspectives of financial risk management.

3. Method

This paper is built based on a hypothetical and deductive principle, according to which it tests three offered hypotheses with the help of the corresponding methodol-

ogy. The main data, which are studied in this paper, are taken from the materials of the Global Green Economic Institute (2021a, 2021b) for 2019–2020 (sheet 1 of the Excel file in the Supplementary Materials). This research is based on the following conceptual model, which demonstrates the methodology and logic of the hypothesis's verification (Table 1).

Table 1. The conceptual model of the research.

Research Question	Hypothesis	Research Task	Research Method	Control Indicator
RQ_1: How is the green economy's sustainability understood, how is it measured, and what is it at present?	H_1: Sustainability of the green economy differs depending on regions of the world (varIS2020 > 10%)	Finding the current level of the green economy's sustainability	Proprietary methodology	Worldwide mean IS_{2020} (indicator of the green economy's sustainability)
		Finding the differences in the green economy's sustainability among regions of the world	Analysis of variance	var_{IS2020}
RQ_2: What was the impact of the COVID-19 pandemic and financial and economic crisis on the green economy's sustainability?	H_2: The pandemic reduced the green economy's sustainability (GT2020−GT2019 < 0 and/or GE2020−GE2019 < 0 and/or GI2020−GI2019 < 0)	Finding the change in the green economy's sustainability in 2020 compared to 2019	Horizontal analysis	Green trade GT); green employment (GE); green innovation (GI)
RQ_3: How to reduce the negative impact of the COVID-19 pandemic and financial and economic crisis through financial risk management of the green economy's sustainability?	H_3: Growth of green investments allows reducing the financial risks of the green economy, raising its sustainability and reducing its differences among regions of the world (ISoptim-IS2020 > 0; $var_{ISoptim}$-var_{IS2020} < 0)	Finding the role of (private) green investments in financial risk management of the green economy	Regression analysis	Research model (1)
		Discovering the potential of green economy sustainability and the reduction of its differences among regions of the world with the help of green investments	Least square method	ISoptim; $var_{ISoptim}$

Source: authors.

According to Table 1, to find the current level of green economy sustainability within the testing of the hypothesis H_1, a specially developed proprietary methodology of measuring green economy sustainability was used, which is based on the system of the indicators of the green economy from the materials of the Global Green Economic Institute (2021a, 2021b), as well as T. Saaty's hierarchy process. The following sequence of actions was supposed:

1. Unification of the statistics on the green economy for 2020 (as a result of the year) of Global Green Economic Institute (2021b) and the statistics of sustainable development for 2021 (as of the beginning of the year) of the UN (2021) in one table, with the same list and order of countries (sheet 2 of the Excel file in the Supplementary Materials);
2. Calculation of weight coefficients (w). For this, the authors calculate coefficients of correlation (R^2) between the indicators of the green economy—green investment, green trade, green employment and green innovation (Global Green Economic Institute 2021b) and the Sustainable Development Index (in isolation for each region). The sum of all positive coefficients of correlation ($\sum R^2$) is calculated. After this, the ratio of each coefficient of correlation to their total sum is calculated: $w = R^2/\sum R^2$;

3. Norming of indicators (nm). Calculation of arithmetic means of the indicators of the green economy for the world on the whole (G_{mid}). Determination of ratios of arithmetic means for each region (R_{mid}) to world average values (bringing all indicators to one denominator for ensuring their compatibility): nm = R_{mid}/G_{mid};
4. Calculation of weighted sums (WS): products of standardized indicators and weights (in isolation for each region): WS = nm * w;
5. Hierarchy synthesis (IS): finding the sum of all weighted sums for the region: IS = ∑WS.

According to the proprietary methodology, the values of the indicators WS and IS are treated in the following way:

- Below 1: The lower the green economy's sustainability (for IS) or its manifestation (for WS);
- 1–1.5: The more moderate the green economy's sustainability (for IS) or its manifestation (for WS);
- above 1.5: The higher the green economy's sustainability (for IS) or its manifestation (for WS).

The sample of countries for this research is taken from the report by Global Green Economic Institute (2021b)—the most respectable source of data on the green economy. Regions of the world are also designated by the classification of Global Green Economic Institute (2021b), since this source reflects with the highest precision and correctness the regional specifics of the green economy. The sample contains 48 countries of Africa, 7 countries of America, 49 countries of Asia, 42 countries of Europe, and 11 countries of Oceania.

