



# GREEN FINANCING AS A CONDITION FOR SUSTAINABLE ECONOMIC GROWTH

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Article History: Received on 27<sup>th</sup> July 2020, Revised on 26<sup>th</sup> August 2020, Published on 1<sup>st</sup> September 2020

## Abstract

**Purpose of the study:** The purpose of the study is to assess the current state of green financing in the Russian Federation and the extent of its impact on economic growth in the country.

**Methodology:** The main research methods utilized were the regression and cluster analysis and principal component analysis (PCA). Cluster analysis implies dividing the set of studied objects and features into groups or clusters that are homogeneous in some way. We used it to determine regional differentiation of subjects from the Russian Federation according to the level of green financing. The clustering of subjects was performed using the ward method. This method is aimed at combining closely located clusters. Regression analysis was used to build an econometric model for assessing the degree of influence of green Finance on economic growth.

**Main Findings:** The authors proved that stimulating green financing in Russia requires the following: creating a regulatory framework and roadmap for the development of green financing, active state participation in financing green projects, creating a “green bond market,” and a specialized banking institution.

**Application of the study:** In this article, the authors assessed the impact of green financing on Russia’s economic growth. As part of the study, the authors analyzed the dynamics of green financing in the Russian Federation from 2000–2018, developed an integrated indicator for sustainable economic growth based on three components of sustainable development (economic, social, and environmental), and estimated the impact of environmental investments on the integral indicator of sustainable economic growth.

**Novelty/Originality of the study:** The proposed methodology for calculating the integrated indicator of sustainable economic development allowed us to assess sustainable development, taking into account economic, social, and environmental indicators. Such an approach has several advantages over the current methods: it is universal, indicators are available, and calculations are clear.

**Keywords:** *Green Economy, Green Financing, Environmental Investments, Green Investments, Economic Growth, Sustainable Development.*

## INTRODUCTION

Anthropogenic impact on the environment before the Period of the Great Industrial Revolution, as a rule, was not accompanied by the destruction of natural complexes and did not have a systemic nature, which explains the postulate of the inexhaustibility of natural resources by representatives of classical political economy. D. Ricardo argued that “nothing is paid to include natural agents because they are inexhaustible and accessible to everyone” (Ruffin, 2002). J.-B. Say held a similar position: “Natural riches are inexhaustible because otherwise, we would not receive them for nothing. Since they cannot be increased or exhausted, they are not an object of economic science” (Eberling, 2017). Similar principles are reflected in the Marxist political economy: “The forces of nature are worthless; they enter the process of labor without entering the process of value creation” (Marx, 1887). In the era of industrialization in society, ideas arose about the need to preserve natural complexes for scientific research, recreation, and conservation of biological diversity, and the need for environmental responsibility was justified: “They are only owners, users of the Earth, and, like good fathers of the family, should leave it improved for future generations” (Ekelund & Tollison, 1976). At the end of the nineteenth century, Arrhenius (1896) formulated the theory of the “greenhouse effect”, which did not deserve due attention until the middle of the twentieth century, until the negative consequences associated with it became apparent. At the end of the twentieth century, the world community concluded that within the framework of the existing model of economic development, it is not possible to resolve the contradictions of the accelerated growth of negative environmental changes and economic growth, therefore, the concept of sustainable economic development was formulated.

In recent decades, the world community has been actively discussing a model of economic growth based, on the one hand, on its foundations (technological progress and the modernization of production, human capital, infrastructure, and macroeconomic stability), and, on the other, on stimulating growth with a “green” component. The rapid scientific and technological development of the world economy and the anthropogenic impact on the environment has led to the depletion of natural capital, degradation of ecosystems, decreased regenerative capacity of the biosphere, and aggravation of environmental problems (climate change, reduction of biodiversity, lack of freshwater, and deforestation).

[Pestel \(1989\)](#), a supporter of the concept of “restrictive growth,” notes that soon, the scale of human activity will increase 15–20 times and the world will face an environmental disaster in 2100.

