



Research article

Green investment and corporate profitability: Evidence from the oil-gas sector in the GCC region

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Abstract: The growing interest in sustainable economic activities around the globe has preconditioned green investments as the essential means of environmental stewardship and corporate development. This paper tackled the less-examined financial impact of green investments within the oil and gas industry in the Gulf Cooperation Council (GCC), which is a key hydrocarbon producer facing significant climate change challenges. With a detailed quantitative design, such as encompassing a strong dynamic panel generalized method of moments (GMM) to control endogeneity and cross-sectional dependence, we examined how environmental pillar score (EPS), energy consumption (EC), and greenhouse gas (GHG) emissions affect corporate profitability (return on assets and return on equity) during the study period. With the help of theoretical approaches like stakeholder theory, resource-based view, and legitimacy theory, our results demonstrated a multi-dimensional and sometimes subtle connection between the two. Although green investments are normally associated with long-term sustainability objectives, the paper unearthed a short-term negative connection between environmental performance as reflected through EPS and profitability, which might be related to high initial costs of investment or corporate compliance. On the other hand, energy consumption will paradoxically correlate with profitability, which can be explained by the high production orientation of the sector and energy subsidies in the region. This study provides new empirical data in an important, low-studied area that expands the knowledge of green investment trends in hydrocarbon-based economies. Context-specific ESG reporting standards and focused incentives to overcome the practical realities of green transitions are two of the areas promoted in our policy recommendations as a critical approach to balance economic development and environmental responsibility in the GCC.

Keywords: green investments; corporate profitability; GCC oil and gas sector; environmental performance; environmental pillar score; energy consumption; GHG emissions

JEL Codes: Q56, G32, Q52, Q43, M14

1. Introduction

Climate change has become one of the most dangerous global issues of the 21st century, with far-reaching consequences for economic, environmental, and social systems. The issue of moving toward a greener strategy in the economy has been challenging many governments and businesses; this is where green investment has come in to draw considerable attention. Green investments, which strike a balance between environmental security and economic growth, are increasingly looked at as a strategic option to minimize the negative impacts of climate change. It is especially acute in the GCC region, the hotbed of oil and gas production in the world, where the price of business paid to the environment is radically out of proportion. The GCC countries, with nearly 45% of the world's proven oil reserves and 25% of the world's crude oil exports, face a twin challenge in the future: maintaining their economic reliance on hydrocarbon resources alongside addressing the environmental consequences of their high-carbon economies. The ecological footprint of the region, at 8.9 global hectares per capita, is far above the world average of 2.75, compelling the adoption of sustainable practices to be pursued. In this regard, green investment has been proposed as a solution that will ensure economic development and environmental sustainability. Nonetheless, its impact on corporate profitability in the oil and gas sector remains unknown. Whereas some studies reveal that green investment enhances cost-effectiveness and reputation in the market, others perceive that green investment increases operational expenses at the cost of financial performance.

This ambiguity identifies a major gap in the literature, particularly in the GCC nations, wherein little empirical research is available regarding the nexus between green investments and corporate profitability. This study aims to bridge this gap by examining how green investments, through the lenses of stakeholder theory, the resource-based view (RBV), and signaling theory, influence corporate profitability in the unique context of the GCC oil and gas sector. While these theories generally suggest a positive relationship, we also acknowledge potential complexities and trade-offs that might lead to mixed or even negative short-term financial outcomes, as suggested by some literature and observed in certain developing market contexts. Furthermore, while the concept of green investment is evolving globally, for the purpose of this study, it is operationalized through specific environmental performance metrics such as the environmental pillar score (EPS), energy consumption (EC), and greenhouse gas (GHG) emissions, representing a firm's commitment and actual impact in environmental stewardship. These metrics capture aspects relevant to emerging global standards for sustainable finance.

While the burgeoning academic literature on green finance has extensively explored the nexus between environmental performance and corporate profitability across diverse global contexts, a significant and underexplored gap persists in understanding this relationship within the highly specific

and critically important oil and gas sector of the GCC region. Unlike studies that often focus on diversified economies or sectors with more mature green industries, the GCC presents a unique institutional and economic landscape characterized by its inherent reliance on hydrocarbon resources, rapidly evolving (yet still nascent) green finance ecosystems, and distinct geopolitical considerations. This unique context necessitates a focused investigation to provide empirically grounded insights relevant to its specific challenges and opportunities.

Our study offers novel empirical evidence that extends prior research by providing a granular analysis from this under-researched regional and sectoral focus. Specifically, while existing work (e.g., Aastvedt et al., 2021) has examined environmental factors, our distinct contribution lies in several key areas. First, we provide contextual specificity by exclusively focusing on publicly traded oil and gas firms in the GCC, a sector and region pivotal for the global energy transition. This contrasts sharply with broader cross-country or multi-industry analyses that may dilute region-specific insights crucial for effective policy and corporate strategy. Second, we offer a nuanced understanding of green investment proxies by employing a multidimensional view of environmental performance through the EPS, EC, and GHG emissions. Our empirical findings, particularly the mixed or sometimes counter-intuitive results (e.g., the negative impact of EPS on profitability in certain models), offer significant empirical novelty. These findings challenge the universal positive assumptions often found in the literature and provide critical insights into the short-to-medium-term trade-offs faced by heavy industries in this unique developmental stage. Third, our research demonstrates econometric rigor in a challenging dataset, applying the robust and dynamic generalized method of moments (GMM) framework. This approach explicitly addresses persistent issues such as endogeneity (including reverse causality and omitted variable bias) and cross-sectional dependence, which is highly pertinent given the deep economic and geopolitical integration of the GCC states. The rigorous application of these methods to a data-constrained, yet highly relevant, sample ($N=13$) further contributes to the empirical methodology in such settings. Finally, our analysis is framed with explicit reference to contemporary green finance developments such as green taxonomies, the Corporate Sustainability Reporting Directive (CSRD),¹ and the Task Force on Climate-related Financial Disclosures (TCFD).² While these frameworks are still developing within the GCC, acknowledging them allows our findings to inform regional policy and corporate strategy in light of evolving international best practices. By shedding light on these complex dynamics in a region at the forefront of global energy transition debates, our research moves beyond incremental novelty to offer unique and critical insights for academics, policymakers, and industry practitioners navigating sustainable development in hydrocarbon-rich economies.

The objective of this study is to examine the impact of various green investment proxies (EPS, EC, and GHG) on corporate profitability, measured by ROA and ROE, in GCC oil and gas firms. The research design uses quantitative analysis as well as empirical modeling to fulfill its aims. A ten-year period of study on basic environmental and financial measures was conducted for GCC oil and gas listed companies. To assess green investment, the analysis calculates the changes in profitability ratios at different time points and corrects them using the variables of firm size, level of leverage, and total

¹ For details see: https://finance.ec.europa.eu/regulation-and-supervision/financial-services-legislation/implementing-and-delegated-acts/corporate-sustainability-reporting-directive_en.

² See Task Force on Climate-related Financial Disclosures website <https://www.fsb-tcfd.org/>.

energy consumption. The researchers run a range of sensitivity tests that include the sensitivity analysis of both models and experimental alternative models. The authors add environmental pillar scores regarding the use of resources and emission rates, along with the innovation measures, to observe their impact on financial performance. The study combines complex sources of information and analytical tools to define the entire analysis of green investment costs in the oil and gas industries in the GCC.

Various important observations are presented in the study findings. To begin with, green investments are found to positively and significantly affect the profitability of the companies in terms of ROA and ROE. This concurs with the conclusions of Lindenberg (2014) and Hartmann et al. (2021), who argue that green investments enhance cost-effectiveness and reputation. Second, the environmental pillar score is highly connected to the financial performance, and what it means is that the companies that carry out environmental practices on a better level perform better regarding profitability. This observation justifies increased motivation to exploit the application of ESG aspects in guiding decision-making at the firm level. Third, energy use and GHG emissions are established to have a negative correlation with profitability, disclosing the financial consequences of unsustainable activities. These results confirm Aastvedt et al.'s (2021) warnings about the potential cost of green investments. However, the study also shows significant heterogeneity between companies, implying that the financial impact of green investments can be dependent on company size, operational efficiency, and market conditions.

This paper continues with the following structure: Section 2 conducts an extensive review of scholarly works surrounding environmental investments and company financial success, along with their important theoretical and experimental contributions. The description of methodology in Section 3 includes explanations of data sources as well as definitions of variables and analytical approaches. Section 4 releases the empirical results alongside their theoretical and practical implications. The final section summarizes the main findings, followed by policy implications and proposed research paths for future work.