To find the differences in green economy sustainability among regions of the world, the authors used the method of analysis of variation, calculating the coefficient of variation of green economy sustainability (IS) among the distinguished regions of the world (sheet 1 of the Excel from the Supplementary Materials). The calculation was performed separately for 2019 and 2020. The hypothesis H_2 was considered proved if coefficients of variation exceeded 30%. The perspectives of the increase in the green economy's sustainability are determined through finding "weak spots"—the lower values of the weighted sums (WS).

To test the hypothesis H_2, the method of horizontal analysis was used for determining the change (growth) in 2020 compared to 2019:

- Indicators of the green economy: green trade (*GT*), green employment (*GE*), green innovation (*GI*) and green investment (R_{fin});
- Green economy sustainability (IS) and its variations among regions of the world (ISvar).

The hypothesis H_2 was considered proven if $Rfin_{2020}$-$Rfin_{2019} > 0$ and/or IS_{2020}-$IS_{2019} > 0$ and/or $ISvar_{2019}$-$ISvas_{2020} > 0$.

To test hypothesis H_3, the method of regression analysis was used. To obtain the most reliable and correct results, the data for 2019 and 2020 were combined in one sample, which contains 376 observations (sheet 2 of the Excel file in the Supplementary Materials). Based on the compiled sample, the authors determined the dependence of each manifestation of the green economy (in isolation)—green trade (*GT*), green employment (*GE*) and green innovation (*GI*)—on the financing of the green economy: green investment (R_{fin}). The research model is a system of equations of linear regression with one regressor:

$$\begin{cases} GT = a_{gt} + b_{gt} \times R_{fin} \\ GE = a_{ge} + b_{ge} \times R_{fin} \\ GI = a_{gi} + b_{gi} \times R_{fin} \end{cases}$$

The hypothesis H_3 was considered proved if all regression coefficients were non-negative: $b_{gt} \geq 0$, $b_{ge} \geq 0$, $b_{gi} \geq 0$.

4. Results

4.1. Evaluation of the Green Economy's Sustainability, Analysis of Its Differences among Regions of the World and Prospects of Their Overcoming

The proprietary concept of the green economy's sustainability was used to determine it. According to this concept, the green economy's sustainability was treated as the contribution of the green economy to the implementation of the SDGs. To determine the green economy's sustainability, the proprietary methodology of its measuring was used. At the first step, a table of data was formed (sheet 2 of the Excel file from the Supplementary Materials). At the second step, the following weight coefficients—in isolation for each distinguished region of the world—were obtained (Table 2).

Table 2. Calculation of weight coefficients.

Region of the World	Indicator	Green Investment	Green Trade	Green Employment	Green Innovation	$\sum R^2$
Africa	Correlation with the Sustainable Development Index, R^2	0.33	0.33	0.31	0.32	1.29
	Weight coefficient, w	0.25	0.25	0.24	0.25	-
Asia	Correlation with the Sustainable Development Index, R^2	0.45	0.26	0.32	0.13	1.16
	Weight coefficient, w	0.39	0.22	0.28	0.11	-
Europe	Correlation with the Sustainable Development Index, R^2	0.59	0.10	0.63	0.54	1.85
	Weight coefficient, w	0.32	0.05	0.34	0.29	-
The Americas	Correlation with the Sustainable Development Index, R^2	0.71	−0.11	0.47	0.52	1.71
	Weight coefficient, w	0.42	0	0.28	0.31	-
Oceania	Correlation with the Sustainable Development Index, R^2	0.73	−0.23	0.67	0.54	1.95
	Weight coefficient, w	0.38	0	0.35	0.28	-

Source: authors.

At the third step, the standardization of the indicators was performed; at the fourth step—the calculation of weighted sums (Table 3).

The hierarchy process (results of the evaluation) is shown in Figure 2.

