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THE IMPACT OF DIGITALIZATION ON ESG PERFORMANCE: EMPIRICAL EVIDENCE FROM EUROPEAN UNION COUNTRIES

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Rezumat: *Scopul acestui articol este de a examina relația dintre digitalizare – măsurată prin Indicele Economiei și Societății Digitale – și sustenabilitate, surprinsă printr-un indice ESG compozit la nivel macro, în statele membre ale UE. Rezultatele arată un decalaj clar: digitalizarea progresează mai rapid decât sustenabilitatea. Țările nordice sunt constant în frunte în ambele domenii, în timp ce țările estice tind să rămână în urmă. Analizele de regresie arată că digitalizarea exercită o influență pozitivă și semnificativă statistic asupra performanței ESG generale, cu efecte deosebit de puternice asupra dimensiunilor de mediu (E) și sociale (S). În schimb, impactul său asupra guvernanței (G) nu este semnificativ statistic, ceea ce sugerează că digitalizarea singură este insuficientă pentru a îmbunătăți rezultatele guvernanței fără reforme instituționale complementare.*

Cuvinte cheie: *digitalizare, DESI, sustenabilitate, performanța ESG.*

Abstract: *The aim of this paper is to examine the relationship between digitalization—measured by the Digital Economy and Society Index—and sustainability, captured through a macro-level composite ESG index, across EU member states. Results show a clear gap: digitalization is progressing more rapidly than sustainability. Nordic countries consistently lead in both domains, whereas Eastern countries tend to lag behind. Regression analyses indicate that digitalization has a positive and statistically significant impact on overall ESG performance, with particularly strong effects on the environmental (E) and social (S) dimensions. In contrast, its impact on governance (G) is not statistically significant, suggesting that digitalization alone is insufficient to improve governance outcomes without complementary institutional reforms.*

Keywords: *digitalization, DESI, sustainability, ESG performance.*

JEL Classification: O33, Q01 Q56

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1. INTRODUCTION

Over the past decades, digital transformation has become one of the most influential drivers of change in modern economies. Technological progress, the development of artificial intelligence, and advances in communication infrastructures are redefining how economies operate, innovate, and compete in an increasingly interconnected global environment. In parallel, growing concerns over climate change, social inequalities, and responsible governance have led to the emergence of a new framework for evaluating sustainability performance, the ESG (Environmental, Social, Governance) criteria. Thus, digitalization and sustainability have become two defining pillars of modern economic development, both essential for the transition toward a competitive, sustainable, and fair economy. The interaction between digitalization and sustainability represents one of the European Union's most important strategic directions. The EU has placed these two objectives at the core of its long-term policies through the European Green Deal (European Commission-EC, 2019), the Digital Compass 2030 (EC, 2021), and the 2030 Agenda for Sustainable Development (United Nations, 2015). These initiatives outline a shared vision for the future of the European economy, a competitive, resilient, and responsible economic system capable of leveraging technology to support the transition toward sustainability. A perspective supported by recent research shows that sustainability reporting is deeply shaped by national institutional and economic contexts (Avram et al., 2025).

Digitalization of the economy can support environmental sustainability goals by improving energy efficiency, reducing resource consumption (Charfeddine & Umlai, 2023), and lowering emissions (Feroz et al., 2021). At the same time, digital transformation may also generate adverse effects, high energy consumption, digital inequalities, and cybersecurity vulnerabilities, which can reduce its positive contribution to sustainable performance if not properly managed. Digital technologies have significant potential to support sustainability goals, although their deployment also entails challenges related to energy consumption, electronic waste, and increasing emissions (Truong, 2022; Raihan, 2024; Goel et al., 2024; OECD, 2025).

Recent studies consistently confirm the positive link between digital transformation and ESG performance (Singhania, et al., 2025; Zhou & Liu, 2023). Zhang et al. (2023) show that digitalization significantly enhances the ESG performance of manufacturing firms by increasing productivity, innovation capacity, and organizational resilience, leading to more efficient resource use. Liu et al. (2025) demonstrate that digitalization has a significant positive effect on the ESG performance of Chinese listed companies, an effect amplified in regions with advanced digital infrastructures, such as those influenced by the "Broadband China" initiative. The impact is stronger in eastern regions, in private firms, and in less-polluting industries, where the digital environment facilitates sustainable innovation.

Furthermore, Li et al. (2024) find that firms' "absorptive capacity", meaning their ability to integrate and utilize innovations, mediates the relationship between digital transformation and ESG performance, while regional digital development and ownership structure (state-owned vs. private) shape the intensity of this effect. According to Fang et al. (2024), enterprise digitalization significantly enhances overall ESG performance, primarily by improving governance and social dimensions, though no significant effect is observed on environmental scores. The positive impact is especially evident in firms without political connections and in regions with stronger institutional quality.

Vărzaru (2025) examines the relationship between digitalization and progress toward the Sustainable Development Goals (SDGs) in EU member states, using components of the Digital Economy and Society Index (DESI) as explanatory variables. The results confirm a significant positive correlation between digitalization and sustainability, showing that human capital and the integration of digital technologies are key determinants of sustainable development progress. However, the study also reveals a gap between the rapid pace of digitalization and the slower progress toward sustainability objectives. Similarly, research by Herman and Georgescu (2025) shows that the level of digital transformation among European enterprises has a significant

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positive influence on progress toward the SDGs, especially SDG 9 (Industry, Innovation and Infrastructure), but only a moderate effect on overall SDG performance. The lack of significant influence on SDG 8 (Decent Work and Economic Growth) suggests that the economic benefits of digitalization do not automatically translate into broader socio-economic inclusion. More critically, a negative influence on SDG 13 (Climate Action) indicates that, in the absence of targeted policies, high levels of digital activity may intensify environmental pressures. The authors highlight a "digital–green trade-off," noting that digitalization does not automatically improve environmental performance (SDG 13) unless supported by coherent policies integrating the digital and green agendas.

