

Sustainability and Financial Performance in the Global Energy Sector: Evidence from ESG Scores and SDG Indicators

Mirela Cristea^{1*}, Raluca Mihaela Drăcea², Ina Nimerenco³, Constantin Ștefan Ponea⁴

^{1*}*Faculty of Economics and Business Administration, University of Craiova
A.I. Cuza Street, No. 13, 200585, Craiova, Dolj, Romania
E-mail. simona.cristea@edu.ucv.ro (Corresponding author*)*

^{2,3}*Faculty of Agrifood and Environmental Economics, Bucharest University of Economic Studies
Piata Romana, No. 6, Bucharest, Romania
E-mail. raluca.dracea@eam.ase.ro, ina.nimerenco@eam.ase.ro*

⁴*Faculty of Legal, Economic and Administrative Sciences, Spiru Haret University
Vasile Conta Street, No. 4, 200580, Craiova, Romania
E-mail. ponea.stefan@yahoo.com*

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The paper's objective is to examine the relationship between sustainability and financial performance for a sample of 575 listed energy companies, extracted from the LSEG database. Sustainability is captured both through ESG scores and SDGs reporting indicators. Financial performance is assessed in terms companies' size (turnover) as well as profitability (proxied by return on common equity and operating income). To capture both direct relationships and indirect mechanisms between variables, the research method combines robust regressions, generalized structural equation modeling and Bayesian networks. The results show that the link between sustainability and performance is not uniform and suggest that the effects of sustainability on performance cannot be reduced to a single direct relationship. Firms' performance reflects the interaction between their structural characteristics, especially size, and the different components of sustainability. ESG scores appear closer to observable financial results, while SDG reporting reflects companies' strategic orientation rather than immediate economic effects.

Keywords: *ESG; Sustainable Development Goals (SDGs); Corporate Performance; Corporate Governance; Energy Sector; Firm Size.*

Introduction

Achieving sustainable development at a global level requires the effort of all parties, whether we are talking about the population, companies, or public and private institutions (United Nations, 2023). In the specialized literature, this subject is very much researched and documented, from the adoption of sustainable development goals (SDGs) by countries to the Environmental, Social and Governance (ESG) reporting of companies and even the behavior of the population regarding sustainability. However, sustainability is integrated and adopted in small but consistent steps, in accordance with the interests of each party involved (Bose *et al.*, 2024). Thus, sustainability initiatives can only be maintained if companies maintain their financial position. Otherwise, their long-term implementation would become impossible (Margolis *et al.*, 2009).

Thus, sustainability within companies, whether we are talking about the adoption of SDGs or ESG reporting, has become an important topic when discussing the financial performance of companies, with many authors addressing this topic across various sectors (Friede *et al.*, 2015; Beretta *et al.*, 2024; Makridou *et al.*, 2024; Saha *et al.*, 2024), including the energy sector (Hurduzeu *et al.*, 2022). Consumers, authorities, and investors have well-defined expectations regarding the sustainable actions of companies

from the perspective of their governance, environmental, and social impact. According to Nguyen *et al.* (2024), the three dimensions of ESG reporting are typically associated with improved financial performance, making it a logical choice for businesses looking to stay competitive. Nevertheless, there is still a question: how do these initiatives affect the financial performance of businesses?

In the energy sector, which is a key driver of one of the biggest structural changes in the world economy, this question is especially pertinent. In addition to being a major source of greenhouse gas emissions, the energy sector is also a major player in the shift to a cleaner energy system (International Energy Agency, 2023). Stricter rules, shifting market norms, heightened investor demands, and, last but not least, the high expenses of adjusting to the new circumstances brought about by the energy transition are all sources of simultaneous pressure on businesses in this industry. According to the Global Sustainable Development Report (GSDR) (United Nations, 2023), out of a total of 36 analyzed targets, only 2 are on track to be achieved, and another 8 are even declining. These trends increase the responsibility of the private sector in both the adoption and implementation of the SDGs (Llach *et al.*, 2025), including the energy sector.

Furthermore, the relationship between sustainability and financial performance in the energy sector can be

further explored through Schumpeter's idea of "creative destruction" (Hart, 2005). Thus, as energy companies invest more in ESG practices and align their strategies with the SDGs, the energy sector is gradually moving away from traditional high-carbon models towards cleaner and more innovative solutions (Dunford & Han, 2025). In this process, energy companies that adapt more quickly to sustainability trends can strengthen their competitive position and financial results, while firms that fail to adapt risk losing relevance in a rapidly changing market.

The literature is increasingly addressing the link between companies' financial performance, ESG reporting, and engagement in achieving the SDGs (Friede *et al.*, 2015; Pizzi *et al.*, 2021; Bose *et al.*, 2024). However, research that directly analyses the relationship between the SDGs and financial results is still scarce. This gap is important because it is not clear enough how real a company's impact on sustainable development is, beyond its statements (Bebbington & Unerman, 2018; Nicolo' *et al.*, 2024).

As for the energy sector, the situation is even more unclear as the field is very diverse (it includes oil and gas exploitation, renewable energies, oil services, or the coal industry, for instance). In such a heterogeneous context, it becomes logical to assume that the link between performance and ESG or SDG indicators is not identical but varies considerably from one subsector to another. For instance, companies operating in renewable energy face very different sustainability pressures, regulatory conditions, and investment needs compared to firms in traditional oil and gas activities. These differences may contribute to the mixed findings reported in the literature on the relationship between sustainability and financial performance (Yucel & Yucel, 2024).

Starting from these research gaps, this study aims to analyse the relationship between sustainability and financial performance for globally listed energy companies. The concept of sustainability is viewed in a broad sense. We thus include both ESG scores and the SDGs, organized around the three classic pillars of sustainable development: environment, social, and economic (Sachs *et al.*, 2019; United Nations, 2023). Financial performance is assessed through three specific indicators, namely turnover, return on common equity, and operating income. Together, these indicators capture both the size of the companies' activity (for turnover) and their level of profitability. In line with the overall objective of this study, *the central research question* guiding the analysis is the following: *How are sustainability reporting practices and ESG performance connected to the financial performance of energy companies?*

The analysis uses data extracted from the London Stock Exchange Group platform, edition 2025 (LSEG, 2025), and includes listed energy companies from around the world. These are divided into the following ten subsectors, according to the Thomson Reuters Business Classification (TRBC): coal, integrated oil and gas, drilling, exploration and production, refining and distribution, oil and gas transportation, oil services and equipment, renewable energy equipment and services, renewable fuels, and uranium. In the present study, the TRBC ten-subsector classification was used to ensure a broader representation of the energy industry and to capture its internal diversity within the overall sample. However, the analysis was

conducted at the aggregated sector level. Due to the heterogeneous energy sectors, future research could therefore examine each subsector separately in order to identify whether the sustainability-financial performance relationship differs across specific energy activities. The methodology combines statistical methods and advanced econometric techniques. The analysis starts with descriptive statistics and panel and robust regressions (RREG), with generalized structural equation models (GSEM) and Bayesian networks, built on graphical models with a Gaussian Copula (GCGM).

The novelty of this study comes from the integrated approach of financial performance with the two sustainability directions, ESG and SDGs, the latter being grouped into the three thematic pillars: economic, social, and environmental. Although the existing literature documents the relationship between ESG and financial performance, and between SDGs and corporate practices separately, we have not identified studies that simultaneously analyze these dimensions for energy companies globally. Furthermore, the methodology used allows capturing more complex relationships than those offered by traditional models in the literature.

The paper is structured in five sections. Following the introduction, the literature dedicated to the relationship between sustainability and financial performance in the energy sector is reviewed, including both the ESG and SDG perspectives. The third section describes the data used, using descriptive statistics of the variables, their categorization, and distribution at the global level and by subsectors, as well as the way in which they were processed, and the second part of this section presents the methodology used and the hypotheses established. The fourth section presents and discusses the empirical results (RREG, GSEM, GCGM). The last section summarizes the conclusions, limitations of the study, and future research directions.

Theoretical Considerations

The Sustainable Development Goals (SDGs) are an increasingly prominent reference point in current discussions on the role of companies in society. The 2030 United Nations Agenda provides a global framework that guides these initiatives but does not establish uniform rules on how companies should implement or report on the SDGs (United Nations, 2023). In practice, approaches have been shaped mainly by international guidelines and voluntary initiatives that provide recommendations, not standardized obligations (GRI, UN Global Compact & WBCSD, 2015; GRI & UN Global Compact, 2017/2018). In this context, the literature shows that SDG reporting is not a neutral process, but the result of strategic decisions of companies and institutional pressures on them (Pizzi *et al.*, 2021; Bose *et al.*, 2024). The level of reporting depends, most often, on the available resources and the degree of public visibility of companies (Pizzi *et al.*, 2021; Bose *et al.*, 2024). For this reason, it cannot be interpreted as a direct and comparable indicator of sustainability performance.

An important starting point in the literature in the field is the recognition that the SDGs are not homogeneous (Sachs *et al.*, 2019; United Nations, 2023). They target different objectives and generate effects in distinct ways and

time frames. Their grouping into the three pillars, economic, social, and environmental, captures precisely these differences in relevance and pace of impact.