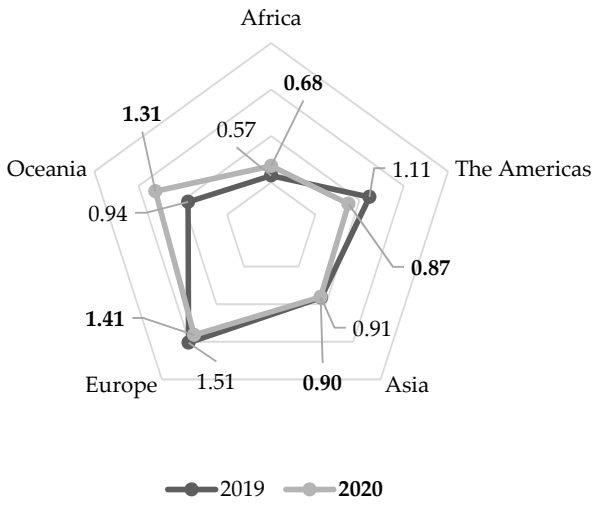

Figure 2. The green economy's sustainability (IS) in 2019–2020. Source: authors.

Table 3. Calculation of arithmetic means, standardized values and weighted sums.

Region of the World	Arithmetic Means, R_{mid}				Standardized Values, nm				Weighted Sums, WS			
	Green Innovation	Green Investment	Green Trade	Green Employment	Green Innovation	Green Investment	Green Trade	Green Employment	Green Innovation	Green Investment	Green Trade	Green Employment
-						2019						
Africa	51.93	51.93	7.48	21.45	0.78	0.35	0.63	0.53	0.20	0.09	0.16	0.13
The Americas	68.01	68.01	18.90	36.76	1.02	0.89	1.09	1.22	0.43	0.00	0.30	0.38
Asia	71.13	71.13	16.05	32.07	1.07	0.75	0.95	0.59	0.42	0.17	0.27	0.06
Europe	69.83	69.83	35.06	54.16	1.05	1.64	1.60	1.90	0.34	0.08	0.54	0.55
Oceania	71.79	71.79	29.14	24.66	1.08	1.37	0.73	0.77	0.41	0.00	0.28	0.25
Average, G_{mid}	66.54	66.54	21.32	33.82	-	-	-	-	-	-	-	-
-						2020						
Africa	56.31	56.31	6.37	23.19	0.86	0.46	0.64	0.76	0.21	0.12	0.16	0.19
The Americas	64.82	64.82	14.34	29.79	0.98	1.04	0.82	0.75	0.41	0.00	0.23	0.23
Asia	68.91	68.91	11.84	32.82	1.05	0.85	0.90	0.50	0.41	0.19	0.25	0.05
Europe	67.84	67.84	30.76	51.18	1.03	2.22	1.41	1.69	0.33	0.11	0.48	0.49
Oceania	71.23	71.23	5.92	44.48	1.08	0.43	1.23	1.32	0.41	0.00	0.48	0.42
Average, G_{mid}	65.82	65.82	13.85	36.29	-	-	-	-	-	-	-	-

Source: authors.

As shown in Figure 2, the green economy's sustainability in 2020 (world average) was assessed at 1.04, i.e., it is moderate (in the range 1–1.5). For some regions, the green economy's sustainability is below 1: in Africa (0.68), America (0.87), and Asia (0.90). In neither region does the sustainability of green economy achieve 1.5: it is the highest in Oceania (1.31) and Europe (1.41).

To determine the differences in green economy sustainability (IS) among the designated regions of the world, the authors calculated the coefficient of variation, which equals 30.04% (exceeding 10%) in 2020. The perspectives of the increase in green economy sustainability were determined through finding the "weak spots"—the least values of weighted sums (WS)—and are as follows:

In Africa, the perspectives include stimulating green trade (0.12) and green employment (0.16);

In America, the perspectives include the development of green employment (0.23) and green innovations (0.23);

In Asia, it is recommended to increase green trade (0.19);

In Europe, it is expedient to increase green trade (0.1);

In Oceania, it is advisable to attract green investments (0.41) and stimulate green innovations (0.42).

As a result, the performed tests (within the verification of hypothesis H_1) showed that the current level of green economy sustainability is moderate (IS2020 = 1.04), and its differences among regions of the world (variation: varIS2020 = 30.04%, which exceeds the control value of 10%) are high. Therefore, hypothesis H1 is proved.

