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# Green Revenue Generation and Sales Contribution: Are Consumers Willing to Bear the Cost of Sustainability?

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## ABSTRACT

This study examines the strategic implications of environmental activities on firm performance, specifically focusing on contribution per dollar sale and operational cost efficiency within US companies. Using a comprehensive dataset of 17,735 firm-year observations from 2008 to 2023, we find that firms engaging in green revenue generation do not pass the associated costs on to consumers through higher prices, leading to a reduction in contribution per dollar sale. However, these firms enhance their operational cost efficiency to offset this impact and maintain profitability, underscoring the operational efficiencies gained from sustainability initiatives. To address potential endogeneity, we employ two-stage least squares and difference-in-differences approaches. Our results indicate that the relationship between green revenue generation, cost efficiency and profitability remains robust regardless of regulatory pressures, indicating that sustainability efforts are embedded within broader strategic and operational practices. We also find that firms adjust marketing expenditures to absorb costs, illustrating a purposeful alignment of sustainability goals with competitive positioning. This study contributes to the strategic management literature by highlighting the role of environmental activities in shaping firm performance and operational strategy. We offer valuable insights for businesses, policymakers and standard setters seeking to balance sustainability with financial performance.

## 1 | Introduction

Climate change and environmental deterioration present formidable global challenges, compelling investors and regulators to advocate for 'green' business models. These models prioritise low-carbon practices, enhanced resource efficiency and overall environmental sustainability. Integrating environmental considerations into business operations has become a defining feature of the modern corporate landscape (Eyo-Udo et al. 2024; Qatawneh 2023). Companies increasingly recognise the strategic importance of adopting environmentally friendly practices to comply with regulations, meet stakeholders' expectations and capitalise on new market opportunities (Le et al. 2024; Maniatis 2016; Xie et al. 2024).

The economic implications of environmental activities reveal mixed findings in the literature (Horváthová 2010). Some studies indicate positive impacts, while others report no significant or adverse effects, illustrating the complexity firms face when aligning environmental responsibility with financial viability (Chen et al. 2023; Duque-Grisales and Aguilera-Caracuel 2021; Parsons 2005; Johansson et al. 2001). Several aggregated financial performance measures have been introduced in the literature to understand the financial impact of ESG activities, such as return on assets (ROA), return on equity (ROE), market-to-book value (TobinQ) and asset turnover, or combinations of these (Bruna et al. 2022; Rao et al. 2023; Shin et al. 2023; Wu et al. 2024; Zhou et al. 2022). These accounting measures are typically based on revenue and costs. However, little emphasis

has been placed on the direct impact on revenue and costs. Therefore, this study examines the effects of environmental activities on firms' revenue and costs.

To address the question of whether it pays to be green, it is essential to analyse the impact of green revenue generation through revenue and cost channels. This approach clarifies the revenue and cost dynamics in generating financial benefits from firm environmental activities. Developing green products requires substantial upfront investments (Kruse et al. 2020; Moussa et al. 2024), potentially increasing marginal or production costs (Wang et al. 2021; Porter and Van der Linde 2002). Incremental production costs affect product contribution from sales and profitability (Day and Venkataramanan 2006; Engle et al. 2020; Virtanen et al. 2022). From the stewardship theory perspective, managers work as stewards of the business (Davis et al. 1997), and it is their fiduciary responsibility to maximise shareholder wealth. As a result, a rational business manager will invest in environmental, social and governance (ESG) activities if the benefit outweighs the cost.[1]

This study contributes to the strategic management literature by examining how firms integrate environmental activities into their broader strategic objectives, particularly concerning operational cost efficiency and competitive positioning. By addressing the trade-offs between profitability and environmental responsibility, our findings provide insights into how firms can strategically navigate the pressures of sustainability without compromising financial performance. Drawing on stewardship theory and the resource-based view (RBV), we argue that firms adopting green initiatives can enhance their operational capabilities, turning sustainability into a source of competitive advantage. This study extends existing research by showing how environmental activities influence not just firm-level financial performance but also long-term strategic positioning, particularly in an increasingly sustainability-driven market landscape.

