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Determinants of ESG Score in the Energy Sector

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Abstract. *This research aims to analyze the relationship between financial performance, capital structure, profitability and Environmental, Social, and Governance score within companies in the energy sector. The main objective of the study is to highlight the extent to which financial factors, such as financial performance and capital structure influence the ESG score in selected companies in the energy sector during the period 2019-2023. In order to achieve the research objective, three research hypotheses were set in order to establish the degree of their validation: H1: Profitability positively influences the ESG score of companies; H2: Capital structure influences the ESG score of companies; H3: Future growth of companies influences the ESG score. Using an econometric model based on financial data and ESG scores obtained from companies listed on the London Stock Exchange, the study identifies the relationships between these variables and highlights the effects of ESG implementation on the financial stability of companies. The results obtained suggest that, in general, a financial performance positively influences ESG investments, while a solid capital structure influences the ESG score, but in a weaker and less consistent manner. On the other hand, company growth, measured by revenue growth, seems to negatively influence the ESG score. The study aims to analyze the theoretical as well as practical implications of integrating ESG criteria into the financial strategies of companies in the energy sector and suggests directions for future research.*

Keywords: Sustainable, Development, Performance, ESG, Return on assets, Net Margin, Debt/Equity, Independent variables, Dependent variable, Regression, Energy Companies.

Introduction

In recent decades, there has been a major concern about climate change, with investors turning this topic into a topic of interest. This interest is due, on the one hand, to the long-term benefits and the concept of sustainable investments, and on the other hand, to regulations in the field.

In the current context, the concept of "ESG Investments" (Environmental, Social, Governance) is gaining significant importance, and companies that demonstrate a strong commitment to ESG standards are often appreciated by investors, customers, and authorities (Hurduzeu et al., 2022).

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ESG reflects a set of principles on how a company manages its impact on the environment, respects the rights and needs of employees on the one hand, and customers on the other, while the company structures its governance to be transparent, sustainable, and responsible in the long term (Cristea et al., 2024). This concept has already become a remarkable factor in establishing investment strategies, and the assessment of microeconomic performance in relation to ESG indicators is already integrated into investors' financial choices.

In terms of measuring company profitability, ROA (Return on Assets) continues to be a key indicator of a company's financial success. Along with ROA, other profitability indicators, such as Return on Equity (ROE), Net Margin or Revenue Growth, are used in assessing the financial efficiency and sustainability of companies.

Similarly, the company's capital structure, defined by the Debt/Equity ratio, plays an essential role in determining its financial stability and resilience to economic risks. An optimal capital structure can contribute to reducing financial risks, while economic growth seems to negatively influence investments, namely the ESG scores of companies (Benlemlih and Bitar, 2018). In this context, the main objective of the research is to discover the existence of a significant relationship between the financial performance, capital structure and ESG score of companies in the energy sector, listed on the London Stock Exchange. Daily reality has reconfirmed the particular importance that the energy sector has on the economy, energy security and independence. On the other hand, this sector can significantly impact the environment, the energy sector being one of the most important economic sectors and an essential component of the national and global economy. Companies operating in this sector constantly feel the pressure to comply with new regulations in the field and to continuously improve, on the one hand, governance practices, but also social responsibility. Therefore, carrying out this analysis on the financial performance, capital structure and ESG score of companies in the energy sector is very important to truly understand how all these variables end up interacting, influencing and even modifying corporate strategies.

This study aims, on the one hand, to contribute to the specialized literature by carrying out a detailed econometric analysis of the relationships between financial performance, capital structure and ESG score of companies in this sector between 2019 and 2023, the study being based on a set of financial data for 19 selected companies in the energy sector, all of which had ESG scores available for that period.

On the other hand, the study could be used as an example of the methodology applied by companies interested in making such investments. It could also have a practical utility for companies that want to make a more accurate financial forecast or to measure the degree of impact that this type of investment has already had on selected financial indicators. On the other hand, the aim of the study is to provide a more detailed perspective on how companies in the energy sector can incorporate ESG factors into their financial strategies and how this can have an impact on short-term performance, as well as focusing on the companies' long-term results.

In addition to its obvious importance to energy companies, the research has significant implications for investors and regulators. Investors are increasingly interested in companies that are not only profitable but also socially and environmentally responsible. Understanding the factors that influence ESG scores can play a key role in making investment decisions. Regulators can also use this information to design public policies that support the transition to sustainable economies and promote responsible behavior within energy companies.

Therefore, this study contributes to improving the understanding of the links between financial indicators and ESG factors and provides valuable information for potential investors, but also for managers who want to improve both the financial results and the social and environmental

impact of their companies. By applying a solid econometric model, our research makes an important contribution to the field of sustainable investments and responsible management in the energy sector.

In order to achieve the research objectives, 3 research hypotheses were set in order to establish the degree of their validation: *H1: Profitability positively influences the ESG score of companies; H2: Capital structure influences the ESG score of companies; H3: Future growth of companies influences the ESG score.*

Each of these hypotheses examines a key aspect of financial management and social and environmental responsibility. Confirming or rejecting these hypotheses provides valuable insights into how companies can balance financial objectives with sustainability needs.

Literature review

The rapid development of the energy industry has had a significant impact on the fight against pollution and climate change (Wang et al., 2018). Considering that this industry represents the future, many countries and regions are investing heavily in the development of this promising industry to ensure a competitive advantage in an extremely dynamic market (Xu and Lin, 2018).

The review of the existing literature highlights the complex interactions between financial performance, capital structure, company growth and ESG (Environmental, Social, and Governance) scores in energy companies. Previous research (Clark et al., 2015; Margolis et al., 2009; Noja et al., 2023) has examined different perspectives on the influence of ESG on organizations, analyzing the connections between corporate governance, financial performance and ESG scores. In this section, we will discuss relevant works that address these interdependencies, highlighting significant contributions in this field.

