

CROSS-COUNTRY ANALYSIS OF PROGRESS IN THE TRANSITION TO A GREEN ECONOMY: THE CASE OF THE GGEI INDEX

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Abstract: In the context of the global environmental crisis and the growing need to transition to a sustainable development model, assessing the degree of readiness and progress of countries in the field of green economy is of paramount importance. This article presents an empirical study based on data from the Global Green Economy Index (GGEI), aimed at identifying the statistical characteristics of the index and analyzing the relationships between it and other key variables reflecting the sustainability and environmental performance of countries. Using JASP software, descriptive and correlation analysis was conducted, which made it possible to determine both general trends and specific relationships between variables. The results of the study emphasize the importance of integral indicators in assessing the environmental focus of development and can be used for further modeling and development of strategic decisions in the field of green economy.

Key words: green economy, sustainable development, GGEI, environmental policy, correlation analysis, JASP, environmental indicators, global index, statistical analysis.

INTRODUCTION

In the context of worsening global environmental problems such as climate change, environmental degradation, loss of biodiversity and unsustainable resource consumption, sustainable development issues are acquiring particular importance at both the national and international levels. Modern economic models, focused exclusively on the growth of gross domestic product, are increasingly being criticized for ignoring the environmental consequences of their activities. In this regard, there is an objective need to move to a new development paradigm based on the principles of a “green economy” - a model focused on reducing the carbon footprint, rational use of natural resources and maintaining the ecological balance.

To assess the degree of achievement of countries in this direction, special indicators and ratings are developed. One of the most well-known and internationally recognized tools is **Global Green Economy Index (GGEI)** — an index that allows for a comprehensive assessment of the efforts of states in forming and promoting the green agenda. It takes into account both objective indicators (for example, the level of emissions, the share of renewable energy sources, etc.) and the perception of the expert community regarding the sustainability of a country's policy.

This study aims to quantify the statistical properties of the GGEI and to identify the relationships between the index and a range of other economic and environmental indicators available in the database. Particular attention is paid to the analysis of the degree of dispersion of the index values between countries, the structure of the distribution, and whether there are stable correlations between the level of greenness of the economy and other variables, such as income levels, innovation potential, climate policy, or investments in sustainable infrastructure.

METHODOLOGY

The data analysis was performed using JASP software, a modern tool for statistical and econometric research, featuring an intuitive interface and the ability to visualize results. The use of JASP allows not only to perform basic analytical procedures, but also ensures transparency and clarity of conclusions, which is especially important when interpreting complex international indices such as GGEI.

At the first stage of the study, a **descriptive statistical analysis of the Global Green Economy Index (GGEI)** . The main objective of this stage was to obtain a general idea of the nature of the distribution of index values among the countries represented in the sample. Key indicators of central tendency were calculated - the arithmetic mean, median and mode, which made it possible to assess the extent to which the GGEI values are prone to symmetry or asymmetry, as well as to identify possible biases. In addition, the standard deviation was determined, reflecting the level of data dispersion and the variability of index values from the average value. A range was also calculated demonstrating the difference between the highest and lowest GGEI values among countries, which made it possible to determine the level of dispersion of values on a global scale. To increase the reliability of the interpretation, 95% confidence intervals were additionally calculated, reflecting the statistical stability of the average value and allowing us to judge its significance within the entire sample.

At the second stage, a **correlation analysis was conducted** to identify possible statistically significant linear dependencies between the GGEI index and a number of other economic and environmental variables presented in the original database. The analysis was based on the calculation of the Pearson correlation coefficient, which allows one to establish both the direction (positive or negative relationship) and the strength of the relationship between the variables. This stage of the analysis made it possible to determine whether there are stable patterns between the level of green economy development and such indicators as economic growth, the level of investment in sustainable technologies, the level of carbon dioxide emissions, the development of environmental infrastructure and other relevant factors. The results obtained formed the basis for further interpretation and discussion of the factors that contribute to or, conversely, hinder the environmental transformation of the economies of various countries.