At present, humanity is consuming natural capital (and leaving its ecological footprint) at a rate exceeding 50% of the biosphere's production capacity, as well as its ability to supply biological resources and services that are useful to humans. According to the calculations of the Global Footprint Network Analytical Center, the bio-capacity of our planet is 1.7 hectares per person. Russia is in the top ten countries with the largest bio-capacity reserves at 7.9% of the total. At the same time, it has the largest ecological footprint: 4.0% ([Boev, 2017](#)). More and more countries, such as the OECD countries of Japan and South Korea, are naming the green growth concept as a part of the national strategy. Russia also joined this trend and adopted the Strategy of Ecological Safety of the Russian Federation for the Period up to 2025, which confirms a focus on green economic growth. This document defines the main challenges and threats to environmental safety, goals, objectives, and mechanisms for implementing state policy in the field of environmental safety. Besides, in 2019, an expert platform in the field of sustainable development and green Finance, the Center of Competencies and Green Expertise, was created in Russia. Also, since 2019, the national project “Ecology” has been implemented, as a result of which effective management of production and consumption waste should be ensured; a significant reduction in the degree of air pollution in large industrial cities.

However, ensuring sustainable economic growth on the “green” basis remains a distant goal for both Russia. In particular, the Russian Federation took 116th place among 141 countries of the world in the ranking of countries by the Global Green Economy Index in 2018. A green economy usually means an economy that enhances the wellbeing of the population ensures social justice and reduces environmental risks ([Bierman et al., 2017](#)). The most significant characteristic features of the green economy include: reducing the negative impact of greenhouse gases on the environment (low carbon footprint), introducing environmentally friendly manufacturing procedures and methods for utilizing industrial waste, rational use of natural resources, and development of renewable energy in the context of growing energy consumption. The transition to a new model of the economy on a “green” basis has led to the fact that one of the most discussed issues in this area has been the creation of an effective system of green financing ([Balynskaya et al., 2017](#)). The scientific studies received close attention to the development of green financing instruments (climate bonds, green loans, green investments, etc.), as well as the development of indicators reflecting the impact of the state of the environment and natural resources on economic development ([Aglietta et al., 2015](#); [Chien, 2020](#)).

### Research gap and objective of the study

At the same time, issues related to the formation of a panel of indicators of sustainable economic growth, the assessments of the impact of green Finance on economic development, and the search for effective tools for green Finance for sustainable development remain debatable and need to be resolved. This article analyzes the level of development of green finance in the Russian Federation and the extent of its impact on economic growth in the country from the perspective of ensuring sustainable development.

### LITERATURE REVIEW

An interest in sustainable development within the context of global climate and environmental change has led to the emergence of a new paradigm in the scientific community: the green economy. This issue is studied from a wide range of approaches, so let us consider those, which explore the integration of economic growth and the environment. As early as the 1970s, [Nordhaus \(1977\)](#) investigated the factors of economic growth and claimed that the global climate and environment directly affect continual economic development. Throughout the 60s and 70s, the issues related to climate change and negative anthropogenic impacts on the environment were developed by supporters of the school of environmental economics, such as H. Daley, D. M. Alier, P. Hay, and R. Constanta, who considered the economy as an integral part of the ecosystem. Environmental economists believed that limiting economic growth would help solve environmental problems.

The idea of an environmentally-oriented economy was developing rapidly and in 1987, the International Commission on Environment and Development published the report, *Our Common Future*, which identified the priority of harmonious coexistence of society and the environment, and claimed that environmental safety should be seen as an integral part of sustainable development ([Brundtland, 1987](#)). In 1992, a UN conference was held in Rio de Janeiro and sustainable development was defined as development balanced in economic, social, and environmental aspects. It became clear that humanity's global problems could not be solved within the existing economic model, and it was necessary to create a new economy. From that moment, ecology was taken into account when developing and implementing both national and international economic policies ([Fedorenko et al., 2016](#)). [Lafferty \(1996\)](#) identifies four basic principles of sustainable development: conservation of natural resources; meeting the basic demand of the current generation; equal approach to meeting the needs of all people; preservation of opportunities for future generations to fulfill basic needs. During the UN World Summit on Sustainable Development (RIO + 10) in 2002, the parties adopted an action plan to protect the environment. The UN Conference on Sustainable Development (RIO + 20) in 2012 focused on the transition to a sustainable development model based on the green economy. Well known German politician and publicist, [Fücks \(2013\)](#), believes that humanity, “has already reached the stage when the costs of growth that consumes natural resources exceed the effect of the wealth growth ... we need a real green revolution.”