There is a notable research gap regarding macro-level ESG performance, as emphasized by recent studies (Tan et al., 2025; Jiang et al., 2022). A nation's transition toward a low-carbon, green, and circular economy depends heavily on its overall ESG performance, underscoring the need to rethink economic development strategies and reshape production and lifestyle patterns (Long & Feng, 2024; Wang et al., 2023). To build on this gap, the paper examines how digital transformation intersects with sustainability at the national level, highlighting the mechanisms through which digitalization may influence macro ESG outcomes.

In this context, the present research aims to analyze the relationship between the level of digitalization and macro-level ESG performance across EU member states. The study seeks to assess the extent to which digital progress, measured by the DESI (Digital Economy and Society Index), influences the sustainable performance of European economies, evaluated through a composite ESG index. To assess the impact of digitalization on ESG performance, the analysis is structured in two stages. In the first stage, the general relationship between the level of digitalization (DESI) and ESG performance is examined. In the second stage, the ESG index is decomposed into its three main components, environmental (E), social (S), and governance (G), to evaluate how digitalization influences each dimension of sustainability.

2. DEFINING THE RESEARCH PROBLEM

The research focuses on examining the relationship between the level of digitalization and ESG performance across the member states of the European Union. First, this study aims to assess the extent to which digital progress, measured through the Digital Economy and Society Index (DESI), influences the sustainable performance of European economies, evaluated through a composite ESG index. Second, it investigates whether this relationship varies across the three individual ESG dimensions, environmental (E), social (S), and governance (G).

Building on these research objectives and previous findings, the following hypotheses (H) are proposed:

H1*: The level of digitalization, measured through the* DESI*, has a significant and positive impact on overall ESG performance.*

H2*: The level of digitalization, measured through the DESI, has a positive impact on each ESG component, environmental (E), social (S), and governance (G).*

The dataset consists of panel data from 27 EU member states for the period 2017–2022, resulting in a total of 162 observations. To measure the sustainable performance of EU member states, a composite ESG index was developed that reflects the overall sustainability level of each country. Each dimension of ESG is represented by a set of variables (see Table no.1) and the weights assigned to the three components were established to reflect their relative importance. The weighting structure used in the calculation of the composite index is presented in Table no. 1. Data were collected from the World Bank database (2025), while the digitalization indicator was sourced from the European Commission (2025a) and is reflected through an overall DESI score.

Table no. 1 – Variables used for each dimension of ESG and their weights

Environment [40%]	Social [30%]	Governance [30%]
Carbon dioxide (CO2) emissions per capita (t CO2e / capita) [65%]	Labor force participation rate (% of total population ages 15+) [40%]	Control of Corruption: Percentile Rank [40%]
Renewable energy consumption (% of total final energy consumption) [35%]	Life expectancy at birth (years) [30%]	Rule of Law: Percentile Rank [30%]
	Gini index [30%]	Government Effectiveness: Percentile Rank [30%]

Source: Authors' projection based on data provided by World Bank database (2025)

A higher weight was assigned to the Environmental dimension (40%), reflecting the current priorities of the European Union, as outlined in the European Green Deal and the 2030 Agenda for Sustainable Development, which place the green transition and carbon-emission reduction at the core of public policy. The Social and Governance dimensions were given equal weights (see Table no. 1).

For the *Environmental (E) dimension*, two variables were selected: carbon dioxide (CO_2) emissions per capita and the share of renewable energy in total final energy consumption. CO_2 emissions per capita were chosen instead of total emissions, as they allow for meaningful comparisons between countries with different population sizes. This indicator highlights the individual contribution to environmental degradation. The values are expressed in metric tons of CO_2 per person, providing a balanced picture of emission intensity. The share of renewable energy in total energy consumption reflects the degree of transition toward a sustainable energy system and a country's commitment to European climate objectives. A higher value of this indicator suggests reduced dependence on fossil fuels and a clear orientation toward developing a green economy (Presno & Landajo, 2021; EC, 2025b).

The *Social (S) dimension* is represented by three indicators: life expectancy at birth, the labor force participation rate, and the Gini Index. Life expectancy at birth expresses the average number of years a newborn is expected to live under the current health and living conditions of a country. This indicator captures the overall quality of life, the development level of the healthcare system, and the population's access to basic services. Higher values indicate greater social well-being and human development. The labor force participation rate reflects the proportion of the working-age population (aged 15 and over) that is active in the labor market. It is an indicator of economic inclusion and the efficient use of human resources. A higher participation rate signals a more dynamic economy and a lower degree of social exclusion. The Gini Index measures income inequality within a country, with values ranging from 0 (perfect equality) to 100 (maximum inequality). A lower Gini score indicates a more equal distribution of income, contributing to social stability (UN-SDSN, 2022; World Bank, 2025a).

The *Governance (G) dimension* is captured through three indicators proposed by the World Bank within the World Governance Indicators framework. Control of corruption reflects the extent to which public power is perceived to be used for private gain, thereby measuring institutional integrity and the transparency of the decision-making process. The rule of law assesses the degree to which laws are respected, the independence of the judiciary, and the equal application of legal norms, all of which are essential for institutional stability. Government effectiveness captures the quality of public services and the capacity of the administration to formulate and implement coherent and efficient policies. Higher values, closer to 100, indicate stronger governance, more effective institutions, and a more favorable environment for sustainable development (Kaufmann & Kraay, 2024; World Bank, 2025b).

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All indicators were transformed and normalized on a common 0–100 scale to ensure comparability across dimensions. For indicators with a negative impact on sustainability, such as CO_2 emissions and the Gini index, reverse normalization was applied so that lower initial values correspond to higher performance.