LITERATURE REVIEW

The transition to a green economy is seen as a key element of sustainable development, aimed at reducing environmental impact while maintaining economic growth. However, the implementation of this concept faces a number of challenges, including institutional barriers, lack of public participation and limited financial resources. At the same time, the green economy provides opportunities to create new jobs, stimulate technological innovation and strengthen international cooperation [1].

Various indices have been developed to quantify progress in the transition to a green economy. One of the most well-known is the Global Green Economy Index (GGEI) , which assesses 160 countries on 18 indicators, including climate policy, sectoral decarbonization, ESG investment, and environmental health. The GGEI methodology takes into account both current indicators and progress since 2005, allowing for tracking of change dynamics [2].

Other indices such as Green Growth Index from the Global Green Growth Institute (GGGI) and Green Economy Progress Index from the United Nations Environment Programme (UNEP) offer alternative approaches to measuring green growth. A comparative analysis of these indices revealed both similarities and differences in methodologies and coverage of indicators, which highlights the need for a comprehensive approach to assessing the green economy [3].

Regional aspects of the transition to a green economy

Countries in Eastern Europe, the Caucasus and Central Asia have made significant progress in integrating environmental and climate considerations into development strategies. However, challenges remain in attracting investment and strengthening institutional mechanisms. The Organisation for Economic Co-operation and Development (OECD) has stressed the importance of further action to accelerate the transition to a green economy in the region [4].

Methodological approaches and challenges

Despite the diversity of indices and methodologies, there is a need to unify approaches to measuring the green economy. This will ensure comparability of data and improve the effectiveness of sustainable development policies. In addition, it is important to take into account the characteristics of developing countries, where the transition to a green economy can help solve the problems of poverty and unemployment [5].

ANALYSIS AND RESULTS

In the context of the growing climate crisis and global ecological depletion, the transition to a green economy is becoming not just a desirable direction, but a strategically necessary choice for the entire global community. The current model of economic development, based on the widespread consumption of fossil resources and extensive exploitation of the environment, has already proven its failure in terms of sustainability. Continuing along this path leads to deepening socio-economic inequalities, worsening climate change and increasing instability. Therefore, the formation of an environmentally oriented growth model that maintains a balance between economic development, social justice and environmental protection is becoming a priority task.

The green economy aims to achieve sustainable growth while reducing environmental risks and resource scarcity. One of the key advantages of this approach is the ability to stimulate innovation, expand the market for green technologies and increase the competitiveness of countries in the long term [6]. The introduction of energy-efficient production, the development of renewable energy, the transition to a cyclical economy and sustainable agriculture create conditions for economic diversification, reducing dependence on fossil fuels and increasing national energy security [7].

However, the transition to a green economy involves not only technological and infrastructural changes, but also deep institutional and social transformations. It requires taking into account the interests of all segments of the population, especially vulnerable groups, in order to ensure social justice. The concept of a just transition implies providing equal access to new opportunities, ensuring decent working conditions, retraining systems, and the participation of local communities in key decision-making [8]. This approach not only helps reduce social tensions, but also strengthens trust in reforms, ensuring their sustainability.

An important element of successful transformation is innovative development and support for scientific and technological progress. Investments in R&D, digitalization and the development of green start-ups are becoming an important driver of change. It is technological innovation that allows us to overcome resource constraints, minimize emissions and adapt to climate change [9]. The creation of a favorable institutional environment that stimulates sustainable entrepreneurship and "green" investments is considered an important area of public policy.

Countries around the world have consistently begun to implement management systems oriented towards the principles of a green economy. This process, although it varies in pace and scale depending on the level of economic development, climate conditions and political will, has acquired the character of a global trend. The transition to a green economy is becoming an integral part of national sustainable development strategies, and international cooperation and exchange of experience in this area are becoming increasingly important. Many countries have adopted strategic documents that include goals for decarbonizing the economy, developing renewable energy sources, sustainable use of natural resources, modernizing production and greening transport infrastructure [10].

