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Sustainability, Financial Performance, and Green Investment: Evidence from the Portuguese Energy Sector

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Abstract: This study investigates whether sustainability policies translate into measurable corporate value, focusing on a comparative analysis of EDP and Galp between 2011 and 2023. Using audited integrated annual reports, the analysis combines financial indicators (ROA, ROE, EBITDA margin) with sustainability metrics (CO_2 emissions, renewable share, and green capital expenditure). The results show partial yet significant relationships. The renewable share is positively associated with asset profitability (ROA) for both firms, with a stronger effect for Galp ($r = 0.49$) than for EDP ($r = 0.26$). Carbon emissions exhibit a negative relationship with shareholder returns (ROE) in EDP ($r = -0.32$) but remain positively linked for Galp ($r = 0.43$), illustrating the persistence of short-term "brown profits." Green capital expenditure has divergent effects, slightly reducing operating margins in EDP but improving efficiency in Galp. These findings highlight how transition timing and strategic orientation shape the financial outcomes of sustainability policies. Consistent with stakeholder theory and the concept of shared value, the study suggests that sustainability-oriented strategies enhance firms' resilience and long-term competitiveness. By integrating financial and environmental, social, and governance (ESG) dimensions, it contributes comparative firm-level evidence from Portugal and underscores the emerging role of FinTech solutions in enhancing ESG transparency and the efficiency of sustainable finance mechanisms.

Keywords: sustainability policies, corporate value, financial performance, renewable energy, green investment, Portuguese energy sector, Fintech

1. Introduction

The transition toward sustainable business models has become a central concern for companies, investors, and policymakers worldwide. Increasingly stringent environmental regulations, the financial implications of climate risk, and heightened societal expectations are pushing firms to embed sustainability into their strategic agendas. Within this context, sustainability policies are often presented as instruments for long-term value creation, associated with benefits such as lower financing costs, enhanced brand reputation, and improved access to green capital. Yet, the extent to which such policies translate into measurable economic and financial value remains an open and debated question.

The energy sector is particularly relevant to this discussion, as it is both a major contributor to global greenhouse gas emissions and a focal point of decarbonization efforts. Energy firms must balance the short-term costs of transitioning toward renewables with the long-term opportunities of achieving environmental leadership. For stakeholders (including investors, regulators, and society at large), it is crucial to understand whether sustainability-oriented strategies are financially rewarded or penalized in the transition period.

This article focuses on the Portuguese energy sector, analyzing two of the most significant companies (EDP and Galp) that have adopted markedly different approaches to sustainability. EDP has positioned itself as a global leader in renewable energy, consistently allocating most of its capital expenditure to green projects. Galp, on the other hand, has historically prioritized fossil fuels and has only recently accelerated its transition.

This contrast between EDP and Galp provides an ideal setting to test whether corporate sustainability orientation translates into measurable financial outcomes. The different approaches taken by the companies lead to the central question of the research:

Do sustainability policies translate into measurable corporate value in the Portuguese energy sector?

To address this question, the study integrates financial indicators (ROA, ROE, EBITDA margin) with sustainability metrics (CO_2 emissions, renewable share, and green capital expenditure) to test three hypotheses linking sustainability practices to financial outcomes. The results provide empirical insights into how sustainability strategies influence profitability, efficiency, and resilience, offering implications for both corporate strategy and public policy.

2. Literature Review

The relationship between sustainability policies and corporate value creation has been the subject of extensive academic debate. From a theoretical perspective, stakeholder theory argues that companies must consider the expectations of various stakeholders (including regulators, customers, employees, and investors)

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to achieve long-term viability [1, 2]. Similarly, the concept of shared value creation emphasizes that corporate engagement with social and environmental issues can increase competitiveness while addressing social challenges [3–6]. These frameworks provide the basis for examining sustainability not only as a matter of compliance but as a potential driver of financial performance.

