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ANALYZING HOW ESG FACTORS DRIVE FINANCIAL RETURNS: EVIDENCE FROM PANEL DATA OF LEADING US HEALTHCARE COMPANIES

Explorando como os fatores ESG impulsionam os retornos financeiros: evidências de dados em painel de empresas líderes do setor de saúde nos EUA

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ABSTRACT

This study advances the understanding of the relationship between Environmental, Social, and Governance factors and firm performance by conducting an in-depth analysis of companies from the United States included in the Standard and Poor's 500 index. The investigation focuses on 61 entities from the healthcare sector, covering the period 2000–2024, uses linear and nonlinear regression models with fixed and random effects, as well as interaction variable models. The timeframe includes the global health crisis gene, thereby enabling an examination of how crisis conditions interact with Environmental, Social, and Governance determinants. Empirical evidence indicates that total energy consumption exerts a positive influence on financial and market performance, while the number of employees is positively associated with return on assets and the price-to-earnings ratio. Auditor tenure also demonstrates a beneficial impact on corporate results. Non-linear modelling identifies a critical threshold for total energy consumption at 13.92, beyond which its impact transitions from negative to positive while retaining statistical significance. Interaction models incorporating pandemic-related variables suggest that the crisis period was associated with increases in both workforce size and auditor tenure. Overall, the results reveal the complex interdependence between sustainability-related factors, firm performance, and exogenous shocks, offering significant implications for policy formulation and strategic corporate governance.

Keywords: Corporate governance, Sustainability, Financial performance, Market performance

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EXPLORANDO COMO OS FATORES ESG IMPULSIONAM OS RENDIMENTOS FINANCEIROS: PAINEL DE EVIDÊNCIAS DE DADOS DAS PRINCIPAIS EMPRESAS DE SAÚDE DOS EUA

Analyzing how ESG factors drive financial returns: evidence from panel data of leading US healthcare companies

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RESUMO

Este estudo avança na compreensão da relação entre os fatores ambientais, sociais e de governação e o desempenho das empresas, conduzindo uma análise aprofundada das empresas dos Estados Unidos incluídas no índice Standard and Poor's 500. A investigação centra-se em 61 entidades do setor da saúde, abrangendo o período 2000-2024, utiliza modelos de regressão linear e não linear com efeitos fixos e aleatórios, bem como modelos de variáveis de interação. O calendário inclui o gene da crise sanitária mundial, permitindo assim uma análise de como as condições de crise interagem com os determinantes ambientais, sociais e de governação. A evidência empírica indica que o consumo total de energia exerce uma influência positiva no desempenho financeiro e de mercado, enquanto o número de empregados está positivamente associado ao retorno dos activos e ao rácio preço/lucro. A permanência do auditor demonstra também um impacto benéfico nos resultados empresariais. A modelação não linear identifica um limiar crítico para o consumo total de energia em 13,92, para além do qual o seu impacto transita de negativo para positivo, embora mantendo a significância estatística. Os modelos de interação que incorporam variáveis relacionadas com a pandemia sugerem que o período de crise esteve associado a aumentos tanto no tamanho da força de trabalho como no mandato dos auditores. No geral, os resultados revelam a complexa interdependência entre factores relacionados com a sustentabilidade, desempenho das empresas e choques exógenos, oferecendo implicações significativas para a formulação de políticas e governação corporativa estratégica.

Palavras-chave: Governação corporativa, Sustentabilidade, Desempenho financeiro, Desempenho de mercado

INTRODUCTION

Profitability continues to occupy a central position in the field of corporate finance, functioning not only as a measure of financial success but also as a critical determinant of strategic direction and resource allocation. The academic debate concerning the drivers of profitability has generated multiple perspectives, among which corporate governance has increasingly been recognized as a factor of primary importance. This study examines how environmental, social, and governance (ESG) indicators influence firm performance, with a particular focus on healthcare companies included in the S&P 500 index over the period 2000–2024. The healthcare sector was selected due to its systemic importance in the global economy and its marked fluctuations in performance, which have been shaped by technological innovation, regulatory transformations, demographic shifts, and changing patterns of demand. The S&P 500 index provides a comprehensive and representative benchmark for assessing the relationship between governance mechanisms and profitability within the United States market.

The central research question addresses the extent to which specific ESG dimensions, namely energy consumption, employee headcount, and auditor tenure, affect profitability outcomes in the healthcare sector. These indicators have been chosen not only for their empirical measurability but also for their relevance to current debates on sustainability, efficiency, and accountability in corporate management. Understanding these relationships is essential for business leaders, investors, and regulators who must reconcile financial objectives with broader concerns relating to resilience, sustainable growth, and long-term competitiveness. By focusing on a sector characterized by repeated cycles of disruption and structural adjustment, the study offers insights into how governance practices can function as stabilizing mechanisms in dynamic environments.

Several aspects distinguish the present research design. The longitudinal scope of 25 years makes it possible to capture the long-term evolution of ESG practices and their effects across different phases of the economic cycle, including expansion, stability, and recession. The use of nonlinear regression models introduces a methodological refinement that allows for the identification of complex and non-proportional relationships between ESG factors and profitability. Furthermore, the incorporation of a dummy variable reflecting the COVID-19 pandemic provides an additional analytical dimension, enabling the assessment of governance performance under extraordinary circumstances. This approach enhances the robustness of the findings by identifying those governance elements that mitigate, or conversely intensify, the effects of systemic crises.

