Does Operation Energy Cost Affect Financial Performance? The Moderating Role of SDG13 – Climate Action

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هل تؤثر تكلفة الطاقة التشغيلية على الأداء المالي؟ الدور المعدل للهدف الثالث عشر من أهداف التنمية المستدامة - العمل المناخي

إعداد

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دكتور الفلسفة في المحاسبة كلية التجارة جامعة عين شمس

مجلة راية الدولية للعلوم التجارية

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ABSTRACT

This study seeks to analyze the influence of operational energy expenses on corporate financial performance, while exploring the moderating effect of Sustainable Development Goal 13 (SDG13: climate action) over the period of disruptions from 2021 to 2023.

The research employs a sample of 63 publicly traded companies on the Egyptian stock exchange from diverse energy-intensive sectors. Operational energy cost is quantified as energy cost per sales, whilst financial performance is assessed using Return on Assets (ROA) and Return on Equity (ROE), utilizing a latent factor derived from principal component analysis (PCA). We utilize panel data models incorporating company and year fixed effects, along with clustered standard errors, while controlling for governance and carbon emissions. The findings indicate a substantial positive correlation between operational energy expenses and financial performance, highlighting pressure on operating margins, whereas SDG13 alleviates this impact via enhanced energy efficiency and less financing risk. The results remain consistent when: (1) employing the composite performance factor; and (2) redefining the independent variables to incorporate carbon emissions (scope 1+2) and governance as control variables, since the signs and directions of the impacts persist unchanged. This study advances theoretical and methodological frameworks by incorporating an accounting-climate perspective to examine moderation, elucidating the of outcomes in an emerging market context.

Keywords: Operational Energy Costs, Financial Performance, SDG13, Carbon Emissions.

المستخلص

تسعى هذه الدراسة إلى تحليل تأثير تكاليف الطاقة التشغيلية على الأداء المالي للشركات، مع استكشاف التأثير المعتدل للهدف ١٣ من أهداف التنمية المستدامة :SDG13) العمل المناخي (خلال فترة الاضطرابات من ٢٠٢١ إلى ٢٠٢٣. يستخدم البحث عينة من ٦٣ شركة مدرجة في البورصة المصرية من قطاعات متنوعة كثيفة الاستهلاك للطاقة. يتم تحديد تكلفة الطاقة التشغيلية كتكلفة الطاقة لكل عملية بيع، بينما يتم تقييم الأداء المالي باستخدام العائد على الأصول (ROA) والعائد على حقوق الملكية(ROE) ، باستخدام عامل كامن مشتق من تحليل المكونات الرئيسية (PCA) نستخدم نماذج بيانات اللوحة التي تتضمن تأثيرات الشركة والسنة الثابتة، إلى جانب الأخطاء المعيارية المجمعة، مع التحكم في الحوكمة وانبعاثات الكربون. تشير النتائج إلى وجود علاقة إيجابية كبيرة بين تكاليف الطاقة التشغيلية والأداء المالي، مما يسلط الضوء على الضغط على هوامش التشغيل، في حين يخفف الهدف ١٣ من أهداف التنمية المستدامة من هذا التأثير من خلال تحسين كفاءة الطاقة وتقليل مخاطر التمويل. تظل النتائج متسقة عند استخدام عامل الأداء المركب؛ وإعادة تعريف المتغيرات المستقلة لتشمل انبعاثات الكربون (النطاق ١+٢) والحوكمة كمتغيرات تحكم، نظرًا لثبات مؤشرات واتجاهات التأثيرات. تُطوّر هذه الدراسة الأطر النظرية والمنهجية من خلال دمج منظور المحاسبة والمناخ لدراسة الاعتدال، وتوضيح نتائجه في سياق الأسواق الناشئة.

