ESG Performance and Disclosure: National Composite Indicators for Monitoring Sustainable Growth Conditions in the EU-27

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Abstract **– Sustainable growth is a major global concern due to environmental challenges, social and corporate governance matters. Identifying and analyzing key indicators can provide valuable insights into the critical factors affecting sustainability in the EU-27 countries. This paper analyzes environmental, social and governance national composite indicators for monitoring sustainable growth conditions in the EU-27. The authors develop a simplified algorithm based on the ESG index methodology and composite indicators theory. The three pillars of the ESG methodology are examined with a focus on the ten most valuable indicators in each pillar. A sub-objective is to verify what percentage of the results are consistent with the original approach. The data were collected for the EU-27 countries for 2020–2021. The study's main outcome is a simplified approach to measuring sustainability that is 81% consistent with previous calculations. In line with previous studies, Norway, Sweden, and Finland rank highest on the ESG index, while Cyprus, Bulgaria, Lithuania, and Greece rank the lowest.**

Keywords **– composite indicators, DSG, ESG, non-financial reporting, sustainable development.**

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1. Introduction

ESG (environmental, social, and governance), a composite country indicator, evaluates and ranks countries based on their sustainability performance in various ESG categories. These indicators account for various data points, such as a country's emissions, labour rights, corruption levels, and other ESG-related factors. There is a strong correlation between the amount of ESG information disclosed and the quality of a firm's disclosure [1].

The European Union (EU) is committed to promoting sustainable, resource-efficient innovation to support competitiveness. Such innovation is critical to the competitiveness of the European regions, and it drives transformation. The EU has seen a growth in prosperity in recent years, and its focus is now on sustainable development and economic recovery, considering all dimensions of sustainability: environment, governance, and economics. After the 2009 financial crisis, the EU transformed its economy to create an innovative, transparent, sustainable, and more inclusive economy that delivers high employment, competitiveness, productivity, and deep social cohesion. This objective was set in a rapidly changing global economy where the EU faced new economic, social, and environmental challenges [2].

After the COVID-19 pandemic crisis in 2019 and 2020, many countries and international organizations shifted to addressing the pandemic's immediate health and economic impacts while also considering the long-term implications of the crisis. Following the European Parliament general elections in June 2019, the European Council has outlined the European Union's political priorities for the next five-year period by publishing the "New Strategic Agenda 2019–2024". This document provides a comprehensive framework setting out the European Union's priorities and objectives for the forthcoming years, focusing on creating a more united, secure, and prosperous Europe.

The New Strategic Agenda sets out five priority areas: i) safeguarding citizens' well-being and freedoms; ii) constructing a green, climate-neutral, equitable, and socially inclusive Europe; and iii) promoting European values and upholding its core principles internationally [3].

The New Strategic Agenda's focus on sustainable and inclusive economic growth aligns with the Paris Agreement on climate change, adopted in 2018. This drive for a green transition depends on the solid mobilization of private and public investment and an efficient circular economy. Some authors discussed how ESG factors can influence businesses' valuation and financial performance [4]. The discussions revolve around the assessment of the non-financial performance of firms and the utilization of ESG criteria to evaluate their overall effectiveness [5].

In 2023, European countries are facing challenging energy market dynamics. After a positive first half of 2022, real GDP growth is forecast to be only 0.5% in 2023 due to the global European economic slowdown. Rising inflation, driven by increasing energy, food, and commodity prices, can significantly impact the economy. In 2023, there has been a noticeable increase in inflation, reflected by a significant increase of 7.0% in the European Union and 6.1% in the euro area. This fact can decrease consumer and business purchasing power, reducing economic growth and stability. Various sectors of the economy can be negatively affected, including consumer spending, investment, and trade [6].