4.2. Analysis of the Impact of the COVID-19 Pandemic and Financial and Economic Crisis on Financial Risks of the Green Economy

To determine the impact of the COVID-19 pandemic and financial and economic crisis on financial risks of the green economy with the help of the method of horizontal analysis, the authors found a change (growth) in its sustainability in 2020 compared to 2019.

- Indicators of the green economy (the overall growth of their sum—from 139.96 to 142.83, i.e., Rfin2020-Rfin2019 > 0, is observed):
  - ➢ Green trade (*GT*) decreases insignificantly—from 66.54 to 65.82;
  - ➢ Green employment (*GE*) reduced from 21.32 to 13.85;
  - ➢ Green innovation (*GI*) grew from 33.82 to 36.29;
  - ➢ Green investment (R_{fin}) grew from 18.28 to 26.87.
- The green economy's sustainability (IS): from 1.01 to 1.04, i.e., IS_{2020}-$IS_{2019} > 0$;
- Variation in green economy sustainability among regions of the world (ISvar): from 33.84% to 30.04% (homogeneity grew, but insignificantly; variation remained high), i.e., $ISvar_{2019}$-$ISvas_{2020} > 0$.

Thus, the COVID-19 pandemic and financial and economic crisis increased the financial risks of the green economy, reducing green trade and green employment. However, despite the generally known and acknowledged (in the current literature) reduction in government financing, the green economy's sustainability did not reduce, but ecological disproportion in regions of the world (differences in the green economy's sustainability among regions of the world) did not grow.

This is vividly shown by the contradiction and imperfection of the existing theory of financial risks of the green economy, which does not explain the financial risks of the green economy amid the COVID-19 pandemic and crisis. Government financing has a secondary role in green economy financing. To specify the essence of financial risks of the green economy from the positions of its sustainability, it is expedient to study the contribution of (private) green investments in more detail.

Therefore, the performed tests (within the verification of hypothesis H_2) showed that the current level of the green economy's sustainability changed in 2020 compared to 2019. Green trade reduced by 1.08% (GT2020-GT2019 = 65.82–66.54 = $-0.72 < 0$). Green

employment reduced by 35.04% (GE2020-GE2019 = 13.85–21.32 = −7.47 < 0). Therefore, hypothesis H_2 is proved.

4.3. Determining the Impact of Financial Risks on the Development of the Green Economy through the Prism of Green Investments

To find the role of (private) green investments in financial risk management of the green economy using the method of regression analysis, the authors determined the dependence of each manifestation of the green economy (in isolation)—green trade (*GT*), green employment (*GE*) and green innovation (*GI*)—on green investment (R_{fin}), according to the research model (1). As a result, the following system of equations of linear regression with one regressor was obtained:

$$\begin{cases} GT = 10.531 + 0.097 \times R_{fin} \\ GE = 7.253 + 0.338 \times R_{fin} \\ GI = 1.968 + 0.211 \times R_{fin} \end{cases}$$

All three regression equations in the model (2) are correct at the significance level of 0.05, i.e., they are reliable. Model (2) states that an increase in accessibility of green investments (reduction of financial risks) by 1 point leads to an increase in the level of development of green trade by 0.097 points, green employment—0.338 points and green innovations—0.211 points. The expanded results of the regression analysis are presented in sheet 2 of the Excel file from the Supplementary Materials. In model (2), all coefficients of regression are non-negative: $b_{gt} \geq 0$, $b_{ge} \geq 0$, $b_{gi} \geq 0$.

To determine the potential of (private) green investments in the reduction of the negative impact of the COVID-19 pandemic and financial and economic crisis on financial risks of the green economy's sustainability, the authors find—for each region of the world—the dependence of the selected (influenced by the COVID-19 pandemic and crisis) manifestations of the green economy (in isolation)—green trade (*GT*), green employment (*GE*)—on green investment (R_{fin}), according to the research model (1). The results of the regression analysis, received based on the systemic data for 2019–2020, are collected in Table 4.

Table 4. Regression dependence of the indicators of the green economy that are subject of the financial risks of the pandemic on (private) green investments in the context of regions of the world in 2019–2020.