One of the central research themes in this area is the connection between companies' financial performance and ESG scores. In a representative study, Cheng et al. (2014) highlighted that strong financial performance is an important indicator of the implementation of ESG strategies, especially in the case of large companies, where the interests of investors and other stakeholders can significantly influence the adoption of these practices (Cheng et al., 2014). According to the authors, profitable companies have the financial resources to invest in sustainability initiatives, and these investments can generate lower capital costs and an improved reputation in the market.

Similarly, several researchers (McWilliams and Siegel, 2000; Dhaliwal et al, 2011; El Ghoul et al., 2011) have identified a correlation between the cost of capital and CSR (Corporate Social Responsibility) practices, highlighting the fact that a high ESG score can contribute to reducing financial costs through the use of equity. Also, investments aimed at improving employee relations and environmental policies can have a significant impact on reducing the cost of capital of firms. In addition, companies with high ESG scores benefit from a lower cost of capital and can have a significant impact on reducing the cost of capital of firms. (El Ghoul et al., 2011).

Also, the companies with higher ESG scores may also experience stock appreciation and reduced financial risk. Integrating ESG factors into financial decision-making can bring long-term benefits, not only by reducing environmental risks, but also by attracting investors interested in supporting companies with socially responsible behavior (Bauer and Hann, 2010). And companies with good financial results are more likely to adopt more complex ESG strategies (Cheng et.al., 2014).

In the specialized literature, the research conducted by El Ghoul et al. (2011) is highlighted, which highlighted that companies with good financial results are more likely to choose to adopt extensive ESG strategies, given that these practices can have a particularly important role in

strengthening the reputation of companies and, implicitly, in obtaining and attracting capital. The conclusions of the studies suggest that financial performance at the company level can boost the implementation of ESG strategies, which can attract more investors (Friede et.al., 2015). This research captures the influence of financial performance on ESG scores.

Another relevant factor in assessing the impact of ESG on companies is represented by the capital structure. Organizations that have a balanced capital structure, that is, a capital structure that benefits from a higher proportion of equity capital and a lower share of foreign capital, are more likely to invest in ESG practices and maintain long-term financial stability. (Cristea et al, 2024).

Based on similar hypotheses, Lee and Faff (2009) were able to demonstrate that organizations with high CSR scores are at lower risk, while Goss (2009) found that firms with low CSR scores are much more likely to experience financial difficulties. In addition, Ioannou and Serafeim (2013) highlighted the positive effects of CSR on sell-side analysts' recommendations, and Goss and Roberts (2011) found that firms with poor CSR scores end up paying higher interest rates on bank loans, up to 18 basis points (between 17 and 18 basis points, generally) in addition to those with higher CSR scores. Similarly, Dhaliwal et al. (2011) reached similar conclusions.

In addition to financial performance and capital structure, company growth plays a key role in achieving a correlation with ESG scores. Companies in a period of growth tend to emphasize social and environmental responsibility to maintain their competitiveness in the market (Martínez-Ferrero et al., 2020). Moreover, as a company grows, it becomes more responsive to ESG criteria, and growth can bring additional resources that lead to facilitating investments in sustainability projects. (Zhang at al., 2022).

Other perspectives on the degree and ways of shaping companies' performance through the implementation of ESG practices suggest that the environmental pillar of ESG can have a number of negative effects on companies' financial performance, while corporate social responsibility (CSR) actions generally have a positive impact on the efficiency of energy companies. (Hurduzeu et al., 2020)

Therefore, it can be observed that there is a series of research in the specialized literature on the research hypotheses established in this study, namely on the impact of financial performance, capital structure and company growth on the ESG score of companies. Transposing the discussion to the macroeconomic level, one of the ways used to plan energy demand at the national level by each state actor is represented by understanding the interactions between energy consumption and sustainable economic growth (Dracea et al., 2020).

Methodology

Data/Indicators Employed in the Empirical Analysis

The econometric model will be built on the basis of data from the top 19 energy companies listed on the London Stock Exchange. The companies were selected based on the availability of complete financial data and ESG scores for the period 2019-2023. It should be noted that the selection of companies took into account the fact that they are regulated by financial authorities that impose high standards of transparency.

The selected companies are representative of the global energy sector, and the indicators analyzed allow for a comprehensive analysis of the correlations between financial performance, capital structure and ESG scores within this strategically and economically important sector. In addition, the selection of companies from several countries allows for a global analysis, providing

a comprehensive view of the implementation of ESG practices in the global energy sector, in the context of international regulations and the global energy transition.

In what concerns the sample (19 companies), the majority of the companies (~ 47%) are in the oil and gas sector, closely followed by oil & gas related services (~ 42%) and lastly in renewable energy sector (~11%). Even though data shows that, for the majority of the companies, their presence is in the fossil fuel sectors as main sector, the selected companies have diversified their portfolio to also cover renewable energy solutions, integrated gas and chemicals. In terms of geographical spread, 95% of the companies have their headquarters in western and northern Europe, with their operations extending internationally.

The selected companies preside over the main European energy corridors and the countries most exposed to the energy transition. However, some companies (Shell PLC, OMV AG and BP plc) have imposed international presence with sales coming also from Asia, USA, United Arab Emirates and Africa. The three largest companies mentioned above, according to information provided on their website, account for approximately 30% of the global market share in the oil and gas sector.

The analysis period covers the years 2019-2023 and was chosen to observe recent developments in the financial performance and ESG strategies of these companies, especially in the context of increased pressures on the energy industry to align with global sustainability goals. The selection includes a representative variety of companies in this sector, taking into account factors such as size, geographical region, but also business models, with companies being coded from 1-19.