The values for each sub-indicator were normalized to the interval [0, 1] using the min–max standardization formula:

$$x' = \frac{x - x_{\min}}{x_{\max} - x_{\min}}$$

$$x' = \frac{x_{\max} - x}{x_{\max} - x_{\min}}$$

where:
x - initial value
$x_{\min}, x_{\max}$ - minimum and maximum values
x' - normalized value

In addition, some missing values were identified in the dataset. The renewable energy share for the year 2022 was unavailable for several EU member states, and gaps were also present in the Gini Index series for Hungary, Germany, and the Netherlands. To preserve the completeness of the panel and avoid removing observations, the missing data points were estimated through linear extrapolation based on simple linear regression. This approach assumes that both the renewable energy share and the Gini Index follow a stable linear trend over the observed period, allowing for consistent prediction of the missing years.

Descriptive statistics for the normalized values of all indicators used to evaluate macro-level ESG performance and its dimmensions are presented in Table no. 2.

Table no. 2 – Descriptive statistics for the ESG-related variables

Variables	Mean	Median	Min	Max	Std. Deviation	Skewness	Kurtosis
Renewable energy consumption	32.18	23.61	0	100	22.86	0.96	0.08
CO2 emissions per capita	74.94	79.76	0	100	18.93	-1.52	3.12
Labor force participation rate	54.77	57.83	0	100	23.24	-0.44	-0.44
Life expectancy at birth	67.91	79.84	0	100	23.81	-0.79	-0.70
Gini index	56.87	57.40	0	100	21.04	-0.11	-0.26
Control of Corruption	58.85	57.41	0	100	28.71	-0.13	-1.29
Rule of Law	61.04	66.05	0	100	27.26	-0.41	-0.94
Government Effectiveness	66.03	67.78	0	100	23.18	-0.75	0.30

Source: Authors' calculations based on World Bank data (2025)

To investigate the impact of digitalization on ESG performance, a simple linear regression model was applied on a panel dataset for 27 EU countries covering the period 2017–2022, using data sourced from the World Bank data (2025) and European Commission (2025a). The composite ESG index represents the dependent variable and the level of digitalization, measured by through the *Digital Economy and Society Index* (DESI), is the independent variable. The model was selected according to the Hausman test, and to ensure the reliability of the estimates, robust standard errors were used to address potential heteroscedasticity and autocorrelation within the panels

The general econometric model is defined as:

$$ESGI_{it} = \alpha + \beta_1 \times DESI_{it} + \epsilon_{it}$$

where: α – constant; $ESGI_{it}$ – composite ESG index; $DESI_{it}$ - digitalization index; β_1 – coefficient of the independent variable; ϵ_{it} – residual.

To further analyze the impact of digitalization on each ESG dimension, separate regression models were estimated for the Environmental (E), Social (S), and *Governance* (G) components:

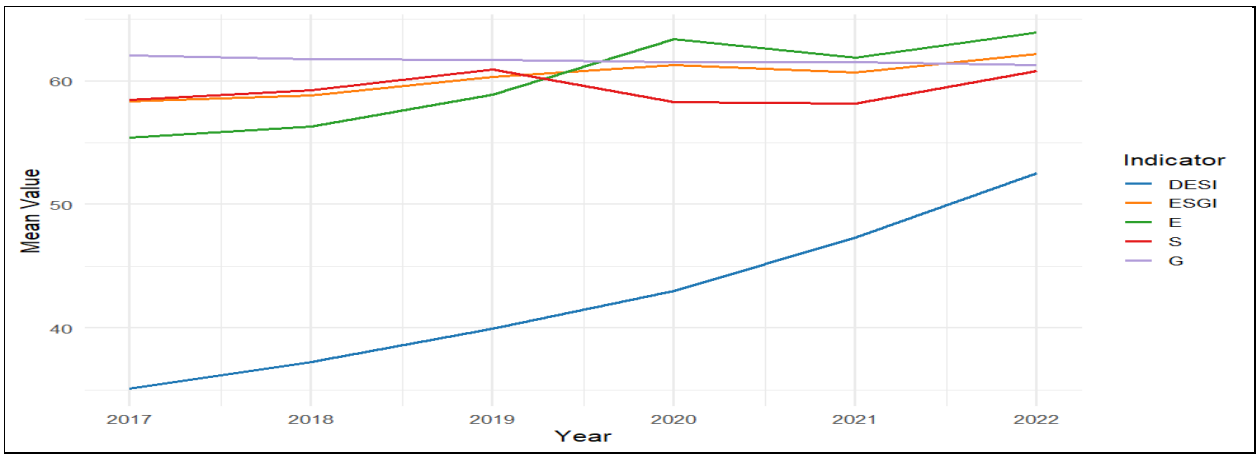
$$E_{it} = \alpha + \beta_1 \times DESI_{it} + \epsilon_{it}$$
$$S_{it} = \alpha + \beta_1 \times DESI_{it} + \epsilon_{it}$$
$$G_{it} = \alpha + \beta_1 \times DESI_{it} + \epsilon_{it}$$

R software was utilized used for data processing and statistical analysis.

3. PRESENTING THE RESEARCH FINDINGS

Figure no. 1 illustrates the average evolution of the digitalization index (DESI), the composite ESGI, and its three components - Environmental (E), Social (S), and Governance (G), for EU member states over the 2017–2022 period. The most dynamic trend is observed for DESI, which shows a steady and substantial increase throughout the entire period. This reflects the continuous expansion of digital infrastructure, improved digital skills, and broader integration of digital technologies across European economies.

Figure no. 1 – The evolution of DESI and ESGI during the period 2017–2022



Source: Authors' projection based on World Bank data (2025) and European Commission (2025a).

