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REVISITING THE IMPACT OF ESG PRACTICES ON FIRM FINANCIAL PERFORMANCE IN THE ENERGY SECTOR: NEW EMPIRICAL EVIDENCE

Abstract. *This paper examines the role played by the ESG credentials in enhancing the financial performance of companies operating in the energy sector, as well as the deterring factors of firm profitability under the impact of negative environmental spillovers. The analyzed sample comprises over 500 publicly reported companies from various energy fields and the research methodology embeds robust regression models and network analysis through Gaussian/Markov Mixed graphical models as two advanced econometric techniques essential to processing cross-sectional data. Main results bring new insights into the modelers of company performance through ESG practices and entail that the environmental pillar of ESG has negative effects on firm financial performance, while CSR actions positively affect energy companies' efficiency and support the benefits that sustainability measures can have on the financial results of companies in the energy sector.*

Keywords*: Performance, Environment, Governance, Energy, Econometric Modelling.*

JEL Classification: O13, G32, L25, Q56, F64

DOI: 10.24818/18423264/56.4.22.03

1. Introduction

The increasing momentousness of the energy field, especially related to environment and social implications (Shahbaz et al., 2020) or the nowadays crisis induced by the geopolitical events following the invasion of Ukraine by Russia (Climate Action Tracker, 2022), has determined the awareness of the corporate social responsibility (CSR) practices (Karaman at el., 2021) for this multi-faceted field.

Whereas conventional resources of energy supplied from fossil fuels (gas, coal, or oil), which are contributing massively to the increase of pollution by greenhouse gas (GHG) emissions (Khan et al., 2014) and, implicitly, to global warming (Batruch, 2017), are on the way of depletion, new strategies and practices for alternative energy resources, environmental protection and ensuring social responsibility are increasingly sought after. Therefore, the attentiveness to CSR actions and practices for all energy fields - conventional and renewable - is highly followed both by shareholders and policymakers (Shahbaz et al., 2020; Karaman et al., 2021). Further away, the implications of CSR actions on energy companies' efficiency have been intensively studied, with controversial results that acclaim continuously research into "a contextualized setting of the energy sector" (Lloyd, 2018, p. 25; Sichigea et al., 2021), adapted to different conjuncture, regions, or resources.

On this contextualized significance and concerns of the energy sector, the general objective of our research is to assess the synergy between each ESG pillar, as the main driver of CSR actions - direct, indirect and overall - and the financial performance of publicly reported companies from energy fields. Data were selected from the Refinitiv Eikon database (2021), from the last available balance sheet, including a number of 541 energy companies. We accomplish two advanced econometric methods, namely *robust regression models (RREG)*, with Huber and biweight iterations, to assess direct influences among ESG measures and financial performance, and network analysis through *Gaussian/Markov Mixed graphical models* (GGM), to appraise direct, indirect, and overall connections between variables. Accordingly, the novelty of our research is relied on two modern econometric approaches to explore the relation CSR-financial performance of energy companies, whose results afford a strapping groundwork for other similar research underpinnings, thus, enriching the literature in the field.

The paper is organized as follows: after a specific approach to the research context, the research objective and the novelty brought by this study, accomplished in the Introduction part, an investigation of the main results obtained in literature as regards the ESG drivers-financial performance relationship in energy sectors was realized. The data and the applied research methodology were then described, accompanied by the results and the discussions related to the results obtained by other researchers. In the final section of our paper, we conclude the summary of the

objective and hypotheses followed, the main implications, with strategies proposed, limitations, and future research directions.

2. Literature Review

As a repercussion of noxious effects of energy companies, but also as a paramount mainstay of all activities into a society, CSR actions have also become a cornerstone in energy companies in their engagement with all shareholders, internal and external stakeholders (Khan et al., 2014; Lloyd, 2018; Shahbaz et al., 2020; Karaman et al., 2021; Puime et al., 2022).

At the European Union level, the CSR concept was reshaped by the European Commission (2011), being stated that CSR represents "the responsibility of enterprises for their impacts on society and outlines what an enterprise should do to meet that responsibility" for which companies "should have a process in place to integrate social, environmental, ethical human rights and consumer concerns into their business operations and core strategy in close cooperation with their stakeholders". The European Commission (2011) stated that the final purpose of CSR is to create "shared value", with benefits both for shareholders and other internal and external stakeholders, including the whole society, but also "to identify, prevent and mitigate possible adverse impacts which enterprises may have on society".