Every year, the number of studies aimed at assessing the progress and effectiveness of the transition to a green growth model increases. Numerous analytical reports are developed by both national institutions and international organizations. For example, the United Nations Environment Programme (UNEP) regularly publishes reports on global and regional trends in the field of green economy, including the Global Environment Outlook » and « Green Economy Progress Report » [11]. The World Bank, in turn, analyzes the links between environmental sustainability and economic growth,

offering countries recommendations on environmental economic reform [12]. The Organization for Economic Cooperation and Development (OECD) also publishes extensive reviews, such as « Green Growth Indicators », which provides comparative assessments of the effectiveness of environmental policies in different countries [13].

Along with these initiatives, indices and ratings are of particular importance, allowing for a comparable analysis of countries' achievements in the green economy. Among them, one of the most authoritative is **Global Green Economy Index (GGEI)**, which is being developed by the international consulting organization Dual Citizen LLC. GGEI is a comprehensive assessment that includes many parameters reflecting both real achievements in “greening” the economy and the perception of these efforts by the global community. The index covers four key dimensions: leadership in climate and environmental issues, the clean technology sector, resource and natural capital efficiency, and overall sustainable development policy. Thanks to this approach, GGEI allows not only to compare countries with each other, but also to identify structural strengths and weaknesses in the “green” policies they implement [14]. The use of GGEI in academic and applied research helps to increase the objectivity of assessing progress in sustainable development. It becomes a reliable tool in the hands of researchers, politicians and investors, allowing them to judge the systemic nature of environmental transformations, formulate public policy priorities and assess reputational risks. In this study, statistical analysis will be carried out on the basis of GGEI data, aimed at identifying key patterns and relationships in the global transition to a green economy.

Global Report Green Economy Index (GGEI) is one of the most comprehensive and authoritative studies dedicated to measuring the degree of transition of countries to a green economy. The latest version of the report, prepared by the consulting company **Dual Citizen LLC** includes an analysis of 160 countries, making it one of the most comprehensive international comparative instruments in the field of sustainable development and environmental policy [14].

The main objective of the report is to assess the effectiveness and progress of countries in building a green economy, as well as to identify the differences between actual results and the perception of countries' efforts by the global community. The index is based on two key components: " performance " (actual achievements) and " perception ". This allows not only to quantitatively measure success in specific areas, but also to understand how much the reputational strategies of countries coincide with their actual results.

The GGEI methodology includes four main assessment categories:

1. **Leadership on climate change and environmental issues** - reflects the country's political activity in the international environmental agenda, the presence of strategies to reduce greenhouse gas emissions and adapt to climate change.
2. **Clean technology sector** - covers such aspects as the level of investment in renewable energy, the development of green innovations, and the degree of diversification of the energy balance.
3. **Efficiency of natural resource use and natural capital management** - takes into account the sustainability of the agricultural sector, pollution levels, water and land management.
4. **General sustainable development policy** – includes green finance regulation, green taxation, institutional reforms and the promotion of sustainable development goals.

Each category contains specific quantitative indicators collected from open international sources such as the World Bank, the International Energy Agency (IEA), the United Nations Environment Programme (UNEP), as well as expert assessments and global surveys.

The analysis covers both developed and developing countries, allowing us to trace patterns and features of the green transition in different regions of the world. The report pays special attention to countries that demonstrate a sharp discrepancy between perception and performance — that is, those

with a strong reputation in the field of sustainable development, but lagging behind in actual indicators, or vice versa.

Descriptive Statistics

Global Green Economy Index. (GGEI)	
Valid	160
Missing	8
Mode	0.469 ^a
Median	0.503
Mean	0.504
95% CI Mean Upper	0.549
95% CI Mean Lower	0.458
Std. Deviation	0.289
95% CI Std. Dev. Upper	0.325
95% CI Std. Dev. Lower	0.261
95% CI Variance Upper	0.106
95% CI Variance Lower	0.068
Range	0.994
Minimum	0.006
Maximum	1.000

^a The mode is computed assuming that variables are discreet.