In contrast, ESGI and its components display more moderate changes. The ESGI indicator follows a gentle upward trajectory, indicating gradual improvements in sustainability performance at the EU level. Such slow progress is expected, as environmental, social, and governance outcomes typically evolve over longer time horizons. Among the ESG components, the Environmental dimension (E) shows a consistent rise, particularly after 2020. This pattern aligns with the intensification of EU climate policies, increased adoption of renewable energy, and wider implementation of energy-efficiency measures driven by the European Green Deal.

The Social component (S) exhibits a temporary decline around 2019–2020, likely reflecting the negative impact of the COVID-19 pandemic on labor market participation and social conditions. The subsequent recovery after 2021 suggests improved employment dynamics and strengthened social support mechanisms within the EU.

The Governance component (G) remains relatively stable across the entire period, maintaining values above 60 on average. This stability indicates a consistent level of institutional quality, regulatory efficiency, and rule of law across EU member states. Overall, Figure no. 1

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highlights a clear divergence in the pace of progress: digitalization advances rapidly, while sustainability improvements, although positive, develop more gradually, reflecting the structural and long-term nature of environmental, social, and governance transformation.

Table no. 3 presents the descriptive statistics for the main variables included in the analysis: the Digital Economy and Society Index (DESI), the composite ESG Index score (ESGI), and its three components. The DESI index has a mean value of 42.52, indicating a moderate level of digitalization across EU member states. The minimum value of 19.40 and the maximum of 69.60 highlight substantial disparities between highly digitalized economies (such as Finland, Denmark, and the Netherlands) and countries where digital transformation is progressing more slowly (Romania, Bulgaria, and Greece).

Table no. 3 – Descriptive statistics for the DESI, ESGI and its components

Variables	Mean	Median	Min	Max	Std. Deviation	Skewness	Kurtosis
DESI	42.52	42.36	19.40	69.60	10.58	0.21	-0.31
ESGI	60.29	61.68	29.91	90.74	12.58	0.13	0.06
Environmental (E)	59.98	60.86	12.59	98.53	16.10	-0.41	0.72
Social (S)	59.34	61.96	18.35	88.85	15.51	-0.54	-0.36
Governance (G)	61.66	62.84	1.23	100.00	25.93	-0.28	-1.00

Source: Authors' calculations based on World Bank data (2025) and European Commission (2025a).

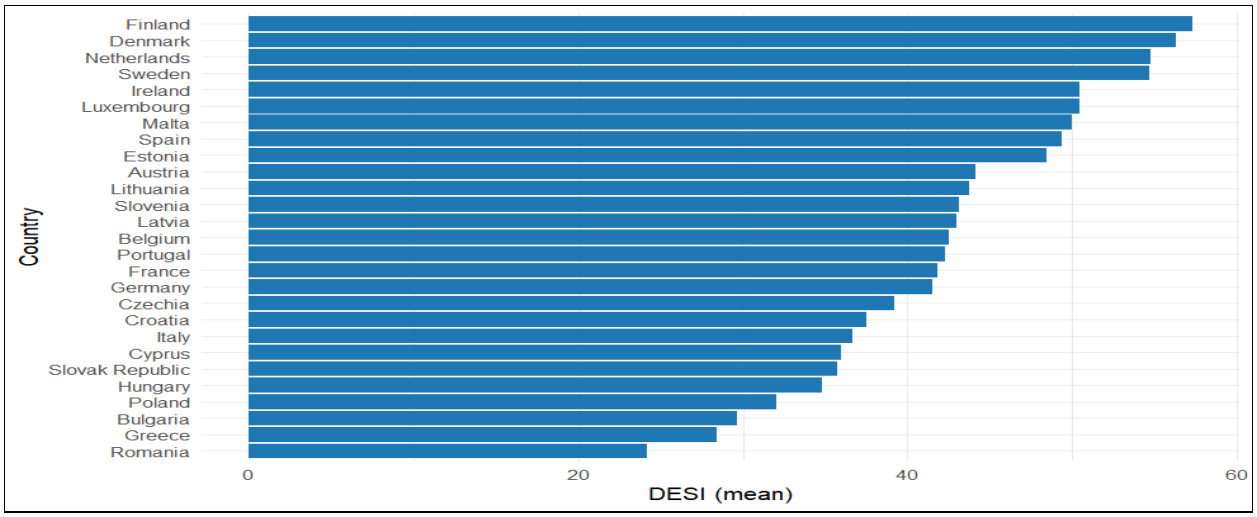
The composite ESG index (ESGI) records an average of 60.29, suggesting a moderate overall level of sustainability within the EU. The Environmental component (E) has a mean of 59.98 and a relatively high standard deviation of 16.10, reflecting major differences between countries with advanced environmental policies and those that remain more dependent on traditional energy sources. The Social dimension (S) has a mean of 59.34, indicating relatively comparable social performance across EU member states, although the range remains wide, with values between 18.35 and 88.85. In contrast, the Governance component (G) shows the highest variability (Std. Deviation = 25.93), revealing substantial differences in institutional quality and administrative capacity across countries. The skewness and kurtosis coefficients are close to zero for most variables, suggesting that the distributions are approximately symmetric and close to normal. Therefore, the data are well-suited for linear regression analysis, as no strong deviations from normality or extreme outliers are observed.

Figure no. 2 presents the ranking of EU member states according to the average value of the DESI (Digital Economy and Society Index) over the 2017–2022 period. The results highlight a clear and persistent digital divide within the European Union, with substantial differences between highly digitalized Northern countries and several Eastern and Southern member states. Finland, Denmark, the Netherlands, and Sweden occupy the top positions, reflecting their advanced digital infrastructure, high-speed connectivity, strong digital skills, and the extensive integration of digital technologies across both public administration and the private sector. These countries benefit from coherent digital strategies, long-term policy continuity, and institutional frameworks that actively support innovation, digital inclusion, and technological advancement.