As regards the main proxy for CSR actions, the Environmental, Social, and Governance (ESG) components, "as primary drivers of CSR activities, (…) should be considered and implemented by managers (..) both for the headway to sustainable development and as a promoter of financial profitability" (Shahbaz et al., 2020; Cristea et al., 2022, p. 2). As for CSR activities, namely "CSR performance, reporting, assurance, Global Reporting Initiative (GRI) adoption", Karaman et al. (2021, p. 10), based on data extracted from Thomson Reuters Eikon database for energy companies, 2012-2018 lapse of time, proved a strong connection between CSR performance and CSR reporting.

The pursuit of scientists for CSR actions and financial performance is manifold, being assessed specific/distinctive pillars of ESG, specific regions or countries, or specific fields of energy domain, on the one hand, and different measures of financial performance.

Thereby, Lloyd (2018) assayed the relation between CSR (measured by ESG score - general and distinctive for each pillar) and financial performance - proxied by "return on assets (ROA)", "return on equity (ROE)", and "earnings before interest, taxes, depreciation, and amortization (EBITDA)" - of energy companies that reported to Bloomberg database, for 2010-2015 fiscal years. Lloyd (2018) made the analysis on specific regions (North America, Latin America, Asia – Pacific, Europe, Africa – Middle East) and specific energy fields. Lloyd (2018, p. 41) concluded that "firms are responding to stakeholder interests for reasons other than financial interest".

Although the literature cannot identify an impact model of ESG factors on the financial performance of energy companies (Arslan-Ayaydin & Thewissen, 2016; Gonenc & Scholtens, 2017; Jiang et al., 2018), in an era of increasingly globalized and charged with various challenges, energy companies are looking for new strategic actions that improve the level of financial performance, motivating them to adopt competitive ESG practices.

With the increasing environmental responsibility of companies, several recent studies suggest that concern for decarbonisation generates good financial performance for both investors and companies (Cheema-Fox et al., 2019; In et al., 2019; Eckerle et al., 2020; França et al., 2021; Ghosh & Gupta, 2022). Cheema-Fox et al. (2019) identified several decarbonisation strategies for a portfolio of US and European listed stocks over the period 2009-2018. The portfolio included companies from sectors with high CO2 emissions as well as from sectors that generate lower emissions. The results show that decarbonisation strategies improve investor returns, with the results being more pronounced for Europe than for the US.

In et al. (2019) analyzed a portfolio of 736 US firms from 2005 to 2015, sorting stocks into 10 groups by market capitalization and 3 groups by carbon intensity. The results obtained also suggested that carbon-efficient groups of firms tend to have better financial performance (ROA, Tobin`s Q, higher cash flow and higher rates of remuneration for shareholders). The results are similar to those obtained by França et al. (2021), who, after studying a sample of companies, for the period 2005-2019, show that decarbonization strategies have a positive impact on the financial performance of companies.

The connection between the attributes of the directors' board and performance or sustainability is also frequently analyzed (Batruch, 2017; Gardazi et al., 2020; Shahbaz et al., 2020; Shakil, 2021). Shahbaz et al. (2020), using as proxies, for financial performance, ROA and Tobin's q ratio, and a sample of energy companies that reported data in the Thomson Reuters Eikon database, for the 2011-2018 timespan, substantiated that further-up CSR performance, induced by governance pillar, would not automatically ensure a better financial performance. Instead, there might be a positive link between energy companies' performance and board composition, highlighting the importance of corporate governance in the adoption of energy sustainability policies.

Analyzing a sample of 70 oil and gas firms for the period 2010-2018, Shakil (2021) shows that board gender diversity acts as a catalyst between ESG and financial risks. Thus, the results of the empirical study reveal, on the one hand, that the weak participation of women in the board of oil and gas companies generates an intensification of the link between ESG and financial risk, and on the other hand, the effects of ESG controversies are highlighted on the overall performance of companies.

As summary, theorists and practitioners are increasingly concerned with examining the benefits that sustainability measures can have on the financial and

non-financial performance of companies (Puime et al., 2022). The literature review considered a series of implications of ESG dimensions on the financial performance of energy companies and other distinct sectors, using different indicators, the results showing inconclusive effects of CSR strategies on their performance and sustainability.