According to Ambec and Lanoie's (2008) conceptual framework, the initial outlay for environmental activities can benefit the organisation through revenue or cost channels, either by increasing revenue, reducing costs or both. We argue that increased sales revenue may not necessarily bring benefits if firms fail to pass the incremental production costs of environmental activities to the customer through higher sales prices unless they have substantial access to new markets. Alternatively, if managers cannot pass the incremental environmental costs to the customer, they can benefit by achieving operational efficiency, thus reducing operational costs and outweighing the incremental costs of environmental activities.

Our study contributes to the literature by providing empirical evidence to address the pivotal question, 'Who pays for it?' By analysing the impact of green revenue generation on contributions per dollar of sales, we determine whether the additional costs of environmental activities are passed on to society through higher sales prices or absorbed by firms to maintain market share and competitive advantages. This analysis informs policy-level discussions on whether environmental concerns are truly valued by society.

This paper empirically examines two mechanisms through which sustainability investments influence firm outcomes: the revenue channel, where costs may be passed on to consumers through pricing strategies, and the cost channel, where firms might absorb these costs internally through operational efficiencies. Rather than relying solely on traditional metrics such as ROA or ROE, we emphasise operational-level insights into how firms manage the financial dynamics of sustainability-related initiatives. This dual approach allows us to examine whether environmental efforts create financial strain or operational advantages, offering a more nuanced understanding of their economic consequences. We conduct panel data regression analysis models. Specifically, we test whether higher levels of green revenue are associated with firms' ability to maintain profit margins, as reflected in the contribution earned per dollar of sales. This analysis helps determine whether managers transfer the cost of environmental initiatives to consumers. Alternatively, we investigate the relationship between green revenue and operational cost efficiency to assess whether managers absorb these costs internally by improving efficiency, rather than passing them on. As a robustness check, we also examine whether merely reporting green revenue (as a binary indicator) has similar effects on profit contribution and cost efficiency. To address potential endogeneity issues, we employ a two-stage least squares (2SLS) instrumental variable (IV) regression, using industry-level green intensity as an instrument for firm-level green revenue. Finally, we supplement our analysis with a quasi-natural experiment, focusing on US firms' adoption of green revenue reporting practices following the 2015 Paris Agreement (Klausmann et al. 2024).

Our study offers a comprehensive understanding of the costs and benefits of environmental activities. We show how adopting these practices influences firms' revenue and cost structures while keeping benefits at the forefront. Our findings also show whether the cost and revenue dynamics of firms driven by regulatory compliance and those motivated by self-initiated environmental engagement differ. Furthermore, we provide empirical evidence on how businesses adjust resource allocation after adopting environmental activities to enhance their brand image, a primary motivation for environmental engagement.

This study has significant implications for various stakeholders. It provides the academic community with insights into the revenue and cost dynamics underlying the economic impact of environmental activities. The findings highlight the importance of regulatory policies in driving sustainable business practices that contribute to environmental protection and climate action, aligning with the United Nations' Sustainable Development Goals (SDGs). Additionally, the study offers recommendations to the International Sustainability Standards Board (ISSB) on metrics to include in their new standards, S1 and S2.

Business managers and owners can utilise the insights from this study to navigate environmental practices while maintaining profitability. They can strategically implement environmental initiatives that comply with regulations and

simultaneously enhance operational cost efficiency. This dual approach enables companies to gain a competitive advantage through cost savings. The study underscores the value of integrating sustainability into core business strategies, providing a roadmap for firms to achieve long-term economic and environmental success.

This paper empirically examines two mechanisms through which sustainability investments impact firm outcomes: (i) *the revenue channel*, whether costs are passed on to consumers via green pricing (proxied by CPDS), and (ii) *the cost channel*, whether firms absorb the costs through operational efficiency improvements (proxied by OP_COST_EFF). Prior research supports this dual perspective. Zhou et al. (2022) demonstrate that ESG engagement can enhance firm value via indirect efficiency gains, while Duque-Grisales and Aguilera-Caracuel (2020) emphasise that green innovation impacts financial performance through multifaceted, non-linear mechanisms beyond profitability. In support of the cost efficiency view, Wang et al. (2021) find that process innovation improves financial efficiency, and Salandri et al. (2022) show that green practices enhance operational performance by fostering agility.