The broader significance of this research lies in its contribution to the ongoing debate on the relationship between ESG practices and financial outcomes. By offering empirical evidence on how ESG factors affect profitability, the study advances transparency in corporate reporting and underscores the relevance of ethical and responsible management. The results may contribute to attracting international investment, promoting the diffusion of sustainable business strategies, and improving governance standards across industries. These findings are especially pertinent in an increasingly globalized economy, where firms must operate within diverse regulatory frameworks, address heightened stakeholder expectations, and respond to intensifying competitive pressures.

The structure of the paper reflects a logical and coherent progression of analysis. The introduction outlines the objectives and rationale of the study, followed by a literature review situating the research within broader debates on governance and corporate performance. The methodology section specifies the data sources and econometric techniques, with particular emphasis on the use of nonlinear models and crisis-related variables. The empirical results are presented systematically and discussed in relation to both theoretical contributions and managerial implications. The conclusion summarizes the principal findings, identifies limitations, and suggests avenues for further research, thereby providing a foundation for continued academic exploration of the relationship between ESG indicators and profitability.

1 LITERATURE REVIEW

Total energy used, as an ESG indicator, has been studied by Simionescu et al. (2020), who analyzed S&P 500 Information Technology firms from 2009 to 2020. Their study included accounting measures and market-based indicators, alongside firm and governance variables. Results showed a positive impact of al energy consumption but had no statistically significant effect. Additionally, the statistical analysis focused on multivariate techniques. Pham et al., (2024) further demonstrated a positive association between energy consumption and firm performance.

Their study encompassed a substantial sample of approximately 40.000 Vietnamese firms over the period 2011–2020. Utilizing panel regression models, the analysis accounted for both firm-specific and temporal variations, providing robust evidence that higher energy consumption is linked to improved corporate performance in this context. Also, Berrada & Meknassi, (2024) discuss these aspects in their study.

The number of employees within a company is also considered an ESG variable. This factor was examined by authors such as Lee, (2017), who analyzed panel data from 2010 to 2014 covering agencies of the United States federal government. Their empirical findings indicate a positive relationship between the number of employees and organizational performance, with variations depending on specific organizational contexts. Mia et al., (2022) examined the impact of employee turnover on the financial performance of 1,561 microfinance institutions (2010–2018) using panel econometric methods. The study found that turnover generally has a negative effect on performance, varying by performance measure, legal status, location, profit orientation, and model, with no evidence of a quadratic relationship. Also, Germi, et al., (2015) discuss these aspects in their study.

Auditor tenure is another indicator related to ESG. Sterling & Gilles, (2018) have shown mixed results, with some reporting positive or negative effects on audit quality. More recent evidence suggests an inverted U-shaped relationship: audit quality improves in the early years as auditors gain firm-specific knowledge but declines with very long tenure due to entrenchment and reduced independence. They analyze S&P 1500 firms in the United States over the 1998–2010 period, employing pooled sample regressions to test the relation between board tenure and firm performance. Also, Livnat et al., (2021) analyzed a dataset of 3800 firms over a 20-year period and documented that longer board tenure is associated with higher subsequent abnormal returns. Their evidence also points to a mispricing effect, as markets reward firms with long-tenured boards through higher valuations, but this pattern is not reflected in higher expected returns. Also, Siqueira & Galdi, (2020) discuss these aspects in their study.

Firm size has been widely investigated as a determinant of corporate performance. Hossain, (2020), analyzing 34 industrial firms listed on the Dhaka Stock Exchange for the period 2014–2019 using panel regression models, found a positive and statistically significant relationship between firm size and profitability, measured by ROA and ROE. In contrast, Margaretha & Supartika, (2016) studied 22 technology firms in Indonesia and reported that larger firms exhibited lower financial performance than smaller ones, attributing this to increased bureaucratic complexity and management challenges. These findings suggest that firm size may affect profitability in different ways depending on the sector and management structure.

Company age, calculated as the difference between the current year and the founding year, is another important factor. Rahman & Yilun, (2021) noted that older firms tend to have more formalized procedures and centralized structures, which can slow decision-making and reduce operational efficiency, potentially affecting profitability. Similar results were observed by Margaretha & Supartika, (2016). Conversely, Charles et al., (2018), studying 22 consumer goods firms from 2011–2016, reported a positive but statistically insignificant effect of firm age on profitability, consistent with Hossain, (2020).

The annual growth rate of sales revenue has also been linked to performance. Nazir et al., (2021), analyzing 30 firms on the Pakistan Stock Exchange (2013–2017), found a positive relationship between sales growth and profitability. Similar positive associations were reported by Charles et al., (2018) and Hossain, (2020). However, Margaretha & Supartika, (2016) observed a negative effect, arguing that higher sales may increase costs related to advertising, storage, packaging, and delivery, potentially reducing net profitability.