3. Data and methodology

Data was collected from the Refinitiv Eikon database (2021) on 541 publicly reported companies operating in the energy fields, considering the last balance sheet available (year 2020) for the ESG and financial performance indicators. As we can see in Figure 1, the headquarters of these companies are geographically distributed around the world in 8 countries, as follows: the United Kingdom, with 144 listed companies; Germany, with 53 companies; France, with 42 companies; Italy, with 36 companies; Spain, with 18 companies; Denmark, with 8 companies; South Africa, with 16 companies; and Russia, with 224 companies.

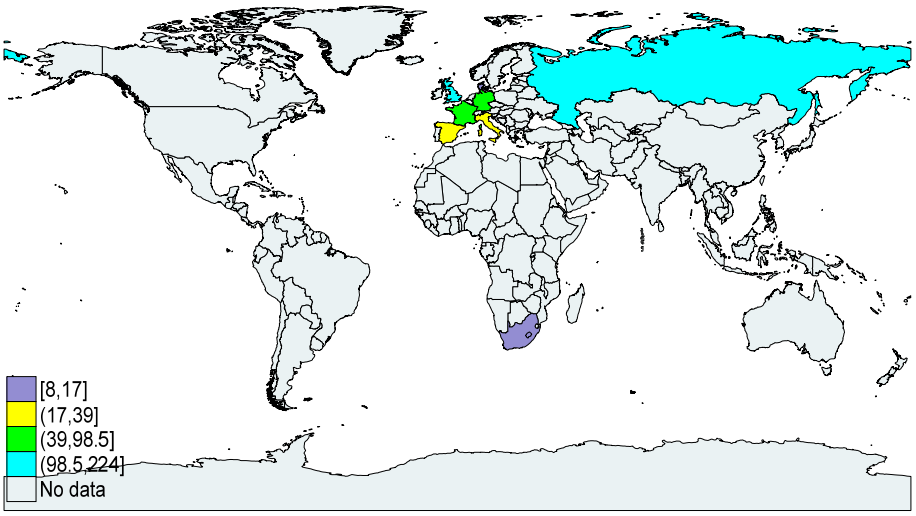

Figure 1. Geographical distribution of energy companies' headquarters

Source: authors' processing based on Refinitiv Eikon database (2021)

The selected indicators were grouped into four categories, as follows (Refinitiv Eikon database, 2021):

1. *Environmental ESG components* (scores 1-100): "total CO2 equivalent emissions to revenues (*CO2_emissions*)"; "targets emissions score (*Targets_emissions*)"; "policy emissions score (*Policy_emissions*)"; "environmental products score (*Env_Products*)";

2. *Social ESG components*: "board size (*Board_size*) (number)"; "board gender diversity (*Board_diversity*) (percent score)"; "women employees (*Women_empl*) (score 1 to 100)"; "average training hours (*Training_h*) (score 1 to 100)";
3. *Governance ESG measures*: "targets diversity and opportunity score (*Targets_Diversity*) (score 1 to 100)"; "policy bribery and corruption score (*Bribery_corrupt*) (score 1 to 100)"; "bribery, corruption and fraud controversies score (*Bribery_corrupt_fraud*) (score 1 to 100)"; "board meetings (*No_board_meet*) (number)"; "compensation committee independence (*Compens_com_indep*) (score 1 to 100)"; "CSR sustainability reporting score (*CSR_report*) (score 1 to 100)"; "CSR strategy score (*CSR_strategy*) (score 1 to 100)"; "ESG score (*ESG*) (score 1 to 100)";
4. *Financial performance indicators*: "earnings before interest and taxes *(EBIT)* (USD, millions)"; "return on assets (*ROA*) (%)"; "return on equity (*ROE*) (%)".

Summary statistics of the data collected from the last balance sheet available (the year 2020) are shown in Table 1. We can see that, among the total number of 541 publicly reported companies from the energy fields, only a number up to 113 companies reported CSR/ESG measures (but not the same). Low mean values were obtained for environmental products (a mean score of 39.89598 out of a maximum of 100), governance components by targets diversity and opportunity policies (a mean score of 29.625 out of a maximum of 100), board size and diversity (a mean of around 10 people, of which the share of women is 42.67%) and the number of board meetings (around 11).