Fig. 1. Analysis of descriptive statistics for the Global index Green Economy Index (GGEI) [3]

Analysis of descriptive statistics for the Global indicator Green Economy The Green Economy Index (GGEI) , calculated for 160 countries, provides valuable insights into the current status and global trends of green economy development.

The average value of the index is 0.504 , which indicates a medium level of engagement of countries in sustainable development processes and the implementation of green economy principles. This value indicates that, globally, countries generally demonstrate moderate results in the area of green growth, although with significant differences between countries.

median value is 0.503 , which is almost the same as the mean. This indicates that the data distribution is close to symmetrical , meaning that extremely high or low index values do not significantly affect the overall picture. The mode , equal to 0.469 , is slightly below the median and mean, which may indicate a slight shift in the distribution to the left , although the overall distribution shape remains close to normal. The standard deviation of 0.289 indicates a high degree of variability in the index scores between countries. Such a spread indicates significant inequality in the level of introduction and implementation of green policies. Some countries demonstrate consistently high results due to investments in renewable energy sources, development of environmentally friendly technologies and environmental responsibility policies. At the same time, other countries show extremely low values , which may be due to limited economic resources, lack of an environmental agenda or dependence on “dirty” sectors of the economy, such as hydrocarbon production. The minimum GGEI value of 0.006 indicates the presence of countries in which the principles of the green economy are practically not implemented. This may be due to socio-economic instability, lack of institutional mechanisms or the priority of short-term economic benefits over long-term sustainability. The maximum index value of 1.000 , on the other hand, reflects the ideal level of development, where all key components of a green

economy – from energy transition to sustainable land management – are integrated into policies and economic activities at all levels. The presence of such contrasting values confirms that the world faces significant heterogeneity in the area of green development.

The calculated 95% confidence interval of the mean value — from 0.458 to 0.549 — indicates high statistical reliability of the obtained average estimate. This means that with a random sample of a similar size from the same set of countries, it is highly likely that the average value of the index will remain within these limits. Thus, the confidence interval not only confirms the validity of the average value, but also helps to clarify the boundaries of its probable variability. The set of statistical characteristics demonstrates that global progress towards a green economy is accompanied by pronounced regional and structural differences . Despite the existence of international agreements and policy initiatives, such as the Paris Agreement and the Sustainable Development Goals (SDGs), countries are at different stages of transition to a sustainable development model. The GGEI analysis emphasizes that successful implementation of a green economy requires not only technological and financial resources, but also political will, institutional maturity, international cooperation and the participation of civil society .

Correlation

Pearson's Correlations

Variable		Global Green Economy Index. (GGEI)	V3	V4
1. Global Green Economy Index. (GGEI)	Pearson's r	—		
	p-value	—		
	Lower 95% CI	—		
	Upper 95% CI	—		
	Effect size (Fisher's z)	—		
	SE Effect size	—		
2. V3	Pearson's r	-0.143	—	
	p-value	0.071	—	
	Lower 95% CI	-0.292	—	
	Upper 95% CI	0.012	—	
	Effect size (Fisher's z)	-0.144	—	
	SE Effect size	0.080	—	
3. V4	Pearson's r	0.189	0.945	—
	p-value	0.017	< .001	—
	Lower 95% CI	0.034	0.925	—
	Upper 95% CI	0.334	0.959	—
	Effect size (Fisher's z)	0.191	1.782	—
	SE Effect size	0.080	0.080	—

The conducted correlation analysis provided an opportunity to more deeply explore the relationship between the Green Economy Index (Global Green Economy Index (GGEI) and two important parameters presented in the report database: “Distance Score (in percentiles)” and “Summary Indicator (in percentiles)” . The objective of this stage of the study was to establish the strength and direction of the linear relationships between the GGEI and the accompanying indicators that could potentially influence the positioning of countries within the green development framework.