Unlike traditional profitability ratios such as ROA or ROE (Bruna et al. 2022; Rao et al. 2023), CPDS focuses on firms' ability to preserve margins in response to green investment, while OP_COST_EFF captures internal process optimisation rather than net returns, offering a granular insight.

The remainder of this paper is structured as follows. Section 2 provides the conceptual framework and hypotheses development. Section 3 outlines the methodology and research design. This is followed by the empirical results in Section 4 and discussion in Section 5. The final section provides our conclusion and suggests directions for future research.

## 2 | Conceptual Framework and Hypothesis Development

To provide a more robust theoretical foundation, this study draws on stewardship theory and the RBV to explain both the motivations behind and the outcomes of firms' engagement in environmental initiatives. Stewardship theory suggests that managers are intrinsically motivated to act in the best interests of the organisation and its stakeholders, especially when there is alignment between personal and organisational goals (Davis et al. 1997). In the context of sustainability, stewardship-oriented managers may pursue green initiatives not merely for compliance or signalling, but because they perceive such investments as enhancing long-term firm performance and societal well-being. In parallel, the RBV argues that environmental capabilities, such as pollution prevention processes, eco-innovation or ESG-oriented governance systems, can serve as strategic resources when they are valuable, rare, inimitable and embedded within the organisation (Barney 1991; Hart 1995). When combined, these theories offer a complementary lens: Stewardship theory explains why managers might be willing to accept short-term trade-offs for long-term environmental value creation, while RBV explains how such initiatives can generate sustained competitive advantage. This integration also supports recent empirical findings showing that environmental investments, when strategically embedded, can reduce operational risks and improve firm reputation and efficiency over time (Lin 2024; Lew et al. 2024). Furthermore, both theories suggest that environmentally oriented managers may forgo short-term gains to build internal resources (e.g., process agility or HR practices) that enhance long-term cost efficiency and stakeholder legitimacy (George et al. 2023; Wang et al. 2021; Salandri et al. 2022).

Environmental goods and services revenue grew significantly, reaching US$1.6 trillion in 2016, underscoring a growing market trend (Kruse et al. 2020). Despite the widespread recognition of the need for environmental regulation to ensure a habitable planet, reluctance persists due to concerns that such regulations may undermine competitiveness (Fowlie 2009; Porter and Van der Linde 2002; Shao et al. 2020; Song et al. 2021; Yan et al. 2023). A survey of global executives reveals that 70% lack a compelling business case for sustainability (Berns et al. 2009), emphasising the challenge of integrating environmental considerations into business strategies.

Evidence on the relationship between green revenue generation and firm financial performance is mixed. Some studies find a positive association (Chen et al. 2023; Flammer 2013; Johansson et al. 2001; Rao et al. 2023; Shin et al. 2023), while others find a negative association (Duque-Grisales and Aguilera-Caracuel 2021; Parsons 2005). This relationship varies with factors like firm size and risk (Rao et al. 2023), stock price or market sentiment (Zhou and Liu 2023), financial disclosure strength (Bruna et al. 2022), national culture (Shin et al. 2023) and product market competition (Martins 2022). Despite extensive research, there is no consensus on the extent to which firms profit from environmental activities.

The discovery of a positive link between financial and environmental performance raises a question: Why do some firms miss out on profitable opportunities (Dowell and Muthulingam 2017; George et al. 2023)? To answer this, we must understand whether consumers are willing to pay for environmental activities undertaken by businesses. Investigating revenue and cost channels separately (Ambec and Lanoie 2008) will help us understand the social willingness to bear the cost of ESG activities.