Table 1. Summary statistics of the data collected for the energy companies

	N	Mean	Standard deviation	Minimum	Maximum
EBIT	488	207.9702	1406.517	-13306	21641.77
ROA	273	0.8023809	5.58805	-35.79	51.67
ROE	273	1.392491	21.03129	-188.44	89.05
CO2_emissions	94	54.43447	28.75673	1.85	98.99
Targets_emissions	112	51.54964	39.55718	0	90
Policy_emissions	113	55.54912	21.74405	0	74.36
Targets_diversity	84	29.625	43.32106	0	95.31
Env_products	112	39.89598	34.18424	0	89.08
CSR_report	113	52.07619	15.71216	0	64.71
CSR_strategy	113	55.36735	29.54108	0	97.56
ESG	113	56.40726	21.92129	5.15	92.17
Training_h	61	48.42672	26.56985	1.6	92.02
Women_empl	97	55.61124	28.13141	3.29	98.44

Board_diversity	113	42.67336	29.08549	1.44	98.73
Board_size	113	9.982301	2.887727	3	19
No_board_meet	95	11.34737	9.09263	2	53
Bribery_corrupt	113	51.60212	21.50733	0	70.59
Bribery_corrupt_fraud	113	51.47788	23.22646	0.05	62.93
Compens_com_indep	96	50.28187	28.153	0.24	96.1
N	542				

Source: authors' processing based on Refinitiv Eikon database (2021)

The research endeavour is fundamentally grounded on the theoretical underpinnings detailed in the previous section and, in line with the general objective, it targets the following research hypotheses:

- *H1. Environmental dimensions of ESG directly and considerably influence the financial performance of publicly reported energy companies;*
- *H2. Social dimensions of ESG directly and notably influence the financial performance of publicly reported energy companies;*
- *H3. Governance dimensions of ESG directly and significantly influence the financial performance of publicly reported energy companies;*
- *H4. All ESG dimensions considerably influence (direct, indirect, overall) the financial performance of publicly reported energy companies.*

In order to verify and validate the above-stated research hypotheses, the methodology employed in this research embeds two advanced econometric procedures, namely *models of robust regression* (with Huber and biweight iterations) and *Gaussian/Markov Mixed graphical models (network analysis)*. Both modern econometric techniques are selected relying on their ability to provide robust estimates, thus avoiding spurious correlations, particularly considering that the sample might be affected by outliers and there are different measurement units for the indicators used as variables of the models configured in the empirical analysis.

Robust regression models (RREG) are advanced econometric procedures that eliminate spurious correlations and provide robust estimates, being based on two types of iterations – Huber and biweight – that are processed after Cook's distance is calculated and the outliers are dropped from the sample. The general configuration of the multiple regression model is entailed by equation 1.

$$\begin{aligned} &Financial\_performance\ (EBIT/\ ROA/\ ROE)\ = \\ &\beta_0 + \beta_1 CO2\_emissions + + \beta_2 Targets\_Emissions + \\ &\beta_3 Policy\_emissions + \beta_4 Targets\_diversity + + \beta_5 Env\_products + \beta_6 CSR\_report + \\ &\beta_7 CSR\_strategy + \beta_8 ESG + \beta_9 Training\_h + + \beta_{10} Women\_empl + \beta_{11} Board\_diversity + \\ &\beta_{12} Board\_size + \beta_{13} No\_board\_meet + \\ &+ \beta_{14} Bribery\_corrupt + \beta_{15} Bribery\_corrupt\_fraud + \beta_{16} Compens\_com\_indep + \varepsilon_{it} \end{aligned} \quad (1)$$

where: "β are the regression parameters (coefficients); eit – the compound error term; i = 1, …, m; t is the number of observed time periods" (Anghel et al., 2019, p. 2707).

The methodological endeavour also embeds *the network analysis* to capture the presence and intensity of the connections between all considered variables and the financial performance of companies in the energy sector, in a comprehensive approach. The network of conditional associations takes the form of Gaussian and Mixed-Markov graphical models, processed through partial correlations.

A Gaussian graphical model (GGM) for a random vector X = (X1, ..., Xp) "is determined by a graph G on p nodes and it comprises all multivariate normal distributions $N(\mu, \theta^{-1})$ whose inverse correlation matrix satisfies that $\theta_{jk} = 0$ when $\{j, k\}$ is not an edge in G" (Foygel and Drton, 2010, p. 1; Noja et al., 2021).