The objectives grouped under the economic pillar generally target productivity, employment, and economic growth (Sachs *et al.*, 2019; Pizzi *et al.*, 2021), while the environmental objectives focus on resource management and ecological impact, with longer-term effects (Bebbington & Unerman, 2018; United Nations, 2023). The social dimension concerns issues such as working conditions, inclusion and access to basic services, and its economic implications quite frequently depend on the institutional framework and the way in which they are integrated into organizational practices (United Nations, 2023; Bose *et al.*, 2024).

The same diversity of perspectives is also found in the literature investigating the link between sustainability and the financial performance of companies. Meta-analyses of the literature show that, on average, there is a positive association between corporate social performance and financial results, but there is no evidence that this relationship is homogeneous. For example, based on an extensive literature review, Orlitzky *et al.* (2003) identify an aggregate positive correlation between financial performance and sustainability, but emphasize that the effect depends on both the indicators used and the context in which the analyses are conducted. A similar conclusion is reached by Margolis *et al.* (2009), which shows that the relationship varies depending on the research methods used. In the same vein, based on an analysis of over 2000 empirical studies, Friede *et al.* (2015) show that sustainability is not consistently associated with a deterioration in financial performance. Therefore, the literature does not yet provide a generally valid conclusion, with the results being mixed.

In this context, more recent research has moved away from the simplistic question of the existence of a direct effect and has begun to focus on the mechanisms through which sustainability can become economically relevant (Margolis *et al.*, 2009; Friede *et al.*, 2015; Pizzi *et al.*, 2021; Bose *et al.*, 2024). In this direction, SDG reporting is increasingly treated as a distinct process. However, this should not be understood as a direct determinant of sustainability performance, but rather as an expression of how companies communicate their priorities in this area.

Another aspect that remains insufficiently explored in the literature is the time dimension of sustainability investments. In many cases, implementing ESG initiatives or aligning business strategies with the SDGs requires considerable investments and operational changes that may affect financial performance in the short term (Verma & Shroff, 2025). At the same time, these efforts can contribute to stronger resilience, improved competitiveness, and greater financial stability over the long run. This difference between short-term costs and long-term benefits may help explain why previous studies have reported inconsistent results regarding the impact of sustainability on financial performance.

Studies show that the selection of SDGs for reporting is not random. It is influenced by the company's governance, institutional pressures, and its degree of visibility. In addition, companies systematically choose which objectives to report on depending on the context in which the company

operates (Pizzi *et al.*, 2021; Bose *et al.*, 2024; Nicolo' *et al.*, 2024). Therefore, SDG reporting should be seen as a sign of strategic direction and level of involvement, not as a direct measure of the intensity of actions.

Moreover, according to the Resource-Based View (RBV) theory (Wernerfelt, 1984; Barney, 1991), sustainability-related capabilities in the energy sector – such as low-carbon technologies and efficiency improvements – may represent strategic internal resources that generate competitive advantages. In addition, Signaling Theory (Connelly *et al.*, 2025) helps explain ESG disclosure as a mechanism through which energy firms communicate their strategic sustainability orientation and reduce information asymmetry with investors.

Another important point concerns *the indicators used for financial performance*. The results of the studies differ depending on the analyzed indicator, namely, return on capital, operating profit, or market indicators, as the use of one or the other can lead to different conclusions. If these differences are not taken into account, interpretations may become erroneous (Orlitzky *et al.*, 2003; Margolis *et al.*, 2009; Friede *et al.*, 2015; Noja *et al.*, 2023). From this perspective, the literature tends to treat financial performance not as a single quantity, but as a set of components that may have different responses to identical sustainability practices.

In parallel, ESG research has developed in response to the need for comparability and standardization. In international databases, ESG scores are built from information that is publicly reported by companies and are structured on the three classic pillars (environment, social, and governance) adapted to each sectoral context (LSEG, 2025).

Thus, the relationship between SDGs and ESG is increasingly treated as one of complementarity. The SDGs provide a normative and guiding framework, while ESG functions as a measurement and evaluation tool, adapted to the requirements of investors and financial markets. In this sense, the literature suggests that SDG reporting and ESG performance are closely correlated, and ESG scores can reflect how the SDGs are integrated into corporate reporting (Bebbington & Unerman, 2018; Pizzi *et al.*, 2021; Nicolo' *et al.*, 2024).

Several studies show that ESG ratings of firms can be influenced by how they report non-financial information and communicate their sustainability initiatives. For example, research shows that firms that are more open in their reporting are rated more accurately by analysts because estimates become more consistent (Lang & Lundholm, 1996; Healy *et al.*, 1999). Other studies show that ESG scores also depend on how the information is presented. Some studies in the literature (Huang *et al.*, 2024; Zhang & Wang, 2024) show that there is a link between the way reports are written and ESG scores. Thus, ESG scores tend to be higher when reporting documents are more detailed and include the company's prospects. Conversely, when reports are highly standardized and similar across companies, scores tend to be lower.

In the case of *company size*, studies are much more convergent. Large companies are more visible, are more closely followed by stakeholders, and feel institutional pressures much more strongly. In addition, these companies

have the resources necessary to support more extensive and better structured reporting. Therefore, firm size consistently appears as a central variable in the analysis of the level of activity, distinct from the financial performance itself (Margolis *et al.*, 2009; Friede *et al.*, 2015; Bose *et al.*, 2024).

From a methodological point of view, methodological research has increasingly moved towards tools capable of capturing the complex relationships, but also the indirect effects between sustainability and financial performance. One example is structural equation models (SEM), used to simultaneously analyze the links between sustainability, financial performance, and control variables. These models are particularly useful when performance is measured by different indicators, each capturing a different side of the same phenomenon (Bollen, 1989; Kline, 2016; Hair *et al.*, 2019). In this framework, the use of latent variables allows the separation of direct effects from mediated ones.

In parallel, there is another series of studies in which the authors use robust regression techniques to handle asymmetric distributions and the presence of extreme values, which frequently appear in the financial data of listed companies. These methods are used precisely to limit the influence of atypical observations and to obtain more stable estimates (Huber, 1981; Rousseeuw & Leroy, 2003; Wilcox, 2012).

More recently, methods based on probabilistic networks, including Bayesian networks and graphical models, are used to explore conditional dependencies between sustainability dimensions and economic indicators (McNally *et al.*, 2015; Williams *et al.*, 2019; Scutari & Denis, 2022). These tools are used precisely in situations where the variables are interconnected, and the relationships between them cannot be assumed to be linear or independent, as is the case with analyses linking SDGs, ESGs, and firm performance.

Despite the growing number of studies, literature presents a number of limitations. First, many analyses treat SDGs or ESGs as homogeneous aggregates, without distinguishing between the pillars. Second, financial performance is often measured by a single indicator, which

can mask divergent relationships between performance and operational profitability. Third, previous studies often overlook the temporal dimension of sustainability investments, which may create short-term financial pressures but generate long-term strategic and financial benefits. Finally, the link between SDGs and ESGs is frequently discussed at a conceptual level, but less often empirically tested in an integrated framework that distinguishes between reporting, structure, and results.

In this context, this paper proposes an approach that starts from the differences between the SDG pillars and traces their economic implications. The analysis treats ESG as an indicator formed by its sub-scores and traces their relationship with the different dimensions of financial performance on these dimensions. We note that, within the analysis, Turnover is analyzed as an expression of the size and positioning of firms, not as a substitute for profitability.

Data and Methodology

Data and Indicators

The data were extracted from the LSEG Workspace platform (formerly Refinitiv Eikon database) for the Energy sector, in which 2,216 publicly listed companies were identified. Since not all these companies reported SDGs and ESG data in LSEG (2025), firstly, we cleaned the sample, keeping only those companies that reported them, leaving a total of 575 companies.

These companies included in the sample belong to the following *types of industries* (fields), according to the TRBC: coal (53 companies); integrated oil and gas (30); oil and gas drilling (20); oil and gas exploration and production (134); oil and gas refining and marketing (91); oil and gas transportation services (63); oil-related services and equipment (82); renewable energy equipment & services (75); renewable fuels (11); uranium (16). Within these industries, the distribution of firms by TRBC types of activities is shown in Figure 1.

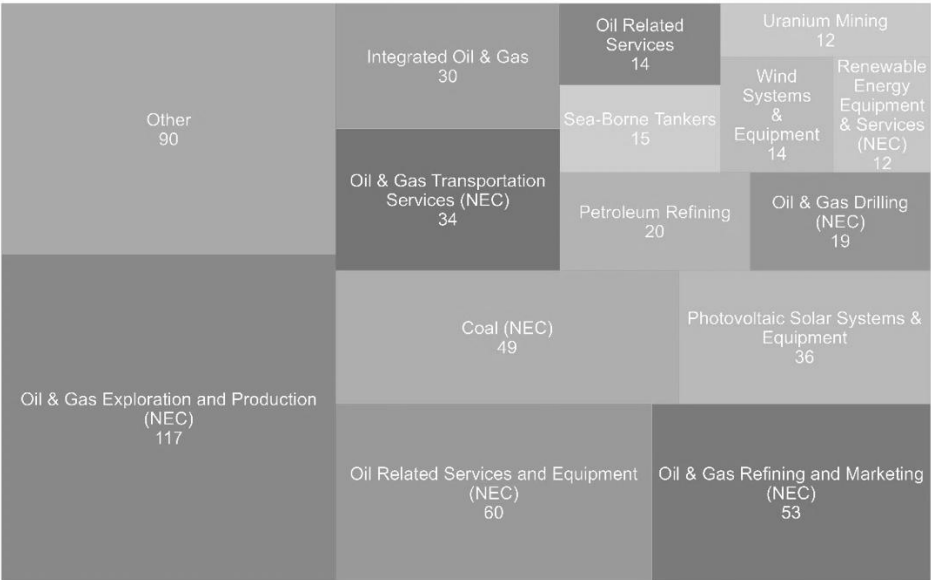


Figure 1. Distribution of Energy Companies by TRBC Types of Activities

Source: Authors' contribution based on data from LSEG (2025)

The geographical distribution of the sample (Figure 2) reveals a fairly high concentration in certain countries. It is observed that China and Canada have the most listed energy companies reporting sustainability-related information, followed by Australia, the United Kingdom, and India. In contrast, several countries in Asia, Africa, and Latin

America have limited participation. This uneven distribution can be explained by differences between countries in the development of capital markets, reporting requirements, and institutional support for sustainability practices.