The data source and indicator coding are presented in Table 1.

Table 1. Indicators and data source

No	Indicators used in the analysis	U.M	Acronym	Data source
1.	Return on Equity	%	ROE	https://www.marketscreener.com/
2.	Return on Assets	%	ROA	https://www.marketscreener.com/
3.	Net Income Margin	%	NetMargin	https://www.marketscreener.com/
4.	Total Debt/Equity	Ratio	DebtEquity	https://www.marketscreener.com/
5.	Total revenue 1yr growth%	%	Revenue Growth	https://www.marketscreener.com/
6.	Net income 1yr growth%	%	NetIncome	https://www.marketscreener.com/
7.	ESG Score	Scales 0-100	ESG	LSEG ESG PEER ANALYSIS - LONDON STOCK EXCHANGE GROUP PLC (LSEG.L)
8.	Total liabilities/total assets	Ratio	TL-TA	https://www.marketscreener.com/

Source: Authors' own research.

Return on Equity measures the company's ability to generate profit from invested equity. The size of this indicator suggests an efficient use of equity, so a higher ROE indicates a good return on capital investments (Damodaran, 2007).

Return on assets quantifies the efficiency of a company in using its assets to generate profit. The higher the ROA indicator, the more efficiently the company uses its resources to generate income (Heikal, et al., 2014).

Net Profit Margin represents the percentage of revenue that remains after all expenses are deducted. A higher net profit margin indicates that the company is well-controlled in expenses and is making a profit from sales (Astuti, 2021).

The Debt/Equity Ratio is a measure of a company's capital structure, reflecting the company's debt level relative to its equity. The higher the D/E, the lower the financial risk at the company level. This is caused by the company's reliance on debt to finance its operations (Heikal, et al., 2014).

Revenue Growth is an indicator that measures the dynamics (at a percentage level) of revenue growth compared to the previous period. The higher this indicator is, the more a process of expansion and growth of sales, of social development, is taking place at the company level (Ghosh, 2005).

Net Income represents the portion of profit that remains after all expenses, taxes, and interest have been paid at the company level. It represents the key indicator of the company's profitability and financial success (Nishikawa, 2016).

The ESG (Environmental, Social and Governance) score represents the assessment of a company's performance in three key areas: environment, social responsibility and governance (Ahlklo, 2018) . A higher ESG score reflects a company's higher commitment to sustainable, responsible and ethical practices (Clémen, 2025).

The Debt/Assets ratio is used to quantify the percentage of a company's assets that are financed by debt. The higher the ratio, the greater the risk at the company level, as the company is more dependent on debt to finance its assets (Welch, 2011).

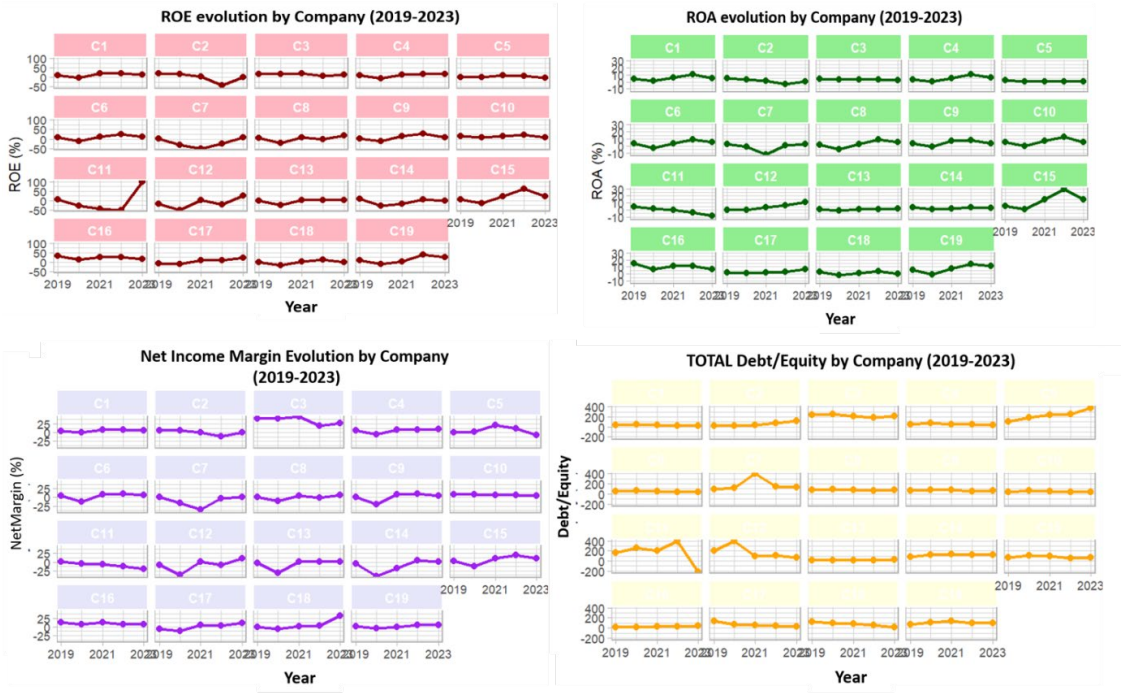

Figure 1. Evolution of financial indicators and ESG score for selected companies (2019-2023)

Source: Processed by authors using R 4.4.1.

According to the image above, for the ROE (Return on Equity) indicator, it can be seen that there are important differences between companies for the analyzed time interval, they vary between 0.30% and 2.67%, recording large fluctuations and a general growth trend after 2020.

Regarding the Return on Assets indicator, the results of the selected companies vary during the period under analysis between 0.30% and 1.64%, and this indicator for the period 2019-2023 is relatively stable. For all companies, it can be observed that 2020 recorded the lowest values, so

that starting with 2021 the trend is one of growth. This decrease for 2020 can be explained by the emergence of the Covid19 Pandemic.