1. Introduction

Recent years have witnessed significant volatility in global energy markets due to intertwined geopolitical and economic factors, resulting in increased pressure on companies' cost structures, particularly in energy-intensive industries. Literature shows that operational energy is a critical factor influencing business profitability and efficiency, as their escalation correlates with diminished operating margins and decreased financial returns (Milewska & Milewski, 2023; Herman et al., 2023). In

contrast, effective energy cost management and diversity of energy sources can improve long-term financial performance and competitiveness (Xu et al., 2022). In this environment, the Sustainable Development Goals (SDGs), especially SDG 13 (Climate Action), have arisen as a worldwide normative framework that drives firms to implement more sustainable strategies for emissions reduction and energy efficiency. Recent studies highlight that the incorporation of SDG13 into corporate practices transcends social responsibility, potentially transforming the interplay between environmental resource management and corporate financial performance by promoting environmental innovation and alleviating climate risks (Akhtaruzzaman et al., 2025; Kheireddine et al., 2024). Nonetheless, the majority of prior studies have concentrated on the direct correlation between sustainability and profitability or between carbon emissions and financial performance (Oestreich et al., 2024), whereas the influence of operational energy costs—as a critical accounting factor—on corporate financial performance in the context of SDG13 remains inadequately explored. Therefore, there is a need for a more in-depth analysis that integrates the cost dimension with the global sustainability agenda to clarify how companies can reconcile financial efficiency with climate commitments. Accordingly, this study aims to investigate the impact of operational energy costs on corporate financial performance while examining the moderating role of sustainable development goal 13 (SDG 13) and incorporating control variables such as corporate governance and carbon emission. Within this framework, the study makes a twofold contribution to the literature: first, by highlighting the importance of operational energy costs as a critical factor in sustainable profitability; and second, by integrating sustainable development goals into

accounting and financial models, thus reflecting the institutional dimension of climate change response.

The study period was limited to 2021–2023, a period characterized by global shocks (the covid-19 pandemic and the Russia-Ukraine war), thus providing an ideal environment to test the relationship between energy costs and financial performance. However, the results may reflect the specificities of this period and may not necessarily be generalizable to periods of economic stability. Furthermore, the research focused on energy-intensive and moderately energy-intensive sectors; therefore, the findings cannot be directly generalized to service or financial sectors, which are less dependent on operational energy. The study relied on publicly available data from financial and sustainability reports, which may be influenced by the level of corporate transparency and the quality of the published information. The study was unable to consider all macroeconomic variables, like alterations in government policy or global energy costs, which may influence the examined connection.

2. Literature review, hypotheses, and theories.

Operational energy costs are a key component of a company's overall cost structure, representing a significant portion of total operating expenses, particularly in energy-intensive industries such as cement, iron and steel, and petrochemicals. This issue has become increasingly significant in recent years due to the substantial volatility in global energy markets following the COVID-19 pandemic and the Russian-Ukrainian conflict, which resulted in unprecedented surges in electricity and gas prices, directly affecting corporate profit margins (Herman et al., 2023). Literature indicates that these developments have prompted significant discourse among finance and accounting

researchers over the correlation between energy expenses and business financial performance. Some contend that elevated energy costs signify heightened business activity and revenue expansion (Xu et al., 2022), whereas others assert that these costs impose a direct burden that diminishes profitability and adversely affects financial performance metrics such as return on assets (ROA) and return on equity (ROE) (Milewska & Milewski, 2023). As a result, two opposing viewpoints have arisen in the literature: one endorsing a positive correlation and the other highlighting a negative correlation.

The viewpoint advocating for the affirmative correlation between operational energy expenditures and financial performance

Numerous studies indicate that escalating operational energy expenses do not inherently signify a deterioration in corporate financial performance; rather, they may represent business growth and enhanced productivity. This viewpoint arises from the recognition that energy is not solely a financial liability for enterprises but a strategic component that signifies operational magnitude and economic activity levels. Consequently, firms that have elevated energy expenses tend to be more competitive, exhibit growth potential, and achieve profitability, particularly in contexts that permit the transfer of these costs to consumers.

The research conducted by Xu et al. (2022) demonstrated that elevated energy consumption in emerging economies correlated with enhanced productivity and greater revenues, hence favorably influencing financial performance. Manuel et al. (2024) shown that firms possessing market power or functioning inside adaptable regulatory frameworks effectively transferred energy price hikes to consumers without experiencing a reduction in profitability; indeed, their revenues escalated at a rate