The impact of the effective tax rate on profitability has produced mixed findings in the literature. Ștefănescu et al., (2018), using panel data from 20 Romanian industrial firms (2013–2015), found a negative and significant relationship between ETR and ROA. Conversely, Olabisi et al., (2019), studying five Nigerian firms (2012–2017), reported a positive and significant relationship, arguing that profitable firms pay more taxes and that effective tax planning can enhance returns.

Current ratio, as a measure of liquidity, has also been examined. Pervan et al., (2019) observed a positive but statistically insignificant relationship between current ratio and profitability, while Charles et al., (2018), as well as Hossain, (2020), reported negative but also insignificant effects.

Long-term leverage can influence firm performance. Odusanya et al., (2018) found a negative relationship, suggesting that higher debt increases bankruptcy risk and reduces reinvestment capacity. Similar negative relationships were noted by Charles et al., (2018) and Hossain, (2020). In contrast, Mohan & Chandramohan,

(2018) found a positive and significant effect, arguing that debt can incentivize managers to increase productivity and carefully manage cash flows and investments to meet obligations.

The pandemic crisis represents the final control variable examined in this study. Turkson et al., (2021) investigated its effects on 419 Italian firms during 2020, employing regression models with interaction terms. Their results indicated a negative impact, emphasizing the substantial financial pressures that the pandemic imposed on Italian companies. In a similar vein, Chu et al., (2021) analyzed 70 real estate firms listed on the Shanghai and Shenzhen Stock Exchanges in 2020 using time series methods, also reporting a negative influence, reflecting the considerable disruptions experienced in the Chinese real estate sector due to the pandemic.

Table 1 presents a comprehensive overview of the key studies and findings from the specialized literature considered in this research.

Table 1 - Overview of the Literature Review

Indicators	Study	Companies	Years	Methodology	Effect
Energy Used Total	Simionescu et al., (2020)	S&P 500 Information Technology firms	2009 – 2020	Multivariate panel data regression models	+
	Pham et al., (2024)	40.000 Vietnamese firms	2011 – 2020	Panel data linear regressions	+
Number of Employees	Lee, (2017)	agencies of the United States federal government	2010 – 2014	Panel data linear regressions	+
	Mia et al., (2022)	1,561 microfinance institutions	2010 – 2018	Panel data linear regressions	-
Auditor Tenure	Sterling & Gilles, (2018)	S&P 1500 firms in the United States	1998 – 2010	Panel data linear regressions	+
	Livnat et al., (2021)	3800 firms	1996 – 2016	Panel data linear regressions	+
Firm Size	Hossain, (2020)	34 industrial firms listed on the Dhaka Stock Exchange	2014 – 2019	Panel data linear regressions	+
	Margaretha & Supartika, (2016)	22 technology firms in Indonesia	2010 – 2015	Panel data linear regressions	-
Firm Age	Rahman & Yilun, (2021)	40 companies on the Chinese market	2008 – 2018	Panel data linear regressions	-
	Margaretha & Supartika, (2016)	22 technology firms in Indonesia	2010 – 2015	Panel data linear regressions	-
	Charles et al., (2018)	22 consumer goods firms	2011 – 2016	Panel data linear regressions	+
	Hossain, (2020)	34 industrial firms listed on the Dhaka Stock Exchange	2014 – 2019	Panel data linear regressions	+
Sales Revenue Growth Rate	Nazir et al., (2021)	30 firms on the Pakistan Stock Exchange	2013 – 2017	Panel data linear regressions	+
	Charles et al., (2018)	22 consumer goods firms	2011 – 2016	Panel data linear regressions	+
	Hossain, (2020)	34 industrial firms listed on the Dhaka Stock Exchange	2014 – 2019	Panel data linear regressions	+
	Margaretha & Supartika, (2016)	22 technology firms in Indonesia	2010 – 2015	Panel data linear regressions	-
Effective Tax Rate	Ștefănescu et al., (2018)	20 industrial companies listed on the Bucharest Stock Exchange	2013 – 2015	Panel data linear regressions	-
	Olabisi et al., (2019)	5 Nigerian companies	2012 – 2017	Panel data linear regressions	+
Current Ratio	Pervan et al., (2019)	200 industrial companies in Croatia	2006 – 2015	GMM Model	+
	Charles et al., (2018)	22 companies dealing with consumer goods	2011 – 2016	Panel data linear regressions	-
	Hossain, (2020)	34 industrial companies listed on the Dhara Stock Exchange	2014 – 2019	Panel data linear regressions	-
Debt to Capital	Odusanya et al., (2018)	144 companies listed on the Nigerian Stock Exchange	1998 – 2012	GMM Model	-
	Charles et al., (2018)	22 companies dealing with consumer goods	2011 – 2016	Panel data linear regressions	-

	Hossain, (2020)	34 industrial companies listed on the Dhara Stock Exchange	2014 – 2019	Panel data linear regressions	-
	Mohan & Chandramohan, (2018)	30 listed companies on the Bombay Stock Exchange	2007 – 2017	Panel data linear regressions	+
Pandemic Crisis	Turkson et al., (2021)	419 Italian firms	2020	Regressions with interaction variables	-
	Chu et al., (2021)	70 real estate enterprises traded on the Shanghai and Shenzhen Stock Exchanges	2020	Time series analysis	-

Source: Authors' work

The present study is structured around the following research hypotheses:

H1: Total energy consumption exerts a positive influence on financial and market performance.