The definition of “green economy” was first introduced in 1989 by researchers of the London Environmental Economics Centre (LEEC) in the report, “Fundamentals of the Green Economy” (Pearce et al., 1989). In modern economic literature, the green economy is seen as one of the key vectors of sustainable development (Selishcheva, 2018) and is interpreted as an economy that improves the welfare of the population, ensures social justice, and reduces environmental risk (Bierman et al., 2017; Arnell et al., 2019). According to the provisions of the document, “Towards Green Growth, developed by the Organization for Economic Co-operation and Development (Organisation for Economic Co-operation and Development, 2011), the concept of “green growth” implies accelerating economic development while maintaining or increasing the sustainability of the natural resources underlying societal welfare. The more distinctive features of the green economy are: a) low carbon and hydrocarbon emissions; b) preventing the degradation of ecological services and biodiversity; c) preservation and growth of natural capital; d) saving resources and energy efficiency; and e) increasing income and employment (Demirel et al., 2019; D’Orazio & Popoyan, 2019; Fatoki, 2019; Abid et al., 2019; Semin et al., 2019).

Currently, various methods and indicators are used to assess sustainable development. For instance, the OECD calculates the decoupling coefficient, which reflects the relationship between economic growth and resource consumption or environmental pollution (Pan et al., 2019; Chien, 2020). In 1996, the UN Commission on Sustainable Development proposed the Sustainable Development Goals Index (SDG), which takes into account a significant number of indicators (over 240). Supporters of the School of Environmental Economics have proposed the Index of Sustainable Economic Welfare (ISEW) and the General Progress Indicator (GPI) as key indicators of sustainable development (Maiti & Awasthi, 2020). However, Gil and Sleszynski (2003) noted that in recent decades, welfare inequality has been much higher than before, which reduces the value of ISEW. Since 2016, the Moscow Exchange and the Russian Union of Industrialists and Entrepreneurs, based on the analysis of non-financial reports of the largest Russian companies on activities to create conditions for sustainable development, are calculating two main sustainable development indices - “Responsibility and openness” and “Vector of sustainable development”. The first index captures indicators (70 economic, environmental, and social indicators). The second index reflects the dynamics of 10 key indicators, shows how the activities of sustainable development companies have improved or worsened compared to previous periods. Of particular interest is the Global Green Economy Index (GGEI), calculated by the American consulting company Dual Citizen LLC. GGEI has been calculated since 2010 and aims to show how sustainable and balanced, in the long run, is the economic development of various countries of the world (Glazyrina & Zabelina, 2018). Some economists (Luukkanen et al., 2019; Halisçelik & Soytaş, 2019) calculate an integrated indicator of sustainable development; one that combines a set of monetary and non-monetary indicators. This synergistic approach, based on the assessment of the economic, social, and environmental components of sustainable development, was used in this study. Calculating an integrated indicator of sustainable economic growth has some advantages over the existing methods: universality, availability of indicators, and clarity of calculations.

Sustainable or green economic growth cannot occur without an effective green financing mechanism (Criscuolo & Menon, 2015; Porfiriev, 2016; Dvoretzkaya, 2017; Banga, 2019; Raberto et al., 2019; Zimmerman et al., 2019; Avis, 2019; Kissinger et al., 2019). However, the reports by G20 experts or economic research papers present no universally accepted definition of the term “green financing” (Green Finance Study Group, 2017; Al-Sheryan & Nobanee, 2020). This term refers to a solution to environmental problems and resource management (Wang, 2013; Cadman, 2014). Some institutions use the term “sustainable financial system” as an alternative to green Finance (Malhotra & Thakur, 2020). Currently, researchers most often use the term “green finance,” which means the funds allocated to finance environmental projects (Khudyakova, 2018; Zhang et al., 2019; Karpova & Obuvalov, 2020; Borkova, 2020; Sahin, 2020). Green Finance underlies the concept of green (low-carbon) economic growth because it links financial institutions, environmental action, and economic growth (Soundarrajan & Vivek, 2016; Yatim et al., 2017; Cui et al., 2018; Lavrinenko et al., 2019; Kabir, 2019). According to Bogacheva and Smorodinov (2017), green Finance includes financial services intended for economic activities that are aimed at improving the environment, mitigating the effects of global climate change, and using resources more efficiently. Soundarrajan and Vivek (2016) define green Finance as an investment or loan that takes into account the risks of anthropogenic impact on the environment. They are critical to the transition to a lowcarbon economy and adapt to the effects of climate change (Falcone & Sica, 2019). Green Finance includes various aspects of the financial sector and products (Bazhenov, 2018). They can be combined into three categories: a) infrastructure financing; b) financial assistance for industries and companies (Miroshnichenko & Mostovaya, 2020); and c) financial markets (Rubtsov et al., 2018). In this study, unlike existing interpretations, green financing refers to investments in technology and infrastructure aimed at reducing carbon emissions and environmental pollution, as well as increasing the resource and energy efficiency of the national economy.