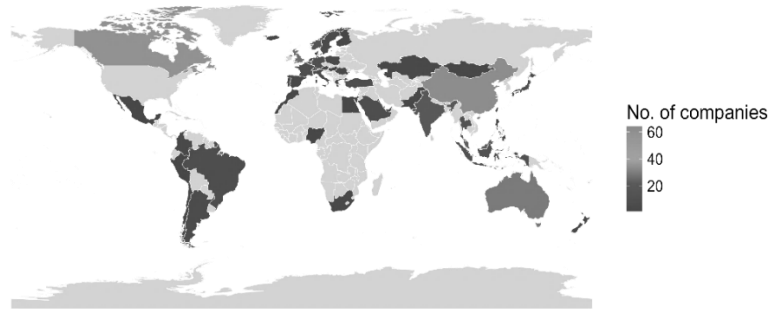


Figure 2. Geographical Distribution of Energy Companies by Country of Headquarters

Source: Authors' contribution based on data from LSEG (2025)

The **data/variables** included for the research, extracted from LSEG (2025) for the fiscal year FY(0), include metrics, which are categorized into the following three groups:

- **Financial outcomes:** Turnover (*tnv*) (United States Dollars - USD); Return on Common Equity (*roec*) (%), Trailing Twelve Months - TTM) and Operating Income (*opi*) (USD);

- **Sustainable development targets (SDGs):** No Poverty (*sdg1*), Zero Hunger (*sdg2*), Good Health and Well-being (*sdg3*), Quality Education (*sdg4*), Gender Equality (*sdg5*), Clean Water and Sanitation (*sdg6*), Affordable and Clean Energy (*sdg7*), Decent Work and Economic Growth (*sdg8*),

- Industry, Innovation and Infrastructure (*sdg9*), Reduced Inequality (*sdg10*), Sustainable Cities and Communities (*sdg11*), Responsible Consumption and Production (*sdg12*), Climate Action (*sdg13*), Life Below Water (*sdg14*), Life on Land (*sdg15*), Peace and Justice Strong Institutions (*sdg16*), Partnerships for the Goals (*sdg17*) - which are binary variables (1 = TRUE, company integrates the SDG, 0 = FALSE, company does not integrate it);

- **ESG pillars:** Environment pillar score (*eps*), Social pillar score (*sps*), Governance pillar score (*gps*), with scores ranging between 0 and 100;

- **Control variables:** Market Capitalisation (USD) (*mkc*) and Total Debt to Total Equity (%) (*de*).

Table 1

Summary Statistics of the Variables

Variables	Observations	Mean	Standard Deviation (Sa)	Minimum	Maximum	Skewness	Kurtosis
Crude values							
<i>tnv</i>	560	34400000	1.010e+08	0.01	1.400e+09	8.267	95.883
<i>roec</i>	523	-0.012	0.662	-10.366	1.877	-10.65	149.392
<i>opi</i>	575	1.530e+09	9.570e+09	-3.700e+09	2.100e+11	18.46	394.574
<i>mkc</i>	575	1.330e+10	7.040e+10	215.34	1.500e+12	17.25	351.73
<i>de</i>	547	1.828	16.952	0	382.401	21.055	467.606
<i>sdg1</i>	573	0.255	0.436	0	1	1.125	2.267
<i>sdg2</i>	573	0.157	0.364	0	1	1.885	4.553
<i>sdg3</i>	573	0.462	0.499	0	1	0.151	1.023
<i>sdg4</i>	573	0.41	0.492	0	1	0.365	1.134
<i>sdg5</i>	573	0.45	0.498	0	1	0.2	1.04
<i>sdg6</i>	573	0.325	0.469	0	1	0.749	1.561
<i>sdg7</i>	573	0.49	0.5	0	1	0.038	1.001
<i>sdg8</i>	573	0.56	0.497	0	1	-0.243	1.059
<i>sdg9</i>	573	0.422	0.494	0	1	0.314	1.099
<i>sdg10</i>	573	0.377	0.485	0	1	0.508	1.258
<i>sdg11</i>	573	0.288	0.453	0	1	0.937	1.877
<i>sdg12</i>	573	0.489	0.5	0	1	0.045	1.002

Variables	Observations	Mean	Standard Deviation (Sd)	Minimum	Maximum	Skewness	Kurtosis
sdg13	573	0.543	0.499	0	1	-0.172	1.029
sdg14	573	0.298	0.458	0	1	0.881	1.776
sdg15	573	0.351	0.478	0	1	0.625	1.391
sdg16	573	0.393	0.489	0	1	0.44	1.193
sdg17	573	0.325	0.469	0	1	0.749	1.561
sps	575	48.369	23.858	0.68	94.72	-0.075	1.95
eps	565	43.993	25.088	0.21	95.91	0.024	1.996
gps	575	50.626	23.106	1.55	95.88	-0.154	1.984
SDGs data aggregation							
sdg_counte	575	1.509	1.54	0	4	0.43	1.652
sdg_counts	575	2.891	2.924	0	8	0.434	1.683
sdg_countec	575	1.839	1.708	0	4	0.108	1.298
Winsorizing, standardization and logarithmic procedures							
roec_w	575	0.081	0.334	-1.413	0.685	-1.179	8.165
roec_std	575	0	1	-4.472	1.81	-1.179	8.165
opi_w	575	1.200e+09	3.760e+09	-1.530e+09	2.600e+10	5.092	31.439
opi_std	575	0	1	-0.725	6.603	5.094	31.458
de_w	575	1.284	2.146	0	8.84	2.732	9.674
de_std	575	0	1	-0.598	3.521	2.732	9.674
ln_tnv	560	14.828	3.317	-4.605	21.06	-1.633	8.119
ln_mkc	575	21.188	2.29	5.372	28.036	-0.9	7.088

Source: authors' contribution in Stata 17

The dataset is relatively balanced (Table 1), with most variables containing around 570 observations, although some financial indicators exhibit missing values. Financial variables display very high dispersion and extreme positive skewness and kurtosis, indicating highly non-normal distributions driven by the presence of outliers. In contrast, ESG scores and SDG indicators exhibit relatively balanced distributions. According to aggregated data, companies report on average around 3 social SDGs (out of 8 SDGs) and 1 to 2 environmental and economic SDGs (out of 4 SDGs for each of them).

Since the individual **SDG variables** are binary values (0/1), in order to measure their implications on each domain of sustainable development (environmental, social and economic), but also to avoid multicollinearity between them, we proceeded to their **aggregation through summation** across the 3 domains of sustainable development, the so-called “SDGs wedding cake”, according to Rockström and Sukhdev (2016) and Wu et al. (2023). These dimensions include the following SDGs:

- *Environmental dimension (sdg_counte)* comprises four SDGs: *sdg6*, *sdg13*, *sdg14* and *sdg15*;
- *Social dimension (sdg_counts)* includes eight SDGs: *sdg1*, *sdg2*, *sdg3*, *sdg4*, *sdg5*, *sdg7*, *sdg11*, and *sdg16*;
- *Economic dimension (sdg_countec)* includes four SDGs: *sdg8*, *sdg9*, *sdg10*, and *sdg12*.

SDG17 (Partnerships for the Goals) is considered a transversal objective that does not belong to a specific sustainability pillar (Rockström & Sukhdev, 2016; Wu et al., 2023).

Thus, this summative aggregation method preserves the discrete nature of the original variables - they have been transformed into count variables, whose values represent measures of breadth (coverage) and not “intensity”.

As for the variables operating income (*opi*), Return on Common Equity (*roec*) and debt to equity (*de*), as they present extreme outliers (skewness), negative values and

zero (0), in order to keep all observations (not eliminate them), we first opt for applying the **winsorizing procedure** at 1 %–99 % (replacing values below p1 or above p99 with percentile limits). After that, to ensure the comparability and stability of estimates within the models, we apply **standardization (z-score)**, using the formula (OECD, 2008, p. 30; Hair et al., 2019):

$$Z_i = \frac{x_i - \bar{x}}{sd}, \quad (1)$$

where:

Z_i = standardized value of the observation i ;

x_i = the value of the variable for the observation i ;

$\bar{x}$ = arithmetic mean of the variable;

sd = standard deviation of the variable.