Over the past few years, there has been an increasingly prevalent pattern among companies to be publicly committed to adopting environmental, social, and governance (ESG) strategies. By addressing ESG issues and demonstrating their commitment to ESG principles, companies can improve their reputation, build trust with customers and investors, and reduce risk profiles. The 2022 energy crisis is a severe test of this concept. The strategic objectives of the ESG must be carefully balanced with the financial objectives. The specifics of the regulation of non-financial reporting can vary from country to country. Still, it typically covers various topics, including corporate environmental performance, labour standards, human rights, and active involvement in community engagement. As a result, many countries have adopted regulations requiring companies to disclose ESG information in non-financial reports. The overall scoping review of European sustainability has been conducted by studies [7] and [8].

This paper examines ESG composite indicators of countries within the EU-27 and aims to simplify the methodology employed to calculate their performance.

The paper is arranged as follows: Section 1 serves as an introduction. Section 2 offers a comprehensive literature review and summarizes this research to date on the topic under study. Section 3 details the approach employed in the study, including research data, methods, and data analysis techniques. Section 4 outlines the data set employed in the empirical analysis. Section 5 presents the findings and results of the paper. Finally, Section 6 presents the concluding remarks and overall conclusions drawn from the paper.

2. Literature Review

As a model that differs from the traditional economy, the green economy is a path to sustainable development. The EU's vision is based on a resource-efficient green economy, as outlined in the European Environment Agency Report [9]. This document states that EU cooperation in the green economy intersects with the EU's goals for the planet, people, and prosperity objectives. Government intervention at national, multilateral, regional, and sub-national levels is necessary to accelerate this process and address market failures.

The World Economic Forum introduced the Environmental Sustainability Index (ESI) in 2001 as a metric to assess the environmental sustainability of 122 countries. The subsequent versions were released in 2002, 2005, 2008, and 2012. The ESI measures the overall progress of nations toward environmental sustainability. It comprehensively assessed a country's environmental performance and was used to help policymakers make informed decisions about environmental policies and strategies. The ESI score consists of 22 sub-indicators, each combining two to six variables, for a total of 67. This document recognizes competitive performance as the combination of various factors and policies which drive a country's level of economic performance". It formulates "12-pillars" for measuring competitiveness through the Global Competitiveness Index (GCI). It aims to provide EU Member States with a targeted baseline to coordinate their ambitions for a more sustainable Europe [10]. In 2022, the index was transformed into the Environmental Performance Index (EPI). This calculation employs forty performance indicators covering 11 categories. These indicators aim to evaluate 180 countries based on their performance in defined areas [11].

Secondly, the Sustainable Development Goals (SDGs) and their associated targets were adopted in 2015. The SDG Index score, presented in the Sustainable Development Report, was established to measure progress toward achieving the SDGs [12], [13].

The index score provides a comprehensive picture of a country's progress and is a valuable tool for policymakers, governments, and other stakeholders to understand their progress. (Sustainable Development Report, 2021). In 2019, there were six primary transformation goals mainly focused on: i) health and well-being; ii) education and skills; iii) sustainable land use; iv) energy and industry; v) digital technologies; and vi) sustainable cities. In 2021, the survey covered 165 countries worldwide, many OECD countries, and all of the G20 countries [14], [15].

This article presents ESG profiles of EU countries based on composite sustainable development indicators. For simplicity, the paper assumes that only the ten most fundamental indicators are included in each pillar. The framework for measuring each country's sustainable development currently covers the whole group of 27 EU countries. We have included thirty indicators aggregated into three main dimensions: i) environmental; ii) social; and iii) governance, which was indicated based on available data in three defined datasets [15], [16], [17], [18]. To this end, a set of indicators was constructed, a complex mathematical problem.

The environmental pillar has ten environmental indicators ($e_1 - e_{10}$) which can be found in Table 1.