At the lower end of the ranking, Romania, Greece, Bulgaria, and Poland record average DESI scores below 40 points, indicating structural challenges across multiple areas of the digital ecosystem. These include weaker digital skills among the population, lower adoption rates of digital services, and slower progress in the digitalization of public administration (Herman, 2022; EC, 2022). For instance, Romania, despite notable improvements in broadband connectivity, continues to lag significantly behind in digital public services and human capital (EC, 2022). This underscores that digitalization within the EU remains unevenly distributed, and the convergence process between member states is progressing slowly. This persistent gap

suggests the need for targeted policies aimed at strengthening digital capabilities in less advanced regions to ensure balanced and inclusive digital transformation across the EU (EC, 2024).

Figure no. 2 – Countries ranked by DESI for the period 2017–2022



Source: Authors' calculations based on European Commission (2025a).

Figure no. 3 presents the ranking of EU member states based on the average value of the composite ESGI for the period 2017–2022. The results reveal substantial differences across the European Union, with a clear divide between Northern European countries and several Southern and Eastern member states, indicating structural disparities in sustainability performance.

Sweden, Denmark, and Finland occupy the top positions, reflecting their strong commitment to environmental protection, social inclusion, and high standards of governance. These countries consistently invest in coherent climate policies, robust healthcare and education systems, and well-functioning institutions, which translate into high and stable ESGI values. Moreover, they also rank among the most digitalized economies in the EU, allowing them to leverage digital technologies to improve energy efficiency, transparency, and sustainability performance overall.

At the lower end of the ranking, Greece, Romania, and Bulgaria register the lowest average ESGI scores (below 45 points). These results can be attributed to lower levels of digitalization and institutional transparency, more pronounced social and economic inequalities compared to the EU average, and persistent governance challenges that affect the consistency and effectiveness of public policies. The differences highlighted that ESG performance is closely linked to a country's level of economic and digital development. Member states with stronger governance systems and advanced digital infrastructures tend to achieve higher sustainability outcomes. The figures 2 and 3 also point to a positive alignment between DESI and ESGI scores: countries leading in digitalization, such as Sweden, Denmark, Finland, and the Netherlands, also appear among the top performers in the ESG ranking.

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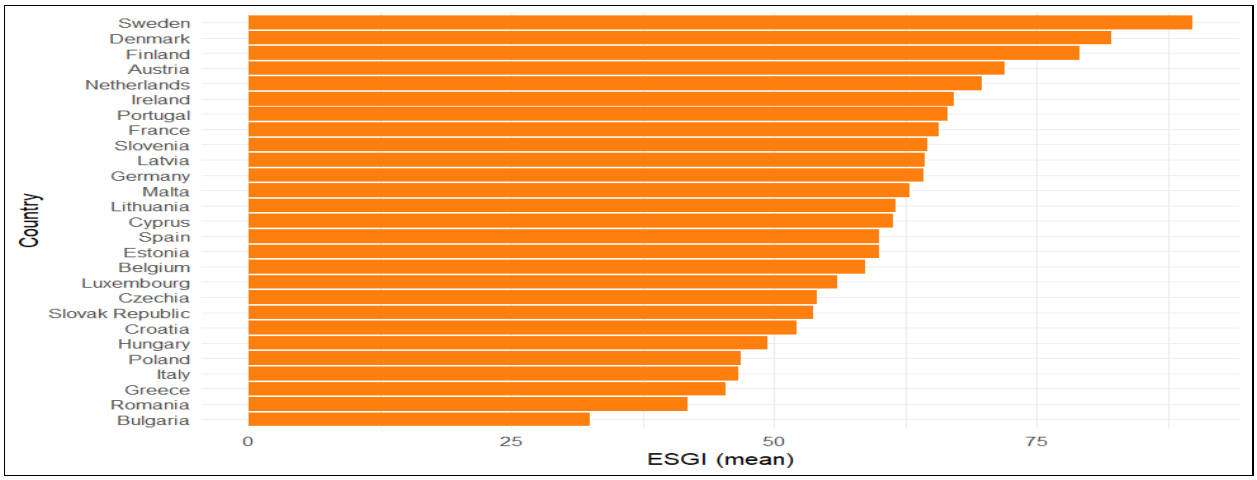
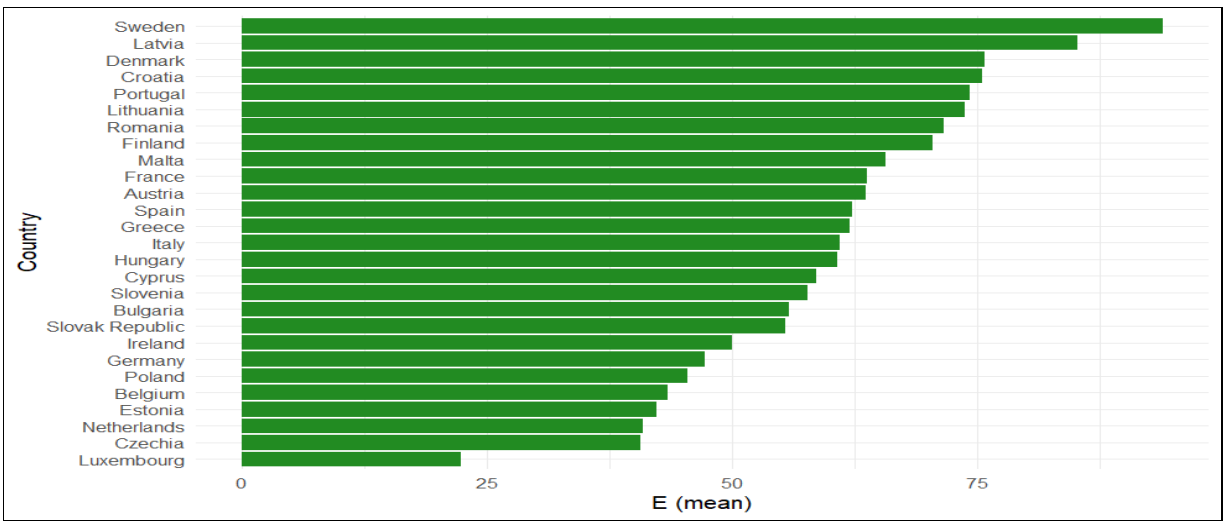
Figure no. 3 – Countries ranked by ESGI for the period 2017–2022