In contrast, the **firm size variables** - turnover (*tnv*) and market capitalization (*mkc*) - exhibit a strong asymmetry to the right (positive skewness) and thick-tailed distributions (kurtosis), with values over several orders of magnitude. Consequently, the natural logarithm ($\ln$) function was applied to these variables to reduce asymmetry and capture proportional relationships (Hair et al., 2019).

Financial results are measured by several indicators that provide an overview of the financial performance of companies. Turnover (*tnv*) indicates the volume of sales and activity. Profitability (measured by *roec_std*) shows how efficiently equity is used. In turn, *opi_std* captures operational performance, i.e. the profit generated from core activities.

Research Methodology

For the research methodology, we followed several approaches that complement each other: Robust regression to account for outliers (RREG); Generalized Structural Equation Modeling (GSEM); Bayesian network analysis using Gaussian Copula Graphical Models (GCGM).

First, we aimed to evaluate **the direct effects** of the variables on sustainability, grouped by their domains – namely, the aggregate values for environment, social, and economic SDGs, and each dimension of ESG - along with those introduced as control variables, on each dimension of financial results. For this, we resorted to **robust regression to account for outliers (RREG)**, for which we will build three models, one for each dependent variable that measures the financial result, namely turnover (ln_tnv), return on common equity ($roec_std$), and operating profit (opi_std).

RREG was applied in Stata 17 and estimates a linear regression model as ordinary least squares (OLS), for which the coefficients are obtained using M-estimators implemented through iteratively reweighted least squares (IRLS), according to the Huber and Tukey bisquare procedure (Huber, 1981; Tukey, 1992; Wilcox, 2012). In this way, robust regression reduces the influence of extreme observations.

The robust regression equations (2) for the three dependent variables are as follows:

$$ln_tnv_i/roec_std_i/opi_std_i = \beta_0 + \beta_1sdg_counte_i + \beta_2sdg_counts_i + \beta_3sdg_countec_i + \beta_4sps_i + \beta_5eps_i + \beta_6gps_i + \beta_7de_std_i + \beta_8ln_mkc_i + \varepsilon_i, \quad (2)$$

where:

ln_tnv_i = dependent variable ln_tnv for the observation i ;

$roec_std_i$ = dependent variable $roec_std$ for the observation i ;

opi_std_i = dependent variable opi_std for the observation i ;

i = the statistical units included in the analysis, namely the energy companies;

β_0 = model intercept;

β_1 - β_8 = regression coefficients;

sdg_counte_i = explanatory variable sdg_counte for the observation i ;

sdg_counts_i = explanatory variable sdg_counts for the observation i ;

$sdg_countec_i$ = explanatory variable $sdg_countec$ for the observation i ;

sps_i = explanatory variable sps for the observation i ;

eps_i = explanatory variable eps for the observation i ;

gps_i = explanatory variable gps for the observation i ;

de_std_i = explanatory variable de_std for the observation i ;

ln_mkc_i = explanatory variable ln_mkc for the observation i ;

ε_i = error term.

Then follows **an integrated approach**, through which we track the **direct, but also indirect and global effects** of

the variables, in which the financial results are oriented on two dimensions, respectively, one for turnover (ln_tnv), as the main dependent variable, which measures the size of the operations of companies in the energy sector, complemented by a latent variable for financial performance (FP), which brings together the 2 indicators selected for its evaluation, namely return on common equity ($roec_std$) and operating profit (opi_std), used as dependent variables for robustness. For this, we use **Generalized Structural Equation Modeling (GSEM)**.

Given the nature of the variables, the approach of **GSEM** is justified (StataCorp, 2025). While the ESG pillar scores (sps , eps , gps) are continuous variables, the SDG aggregation variables (sdg_counte , sdg_counts , $sdg_countec$) are count variables, the financial performance indicators (ln_tnv , $roec_std$, opi_std), and control variables (ln_mkc , de_std) display non-normal distributions with high skewness and kurtosis.

GSEM, compared with standard SEM, treats mixed types of variables simultaneously, including count outcomes, continuous outcomes with non-normal distributions, and also with latent variables (StataCorp, 2025). GSEM was estimated using the Maximum Likelihood (ML) model, with robust standard errors (vce robust) to correct for non-normal distributions and possible heteroskedasticity. The statistical tests were evaluated at a 95% confidence level.

According to Skrondal and Rabe-Hesketh (2004), GSEM extends standard SEM by linking the conditional expectation of the dependent variable to latent and observed variables through an appropriate link function, in our case, the log for count variables.

The general configurations of the two GSEM models are presented in Figure 3 – Model (1) for main dependent variable turnover (ln_tnv), and Figure 4 - Model (2) for the latent dependent variable financial performance (FP), for robustness, which comprises return on common equity, standardized value ($roec_std$) and operating profit, standardized value (opi_std).

For each model, we have a latent variable construct on **ESG**, which brings together the scores of the three pillars, environment (eps), social (sps), and governance (gps). The implications of this latent variable on the dependent variable are achieved by averaging the following dimensions: each aggregate group of SDGs for environment (sdg_counte), social (sdg_counts), and economic ($sdg_countec$), complemented by the size of the firms in the market (ln_mkc) and the debt-to-equity ratio (de_std).

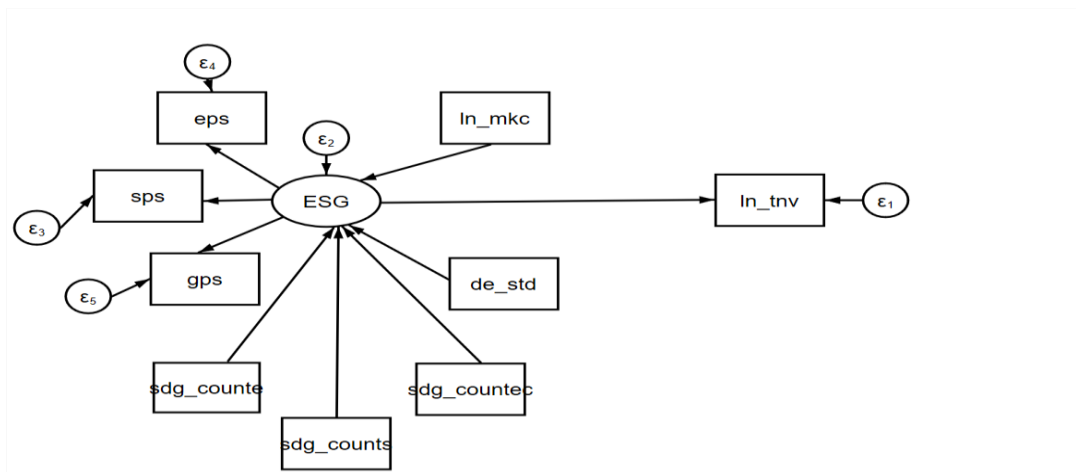


Figure 3. General Configuration of the GSEM for the Main Dependent Variable Turnover ($\ln_{tnv}$), Model (1)
Source: Authors' contribution in Stata 17

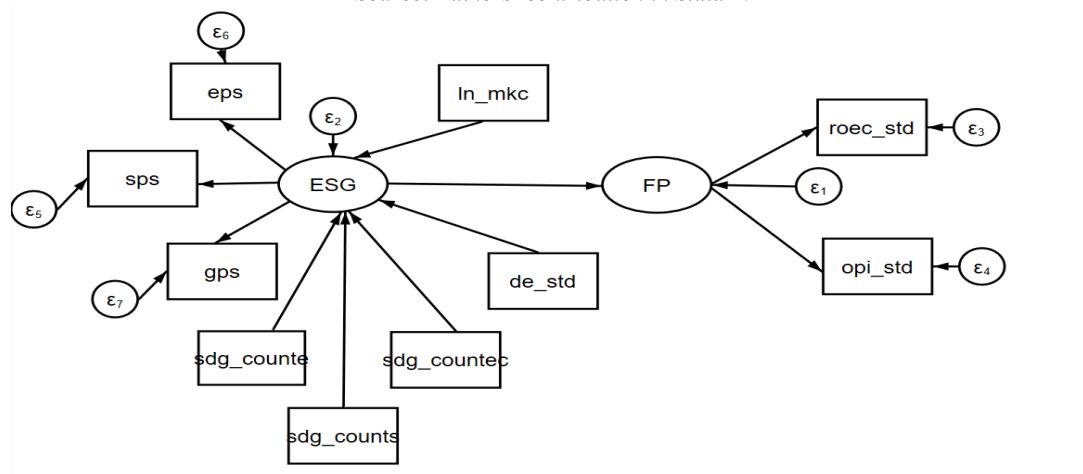


Figure 4. General Configuration of the GSEM for the Latent Dependent Variable Financial Performance (FP), (including $roec_std$ and opi_std), Model (2)
Source: Authors' contribution in Stata 17

Finally, in an explanatory manner, we tracked **the transversality of individual SDGs** and the extent to which they interconnect with the ESG dimensions and the financial outcomes of companies in the energy sector. For this, we used **Bayesian network analysis using Gaussian Copula Graphical Models (GCGM)**, using JASP software.

Bayesian network analysis using GCGM is an exploratory network analysis method between variables that estimates interdependent relationships between variables, even when the data does not follow a normal distribution (Williams & Mulder, 2020). The choice of the GCGM model is based on the fact that it allows the analysis of continuous, binary, or mixed variables together.