Regression Model	Regression Statistics	Africa	The Americas	Asia	Europe	Oceania
Model for Green trade	Correlation, %	10.31	26.64	32.31	41.84	7.43
	Constant	3.92	24.61	4.32	12.29	13.25
	Coefficient of regression	0.03	−0.19 (Negative impact)	0.14	0.32	0.06
	Significance F	0.3098 (Not reliable)	0.0218	0.0012	$7.5 \times 10^{-0.5}$	0.7423 (not reliable)
Model for Green employment	Correlation, %	24.71	30.71	24.33	51.75	34.77
	Constant	1.53	4.22	18.01	14.41	6.93
	Coefficient of regression	0.18	0.24	0.19	0.57	0.25
	Significance F	0.0137	0.0080	0.0163	$4.6 \times 10^{-0.7}$	0.1128 (not reliable)

Source: calculated and compiled by the authors.

The results of the regression analysis (Table 3) show that in almost all regions of the world the indicators of the green economy that are subject to financial risks of the pandemic are characterised by the reliable and positive dependence on (private) green investments. The exceptions are: Africa, where the model for green trade is not reliable; America, where green investments demonstrated a negative impact on green trade; and Oceania, where both models are not reliable (perhaps due to a small sample of 22 observations). In other cases, reliable models with a moderate or high correlation, which show a close connection between the considered indicators, were received.

Based on the received reliable regression models, the prospects of the reduction of the previously discovered financial risks of the COVID-19 pandemic and crisis for the green economy are as follows:

- In Africa, an increase in green investment from 50.79 points (in 2020) to 100 points (+96.88%) leads to an increase in green employment from 10.91 points to 19.96 points (+82.86%);
- In America, due to the discovered negative impact of green investments on green trade, the optimisation of green investments is inaccessible (inexpedient);
- In Asia, an increase in green investment from 57.43 points (in 2020) to 100 points (+74.13%) leads to an increase in green trade from 10.85 points to 38.58 points (+55.58%) and an increase in green employment from 30.76 points to 100 points (+90.45%);
- Europe has the highest level of green trade (29.30 points) and green employment (47.53 points). That is why, in order not to increase the disproportion of the green economy and its sustainability in regions of the world and Europe, the special (artificial) increase in green investments is not recommended;
- In Oceania, insufficient reliability of the models makes the optimisation of green investments inaccessible (its consequences for financial risks of the green economy are unpredictable).

The calculation of arithmetic means, standardized values, and weighted sums for the obtained (above) optimisation values of the indicators with the use of the proprietary methodology is shown in Table 5.

Table 5. Calculation of arithmetic means, standardized values, and weighted sums for the optimisation values.

Region of the World	Arithmetic Means, R_{mid}				Standardized Values, nm				Weighted Sums, WS			
	Green Innovation	Green Investment	Green Trade	Green Employment	Green Innovation	Green Investment	Green Trade	Green Employment	Green Innovation	Green Trade	Green Employment	Green Innovation
-							2020					
Africa	56.31	7.01	19.96	100.00	0.86	0.42	0.58	1.09	0.21	0.10	0.15	0.26
The Americas	64.82	20.15	24.61	100.00	0.98	1.20	0.72	1.09	0.41	0.47	0.16	0.31
Asia	68.91	14.62	41.49	100.00	1.05	0.87	1.21	1.09	0.41	0.28	0.06	0.37
Europe	67.84	29.30	47.53	58.15	1.03	1.75	1.39	0.63	0.33	0.74	0.00	0.18
Oceania	71.23	12.59	37.85	100.00	1.08	0.75	1.10	1.09	0.41	0.29	0.00	0.38
On average, G_{mid}	65.82	16.73	34.29	91.63	-	-	-	-	-	-	-	-

Source: authors.

The hierarchy process (results of the evaluation) is shown in Figure 3.