Empirical research has produced conflicting evidence on the financial impact of sustainability initiatives. On the one hand, several meta-analyses [7, 8] demonstrate a positive association between environmental, social, and governance (ESG) practices and corporate financial performance [9–11]. These studies suggest that sustainability policies can reduce risk, lower the cost of capital, and attract long-term investors. More recent works [12–14] highlight that companies with higher ESG scores tend to have lower volatility and more stable returns.

On the other hand, critics argue that the implications in terms of value are not universal. Some studies show that sustainability policies can impose short-term costs without bringing clear benefits, particularly in sectors where green innovation requires significant capital expenditure [15–18]. Furthermore, Marquis et al. [19] note that concerns about greenwashing suggest that ESG disclosures do not always reflect genuine operational changes. This tension underscores the importance of context-specific analyses that can clarify when and how sustainability policies create measurable value.

The energy sector is a particularly relevant setting for this debate, given its exposure to carbon-intensive operations and regulatory pressures. Research indicates that companies investing in renewable energy and emissions reduction are better positioned to benefit from policy incentives, reputational gains, and access to green finance [20–23]. Renewable energy-oriented utilities tend to benefit from regulatory incentives and investor support, while oil and gas companies face transition risks and pressure from decarbonization policies [15, 24, 25]. Utilities such as EDP, which have invested heavily in renewable energy, are often seen as less exposed to market cycles and more resilient to policy changes [26–29]. In contrast, oil and gas companies (such as Galp) face transition risks associated with stranded assets, regulatory pressure, and changes in demand [15, 30]. Focusing on companies operating under the same institutional framework but pursuing divergent sustainability strategies offers valuable insights into the financial implications of the transition. Although large-scale transnational analyses dominate the literature, there is little evidence on how sustainability strategies affect value creation. This situation is common in national contexts where energy companies face similar institutional structures but adopt divergent strategic approaches.

Comparative studies at the firm level remain relatively scarce, particularly in smaller European markets. Most of the literature adopts cross-country perspectives, overlooking the value of examining companies exposed to similar institutional frameworks but pursuing divergent sustainability strategies. In the Portuguese energy market, EDP has established itself as a global leader in renewable energy investment, while Galp has traditionally focused on fossil fuels and is only now transitioning to sustainable practices. This divergence presents a unique natural experiment to assess whether sustainability-oriented strategies are associated with superior financial outcomes.

Recent literature highlights the growing role of financial technologies (often referred to as green digital finance) in supporting sustainability transitions [31, 32]. Digital platforms, blockchain-based green bonds, and automated ESG reporting tools increase transparency, reduce information asymmetry, and facilitate access to sustainable finance [33–35]. These tools are increasingly relevant in the European context, where regulatory frameworks such as the EU taxonomy and Sustainable Finance Disclosure Regulation (SFDR) require reliable and comparable ESG disclosures [36, 37]. The intersection between FinTech and sustainability thus offers a promising avenue for both business practice and academic research, particularly in energy-intensive industries [38, 39].

The proposed study explores the relationship between sustainability policies and financial performance through three key relationships. These relationships are based on previous literature on corporate sustainability, energy transition, and financial value creation. Building on this literature, the following hypotheses are proposed:

H_1: A higher renewable share in the production mix is positively associated with return on assets (ROA).

The link between the renewable share and ROA reflects the idea that investments in renewable energy reshape companies' asset bases. A higher proportion of renewable assets is expected to stabilize returns, as renewable generation is typically less exposed to market volatility than fossil fuel assets. Previous studies suggest that companies that increase their renewable share achieve more predictable cash flows and asset efficiency [27, 28]. Thus, a positive association between renewable share and ROA is hypothesized.

H_2: Higher carbon emissions are negatively associated with shareholder returns (ROE).