surpassing that of their costs. Milewska & Milewski (2023) discovered that the influence of energy expenses on corporate profitability is not invariably detrimental, as several firms managed to counterbalance costs by enhanced operational efficiency or increased product pricing, leading to a positive, rather than negative, correlation. Hulshof & Mulder (2020) contended that the utilization of renewable energy can augment corporate profitability, as investment in alternative energy sources fosters enhanced long-term financial performance. A systematic literature study by Sitompul et al. (2024) demonstrated that dependence on renewable energy is frequently correlated with enhanced financial performance and elevated market value for enterprises. This viewpoint is corroborated by Issa & Hanaysha (2023), who illustrated that the implementation of renewable energy by European firms resulted in enhanced profitability and financial sustainability concurrently. The research conducted by Dorigoni et al. (2024) indicates that energy generation from renewable sources correlates with enhanced liquidity and profitability, suggesting that energy expenses—when coupled with investments in alternative sources—can positively influence financial performance. Recent research by Joaqui-Barandica et al. (2024) also showed that common factors, including energy prices themselves, can explain the profitability of companies, suggesting that high costs are not always detrimental. On the other hand, Nurkhasanah et al. (2025) examined the relationship between financial performance and energy indicators and confirmed that energy companies with higher ROA levels also had higher stock prices, indicating that strong financial performance can coexist with high energy costs. Pham et al. (2024) support this view by demonstrating that conventional energy consumption (even polluting sources) can, in some cases, be associated with strong financial performance. Additional studies, such as Bank for the

Accounts of Companies Harmonized [BACH] (2023), which analyzed data from 11 European countries, found that the impact of energy costs on company profitability was not entirely negative, as many companies were able to adapt to energy shocks without significant declines in financial performance. Other literature, such as that of Dorigoni et al. (2024), also confirms this. And Chebotareva (2018) suggests that renewable energy companies, in particular, can transform their relatively high operating costs into a long-term competitive advantage, as investors react positively to such investments, viewing them as an indicator of sustainable growth.

Therefore, these studies demonstrate that the relationship between energy operating costs and financial performance is not always negative; it can be positive in certain contexts, especially when high costs reflect business expansion, strategic investments in renewable energy, or the company's ability to pass on costs to consumers.

Based on these previous studies, we propose the following hypothesis:

(H1A): There is a statistically significant positive relationship between energy operating costs and the financial performance of companies.

The counterargument to the positive relationship (the negative perspective).

The prevailing view in the literature is that rising energy costs lead to a decline in corporate financial performance because they represent a direct burden on profits and operating margins (Herman et al., 2023). This perspective has gained further attention following the energy price shocks triggered by the covid-19 pandemic and the Russia-Ukraine conflict, as European studies have shown that rising electricity and gas prices quickly translated into negative profits for a wide range of industrial companies (Milewska & Milewski, 2023; Xu et al., 2022). This view is based on a simple accounting principle: any increase in costs, with revenues remaining constant, erodes profits

(Manuel et al., 2024). Evidence suggests that energy-intensive industries, such as cement, steel, and chemicals, are most vulnerable to the impact of rising costs, as energy represents a very high proportion of their total costs (Choi et al., 2017). For example, Milewska & Milewski's (2023) study showed that rising energy costs in European industrial companies were associated with a significant decline in both return on assets (ROA) and return on equity (ROE). Similarly, Herman et al. (2023) found that the European energy crisis led to reduced operating margins and weakened competitiveness in international markets. Xu et al. (2022) also demonstrated that rising energy costs in emerging economies led to lower productivity and profitability for companies, with a more pronounced effect on polluting industries. Fan et al. (2023) further confirmed this by a study of energy-intensive Chinese companies that showed that improving energy efficiency enhances financial performance, meaning that uncontrolled increases in energy costs negatively impact profitability. The findings of Marin and Vona (2021) indicate that energy price increases in the French industrial sector between 1997 and 2015 reduced productivity and weakened the long-term economic performance of companies. Bijnens et al. (2022) also demonstrated that rising electricity prices in Europe negatively affected employment and operational efficiency in electricity-intensive sectors. In emerging markets, Abeberese (2017) showed that higher electricity costs for companies in India led to a significant decline in productivity growth and profitability for industrial units. Sadath and Acharya (2015) demonstrated that higher energy prices reduced capital investment by Indian industrial companies, thus weakening their long-term financial performance. In advanced economies, Saussay (2024) found that rising energy prices negatively impacted industrial investment location decisions in Europe, with many investments shifting to