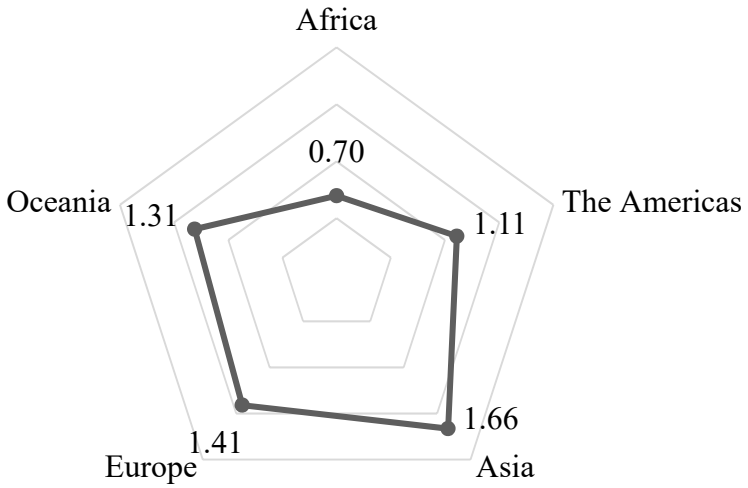

Figure 3. The green economy's sustainability (IS) during the optimisation. Source: authors.

As shown in Figure 3, optimisation led to the growth of the green economy's sustainability in:

- Africa: from factual 0.68 in 2020 to 0.70;
- Asia: from factual 0.90 in 2020 to 1.66;

In America, Europe, and Oceania, the green economy's sustainability remained at the 2020 level. As a result, on average in the world, sustainability of the green economy grew—due to optimisation—from factual 1.04 in 2020 to 1.24, and its variation (disproportion) among regions of the world reduced from factual 30.04% in 2020 to 29.26%.

The test performed (within the verification of hypothesis H_3) demonstrated that (private) green investments have an important role in financial risk management of the green economy. Their optimisation allows raising the sustainability of the green economy by 19.23% (ISoptim-IS2020 = 1.24–1.04 = 0.2 > 0) and reducing its variation among regions of the world by 2.60% (varISoptim-varIS2020 = 29.26–30.04 = −0.78 < 0). Therefore, hypothesis H_3 has been proved—green investments do allow reducing financial risks of the pandemic for the green economy, but its financial risk management based on green investments must be flexible and take into consideration the specifics of regions of the world.

5. Discussion

This paper specifies the fundamental provisions of the theory of financial risks of the green economy by filling its gaps (Table 6).

As shown in Table 6, unlike (Abid et al. 2021; Asongu and Nnanna 2021; He and Kim 2021; Jones and Bi 2020; Lăzăroiu et al. 2020; Mach et al. 2021; Rogulenko et al. 2021), from the positions of sustainability, the goal of state management consists of the increase in the contribution of the green economy to sustainable development (at the output of the "black box" in Figure 1). The advantage of the new formulation of the goal is specifying the reason behind the necessity for the green economy's development—achievement of sustainable development (implementation of the SDGs). The new formulation of the goal opens a possibility for creation and calculation in the practice of new indices that characterize the green economy's sustainability separately from the statistics of the green economy. This allows studying the effectiveness of the green economy through the prism of achievement of the set goal—stimulating sustainable development.

Table 6. The specified fundamental provisions of the Theory of financial risks of the green economy.

The Paper's Research Question	Gap in the Existing Literature (Figure 1)	The Result That Is Received in This Paper and Answers the Research Question and Fills the Gap in the Literature
What is the sustainability of the green economy? How can it be measured? What is its current level?	What does the development of the green economy consist in? What is it necessary for?	The development of the green economy is necessary for supporting sustainable development; it is treated as a contribution to sustainable development. A proprietary methodology is proposed for measuring the green economy's sustainability. At present, the green economy's sustainability is moderate at the global scale, but rather differentiated among regions of the world.
What was the impact of the COVID-19 pandemic and financial and economic crisis on the financial risks of the green economy's sustainability?	What is the structure of financing of the green economy? What is the role of (private) green investments in it?	In the structure of the green economy financing, it is expedient to distinguish and differentiate government financing and (private) green investments which have the key role.
	What was the impact of the COVID-19 pandemic and financial and economic crisis on the financial risks of the green economy?	The COVID-19 pandemic and financial and economic crisis has a contradictory impact on the financial risks of the green economy. On the one hand, there was a decline in government financing, which is noted in the literature. On the other hand, green investments did not reduce but grew, which allowed preserving green innovation at the pre-crisis level and even increasing it.
How to reduce the negative impact of the COVID-19 pandemic and financial and economic crisis on the financial risks of the green economy's sustainability?	How to reduce the financial risks of the green economy that are caused by the pandemic?	The financial risks to the green economy is the reduction of its contribution to sustainable development under the influence of the decrease in financing. The COVID-19 pandemic and crisis led to the reduction of green trade and green employment—as a result of the decrease in government financing (noted in the literature). Financial risk management of the green economy (amid the pandemic and crisis) is allowed by green investments, the increase in which could ensure also the increase in the global green economy's sustainability and the reduction of its disproportions among regions of the world.