Source: Authors' calculations based on World Bank data (2025)

Figure no. 4 presents the ranking of EU member states according to the average value of the Environmental component (E) of the composite ESG index for the period 2017–2022. This component captures countries' performance in two key sustainability indicators: CO_2 emissions per capita and the share of renewable energy in final energy consumption. Together, these variables provide a comprehensive reflection of environmental efficiency, energy transition progress, and commitment to climate mitigation.

Figure no.4 – Countries ranked by the Environmental (E) component for 2017–2022



Source: Authors' calculations based on World Bank data (2025)

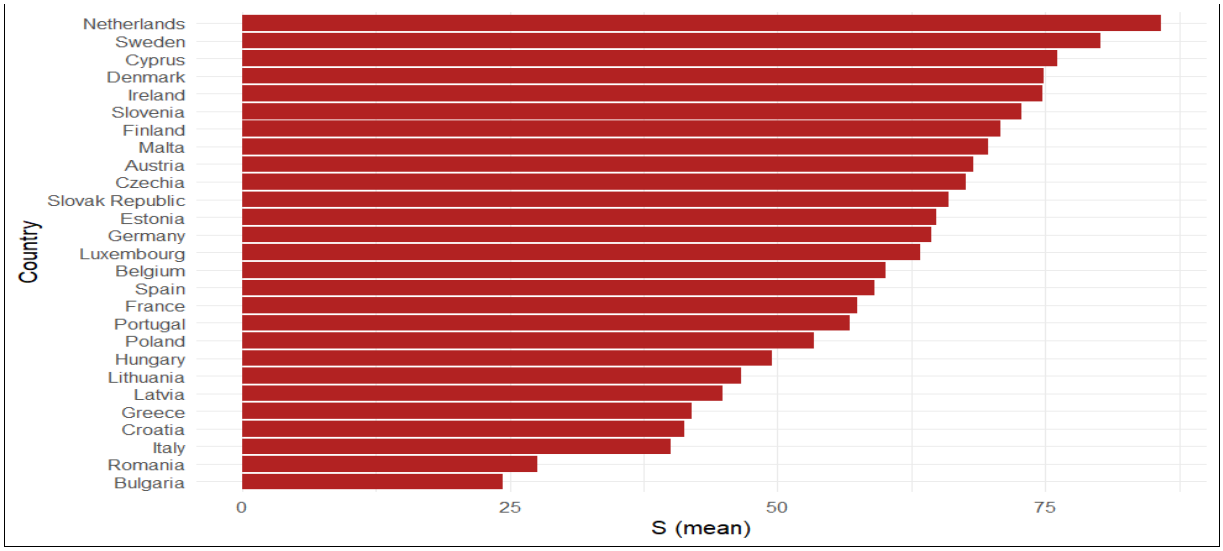
At the top of the ranking are Sweden, Latvia, and Denmark, countries widely recognized for their ambitious climate policies, substantial investments in renewable energy, and consistent efforts to reduce carbon intensity. Sweden stands out in particular, generating over 60% of its

electricity from renewable sources such as hydropower, wind, and biomass, and operating one of the most effective carbon taxation systems in the world. Latvia and Denmark also rely heavily on green energy strategies aimed at reducing dependence on fossil fuels and accelerating the adoption of clean energy technologies.

In the upper middle of the ranking are countries such as Croatia, Portugal, Lithuania, Romania, Finland, and others, which have achieved notable progress in expanding renewable energy production and lowering emissions. Romania, for instance, benefits from a relatively balanced energy structure, with a significant share of renewable resources, which explains its mid-to-upper position in the ranking despite its overall lower ESGI score. At the lower end of the distribution, highly industrialized countries, such as the Netherlands, Luxembourg, Belgium, and Germany, record comparatively lower environmental scores. This pattern is primarily driven by higher energy consumption and elevated per capita emissions associated with advanced industrial sectors. Additionally, these countries still rely more heavily on fossil fuels, which negatively affect their environmental performance despite ongoing efforts to improve energy efficiency. Overall, the results highlight that environmental performance is not directly proportional to economic development. Instead, it is shaped by each country's energy structure, industrial mix, and the strength and coherence of national climate policies.

Figure no. 5 presents the ranking of EU member states based on the average value of the Social component (S) of the composite ESG index for the period 2017–2022. This component captures countries' performance in key social dimensions, such as life expectancy at birth, the labour force participation rate, and the Gini index, three indicators that reflect broader social development, cohesion, and economic inclusion.

Figure no. 5 – Countries ranked by the Social (S) component for 2017–2022



Source: Authors' calculations based on World Bank data (2025)

At the top of the ranking are the Netherlands, Sweden, and Cyprus, followed closely by Denmark and Ireland. These countries stand out for their high levels of quality of life, strong healthcare and education systems, and inclusive labour markets. They also record the highest labour force participation rate in the European Union (over 62%) and benefits from an advanced social protection system supported by policies that promote equality and gender balance. Cyprus, despite being a smaller economy, achieves high labour force participation (65%) and above-average life expectancy (81.13 years).