The undirected graph "$G = (V, E)$ includes a vertex set $V = \{1, \ldots, p\}$ as well as an edge set $E \subset V \times V$" (Williams, 2019, p. 3). Let "$\Omega_d = (\omega_{ij,d}) = \Sigma_d^{-1}$ for d = 1,2 be the precision matrix for $X = [x^1, \ldots, x^{n1}]^T \in R^{n1xp}$ and $Y = [y^1, \ldots, y^{n2}]^T \in R^{n2xp}$. X and Y denote the data matrices. The precision matrix (inverse covariance matrix) $\Omega = \Sigma^{-1}$ represents a GGM. A GGM associated with X is a graph, where the node set $V = \{x_1, x_2, \ldots, x_p\}$ has p components and the edge set E such that any edge between xk and xj if and only if xk and xj are conditional dependent given all other variables. Similarly, a GGM associated with Y is also a graph" (He et al., 2019, p. 1; Sichigea et al., 2021).

4. Results and discussions

4.1. Results of Robust regression model (RREG)

As regards the direct influences of the indicators selected from each pillar of the ESG practices, the results (Table 2) point out that the variation of these indicators can explain about 92.5% in the variation of EBIT (Table 2, model 1), 84.1% of ROA (Table 2, model 2), and 59.1% of ROE (Table 2, model 3).

In terms of the influences of *ESG environmental pillar* on the financial performance of energy companies, we observe that targets emissions (*Targets_emissions*) have affected positively and statistically significant the financial performance expressed by all selected measures, EBIT, ROA and ROE (Table 2), a distinctive high influence being entailed in the case of EBIT (Table 2, model 1). Policy emissions (*Policy_emissions*) have positively (from the statistical point of view) influenced only the financial performance expressed by EBIT, while high CO2 emissions to revenues (*CO2_emissions*) would induce positive effects on EBIT, that would not be beneficial for the environment. On the same line of unfavorable influence induced on EBIT, we notice also impact of the environmental products (*Env_Products*).

Consequently, hypothesis *H1. Environmental dimensions of ESG directly and considerably influence the financial performance of publicly reported energy companies* is partially fulfilled. For the environmental pillar of ESG, these results imply special attentions paid by energy companies' managers/shareholders for CO2 emissions to revenues and the environmental products.

As for *social pillar of ESG,* the selected variables influenced only EBIT and ROA, while for ROE, the results were not significant from the statistical point of view (Table 2). As much, the score of women employees (*Women_empl*) has induced positive effects both for financial performance expressed by EBIT and ROA (Table 2, model 1 and model 2). Also, average training hours of employees (*Training_h*) also favorable influenced the financial performance related to assets – ROA, which means that investment in human capital is beneficial for motivation and higher knowledge of the employees (Yahya & Goh, 2002). On the other hand, the share of board gender diversity (*Board_diversity*) has not led to positive effects on the EBIT, due to less than half the representation of women in the total board of energy companies (the mean is 42.67336, as it is shown by the summary statistics in Table 1). Likewise, the size of the board (*Board_size*) induced unfavorable impacts on the financial performance expressed by ROA (statistically significant), the average number of board members being of almost 10 members (Table 1 - the mean is 9.982301).

Accordingly, hypothesis *H2. Social dimensions of ESG directly and notably influence the financial performance of publicly reported energy companies* is also partially fulfilled. Therefore, for the social pillar of ESG, special attentions may be paid for reconsideration of women inclusion in the board of energy companies and the total number of the board.

Table 2. Results of Robust regression model (RREG)

Variables	(1)	(2)	(3)
	EBIT	ROA	ROE
CO2_Emissions	36.16***	0.0143	-0.0364
	(8.703)	(0.0262)	(0.101)
Targets_Emissions	36.43**	0.0665*	0.357**
	(10.98)	(0.0306)	(0.118)
Policy_Emissions	140.3*	0.0398	-0.310
	(53.78)	(0.177)	(0.681)
Targets_Diversity	-2.946	-0.0473*	-0.0594
	(6.124)	(0.0174)	(0.0672)
Env_Products	-32.97**	-0.0171	0.0114
	(8.784)	(0.0235)	(0.0907)
CSR_report	-460.4***	-1.375***	1.077
	(110.3)	(0.320)	(1.234)
CSR_strategy	6.187	-0.0361	-0.163
	(14.03)	(0.0366)	(0.141)