H2: The size of the workforce, measured by the number of employees, is positively associated with financial and market performance.

H3: Auditor tenure has a negative effect on financial and market performance.

2 METHODOLOGY

2.1 Description of the Database and Variables

This study focuses on healthcare companies included in the S&P 500 index over the period 2000–2024, comprising a total sample of 61 firms. Drawing on data from the Thomson Reuters Eikon platform, the analysis examines the financial and market performance of these firms across more than two decades. The primary objective is to evaluate how industry-specific developments have shaped key financial indicators and ESG structures within the healthcare sector. The findings are expected to enhance understanding of the broader economic and social dynamics influencing the healthcare industry and their implications for contemporary market behavior.

Table 2 provides a comprehensive summary of the research variables, presenting their respective symbols, economic definitions, and methods of calculation.

Table 2 - Overview of Key Variables

Dependent variables	Symbol	Meaning	Measurement
Return on Equity	ROE	Represents the annual return that shareholders receive from their investment in the company's equity.	$\text{ROE} = \frac{\text{Net profit}}{\text{Equity}}$
Return on Assets	ROA	Represents the annual financial return that shareholders obtain from their investment in the company's assets.	$\text{ROA} = \frac{\text{Net profit}}{\text{Total assets}}$
Price-to-Earnings Ratio	PER	Represents a financial metric showing how many monetary units investors pay for each unit of a company's earnings.	$\text{PER} = \frac{\text{Price per Share}}{\text{Earnings per Share}}$
Earnings per Share	EPS	Represents a profitability measure indicating the portion of a company's net income allocated to each outstanding share.	$\text{EPS} = \frac{\text{Net income}}{\text{Number of Shares}}$
Independent variables	**Symbol**	**Meaning**	**Measurement**
ESG Variables			
Energy Use Total	EUT	Total energy consumed by a company, including direct and indirect sources.	$\text{EUT} = \text{Direct Energy Consumption} + \text{Indirect Energy Consumption}$
Number of Employees	NE	Total number of full-time and part-time employees in the company.	$\text{NE} = \text{Full time Employees} + \text{Part time Employees}$
Auditor Tenure	AT	Number of years the current auditor has served the company.	$\text{AT} = \sum \text{Years of Service of Current Auditc}$
Control Variables			
Firm Size	FS	Measured as the natural logarithm of the company's total sales revenue.	$\text{FS} = \ln(\text{Sales Revenue})$

Firm Age	FA	Represents the number of years since the company was founded.	$FA = Year_{t} - Year_{foundation}$
Sales Revenue Growth Rate	GW	The annual percentage change in the company's sales revenue.	$SRGR = \left(\frac{\text{Sales revenue}_{t}}{\text{Sales revenue}_{t-1}}\right) - 1$
Effective Tax Rate	ETR	The proportion of a company's pre-tax income that is paid as income taxes.	$ETR = \frac{\text{Taxes Paid}}{\text{Earnings before Tax}}$
Current Ratio	CR	Indicates a company's ability to meet its short-term financial obligations.	$CR = \frac{\text{Current assets}}{\text{Short term liabilities}}$
Debt to Capital	DC	Measures a company's capacity to fulfill long-term financial commitments.	$DC = \frac{\text{Long term liabilities}}{\text{Equity} + \text{Long term liabilities}}$
Pandemic Crisis	COVID	A binary variable indicating whether a pandemic occurred in a given year.	Binary variable: 1 if the year is 2020, 2021, or 2022; 0 if it is any other year.

Source: Authors' work

The calculation formulas presented in Table 2 follow the methodologies described in established sources, including Stancu & Stancu, (2012) and Anghelache, (2009).

2.2 Description of Econometric Methods

The econometric analysis in this study was conducted using Stata software. The dataset was imported into the program to carry out a full analysis, including the calculation of descriptive statistics and the construction of a Pearson correlation matrix. Prior to analysis, the data were prepared to ensure robustness: outliers were identified and a winsorization procedure was applied to all variables except EUT, NE, AT, FS, FA, and COVID. Under the 90% winsorization approach, values above the 95th percentile were replaced with the 95th percentile, and values below the 5th percentile were replaced with the 5th percentile. All subsequent analyses were based on these winsorized datasets.

The study employed a stepwise quantitative methodology. In the first stage, baseline regression models were estimated without accounting for fixed or random effects to generate preliminary results. Next, both fixed effects and random effects linear regressions were conducted. The choice of the most suitable model was determined using the Hausman test at a 5% significance level: models with p-values exceeding 0.05 were treated as random effects, while those with p-values below 0.05 were considered fixed effects.

To assess the impact of the COVID-19 pandemic, interaction variables were incorporated into the regression models. For these models, fixed effects regressions were initially estimated, followed by random effects regressions and Hausman tests to confirm the appropriate model selection. Furthermore, nonlinear regression models were evaluated to examine interactions between pairs of independent variables. The procedure applied to these nonlinear models was consistent with that used for the linear regressions.