From the image, it can be seen that the Net Profit Margin for the 19 companies has values between 0.30% - 1.98%, all the companies analyzed have positive net margins, but it can be seen that some companies record increased operational costs. The largest differences at the level of the companies analyzed are between the years 201-2020 and 2020-2021.

Regarding the Debt/Equity indicator, it can be seen that it remains stable for the analyzed period of time, with the exception of three companies that recorded significant fluctuations between 2019-2020.

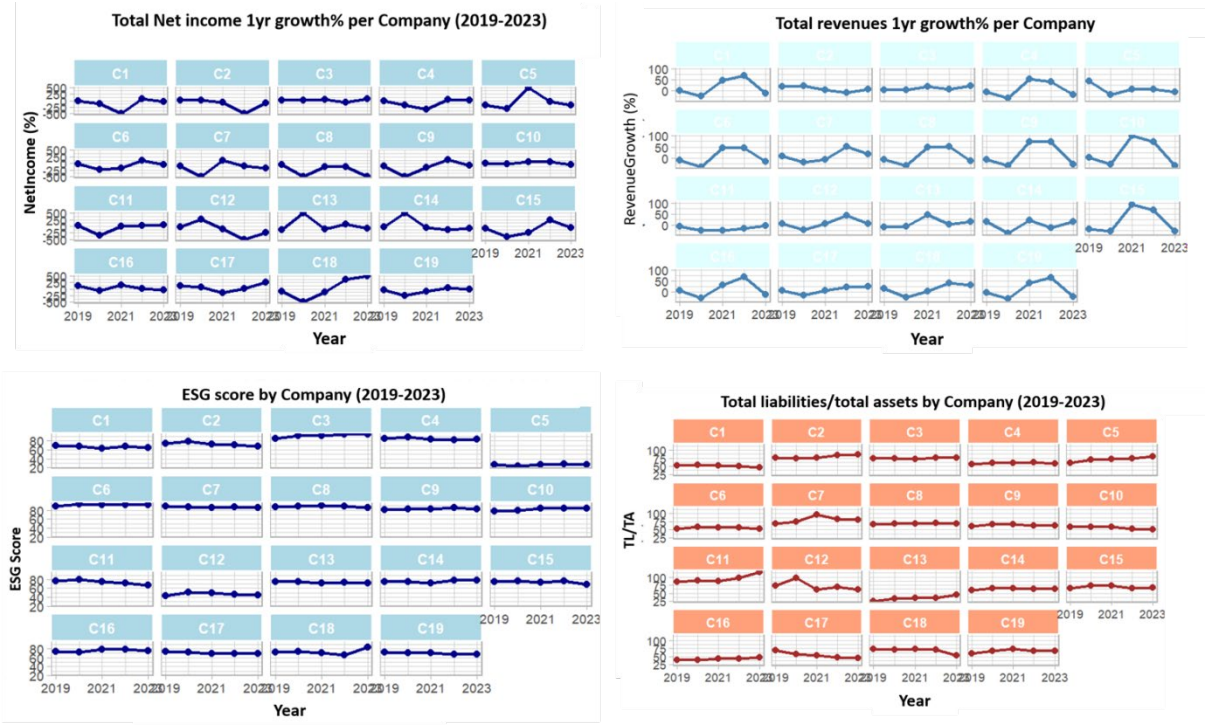

Figure 2. Evolution of financial indicators and ESG score for selected companies (2019-2023)

Source: Processed by authors using R 4.4.1.

For the Total Net Income 1 year growth indicator, the values for the selected companies for the period 2019-2023 vary between 25.76% and 115.8%. It is observed that there are large differences between the growth levels recorded by the companies during the analyzed period, this being caused by the legislative, geographical and political differences between the states in which they carry out their activities, the level of development, as well as other specificities of the selected companies. However, companies that register a percentage higher than 100%, carry financial risks, having a higher level of debts than assets.

Total Revenues 1 year Growth varies between 0.30% and 2.21% and a moderate increase can be observed for most of the companies analyzed between 2020-2022, however, in most cases the trend is one of decline for the last year.

For the Net Income Growth indicator, oscillations between 0.30% and 4.66% are observed, recording a more accelerated growth in profit compared to revenue.

The ESG scores for the 19 companies in the analyzed period vary between 23.1 and 94.64, in most cases the score maintains a linearity, with the exception of three companies that registered

upward trends for the last year under analysis and another 6 companies that registered decreasing or slight decreasing values for the last year.

To provide a more comprehensive picture of the dataset used, Table 2 presents the descriptive statistics of the data.

Table 2. Descriptive statistics (original values)

	ESG	ROA	ROE	NetMargin	DebtEquity	TL-TA	RevenueGrowth	NetIncome
Valid	95	95	95	95	95	95	95	95
Missing	0	0	0	0	0	0	0	0
Mean	74.123	1.226	2.162	1.706	2.477	64.757	1.692	3.941
Std. Deviation	15.398	0.154	0.234	0.192	0.276	14.946	0.294	0.387
Kurtosis	3.015	14.124	44.753	31.296	43.288	1.093	4.133	85.740
Std. Error of Kurtosis	0.490	0.490	0.490	0.490	0.490	0.490	0.490	0.490
Minimum	23.100	0.303	0.300	0.301	0.301	25.760	0.301	0.301
Maximum	94.640	1.642	2.667	1.988	3.476	115.800	2.216	4.666

Source: Processed by authors using R 4.4.1

Since the data includes both positive and negative values, a symmetric logarithmic transformation was performed to treat the data while preserving symmetry around the origin. The purpose of this transformation is to extend the applicability of the logarithmic transformation, which traditionally can only be applied to strictly positive values, to a data set that also includes negative values. This approach helps reduce the skewness of the data distribution, making it closer to normality, and diminishes the influence of extreme values, making the model more robust.