ESG	-36.31 (31.51)	-0.105 (0.0938)	-0.390 (0.362)
Training_h	13.04 (10.98)	0.152*** (0.0294)	-0.0194 (0.113)
Women_empl	57.82*** (9.418)	0.0852** (0.0248)	0.0888 (0.0955)
Board_diversity	-69.48*** (7.572)	-0.0133 (0.0215)	0.0265 (0.0829)
Board_size	14.05 (92.34)	-1.108*** (0.260)	-1.403 (1.002)
No_board_meet	-30.70 (33.73)	-0.305** (0.0897)	-0.134 (0.346)
Bribery_corrupt	22.59 (21.24)	0.0687 (0.0502)	0.0197 (0.193)
Bribery_corrupt_fraud	-21.08* (8.805)	-0.0385 (0.0241)	-0.107 (0.0931)
Compens_com_indep	-36.56** (9.683)	-0.0811** (0.0238)	0.117 (0.0917)
_cons	18321.9* (7992.8)	91.52** (25.41)	-1.953 (97.92)
N	32	35	35
R^2	0.925	0.841	0.591

"Standard errors in parentheses, *p<0.05, **p<0.01, ***p<0.001"

Source: authors' processing

As for the *governance pillar of ESG,* the selected measures statistically influenced only EBIT and ROA, with insignificant results, from the statistical point of view, also for ROE (Table 2). In case of these pillar, all the influences induced by governance on EBIT or/and ROA were unfavorable, determined by: targets diversity and opportunity (*Targets_Diversity*) and number of board meetings (*No_board_meet*), with statistical relevance only for ROA (Table 2, model 2); reporting of CSR sustainability (*CSR_report*) and compensation committee independence (*Compens_com_indep*), both for EBIT and ROA (highest unfavorable effects for EBIT); and policy for bribery and corruption (*Bribery_corrupt*), with statistical relevance only for EBIT (Table 2, model 1). As much, for the governance pillar of ESG, special attentions may be paid for all its components.

Therefore, hypothesis *H3. Governance dimensions of ESG directly and significantly influence the financial performance of publicly reported energy companies,* is also partially fulfilled.

4.2. Results of Gaussian/ Markov-Mixed Graphical Models (GGMs/ MGMs)

The results of Gaussian Graphical Models (GGMs) allow the evaluation of connections between the variables selected for the analysis, through the structure taken within the network, revealing both the intensity and type of influences among them. The estimation of the GGMs was performed by two methods, namely by Least Absolute Shrinkage and Selection Operator (LASSO) estimation with Extended Bayesian Information Criterion (EBIC), and by the partial correlation method (PCOR). As regards the connections of *environmental pillar of ESG* with financial performance of energy companies, within the network with all considered variables, both the results using LASSO estimation with EBIC (Figure 2), and PCOR (Figure 3), show that: the emissions of CO2 to revenues (*CO2_emissions*) generated favorable effects in relation with ROA, and unfavorable, in relation with EBIT, but with moderate to low intensity; targets and policy emissions (*Targets_emissions,* respectively *Policy_emissions*) implied favorable and medium intensity in relation with ROA; environmental products (*Env_Products*) generated favorable connection with ROA, and unfavorable one with ROE and EBIT. Therefore, as for the environmental pillar of ESG, the results of network connections point out strategies to be followed by managers of energy companies for CO2 emissions to revenues and the environmental products. These general findings are similar those obtained for direct implications using RREG models.

As for the *social pillar of ESG,* favorable influences were revealed between the number of board members (*Board_size*) and EBIT, women employees (*Women_empl*) and ROA, ROE, respectively training of employees (*Training_h*) and EBIT. Unfavorable influences were captured between the share of women on board (*Board_diversity*), whose average is under 50% for energy companies and EBIT. Similar results for ROA-gender board diversity implication, but opposite for board size-ROA relation, ware obtained by Shahbaz et al. (2020) that have analyzed energy companies from Thomson Reuters Eikon database for the period 2011-2018. Therefore, this dimension requires an adequate reconsideration of women representation on the board of energy companies.