regions with lower energy costs, reflecting weaker profitability domestically. Calì et al. (2023) confirmed that higher energy prices in developing countries led to a decline in the economic performance of companies, particularly in energy-intensive sectors. In sector-specific studies, Wen et al. (2021) showed that high energy intensity in Chinese industrial companies significantly increased the vulnerability of their financial performance to price shocks. Kumar et al. (2022) found that energy-intensive firms in India experienced lower profit growth compared to more energy-efficient firms. Dechezleprêtre et al. (2020) shown that increasing energy prices, along with more stringent environmental regulations, resulted in reductions in employment and profitability within the manufacturing sectors of OECD member nations. Additional research has substantiated that this adverse effect influences business worth, as Oestreich et al. (2024) associate elevated emissions and energy expenses with diminished market value and profitability. Bijnens et al. (2022) discovered that energy shocks diminish enterprises' capacity to secure fresh credit, as performance indicators decline, hence elevating financing costs and intensifying the adverse effects on profitability. Herman et al. (2023) elucidated that small and medium-sized organizations (SMEs) exhibit greater susceptibility to these shocks due to their diminished capacity to transfer costs to consumers relative to larger corporations.

Consequently, the second hypothesis (H1B) is posited:

A statistically substantial inverse correlation exists between operational energy expenses and corporate financial performance.

The role of sustainable development goal 13 (SDG13) as a moderating variable

Given the conflicting findings regarding the relationship between operational energy costs and financial performance, the importance of identifying moderating variables to

explain this discrepancy becomes evident. Studies from Europe and the Gulf Cooperation Council (GCC) countries have also shown that climate governance and the quality of ESG reporting are positively associated with profitability, as climate commitments enhance corporate image and attract green financing (A-Kubaisi & Abu Khalaf, 2025). From an investment perspective, the World Bank has demonstrated that rising electricity and energy prices can have a mitigated negative impact if companies are aligned with climate policies, as investors tend to reward such companies with higher market valuations (World Bank, 2022). Saussay (2024) further explains that sustainability strategies play a crucial role in industrial investment location decisions, as companies tend to remain in high-cost environments if clear climate policies provide long-term stability. The findings of Habib et al. (2025) support this view, where this perspective posits that combining ESG disclosure with access to green financing improves the financial performance of Chinese companies. Qing et al. (2024) further argue that shifting the energy consumption structure towards cleaner sources enhances macroeconomic productivity, thus mitigating the impact of high energy costs. Some literature suggests that SDG 13 acts as a "green shield" against risks. A recent study demonstrated that firms with robust environmental practices display enhanced resilience to economic downturns, hence mitigating the effects of energy price volatility on performance (Kansoy & Stasiulaitis, 2025). Additional research corroborates this notion, highlighting that robust ESG performance enables organizations to sustain greater financial resilience in high-risk contexts (Li, 2025). Similarly, Rentschler et al. (2017) found that companies that improve energy efficiency and adjust their energy mix are less affected by rising energy prices, which supports the idea that transparent and sustainable climate strategies can enhance financial resilience in high-risk

environments. Similarly, Hou et al. (2024) demonstrated, using the AI-based Investesg model, that climate investment decisions based on sustainable development goal 13 (SDG13) can strike a balance between profitability and sustainability. From a policy perspective,

Sun et al. (2024) showed that good corporate governance enhances the impact of SDG reporting, as robust regulatory frameworks help companies transform climate commitments into a competitive advantage. Other research suggests that an innovative organizational climate enhances the success of integrating the SDGs and increases the likelihood that these strategies will lead to better financial performance (Hieu, 2023).

These findings offer an explanation for the previous inconsistencies in the literature: for companies that showed a positive relationship between costs and performance (quadrant 1), incorporating SDG 13 reveals that this relationship may not always be sustainable but rather based solely on cost-shifting. For companies that experienced a negative relationship (quadrant 2), commitment to SDG 13 provides mechanisms to reduce energy intensity and attract investors, thus mitigating the negative impact.Therefore, SDG 13 can be considered a crucial moderating variable that balances these two trends, weakening the negative relationship and revealing the limitations of the positive one, thus making the results more realistic and consistent with long-term sustainability requirements.

Porter's hypothesis suggests Well-crafted environmental legislation can foster inventive solutions that mitigate, or even surpass, compliance costs. (Porter & Van Der Linde, 1995). When climate commitments translate into energy efficiency projects and clean technologies, productivity gains (in terms of materials, energy, and labor) emerge, restoring profitability (Ambec & Lanoie, 2008). Stakeholder/legitimacy theory further

argues that a company's responsiveness to investor, regulator, and customer preferences enhances its legitimacy, reducing reputational and regulatory risks, lowering the cost of capital, and increasing market valuation (Donaldson & Preston, 1995; Clarkson, 1995; Orlitzky, Schmidt, & Rynes, 2003; Waddock & Graves, 1997; Matten & Moon, 2008).In essence, improving environmental and climate legitimacy mitigates some of the impact of energy costs through the cost of capital channel, thus maintaining relative performance.