Aligned with the general research objective, the central research question, the main findings from the literature, and the methodology, the study further addresses several related questions: *To what extent does aggregated reporting of sustainable development objectives across the economic, social, and environmental pillars influence the financial performance of energy companies?; Are there significant differences between the effects of environmental, social, and economic sustainability reporting on the financial performance of energy companies?; How do ESG practices and their individual components affect the financial results*

of energy companies?; What role do market-related characteristics, together with sustainability practices, play in explaining the financial performance of energy companies?; How do the interactions between individual SDGs and ESG dimensions influence the financial performance of energy companies?

Based on these research questions, the following **research hypotheses** are proposed:

- H1. Reporting sustainable development objectives in aggregate form on its pillars is associated with better financial results for energy companies, with a greater economic impact and a less intense social impact;
- H2. The relationship between reporting sustainable development objectives in the environmental pillar and the financial results of the energy companies is different from that associated with the social and economic pillars;
- H3. Sustainability practices, reflected by the ESG sub-scores, are associated with better financial results of the energy companies, depending on their components;
- H4. The market-related dimension of the energy companies, together with the sustainability practices, plays a central role in their financial results;

- H5. Individual SDGs and ESG pillars interfere/relate to each other, influencing the financial results of the energy companies.

The hypotheses are anchored in the theoretical framework as follows. H1 draws on Signaling Theory (Connelly et al., 2025), as reporting on SDGs signals a firm's strategic sustainability orientation to investors and reduces information asymmetry, and on the Resource-Based View (Wernerfelt, 1984; Barney, 1991), since economic-related SDGs reflect efficiency-oriented capabilities that translate more directly into financial outcomes. H2 is grounded in Schumpeter's creative destruction perspective (Hart, 2005; Dunford & Han, 2025), according to which environmental commitments in the energy sector entail costly restructuring of high-carbon assets whose financial returns may be delayed or uncertain. H3 follows the Resource-Based View, treating ESG practices as valuable and hard-to-imitate internal resources, while also reflecting Signaling Theory, as ESG ratings convey credible information to the market. H4 combines both perspectives: larger firms possess more resources to deploy sustainability strategies and greater

visibility, which makes their sustainability signals more credible. Finally, H5 reflects the creative destruction perspective, as the energy transition is a systemic process in which individual SDGs and ESG dimensions interact rather than operate in isolation.

Results and Discussion

Results of Robust Regression – RREG

The RREG results (Table 2), through R^2 , show that the most consistent model is that of the main chosen dependent variable, turnover ($\ln_tnv$) – Model (1) – for which 78% of the variation in turnover in logarithmic form is explained by sustainability practices, together with the market dimension of the energy companies and the debt-to-equity level. For the other models, whose dependent variables belong to financial performance, they reveal a lower consistency, above average, in the case of common equity return ($roec_std$) – Model (2) – and slightly below average, in the case of operational profit (opi_std) – Model (3).

Table 2

Results of the RREG

Variables	Model (1)	Model (2)	Model (3)
	$\ln_tnv$	$roec_std$	opi_std
sdg_counte	-0.0928 (0.0765)	0.00228 (0.0240)	0.00887 (0.00481)
sdg_counts	0.0689 (0.0453)	0.0339* (0.0141)	-0.00588* (0.00282)
$sdg_countec$	-0.0615 (0.0750)	-0.0758** (0.0234)	0.00327 (0.00469)
sps	-0.000412 (0.00405)	0.000301 (0.00126)	0.0000499 (0.000253)
eps	-0.00144 (0.00378)	-0.00183 (0.00118)	0.00000556 (0.000236)
gps	0.00962*** (0.00268)	-0.000984 (0.000838)	0.000132 (0.000168)
de_std	0.0347 (0.0594)	0.472*** (0.0184)	0.00215 (0.00369)
$\ln_mkc$	1.116*** (0.0302)	0.0591*** (0.00937)	0.0255*** (0.00188)
$_cons$	-8.904*** (0.600)	-0.991*** (0.187)	-0.805*** (0.0375)
N	550	564	564
R^2	0.780	0.556	0.330

Note: Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Regarding the implications of the sustainable development objectives, in aggregate form, on the financial outcomes of energy companies, the results reveal that there are mixed influences. These results suggest that the dimensions of sustainable development goals do not translate uniformly into the activities of firms. The economic dimension of the SDGs ($sdg_countec$) was negatively associated with the profitability of common equity ($roec_std$) – Model (2) (statistically significant for $p < 0.01$). This result indicates a negative association that may reflect differences in financial profiles across firms. These results have also been obtained in previous empirical studies in the literature (Margolis et al., 2009; Friede et al., 2015).

Conversely, the social dimension (sdg_counts) induced positive associations on profitability of common equity

($roec_std$) – Model (2) (statistically significant for $p < 0.05$), while exerting negative associations with operational profit (opi_std) – Model (3) (statistically significant for $p < 0.05$). This mixed result suggests that social investments may be associated with improved stakeholder relations, though they also appear linked to higher operational costs (Bose et al., 2024).

Therefore, the 1st hypothesis, H1. Reporting sustainable development objectives in aggregate form on its pillars is associated with a better financial result for energy companies, with a greater economic impact and a less intense social impact, which is fulfilled only in the case of the social dimension in relation to common equity.

The environmental dimension (sdg_counte) has no statistical significance in any of the estimated RREG models.

Accordingly, the RREG results do not provide statistical support for the 2nd hypothesis, *H2. The relationship between reporting sustainable development objectives in the environmental pillar and the financial results of the energy companies is different from that associated with the social and economic pillars.*

One possible explanation for the lack of statistical significance in the environmental pillar may relate to the specificity of the energy sector, which operates within highly regulated frameworks (e.g., CSRD requirements on ESG reporting, EU ETS scheme on carbon emissions, or EU taxonomy regulations). In such contexts, variation between firms may be relatively small, potentially limiting the ability to detect statistical differences in financial performance. However, this interpretation extends beyond what the present data can directly confirm and warrants further empirical investigation. Moreover, the literature highlights that in highly regulated industries, the relationship between environmental indicators and financial performance is more difficult to identify statistically (Friede *et al.*, 2015; Bebbington & Unerman, 2018).

Regarding the implications of each ESG pillar on the financial outcomes of energy companies, we observe that only governance practices (*gps*) are statistically significant ($p < 0.001$) and positively associated with the size of companies' sales, measured by turnover (*ln_tnv*) – Model (1). This finding is supported by corporate governance literature. Studies show that firms with stronger governance have higher operational efficiency and exhibit higher levels of trust (Orlitzky *et al.*, 2003; Friede *et al.*, 2015).

The other components, environmental and social, do not show statistical significance in the RREG models. Consequently, the 3rd hypothesis, *H3. Sustainability practices, reflected by the ESG sub-scores, are associated with better financial results of the energy companies, depending on their components*, is fulfilled and justified only for governance practices of the energy companies.

As regards the control variable, introduced as a proxy for companies' dimension, namely market capitalization (*ln_mkc*), the results highlight positive associations, strongly statistically significant ($p < 0.001$) on all dimensions of financial outcomes, being most pronounced for turnover (*ln_tnv*) – Model (1) (coefficient is 1.116). The result is consistent with the literature, which shows that larger firms tend to have better financial performance, a pattern that the literature associates with factors such as easier access to capital, though the present data do not allow for causal attribution (Margolis *et al.*, 2009). Accordingly, the 4th hypothesis, *H4. The market-related dimension of the energy companies, together with the sustainability practices, plays a central role in their financial results*, is fulfilled.

Regarding the second control variable, introduced as a proxy for companies' indebtedness, debt-to-equity (*de_std*), the results show a positive and statistically significant association ($p < 0.001$) with common equity return (*roec_std*). This result suggests a positive association between leverage and return on equity. This pattern is consistent with capital structure theory, which indicates that moderate leverage can enhance shareholder returns (Modigliani & Miller, 1963).

Therefore, the RREG results obtained show that, in the case of energy companies, the relationship between

sustainability and financial performance is not homogeneous, being dependent on the choice of the financial indicator for the analysis. SDG indicators do not present uniform associations, and statistical significance does not appear consistently. The results are confirmed by the specialized literature that deals with the sustainability-performance relationship (Margolis *et al.*, 2009; Friede *et al.*, 2015) and that emphasizes this lack of homogeneity. However, in addition to the literature, the results obtained highlight the link between the structural variables of the companies (especially the size of the company) and all the financial indicators analyzed. Therefore, the results suggest that structural characteristics, particularly firm size, are strongly associated with the financial performance of energy companies. As for the sustainability indicators, they contribute differently, depending on the size analyzed.

Results of Generalized Structural Equation Modeling – GSEM

The GSEMs estimated with robust standard errors (vce robust) for each of the two dependent variables, turnover (*ln_tnv*) – Model (1) – and latent variable financial performance (*FP*) – Model (2) – were first tested and validated, applying the following tests: the goodness-of-fit statistics that reveal acceptable model fit in case of Model (1) (SRMR value of 0.096), and very good for Model (2) (SRMR = 0.068), and the coefficient of determination (CD) around average (Table A1, Appendix); Wald test for equation very good which confirms the relevance of indicators, respectively of latent constructs - in case of Model (2) (Table A2, Appendix); and Cronbach alpha very good (0.84, in the case of Model (1), and 0.79 in the case of Model (2)) (Table A3, Appendix). GSEM estimated with robust standard errors (vce robust) in Stata, assessing the goodness-of-fit statistics, does not offer the results for CFI, TLI, RMSEA, and chi-square global, being specific to these models.