The results of the analysis showed that there is a weak negative correlation between the GGEI index and the variable "Distance Result (in percentiles) ", the Pearson coefficient was $r = -0.143$. However, despite the presence of a relationship, its statistical significance was insufficient (p -value = 0.071), which allows us to conclude that there is no reliable linear relationship between these two variables. Such a weak and statistically insignificant correlation indicates that the distance calculated using a certain methodology within the assessment may not directly reflect the qualitative characteristics of

the green economy, but is an auxiliary technical indicator that does not have a decisive effect on the final index.

On the other hand, the variable "Composite indicator (in percentiles)" demonstrated a statistically significant positive relationship with the GGEI index. The correlation coefficient was $r = 0.189$, while the p-value was 0.017, which indicates the presence of a reliable, albeit weak, positive correlation. This suggests that countries with higher values of the composite indicator tend to demonstrate higher scores on the GGEI. Thus, the composite indicator can be considered as a potentially significant factor reflecting the systemic contribution of various components to the sustainable development of a country, as well as its orientation towards green principles.

Also noteworthy is the extremely high level of correlation between the two variables, "Distance Score (in percentiles)" and "Summary Indicator (in percentiles)". The correlation coefficient between them was $r = 0.945$, with $p < 0.001$, indicating an almost complete linear relationship between these indicators. Such a close relationship indicates a potential multicollinearity effect, in which two predictors in the model are excessively interrelated, making it difficult to interpret their individual contributions when constructing regression models. In the context of subsequent modeling, this circumstance requires special attention: it may be necessary to exclude one of these indicators or apply methods to combat multicollinearity (e.g., principal components or regularization).

Thus, the obtained results not only reveal specific statistical relationships between the GGEI index and related variables, but also form the basis for the subsequent construction of models for the quantitative assessment of sustainable development factors. The established correlation dependencies allow us to state that the "Consolidated indicator (in percentiles)" is of the greatest interest for further analysis and can be used as one of the key indicators in assessing the country's progress towards a green economy.

CONCLUSION

In the context of growing environmental challenges and the global community's desire for sustainable development, the transition to a green economy is becoming not only a pressing issue, but also an integral element of strategic planning at the state level. The study, based on data from **Global Green Economy The Green Economy Index (GGEI)** has provided an in-depth analysis of countries' position in terms of environmental sustainability and has identified quantitative relationships between the Green Economy Index and key parameters that reflect performance and cumulative achievements in this area.

The analysis of descriptive statistics showed a diversity of GGEI values among countries, reflecting differences in approaches to the implementation of environmental policies, the level of development of institutional mechanisms, innovation potential and the depth of integration of sustainability principles into economic strategies. This emphasizes the need for a comprehensive and tailored approach to assessing green development, taking into account both quantitative and qualitative aspects.

The correlation analysis demonstrated that the variable "**Summary indicator (in percentiles)**" has a positive and statistically significant relationship with the GGEI index, which indicates that the integral indicators that aggregate various sustainability dimensions do reflect the contribution of countries to the development of the green economy. At the same time, the variable "**Distance result (in percentiles)**" did not show a reliable relationship with the index, which may indicate its auxiliary, rather than explanatory nature.

Particular attention should be paid to the extremely high correlation between these two variables, which creates risks of multicollinearity when constructing further econometric models. This requires careful selection of variables and the use of advanced analytical methods aimed at correctly interpreting the contribution of each factor.

Thus, the results of this study not only highlight the importance of quantitatively assessing progress towards a green economy, but also point to the need for a comprehensive, structured approach to environmental policymaking. The findings may be useful for both scientists working on sustainable development issues and practitioners developing strategic documents and making decisions at the state level.

In the future, further research could be aimed at expanding the sample of countries, including new variables reflecting climatic, social and institutional aspects, and using more complex analytical models (e.g. regression and cluster), which would allow for more accurate prediction and interpretation of the dynamics of green development on a global scale.

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