2. Literature review

The intensified global concern surrounding environmental sustainability and climate change has propelled green investments into a central focus of academic inquiry concerning corporate profitability. This literature review critically synthesizes extant research on the environmental and financial dimensions of green investments, particularly emphasizing their implications for the distinctive context of GCC oil and gas industries. The review is structured around three interconnected thematic streams: (1) the unique environmental footprint and energy transition dynamics within GCC economic activities; (2) the complex and often conflicting empirical evidence on the correlation between environmental indicators and corporate financial performance, including underlying theoretical debates; and (3) the specific role of green investments in enhancing corporate financial achievements, considering both their strategic and financial implications. Through this critical synthesis, the review aims to illuminate key research shortcomings and conceptual tensions within the existing body of knowledge, thereby establishing the precise scholarly gaps that this study seeks to address concerning the financial effects of green investments in the GCC oil and gas sector.

2.1. Environmental impact and energy transition dynamics in GCC economic activities

The GCC region is a pivotal global hub for oil and gas production, significantly shaping international energy markets and influencing global environmental outcomes. Annually, the GCC contributes approximately 32% of worldwide oil and 12% of global natural gas, with projections indicating further expansion (Alam & Azalie, 2023). However, this extensive reliance on hydrocarbon resources has resulted in severe environmental consequences, particularly in hazardous levels of carbon dioxide (CO₂) and methane (CH₄) emissions. These greenhouse gases exacerbate global warming, rising sea levels, and extreme weather patterns, posing substantial threats to both ecological systems and business operations (Grasso, 2019). The environmental emissions from such operations are directly linked to intensified climate change effects, contributing to disrupted supply chains, elevated operating expenses, and diminished corporate reputations (Ekemezie & Digitemie, 2024). This situation is underscored by the GCC's excessive ecological footprint, recorded at 8.9 global hectares per person, significantly surpassing the worldwide standard of 2.75 (Sweidan, 2021).

The escalating environmental pressures and the imperative for sustainable development have spurred GCC governments and corporate entities to pursue renewable energy solutions and green initiatives actively. Nations like Qatar and Saudi Arabia have launched large-scale initiatives aimed at fostering sustainable urban growth and achieving significant carbon emission reductions by 2030 (Alam & Azalie, 2023). This strategic shift toward cleaner energy sources is globally recognized as crucial for mitigating environmental degradation, as demonstrated by studies like Chen et al. (2023), which assessed the profound environmental benefits of renewable energy in reducing air pollution and carbon emissions. However, the transition to a low-carbon economy in the GCC faces considerable obstacles, including the substantial costs of accessing green technologies and the pervasive economic dependence on petroleum resources. As Alkathery et al. (2022) highlighted, the dynamics of clean energy adoption and fluctuating oil and emissions pricing have direct and significant implications for the financial performance of energy sector firms in the GCC. This intricate developmental context reinforces the urgent need for precise strategies that effectively integrate green investments with both sustained economic progress and long-term environmental sustainability, compelling firms to proactively manage these transitions to mitigate risks and capitalize on new opportunities.

2.2. The complex nexus between environmental and financial performance: competing mechanisms and empirical divergence

The relationship between corporate environmental performance and financial profitability remains a subject of intense academic debate, yielding empirical evidence characterized by conflicting results. This divergence stems from the multifaceted impacts of environmental initiatives on various business performance metrics. On one hand, numerous studies advocate for a “win-win” scenario, demonstrating positive financial outcomes. For instance, research by Guenster et al. (2011) and Susanti et al. (2023) indicated that enhanced eco-efficiency and robust green accounting practices translate into tangible financial benefits. This perspective is well-aligned with the resource-based view (RBV), positing that developing superior environmental management capabilities can serve as inimitable resources leading to competitive advantages, operational efficiencies, and reduced costs (Guenster et

al., 2011). Furthermore, firms implementing environmentally sustainable practices often achieve lower operational costs and enhanced market recognition, ultimately boosting shareholder value (Chariri et al., 2018). This market recognition can be illuminated by signaling theory, where credible environmental performance acts as a positive signal to investors and consumers, indicating a robust, forward-thinking, and well-managed company, thereby attracting investment and fostering brand loyalty. Additionally, a strong environmental performance can attract socially responsible investors, potentially reducing a firm's cost of capital and fostering positive stakeholder relationships, aligning with stakeholder theory (Morrone et al., 2022). Further supporting the win-win perspective, Jin and Lei (2023) empirically demonstrated that robust corporate ESG performance positively influences corporate value and innovation, with innovation acting as a key mediating mechanism. Their findings also highlighted that these positive effects are more pronounced in specific contexts, such as for non-state-owned enterprises and in regions with developed institutional environments, suggesting that the benefits of green investments are not uniform and are influenced by various internal and external factors.

Conversely, significant literature highlights the potential for “win-lose” or mixed outcomes, particularly in the short term or for industries with substantial environmental footprints like oil and gas. The transition to sustainable practices often necessitates considerable initial expenditures, which can pose a notable financial burden. Dowell et al. (2000) demonstrated that the economic benefits from green investments are contingent upon fundamental criteria such as company size, sector, and local developmental stages. Larger organizations, possessing greater financial resources, tend to be better positioned to absorb these initial costs, while smaller operations frequently encounter difficulties in implementing green solutions. Swamy and Dharani (2019) further illustrated that operational expenses incurred to reduce GHG emissions can lead to short-term financial losses, suggesting that the immediate costs may outweigh the benefits in certain contexts. Recent research further illuminates this complexity, with studies such as Jin and Lei (2024) demonstrating that stringent environmental regulations, while potentially imposing initial financial burdens on heavy polluting industries, can ultimately drive long-term positive financial performance by fostering technological innovation and improved environmental management. This dynamic underscores the critical role of robust regulatory frameworks in shaping the time-dependent relationship between environmental compliance and corporate profitability.

These conflicting findings underscore the presence of competing causal mechanisms and theoretical debates within the literature. One such debate concerns short-termism versus long-term value creation. While green investments often promise long-term benefits (e.g., reduced regulatory risk, enhanced brand loyalty, access to new markets), their significant upfront costs can depress short-term profitability, a concern for investors with short horizons (Margolis & Walsh, 2003). Another critical aspect is greenwashing, where firms might engage in superficial environmental claims for reputational gain without genuine commitment, leading to skepticism and potentially undermining long-term financial benefits if exposed (Delmas & Burbano, 2011). Relatedly, legitimacy theory posits that firms undertake green initiatives not only for direct financial returns but also to align with societal expectations and gain social acceptance, thereby enhancing their “license to operate” and potentially mitigating non-market risks. This pursuit of legitimacy can explain investments that may not immediately translate into higher ROA or ROE but are vital for long-term survival and reputation (Dowling & Pfeffer, 1975). Therefore, a deeper investigation into which specific business conditions

and strategic intents yield positive financial returns from green investments remains crucial, as current empirical evidence is insufficient and context-dependent.

2.3. The role of green investments in enhancing corporate profitability: global insights and regional gaps

The strategic financing of projects with environmental responsibility at their core constitutes green investments that corporations utilize to unite sustainable practices with economic performance goals. Chen and Ma (2021) and Kruse et al. (2020) empirically showed that such investments can contribute to business financial success, a finding consistent with the resource-based view (RBV), where investments in green technologies and processes yield efficiency gains and enhance competitive advantage. Specifically, combining energy conservation with emission reduction efforts has been shown to generate profit growth within a three-year horizon, primarily by decreasing operational costs and improving overall performance (Chen & Ma, 2021). Similarly, green innovation, encompassing environmentally friendly product development and process optimization, has been directly linked to positive market valuation and increased investor confidence levels (Chariri et al., 2018), further reinforcing signaling theory regarding investor perceptions of sustainable and forward-thinking firms.

However, the financial profits derived from green investments exhibit varying levels of uniformity across different economic contexts and sectors. The ultimate financial outcomes are significantly influenced by a confluence of factors, including technological advancements, the availability of government support through subsidies, and access to adequate funding. For instance, while environmental taxes may initially reduce short-term profitability by increasing operational expenses, government subsidies can effectively offset these costs, thereby stimulating and sustaining long-term green technology investments (Chen & Ma, 2021). Nevertheless, the successful implementation of green projects remains particularly challenging in many developing regions, largely due to inadequate regulatory guidelines and insufficient financial support (Tran et al., 2020).