As regards the GSEM results for the aggregate constructs on the three dimensions of the SDGs, these show positive influences on the ESG construct, which acts as a mediating factor on financial outcomes for both models. Specifically, the economic dimension (*sdg_countec*), through ESG, exerts positive and statistically significant ($p < 0.001$) effects both on the dimension of sales (*ln_tnv*) – Model (1), Figure 5 and Table A4 from Appendix - and on financial performance (*FP*), expressed by common equity profitability (*roec_std*) and operating income (*opi_std*) – Model (2), Figure 6 and Table A4 from Appendix. The social dimension also positively and statistically significantly ($p < 0.05$) influenced financial performance (*FP*) – Model (2), through the mediating construct ESG, but at a lower intensity compared with the economic dimension. Consequently, the 1st hypothesis, *H1. Reporting sustainable development objectives in aggregate form on its pillars is associated with a better financial result for energy companies, with a greater economic impact and a less intense social impact*, is fulfilled, with the mention that they act through the mediating factor ESG.

The same with the RREG results in the case of the environmental dimension, the results are not statistically significant, so they do not provide statistical support for the

2nd hypothesis, H2. The relationship between reporting sustainable development objectives in the environmental pillar and the financial results of the energy companies is different from that associated with the social and economic pillars. This result is consistent with the RREG findings

discussed above. It suggests that the lack of statistical significance for the environmental pillar does not depend on the estimation method used, but rather on compliance with environmental requirements.

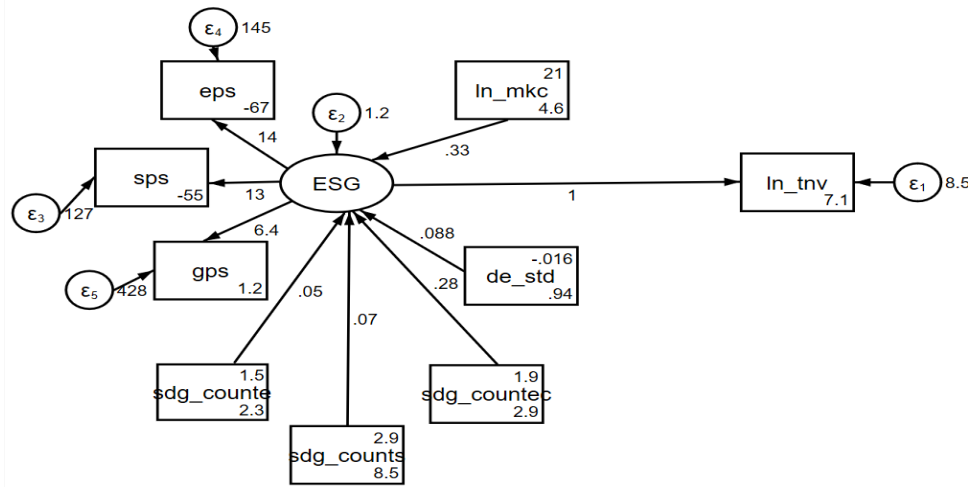


Figure 5. Results of the GSEM for Dependent Variable Turnover ($\ln_{tnv}$), Model (1)
Source: Authors' contribution in Stata 17

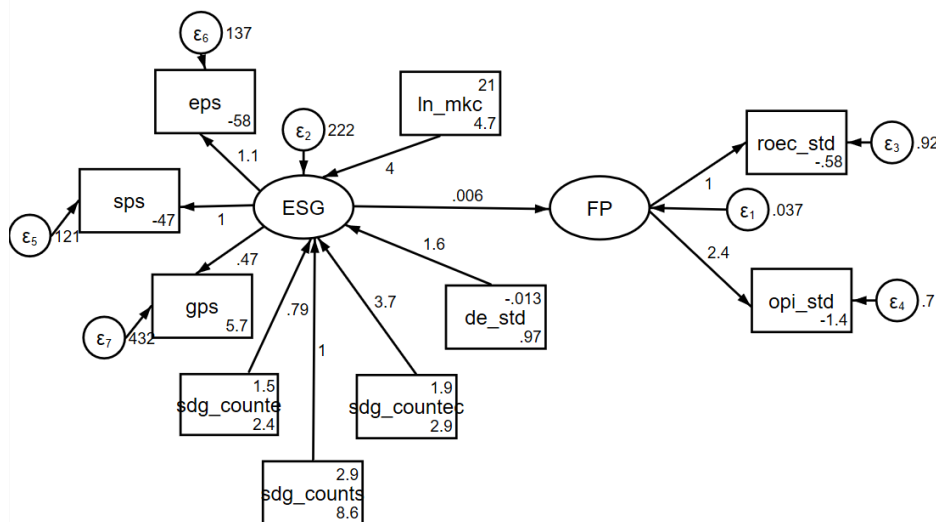


Figure 6. Results of the GSEM for the Latent Dependent Variable Financial Performance (FP), ($roec_std$ and opi_std), Model (2)
Source: Authors' contribution in Stata 17

As for the ESG pillars, each of them positively measures ESG, being more pronounced in the case of the environmental (eps) and social dimensions (sps), compared with the governance dimension (gps) – all of them statistically significant ($p < 0.001$). As regards the implications on financial outcomes, the latent variable construct (ESG) was fixed at 1 in the case of the sales dimension ($\ln_{tnv}$) - Model (1), Figure 5 and Table A4 from the Appendix - whose intercept (7.105, statistically significant, $p < 0.001$) reveals that, when ESG is 0, the expected value of $\ln_{tnv}$ is 7.105. In contrast, regarding the influence of ESG on latent financial performance (FP) - Model (2), Figure 6 and Table A4 from Appendix - ESG exerts a positive and statistically significant ($p < 0.05$) effect on financial performance (FP), measured by common

equity profitability ($roec_std$) and operating profit (opi_std), both having positive and statistically significant factor loadings ($p < 0.05$). Accordingly, the 3rd hypothesis, H3. Sustainability practices, reflected by the ESG sub-scores, are associated with better financial results of the energy companies, depending on their components, is fulfilled and justified for financial performance.

Considering the value of market capitalization ($\ln_{mkc}$), being introduced as a control variable, the results indicate that there are positive and statistically significant ($p < 0.001$) associations with financial outcomes in the case of both models being transmitted indirectly through ESG performance. Moreover, ESG represents a mediating factor also in relation to the aggregate SDGs fields, environmental (sdg_counte), social (sdg_counts), and economic

(*sdg_countec*). Accordingly, the 4th hypothesis, *H4. The market-related dimension of the energy companies, together with the sustainability practices, plays a central role in their financial results*, is fulfilled.

The results obtained indicate that the relationship between sustainability and financial performance cannot be captured through direct links, but through indirect mechanisms. The literature addresses these issues, and many studies show that ESG dimensions can explain how the strategic orientation of companies ends up influencing their economic results (Bollen, 1989; Kline, 2016).

At the same time, empirical studies suggest that greater involvement of companies in the economic and social pillars is associated in the short term with better financial results. As for the environmental dimension, the cited literature suggests that such efforts may translate into financial results over longer time horizons (Margolis *et al.*, 2009; Friede *et al.*, 2015; Verma & Shroff, 2025); however, this proposition cannot be empirically tested within the present cross-sectional dataset and should be regarded as a direction for future longitudinal research rather than a finding of this study.

The placement of ESG as a relevant variable in the results obtained is in line with studies in the literature (Bebbington & Unerman, 2018; Pizzi *et al.*, 2021; Nicolo' *et al.*, 2024). They show that high ESG scores are associated with active sustainability practices and are positively perceived by markets and investors. Therefore, the results indicate that sustainability initiatives at the company level do not produce financial effects through a single factor but arise from the simultaneous interaction of several factors.

Compared to the RREG estimates, the GSEM results provide additional information by identifying indirect links between the SDGs, ESG performance and financial results. Although the strength of the links between some relationships is moderate (e.g., *sdg_countec*-ESG-FP or *sdg_counts*-ESG-FP), the fact that they appear repeatedly and are statistically significant suggests that ESG does not act as a direct factor of financial performance, but as an intermediary one.

This finding adds value to structural modelling, as it allowed us to simultaneously examine latent constructs and mediated relationships that cannot be captured by single-equation regressions.

Results of Bayesian Network Analysis Using GCGM

The application of Bayesian network analysis through GCGM aims to provide an exploratory analysis regarding the association of each individual SDG with ESG pillars and the financial dimensions of energy companies.

A general assessment of the results of Bayesian analysis through GCGM, estimated in JASP, is that the model presents a sparsity degree of 0.654 (Table A5 from Appendix), which suggests a relatively sparse network structure, in which only relevant direct connections between variables are highlighted - 65% of the possible conditional relationships between variables have been eliminated. The relative importance of each variable in the GCGM network is given by the centrality measures (Figure A1 in the Appendix), indicating how connected, intermediary, or influential each variable is in relation to the others.