Table 1. Environmental Pillar

Symbol	Variables	Measure
$\mathbf{e_1}$	Poverty rate (based on threshold of $3.20 per day)	(%)
$\mathbf{e_2}$	Percentage of population experiencing undernourishment	(%)
$\mathbf{e_3}$	Prevalence of stunted growth in children under the age of 5	(%)
$\mathbf{e_4}$	Obesity prevalence (with a body mass index (BMI) of 30 or higher)	(% of adult population)
$\mathbf{e_5}$	Neonatal mortality rate	(per 1,000 live births)
$\mathbf{e_6}$	The age-standardized death rate in adults aged 30–70 years	(%)
$\mathbf{e_7}$	Life expectancy at birth in years	(years)
$\mathbf{e_8}$	Measuring access to essential health services	(index)
$\mathbf{e_9}$	Access to basic drinking water services	(% of population)
$\mathbf{e_{10}}$	Access to basic sanitation services	(% of population)

Source: Author's analysis based on [15], [16], [17], [18].

Secondly, we defined a social pillar ($s_1 - s_{10}$) by ten social indicators, shown in Table 2.

Table 2. Social Pillar

Symbol	Variables	Measure
$\mathbf{e_1}$	CO_2 emissions per unit of electricity generated from fuel combustion	($MtCO_2$/TWh)
$\mathbf{e_2}$	Renewable energy share in primary energy supply	(%)
$\mathbf{e_3}$	Amount of solid waste generated by municipalities	(kg/capita/day)
$\mathbf{e_4}$	Amount of electronic waste generated	(kg/capita)
$\mathbf{e_5}$	SO_2 emissions generated by production activities	(kg/capita)
$\mathbf{e_6}$	Nitrogen emissions generated by production activities	(kg/capita)
$\mathbf{e_7}$	Nitrogen emissions embodied in imported goods	(kg/capita)
$\mathbf{e_8}$	CO_2 emissions generated from fossil fuel combustion and cement production	(tCO2/capita)
$\mathbf{e_9}$	Quantity of municipal solid waste that is not recycled	(kg/capita/day)
$\mathbf{e_{10}}$	Permanent loss of forest cover due to deforestation	(% of forest area, 3-year average)

Source: Author's analysis based on [15], [16], [17], [18].

Thirdly, ten indicators ($g_1 - g_{10}$) are defined for the governmental pillar presented in Table 3.

Table 3. Governmental pillar – indicators

Symbol	Variables	Measure
$\mathbf{g_1}$	The ratio of mean years of education received by females to males	(%)
$\mathbf{g_2}$	The ratio of labour force participation rate of females to males	(%)
$\mathbf{g_3}$	Effectiveness of guarantee for fundamental labour rights	(index)
$\mathbf{g_4}$	The internet penetration rate	(%)
$\mathbf{g_5}$	Number of mobile broadband subscriptions	(per 100 population)
$\mathbf{g_6}$	Logistics Performance Index	(index)
$\mathbf{g_7}$	Number of academic journal articles published	(per 1,000 population)
$\mathbf{g_8}$	Amount of expenditure on research and development	(% of GDP)
$\mathbf{g_9}$	The index measuring freedom of the press	(index)
$\mathbf{g_{10}}$	The index measuring freedom of the press	(% of GDP)

Source: Author's analysis, based on [15], [16], [17], [18].

The following hypotheses (H1 - H2) were formulated:

H1: Based on investigated ESG index methodology, a simplified algorithm can be developed based on the composite indicators theory that provides an approximate estimate of a country's sustainability rating. The simplified algorithm would aim to determine which quadrants (Q1 to Q4) each country falls into.

H2: The simplified national ESG algorithm results are the same in 80% or more cases, providing a quick and efficient way to assess a country's sustainability that would also capture the main features of the ESG index methodology.

In line with hypotheses H1–H2, the following research question was established: Is it possible and more effective to measure the conditions for sustainable development in countries, as expressed by the ESG country composite indicator, more simply?