## MATERIALS AND METHODS

The main research methods used were economic and statistical methods, such as principal component analysis (PCA) and cluster and regression analysis. PCA was used to build an integrated indicator of sustainable economic growth. The algorithm for calculating the integrated indicator of sustainable economic growth consists of the following steps:

- Creating a panel of indicators that characterize the sustainability of economic growth:

- a) Economic indicators: GDP at current prices in billions of rubles; inflation rate percentage; surplus (+) / deficit (-) of the consolidated budget of the Russian Federation in billions of rubles; industrial production index as a percentage of the previous year.
- b) Social indicators: population, million people; natural population migration coefficient; population with cash income below the subsistence level, million people; unemployment rate, %; average per capita cash income of the population (per month), rubles.
- c) Environmental indicators: water withdrawal from natural water bodies for use and discharge of polluted wastewater in billion m<sup>3</sup>; pollutant emissions into the air from stationary and mobile sources in millions of tons, production and consumption waste in millions of tons.

- Building a matrix of values from pair correlation coefficients:  $r(x(j)(k), x(q)(k))$ , ( $j, q=1,2,\dots,m_k$ ) and characterizing the degree of closeness in the statistical relationship of pairs between the indicators of the analyzed set:  $x_i(j)(k)$ .
- Calculating determination coefficients:  $R^2(y, (x(1), \dots, x(s)))$  of each of the partial criteria from an analyzed a priori set for all other indicators of this set.
- Limiting the range of possible values of partial criteria to the segment  $[0; 1]$  with a specific choice of a unifying transformation:

a) 
$$\tilde{x} = \frac{x_i - x_{\min}}{x_{\max} - x_{\min}};$$

b) 
$$\tilde{x} = \frac{x_{\max} - x_i}{x_{\max} - x_{\min}};$$

c) 
$$\tilde{x} = \frac{|x_i - x_{onm}|}{\max\{x_{\max} - x_{onm}, (x_{onm} - x_{\min})\}}.$$

- Estimating the average values of partial criteria:

$$\bar{x}_i^j = \frac{1}{n} \sum_{i=1}^n \tilde{x}_{it}^{(j)}$$

- Calculating the elements of the correlation matrix based on the central values of partial indicators:

$$r_{jk}(t) = \frac{\sum_{i=1}^p (\tilde{x}_{it}^{(j)} - \bar{x}_t^{(j)})(\tilde{x}_{it}^{(k)} - \bar{x}_t^{(k)})}{\sqrt{\sum_{i=1}^p (\tilde{x}_{it}^{(j)} - \bar{x}_t^{(j)})^2 \sum_{i=1}^p (\tilde{x}_{it}^{(k)} - \bar{x}_t^{(k)})^2}}$$

- Determining the largest eigenvalue of the matrix:

$$|R(t) - \lambda I| = 0$$

- Estimating the components of the eigenvector that corresponds to the largest eigenvalue:

$$(R(t) - \lambda_1(t)I) \begin{pmatrix} c_1 \\ c_2 \\ \dots \\ c_p \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ \dots \\ 0 \end{pmatrix}$$

- Determining the values of the first main component characterizing the  $i$ -th year:

$$y_i(t) = \sum_{j=1}^p c_j (\tilde{x}_{it}^{(j)} - \bar{x}_t^{(j)})$$

- Defining an integrated indicator of sustainable economic growth for a time step  $t$  in the  $N$ -point scale:

$$\tilde{y}_i = \frac{y_i - y_{\min}}{y_{\max} - y_{\min}} \cdot N$$

It is proposed that the obtained values are interpreted taking into account the following conditions:

- From 0 to 3 points—a destructive type of economic growth;
- From 3.1 to 6 points—an unstable type of economic growth;
- From 6.1 to 8 points—a dynamic type of economic growth;
- From 8.1 to 10 points—a steady type of economic growth.