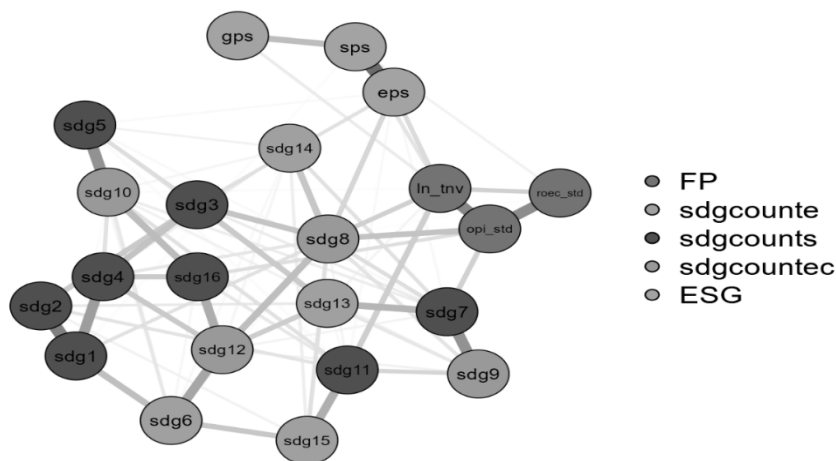


Figure 7. Results of Bayesian Network Analysis Through GCGM

Source: Authors' contribution in JASP

The analysis of the results obtained (Figure 7) indicates that certain SDGs play a central role in the structure of the relationships between the SDGs, the ESG pillars, and financial outcomes. These are components from the social domain - SDG 7 (Affordable and Clean Energy) - and two others from the economic category - SDG 8 (Decent Work and Economic Growth) and SDG 12 (Responsible Consumption and Production), objectives that present a relatively central position in the interconnection with other SDGs, which results in their transversal role in the achievement of the SDGs. Direct conditional connections

are established both with the ESG components - through the environmental pillar (*eps*), as a gateway to the other pillars, social and governance - and with the financial outcomes' dimensions, under the indirect implications of other sustainability variables. Specifically, regarding the conditional association between the SDGs and the ESG pillars, direct positive connections were established between the economic and environmental domains – through *sdg8-eps* – and between environmental sustainability indicators, but negative ones – *sdg14-esg*.

Direct conditional associations with the financial outcomes are established as positive interconnections between the central SDG of the economic category, SDG 8 (Decent Work and Economic Growth), and operating income – *sdg8-opi_std* - and also between the sales dimension of energy companies and a social component, SDG 11 (Sustainable Cities and Communities) - *ln_tnv-sdg11*. Conversely, negative and direct interconnections were established at the level of social category - SDG 7 (Affordable and Clean Energy) and SDG 16 (Peace and Justice Strong Institutions) with financial performance expressed by operating income (*opi_std*), but also between the central economic SDG, SDG 8 (Decent Work and Economic Growth), and the sales' dimension (*ln_tnv*).

Consequently, the 5th hypothesis, *H5. Individual SDGs and ESG pillars interfere/relate to each other, influencing the financial results of the energy companies*, as is fulfilled, suggesting that all sustainability dimensions act together for the overall outcomes of energy companies.

The results of the Bayesian network analysis indicate that the relationships between the SDGs, ESG dimensions, and financial performance are interdependent. The results are in line with the literature (Sachs *et al.*, 2019; United Nations, 2023) that highlights the cross-cutting nature of the SDGs. Thus, progress on a particular pillar is associated with changes in the other dimensions.

In this context, studies based on network models show that certain variables have central positions because they influence the functioning of the entire system (Williams *et al.*, 2019; Scutari & Denis, 2022). Therefore, the central position identified in the paper for SDG 7, SDG 8, and SDG 12 suggests that these goals link the dimensions of sustainability to the financial results of companies.

The identification of direct and indirect links between SDGs, ESG, and financial indicators is confirmed in the literature (McNally *et al.*, 2015; Williams *et al.*, 2019). Empirical studies show that the relationship between sustainability and company performance is much better explained by interdependence mechanisms than by simple linear relationships. Therefore, the results support the idea that company performance is influenced by the set of relationships between sustainability variables, not by the isolated action of a single component. This perspective complements the RREG results, as it highlights the interdependencies between variables, which cannot be captured when the coefficients are estimated separately.

Conclusions

The objective of this study was to identify the link between sustainability, measured by ESG and SDGs, and the financial performance of 575 listed energy companies globally. The research methodology combined complementary statistical-econometric approaches that capture both direct relationships - robust regression (RREG) - and indirect and overall effects - Generalized Structural Equation Modeling (GSEM) and Bayesian networks (GCGM) - between sustainability indicators and financial performance. This methodological choice provides a more nuanced picture of how ESG indicators and SDG reporting are associated with the financial results of the companies in the sample.

However, the results obtained do not support the idea of a uniform relationship between sustainability and financial performance. On the contrary, they show that the effects differ depending on the analyzed dimension and the financial indicator used. Thus, energy companies in the sample that report more SDG economic objectives tend to record lower values of return on equity in the analyzed year. The social component presents a mixed profile, the results show a positive association for profitability (measured by *roec*) and a negative one for operating profit (*opi*). This difference suggests that social investments may be associated with performance gains in certain financial dimensions while generating costs on others, at least within the analyzed cross-sectional frame. In contrast, the environmental dimension does not appear statistically significant in any estimated model, which indicates the absence of a detectable financial association in the analyzed period.

A more nuanced perspective appears when ESG scores are analyzed. In robust regression models (RREG), only the governance component has a significant effect, being positively associated with the turnover of the analyzed companies. However, the social and environmental dimensions do not present measurable direct effects. However, structural modeling (GSEM) shows that when environmental, social, and governance scores are analyzed together as an aggregate ESG indicator, they are positively associated with financial performance. The difference in results suggests that ESG scores may not be statistically relevant when analyzed separately but become relevant when assessed at the aggregate level.

A consistent result, regardless of the research method applied, is the role of firm size. The results show that firms with a higher market capitalization tend to have higher values of all financial indicators, especially for turnover. In addition, structural models (GSEM) indicate that firm size is associated with performance not only directly, but also indirectly, through ESG scores. This finding suggests that the scale and visibility of larger companies may be linked to greater integration of sustainability practices, though the direction and mechanism of this relationship cannot be established from cross-sectional data alone.

Network analysis (GCGM) completes this picture and shows that the SDGs do not act in isolation. The structure of the network of relationships between variables is relatively sparse, indicating that the model retains only relevant connections, and some goals occupy central positions. In particular, SDG 7, SDG 8, and SDG 12 appear as nodes that simultaneously connect ESG dimensions and financial indicators. Their position indicates a cross-cutting role in the corporate sustainability architecture and suggests that not all goals contribute equally to the dynamics of performance.

In summary, the results outline a clear difference between ESG scores and SDG reporting indicators. ESG scores are more closely related to financial performance and show more statistically stable relationships. In contrast, SDG reporting, which is voluntary reporting, mainly reflects the strategic orientation of the company, which does not appear to translate into short-term in financial results within the analyzed sample. This distinction is important because it shows that reporting and performance are not equivalent concepts and should not be treated as such in empirical analyses.

As for the practical implications, they derive directly from the results obtained. Thus, governance practices are the only ones that show a significant direct association on turnover in the estimated models. Therefore, we consider that management structures and organizational transparency can be associated with the level of turnover of the energy companies analyzed.

Social investments, although associated with an increase in return on equity, are negatively associated with operating profit, which indicates that their financial effects are not uniform across performance dimensions. Regarding environmental initiatives, the absence of a statistically detectable association with any financial indicator in the analyzed period should be interpreted with caution: given the cross-sectional and single-year nature of the dataset, no conclusions can be drawn regarding potential long-term dynamics. Whether environmental initiatives may yield financial effects over longer time horizons remains an empirical question that future longitudinal research should address.

From a regulatory perspective, the results suggest that uniform approaches are difficult to apply in a sector as heterogeneous as the energy sector. The different relationships identified between sustainability dimensions and financial results indicate that regulatory policies on sustainability may need to be adapted to each of the energy subsectors. ESG also plays a role in bridging reporting and performance, suggesting the usefulness of comparable reporting standards across firms and regions, such as the European Sustainability Reporting Standards (ESRS) provided for by the Corporate Sustainability Reporting Directive (CSRD) framework, for the European Union (EC, 2023).

However, the study also has several limitations that need to be taken into account when interpreting the findings. The analysis is based on data reported for a single year, which does not allow for the observation of developments over time. In this regard, the identified results may reflect a conjunctural picture rather than stable structural patterns, and the long-term effects of sustainability strategies on financial results remain outside the scope of this study. The SDG indicators are binary and capture only the presence of reporting, not the level of engagement of the energy

companies in the sample in the respective objectives, a constraint that limits analytical granularity and may hide meaningful variation among firms that nominally report on the same indicators. Regarding the selected financial indicators (Turnover, Return on Common Equity, and Operating Income), although they are widely used in the specialized literature and capture distinct dimensions of financial performance, namely revenue generation, equity profitability, and operational efficiency, they do not account for other relevant dimensions such as liquidity, leverage, or market-based valuation, and the results obtained may vary if alternative financial indicators are taken into account. In addition, the sample only includes companies that publish such data and are listed on LSEG, which introduces a selection bias towards companies with stronger sustainability profiles. Last but not least, it should be reiterated that the results obtained exclusively target the energy sector, whose specific regulatory and institutional context may not be transferable to other industries. Taken together, these limitations circumscribe the external validity of the findings and emphasize the importance of treating them as sector-specific and cross-sectional conclusions, rather than universal ones. Future research directions will be oriented towards specific types of energy industries in a comparative analysis, traditional vs. renewable energy companies, but also on the sub-components of each ESG score. Given the heterogeneity of the energy sector, identified as a gap in the literature, future research could analyse individual subsectors to see whether the sustainability-financial performance relationship differs across them. Moreover, we will follow the impact of energy companies' sustainability on the economic resilience of countries.