Source: authors.

Accordingly, the indicator of achievement of the goal in its new formulation is the increase in the green economy's sustainability, which could be measured with the help of the proprietary methodology, which is tested in this paper. That is, this paper specifies not only theory but also the methodology of research and monitoring of the green economy.

With the help of the proprietary methodology, it was discovered that the green economy's sustainability at the global scale is moderate, but rather differentiated among regions of the world.

The obtained results show, contrary to (Gün and Kutlu 2021; Jinru et al. 2021; Sriyono and Proyogi 2021; Trippel 2020), that at the input of the "black box" (Figure 1), there is the financing of the green economy, in which structure it is expedient to distinguish and differentiate government financing and (private) green investments, which play the key role. The COVID-19 pandemic and financial and economic crisis had a contradictory impact on the financial risks of the green economy. On the one hand, government financing decreased (which is noted in the literature). On the other hand, green investments did not decrease but even grew, which allowed preserving green innovation at the pre-crisis level and even increasing it.

Unlike (Chiang 2021; Hagspiel et al. 2021; Mezghani et al. 2021; Nagy et al. 2021; Yang et al. 2021; Zhao et al. 2021), it is shown that the financial risks of the green economy is the reduction of its contribution to sustainable development under the impact of the decrease in financing. Unlike (Ruiz 2020; Ruiz and Stupariu 2021), it is demonstrated that the COVID-19 pandemic and crisis led to the reduction of green trade and green employment—as a result of the decrease in government financing. Unlike (Arcese et al. 2020; Baggio and Valeri 2020; Elmo et al. 2020; Essaber et al. 2021; Mensi et al. 2022;

Valeri 2021), it is substantiated that financial risk management of the green economy (amid the pandemic and crisis) is allowed by green investments, the increase in which could ensure the increase in the global green economy's sustainability and the reduction of its disproportions among regions of the world.

The elaboration of the Theory of financial risks of the green economy opened the existing "black box" and shed light on the causal connections of the green economy development, its financial risks, the impact of the COVID-19 pandemic and financial and economic crisis on them, and the prospects (levers) of financial risk management of the green economy amid the pandemic.

6. Conclusions

Thus, the paper answered all the research questions and proved all offered hypotheses. First, it is suggested that the green economy's sustainability be treated as the contribution of the green economy to the implementation of the SDGs. The proprietary methodology was used to prove that the green economy's sustainability is moderate as of now, but there are large perspectives for its increase. As for the world average, the green economy's sustainability is assessed at 1.04 (moderate). In certain regions, the green economy's sustainability is low: in Africa (0.68), America (0.87) and Asia (0.90). In neither region of the world does the green economy's sustainability achieve a high level; it is the highest in Oceania (1.31) and Europe (1.41).

It is also proved that the differences in the green economy's sustainability among regions of the world are rather big (they cannot be ignored—they should be taken into account; variation—30.04%), and each region has its perspectives of increasing the green economy's sustainability. In Africa, the perspectives include stimulation of green trade (0.12) and green employment (0.16). In America, the development of green employment (0.23) and green innovations (0.23) is very perspective. In Asia, it is recommended to increase green trade (0.19). In Europe, the recommendation is to increase green trade (0.1), as well. In Oceania, it is advised to attract green investments (0.41) and stimulate green innovations (0.42).

Second, it is proved that in the structure of green economy financing, it is expedient to distinguish and differentiate government financing and (private) green investments, which have a key role. The COVID-19 pandemic and financial and economic crisis had a contradictory impact on the financial risks of the green economy. On the one hand, government financing decreased (which is noted in the literature). On the other hand, green investments did not decrease but even grew—which allows preserving green innovation at the pre-crisis level and even increasing it.