3. Materials and Methods

A composite indicator is a statistical tool combining multiple indicators or variables into a single index or score, providing a more comprehensive and integrated picture of a particular phenomenon or issue [18]. Composite indicators are widely used in various fields, including economics, finance, health, education, and environmental sustainability. They can help address complex problems where capturing the full impact of different variables is difficult with a single measure. Indicators are used in cases where trends need to be analyzed. According to [19], there are three levels of the indicator: i) Individual indicators; ii) Thematic indicators; and iii) Composite indicators. Composite indicators are increasingly used to compare a country's performance in specific domains such as sustainability, economic productivity, and technological advancement.

Composite indicators can be developed using various methods, including principal component analysis, factor analysis, or weighted averaging. The choice of method will depend on the specific aims and objectives of the composite indicator, as well as the available data and characteristics of the combined indicators. In other words, the composite indicator is a combination of multiple variables. In this case, the composite indicator was constructed based on 40 variables. A composite indicator requires sub-indicator standardization to make them comparable and aggregable and to accommodate different units and content. The standardization process converts sub-indicators into dimensionless, easily interpretable quantities that range from 0 to 100 %. .

These standardized values are then combined into a composite indicator. For each sub-indicator, it is necessary to distinguish whether it is positive, increasing, or decreasing. Values standardized in this way are already aggregable, well-interpretable, and dimensionless.

It is essential to have comparable data from all countries analyzed. Variables must be standardized or normalized before aggregation into composite indicators. On the other hand, a lot of other indicators of sustainable performance have not been available. Specific indicators were chosen as internationally comparable figures were available for all EU-27 countries.

The relationship for the calculation of the standardized sub-indicator (*j*) in the year (*i*) in case,

i) the growth is positive, and

$$A_{ij} = \frac{a_{ij} - a_{dj}}{a_{hj} - a_{dj}} \tag{1}$$

ii) the growth is negative.

$$A_{ij} = 1 - \frac{a_{ij} - a_{dj}}{a_{hj} - a_{dj}} \tag{2}$$

Where A_{ij} is the standardized sub-indicator of the pillar in a given year ($_i$), a_{ij} is the non-standardized sub-indicator of the pillar, a_{dj} is the lower threshold for the sub-indicator, and a_{hj} is the upper threshold for the sub-indicator. ($_i$) is a time index indicating the year. The number of years is *n*. An index is a natural number $i \in \langle 1, n \rangle$. ($_j$) is a pointer index that indicates the sub-pointer's order in the pillar. The number of sub-indicators in the pillar is *m*. The index is a natural num r $j \in \langle 1, m \rangle$.

The next step is to use the geometric mean of all standardized sub-indicators for a given year and ensure that the value of the composite indicator in that year, whenever it is at the upper or lower critical point, is zero.

$$A_i = \sqrt[m]{\prod_{j=1}^{m} A_{ji}} \tag{3}$$

The share of standardized sub-indicator ($_j$) in the composite indicator ($_i$) is calculated according to the following formula:

$$p(A_{ij}) = \frac{\ln(1 - A_{ij})}{\sum_{j=1}^{m} \ln(1 - A_{ij})} \tag{4}$$

The contribution of the standardized sub-indicator (j) in the given pillar (*E*, *S*, *G*, *N*) to the composite indicator of the pillar in the given year ($_i$) is given by the following formula:

$$r(A_{ij}) = A_{ij} \,.\, p(A_{ij}) \tag{5}$$

The calculation of the overall composite indicator involves the simple geometric mean of the composite indicators of the individual pillars. *E* is specified as the environmental, *S* as the social, and *G* as the governance pillar.

$$K = \sqrt[4]{E.S.G}. \tag{6}$$

The logarithmic expression (6) can be used to calculate the shares of the influence of individual pillars on the overall composite indicator.

$$p(E) = \frac{ln(1-E)}{ln(1-E)+ln(1-S)+ln(1-G)} \tag{7}$$

Expressions for other pillars are analogous. Contributions are calculated analogously as in the same manner as the relationship described earlier (5). It follows the definition that the sum of the shares of the influences of the individual pillars is 1 (i.e., 100%). The sum of the contributions is equal to the value of the composite indicator.