Overall, the analysis shows that the relationship between sustainability and financial performance cannot be reduced to a single general conclusion. It depends on the dimension of sustainability, the financial indicator used in the analysis, and the way in which the relationships between the variables are statistically modeled. It is precisely this variation that explains why literature provides different results and shows that sustainability assessment must be done by components, not through aggregate indicators treated as equivalent.

Annexes

Table A1

Goodness-of-Fit Tests for the GSEM Models

Fit statistic	Value Description	
	Model (1) (<i>ln_tnv</i>)	Model (2) (latent <i>FP</i> - <i>roec_std</i> and <i>opi_std</i>)
Size of residuals		
SRMR (Standardized root mean squared residual)	0.096	0.068
CD (Coefficient of determination)	0.521	0.490

Note: model was fit with *vce(robust)*; only stats(residuals) valid.

Source: Authors' contribution in Stata 17

Table A2

Wald Test Results for the GSEM Models

Variables	Model (1) (<i>ln_tnv</i>)			Model (2) (latent <i>FP</i> - <i>roec_std</i> and <i>opi_std</i>)		
	Chi ²	df	p-value	Chi ²	df	p-value
Observed						
<i>ln_tnv</i>	0.00	0	-			

Variables	Model (1) (<i>ln_tnv</i>)			Model (2) (latent <i>FP</i> - <i>roec_std</i> and <i>opi_std</i>)		
	Chi ²	df	p-value	Chi ²	df	p-value
<i>sps</i>	75.73	1	0.0000	0.00	0	-
<i>eps</i>	79.20	1	0.0000	655.02	1	0.0000
<i>gps</i>	50.36	1	0.0000	115.71	1	0.0000
<i>roec_std</i>				0.00	0	-
<i>opi_std</i>				5.48	1	0.0192
Latent						
<i>ESG</i>	95.35	5	0.0000	392.36	5	0.0000
<i>FP</i>				6.19	1	0.0129

Source: Authors' contribution in Stata 17

Table A3

Cronbach's Alpha for the GSEM Models

Items	Model (1) (<i>ln_tnv</i>)		Model (2) (latent <i>FP</i> - <i>roec_std</i> and <i>opi_std</i>)	
	Item–test Correlation	Alpha	Item–test correlation	Alpha
<i>ln_tnv</i>	0.6262	0.8310		
<i>sdg_counte</i>	0.7530	0.8139	0.7522	0.7486
<i>sdg_counts</i>	0.7653	0.8120	0.7601	0.7473
<i>sdg_countec</i>	0.7520	0.8140	0.7437	0.7500
<i>sps</i>	0.7705	0.8118	0.7774	0.7445
<i>eps</i>	0.7627	0.8137	0.7722	0.7464
<i>gps</i>	0.5063	0.8460	0.4915	0.7875
<i>ln_mkc</i>	0.6695	0.8255	0.6480	0.7653
<i>de_std</i>	0.3936	0.8592	0.3092	0.8104
<i>roec_std</i>			0.1929	0.8226
<i>opi_std</i>			0.4597	0.7915
Total scale		0.8424		0.7916

Source: Authors' contribution in Stata 17

Table A4

Detailed Results of the GSEM for Main Dependent Variable Turnover, Model (1), and the Latent Dependent Variable Financial Performance, Model (2)

Variables	Model (1)	Model (2)
	<i>ln_tnv</i>	<i>FP</i> (<i>roec_std</i> , <i>opi_std</i>)
<i>ESG</i>		
<i>sdg_counte</i>	0.0505 (0.0713)	0.790 (0.969)
<i>sdg_counts</i>	0.0703 (0.0389)	1.035* (0.520)
<i>sdg_countec</i>	0.285*** (0.0690)	3.742*** (0.870)
<i>ln_mkc</i>	0.327*** (0.0639)	3.984*** (0.411)
<i>de_std</i>	0.0882 (0.0603)	1.574 (0.823)
<i>ln_tnv</i>		
<i>ESG</i>	1 (.)	
<i>_cons</i>	7.105*** (1.405)	
<i>sps</i>		
<i>ESG</i>	13.33*** (1.531)	1 (.)
<i>_cons</i>	-54.50*** (9.695)	-46.95*** (8.663)
<i>eps</i>		
<i>ESG</i>	14.27*** (1.603)	1.064*** (0.0416)
<i>_cons</i>	-66.79*** (10.61)	-58.04*** (9.618)
<i>gps</i>		

Variables	Model (1)	Model (2)
	<i>ln_tnv</i>	<i>FP (roec_std, opi_std)</i>
ESG	6.444*** (0.908)	0.472*** (0.0439)
_cons	1.172 (6.674)	5.746 (5.920)
/		
var(e.ln_tnv)	8.506*** (1.294)	
var(e.sps)	126.7*** (15.36)	120.8*** (16.20)
var(e.eps)	144.8*** (17.27)	136.9*** (18.05)
var(e.gps)	427.9*** (21.71)	432.2*** (21.42)
var(e.ESG)	1.157*** (0.196)	221.6*** (22.91)
var(e.opi_std)		0.700*** (0.202)
var(e.FP)		0.0371* (0.0169)
var(e.roec_std)		0.919*** (0.101)
FP		
ESG		0.00603* (0.00242)
opi_std		
FP		2.449* (1.046)
_cons		-1.409*** (0.268)
roec_std		
FP		1 (.)
_cons		-0.583* (0.263)
N	550	564

Note: Standard errors in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Authors' contribution in Stata 17

Table A5

Summary of Network

Number of nodes	Number of non-zero edges	Sparsity
22	80 / 231	0.654

Source: Authors' contribution in JASP

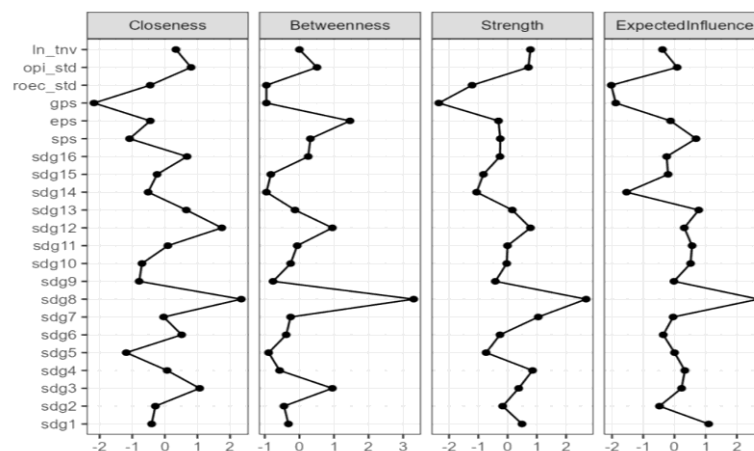


Figure A1. Centrality Plot of the Variables For GCGM

Source: Authors' contribution in JASP

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Authors' Biographies

Mirela Cristea is a Full Professor at the University of Craiova, Faculty of Economics and Business Administration, PhD supervisor in Economics. Her main research directions and teaching activities are interdisciplinary research in economics, sustainable development, good governance in the economy, responsible development in banking, insurance, and private pensions, with over 100 papers in academic journals and volumes. She received two national awards from the Association of the Faculties on Economics from Romania, and the Emerald Literati Award for outstanding author contribution, in 2023. She is a reviewer and member of the scientific and organizational committees for numerous journals and conferences.

Raluca Mihaela Drăcea is a Professor at the Bucharest University of Economic Studies, Faculty of Agri-Food and Environmental Economics, PhD supervisor, and member of the Council of the Doctoral School of Economics II. Her areas of interest include sustainable development, sustainable financing, and the interaction between fiscal policies and environmental performance. She has participated in national projects on carbon footprint assessment, sustainability reporting, and green transition in the agri-food and environmental sectors, analyzing the relationships between macroeconomic dynamics and sustainability indicators.

Ina Nimerenco is an Assistant Lecturer within the Department of Agri-Food and Environmental Economics at the Bucharest University of Economic Studies. Her research lies at the intersection of sustainability, green economy, and higher education, focusing on the role of universities in advancing responsible development. She has conducted bibliometric and empirical studies on green skills, sustainable business practices, CO₂ emissions, regional energy transitions, and the integration of Sustainable Development Goals in higher education. Her work employs quantitative methods, including VAR modeling and regression analysis, alongside systematic literature reviews, contributing to debates in environmental economics and education policy.

Constantin Ștefan Ponea is a Lecturer in the Department of Management within the Faculty of Legal, Economic and Administrative Sciences, Spiru Haret University. He holds a PhD in Management and is actively engaged in teaching and research in the field of organizational and public management, good governance, and sustainable development. He is the author and co-author of numerous scholarly articles in the economic field, published in prestigious journals and presented at recognized international conferences.

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