In more developed markets, the landscape of green finance is increasingly shaped by a growing body of regulatory frameworks and reporting standards designed to provide clarity, drive investment, and enhance transparency. Key global initiatives include green taxonomies (e.g., the EU Taxonomy), the Corporate Sustainability Reporting Directive (CSRD), and disclosure frameworks like the Task Force on Climate-related Financial Disclosures (TCFD). These initiatives aim to standardize the definition of “green” activities and mandate transparent environmental disclosures, thereby profoundly shaping contemporary research and policy in sustainable finance. While these global frameworks are still nascent or adapted within the GCC region, their increasing international influence underscores the importance of robust, quantifiable measures of green investments and their financial implications. This evolving context further emphasizes the empirical novelty of our study, which examines how firms in the GCC oil and gas sector manage environmental performance indicators (EPS, EC, GHG) within an environment characterized by developing, rather than fully mature, green finance regulations.

Despite the growing global focus, the GCC region specifically lacks sufficient empirical research on how financing green projects affects corporate profitability rates. While oil and gas companies operating in this region face an imperative to implement sustainable practices, the precise financial outcomes of these initiatives remain underexplored. Existing research, though limited for the GCC, offers mixed signals; some studies suggest that green investments can lead to increased profitability

through reduced power usage and lowered operational expenses (Al-Karaghoul & Kazmerski, 2013), while others indicate that the expenses associated with renewable energy technology may, in some cases, exceed their immediate financial benefits (Simionescu et al., 2020). Given the GCC's unique economic reliance on oil assets and its heightened sensitivity to climate change, there is a clear demand for region-specific green investment strategies and a nuanced understanding of their financial implications.

2.4. Research gaps and study contributions

Despite the increasing volume of research on green investments and corporate profitability, several critical research gaps persist, particularly concerning emerging economies. A significant portion of the extant literature predominantly focuses on developed economies, leaving the GCC region largely underexplored. This exclusive focus on the GCC is crucial not only because the region is central to global energy systems but also due to its exceptional environmental vulnerabilities and its unique stage of green economic transition. Prior research has often neglected to analyze how specific organizational characteristics, nuanced regulatory environments, and distinct market classifications within such regions influence the financial response to green investment initiatives. Furthermore, the nascent stage of widely adopted green taxonomies and standardized environmental reporting frameworks (such as under CSRD or TCFD) in the GCC presents unique empirical challenges and opportunities. Our study, by focusing on measurable environmental performance indicators (EPS, EC, GHG) in a region without fully mature green finance regulations, offers substantial empirical novelty by examining how firms respond to environmental pressures in the absence of the stringent reporting mechanisms prevalent in more developed markets. Building upon these identified gaps, this study undertakes a pioneering investigation into the financial effects of green investments on corporations operating within the GCC oil and gas industry, where such connections have not yet been comprehensively studied. Specifically, this research aims to examine the impact of various green investment proxies (EPS, EC, and GHG) on corporate profitability, measured by ROA and ROE, in GCC oil and gas firms.

The empirical findings derived from GCC corporations contribute new knowledge to the academic literature by providing context-specific evidence from a critical global energy hub. This study also offers valuable strategic guidance for corporate executives, financial stakeholders, and governmental authorities grappling with the complexities of sustainable development. Ultimately, by illuminating how green investments can foster financial profitability opportunities alongside environmental sustainability improvements, this research supports the GCC countries' strategic imperative to shift toward a diversified, low-carbon economy.

3. Methodology

3.1. Data selection

This study examines the impact of green investments on corporate profitability within the oil and gas sector of the GCC region. The analysis focuses on publicly listed oil and gas companies in four GCC countries—Saudi Arabia, Qatar, Oman, and the United Arab Emirates—over the period 2015–

2022. The study evaluates data from 13 companies that remained accessible during the study period. The Bloomberg database serves as the primary information source for financial and environmental data, while the World Bank provides macroeconomic variables, including GDP and GDP per capita. The research used environmental scores and financial profitability ratios together with macroeconomic variables in accordance with Aastvedt et al. (2021), who analyzed comparable traits between the US and European markets.

Corporate profitability is measured through the dependent variables of return on assets (ROA) and return on equity (ROE). While these ratios are standard in financial performance analysis, providing insights into asset utilization and shareholder returns, it is crucial to acknowledge their potential interpretive limitations within the unique GCC context, particularly for the oil and gas sector. The financial performance of firms in this region can be significantly influenced by factors such as substantial direct or indirect state ownership and the prevalence of government subsidies, which may artificially inflate reported profits or stabilize performance irrespective of market-driven efficiency.

Furthermore, green investments by state-backed entities in the GCC might be driven by broader national strategic objectives like economic diversification or international reputation, rather than solely by conventional profit maximization. This can mean that ROA and ROE may not fully capture the complete strategic value or non-financial returns of these initiatives. Additionally, the distinct capital structures of state-influenced firms, often involving direct government equity injections or reduced reliance on traditional debt markets, can affect the comparability and interpretation of these profitability metrics against international benchmarks. Therefore, while ROA and ROE remain the most appropriate available quantitative measures, these contextual nuances highlight the imperative for careful interpretation of our findings, recognizing the systemic influences beyond purely market-driven efficiency gains or losses from green investments.

The study investigates three independent variables: environmental pillar score (EPS), energy consumption (EC), and greenhouse gas (GHG) emissions, since these metrics are primary methods of assessing a company's environmental performance. The EPS operates as a 100-point scale that unites three components, including resource use, emissions reduction, and innovation scores. This indicator demonstrates how companies control their material, energy, and water usage through operational and production processes, as it indicates their environmental emission reduction potential (Aastvedt et al., 2021). Operation-related EC consists of direct and indirect usage of electricity (kilowatt-hours), heat (British thermal units), and fuel in all its forms (liters or gallons), according to Boffo et al. (2020). Greenhouse gas (GHG) emissions require organizations to separate them by direct (Scope 1) processes owned or controlled and indirect (Scope 2 & 3) processes that occur due to purchased energy and within the value chain (Boffo et al., 2020; Swamy & Dharani, 2019). These environmental metrics give organizations complete insight into their performance, which produces detailed financial analyses of how green investments relate to profitability.

The research utilizes control variables consisting of company size (Size) measured by the log of total assets; leverage (L) displayed through the debt-to-equity ratio; crude oil prices (OP) measured as the log of Brent crude prices; and gross domestic product (GDP) per capita using the annual log of GDP per capita. The company size of organizations matters for the economy of scale benefits because larger companies achieve operational cost advantages (Khalid et al., 2023). Leverage ratios act as controls for debt financing financial risks because higher leverage ratios show more financial strain,

which reduces profitability. The study includes crude oil prices to assess their strong impact on oil and gas firm profitability, as GCC countries depend heavily on hydrocarbon revenues (Aastvedt et al., 2021). Finally, the economic development level in each country varies with GDP per capita and this affects business profitability (Algarini, 2020).

This study draws its conclusions from data analysis of 13 companies across four GCC countries. This limited sample size is justified by data availability, along with unique economic and environmental circumstances in the region. This examination brings together financial, environmental, and macroeconomic metrics to deliver a complete assessment of green investments' effect on GCC oil-and-gas sector profitability.

3.2. Methodology

The study employs panel data analysis for investigating relationships, as this approach delivers higher benefits than time-series and cross-sectional analyses. Panel data analysis allows a wider scope of available degrees of freedom while addressing the omitted variables challenge, as discussed by Hsiao et al. (1995) and Hsiao (2007). Yet, panel data analysis suffers from particular drawbacks that researchers need to consider. A crucial matter that arises mainly in macroeconomic research involves cross-sectional or spatial dependence (Driscoll & Kraay, 1998). This dependence develops among groups that have been non-randomly selected, like states, countries, or industries, since they experience shared observable and unobservable disturbances with time (Smolo & Alsuhaibani, 2024). The presence of spatial dependence leads to accurate parameter estimation but interferes with the accuracy of standard errors (Driscoll & Kraay, 1998; Hoechle, 2007). The methodology by Hoechle (2007) enables pooled ordinary least squares (POLS) and fixed effects (FE) within estimates, together with Driscoll and Kraay's (1998) standard errors for robustness testing. According to Hausman (1978), the selection between POLS and FE models relies on the Hausman test results showing a significant F-statistic p-value ($p < 0.05$) in testing $\gamma = 0$ to support the FE model implementation. POLS proves appropriate for the sample when the null hypothesis fails to achieve rejection (Hoechle, 2007). The research design based on these principles delivers reliable results for the examined relationship dynamics. Hence, the study utilizes pooled ordinary least squares (POLS), fixed effects (FE), and generalized method of moments (GMM) for its estimation methods. These methods were selected since they were designed to address unique data aspects and research inquiries, resulting in reliable findings.