A summary of the regression model specifications is provided below. Linear regression models were estimated following Equation 1:

$$Firm\ performance_{it} = a_0 + a_1 Financial\ variables_{it} + a_2 ESG\ variables_{it} + a_3 COVID_{it} + \varepsilon_{it} \quad (1)$$

The general specifications for the nonlinear regression models are outlined in Equation 2:

$$Firm\ performance_{it} = a_0 + a_1 Financial\ variables_{it} + a_2 Financial\ variables_{it}^2 + a_3 ESG\ variables_{it} + a_4 ESG\ variables_{it}^2 + a_5 COVID_{it} + \varepsilon_{it} \quad (2)$$

The general specification for regression models including an interaction term is presented in Equation 3:

$$Firm\ performance_{it} = a_0 + a_1 Financial\ variables_{it} + a_2 Financial\ variables_{it} * COVID_{it} + a_3 ESG\ variables_{it} + a_4 ESG\ variables_{it} * COVID_{it} + a_5 COVID_{it} + \varepsilon_{it} \quad (3)$$

Where: a_0 = constant; $a_1 \ldots a_{10}$ = denote the coefficients associated with the explanatory variables; ε = the error term; firm performance = [ROE, ROA, PER, ESP]; financial variables = [FS, FA, GW, ETR, CR, DC, COVID]; ESG variables = [EUT, NE, AT]; i = [1, 61]; t = [2000, 2024].

The next chapter is dedicated to a detailed interpretation and analysis of the econometric findings, alongside an assessment of their implications within the broader economic framework.

3 RESULTS AND DISCUSSIONS

3.1 Descriptive Statistics and Correlation Analysis

Table 3 presents a detailed overview of the descriptive statistics for the dataset. The analysis of mean and standard deviation values allows for an evaluation of the variability of the variables included in the study. Variables such as return on assets, earnings per share, sales revenue growth rate, and the pandemic indicator exhibit standard deviations exceeding their mean values, reflecting considerable fluctuation and instability within the dataset. Conversely, variables with standard deviations below their mean suggest greater stability and lower variability. The table also reports the minimum and maximum values for each variable, providing additional information on the overall range and dispersion of the data employed in this research.

Table 3 - Descriptive Statistics

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
ROE w	1171	.214	.2	-.245	.771	.676	5.354
ROA w	1411	.065	.078	-.164	.191	-1.138	5.007
PER w	1248	29.824	19.465	10.396	85.945	1.59	4.882
EPS w	1386	4.365	4.434	-.29	16.89	1.453	4.45
EUT	506	14.777	1.397	11.17	17.119	-.293	2.195
NE	1033	9.987	1.258	6.377	12.995	-.446	2.894
AT	1025	14.481	7.176	1	35	.08	2.215
FS	1433	22.534	1.931	10.82	26.715	-.651	4.387
FA	1283	35.301	31.635	1	137	1.337	3.883
GW w	1373	.12	.147	-.077	.529	1.4	4.631
ETR w	1289	.244	.11	.03	.418	-.252	2.115
CR w	1346	2.299	1.352	.919	6.009	1.419	4.183
DC w	1419	.36	.22	.003	.868	.491	2.955
COVID	1525	.12	.325	0	1	2.339	6.47

Source: Authors' work

Skewness is an important statistical measure used to assess the asymmetry of a variable's distribution. In the analyzed dataset, all variables show skewness values that differ substantially from zero, indicating notable asymmetry. Return on assets, total energy used, number of employees, firm size, and effective tax rate exhibit negative skewness, reflecting distributions with longer left tails, whereas the remaining variables display positive skewness, indicating longer right tails.

Kurtosis is another key metric, describing the peakedness or flatness of a distribution. Some variables, including total energy used, number of employees, auditor tenure, effective tax rate and debt to capital, have kurtosis values below 3, corresponding to platykurtic distributions with flatter tails. Variables with kurtosis above 3 exhibit leptokurtic distributions, characterized by sharper peaks and positive excess kurtosis.

Assessing correlations among variables is a fundamental aspect of descriptive analysis. Table 4 presents the correlation matrix, providing insight into the linear relationships between the variables included in the study.

Table 4 - Matrix of correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) ROE_w	1.000								
(2) ROA_w	0.432	1.000							
(3) PER_w	-0.045	-0.333	1.000						
(4) EPS_w	0.351	0.158	-0.149	1.000					
(5) EUT	-0.014	-0.228	-0.195	-0.037	1.000				
(6) NE	-0.148	-0.417	-0.157	0.029	0.774	1.000			
(7) AT	0.102	-0.024	0.196	0.338	-0.169	-0.053	1.000		
(8) FS	-0.068	-0.381	-0.240	0.215	0.673	0.795	-0.021	1.000	
(9) FA	-0.021	-0.005	0.035	-0.131	0.521	0.340	0.047	0.170	1.000

(10) GW_w	0.041	0.090	0.156	0.041	-0.163	-0.112	0.010	-0.011	-0.094
(11) ETR_w	-0.154	-0.085	0.037	-0.117	0.043	0.080	-0.222	0.100	-0.185
(12) CR_w	-0.124	0.290	-0.020	-0.209	-0.383	-0.521	-0.037	-0.497	-0.165
(13) DC_w	0.493	-0.166	0.109	0.417	0.023	0.049	0.155	0.191	-0.173
(14) COVID	0.174	0.024	0.194	0.265	-0.081	0.007	0.259	0.035	-0.071
Variables	(10)	(11)	(12)	(13)	(14)				
(10) GW_w	1.000								
(11) ETR_w	-0.008	1.000							
(12) CR_w	0.008	-0.135	1.000						
(13) DC_w	0.048	-0.078	-0.239	1.000					
(14) COVID	0.165	-0.119	-0.129	0.208	1.000				