The relationship between carbon emissions and ROE derives from the literature on transition risks, with high emissions exposing companies to regulatory sanctions, reputational damage, and the risk of stranded assets, which can erode long-term shareholder returns [15, 16]. Although carbon-intensive companies may see short-term gains, over time, emissions are expected to have a negative impact on ROE. Thus, a negative association between CO_2 emissions and shareholder returns is hypothesized.

H_3: Green capital expenditure is positively associated with operational efficiency (EBITDA margin).

Finally, the link between green Capex and EBITDA margin reflects the trade-off between short-term costs and long-term competitiveness of sustainability investments. Allocating a larger share of capital expenditure to renewable projects may initially reduce operating margins due to high initial investment costs. However, in the medium to long term, such investments are expected to improve efficiency and competitiveness, reducing exposure to fossil fuel price cycles [7, 12]. The study therefore hypothesizes a positive relationship, while acknowledging possible negative effects in the short term.

Taken together, these hypotheses capture the dual role of sustainability policies as both a strategic cost and a source of long-term value creation. They provide a framework for assessing whether firms that commit earlier and more decisively to sustainability (such as EDP) demonstrate stronger and more resilient financial outcomes than those that delay transition, such as Galp.

Despite the growing body of evidence linking sustainability and financial performance, few studies have conducted direct comparative analyses of companies within the same national context that adopt divergent sustainability strategies. The Portuguese energy sector offers a unique opportunity to address this gap, with EDP emerging as a global leader in renewable energy and Galp recently beginning its transition away from fossil fuels. This divergence provides a natural experiment to test the financial implications of sustainability-oriented strategies. Furthermore, recent literature highlights the growing role of FinTech solutions (such as blockchain-based green bonds, digital ESG disclosure platforms, and decentralized finance) in increasing transparency and financing sustainability transitions. By combining financial and ESG indicators, this study contributes to the literature by offering comparative

evidence at the firm level in Portugal and bridging the gap between sustainability theory, financial practice, and the emerging role of FinTech in sustainable innovation.

3. Methodology

This study adopts a firm-level comparative design, analyzing EDP and Galp between 2011 and 2023. Both companies operate within the same national institutional and regulatory framework but have pursued different sustainability trajectories. This setting allows for a focused assessment of how distinct strategic approaches to the energy transition influence corporate value creation.

All data were collected from the audited Integrated Annual Reports of EDP and Galp (2011–2023), which provide consistent and comparable information on both financial and sustainability indicators [40, 41]. Although self-reported corporate data may be subject to reporting bias, their use is justified by the high level of assurance, external auditing, and standardized disclosure formats required under EU reporting regulations. This ensures transparency and reliability in line with best practices for corporate sustainability research. Nevertheless, the potential for selective disclosure remains a recognized limitation and is acknowledged in the Discussion and Limitations sections. Financial and sustainability data were collected directly from companies' integrated annual reports, providing consistent information on traditional financial metrics and ESG indicators.

Three financial indicators were used: (1) ROA – net profitability relative to total assets; (2) ROE – profitability of shareholders' equity; and (3) EBITDA Margin – operational efficiency and ability to generate cash. Three sustainability indicators were included: (1) CO_2 emissions (tons per unit of energy produced or sold); (2) renewable share in the production mix (for EDP) and fossil share in the production portfolio (for Galp); and (3) green capital expenditure as a percentage of total investment. Descriptive statistics and correlation analyses were conducted using Microsoft Excel (version 2508) with embedded statistical functions [42]. The choice of Pearson correlation analysis was guided by the small sample size (13 years × 2 firms = 26 observations) and the exploratory nature of the study. Correlation allows examination of the strength and direction of linear relationships between variables while avoiding the overfitting risk inherent in regression models with limited degrees of freedom. Correlation coefficients were tested for significance at the 5% level ($p < 0.05$).

The period from 2011 to 2023 was selected for two main reasons. First, it covers more than a decade, including different phases of the economic cycle and critical moments (e.g., European debt crisis, COVID-19 pandemic, energy shock of 2022). Second, it is the period for which both companies provide complete and comparable annual series of financial indicators in their respective reports.