Due to the increase in the volume of green investments (from 18.28 points in 2019 to 26.87 points in 2020), the COVID-19 pandemic and financial and economic crisis did not cause a large decrease in the green economy's sustainability (which grew from 1.01 in 2019 to 1.04 in 2020) and did not lead to the growth of the ecological disproportion of regions of the world (growth of differences in the green economy's sustainability among regions of the world)—the variation reduced from 33.84% in 2019 to 30.04% in 2020 (which led to the growth of homogeneity of the world economy and reduction of inequality of world regions).

Third, the essence of the financial risks of the green economy is specified. It is suggested they be treated as a reduction of its contribution to sustainable development under the influence of the decrease in financing. The COVID-19 pandemic and crisis led to the decrease in green trade and green employment, as a result of the decrease in government financing. Financial risk management of the green economy amid the pandemic and crisis is allowed by green investments, the increase in which, according to the authors' recommendations (optimisation) could be ensured by the growth of sustainability of the global green economy (from 1.04 to 1.24) and reduction of its disproportions among regions of the world (from 30.04% to 29.26%). The regularity of the change of the green economy

indicators depending on the change of the sufficiency of green investments is reflected by the created regression model.

This paper's contribution to the literature consists of the specification of the theory of financial risks of the green economy. According to the specified fundamental provisions of this theory, the essence of the process of the green economy development is specified (the "black box" is opened) as the increase in its contribution to sustainable development. It is suggested that the indicator of the achievement of this development be the increase in the green economy's sustainability. A new source of the achievement of the goal is proposed—financial risk management of ecologically responsible entrepreneurship based on (private) green investments.

The essence and recommended approach to financial risk management of the green economy amid the COVID-19 pandemic and crisis consist in the attraction of green investments in the economy. This allows discovering the causal connections of the green economy development and the perspectives (levers) of its financial risk management.

The management impact is the clarification of the role of business in financial risk management of the green economy's sustainable development. As was shown, this role consists not only in manifestation of corporate social responsibility (which allows achieving certain small-scale results) but also in managing the financial risks of the green economy through the placement of green investments (which provides the systemically important impact, thus being more significant).

The offered recommendations allow correcting corporate social responsibility reports through reflecting not only green initiatives but also the contribution to implementing the SDGs. This allows increasing the value of reports on corporate social responsibility for consumers (due to better informative value) and companies (due to a larger contribution to the growth of loyalty to them).

Policy impact is the paper's improving the conceptual vision and approach to financial risk management of the green economy, offering a wider spectre of leverage for this regulation (aimed at stimulation of green investments in the economy). The advantage of the authors' developments is that they ensure the essential manageability of the green economy and guarantee its high effectiveness from the positions of the contribution to sustainable development.

The paper's conclusions and recommendations also allow for improvements in the practice of state monitoring and statistical accounting of the green economy, through the creation of special indices of its sustainability, which will increase the information value and precision of the statistics and strengthen the information support for decision-making in the sphere of state management of financial risks of the green economy.

Social impact consists of the paper's providing a connection between the theory and practice of financial risks of the green economy and sustainable development. Due to this, "green" economic practices (green investment, green trade, green employment and green innovation) ceased to be goals in themselves but became the tool of implementing the SDGs. The systemic implementation of "green" initiatives and the SDGs due to the more effective financial risk management (based on the authors' recommendations) will ensure the synergetic effect in the form of increasing the rate of sustainable development.

Summing up the research, it should be acknowledged that, together with the described advantages (determination of more general perspectives and development of universal recommendations that would be effective at the level of world regions), choosing large economic systems (regions of the world) as the research objects implies a drawback—national specifics could reduce the effectiveness of the offered recommendations on managing the green economy's sustainability in certain countries. To overcome this shortcoming, it is recommended to perform—in future works—more detailed national studies on the example of separate countries and offer specific recommendations for them.

It should be also noted that financial risk management of the green economy based on (private) green investments does not allow us to fully overcome the disproportions in the green economy's sustainability in regions of the world. Though the authors' recom-

mendations allow moving below the lower limit of 30%, even in this case the variation of the green economy's sustainability among regions of the world is still noticeable and discernible. Perhaps, the prospects for its further reduction lie in the sphere of green innovations and/or government financing of the green economy, which should be studied in future scientific works.

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