The resulting hypothesis can be formulated as follows:

(H2): companies' commitment to sustainable development goal 13 (SDG 13) weakens the relationship between operational energy costs and corporate financial performance.

This research aims to analyze the direct impact of operational energy costs on the financial performance of companies while testing the moderating role of sustainable development goal 13 (SDG 13: climate action) on this relationship. This is achieved through: estimating the fundamental relationship between operational energy costs and financial performance using panel data for 63 companies across energy-intensive/medium-intensity sectors. controlling for other relevant variables: corporate governance and the co2 emission.

Research gap and contributions:

Most studies have addressed energy prices at the macro level or their sectoral impacts, while fewer studies have examined operational energy costs as a specific accounting variable at the company level (e.g., utilities/fuel & power expenses) and directly linked them to financial performance.

Despite the abundance of ESG/climate studies, SDG 13 is rarely modeled as an interactive variable that explains the variance between positive and negative findings in the relationship between energy costs and financial performance.

Many studies relied on a single performance metric (ROA or ROE), while there is insufficient coverage of extracting a latent financial performance index through factor analysis/PCA, which reflects the common dimension and reduces measurement noise. There is a lack of short-term micro-panel studies covering periods of shocks (Covid-19/European energy crisis) that leverage temporal variation to more accurately identify the relationship.

These gaps justify an integrated accounting-financial-climate model that directly addresses the cost item and tests SDG13 as a moderator. Therefore, this study contributes to the literature by incorporating operational energy costs as an explicit accounting metric in financial performance models. This enriches the theoretical discussion beyond a purely price-based perspective and highlights a cost management approach rather than mere price responsiveness. Furthermore, the inclusion of an interactive climate-financial model, by proposing and testing SDG 13 as a moderating factor, explains why the relationship sometimes appears positive (pass-through/expansion) and sometimes negative (margin compression). This provides a more comprehensive framework that integrates stakeholder theory and the modified Porter hypothesis (eco-efficiency). Additionally, introducing and testing a composite financial performance indicator (ROA/ROE) improves construct validity and reduces measurement bias compared to using a single indicator.

3. Methodology

3.1 Research design and sample

This research employs a quantitative approach using panel data to analyze the relationship between operational energy costs and the financial performance of companies, while examining the moderating role of sustainable development goal 13 (SDG 13: climate action). The sample comprised 63 non-financial companies listed on the Egyptian stock exchange, representing both energy-intensive and moderately energy-intensive sectors (such as heavy manufacturing, non-energy metals, utilities, transportation, and industrial services). The study period covers 2021–2023, a period characterized by significant disruptions in energy markets due to global crises, thus providing a suitable context for testing the relationship under conditions of high volatility. The use of a short panel allows for the exploitation of both inter-sectoral and temporal variations, thereby enhancing the robustness of the causal inferences.

Table 1. Sectors in the sample

Sector	Examples	Number of firms
Process industries	Chemicals, fertilizers, petrochemicals	22
Non-energy minerals	Cement, glass, ceramics	12
Producer manufacturing	Equipment, product manufacturing	9
Industrial services	Industrial services	7
Utilities	Electricity, water, gas	3
Transportation	Transport, logistics	5
Consumer non-durables	Food, beverages	5
Total		**63**

3.2 Justification for sample selection

The final sample comprises 63 non-financial companies listed on the Egyptian stock exchange, distributed across energy-intensive or moderately energy-intensive sectors (such as chemicals, cement, metals, utilities, transportation, and food processing). It should be noted that the total number of companies listed on the Egyptian stock exchange is significantly higher. However, the sample selection was limited to these companies for several reasons, the most important of which are:

- Direct correlation with operational energy consumption: these sectors are among the most energy-intensive, thus representing a suitable environment for testing the impact of energy costs on financial performance.
- Exclusion of non-energy-related sectors: sectors such as banking, insurance, and financial services were excluded because they do not rely heavily on operational energy in their business activities.
- Data availability: several other companies were excluded either due to insufficient financial or climate-related data, or because of significant gaps in their disclosures regarding corporate governance and emissions.