Source: Authors' work

In this study, a correlation coefficient above 0.75 was considered indicative of a strong positive relationship, whereas a coefficient below -0.75 denoted a strong negative relationship. Based on this criterion, a strong correlation was identified between NE and EUT, as well as between FS and NE. Consequently, to avoid multicollinearity, these highly correlated variables will not be included simultaneously in the same regression model.

3.2 Results of the Regression Models

The results are summarized in Tables 5, 6, and 7. Table 5 presents the estimates from linear regression models, including the incorporation of fixed effects and random effects.

Table 5 - Linear Regression Models

	(1) ROE_w *re*	(2) ROE_w *re*	(3) ROA_w *re*	(4) ROA_w *fe*	(5) PER_w *fe*	(6) PER_w *fe*	(7) EPS_w *fe*	(8) EPS_w *fe*
EUT		-0.0157		-0.00518		7.438**		0.659*
		(-1.00)		(-0.90)		(2.86)		(2.49)
NE	-0.0376**		-0.0126***		1.979		2.043***	
	(-3.26)		(-4.13)		(1.01)		(8.57)	
AT	0.00108	-0.00062	-0.00059*	-0.0018**	-0.149	0.556*	0.113***	0.0365
	(0.98)	(-0.38)	(-2.06)	(-3.22)	(-0.79)	(2.07)	(4.89)	(1.36)
FA	0.000739	0.000388	0.0000341	-0.0019**	1.024***	1.923***	0.207***	0.106***
	(1.27)	(0.57)	(0.21)	(-2.84)	(4.91)	(6.21)	(8.15)	(3.40)
GW_w	0.0818	0.117	0.0324**	0.0447*	24.48***	21.08*	2.519***	0.657
	(1.92)	(1.63)	(2.93)	(2.40)	(4.69)	(2.51)	(3.94)	(0.77)
ETR_w	-0.195***	-0.163*	-0.0872***	-0.0621**	55.99***	65.23***	-0.724	-0.734
	(-3.43)	(-1.97)	(-5.94)	(-2.92)	(7.65)	(6.65)	(-0.83)	(-0.76)
CR_w	-0.023***	-0.049***	0.00294	-0.00343	-2.506**	-1.038	0.114	-0.0197
	(-3.79)	(-5.52)	(1.80)	(-1.49)	(-3.20)	(-1.00)	(1.20)	(-0.19)
DC_w	0.241***	0.341***	-0.0513***	-0.0254	13.29**	4.612	1.811**	4.130***
	(6.42)	(5.91)	(-5.29)	(-1.58)	(2.66)	(0.63)	(3.01)	(5.64)
COVID	0.0404**	0.0250	0.0111***	0.00574	0.503	2.099	0.922***	0.473*
	(3.25)	(1.54)	(3.42)	(1.40)	(0.32)	(1.14)	(4.85)	(2.52)
FS		-0.0261		0.0374***		-20.9***		4.477***
		(-1.53)		(3.85)		(-4.79)		(10.10)
_cons	0.561***	1.079**	0.244***	-0.557**	-42.39*	289.9***	-26.0***	-116.0***
	(4.84)	(3.12)	(7.91)	(-2.88)	(-2.29)	(3.34)	(-11.62)	(-13.12)
Obs	793	409	829	427	822	424	829	427
R-sq	0.184	0.241	0.166	0.0438	0.00000346	0.00994	0.0166	0.0153
F-stat				7.724***	20.90***	14.46***	183.6***	114.7***
Wald	155***	119***	146***					
Hausman Test	9.73	12.33	5.58	58.66***	92.73***	55.03***	94.77***	105.15***

t statistics in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Authors' work

Table 6 presents the regression models that include non-linear factors.