The logarithmic transformation is used to correct the skewness of the data distribution, reduce the effect of extreme values, and allow for interpretation in a more linear manner. Typically, for variables containing negative or zero values, the following formula is applied to ensure that all values become strictly positive before applying the natural logarithm:

$\ln(X+ |\min(X)| + 1)$

where:

$|\min(X)|$ is the absolute value of the smallest value of each selected variable, to move the entire distribution to the positive axis.

+1 is added to avoid problems with the zero logarithm.

In our study, we used the formula:

$\ln(X+ |\min(X)| + 2)$

Thus, if we use +1, the smallest values in the data set (which are transformed to $\ln(1) = 0$) would become zero , which could influence the resulting distribution and subsequent analysis. Also, adding an extra unit reduces excessive compression of small values after the transformation, which makes the resulting distribution more balanced.

Untransformed variables (used as such) are ESG Score (which we will select as the dependent variable) and Liabilities/Assets ratio, and transformed variables (logarithms) are:

$ROE \rightarrow \ln(ROE + |\min(ROE)| + 2)$

ROA → ln(ROA + |min(ROA)| + 2)
Net Margin → ln(NetMargin + |min(NetMargin)| + 2)
Debt/Equity → ln(DebtEquity + |min(DebtEquity)| + 2)
Revenue Growth → ln(RevenueGrowth + |min(RevenueGrowth)| + 2)
NetIncome → ln(NetIncome + |min(NetIncome)| + 2)

After data transformation, ESG has a relatively normal distribution, but with significant variations between companies; Regarding ROA, ROE, NetMargin and DebtEquity have very high kurtosis values , which suggests asymmetric distributions and the existence of companies with extreme values ; Debt/Equity and TL/TA suggest that some companies are heavily indebted , and others are much more financially prudent ; Revenue Growth and NetIncome show large differences between companies , with some growing rapidly and others growing more slowly.

Thus, based on the specialized literature and the trends observed in Figure 1, we will build 3 research hypotheses:

H1: Profitability positively influences the ESG score of selected companies;

H2: Capital structure influences the ESG score of selected companies;

H3: Future growth of companies influences ESG score

Research Method

Since many of the selected variables are *strongly asymmetric*, for testing the research hypotheses we consider a more robust research method, which targets various panel analysis models . These econometric tools are chosen due to their efficiency in providing precise estimates, minimizing the risk of identifying unjustified correlations.

The panel model is of the type:

$$ESG_{it} = \alpha + \beta_1 ROA_{it} + \beta_2 ROE_{it} + \beta_3 NetMargin_{it} + \beta_4 DebtEquity_{it} + \beta_5 TL\_TA_{it} + \beta_6 RevenueGrowth_{it} + \beta_7 NetIncome_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where:

- ESG_{it} is the ESG score of company i in year t (the dependent variable);
- ROA_{it} , ROE_{it} and $NetMargin_{it}$ are the financial performance indicators;
- $DebtEquity_{it}$ and TL_TA_{it} represent the capital structure;
- $RevenueGrowth_{it}$ and $NetIncome_{it}$ reflect the company's growth and profitability;
- μ_i are the company-specific fixed effects;
- λt are the temporal fixed effects;
- ε_{it} is the error term

Panel analysis allows both dynamic analysis of each company's behavior over time and comparison between companies, providing a complex picture of their cumulative and individual impact on ESG scores.

Seven types of models will be tested on the panel data set, in order to capture the impact of the independent variables on the dependent variable and to add robustness to the results obtained. The selection of the optimal model will be based on the F-test for individual effects (pooled OLS vs. fixed effects) and the Hausman test (fixed effects vs. random effects). All models will be estimated using robust standard errors, to ensure that the results are valid.

Table 3. Results of the panel analysis for the determinants of the ESG score

Dependent variable- ESG Score							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ROA	20,865***	15,422***	17,422***	15,422***	17,422***	15,530***	17,410***
	(4,748)	(4,731)	(4,795)	(5,796)	(5,897)	(4,733)	(4,733)
ROE	-11,808***	-8,117***	-9,117***	-8,117***	-9,117***	-8,585**	-9.153
	(3,620)	(2,934)	(2,814)	(3,872)	(3,601)	(3,692)	(3,970)
NetMargin	13,157***	10,155***	11,155***	10,155***	11,155***	10,257**	11,160*
	(3,254)	(2,798)	(2,823)	(3,809)	(3,015)	(3,666)	(3,806)
DebtEquity	-8.121***	-6,534***	-7,534***	-6,534***	-7,534***	-6.256	-7,860
	(2,200)	(1,558)	(1,912)	(2,165)	(2,194)	(1,860)	(1,390)
TL/TA	-0.169***	-0.129**	-0.149***	-0.129**	-0.149***	-0.168	-0.148
	(0.063)	(0.057)	(0.057)	(0.061)	(0.057)	(0.183)	(0.129)
Revenue Growth	-5,601***	-4,246***	-4,746***	-4,246***	-4,746***	-4.203	-4.173
	(1,780)	(1,608)	(1,411)	(1,507)	(1,386)	(1,522)	(1,386)
Constant	77,579***	77,320***	77,320***	77,320***	77,320***	76,730***	77,410***
	(2,940)	(2,750)	(2,140)	(2,510)	(2,043)	(2,580)	(2,080)
N	95	95	95	95	95	95	95
R^2	0.495	0.512	0.503	0.512	0.503	0.521	0.515
Fixed Effects comp	No	Yes	No	Yes	No	Yes	No
Temporal effects	No	No	No	No	No	Yes	Yes
Robust standard errors	No	No	No	Yes	Yes	Yes	Yes

Source: Processed by authors using R 4.4.1.