Cluster analysis implies dividing the set of studied objects and features into groups or clusters that are homogeneous in some way. We used it to determine regional differentiation of subjects from the Russian Federation according to the level of green financing. To study the relationship between the level of green financing and the pace of economic development in Russia, we constructed a regression model that showed the influence of the indicators of “investment in fixed assets aimed at protecting the environment and the rational use of natural resources” and “current expenditures on environmental protection” on the integrated indicator of sustainable economic growth.

## RESULTS AND DISCUSSION

Green financing is one of the most important priorities for the development of the Russian economy. Unfortunately, Russia’s current level of green investments is insufficient for green development and accounts for only 0.9% of the total volume of investments in fixed assets (Table 1). From 2000 to 2018, the share of green investments of the total in fixed assets fell by one half. At the same time, there was an increase of more than 450% in current costs of organizations associated with the protection of the environment. The territorial distribution of green financing in Russia is uneven. In this study, we performed a cluster analysis of the Russian regions. Five clusters were identified according to the level of green investments. Having grouped the regions according to the level of current expenditures on environmental protection, we obtained three aggregate clusters (Table 2).

**Table 1:** The dynamics of green financing in the Russian Federation from 2000 to 2018

Year	Green Investments, million rubles	The Share of Green Investments in the Total Investment, %	Current Environmental Protection Costs, million rubles
2000	22338.6	1.92	76235.6
2001	27710.0	1.84	76832.0
2002	25270.1	1.43	89365.0
2003	35407.0	1.62	110705.0
2004	41167.6	1.44	126560.0
2005	58738.0	1.63	142655.0
2006	68188.0	1.44	133330.0
2007	76884.0	1.14	148157.0
2008	102388.0	1.16	183905.0
2009	81914.0	1.03	183655.0
2010	89093.9	0.97	193463.0
2011	95662.0	0.86	222599.0
2012	116543.0	0.92	239170.0
2013	123807.0	0.92	254377.0
2014	158636.0	1.14	269839.0
2015	151788.0	1.09	290890.0
2016	139677.1	0.95	306534.0
2017	154042.3	0.96	320947.0
2018	157651.0	0.89	345464.1

**Table 2:** The results of the Russian regions clustering

Cluster No.	Regions
<b>According to the Level of Green Investments</b>	
1	Moscow, St. Petersburg, Tyumen Oblast, Yamalo-Nenets Autonomous Okrug, and Krasnoyarsk Krai.
2	Komi Republic, Volgograd Oblast, Republic of Bashkortostan, Republic of Tatarstan, Perm Krai, and Sverdlovsk Oblast.
3	Leningrad Oblast, Irkutsk Oblast, Omsk Oblast, and Republic of Sakha (Yakutia)
4	Belgorod Oblast, Lipetsk Oblast, Arkhangelsk Oblast, Vologda Oblast, Murmansk Oblast, Orenburg Oblast, Samara Oblast, Chelyabinsk Oblast, Kemerovo Oblast, Tomsk Oblast, Primorsky Krai, Khabarovsk Krai, and Sakhalin Oblast.
5	Pskov Oblast, Novgorod Oblast, Tver Oblast, Moscow Oblast, Vladimir Oblast, Ivanovo Oblast,

Ryazan Oblast, Smolensk Oblast, Voronezh Oblast, Kaluga Oblast, Kaliningrad Oblast, Oryol Oblast, Kursk Oblast, Tambov Oblast, Tula Oblast, Kostroma Oblast, Yaroslavl Oblast, Kirov Oblast, Nizhny Novgorod Oblast, Penza Oblast, Saratov Oblast, Ulyanovsk Oblast, Novosibirsk Oblast, Magadan Oblast, Kurgan Oblast, Amur Oblast, Jewish Autonomous Oblast, Astrakhan Oblast, Rostov Oblast,

Republic of Kalmykia, Republic of Karelia, Republic of Khakassia, Chechen Republic, Udmurt Republic, Karachay-Cherkess Republic, Republic of Mordovia, Republic of Tuva, Republic of Adygea, Republic of Buryatia, Republic of Dagestan, Republic of North Ossetia-Alania, Chuvash Republic Altai Republic, Kabardino-Balkar Republic, Republic of Mari El, Chukotka Autonomous Okrug, Altai Krai, Zabaykalsky Krai, Stavropol Krai, Krasnodar Krai, and Kamchatka Krai,