4. Dataset Description

This research utilizes annual data sourced from the World Development Indicators, a dataset, maintained by the World Bank, that contains 68 ESG indicators for 239 countries worldwide. Secondly, we used the 2022 Sustainable Development Report, a dataset that offers 94 global indicators for 163 countries worldwide and 26 additional indicators, specifically for OECD countries. Finally, we used the Eurostat dataset. The data collected was from the EU-27 countries for 2020–2021. To ensure optimal comparability of data, we use data from official sources to ensure the highest level of data comparability.

The criteria for selecting the indicators used in the report were based on several factors: i) the required indicators had to be in line with the specific SDG issues; ii) the selected indicators had to be relevant; iii) the selected indicators had to be valid; iv) the selected indicators had to be up-to-date and published and had to be available throughout the 2020–2021 period.

In the second step, the dataset was carefully reviewed, and any incomplete annual data indicators were removed. We aimed to calculate a country's ESG composite indicators based on 30 indicators measuring environmental, social, and governance strategies. The factors were weighted across the three ESG dimensions as follows: 33% to environmental (10 indicators), 33% to social (10 indicators), and 33% to governance (10 indicators) (see Tables 4, 5, and 6).

Table 4. Environmental dimension indicators

Symbol	Min	Max	Average
$\mathbf{e_1}$	14.2	96.2	50.4
$\mathbf{e_2}$	0.1	85.3	10.5
$\mathbf{e_3}$	38.0	81.5	47.2
$\mathbf{e_4}$	3.0	79.9	22.5
$\mathbf{e_5}$	10.1	98.7	68.2
$\mathbf{e_6}$	43.5	100.0	61.6
$\mathbf{e_7}$	33.3	96.1	55.7
$\mathbf{e_8}$	4.9	85.2	39.7
$\mathbf{e_9}$	58.5	98.3	59.1
$\mathbf{e_{10}}$	63.2	100.0	70.8

Source: Author's analysis

Table 5. Social dimension indicators

Symbol	Min	Max	Average
$\mathbf{s_1}$	71.9	100.0	70.3
$\mathbf{s_2}$	66.0	94.1	66.7
$\mathbf{s_3}$	72.1	100.0	68.5
$\mathbf{s_4}$	19.2	89.6	27.8
$\mathbf{s_5}$	10.1	100.0	64.7
$\mathbf{s_6}$	8.9	100.0	39.9
$\mathbf{s_7}$	55.8	100.0	55.2
$\mathbf{s_8}$	14.2	84.7	36.4
$\mathbf{s_9}$	61.7	100.0	70.8
$\mathbf{s_{10}}$	63.2	100.0	68.8

Source: Author's analysis

Table 6. Governance dimension indicators

Symbol	Min	Max	Average
$\mathbf{g_1}$	54.1	98.5	53.4
$\mathbf{g_2}$	3.9	94.8	34.2
$\mathbf{g_3}$	36.6	99.3	48.3
$\mathbf{g_4}$	48.0	87.1	51.5
$\mathbf{g_5}$	0.1	53.6	12.1
$\mathbf{g_6}$	-0.3	45.7	0.2
$\mathbf{g_7}$	0.1	64.8	0.5
$\mathbf{g_8}$	-13.1	75.0	0.8
$\mathbf{g_9}$	0.2	9.5	1.1
$\mathbf{g_{10}}$	54.1	98.5	53.4

Source: Author's analysis

Our research covers 27 EU countries for the years 2020–2021. To analyze the research question, we created composite indicators and tested two hypotheses.

5. Results and Discussion

This paper aims to analyze ESG national composite indicators for monitoring sustainable growth conditions in EU-27 and simplify their calculation method. Based on the literature review, the main theoretical framework was set in three ESG pillars. These indicators are designed to measure sustainable growth's environmental, social, and governance dimensions and are therefore collectively known as environmental, social, and governance (ESG) indicators.