The decision not to use regression models at this stage was methodological: the small N limits the statistical power of multivariable approaches. However, to verify robustness, complementary checks were conducted using simple trend analyses and visual inspection of time-series plots. Future research will expand the dataset and apply panel regression models to test causality more rigorously. Building on these insights, this study operationalizes the link between financial and sustainability indicators through a set of testable hypotheses.

Although the study refers to its assumptions as H_1–H_3, they are formulated in the alternative (directional) form rather than as null hypotheses. This is consistent with the exploratory correlational design, which aims to test the presence and direction of relationships rather than the rejection of statistical nulls. Similar formulations are used in firm-level ESG–finance studies [7, 44].

4. Results

The empirical analysis of EDP and Galp's financial and sustainability indicators between 2011 and 2023 reveals marked contrasts in performance stability and transition dynamics. EDP maintained relatively stable profitability, with moderate fluctuations in both ROA and ROE, whereas Galp displayed greater volatility, particularly during the 2014–2015 oil price collapse and the 2020 pandemic shock. Figures 1 and 2 illustrate these differences. On average, EDP's ROA was 2.8% (SD = 3.3) and Galp's 7.6% (SD = 10.4). The gap in volatility reflects their different exposure to

Figure 1
ROA evolution (%)

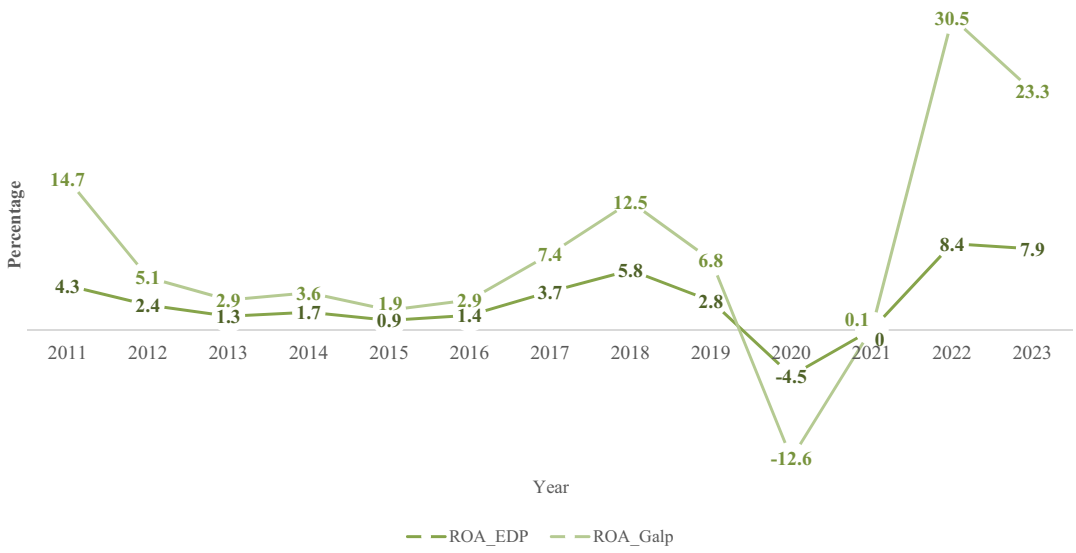


Figure 2
ROE evolution (%)