Therefore, the 63 companies represent the final, valid sample for analysis

3.3 Variables and Measurement Techniques:

- **Dependent Variable:** (Financial Performance – FP): Assessed by a latent factor derived from Principal Component Analysis (PCA), integrating Return on Assets (ROA) and Return on Equity (ROE). This produces a composite indicator that reduces measurement noise and represents the shared aspect of profitability.

- **Independent Variable** (Operational Energy Expenditures - OEE): Quantified as the proportion of energy expenditures to revenue, indicating the energy intensity of the company's operations.

- **Moderating Variable**: (SDG13 – Climate Action): Defined as an indicator of corporate commitment to climate transparency and emissions reduction objectives, on a scale from 0 to 4. This score derives from sustainability reports, TCFD reports, and ESG databases.

- **Control Variables:**

- Carbon Emissions (CO_2E): Quantified as direct and indirect emissions (Scope 1+2) expressed as a percentage of production.
- Governance (G): An index indicating the caliber of corporate governance frameworks, board composition, and transparency. The Governance Index is a composite metric created from the board report, annual report, and sustainability report, encompassing the following components: Proportion of independent directors. Proportion of female's directors- CEO duality- Annual frequency of board meetings- Presence of specialized committees (audit committee, risk committee).

3.4 Econometric Model

To address firm-level heterogeneity and temporal dynamics, the study applies a **two-way fixed effects (FE) panel regression model** with clustered robust standard errors at the firm level. The baseline specification is:

$$FP_{it}=\alpha+\beta_1 OEC_{it}+\beta_2 (OECit\times SDG13it) - \beta_3 CO2E_{it}+ \beta_4 G_{it}+ +\varepsilon_{it}$$

- **Estimation Procedure**

- Both Fixed Effects (FE) and Random Effects (RE) estimators are initially evaluated. A Hausman specification test is performed to identify the suitable model; findings significantly support the FE estimator, guaranteeing constant estimates amid correlation between regressors and firm-specific effects. Clustered standard errors at the business level are utilized to address potential endogeneity issues and heteroskedasticity.

- **Diagnostic Assessments**

- A series of robustness checks were conducted:

- Multicollinearity: Variance Inflation Factors (VIFs) were under 2, signifying the absence of significant collinearity among predictors.

- various Specifications: Re-evaluations utilizing the composite financial performance factor and various definitions of OEC validated the consistency of the findings.

- Sensitivity Analysis: Models were re-estimated incorporating extra lags of control variables and eliminating outliers, resulting in consistent signs and significance of coefficients.

3.5 Data Analysis

- **variable description**

Table 2. variable description

VARIABLE	SYMBOLS
Financial Performance	FP
Operation Energy Cost	EC
Sustainability Development Goal(Climate Action)	SDG13
Carbon Emission	CO2E
Governance	G

- **Descriptive statistics (2021-2023)**

Table 3. variable descriptive

VARIABLES	OBS	MEAN	STD.DEV.	MIN	MAX
FP	186	6.623489	8.198616	0.107910	48.15751
OEC	186	26.51559	17.74169	0.700000	87.00000
SDG13	186	77.44624	26.1819	2.000000	99.00000
CO2E	186	32.35092	30.28589	0.000000	100.0000
G	186	0.001667	1.056342	-2.330000	2.320000

Descriptive statistics in table (3) reveal significant disparities among the companies studied regarding financial performance (FP), ranging from nearly zero (0.1) to very high levels (48.1), with an average of 6.6. This reflects a gap between low- and high-cost companies.

Furthermore, the operation energy cost shows a relatively low average (26.5), with considerable variation, indicating substantial institutional differences among the companies. The governance is close to zero on average, suggesting that the sample comprises companies with both strong and very weak institutional systems. Regarding energy infrastructure, the share of (CO2 E) is approximately 32% on average, but varies from zero to full reliance on clean energy, reflecting structural differences in energy transition pathways. Finally, the index for commitment to sustainable development goal 13 (SDG 13) is high (77.4), but varies significantly across companies, reflecting differing levels of political and institutional will regard climate issues. Overall, these findings confirm that the studied sample exhibits a high degree of structural and institutional heterogeneity, justifying the use of fixed-effects panel models to control for unobserved companies-specific characteristics and enhancing the robustness of subsequent hypothesis tests.