The POLS model functions as the baseline model by uniting all observations into one regression to determine the relationship between green investments and corporate profitability. The straightforward nature of this technique does not represent firm-specific or time-specific differences, which could negatively affect the study findings (Baltagi, 2021).

The FE model is used to address this limitation. This approach mitigates unobserved time-stable variables by applying specific firm-level intercepts to establish a within-firm time-series relationship. The panel data analysis requires this approach, enabling researchers to focus on firm-level variable relationships, thus reducing potential omitted variable biases (Asteriou et al., 2005; Bell & Jones, 2014; Flannery & Hankins, 2013). However, FE does not allow for the inclusion of time-invariant variables, which may limit its applicability in specific contexts.

In addition, the research employs the GMM framework from Blundell and Bond (1998) to achieve its dynamic analysis. This approach is particularly well-suited for panel data with extensive cross-sectional elements (N) and limited time scope (T), as it effectively addresses common endogeneity issues prevalent in such studies, namely *reverse causality* (where profitability might influence green investment, and vice-versa) and *omitted variable bias* (due to unobserved firm-specific factors). By treating explanatory variables as potentially endogenous and incorporating lagged values of the dependent variables (ROA and ROE) as instruments, the GMM framework takes care of persistence in profitability over time and enables a robust examination of the dynamic relationship between green investments and financial performance, yielding consistent and unbiased estimates (Abrigo & Love, 2016).

Furthermore, while the system GMM is our primary estimation strategy, other methods designed explicitly for CSD, such as the common correlated effects mean group (CCEMG) or pooled mean group (PMG) estimators by Pesaran (2006), could be considered in future research with larger datasets. These methods explicitly model and remove the common factors driving cross-sectional dependence (CSD). However, given our small N and the dynamic nature of our model, the robust GMM framework, coupled with appropriate standard error adjustments, provides a suitable and transparent approach to account for CSD while maintaining the benefits of GMM for endogeneity.³

The study adopts methods similar to those used by Aastvedt et al. (2021) in its research design. This study adopted two analytical methods: static regression and dynamic regression models. The static panel model is specified as follows:

$$PR_{i,t} = \alpha_0 + \beta_1 GI_{i,t} + \beta_2 \log(Size_{i,t}) + \beta_3 (L_{i,t}) + \beta_4 \log(OP_{i,t}) + \beta_5 \log(GDP)_{i,t} + \varepsilon_{i,t} \quad (1)$$

In the model, i represents the company in the cross-sectional dimension at time t , while PR, measured by ROA and ROE, represents the two profitability ratios employed as dependent variables for the i th company at time t . GI (green investment) represents the firm's environmental performance as measured by EPS, EC, and GHH. To control for potential confounding effects, several variables are incorporated: Size, measured as the natural logarithm of total assets, represents company size; L, the leverage ratio, is calculated as the debt-to-equity ratio; OP, reflecting crude oil prices, is based on the Brent benchmark; and GDP, representing the economic context, is measured as the GDP per capita of each country. These control variables account for the influence of firm-specific characteristics, financial structure, external market conditions, and macroeconomic factors on the relationship between green investment and firm profitability.

To examine the impact of green investment on corporate profitability within a dynamic linear model framework, this study employs the GMM method to facilitate a robust dynamic analysis. The model is specified as follows:

³ The choice of the GMM dynamic panel data model was deliberately made to address specific econometric challenges inherent in our dataset. The GMM approach, as pioneered by Arellano and Bond (1991) and further developed by Arellano and Bover (1995) and Blundell and Bond (1998), is particularly well-suited for a dynamic panel setting. It effectively handles unobserved firm-specific heterogeneity and controls for endogeneity arising from the inclusion of a lagged dependent variable. This is crucial for obtaining consistent and efficient estimates of the relationship between green investment and corporate profitability. While alternative models such as the CCEMG or PMG estimators are valuable, they are primarily designed to address cross-sectional dependence. Our GMM specification, which incorporates time dummies and robust standard errors, sufficiently mitigates potential cross-sectional correlation while directly tackling the dynamic nature and endogeneity of the profitability-investment relationship. This methodological choice ensures the robustness and reliability of our empirical findings.

$$PR_{i,t} = \alpha_0 + \beta_1 PR_{i,t-1} + \beta_2 GI_{i,t} + \beta_3 \log(Size_{i,t}) + \beta_4 (L_{i,t}) + \beta_5 \log(OP_{i,t}) + \beta_6 \log(GDP)_{i,t} + \eta_i + \varepsilon_{i,t} \quad (2)$$

Where $PR_{i,t-1}$ denotes the lagged dependent variable to account for dynamic effects, and η_i represents unobserved firm-specific effects. The rest of the variables are as described earlier.

By integrating these methodologies, this study comprehensively analyzes the relationship between green investments and corporate profitability in the GCC oil and gas sector, contributing to the broader literature on sustainable finance and corporate performance.

4. Empirical analysis

This chapter discusses the results of different estimations based on the data and model specified earlier. It starts with a brief analysis and discussion of descriptive statistics and correlation between variables. This is followed by the presentation and discussion of static models where pooled OLS (POLS) and fixed effects (FE) are used. After that, the study estimates dynamic models using the system form of the GMM, introduced by Blundell and Bond (1998).

4.1. Data summary

Table 1 presents the descriptive statistics for the sample companies. The mean values of the ROA and ROE are 1.65% and 1.67%, with standard deviations of 11.20% and 83.18%, respectively. The largest and lowest ROA were recorded by WFRD in UAE, at 52.32% in 2019 and −34.38% in 2018, respectively. As for EPS, EC, and GHG, the highest rates were recorded by BP OMAN (7.09) in 2022, WFRD UAE (417,621) in 2022, and by ARAMCO KSA (72,600) in 2023, respectively. The lowest rates, on the other hand, are recorded by TAQA UAE (0.14) in 2019, MAADEN KSA (307.85) in 2021, and PETRO KSA (15.516) in 2022, respectively.

Table 1. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
Return on asset	116	1.656	11.202	−34.389	52.325
Return on equity	116	1.679	83.181	−655.215	492.644
Environmental pillar score	94	2.925	1.895	.14	7.09
Energy consumption	97	67,767.999	89,215.671	307.85	417,621
Total greenhouse gas emissions	98	20,308.063	24,313.959	15.516	72,600
Leverage	116	156.127	258.313	−1346.585	1015.305
Company size (total assets)	116	84,817.648	131,613.79	2759	663,346.9
Oil prices (Brent)	117	63.7	14.476	37.28	85.91
GDP per capita	117	38,786.486	20,198.246	16,707.623	129,339

Source: Author's calculations.

The study uses Pearson correlation analysis to investigate the strength and direction of the linear relationship between the variables under investigation. As evident from Table 2, the overall financial performance measured by the ROA is significantly correlated with the company size (S). Similarly, the total GHG and oil prices significantly and positively correlate with ROA. As for the ROE, leverage is the only variable on the list that shows a significant but negative correlation with the

ROE. Regarding other variables, the highest significantly positive correlation is recorded between GHG and S, which is expected as larger companies are expected to have higher gas emissions. The next significant correlation between GHG and EC is detected. This is again expected as higher energy consumption is positively related to higher gas emissions.

Table 2. Pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Return on asset	1.000								
(2) Return on equity	0.268*	1.000							
(3) Leverage	-0.068	-0.628*	1.000						
(4) Company size (total assets)	0.409*	0.090	-0.220*	1.000					
(5) Environmental pillar score	-0.051	-0.108	-0.173	0.262*	1.000				
(6) Energy consumption	0.092	-0.007	-0.058	0.150	0.022	1.000			
(7) Total greenhouse gas emissions	0.369*	0.066	-0.213*	0.720*	0.054	0.650*	1.000		
(8) Oil prices (Brent)	0.261*	0.129	-0.090	0.102	0.233*	0.068	0.008	1.000	
(9) GDP per capita	0.030	0.038	0.024	-0.304*	0.034	-0.207*	-0.366*	0.215*	1.000

Note: Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Source: Author's calculations.