Based on the literature review, a composite index was selected as a statistical tool combining multiple indicators or variables into one index or score. This approach provides a more comprehensive picture of a phenomenon or problem.

A National Composite Indicator for Monitoring Sustainable Growth Conditions was conducted for each country. All countries were then compared with the results of the 2022 Sustainable Development Report. As evidence of the validation of H1, the positions of each EU-27 country in selected quadrants were examined.

First, we wanted to verify **H1:** Based on the methodology of the ESG indices, a simplified algorithm can be developed that provides an approximate estimate of a country's sustainability rating. For the calculated composite indicators, the minimum and maximum were taken. The resulting range was divided by 4 to produce the following SDG and ESG indicators thresholds. This simplified algorithm aimed to determine which quadrants (Q1 to Q4) each country falls into for both methodologies, see Table 7.

Table 7. Position of the EU-27 countries in Q1–Q4

Q1 – Q4	SDG (in %)	ESG (i %)
Q1	83.4 - 86.5	29.7 – 33.7
Q2	80.4 - 83.4	25.7 – 29.7
Q3	77.3 - 80.4	21.7 – 25.7
Q4	74.2 - 77.3	17.7 – 21.7

Source: Author's analysis

Second, we would like to verify **H2:** The simplified national ESG algorithm results are the same in 80% or more of the cases. It provides a quick and efficient way to assess a country's sustainability that would also capture the main features of the ESG index methodology.

The question was: how many countries would change their ranking? It was verified that the result was identical in 81% of the cases. Based on the composite indicators, the same ranking was achieved for 22 positions (see Table 8).

Table 8. Position of the EU-27 countries in Q1–Q4

EU-27	SDG		ESG	
	symbol	%	symbol	%
Cyprus	**CYP**	74.2	**BGR**	17.7
Bulgaria	**BGR**	74.3	**LTU**	20.5
Lithuania	**LTU**	74.5	**ROU**	20.6
Luxembourg	**LUX**	75.7	**GRC**	21.4
Greece	**GRC**	76.8	**CYP**	21.6
Malta	**MLT**	76.8	**SVK**	21.9
Romania	**ROU**	77.7	**HRV**	22.0
Italy	**ITA**	78.3	**MLT**	22.9
Slovakia	**SVK**	78.7	**ITA**	23.0
Croatia	**HRV**	78.8	**LVA**	23.2
Hungary	**HUN**	79.0	**LUX**	23.4
Portugal	**PRT**	79.2	**SVN**	23.5
Belgium	**BEL**	79.7	**NLD**	24.2
Netherlands	**NLD**	79.9	**HUN**	24.7
Spain	**ESP**	79.9	**BEL**	24.8
Slovenia	**SVN**	80.0	**CZE**	25.7
Latvia	**LVA**	80.3	**EST**	26.0
Czechia	**CZE**	80.5	**POL**	26.4
Poland	**POL**	80.5	**AUT**	27.1
Estonia	**EST**	80.6	**ESP**	27.6
Ireland	**IRL**	80.7	**PRT**	27.9
France	**FRA**	81.2	**DEU**	27.9
Germany	**DEU**	82.2	**FRA**	29.1
Austria	**AUT**	82.3	**IRL**	29.5
Sweden	**SWE**	85.2	**FIN**	31.6
Denmark	**DNK**	85.6	**SWE**	32.4
Finland	**FIN**	86.5	**DNK**	33.7
Percentage of compliance (DSG x ESG)	81		**Number of states with the same position**	**22**