- **Correlation Matrix**

Table 4. correlation matrix

VARIABLES	FP	OEC	SDG13	CO2E	G
FP	1				
OEC	0.455***	1			
SDG13	-0.92***	-0.52***	1		
CO2E	-0.25***	-0.25***	0.16**	1	
G	0.458***	0.50***	-0.57***	0.04	1

The results of the correlation analysis indicate a significant negative relationship between (FP) and both (SDG13) and (CO2E), suggesting that improved performance in these indices is associated with lower financial performance. Conversely, the results showed a significant positive relationship between FP and both the (OEC) and (g) indicating that higher values of these indices are associated with increased FP levels all variable presented in table (4)

- **Regression Models**

Table٥ . Regression Models

MODELS	FE	RE
DEPENDENT VARIABLE	FP	
VARIABLES	ESTIMATED COEFFICIENTS	
OEC	0.1013***	0.2459***
	(0.0290)	(0.0271)
OEC*SDG13	-0.0011***	-0.0028***
	(0.00034)	(0.00036)
CO2E	-0.0199**	-0.0147
	(0.0092)	(0.0104)
G	-0.7689***	-0.0211
	(0.2919)	(0.0450)
CONSTANT	6.6523***	6.7842***
	(0.4572)	(0.4820)
OBSERVATIONS	186	186
PERIOD INCLUDED	3	3
HAUSMAN TEST(CHI^2)	84.70***	
R-SQUARED	0.9988	0.9953

Table (5) Presents a comparison between the estimates of the fixed effects (FE) and random effects (re) models for explaining the determinants of financial performance (FP). The Hausman test ($\chi^2 = 84.70$, $p < 0.01$) rejected the null hypothesis of the suitability of the random effects model, indicating that the fixed effects model is more appropriate for the sample data.

Regarding the variables: the coefficient of OEC (operational energy intensity/cost) was positive and significant in both models, but its estimate in re (0.2459) was higher than in FE (0.1013), suggesting a correlation between the explanatory variables and the unobserved characteristics of the firms; therefore, the FE estimate is considered more consistent. The interaction term OEC× SDG 13 was negative and significant at the 1% level in both models (-0.0011 in FE, -0.0028 in RE), meaning that a higher SDG 13 reduces/mitigates the positive effect of OCE on FP (i.e., it modifies the relationship in a weaker direction, rather than directly reducing costs). For CO2E, the effect was negative in both models, but not significant in the re model, while it became significant at the 5% level in the FE model (-0.0199), supporting the notion that higher emissions intensity is associated with lower financial performance after controlling for firm and year fixed effects. The governance variable (G) was also not significant in the re model, but it emerged as negative and significant at the 1% level in the FE model (-0.7689), suggesting that the effect of governance is heterogeneous across firms and only becomes apparent when firm-specific characteristics are accounted for. Both models yielded positive and significant intercepts, with the FE model demonstrating significantly better model fit; the coefficient of determination (R^2) was 0.9988 compared to 0.9953 in

the re model. Overall, the results support the use of the fixed effects model for more reliable estimates, revealing that carbon emissions and governance negatively impact financial performance when unobserved characteristics are controlled for, while SDG13 acts as a moderating factor, weakening the positive relationship between environmental performance and financial performance.

- **Multicollinearity test**

Table 6. Multicollinearity test

VARIABLE	VIF	1/VIF
OEC	1.67	0.60
G	1.82	0.55
CO2E	1.11	0.90
SDG13	1.65	0.61
MEAN VIF	1.56	0.64

The 1/VIF values are all close to 1 ⟶ this indicates that there is no strong correlation between the variables .The average value of approximately 0.64 further supports this conclusion, confirming that the model is not affected by multicollinearity.all variables presented in table (6)

4. Results

- The results of the estimation using the panel data model showed that the coefficient for the operational energy cost (OEC) variable was positive and statistically significant at the 1% level in both the fixed effects model (0.1013) and the random effects model (0.2459). This result indicates that higher operational energy costs are associated with higher financial performance of the studied

companies, thus supporting hypothesis (H1A) and rejecting the alternative hypothesis (H1B).

Hypothesis (H1A), which states that there is a positive relationship between operational energy costs and financial performance, is accepted. The alternative hypothesis (H1B), which assumes a negative relationship, is rejected.