Due to the potential issue of multicollinearity affecting the sample data and possibly leading to biased statistical results, the study utilizes a variance inflation factor (VIF) analysis. The findings presented in Table 3 clearly indicate that our data do not exhibit multicollinearity concerns, as both the individual and mean VIF values for each model are well below the cutoff point of 5.

Table 3. Testing for multicollinearity: Variance inflation factors.

	EPS	EC ROA	GHG	EPS	EC ROE	GHG
Environmental pillar score (log)	1.32			1.32		
Energy consumption (log)		1.65			1.65	
Total greenhouse gas emissions (log)			2.67			3.42
Leverage	1.14	1.11	1.10	1.14	1.11	1.10
Company size (total assets - log)	1.75	2.17	3.42	1.75	2.17	3.42
Oil prices (Brent) (log)	1.09	1.06	1.06	1.09	1.06	1.06
GDP per capita (log)	1.40	1.39	1.54	1.40	1.39	1.54
Mean VIF	1.34	1.47	1.96	1.34	1.47	1.96

Notes: ROA, return on assets; ROE, return on equity; EPS, environmental pillar score (log); EC, energy consumption (log); GHG, total greenhouse gas emissions (log).

Source: Author's calculations.

4.2. Green investment and corporate profitability relationship: static models

This study utilizes both static and dynamic models to investigate how green investment impacts the corporate performance of selected companies from GCC countries. In both cases, the study uses ROA and ROE as the main dependent variables. Green investment is measured by three different measures: environmental pillar score (EPS), energy consumption (EC), and total greenhouse gas emissions (GHG), all measured in natural logarithms. Furthermore, the study aligns with the current

literature and incorporates various control variables, specifically: company size (S), leverage (L), oil prices (OP), and GDP per capita (GDP). All variables are in natural logarithms except L.

This section presents the estimation results of static models using pooled ordinary least squares (POLS) and fixed effects (FE) methods. The next subsection focuses on dynamic models with generalized method of moments (GMM) estimations, comparing results primarily to those of Aastvedt et al. (2021), our reference article. Although all models included time effects, these results are omitted for clarity and to maintain consistency with other studies.

To address the potential issue of cross-sectional or “spatial” dependence in panel data, this study employs Hoechle’s (2007) model. This model provides POLS and FE estimates, complemented by Driscoll and Kraay’s (1998) standard errors for more robust inference. The Hausman test guides the decision between using POLS or FE. A significant p-value below 5% suggests the null hypothesis should be rejected, indicating a preference for the FE estimation results. Conversely, if the p-value is insignificant, the results from POLS estimations are to be followed (see Hoechle, 2007).

Table 4 and Table 5 provide results for ROA and ROE as dependent variables based on POLS and FE estimations. We will first discuss the results from Table 4. Based on the Hausman tests and their p-values (<5%), the preference is to be given to FE estimation results, except in the case of Models (3) and (4) in Table 4, where we should rely on POLS results as the Hausman test p-value (>5%). Generally, FE models are utilized to address company heterogeneity, enabling panel regression with no instruments. Therefore, the discussion is based on models (2), (3), and (6). Very high F-statistics and significant p-values across all models provide support for the overall fitness of all models.

Model (2) shows that about 14.7% of the variations in ROA are explained by the variables used in the model. Our main variable, EPS, has an insignificant impact on ROA. This result, while significant at 10%, contrasts with those reported by Aastvedt et al. (2021). In other words, decisions by GCC companies to invest in green investments do not contribute to companies’ performance measured by ROA. This could be due to short-termism,⁴ as explained by legitimacy theory.⁵ In other words, in state-influenced economies, environmental spending might be driven by strategic mandates rather than market-led efficiency incentives, making them appear as a cost center in short-term financial statements. At the same time, Model (2) shows that leverage (L) and company size (Size) have a positive and significant impact on ROA. While a 1% increase in Size leads to an average of 0.17% increase in ROA, the coefficient of L and its effect on ROA could be economically ignored. The other control variables are insignificant.

⁴ Short-termism refers to a corporate or investor mindset that prioritizes immediate financial gains over long-term value creation. In the context of green investments, it is characterized by the burden of high upfront costs, the delayed realization of returns, and the pressure from investors who focus primarily on short-term profitability. This often discourages firms from committing to environmentally sustainable initiatives that may not yield immediate financial benefits.

⁵ Legitimacy theory suggests that firms undertake certain actions—such as environmental or social investments—not solely for financial returns, but to maintain or enhance their legitimacy in the eyes of stakeholders. In practice, this means companies may invest in sustainability initiatives to align with national visions or societal expectations, thereby securing a “social license to operate”. Especially in regions like the GCC, where state-led development agendas (e.g., Vision 2030) are prominent, firms may prioritize alignment with national goals and reputational benefits over immediate financial gains.

Table 4. Static models estimation results; ROA as dependent variable.

Variables	(1) POLS	(2) FE	(3) POLS	(4) FE	(5) POLS	(6) FE
Environmental pillar score (log)	−0.118** (−0.030)	−0.049 (−0.059)				
Energy consumption (log)			0.001*** (−0.007)	0.138** (−0.057)		
Total greenhouse gas emissions (log)					0.013** (−0.013)	−0.305 (−0.255)
Leverage	0.001*** (0.000)	0.000*** 0.000	0.001*** 0.000	0.000*** 0.000	0.001*** 0.000	0.000*** 0.000
Company size (total assets, log)	0.194** (−0.038)	0.167* (−0.094)	0.174** (−0.032)	0.162* (−0.099)	0.149** (−0.029)	0.305 (−0.122)
Oil prices (Brent) (log)	0.065 (−0.193)	3.287 (−1.222)	0.053 (−0.180)	−0.084 (−0.465)	0.139 (−0.207)	0.989 (−0.737)
GDP per capita (log)	0.133* (−0.072)	−1.189 (−0.571)	0.125* (−0.057)	0.071 (−0.164)	0.114* (−0.060)	−0.147 (−0.387)
Year dummy	YES	YES	YES	YES	YES	YES
No. of observations	94	94	97	97	98	98
No. of companies	13	13	13	13	13	13
R ²	0.251	0.147	0.267	0.201	0.257	0.179
F-stat.	58.691	226968.664	450.445	374074.467	26.294	324272.173
F-stat. p-val.	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hausman		8.240		0.925		3.791
Hausman p-val.		(0.008)		(0.512)		(0.047)

Notes: Regression with Driscoll–Kraay standard errors. POLS, pooled OLS estimations; FE, fixed-effects regression. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculations.

Table 5. Static models estimation results; ROE as the dependent variable.

Variables	(1) POLS	(2) FE	(3) POLS	(4) FE	(5) POLS	(6) FE
Environmental pillar score (log)	−0.030*** (0.007)	−0.025* (0.011)				
Energy consumption (log)			0.003*** (0.001)	0.015*** (0.004)		
Total greenhouse gas emissions (log)					−0.004* (0.002)	0.015 (0.038)
Leverage	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)
Company size (total assets, log)	−0.001 (0.007)	0.002 (0.026)	−0.008 (0.007)	0.013 (0.016)	0.002 (0.007)	0.008 (0.017)
Oil prices (Brent) (log)	1.463*** (0.039)	1.763*** (0.248)	1.813*** (0.040)	1.810*** (0.112)	1.791*** (0.047)	1.681*** (0.153)
GDP per capita (log)	0.007 (0.010)	−0.121 (0.108)	−0.002 (0.007)	−0.031 (0.027)	0.002 (0.009)	−0.092* (0.043)
Year dummy	YES	YES	YES	YES	YES	YES
No. of observations	94	94	97	97	98	98
No. of companies	13	13	13	13	13	13
R ²	0.251	0.147	0.267	0.201	0.257	0.179
F-stat.	11643.785	15182.565	71373.474	1376657.950	18050.533	256800000.000
F-stat. p-val.	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hausman		9.530		26.850		14.680
Hausman p-val.		(0.005)		(0.000)		(0.000)

Notes: Regression with Driscoll–Kraay standard errors. POLS, pooled OLS estimations; FE, fixed-effects regression. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Source: Author's own calculations.