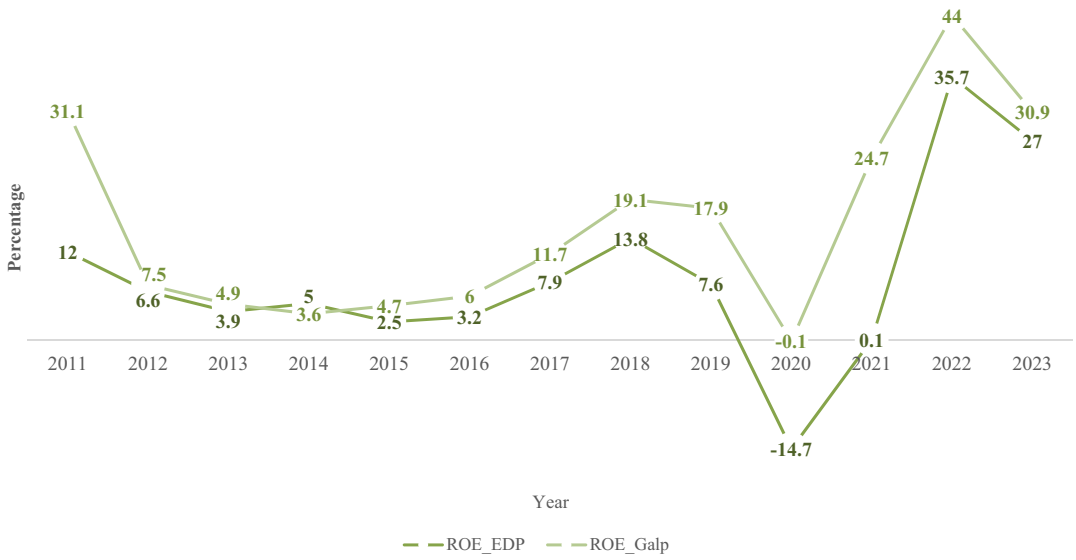
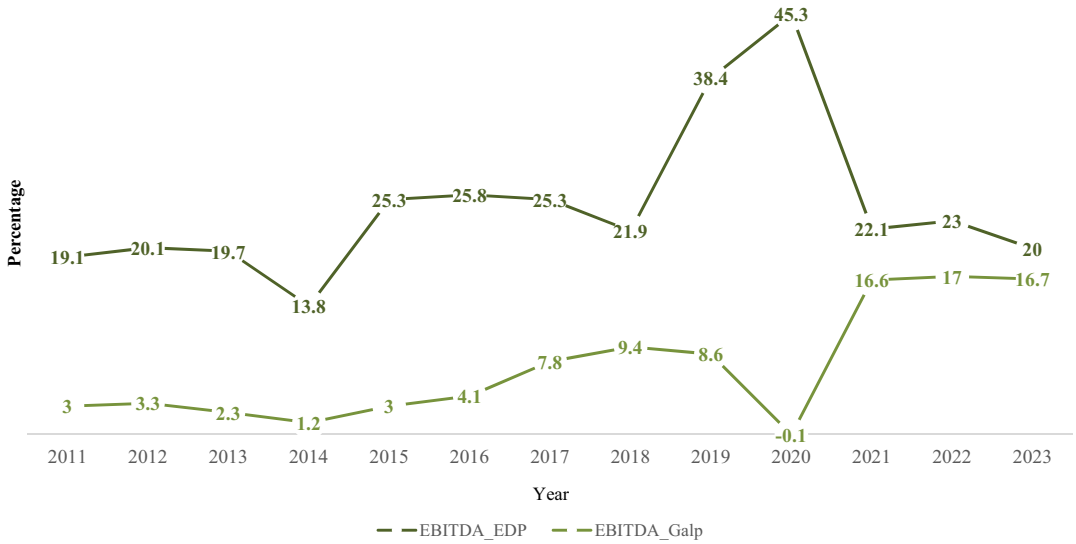


Figure 3
EBITDA margin evolution (%)



fossil fuel cycles and policy risks. EDP demonstrates stability with moderate fluctuations, while Galp shows sharp peaks and troughs, particularly in 2014–2015 and 2020, reflecting oil price shocks and the COVID-19 crisis.