*According to the level of current expenditures on environmental protection*

1	Murmansk Oblast, Tyumen Oblast, and Krasnoyarsk Krai.
2	Belgorod Oblast, Moscow Oblast, Moscow, Leningrad Oblast, Krasnodar Krai, Volgograd Oblast, Republic of Bashkortostan, Republic of Tatarstan, Perm Krai, Nizhny Novgorod Oblast, Orenburg Oblast, Samara Oblast, Sverdlovsk Oblast, Yamalo-Nenets Autonomous Okrug, Chelyabinsk Oblast, Irkutsk Oblast, Kemerovo Oblast, and Republic of Sakha (Yakutia).
3	St. Petersburg, Lipetsk Oblast, Kaluga Oblast, Tomsk Oblast, Rostov Oblast, Yaroslavl Oblast, Bryansk Oblast, Novgorod Oblast, Ryazan Oblast, Tula Oblast, Vladimir Oblast, Oryol Oblast, Smolensk Oblast, Ivanovo Oblast, Kirov Oblast, Tambov Oblast, Arkhangelsk Oblast, Omsk Oblast, Tver Oblast, Novosibirsk Oblast, Voronezh Oblast, Ulyanovsk Oblast, Saratov Oblast, Amur Oblast, Kostroma Oblast, Kursk Oblast, Kurgan Oblast, Vologda Oblast, Magadan Oblast, Sakhalin Oblast, Kaliningrad Oblast, Pskov Oblast, Penza Oblast, Astrakhan Oblast, Chuvash Republic, Republic of North Ossetia-Alania, Republic of Adygea, Republic of Buryatia, Kabardino-Balkar Republic, Chechen Republic, Republic of Ingushetia, Komi Republic, Udmurt Republic, Republic of Kalmykia, Republic of Khakassia, Republic of Karelia, Karachay-Cherkess Republic, Republic of Mordovia, Republic of Dagestan, Republic of Mari El, Tuva Republic, Altai Republic, Khabarovsk Zabaykalsky Krai, Zabaykalsky Krai, Primorsk Krai, Altai Krai, Kamchatka Krai, Stavropol Krai, Chukotka Autonomous Okrug, and Jewish Autonomous Okrug.

The following regions comprise the first cluster and had the highest green investments: Moscow, St. Petersburg, Krasnoyarsk Krai, Tyumen Oblast, and Yamalo-Nenets Autonomous Okrug, whereas Murmansk Oblast, Krasnoyarsk Krai, and Tyumen Oblast had the largest environmental costs. Most Russian regions have low green financing. Moreover, there is a significant gap between the leading regions and those lagging. The “leaders” account for about 25% of the total volume of investments aimed at protecting the environment and rational use of natural resources, while the dozens of outsiders account for only 1%.

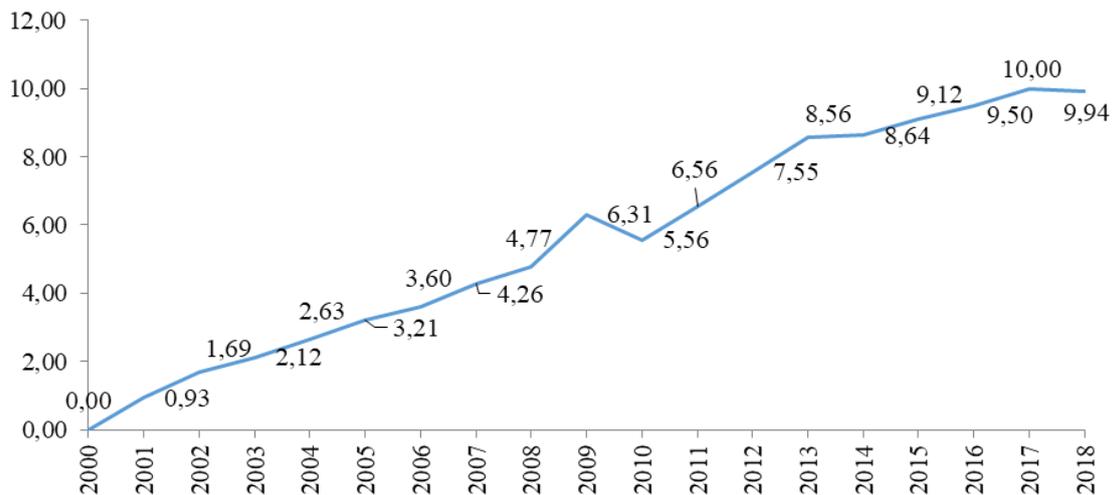
In this study, the emphasis was placed on the development of an integrated indicator of sustainable economic growth by applying the principal component analysis. This allowed us to reveal a significant (over 50%) relative total contribution of the first main component to the total variance of the initial features: 62.19%. The eigenvalue of the first main component (16.78>1) also confirmed this, which indicated one main component could be used for a reliable interpretation. The results of the analysis show that the values of factor loads for most features exceed |0.5| when all were combined into one main component F1 (Table 3). Therefore, this component could be called an integrated indicator of sustainable economic growth. The final step in the component analysis was to obtain the matrix of values for the main component F1 regarding all observed objects and to build a point rating.