Model (3) reports the impact of green investment, represented by energy consumption (EC), on ROA. Due to the Hausman test p-value being greater than 5% (0.512), we rely on results reported using the POLS model. Under this model, EC has a highly significant but negligible impact on ROA. In line with the results reported in Model (2), L and Size, alongside GDP, are also significant. Finally, under Model (6), we investigate the impact of total GHG on ROA. Under this model, the only significant variable with a positive sign is L. Our primary variable, GHG, is found to have a negative but insignificant impact on ROA.

Table 5 reports the impacts of EPS, EC, and GHG on ROE as the primary dependent variable under Models (2), (4), and (6), respectively. We opt for FE models' results as the Hausman tests' p-values are below 5%. For each model, the R-squared is 14.7%, 20.1%, and 17.9%. In other words, 14.7%, 20.1%, and 17.9% of variations in Models (2), (4), and (6) are explained by the models, respectively.

The overall results are slightly different from those reported in Table 4. For instance, EPS is found to have a significantly negative impact on ROE, whereby a 1% increase in EPS leads to a 0.025% decrease in ROE. This result, while contrasting with the general expectation from stakeholder theory and the resource-based view that green investments lead to positive financial outcomes, aligns with concerns raised by Aastvedt et al. (2021) that green investments can incur significant operational expenses or have uncertain short-term financial returns. In the unique context of the GCC oil and gas sector, this finding might indicate several contributing factors:

- Initial investment costs: Companies might be in an early phase of green investments where significant capital expenditures for new technologies or processes outweigh immediate financial returns. The benefits of these investments, such as long-term cost savings or improved brand reputation, may not yet be fully realized or reflected in short-term profitability metrics.
- Lagged returns: The financial benefits of green investments often materialize over a longer time horizon, whereas profitability metrics captured in the short to medium term may only reflect the costs incurred.
- Lack of mature green markets/incentives: Unlike more developed economies with mature green markets and strong governmental incentives for sustainable practices, the GCC region's environmental policies are still in developmental phases. This could mean that the financial benefits derived from "greenness" (e.g., lower cost of capital, premium pricing for green products) are not yet strong enough to offset the costs.
- Reporting versus actual impact: While EPS measures environmental performance, a higher score might reflect robust reporting frameworks or compliance efforts rather than immediate operational efficiencies or revenue generation directly from green initiatives. There might be a lag between reporting improvements and tangible financial benefits.
- Potential misaligned investments (agency theory perspective): It is also plausible that some green investments are not optimally aligned with core business profitability goals, or are undertaken more for reputational reasons without a clear, direct path to maximizing shareholder wealth. This aligns with a potential agency problem where managerial interests might diverge from immediate financial returns.

Under this model, L has a negative (although economically ignorable) and OP has a positive (1.76%) impact on ROE, similar to those reported under Model (2) in Table 4. Model (4) reports a significantly positive effect of EC on ROE. Since EC represents the opposite of green investment, this

means that as companies waste more energy, it is expected that they will produce more, and the profitability (ROA) will be greater in the end. The positive EC–ROE relationship, though counter-intuitive from a sustainability standpoint, can be explained by the unique characteristics of the GCC oil and gas sector, where higher energy consumption often signals greater production activity and operational scale—key drivers of profitability. Additionally, energy subsidies in the region reduce the cost burden of consumption. At the same time, the green transition remains in its early stages, with many firms prioritizing short-term efficiency in traditional operations over long-term sustainability investments. Similar to results reported under Model (2), L and OP significantly contribute to ROE, while other variables are insignificant. Finally, under Model (6), GHG and S are insignificant. On the other hand, L and GDP decrease, while OP significantly increases ROE.

In short, the overall impact of green investments—measured by EPS, EC, and GHG—is insignificant when measured against ROA but significantly negative when applied against ROE. In other words, the results are somewhat conflicting, as green investments may either have no impact or hurt the profitability of companies in GCC countries.

4.3. Green investment and corporate profitability relationship: dynamic models

Given the need for a dynamic analysis that properly controls for endogeneity among our variables, the system GMM method proved to be the most appropriate choice. Table 6 provides the outcomes of these estimations. We examined the impact of EPS, EC, and GHG (our core independent variables in models 1, 2, and 3) on ROA (the dependent variable) for the entire sample.

Following the estimation, we performed a series of post-estimation tests to verify the validity of our GMM results. Across all three models, these tests yielded the correct configuration: the null hypothesis for AR(1) was rejected, while the null hypothesis for AR(2) was retained—a critical finding that validates the consistency of the GMM estimator. Furthermore, the Sargan tests uniformly supported the validity of our chosen instruments, confirming that they are appropriately uncorrelated with the model's error term. This thorough validation process allows us to confidently interpret the GMM results presented in the table.

The regression results from Table 6 using the GMM estimator are partially in line with the previous results we reported using the POLS and FE. The EC and GHG coefficients are positive but insignificant, indicating that they do not impact ROA in the GCC companies. However, the impact of EPS on ROA is found to be significantly negative. As before, our results differ from those obtained by Aastvedt et al. (2021). Under all models, there is a substantial degree of persistence. Specifically, when we analyze the impact of ROA scores from the previous period on our models, we observe that the estimated coefficients remain consistently high and statistically significant, with a negative value of at least 0.342. This indicates that the past ROA scores hurt ROA performance within the sample companies, suggesting that companies' increase in ROA (in previous years) would decrease their profitability in current years. The control variable results are unchanged from previous estimations.

Table 6. Dynamic models estimation results; system GMM–ROA as the dependent variable.

	EPS	EC	GHG
Return on asset (log) _{t-1}	–0.380*** (0.137)	–0.342*** (0.131)	–0.343** (0.134)
Environmental pillar score (log)	–0.122* (0.068)		
Energy consumption (log)		0.018 (0.023)	
Total greenhouse gas emissions (log)			0.017 (0.026)
Leverage	0.001*** (0.000)	0.000 (0.000)	0.001*** (0.000)
Company size (total assets, log)	0.255*** (0.050)	0.203*** (0.052)	0.200*** (0.061)
Oil prices (Brent) (log)		0.651** (0.331)	0.709** (0.328)
GDP per capita (log)	0.174 (0.121)	0.165 (0.113)	0.148 (0.123)
Constant	0.201 (1.535)	–2.096 (1.670)	–2.168 (1.738)
Year dummy	YES	YES	YES
No. of observations	84	90	90
No. of countries	13	13	13
Arellano-Bond: AR(1)	0.003	0.008	0.001
Arellano-Bond: AR(2)	0.384	0.537	0.293
Sargan test (p-val)	0.705	0.899	0.580

Notes: System GMM regressions. EPS, environmental pillar score (log); EC, energy consumption (log); GHG, total greenhouse gas emissions (log). Standard errors are in parentheses. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Source: Author's own calculations.

Table 7 provides system GMM estimations using ROE as the dependent variable. All post-estimation specification tests align with expectations, confirm the validity of the GMM estimates, and validate the instruments. When ROE is used as the dependent variable, EPS and GHG have a negative impact, while EC has a positive impact, on ROE. These results align with those reported in Table 5 using POLS and FE models.

The significantly negative impact of EPS on ROE in this dynamic model, similar to our static model findings, further underscores the complexity of this relationship. This suggests that in the GCC oil and gas sector, efforts to improve the overall EPS, particularly in the short-to-medium term, may come at a direct cost to shareholder returns. This could be due to the substantial, upfront capital allocation required for transitioning to greener operations, which might not yield immediate compensatory financial benefits. Similarly, the negative impact of GHG emissions on ROE implies that higher emissions lead to reduced profitability, likely due to associated costs, regulatory risks, or reduced investor confidence. This finding highlights a potential trade-off between aggressive environmental performance improvements (especially in areas like comprehensive environmental pillar scores and reducing hard-to-abate emissions) and short-term profitability in a hydrocarbon-dependent region, and it warrants deeper investigation into the specific nature of green investments made and their time horizon for returns.

Table 7. Dynamic models estimation results; system GMM–ROA as dependent variable.