- The estimation results showed that the interaction coefficient between operational energy costs (OEC) and sustainable development goal 13 (SDG13) was negative and statistically significant at the 1% level in both the fixed effects model (-0.0011) and the random effects model (-0.0028). This result suggests that companies' commitment to SDG13 acts as a moderating factor, weakening the positive relationship between energy costs and financial performance, thus supporting the validity of hypothesis 2 (H2).

  Hypothesis (H2) is accepted, as SDG13 emerged as a moderating variable that weakens the relationship between operational energy costs and financial performance. The finding indicates that commitment to climate action and disclosure of sustainability goals mitigates the short-term positive impact of rising energy costs, aligning the relationship more closely with long-term sustainability objectives.

5. **Conclusion**:

   This study seeks to evaluate the influence of operational energy expenses on the financial performance of Egyptian publicly traded companies, while investigating the moderating effect of Sustainable Development Goal 13 (SDG13: Climate Action) during the period from 2021 to 2023, a timeframe marked by extraordinary

global disruptions, including the COVID-19 pandemic and the Russia-Ukraine conflict.

The findings indicated a substantial positive correlation between operational energy expenses and financial success, implying that elevated expenditures may, in certain instances, correlate with corporate growth, heightened productivity, and improved competitiveness. Nonetheless, the findings revealed that corporate dedication to climate objectives and sustainability disclosures (SDG13) serves as a moderating variable, diminishing this positive correlation and aligning it with a more sustainable, long-term perspective. The research indicated that carbon emissions and corporate governance adversely affect financial performance, even when accounting for unobserved company characteristics.

The findings underscore that corporate dedication to SDG13 not only fulfills environmental goals but also alleviates risks linked to energy price fluctuations and improves financial performance stability. Moreover, dependence on clean energy sources enhances financial performance by decreasing carbon emissions and alleviating related environmental concerns, hence positively influencing operational efficiency and increasing the company's appeal to investors. This study contributes to the literature in two ways: first, it elucidates the significance of operational energy costs as a critical accounting factor affecting corporate profitability; second, it incorporates sustainable development goals into a financial analytical framework, highlighting the institutional response to climate change. The findings offer critical insights for policymakers and investors, aiding them in reconciling financial performance with climate obligations, consistent with the mandates of sustainable development in emerging markets.

6. Social contributions

- Raising public awareness about energy and sustainability: the study demonstrates that reducing emissions and improving energy efficiency benefits not only businesses, but also contributes to a more sustainable environment, mitigating the climate risks that affect society as a whole.
- Consumer protection: companies' commitment to SDG 13 helps stabilize the prices of final products by mitigating price fluctuations caused by rising energy costs, thus ensuring relative price stability for goods and services provided to consumers.
- Promoting climate justice: the research findings highlight that implementing the sustainable development goals protects vulnerable populations most at risk from climate change, particularly in emerging markets with fragile environmental infrastructure.

7. Policy implications

The findings suggest that commitment to SDG 13 helps mitigate the negative impact of rising energy costs, thus reinforcing the value of policies that promote climate disclosure and environmental governance. Policymakers in Egypt and other emerging economies can use these findings to encourage businesses to invest in renewable energy and green practices through tax incentives and green financing. Furthermore, the study underscores the potential to reconcile economic profitability with climate action, aligning with national and international sustainable development strategies.

8. Recommendation and directions for future research

8.1 The researcher recommends:

- Using clean electricity, which reduces emissions and thus increases financial performance.

- Strengthening Egyptian companies' commitment to the Sustainable Development Goals, particularly SDG 13 (Climate Action – SDG13), and integrating climate action policies into their operational and financial strategies.

8.2 Directions for future research

- The study could be expanded to include other, less energy-intensive sectors (such as financial services and technology) to determine whether the impact of SDG 13 is equally significant.
- Comparisons could be made between emerging and developed markets to assess differences in the impact of SDG 13 on the relationship between energy costs and financial performance.
- The relationship should be tested over longer time periods to determine whether the mitigating effect of SDG 13 is sustainable over time.
- Additional variables, such as employee and customer satisfaction, could be incorporated to measure how climate strategies impact social value, in addition to financial performance.
- Machine learning techniques or dynamic models could be applied to study the non-linear interactions between energy, financial performance, and sustainability.

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