**Table 3:** Factor load matrix

Factor Features	Factor Loads for the Main Component F1
X1	-0.975874
X2	-0.988770
X3	-0.716296
X4	-0.010010
X5	0.957736
X6	0.305965
X7	0.933474
X8	-0.806697
X9	-0.873711
X10	0.991926
X11	0.980167
X12	-0.799566
X13	-0.372346

X14	-0.493886
Eigenvalue	16.78

Before proceeding to the construction of a point rating itself, one should unify the values of the main component. To apply such a transformation would limit the range of its possible values to the interval [0; 10]. In this case, the zero value of the transformed indicator should correspond to the lowest quality for this property, and 10 should correspond to the highest. To do this we used the linear scaling method, which helps trace the dynamics of real growth or decline in parameters. Thus, having performed a comparative analysis of the integrated indicators of sustainable economic growth from 2000 to 2018, we identified the following types of development periods: destructive (2000 - 2004); unsustainable (2005 - 2008, 2010); dynamic (2009, 2011 - 2012); and stable (2013 - 2018) (Figure 1).



**Figure 1:** Integrated indicator of sustainable economic growth in Russia from 2000 to 2018 (authors' calculations), points

To assess the impact of green financing on the integrated indicator of economic growth for the country, we built a regression model based on the empirical data of the Period from 2000 to 2018. An integrated indicator of sustainable economic growth (Y) was taken as an effective indicator. The following indicators were chosen as independent variables: X1 is the green investment in millions of rubles; X2 is the current expenditure on environmental protection in millions of rubles. The factors included in the model had to be linearly independent, and simultaneously have a particular influence on the effective indicator. To check these assumptions we estimated pair correlation coefficients between factors, as well as between a factor and an effective indicator (Table 4).

**Table 4:** Matrix of pair correlation coefficients

Indicator	X1	X2	Y
X1	1.00	0.453	0.677
X2		1.00	0.892
Y			1.00

Table 4 shows the relationship closeness of factors with an effective indicator, as well as with one another. This is strongest between the level of the integral indicator of Russia's sustainable economic growth (Y) and the current costs of environmental protection: (X2) –  $r_{yx2}=0,892$ ;

The resulting regression equation has the following form:

$$Y = -28744.6 + 0.29x_1 + 0.69x_2$$

The reliability and accuracy of the model were confirmed by the coefficient of determination (R<sup>2</sup>), which showed that 98.7% of the resulting feature's (Y) variation was due to the influence of factors (X) included in the model.

Coefficients of the multiple regression equation showed the absolute impact of factors on the effective indicator and characterized the influence of each factor on the analyzed indicator at a fixed (average) level of other factors included in the model. In our case, a million rubles of green investments will increase to 0.29 billion rubles in the integrated indicator of sustainable economic growth in Russia. An increase in current environmental protection costs of 1 million rubles will lead to sustainable economic growth in Russia by 0.69 billion rubles.

The analysis we conducted allowed us to conclude that the mechanisms of green financing in Russia are at the initial stage of development. The territorial distribution of environmental investments in Russia's regions is uneven. There is a significant gap regarding green financing between the leading regions and those lagging: the leaders account for about

25% of total investments aimed at protecting the environment and the rational use of natural resources, while the others only cover 1 %. At the same time, there is a strong correlation between the amount of green financing and the sustainability of economic growth. As rightly [Sedash et al. \(2019\)](#) note, Russia's transition to a green economy “requires substantial current and future investments with a high probability of additional investments during the life cycle of projects”. The wide involvement of all business entities in the process of financing them is necessary to make green investments sustainable and consistent with sustainable development goals and national priorities. Moreover, it is important that not only the state participates in financing green investments and projects, but also private companies. Attracting private capital to finance climate action is one of the pressing challenges. It is recognized worldwide that without long-term investments by large institutional investors it is impossible to implement a wide range of measures to mitigate environmental risks. The state should create favorable conditions for attracting private investors to the green economy ([Owen et al., 2018](#)); growth in the share of green companies using green technologies; increasing the responsibility of business and society for the conservation of nature; the formation of the green finance market.