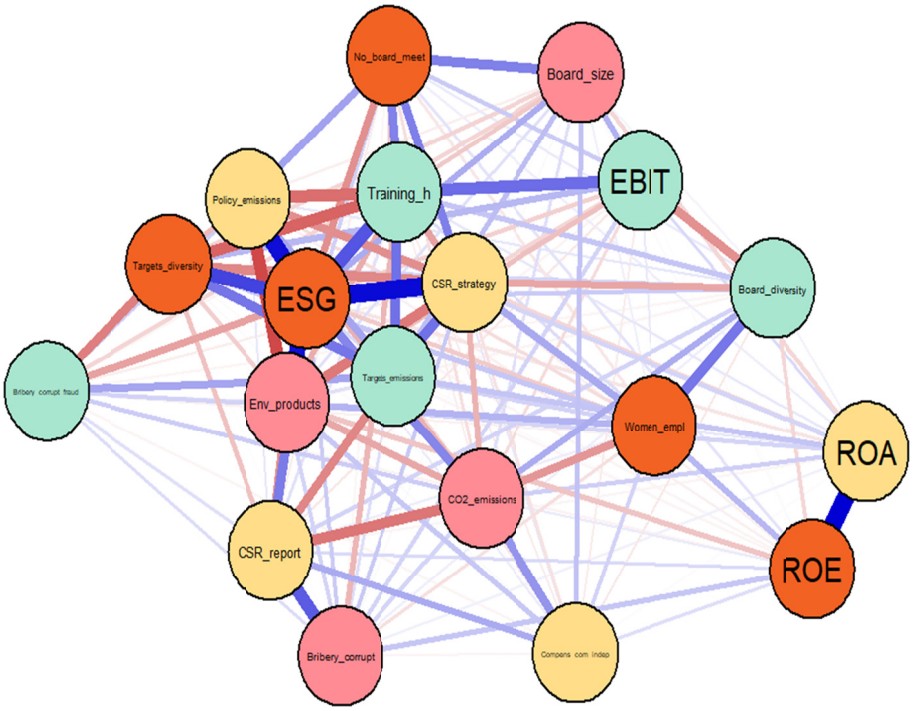

Figure 2. Gaussians and Markov Mixed graphical model - Least Absolute Shrinkage and Selection Operator (LASSO) estimation with Extended Bayesian Information Criterion (EBIC)

Source: authors' processing

As regards the *governance pillar of ESG,* favorable interlinkages were associated between the following pairs of indicators considering the financial performance: targets diversity and opportunity (*Targets_Diversity*) and EBIT; policy bribery and corruption (*Bribery_corrupt*) and EBIT, respectively ROE; board meetings (*No_board_meet*) and EBIT, respectively ROA; compensation committee independence (*Compens_com_indep*), respectively CSR sustainability reporting (*CSR_report*) and ROE. Unfavorable influences were associated between the following governance dimensions and financial performance: policy bribery and corruption (*Bribery_corrupt*), ESG score (*ESG*), respectively CSR strategy (*CSR_strategy*) and EBIT; ESG score (*ESG*) and ROA, but with low intensity. As such, adequate strategies and measures as regards for the governance pillar of ESG are needed for policy bribery and corruption, total ESG score and CSR strategy.

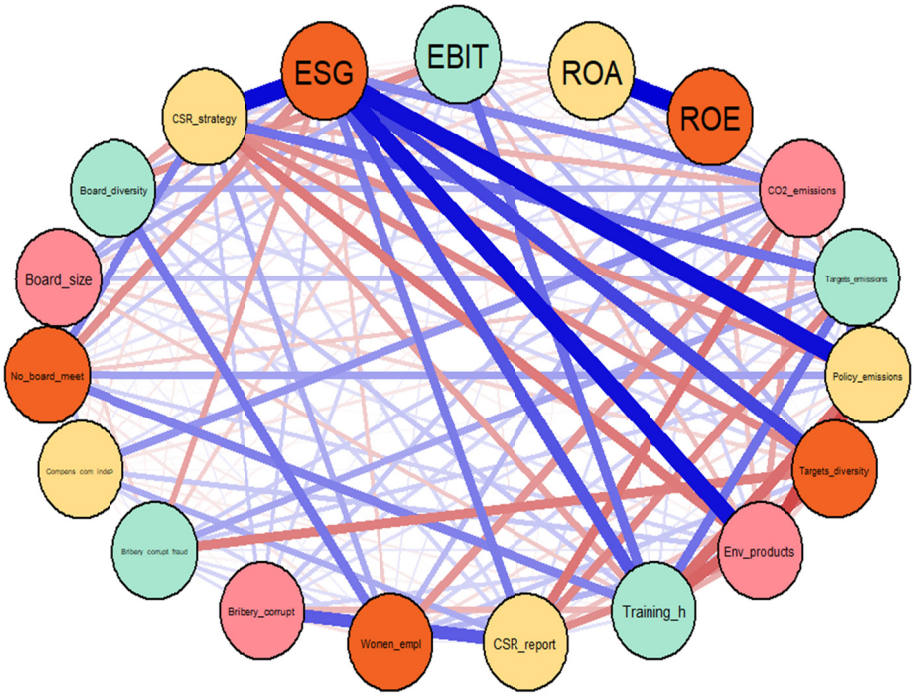

Figure 3. Gaussian and Markov Mixed graphical model - Partial correlation (PCOR) estimation