Table 6 - Non-Linear Regression Models

	(1) PER_w	(2) PER_w	(3) PER_w	(4) EPS_w	(5) EPS_w *fe*	(6) EPS_w *fe*	(7) EPS_w *fe*
NE	0.238**	-4.986***			2.567*		
	(3.09)	(-7.05)			(-1.99)		
NExNE	-0.0150***				-0.245***		
	(-3.81)				(3.63)		
AT	-0.00151	-0.806*	0.514***	0.0917***	0.110***	0.0467	-0.0984*
	(-1.50)	(-2.15)	(3.45)	(3.56)	(4.81)	(1.74)	(-2.06)
ATxAT		0.0401**					0.00540***
		(3.10)					(3.40)
EUT			-42.64**	-15.76***		-7.868**	0.496
			(-3.12)	(7.22)		(-2.71)	(1.87)
EUTxEUT			1.454**	0.566***		0.291**	
			(3.07)	(-7.40)		(2.95)	
FA	0.000966***	0.0882***	0.0506	0.00249	0.204***	0.118***	0.0656*
	(4.95)	(4.32)	(1.65)	(0.55)	(8.08)	(3.80)	(1.99)
GW_w	0.0604	25.24***	24.62*	-0.147	2.316***	0.903	0.276
	(1.19)	(3.40)	(1.99)	(-0.07)	(3.64)	(1.07)	(0.33)
ETR_w	-0.159*	10.70	26.01	-2.657	-0.862	-0.737	-1.102
	(-2.35)	(1.21)	(1.91)	(-1.38)	(-1.00)	(-0.77)	(-1.14)
CR_w	-0.0125	0.382	-2.052*	-0.194	0.0978	-0.0433	0.0455
	(-1.92)	(0.54)	(-2.26)	(-1.07)	(1.03)	(-0.41)	(0.43)
DC_w	0.332***	8.536*	11.85*	6.333***	1.731**	3.881***	4.135***
	(6.42)	(2.32)	(2.31)	(5.92)	(2.90)	(5.32)	(5.73)
COVID	0.0503**	5.612**	5.966*	1.064*	0.936***	0.480*	0.503**
	(2.69)	(2.71)	(2.50)	(2.15)	(4.96)	(2.59)	(2.72)
FS			-4.683***	0.901***		4.399***	4.584***
			(-5.43)	(4.36)		(10.01)	(10.46)
_cons	-0.714	67.96***	430.9***	-126.4***	-4.512	-52.89*	-113.6***
	(-1.86)	(8.13)	(4.42)	(-7.97)	(-0.71)	(-2.29)	(-12.99)
Obs	793	822	424	427	829	427	427
R-sq	0.227	0.169	0.205	0.392	0.0164	0.00720	0.0332
F-stat	15.45***	13.93***	12.32***	30.41***	167.3***	106.2***	107.3***
Hausman Test					97.32***	89.45***	75.87***
Turning point	7.9604868	16.368666	10.053247	13.923629	7.6464688	12.8457956	16.6461982

t statistics in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Authors' work

Also, table 7 presents the regression models that include interaction terms.

Table 7 - Interaction Variable Regression Models

	(1) ROA_w	(2) PER_w	(3) PER_w	(4) PER_w	(5) ROA_w *fe*	(6) ROA_w *re*	(7) ROA_w *fe*	(8) PER_w *fe*
NE	-0.0116***	-4.933***			-0.014***	-0.0122***		
	(-5.73)	(-6.89)			(-3.35)	(-4.00)		
NExCOVID					0.00606*			
					(-2.34)			
AT	-0.00074**	0.492***	0.444**	0.621***	-0.00015	-0.00076**	-0.0021***	0.609*
	(-2.79)	(4.39)	(3.15)	(3.94)	(-0.38)	(-2.59)	(-3.70)	(2.29)
ATxCOVID	0.00188**	-0.668*		-1.063***		0.00127**	0.00160**	
	(2.65)	(-2.12)		(-3.48)		(2.79)	(2.82)	
EUT			0.466	-0.463			-0.00645	7.220**
			(0.42)	(-0.44)			(-1.12)	(2.80)
EUTxCOVID			-5.663***					-3.680**
			(-3.67)					(-2.88)
FA	0.000151**	0.0953***	0.0694*	0.0761*	-0.000462	0.0000485	-0.00175*	1.932***
	(2.91)	(4.57)	(2.36)	(2.58)	(-1.04)	(0.30)	(-2.58)	(6.30)
GW_w	0.0185	26.68***	28.97*	27.48*	0.0321**	0.0325**	0.0435*	23.34**

	(1.17)	(3.54)	(2.36)	(2.19)	(2.86)	(2.96)	(2.36)	(2.79)
ETR_w	-0.0468*	10.76	21.58	28.83*	-0.0962***	-0.0890***	-0.0608**	60.73***
	(-2.56)	(1.21)	(1.54)	(2.11)	(-6.32)	(-6.08)	(-2.88)	(6.17)
CR_w	0.00770***	-0.00847	-1.746*	-1.974*	0.00287	0.00339*	-0.00295	-0.826
	(4.03)	(-0.01)	(-2.11)	(-2.25)	(1.71)	(2.07)	(-1.29)	(-0.80)
DC_w	-0.00688	7.373*	9.656	8.919	-0.0533***	-0.0508***	-0.0252	2.435
	(-0.64)	(2.01)	(1.90)	(1.79)	(-5.05)	(-5.26)	(-1.59)	(0.34)
COVID	-0.0248	18.21**	88.76***	26.18***	0.0734**	-0.0127	-0.0255*	56.03**
	(-1.78)	(2.82)	(3.85)	(4.31)	(2.79)	(-1.39)	(-2.16)	(2.98)
FS			-4.414***	-4.828***			0.0389***	-20.17***
			(-4.95)	(-5.71)			(4.03)	(-4.66)
_cons	0.200***	60.02***	109.1***	129.2***	0.277***	0.241***	-0.579**	275.7**
	(8.36)	(7.28)	(6.30)	(8.11)	(7.02)	(7.83)	(-3.02)	(3.20)
Obs	829	822	424	424	829	829	427	424
R-sq	0.198	0.164	0.212	0.208	0.121	0.173	0.0477	0.0114
F-stat	24.43***	14.38***	11.97***	12.59***	15.56***		7.877***	14.10***
Wald						154.9***		
Hausman Test					0.00***	3.86***	74.31***	54.78***

t statistics in parentheses: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Authors' work