From the analysis of the graphs, periods considered to be turning points stand out: 2012–2016 and 2020. The first coincides with the austerity measures imposed during the period of financial intervention in Portugal, which led to the end of the State's special rights ("Golden Share"). The year 2020 had a significant economic impact on Portugal due to the sharp economic downturn resulting from the pandemic.

Figure 3 shows that EDP consistently achieved higher EBITDA margins (mean = 24.6%) than Galp (mean = 7.1%). The difference was statistically significant ($p < 0.05$). EDP's steady margins demonstrate resilience to market shocks, while Galp's negative margin in 2020 confirms its vulnerability to oil-market fluctuations.

Figures 4 and 5 summarize the evolution of sustainability indicators. EDP steadily increased its renewable share, reaching more than 80% by 2023, whereas Galp only began significant renewable investment after 2019. This divergence confirms the different transition timing and strategic orientation of the two firms.

Table 1 presents descriptive statistics for all variables, and Table 2 reports Pearson correlation coefficients and significance levels. The correlations provide mixed but informative support for the three hypotheses.

H_1: A higher renewable share in the production mix is positively associated with return on assets (ROA): A moderate positive correlation was found for both companies – EDP ($r = 0.26$, $p = 0.021$) and Galp ($r = 0.49$, $p = 0.017$). This suggests that a 10% increase in renewable share is associated with approximately a 0.3% improvement in ROA for EDP and 0.6% for Galp, indicating stronger marginal efficiency gains for the late mover.

Figure 4
Evolution of sustainability indicators: EDP

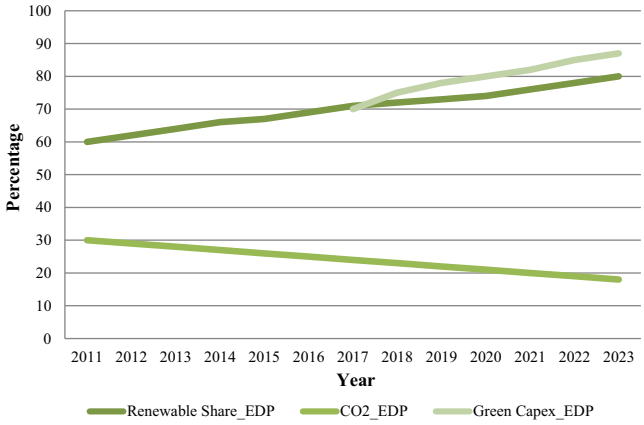
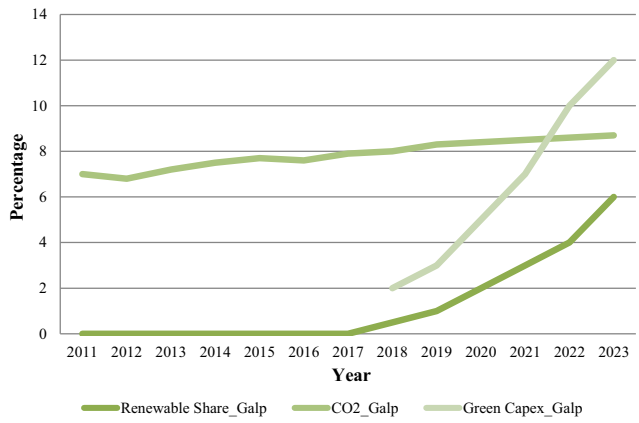


Figure 5
Evolution of sustainability indicators: Galp



H_2: Higher carbon emissions are negatively associated with shareholder returns (ROE): The correlation was negative and significant for EDP ($r = -0.32$, $p = 0.048$) but positive for Galp ($r = 0.43$, $p = 0.036$). These results reveal a paradox of "brown profits," where high-emission activities still generate short-term returns for oil-based firms.

H_3: Green capital expenditure is positively associated with operational efficiency (EBITDA margin): For EDP, the correlation was slightly negative ($r = -0.16$, $p = 0.22$, not significant), whereas for Galp, it was strongly positive ($r = 0.65$, $p = 0.009$). This indicates that green investment has already stabilized EDP's operations but still delivers marginal efficiency gains for Galp as it transitions.