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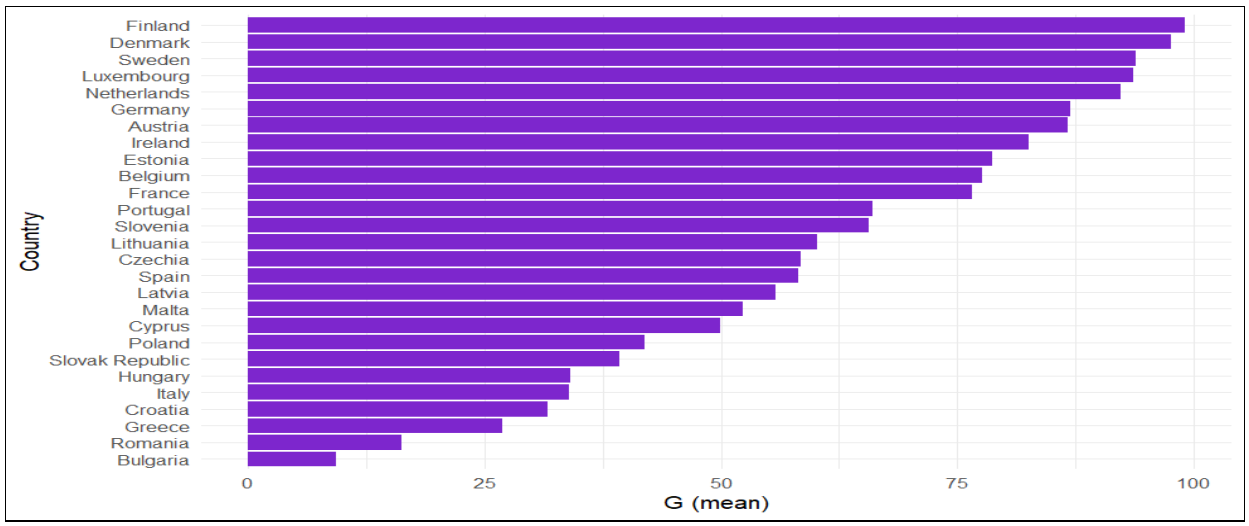
The Nordic countries (Sweden, Denmark, and Finland) also rank prominently, reflecting their long-established commitment to social welfare, equal opportunities, active labour policies, and substantial public investment in health and education. Countries such as Germany, Belgium, Spain, Portugal and others occupy middle positions, displaying moderate but stable social performance. At the lower end of the ranking, Bulgaria, Romania, Italy, Croatia, and Greece record the weakest social scores. These outcomes point to persistent social inequalities, lower labour force participation rates, and shorter life expectancy compared with the EU average. In Romania's case, the low labour force participation rate, significant emigration, and limited investment in healthcare and education contribute to its ranking at the bottom.

Figure no. 6 presents the ranking of EU member states based on the average value of the Governance (G) component of the ESG index for the period 2017–2022. This component reflects the quality of public institutions, measured through the three indicators: Control of Corruption, Rule of Law, and Government Effectiveness.

Figure no. 6 – Countries ranked by the Governance (G) component for 2017–2022



Source: Authors' calculations based on World Bank data (2025)

At the top of the ranking are Finland, Denmark, and Sweden, countries that consistently record the highest governance scores within the European Union. These states are characterized by low levels of corruption, transparent and efficient public administrations, and stable institutions supported by a strong culture of trust and democratic accountability. Notably, these countries are also among the EU leaders in digitalization (DESI) and sustainability (ESGI), suggesting that digital transformation contributes to greater institutional efficiency and transparency. Other high-performing countries include Luxembourg, the Netherlands, Germany, and Austria, developed economies benefiting from robust institutional frameworks and effective public governance. At the lower end of the ranking are Bulgaria, Romania, Greece, and Croatia, with average governance scores below 40 points. These results indicate persistent challenges related to corruption, political instability, and reduced administrative efficiency. Such governance weaknesses can hinder progress across the other ESG dimensions, limiting overall sustainable development performance.

Table no. 4 presents the Pearson correlation coefficients calculated between the digitalization index (DESI) and the variables that make up the ESG performance score. Values

close to 0.7 indicate a strong positive correlation, while lower coefficients point toward more moderate relationships. The results show a strong positive correlation between DESI and the composite ESG index (ESGI) (0.732), suggesting that higher levels of digitalization are associated with better sustainability performance. This supports the idea that digital transformation contributes to sustainable development by enhancing efficiency, transparency, and innovation.

Table no. 4 – Pearson correlation

Variables	ESGI	Environmental (E)	Social (S)	Governance (G)
DESI	0.732	0.137	0.616	0.702

Source: Authors' calculations based on World Bank data (2025) and European Commission (2025a).

The correlation between DESI and the Environmental component (E) is weak (0.137). While digitalization can improve environmental performance through cleaner technologies and more efficient resource use, these effects tend to materialize over the medium and long term. In the short run, investments in digital infrastructure may even increase energy consumption (e.g., data centers, IT equipment), weakening the direct link to environmental indicators. In highly industrialized economies, elevated energy use may also sustain higher emissions despite advanced digitalization.

The correlation between DESI and the Social component (S) is strongly positive (0.616), indicating that digitalization supports social inclusion, labor market participation, and improvements in overall quality of life. A similarly strong positive correlation is observed between DESI and the Governance component (G) (0.702), indicating that more digitally advanced economies tend to have more efficient institutions and greater administrative transparency.

Table no. 5 presents the results of the linear regression analysis (models 1- 4), which reflect the influence of digitalization (DESI) on ESG performance (model 1) and on its three dimensions (Environmental - model 2; Social – model 3, and Governance - model 4). The analysis covers the period 2017–2022 for all EU member states.