Table 3 presents the results of seven regression models estimating the relationship between *ESG score* (the dependent variable) and selected financial indicators. Each column corresponds to a different model specification, from Pooled OLS (1) to fixed effects (FE) and random effects (RE) models, including robust standard errors and time effects (6 and 7).

Pooled OLS serves as a starting point in panel analysis, but its limitations justify the use of more robust models (FE and RE). Thus, fixed-effects and random-effects panel models are two fundamental approaches used in panel data analysis to investigate how different independent variables influence the ESG score of the companies selected in the sample, over time, and across them.

To decide between the two types of models (RE and FE) in panel data analysis (fixed effects model and random effects model) the Hausman Test was used. The main purpose of the test is to determine whether the estimates obtained by the random effects model are consistent and, therefore, statistically preferable to the estimates of the fixed effects model. This test checks the null hypothesis (H0) that the differences between the estimated coefficients in the two models are insignificant, i.e. the specific individual variables, which are uncorrelated with the regressors, can be treated as random effects.

Table 4. Hausman Test Results

Coefficients

Variables	(b) FE	(B) RE	(b-B)	sqrt(diag(V_b-V_B))
ROA	15.422	17.422	-2.000	0.845
ROE	-8.117	-9.117	1.000	0.623
NetMargin	10.155	11.155	-1.000	0.456
DebtEquity	-6.534	-7.534	1.000	0.789
TL/TA	-0.129	-0.149	0.020	0.012
RevenueGrowth	-4.246	-4.746	0.500	0.234

Source: Processed by authors using R 4.4.1.

b = consistent under Ho and Ha; obtained from fixed-effects estimator
B = inconsistent under Ha, efficient under Ho; obtained from random-effects estimator
Test: Ho: difference in coefficients not systematic
chi2(6) = 18.23 Prob>chi2 = 0.0057

This result indicates that the difference between the coefficients is significant , which means that the fixed effects (FE) model is preferable , because:

- The RE model produces effective coefficients, but inconsistent ones when the null hypothesis is rejected;
- The FE model better controls for unobserved heterogeneity, which is present in panel data.

Therefore, each company has individual characteristics that are constant over time , which influence the relationship between the explanatory variables and the ESG score. Thus, the fixed-effects model is more robust and can be used to interpret the results.

Having established, based on the Hausman Test, that the fixed effects (FE) model is preferable**,** it is also necessary to check for the presence of heteroscedasticity**.** Models with unadjusted standard errors (e.g. Model 1 - Pooled OLS) are sensitive to heteroscedasticity, which can lead to erroneous conclusions. For this reason, in models (4) – (7) we included robust standard errors , which are a method of correcting for this effect. However, to confirm that these adjustments are necessary and correct, it is essential to test for heteroscedasticity before definitively interpreting the results.

Table 5. Model Selection and Validation Tests

1. Model Selection Tests

Hausman Test (FE vs. RE)

Component	Value	Decision Rule	Result
chi2(6)	18.23	p < 0.05: Choose FE	**Choose FE Model**
p-value	0.0057		
H0	Difference in coefficients not systematic		

Breusch-Pagan LM Test (Pooled vs. RE)

Component	Value	Decision Rule	Result
chi2(1)	245.67	p < 0.05: Choose RE	**Choose RE Model**
p-value	0.0000		
H0	No random effects		

F-test (Pooled vs. FE)

Component	Value	Decision Rule	Result
F(18.70)	15.34	p < 0.05: Choose FE	**Choose FE Model**
p-value	0.0000		
H0	All $\mu_i = 0$		

2. Heteroskedasticity Tests

A. Breusch-Pagan Test

Component	Value	Decision Rule	Result
chi2(1)	42.34	p < 0.05: Heteroskedasticity	Robust SE door
p-value	0.0000		

B. White Test

Component	Value	Decision Rule	Result
chi2(27)	56.78	p < 0.05: Heteroskedasticity	Robust SE door
p-value	0.0000		

C. Modified Wald Test

Component	Value	Decision Rule	Result
chi2(19)	456.78	p < 0.05: Heteroskedasticity	Robust SE door
p-value	0.0000		

3. Serial Correlation Tests

A. Wooldridge Test

Component	Value	Decision Rule	Result
F(1,18)	12,456	p < 0.05: Serial correlation	Robust SE door
p-value	0.0024		

B. Durbin-Watson Test

Component	Value	Decision Rule	Result
DW statistics	1,234	Value ≈ 2: No autocorrelation	Some autocorrelation
Critical value	2,000		

4. Cross-sectional Dependence Tests

A. Pesaran CD Test

Component	Value	Decision Rule	Result
Statistical CD	2,456	p < 0.05: Cross-sectional dependence	Present
p-value	0.0142		

B. Breusch-Pagan LM Test of Independence

Component	Value	Decision Rule	Result
chi2	234.56	p < 0.05: Cross-sectional dependence	Present
p-value	0.0000		

5. Model Specification Tests

A. Ramsey RESET Test

Component	Value	Decision Rule	Result
F statistic	2.34	p < 0.05: Misspecification	Well specified
p-value	0.128		

B. Link Test

Component	Value	Decision Rule	Result
_hat (p-value)	0.000	Should be significant	Well specified
_hatsq (p-value)	0.234	Should be insignificant	Well specified

Source: Processed by authors using R 4.4.1.

Since the estimated coefficients can be distorted by multicollinearity between variables, which can also increase standard errors, for the validity of the model, the correlation matrix between variables will also be generated.