Table 2
Correlation analysis

Variables		Firm	Correlation
ROA	Renewable share	EDP	0.259
		Galp	0.491
ROE	CO_2 emissions	EDP	−0.315
		Galp	0.430
EBITDA	Green capex	EDP	−0.163
		Galp	0.654

To clarify the empirical relationships, Table 3 summarizes the direction, significance, and interpretation of each tested hypothesis.

Overall, the results confirm that sustainability policies influence financial performance in nuanced ways. The effects vary according to transition timing, investment maturity, and company exposure to fossil fuel risk. EDP's early commitment to renewables enhanced stability and long-term resilience, whereas Galp's later transition produced stronger (but potentially transient) efficiency gains.

Table 1
Descriptive statistics

	Firm	Mean	Standard deviation	Variation coefficient
ROA	EDP	2.78	3.28	1.18
	Galp	7.62	10.41	1.37
ROE	EDP	8.51	11.88	1.40
	Galp	15.85	12.94	0.82
EBITDA	EDP	24.60	8.08	0.33
	Galp	7.15	5.92	0.83
Renewable share	EDP	70.15	5.92	0.08
	Galp	1.27	3.74	2.95
CO_2 emissions	EDP	24.00	5.42	0.23
	Galp	7.86	1.87	0.24
Green Capex	EDP	79.57	0.60	0.01
	Galp	6.50	3.59	0.55

Table 3
Summary of tested hypothesis

	Expected relationship	Observed correlation	Significance ($p < 0.05$)	Empirical outcome
H_1: Renewable share ↔ ROA	Positive	0.26/0.49	Yes	Partially supported – stronger for Galp
H_2: CO_2 emissions ↔ ROE	Negative	–0.32/0.43	Yes	Supported for EDP only ("brown profit paradox")
H_3: Green Capex ↔ EBITDA margin	Positive	–0.16/0.65	Partial	Divergent – cost effect for EDP, efficiency effect for Galp

5. Discussion

This discussion extends existing literature on the relationship between sustainability and financial performance but extends it by offering firm-level comparative evidence from a single national context. The contrasting results between EDP and Galp reveal that sustainability strategies do not produce uniform financial outcomes. Instead, the effects depend on transition timing, sectoral exposure, and firm-specific strategic orientation. These findings reinforce earlier insights from the ESG finance literature but also point to the persistence of short-term trade-offs [7, 8].

A notable outcome of this analysis is the persistence of what can be termed a "brown profit paradox." This divergence between the firms provides further insight into how sustainability maturity shapes financial resilience. While EDP's emission reductions are associated with lower financial risk, Galp continues to generate short-term returns from high-emission activities. This pattern echoes international findings that short-term profitability may still reward carbon-intensive strategies [43, 44]. The results highlight the tension between financial incentives and environmental objectives, suggesting that markets have yet to fully internalize transition risks.

By prioritizing investment in renewable energy, EDP has built a more resilient financial profile that is less exposed to short-term shocks, which is reflected in the stability of its profitability ratios and lower dependence on operating margins. This strategy is consistent with stakeholder theory [1, 2] and the concept of shared value [3–6], which suggest that sustainability-oriented strategies strengthen firms' competitive positioning over time.

On the other hand, Galp exemplifies the risks emphasized in more critical studies [15–18], in which transition costs and exposure to fossil fuels result in greater volatility and lower margins. The strong correlation between Galp's operational efficiency and profitability highlights its vulnerability to market fluctuations and the absence of strategic buffers.