Table no. 5 – Results of regression analysis

Variables	Model 1 DESI→ESGI	Model 2 DESI→E	Model 3 DESI→S	Model 4 DESI→G
Estimated Coefficients	0.200	0.472	0.084	0.013
Std. Error	0.049	0.088	0.037	0.069
t-value/ z-value	4.119	5.368	2.241	0.191
Pr(>|t|) / Pr(>|z|)	6.618e-05	2.757e-07	0.026	0.849
Pr Sign	***	***	*	

Note: Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1.

Source: Authors' calculations based on World Bank data (2025) and European Commission (2025a).

The Hausman test was applied to determine the most appropriate estimation for each panel regression. For the overall ESG index (ESGI), the test ($\chi^2(1) = 7.017$, $p = 0.008$) indicated that the fixed-effects model is more appropriate than the random-effects model. Model 1 shows that digitalization has a positive and highly statistically significant impact on overall ESG performance. More specifically, a 1-point increase in the DESI score is associated with a 0.20-point increase in ESGI score. This finding indicates that countries with higher levels of digital

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transformation tend to achieve better sustainability outcomes across environmental, social, and governance dimensions.

For environmental dimension (E), the Hausman test ($\chi^2(1) = 1.4273$, $p = 0.2322$) showed that the random effects model is more appropriate. The regression Model 2 shows that digitalization has a positive and statistically significant impact on the environmental component (E). The estimated coefficient (0.472) indicates that a 1-point increase in the DESI index is associated with approximately a 0.472-point increase in the environmental score. This finding suggests that EU Member States with higher levels of digitalization tend to perform better in environmental sustainability. Overall, the positive relationship between DESI and the environmental component confirms that digital transformation acts as a key driver of environmental performance, supporting the EU's climate objectives and accelerating the transition toward a low-carbon economy.

Similarly, digitalization has a positive and significant impact on the social component (S) (Model 3). The Hausman test ($\chi^2(1) = 3.2007$, $p = 0.07361$) again support the random effects model. The results suggests that higher levels of digital development support improved social outcomes by enhancing access to public and healthcare services, facilitating participation in the labour market, and promoting broader social inclusion. Thus, digitalization contributes to better living conditions and stronger social cohesion, reinforcing its role as an important driver of social sustainability within EU Member States.

In contrast, in the case of the governance dimension (G), does not show a statistically significant effect of digitalization ($\chi^2(1) = 3.4346$, $p = 0.06384$, random effects model, Model 4). While digital tools can improve transparency and administrative efficiency, their impact on governance largely depends on institutional capacity and the effective implementation of digital reforms. Consequently, digitalization alone is insufficient to strengthen governance without complementary institutional measures.

The results partially support H2. Digitalization (DESI) has a positive and statistically significant effect on the environmental and social components of ESG, but no significant impact on governance.

4. CONCLUSIONS

This study examined the impact of digitalization on ESG performance (Environmental, Social, Governance) across the member states of the European Union, using panel data for the period 2017–2022. The main objective was to assess the extent to which the level of digital development, measured through the DESI index, influences sustainable performance, captured by a composite ESG index constructed based on eight environmental, social and governance variables.

The relationship between digitalization and ESG performance is not uniform across EU member states. Nordic countries, including Finland, Denmark, Sweden, and the Netherlands, consistently rank highest in both DESI and ESGI, reflecting strong innovation ecosystems, advanced digital infrastructure, high-quality education and healthcare systems, and solid institutional frameworks. These states utilize digitalization as a strategic driver of sustainability, integrating technological progress into environmental policy, social development, and transparent governance. In contrast, Eastern European countries such as Romania, Bulgaria, Greece, and Poland display lower values for both indices. This highlights persistent gaps in digital infrastructure, limited adoption of digital technologies, and weaker institutional performance. Although these countries have made notable progress, structural and institutional constraints continue to slow down their digital transformation and, implicitly, their transition

toward sustainable development. We also highlight that the pace of digitalization has increased substantially faster than the evolution of ESG performance across EU member states.

The results of the baseline regression model indicate that digitalization has a positive and statistically significant impact on overall ESG performance. This finding supports the initial hypothesis that digital transformation contributes to the transition toward a more sustainable economic model, reflecting the beneficial role of digital technologies in improving environmental outcomes, social well-being, and institutional functioning.

The analysis of individual ESG components revealed important differences across the three ESG dimensions. For the Environmental component (E), digitalization exerts a positive and significant impact, suggesting that digital technologies support energy efficiency, emissions reduction, and the expansion of renewable sources, in line with the objectives of the European Green Deal. For the Social component (S), the estimated impact is also positive and significant, indicating that greater digital development enhances access to public and healthcare services, promotes inclusion, and improves living standards. In contrast, the Governance component (G) shows a statistically insignificant impact on DESI, suggesting that digitalization does not automatically improve governance quality unless supported by coherent policies. Although digitalization fosters transparency and administrative efficiency, these improvements do not translate immediately into measurable gains in governance quality. Such effects typically require longer time horizons and depend on administrative capacity and institutional strength. Without reforms in institutional frameworks and regulatory oversight, the potential of digitalization to enhance governance remains constrained.

These findings confirm that digitalization acts as an important factor influencing ESG performance, particularly through improvements in the environmental and social dimensions. This reinforces the role of digital transformation in advancing the EU's dual transition toward a green and digital economy. However, for digitalization to generate long-term, broad-based benefits, it must be embedded in coherent public policies, institutional reforms, and governance strategies. Digital transformation is therefore not merely a technological instrument, but a strategic driver of sustainability capable of strengthening competitiveness, social inclusion, and environmental protection.

This research has certain limitations. First, the study period (2017–2022) is relatively short for capturing the long-term effects of digitalization on sustainability outcomes. Due to data availability constraints, the analysis relies on the overall DESI and is limited to a six-year timeframe, which may not fully reflect structural changes or delayed impacts. Future research could extend the time horizon, incorporate additional variables of digital transformation, or explore causal mechanisms through dynamic models or advanced econometric approaches.

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