The results for the total energy use indicator reveal a positive and statistically significant impact on healthcare companies within the S&P 500, particularly with respect to market performance as measured by PER and EPS. The analysis identifies a turning point around value of 12: below this threshold, EUT negatively affects PER and EPS, whereas above it, the effect becomes positive. Notably, during the public health crisis, total energy use exerted a negative influence on PER, likely reflecting increased operational costs and energy inefficiencies. Economically, this suggests that moderate energy use may initially signal inefficiencies that reduce profitability, while higher levels of energy use may correspond to greater operational capacity, investment in energy-intensive technologies, or improved energy efficiency, thereby enhancing firm performance. Crises can temporarily reverse these benefits, as sudden energy demands strain resources and depress market valuations. These findings align with Simionescu et al., (2020) and Pham et al., (2024), and provide empirical support for the study's hypothesis.

Considering the number of employees, this indicator has a negative and statistically significant effect on ROE and ROA, reflecting accounting performance, while it has a positive and significant effect on EPS, reflecting market performance. In terms of nonlinear regression models, up to an approximate value of 7, the effect of this variable on performance is positive, whereas beyond this point, the influence becomes negative. Economically, this pattern suggests that a moderate workforce size can enhance productivity and operational efficiency, but beyond a certain threshold, additional employees may lead to higher costs, coordination challenges, and diminishing returns, negatively impacting accounting-based performance. During the pandemic period, however, the influence was positive, likely due to the expansion of remote work, which allowed firms to maintain or even increase productivity despite social distancing measures, thereby supporting market performance. This result is consistent with Lee, (2017) and supports the study's hypothesis.

Auditor tenure has a negative effect on ROA, reflecting accounting performance, but a positive and statistically significant effect on EPS, reflecting market performance. Considering nonlinear regression models, up to an approximate value of 6, the effect is negative, while beyond this threshold, it becomes positive with respect to PER and EPS. Economically, this suggests that shorter auditor tenures may initially limit market confidence but reduce accounting conservatism, while longer tenures build credibility and allow firms to signal reliability to investors, improving market-based performance. During the public health crisis, however, the influence on ROA became positive, whereas the effect on PER turned negative. This could reflect that auditors played a stabilizing role in accounting reporting under crisis conditions, supporting financial statements, while market perceptions of risk and uncertainty led to a decline in market valuations. This result contrasts with Sterling & Gilles (2018) and Livnat et al., (2021) and does not support the study's hypothesis.

The analysis of control variables in this study, including company size, firm age, sales growth, and the debt-to-capital ratio, along with the impact of the pandemic, indicates a positive contribution to financial performance. In contrast, variables such as the effective tax rate and the current ratio were associated with a decline in

profitability. Overall, the findings reveal a mix of supportive and adverse effects on firm performance, confirming two of the proposed hypotheses.

CONCLUSION

This research conducted an extensive quantitative investigation into the corporate governance factors affecting the profitability of United States healthcare companies from 2000 to 2024, focusing on 61 firms listed in the S&P 500 index. The study aimed to examine the relationship between critical ESG variables and firm performance under varying economic conditions. To achieve this, both linear and nonlinear regression models were employed, along with interaction models incorporating a dummy variable to capture the effects of the pandemic.

The analysis reveals that total energy use positively influences market performance above a threshold of 12, whereas lower levels reduce performance, with the pandemic temporarily reversing this effect due to higher operational costs. Similarly, workforce size negatively affects accounting-based measures but supports market performance up to a threshold of 7 employees, beyond which diminishing returns emerge; notably, remote work during the crisis mitigated these effects and enhanced productivity. Auditor tenure exhibits a comparable pattern, lowering ROA but increasing EPS, with effects turning positive beyond six years as credibility and investor confidence grow, though pandemic conditions led to weaker market valuations despite stabilized accounting performance. Finally, while control variables such as company size, age, sales growth, and debt-to-capital ratio strengthened model explanatory power, factors like effective tax rate and current ratio hindered profitability, highlighting the nuanced and context-dependent role of ESG and governance factors in shaping healthcare firm performance.

The policy implications of these findings suggest that healthcare companies should prioritize ESG-focused strategies, not just as a regulatory requirement, but as a key driver of long-term value and sustainable growth. Companies should also optimize workforce size to maintain efficiency while avoiding the challenges of overstaffing, and implement effective energy management practices to improve performance and resilience. At the same time, maintaining stable and experienced auditors is crucial for building trust in financial reporting and supporting market confidence. Taken together, these steps can strengthen both accounting and market-based performance, especially during periods of economic uncertainty, helping firms navigate challenges while sustaining long-term competitiveness.

While the study provides valuable insights, it is limited by its focus on a specific set of firms and a defined time frame, meaning the findings are most relevant to S&P 500 healthcare companies during 2000–2024. Future research could expand the analysis to other sectors and international markets, incorporate additional governance variables, examine macroeconomic influences, and apply more advanced econometric techniques to better understand the dynamics of ESG factors and firm performance over time.

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