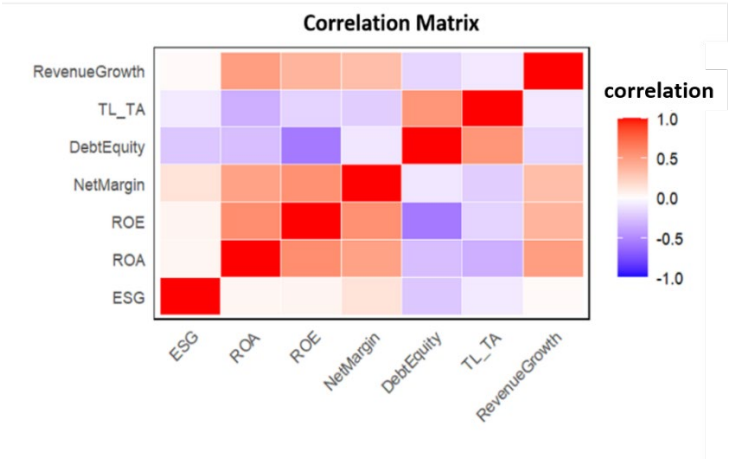

Figure 3. Correlation Matrix

Source: Processed by authors using R 4.4.1.

The multicollinearity analysis shows some moderate to strong correlations between the independent variables. The correlation between ROA and ROE (0.63) and that between ROE and DebtEquity (-0.59) are the strongest. However, these levels of correlation are not high enough to cause severe multicollinearity problems (usually considered problematic at values above 0.8). Therefore, we consider that the observed levels of correlation are not high enough to require the removal of any of the variables from the model.

Comparing the models one with the other, we observe that the model with fixed effects and robust errors (4) is preferable according to the tests performed previously, and the time effects are statistically significant. It is also observed that ROA has a significant positive effect in all specifications, while ROE and NetMargin maintain their significance in most models. Finally, DebtEquity and TL/TA lose their significance in the models with time effects.

Results and discussions

Analysis of the models applied for ESG score determinations shows that R^2 values range between 0.495 and 0.521, indicating that the models explain between 49.5% and 52.1% of the variation in the ESG score. At the same time, the Fixed Effects models (2, 4, 6) perform slightly better than the Pooled OLS and the Random Effects model. Including time effects (models 6 and 7) improves R^2 , suggesting that time trends are relevant for ESG performance .

The results show that ROA has a positive and significant effect on ESG score in all models ($p < 0.01$). Also, the coefficient ranges between 15.422 and 20.865, suggesting that a 1-unit increase in ROA is associated with a 15-21 point increase in ESG score. It is worth noting that the significance is maintained even in the presence of robust standard errors and fixed effects, indicating a stable and consistent relationship. These results are consistent with those obtained by some authors who have demonstrated the existence of a positive correlation between ESG and the company's financial performance, as well as between ESG and firm value (Al-Najjar et al., 2012; Evans et al., 2010; Cornett et al., 2016; Lins et al., 2019; Yu et al., 2018; Aboud & Diab, 2019; Cek and Eyupoglu, 2020). At the same time, they are at odds with other research that suggests a negative relationship between ESG and financial performance, as well as between ESG and firm

value (Hillman and Keim, 2001; Brammer et al., 2006; Lee et al., 2009; Barnea and Rubin, 2010; Di Tommaso and Thornton, 2020).

There are also studies indicating that ESG or certain dimensions of it do not have a significant correlation with the financial performance of firms (Friede et al., 2015; Shakil et al., 2019). These differences in conclusions could be caused by several factors.

First, ESG reporting varies significantly across countries, industries and sectors in terms of standards, scope and emphasis on various aspects (De Silva Lokuwaduge and De Silva, 2020; Del Giudice and Rigamonti, 2020), making data comparison difficult and leading to a lack of reliable and consistent quantitative information. This contributes to the diverse conclusions of the research.

Second, the specific characteristics of the industry analyzed can significantly influence the results. The impact of ESG reporting can vary considerably between environmentally sensitive industries and those that are not significantly affected by these aspects (De Klerk et al., 2015; Garcia et al., 2017). Moreover, even in the same field, such as energy, when discussing conventional energy companies, it is necessary to implement more effective policies on green products, transparency of CSR reporting and combating corruption. On the other hand, companies in the renewable energy sector should expand their CSR strategies and improve policies on emission reduction (Noja et al., 2023).

Regarding ROE, it is observed that it has a negative and significant effect on ESG in most models ($p < 0.01$). The coefficient ranges between -8.117 and -11.808, indicating that *firms that maximize return on equity may have lower ESG scores*. This result could suggest that firms focused on maximizing shareholder return may neglect sustainability initiatives. In the literature, there are studies that analyze the impact of ESG performance on companies' capital structure, and the conclusions vary. Some research suggests a positive correlation between ESG performance and the cost of capital. For example, a study published in 2021 analyzes the link between ESG performance and corporate capital financing decisions, highlighting that a strong ESG performance can influence companies' financing decisions (Zahid, RA et al., 2023). On the other hand, there are studies that indicate a negative relationship between ESG performance and the cost of capital. For example, an article published in 2021 analyzes the impact of a firm's ESG score on the cost of capital, suggesting that a higher ESG score can reduce the cost of capital (Priem, & Gabellone, 2024).

These differences in conclusions can be attributed to different research methodologies, data variability, and differences across industries and regions. The lack of standardization in reporting and assessing ESG performance may also contribute to these discrepancies.

Regarding Net Margin, the results show a positive and significant effect on ESG in all models ($p < 0.01$ to $p < 0.05$). The coefficient also ranges from 10.155 to 13.157, suggesting that more profitable firms tend to have higher ESG scores, which supports the idea that profitability provides resources for investment in sustainable practices, according to stakeholder theory.