For H_1, correlation analysis suggests a moderate positive relationship between renewable share and ROA for both firms, stronger for Galp (0.491) than for EDP (0.259). For EDP, already highly renewable throughout the period, incremental increases had a limited marginal effect on asset efficiency. In Galp's case, the late adoption of renewables meant that small improvements generated noticeable gains, though starting from a very low base. This suggests that the impact of renewables on ROA depends not only on the proportion of green assets but also on the maturity of the transition.

For H_2, results diverge sharply between the two companies. For EDP, CO_2 emissions are negatively correlated with ROE (-0.315), supporting the argument that carbon intensity undermines shareholder returns. For Galp, however, the correlation is positive (0.430), indicating that fossil-based activities still deliver short-term profitability. This outcome highlights the paradox of "brown profits," whereby carbon-intensive firms remain financially rewarded despite growing transition risks.

Finally, for H_3, EDP presents a weak negative relationship (-0.163), reflecting the short-term costs of sustained renewable investment. In contrast, Galp displays a strong positive correlation (0.654), consistent with early-stage green investment improving operational efficiency. This asymmetry suggests that the financial impact of green Capex varies across the transition pathway: initially efficiency-enhancing for laggards, but margin-pressuring for leaders already heavily invested in renewables.

Overall, the statistical analysis shows that sustainability policies influence financial performance in nuanced ways. Their effect depends on timing, intensity, and the company's position within the energy transition curve.

These findings have several implications for policymakers, investors, and corporate decision-makers, particularly in the context of the European Green Deal and the SFDR. Regulators should design incentive mechanisms that reward emission reduction and penalize carbon dependency, ensuring that environmental and financial objectives are better aligned. For investors, the results indicate that firms with earlier and consistent sustainability commitments (such as EDP) may offer more stable returns over the long term. At the managerial level, the evidence underscores the strategic value of integrating environmental targets into financial planning and performance measurement systems.

6. Conclusion and Limitations

This article presents evidence from two leading companies in the Portuguese energy sector that sustainability policies can create value, especially when implemented proactively and supported by transparency. Although both EDP and Galp are transitioning to more environmentally friendly models, the comparative analysis highlights the advantages of early adoption. This study confirms that sustainability policies contribute to value creation in the long run, but their financial impact varies across firms and time horizons. EDP illustrates the benefits of early and consistent renewable investment, while Galp exemplifies the risks of delayed transition and dependence on fossil assets.

For investors, the results suggest that companies with proactive sustainability policies provide more stable long-term returns, while for policymakers, they highlight the importance of regulatory support and incentives for green investment. Future research should extend this analysis to larger samples and transnational contexts, exploring dynamic interactions between sustainability metrics and financial performance. In addition, the integration of FinTech tools,

such as blockchain-based green bonds and automated ESG reporting, could improve transparency and comparability, enhancing the role of digital finance in supporting sustainable innovation.

However, this study has limitations. First, the analysis is based on only two firms, which restricts generalizability but allows for in-depth contextual interpretation. Second, the use of correlation analysis, while appropriate for small samples, limits causal inference. Third, the reliance on self-reported corporate data may introduce disclosure bias, although mitigated by external auditing. These limitations open avenues for future research using broader datasets and more advanced econometric techniques.

Future research should extend this analysis to broader samples and cross-national contexts, combining firm-level ESG data and FinTech-driven transparency indicators to better capture the digital dimension of sustainable finance.

In conclusion, this study provides comparative evidence that sustainability policies can enhance corporate value when strategically integrated into long-term financial planning. However, short-term financial markets continue to reward carbon-intensive activities, creating a gap between environmental progress and economic incentives. By integrating financial and ESG perspectives within a single-country comparative framework, this study contributes to understanding how the sustainability transition unfolds unevenly across firms, sectors, and institutional contexts.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by the author.

Conflicts of Interest

The author declares that she has no conflicts of interest to this work.

Data Availability Statement

The data that support the findings of this study are openly available at https://www.edp.com and https://www.galp.com.

Author Contribution Statement

Natália Teixeira: Conceptualization, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualization, Funding acquisition.

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