	EPS	EC	GHG
Return on equity (log) _{t-1}	−0.199*** (0.044)	−0.131* (0.080)	−0.126 (0.092)
Environmental pillar score (log)	−0.032*** (0.012)		
Energy consumption (log)		0.004* (0.003)	
Total greenhouse gas emissions (log)			−0.004* (0.003)
Leverage	−0.000*** (0.000)	−0.000*** (0.000)	−0.000*** (0.000)
Company size (total assets, log)	−0.002 (0.005)	−0.007 (0.005)	0.004 (0.006)
Oil prices (Brent) (log)	0.083** (0.041)	0.089** (0.035)	0.088*** (0.033)
GDP per capita (log)	0.007 (0.020)	0.000 (0.012)	0.006 (0.014)
Constant	7.456*** (0.383)	7.034*** (0.531)	6.902*** (0.605)
Year dummy	YES	YES	YES
No. of observations	84	90	90
No. of countries	13	13	13
Arellano-Bond: AR(1)	0.025	0.039	0.066
Arellano-Bond: AR(2)	0.103	0.842	0.637
Sargan test (p-val)	0.545	0.955	0.973

Notes: System GMM regressions. EPS, environmental pillar score (log); EC, energy consumption (log); GHG, total greenhouse gas emissions (log). Standard errors are in parentheses. Significance level: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$. Source: Author's own calculations.

5. Conclusions

The main objective of this study was to explore how green investments in 13 GCC companies from 2015 to 2023 affect their performance. The research employs diverse indices of green investments, namely the EPS, EC, and total GHG. Companies' performance, on the other hand, is measured by ROA and ROE. This study aimed to address the gap in research regarding the relationship between green investment and corporate performance in the GCC region.

To address this issue, the study uses a model developed by Hoechle (2007) that provides POLS and FE estimates, along with Driscoll and Kraay's (1998) standard errors. Furthermore, by employing the system GMM approach, our study effectively addresses potential endogeneity issues, such as reverse causality and omitted variable bias, thereby enhancing the credibility and reliability of our findings regarding the intricate relationship between green investments and profitability in this context.

The main conclusion drawn from this study is that the impact of green investments on corporate profitability in the GCC oil and gas sector is complex and multifaceted, warranting further investigation. This complexity, as revealed by our mixed and sometimes counterintuitive results (e.g., the negative relationship between EPS and profitability), offers significant empirical novelty. Our findings challenge the simplistic application of green finance theories developed in more mature markets and highlight the need for context-specific analyses. Specifically, the observed negative relationship between EPS and profitability in some models suggests that firms in this region might be

incurring significant upfront costs without immediate, proportional financial payoffs, or that current green initiatives are more driven by compliance or reputational motives than by direct economic value creation in the short term. This implies that policy frameworks and corporate strategies in the GCC must consider these potential trade-offs and focus on long-term value creation rather than immediate financial returns from certain green investments.

Conversely, the positive association between EC and profitability likely reflects the operational realities of the oil and gas sector in the GCC. Higher energy use may indicate greater production volume, which drives revenue in this resource-intensive industry. Additionally, the presence of substantial energy subsidies in many GCC countries may blunt the cost impact of high energy consumption, making it less detrimental to profitability. This observation underscores the importance of contextualizing sustainability–financial performance relationships, especially in regions where traditional economic and regulatory assumptions may not fully apply. Theoretical contributions of this study include extending legitimacy theory and resource-based view (RBV) by emphasizing how institutional context, state ownership, and the type of green investment moderate the link between ESG performance and financial outcomes. In short, our study complements and extends recent work such as Alkathery et al. (2022), which underscores GCC-specific decarbonization and diversification pressures, and Chen et al. (2023), which emphasizes the urgent environmental imperatives facing high-emission industries.

Our results carry significant policy implications that go beyond generic recommendations. First, we advocate for the development of harmonized ESG reporting standards tailored to the GCC context, drawing from international frameworks such as TCFD (Task Force on Climate-related Financial Disclosures) or SASB (Sustainability Accounting Standards Board)⁶ but calibrated to reflect the region's industrial composition and regulatory capacity. Standardized ESG disclosures would improve transparency, reduce symbolic reporting, and better inform both investors and regulators. Second, we recommend sector-specific regulatory measures for the oil and gas industry, including regionally adapted carbon pricing mechanisms, technology-specific subsidies (e.g., for carbon capture or blue hydrogen), and a phased reform of energy subsidies to gradually align market signals with environmental priorities without causing socio-economic disruptions.

Furthermore, promoting green finance instruments such as green bonds, sustainable sukuk, and region-specific ESG investment funds could alleviate short-term financial burdens and provide long-term capital for environmental initiatives. These instruments would also enable firms to bridge the gap between policy mandates and profitability pressures. Policy frameworks must support economic diversification, upskilling, and job creation in non-hydrocarbon sectors to ensure a just transition. Government support for R&D, public-private partnerships, and university-industry collaboration is vital in addressing technological and infrastructural challenges. In this context, state-owned enterprises (SOEs) should assume leadership roles in ESG disclosure and implementation, setting benchmarks for the broader corporate ecosystem.

While this study offers important insights into the relationship between green investments and corporate profitability in the GCC oil and gas sector, several limitations must be acknowledged. Chief

⁶ SASB Standards provide an industry framework for companies to measure environmental, social, and governance (ESG) risks and opportunities. For details see <https://sasb.ifrs.org/>.

among these is the constrained availability and granularity of environmental performance data, which limited the sample to 13 publicly listed firms. While methodologically sound, the use of proxy indicators—EPS, EC, and GHG emissions—may not fully reflect the scope and financial implications of firm-level green investment activities. Additionally, the findings may not be broadly generalizable due to limited ESG disclosure standards in the region and the predominance of non-listed or state-owned firms. Methodologically, while the study applies the dynamic panel GMM approach to address endogeneity and unobserved heterogeneity, the small number of cross-sectional units poses challenges to estimator efficiency. Further, potential cross-sectional dependence and the short-to-medium-term nature of the panel may limit the complete capture of long-term investment outcomes.

Future research should overcome these limitations by accessing more detailed, firm-level green investment data and extending the observation period to capture long-term financial impacts better. Alternative econometric techniques, such as common correlated effects estimators, could offer improved handling of unobserved standard shocks when data dimensions permit. Comparative studies across different sectors or regions, particularly contrasting the GCC with more mature markets, could shed light on contextual factors shaping green investment outcomes. Additionally, future work may delve into the specific pathways—such as operational efficiency, market differentiation, or improved access to green finance—through which environmental performance influences corporate profitability in emerging economies. Although our sample size limits subgroup analysis, this remains an important area for future research. More granular data across firm size, ownership structure, and national contexts would further clarify heterogeneous effects and strengthen empirical generalizability. In particular, there is a need to explore the impact of various green investment types (e.g., renewable energy, waste management, emissions reduction) on different profitability metrics. Second, a more granular analysis could investigate the role of governance structures, such as the composition of corporate boards and the influence of national development funds, in facilitating green investment. Furthermore, a critical line of inquiry for the GCC context is the potential presence of greenwashing—where firms engage in superficial green initiatives without substantive change. Future studies could employ content analysis of corporate reports and media to assess the authenticity of green commitments and their impact on long-term value creation.

Author contributions

The authors contributed equally to the output of this paper. The initial data gathering and draft of the paper was done by Ola Alaa Farrash with the supervision of Edib Smolo, while the later editing and revisions were performed by Edib Smolo.

Use of AI tools declaration

The authors declare they have not used artificial intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare no conflict of interest.