One of the primary challenges in evaluating the impact of firms' green revenue generation on their economic performance is accurately measuring the extent and degree to which firms transition from non-environmental to environmental activities. Prior literature has used various measures to capture firms' environmental activity, such as voluntary environmental management system adoption (Wagner and Blom 2011; Yin and Schmeidler 2009). Other studies have used corporate environmental initiatives (CEIs) and environmental awards and certifications (EACs) as proxies for environmental performance (Jacobs et al. 2010; Ramanathan 2018). Additionally, some researchers focus on emission reduction, resource reduction and product innovation (Tan et al. 2017). Many studies rely on scores or rankings provided by proprietary databases (Chen et al. 2023; Eliwa et al. 2023; Yadav et al. 2016; Zhou et al. 2022). These measures, however, are inadequate for understanding the cost–benefit dynamics of firms' environmental activities. A cost–benefit analysis requires measuring environmental activities' monetary

impacts on firms' input (cost) and output (revenue). However, the literature has largely overlooked this approach, and empirical evidence identifying who bears the costs of environmental activities is lacking.

Some investments, like charity or social engagement programmes, may not immediately add value but can increase brand image and value (Le et al. 2024). A survey of Norwegian executives found that most business executives engage in sustainable activities to improve brand image (Brønn and Vidaver-Cohen 2009). Monetising these benefits requires long-term assessment, which conventional economic evaluations may not capture (Berns et al. 2009; D'Angelo et al. 2023). However, if a firm generates revenue through environmental products or services, its impact can be monetised immediately, facilitating cost–benefit analysis.

Additionally, green initiatives are increasingly recognised not only as compliance-driven responses but also as strategic tools that can yield substantial competitive advantages. A growing body of research has shown that firms implementing robust ESG practices can differentiate themselves in the market, enhance their brand image and reduce both operational and financial risks (Lew et al. 2024). From an RBV, strong ESG performance enhances firms' internal capabilities, improving operational efficiency and reducing capital costs, while also creating intangible assets such as stakeholder trust and reputational capital (Lin 2024). Moreover, ESG-oriented strategies contribute to more transparent governance structures and sustainable supply chains, fostering long-term stakeholder confidence and collaboration (Peralta et al. 2024).

Following the conceptual framework proposed by Ambec and Lanoie (2008), revenue channels allow managers to pass incremental costs to customers through sales prices. However, businesses should consider product advantages, relative product cost and competitive intensity in pricing strategies (D'Angelo et al. 2023; Ingenbleek et al. 2013). Demand for environmental products is more price-sensitive than traditional products (Zhang et al. 2019), and customers do not tolerate lower quality and higher prices (Cahaya et al. 2023; D'Souza et al. 2006). Therefore, green revenue generators should set prices based on product quality (Hong et al. 2018).

If product quality improves and prices increase, customers pay for enhanced quality, not necessarily environmental benefits. A product improving quality without reducing environmental impact is not considered green. Conversely, if a product improvement positively impacts the environment, it is considered green, regardless of quality enhancement. However, environmental benefits like reduced emissions are often invisible to consumers (Ambec and Lanoie 2008). Thus, managers are unlikely to pass environmental activity costs onto customers through higher prices; resulting in lower contributions from sales. Higher prices are typically due to improved functionality or quality, not solely environmental activities.

Alternatively, managers prioritise benefits and achieve operational efficiency through environmental initiatives (Salandri et al. 2022). These initiatives often require innovation and process improvements to minimise waste, conserve energy, and streamline operations (Ambec and Lanoie 2008) or reduce costs (Dangelico 2016). As firms implement and refine these practices, they can reduce costs in various areas, such as energy consumption (Salandri et al. 2022) and marketing expenses (Ullah 2021). Therefore, we hypothesise:

**Hypothesis 1.** *There is a negative association between a firm's generation of green revenue and its contribution per dollar of sale (**CPDS**).*

**Hypothesis 2.** *There is a positive association between a firm's generation of green revenue and its operational cost efficiency per dollar of sales (**OP_COST_EFF**).*

## 3 | Research Design

### 3.1 | Data and Sample

We examine 17,735 firm-year observations of US companies from 2008 to 2023 to answer the research questions. Table 1 details our sample selection process. We gathered firm-year observations for green revenue data from EIKON and financial data from COMPUSTAT covering 1 January 2003 to 31 December 2023. Our initial sample period yields 257,221 firm-year observations from COMPUSTAT. Due to the regulated nature of financial industries (SIC 4900-4999), we exclude them from our analysis.