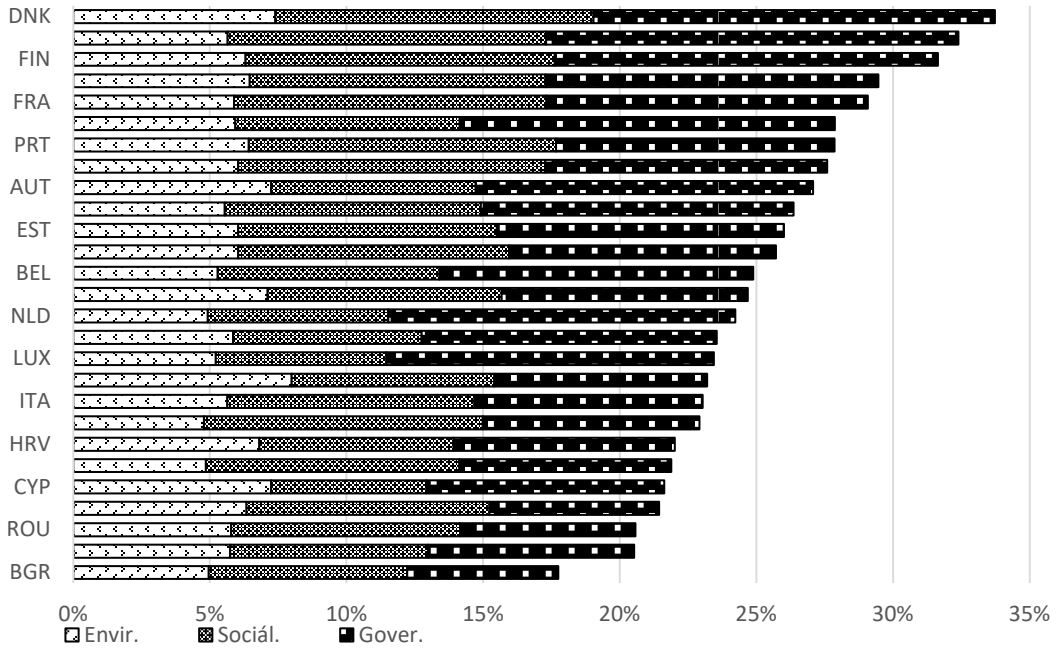
Source: Author's analysis

Based on the results, it is possible to measure the conditions for sustainable development in countries more simply, as expressed by the ESG country composite indicator.

Northern European economies (i.e., Finland, Denmark, and Sweden) are at the top of the ranking, while Cyprus, Bulgaria, and Lithuania are at the bottom. The top-ranked countries in the group (Q1) have an ESG score of 31.6% or higher (85.3% or higher based on the SDG methodology). They also achieve robust and balanced sustainability profiles across all three ESG pillars and have consistently good sustainability performance over the 20 years (2020–2021).

At the other end is a group of 5 countries with an ESG score of 21.6% or lower.

These countries are low-income and have problems in several areas, especially Bulgaria, Lithuania, Romania, Slovakia, Greece, and Cyprus.



Graph 1. ESG pillars in overall composite sustainable indicator
Source: Author's analysis

Graph 1 displays the score attribution of each of the selected country's three dimensions (ESG). As can be seen, the ESG National Composite Indicators for monitoring sustainable growth conditions differ from country to country.

6. Conclusion

The primary objective of this paper was to examine ESG national composite indicators, used to monitor sustainable growth conditions in the EU-27 countries and develop a more straightforward calculation method for these indicators. The study found that a composite index combining multiple indicators or variables into one index or score provides a more comprehensive picture of sustainable growth. A simplified algorithm was developed that provides an approximate estimate of a country's sustainability rating, revealing that the results are the same in 81% of cases compared to the ESG index methodology. The study also found that Northern European economies are at the top of the ranking, while low-income countries have problems in several areas. The simplified national ESG algorithm provides a quick and efficient way to assess a country's sustainability that captures the main features of the ESG index methodology. The paper provides a valuable resource for policymakers, investors, and stakeholders interested in monitoring sustainable growth conditions.

To investigate how the defined variables may affect investors, EU-27 composite indicators have been constructed. By analyzing these composite indicators, the paper seeks to highlight the most important factors and provide insights into how these factors can influence the level of sustainability of EU countries.

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