References

- Aastvedt TM, Behmiri NB, Lu L (2021) Does green innovation damage financial performance of oil and gas companies? *Resour Policy* 73: 102235. <https://doi.org/10.1016/j.resourpol.2021.102235>
- Abrigo MRM, Love I (2016) Estimation of Panel Vector Autoregression in Stata. *Stata J* 16: 778–804. <https://doi.org/10.1177/1536867X1601600314>
- Alam M, Azalie IAN (2023) Greening the Desert: Sustainability Challenges and Environmental Initiatives in the GCC States. In: M. M. Rahman & A. Al-Azm (Eds.), *Social Change in the Gulf Region*, 8: 493–510. Springer Nature Singapore. https://doi.org/10.1007/978-981-19-7796-1_29
- Algarini A (2020) The Relationship Among GDP, Carbon Dioxide Emissions, Energy Consumption, and Energy Production From Oil and Gas in Saudi Arabia. *Int J Energy Econ Policy* 10: 280–285. <https://doi.org/10.32479/ijee.8345>
- Al-Karaghoul A, Kazmerski LL (2013) Energy consumption and water production cost of conventional and renewable-energy-powered desalination processes. *Renew Sustain Energy Rev* 24: 343–356. <https://doi.org/10.1016/j.rser.2012.12.064>
- Alkathery MA, Chaudhuri K, Nasir MA (2022). Implications of clean energy, oil and emissions pricing for the GCC energy sector stock. *Energ Econ* 112: 106119. <https://doi.org/10.1016/j.eneco.2022.106119>
- Arellano M, Bond S (1991) Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *Rev Econ Stud* 58: 277–297. <https://doi.org/10.2307/2297968>
- Arellano M, Bover O (1995). Another look at the instrumental variable estimation of error-components models. *J Econom* 68: 29–51. [https://doi.org/10.1016/0304-4076\(94\)01642-D](https://doi.org/10.1016/0304-4076(94)01642-D)
- Asteriou D, Dassiou X, Glycopantis D (2005) FDI and growth: Evidence from a panel of European transition countries. *SPOUDAI J Econ Bus* 55: 9–30.
- Baltagi BH (2021) *Econometric Analysis of Panel Data*. Springer International Publishing. <https://doi.org/10.1007/978-3-030-53953-5>
- Bell A, Jones K (2014) Explaining Fixed Effects: Random Effects Modeling of Time-Series Cross-Sectional and Panel Data. *Pol Sci Res Methods* 3: 133–153. <https://doi.org/10.1017/psrm.2014.7>
- Blundell R, Bond S (1998) Initial conditions and moment restrictions in dynamic panel data models. *J Econom* 87: 115–143. [https://doi.org/10.1016/S0304-4076\(98\)00009-8](https://doi.org/10.1016/S0304-4076(98)00009-8)
- Boffo R, Marshall C, Patalano R (2020) *ESG Investing: Environmental Pillar Scoring and Reporting*. OECD. <https://doi.org/10.1787/0cc43524-en>
- Chariri A, Bukit GRSB, Eklesia OB, et. al. (2018) Does Green Investment Increase Financial Performance? Empirical Evidence from Indonesian Companies. *E3S Web of Conferences*, 31, 09001. <https://doi.org/10.1051/e3sconf/20183109001>
- Chen XH, Tee K, Elnahass M, et al. (2023) Assessing the environmental impacts of renewable energy sources: A case study on air pollution and carbon emissions in China. *J Environ Manage* 345: 118525. <https://doi.org/10.1016/j.jenvman.2023.118525>
- Chen Y, Ma Y (2021) Does green investment improve energy firm performance? *Energy Polic* 153: 112252. <https://doi.org/10.1016/j.enpol.2021.112252>

- Delmas MA, Burbano VC (2011) The Drivers of Greenwashing. *Calif Manag Rev* 54: 64–87. <https://doi.org/10.1525/cmr.2011.54.1.64>
- Dowell G, Hart S, Yeung B (2000) Do Corporate Global Environmental Standards Create or Destroy Market Value? *Manag Sci* 46: 1059–1074. <https://doi.org/10.1287/mnsc.46.8.1059.12030>
- Dowling J, Pfeffer J (1975) Organizational Legitimacy: Social Values and Organizational Behavior. *Pacif Socio Rev* 18: 122–136. <https://doi.org/10.2307/1388226>
- Driscoll JC, Kraay AC (1998) Consistent Covariance Matrix Estimation with Spatially Dependent Panel Data. *Rev Econ Stat* 80: 549–560. <https://doi.org/10/b88vxp>
- Ekemezie IO, Digitemie WN (2024) Climate Change Mitigation Strategies in the Oil & Gas Sector: A Review of Practices and Impact. *Eng Sci Technol J* 5: 935–948. <https://doi.org/10.51594/estj.v5i3.948>
- Flannery MJ, Hankins KW (2013) Estimating dynamic panel models in corporate finance. *J Corp Finan* 19: 1–19. <https://doi.org/10.1016/j.jcorpfin.2012.09.004>
- Grasso M (2019) Oily politics: A critical assessment of the oil and gas industry's contribution to climate change. *Energy Res Soc Sci* 50: 106–115. <https://doi.org/10.1016/j.erss.2018.11.017>
- Guenster N, Bauer R, Derwall J, et al. (2011) The Economic Value of Corporate Eco-Efficiency: The Economic Value of Corporate Eco-Efficiency. *Eur Financ Manag* 17: 679–704. <https://doi.org/10.1111/j.1468-036X.2009.00532.x>
- Hartmann J, Inkpen AC, Ramaswamy K (2021) Different shades of green: Global oil and gas companies and renewable energy. *J Int Bus Stud* 52: 879–903. <https://doi.org/10.1057/s41267-020-00326-w>
- Hausman JA (1978) Specification Tests in Econometrics. *Econometrica* 46: 1251. <https://doi.org/10.2307/1913827>
- Hoechle D (2007) Robust Standard Errors for Panel Regressions with Cross-Sectional Dependence. *Stata J* 7: 281–312. <https://doi.org/10/gf4j23>
- Hsiao C (2007) Panel data analysis—Advantages and challenges. *TEST* 16: 1–22. <https://doi.org/10.1007/s11749-007-0046-x>
- Hsiao C, Mountain C, Illman KH (1995) A Bayesian Integration of End-Use Metering and Conditional-Demand Analysis. *J Bus Econ Stat* 13: 315. <https://doi.org/10.2307/1392191>
- Jin X, Lei X (2023) A Study on the Mechanism of ESG's Impact on Corporate Value under the Concept of Sustainable Development. *Sustainability* 15: 8442. <https://doi.org/10.3390/su15118442>
- Jin X, Lei X (2024) The Impact of China's New Environmental Law on the Financial Performance of Heavy Polluting Enterprises. *Pol J Environ Stud* 33: 3687–3699. <https://doi.org/10.15244/pjoes/178199>
- Khalid F, Naveed K, Nawaz R, et al. (2023) Does corporate green investment enhance profitability? An institutional perspective. *Econ Res-kon Istraz* 36: 1–24. <https://doi.org/10.1080/1331677X.2022.2063919>
- Kruse T, Mohnen M, Pope P, et al. (2020) *Green revenues, profitability and market valuation: Evidence from a global firm level dataset* (No. Centre for Climate Change Economics and Policy Working Paper 263/Grantham Research Institute on Climate Change and the Environment Working Paper, 71). London School of Economics and Political Science. Available from:

<https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2020/01/working-paper-331-Kruse-et-al.pdf>.

- Lindenberg N (2014) *Definition of Green Finance* (p. 3). German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE). Available from: <https://www.idos-research.de/en/publications/mitarbeiter-sonstige/article/definition-of-green-finance/>.
- Margolis JD, Walsh JP (2003) Misery Loves Companies: Rethinking Social Initiatives by Business. *Adm Sci Q* 48: 268–305. <https://doi.org/10.2307/3556659>
- Morrone D, Schena R, Conte D, et al. (2022) Between saying and doing, in the end there is the cost of capital: Evidence from the energy sector. *Bus Strategy Environ* 31: 390–402. <https://doi.org/10.1002/bse.2900>
- Pesaran MH (2006) Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure. *Econometrica* 74: 967–1012. <https://doi.org/10.1111/j.1468-0262.2006.00692.x>
- Simionescu LN, Gherghina ȘC, Sheikha Z, et al. (2020) Does Water, Waste, and Energy Consumption Influence Firm Performance? Panel Data Evidence from S&P 500 Information Technology Sector. *Int J Environ Res Public Health* 17: 5206. <https://doi.org/10.3390/ijerph17145206>
- Smolo E, Alsuhaibani AA (2024) Financial Development and ESG Performance: Insights from MENA Countries. *J Econ Coop Dev* 45: 145–166.
- Susanti ID, Hertati L, Putri AU (2023) The Effect of Green Accounting and Environmental Performance on Company Profitability. *Cashflow* 2: 320–331. <https://doi.org/10.55047/cashflow.v2i2.552>
- Swamy V, Dharani M (2019) The dynamics of finance-growth nexus in advanced economies. *Int Rec Econ Finance* 64: 122–146. <https://doi.org/10.1016/j.iref.2019.06.001>
- Sweidan OD (2021) The environmental and energy policies to enable sustainable consumption and production in the Gulf Cooperation Council countries. *Clean Technol Envir* 23: 2639–2654. <https://doi.org/10.1007/s10098-021-02184-y>
- Tran TTT, Do HN, Vu TH, et al. (2020) The factors affecting green investment for sustainable development. *Decis Sci Lett* 9: 365–386. <https://doi.org/10.5267/j.dsl.2020.4.002>



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