Today, the formation of an effective mechanism of green financing is considered by experts as “one of the fundamental changes within the existing global financial system” ([Bazhenov, 2018](#); [Porfiriev, 2016](#)), aimed at ensuring sustainable balanced economic growth in conjunction with the solution of social and environmental problems. The mobilization of funds necessary to finance sustainable green economic growth is impossible without the creation of new international standards in the field of green (responsible) investment. In the medium term, economic growth in Russia will be significantly affected by how efficiently the management of natural resources is carried out and measures taken in the field of climate change and environmental protection. Decarbonization and greening the economy will help Russia ensure more sustainable growth, create new economic opportunities.

## CONCLUSION

Green economic growth is a global trend in the development of socio-economic systems. The mechanism of green financing is a prerequisite for sustainable economic growth in the green economy as it allows mobilizing necessary financial resources for the environmentalization and decarbonization of Russia's economy. The study found that “green” financing in Russia is at an early stage of development. There is a significant differentiation of subjects of the Russian Federation on the level of “green” financing. The proposed methodology for calculating the integrated indicator of sustainable economic development allowed us to assess sustainable development, taking into account economic, social, and environmental indicators. Such an approach has several advantages over the current methods: it is universal, indicators are available, and calculations are clear. The study confirmed the hypothesis that a green financing system is a crucial condition for ensuring sustainable and balanced economic growth. The regression equation shows a high correlation between the level of green Finance and economic growth ( $R^2=98.7$ ). To stimulate it in Russia, the following are necessary: (a) development of a regulatory framework for green financing; (b) creation of a road map aimed at the development of green financing; (c) active participation of the state in financing green projects, which can be carried out both directly (budgetary allocations, state guarantees, state lending, subsidizing part of the investors' costs related to loans received for the implementation of environmental projects) and indirectly (providing tax incentives to companies that implement projects with environmental objectives, as well as benefits and preferences to companies that issue green bonds); (d) creation of a green bond market; and (e) creation of a specialized banking institution, the main purpose of which will be lending to projects related to energy efficiency, waste management, development or installation of renewable energy sources, environmentally friendly transport, water purification, landscaping, and land restoration.

## LIMITATIONS AND STUDY FORWARD

The limitations of this study are that the dynamics of green financing are analyzed according to empirical data of the Russian Federation for 2000–2018. The research methodology is based on concepts that recognize green financing as a condition for ensuring sustainable economic growth. The study was conducted using relevant methods: regression and cluster analysis, the method of principal components. The integrated indicator of sustainable economic growth developed by the authors is based on three components of sustainable development (economic, social, and environmental), and the methodology for calculating it has several advantages over existing methods, namely: 1) universality - the indicator can be applied at the state and regional level with minor adjustments; 2) the general availability of indicators - all used statistics are published in open sources; 3) ease of calculation of the indicator. These advantages, in our opinion, are additional arguments in favor of the proposed approach to calculating the integrated indicator of sustainable economic growth.

The approach proposed in the study, in our opinion, can be used in assessing the sustainable development of any region, taking into account economic, social, and environmental indicators. The results of the study can be used to prepare analytical reports in the field of assessing the volume of the green finance market in Russia, creating the legal framework for its formation and development.

## CO-AUTHORS CONTRIBUTION

Nadezhda Semenova was the main leader of the study, who organized the research and distributed roles and tasks, formulated a scientific hypothesis about “green” financing as a condition for sustainable economic growth, and formed a panel of indicators of indicators that characterize the sustainability of economic growth. Olga Eremina conducted the

research and gathered the facts. Olga Eremina collected analytical data and analyzed the existing literature on the research topic. Marina Skvortsova conducted a cluster and built a regression model that showed the influence of the indicators of “investment in fixed assets aimed at protecting the environment and the rational use of natural resources” and “current expenditures on environmental protection” on the integrated indicator of sustainable economic growth in the Russian Federation.

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