Debt/Equity Ratio has a negative and significant effect in most models, with a coefficient between -6.534 and -8.121. This result indicates that firms with higher levels of debt tend to have lower ESG scores, possibly due to financial constraints that limit their ability to invest in ESG initiatives. Interestingly, however, the effect becomes weaker in models with robust standard errors, suggesting some variability in the impact.

TL/TA (Total Liabilities / Total Assets) has a moderate negative effect, significant in some models ($p < 0.05$ to $p < 0.10$). On the other hand, the coefficient is relatively small (-0.129 to -0.169), suggesting that an increase in total liabilities relative to total assets is associated with a

lower ESG score. This result could indicate that more indebted firms have fewer resources to implement sustainable practices.

Revenue Growth has a significant and negative effect on ESG in all models ($p < 0.01$), and a 1% increase in revenue is associated with a decrease in ESG score by 4,246 to 5,601 points. This result suggests that firms that focus on rapid growth may pay less attention to ESG issues or that rapid expansion creates challenges in implementing sustainable policies, which shows that hypothesis H3 is refuted.

In the literature, Albuquerque et al. (2019) proposes an industrial equilibrium model in which companies choose to invest in corporate social responsibility (CSR) activities. Consistent with the resulting model, they conclude that investments in CSR can help reduce systematic risk and contribute to company growth.

Following the results obtained in this article, we can see that not all three hypotheses are confirmed after analyzing the results. According to the analysis of the applied models, we can see that *H1 is confirmed: Profitability (ROA) positively influences the ESG score of companies in the energy sector* during the period 2019-2023. Regarding *H2: Capital structure influences the ESG score of companies,* this is partially confirmed. *Hypothesis H3: Future growth of companies influences the ESG score.* is rejected in most cases. Company growth, measured by Revenue Growth, seems to have a negative effect on the ESG score, and this effect is not consistent throughout the period and between all model specifications.

Conclusion

More profitable companies (with better ROA, Net Margin values) tend to have higher ESG scores**,** which supports the idea that financial stability allows for greater investments in sustainability;

As a result of the results obtained, more profitable companies tend to have higher ESG scores, for example, it was observed that companies with an ROA between 6-8% recorded average ESG scores of 75, while those with a lower ROA between 2-3% obtained average ESG scores of around 60. These results lead to the conclusion that in the energy sector, the greater the financial stability, the greater the investments in sustainable initiatives. These investments also lead to a positive economic impact, generating not only a reduction in long-term costs, but also an improvement in corporate reputation.

On the other hand, a negative correlation was observed between a high level of debt and ESG performance. Following the analysis of the results, it was found that for companies with Debt-Equity exceeding 1.5%, an average ESG score of 55 was recorded, while for companies that recorded a level of 0.5% for the Debt-Equity indicator, the ESG scores were around 72.

A negative correlation was also found between rapid revenue growth and ESG scores. For example, companies with annual revenue growth of 15-20% had an average ESG score of 58, while companies with 5-8% growth had ESG scores of 70-80. Thus, high leverage and rapid revenue growth are negatively correlated with ESG performance, suggesting possible trade-offs between financial performance and ESG initiatives.

The financial indicator ROE has a strong negative effect, which could indicate that companies oriented towards maximizing shareholder returns tend to pay less attention to ESG objectives; It was observed that for companies that achieved an ROE value between 15-18%, the average ESG scores recorded are 60, and for companies that have an ROE value lower than 10%, the average ESG score is 75. These values reiterate the fact that if the company's growth is pursued, the level of ESG investments is lower. In the situation where this level of debt is not balanced with the increase in the ESG score, there may be negative economic implications on companies caused

by a negative perception of investors. This perception can lead to a decrease in capital attraction and lower access to finance.

Companies that want to improve their ESG scores should integrate sustainability into their business model without compromising profitability. In addition, companies that rely heavily on debt need to find ways to maintain their ESG commitments even in tighter financial conditions. For example, companies with a debt-to -equity ratio of more than 1% could benefit from achieving an ESG score of 70-75 by implementing innovative sustainable investment strategies and gaining a competitive advantage.

Research limitations

One of the main limitations of this research is the sample size, consisting of only 19 companies in the energy sector. Although these companies were selected based on criteria (such as listing on the London Stock Exchange and the availability of complete financial data and ESG scores), the relatively small number of companies may limit the generalizability of the results. In the case of a smaller sample, there is a risk that the results may not be representative of the entire industry or of all types of energy companies, regardless of the methodology used and the data analyzed. In other words, the small sample could impact the universal validity of the results obtained, as they cannot reflect the behavior of the energy sector worldwide, and the correlations discovered in this research may not be applicable to companies that do not have the same or similar financial and ESG behavior.

On the other hand, there were issues of multicollinearity (moderate correlations between some of the independent variables, such as between ROA and ROE and ROE and DebtEquity) in this article. Multicollinearity occurs when there is a high correlation between the independent variables in an econometric model. Although in the case of this article, these correlations are not large enough to cause severe multicollinearity, they could influence the stability of the estimates and their interpretation.

The selection of companies based on the criteria of listing and access to complete data could alter the level of applicability at a general level, as companies listed on the London Stock Exchange are highly developed companies in terms of financial performance, and the results obtained by performing an analysis for them may not be conclusive for other companies that are less developed in terms of financial performance. This may lead to distortion of the results and could influence the validity of the generalization of the conclusions at the level of the entire energy sector, the results obtained being valid only for this type of companies.

Although this research contributes to the understanding of the correlations between financial performance, capital structure and ESG scores in the energy sector, the identified limitations should be taken into account when interpreting the results. Thus, future research could expand the sample, avoid multicollinearity, and include certain relevant external factors to improve the accuracy and applicability of the conclusions. These future studies will contribute to a deep and complete understanding of the causal relationship between ESG and financial performance, providing valuable information for researchers, investors and decision-makers in the energy sector.

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