Source: authors' processing

Moreover, apart from the direct associations with financial performance, several partial correlations were induced with the ESG measures, in association of two-by-two variables, namely: CO2 emissions negatively connected with environmental products (*Env_Products*), targets emissions (*Targets_emissions*), reporting of CSR sustainability (*CSR_report*), CSR strategy (*CSR_strategy*), respectively women employees (*Women_empl*), on the one hand. On the other hand, CO2 emissions are positively associated with compensation committee independence (*Compens_com_indep*), ESG score (*ESG*) and board gender diversity (*Board_diversity*). Targets emissions (*Targets_emissions*) are favorably linked with CSR strategy (*CSR_strategy*) and training of employees (*Training_h*), respectively policy emissions (*Policy_emissions*), with ESG score (*ESG*) and the number of board meetings (*No_board_meet*).

Besides policy emissions, ESG scores are highly related to targets diversity and opportunity, environmental products, training hours of employees, CSR sustainability reporting and strategy. Unfavorable and strong connections with total

ESG score were induced by number of board meetings and bribery, corruption, and fraud controversies.

Consequently, hypothesis *H4. All ESG dimensions considerably influence (direct, indirect, overall) the financial performance of publicly reported energy companies,* is partially fulfilled. These results are in line with those obtained by Shahbaz et al. (2020, p. 9), using ROA as proxy for financial performance, that evidenced weak associations between financial performance and environmental, social, and governance components, and stated that "CSR engagement does not necessarily lead to higher corporate performance in the energy sector".

5. Conclusions

According to the general research objective, in this paper, we appraised the interconnections between the ESG components, assessed through each distinctive pillar, and the financial performance of publicly reported companies from energy fields. Through the two econometric methods applied, namely *robust regression models (RREG)* and *Gaussian/Markov Mixed graphical models* (GGM), we assessed both direct influences of ESG measures on the financial performance of energy companies (hypotheses H1-H3, for environmental, social, and governance pillar), and the global (direct, indirect, and overall) interconnections in the synergy ESG-financial performance measures (hypothesis H4).

For the environmental pillar of ESG, considering the negative implications on financial performance of energy companies, as revealed by all four research hypotheses (H1-H4), specific policies and strategies must be implemented to: deplete CO2 emissions through innovation and orientation towards renewable sources of energy (such as wind, solar, bioenergy, or green hydrogen) that be sustained by policymakers, the more so as the new crisis of energy induced by the invasion of Ukraine by Russia may cause a vicious circle in terms of the reorientation of countries on new fossil fuels resources in order to replace the gas provided by Russia – which may "either end up as massive stranded assets or they'll lock the world into irreversible warming" (Climate Action Tracker, 2022, p. i); reorientation of the energy companies and better configured policies for environmental products.

As for the social pillar of ESG, to raise financial performance, specific policies must be applied for: a reconsideration of women's inclusion on companies' boards, as Shahbaz et al. (2020) also recommended for this domain, since the female representation in the energy companies' board is very low in some companies (revealed by summary statistics in Table 1 - the minimum value is 1.44 shown, and the mean – 42.67%).

For enhancing the governance measures to sustain financial performance, special attention should be paid to better targets/policies for diversity and opportunity, but also for control and removal against bribery and corruption; hearten directors/managers for board meetings attendings; as regards CSR

sustainability report, policymakers should state "clear regulations about what items should be disclosed in the annual report (...) increasing the extent of CSR reporting should be done" (Ika et al. 2021, p. 6; Cristea et al., 2022); moreover, as Karaman et al. (2021) proved, a higher CSR performance strong would ensure a better CSR reporting; ensuring the independence of compensation committee.

Notwithstanding the fact that this research enhances the literature in the field and brings valuable ideas for policymakers and managers of energy companies, the results are under some limitations, namely: the sample comprises only publicly reported companies and the results cannot be generalized to all energy companies, including the non-listing ones; there is a lack of reported data by several companies that may induce misrepresentation of econometric results; the sample includes energy companies from Russia that, on the geopolitical events following the invasion of Ukraine by Russia, including these companies may be seen with caution. Future research will focus on specific regions, distinctive fields of energy, respectively, conventional and renewable fields, and will include governance/institutional indicators.

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