A crucial control variable in our analysis is ***STRATEGY***, measured as a 5-year rolling average across six dimensions. This measurement necessitates the exclusion of 221,255 firm-year observations. Merging this data with EIKON's green revenue data further reduces our sample by 12,398 firm-year observations due to missing data. An additional 5833 observations are dropped due to missing data for other control variables, leaving a final sample of 17,735 observations from 2008 to 2023.[2]

### 3.2 | Measures

#### 3.2.1 | Green Revenue Generation

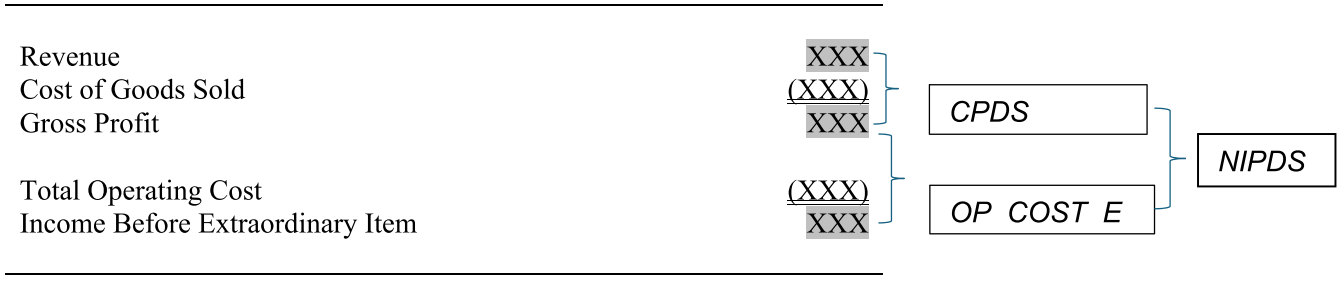
We use the percentage of green revenue (***PCT_GREEN_REV***) as a proxy for green revenue generation (Bassen et al. 2023). This measure, derived from publicly disclosed information, represents the portion of revenue derived from environmental

**TABLE 1** | Sample selection.

| | Observations |
|---|---|
| Compustat observation from 1 January 2003 to 31 December 2023 | 257,221 |
| Missing data for the STRATEGY variable | (221,255) |
| Missing data for GREEN_REV | (12,398) |
| Missing data for other control variables | (5833) |
| Final observations | 17,735 |

*Note:* The definitions of all variables are presented in Table 3.

**TABLE 2** | Illustrations of dependent variables measures.




*Note:* The definitions of all variables are presented in Table 3.

**TABLE 3** | Variable descriptions.

| Variable | Description |
|---|---|
| PCT_GREEN_REV | Percentage of revenue from green activities |
| GREEN_REV | Dummy variable (1 if firm reports green revenue at time t, 0 otherwise) |
| ENV_PRODUCT | Dummy variable (1 if firm has environmental product at time t, 0 otherwise) |
| CPDS | Contribution per dollar of sales (ln(Revenue – CoGS) / Revenue) at time t |
| OP_COST_EFF | Operating cost efficiency (–1*ln(IB – CPDS) / Revenue) at time t |
| NIPDS | Net income per dollar of sales (ln(IB/Revenue)) at time t |
| STRATEGY | Discrete score, ranging from 6 to 30, indicates a firm's strategic orientation: high scores signify a prospector firm, middle scores indicate an analyser firm and low scores represent a defender firm. This score, developed based on Bentley et al. (2013), is constructed from six dimensions of a firm's resource allocation. These dimensions include the 5-year rolling average of R&D to sales, employees to sales, annual percentage change in total sales, general and administrative expenses to sales, the standard deviation of the total number of employees, and net property, plant and equipment (PPE) scaled by total assets. |
| ASSET_TURNOVER | Revenue divided by total assets at time t |
| HERF | Herfindahl Index, as defined by Cheng (2005), is calculated by summing the squares of the market shares of all companies within a three-digit SIC industry. A company's market share is determined by dividing its sales by the total sales of the industry at time t. A higher Herfindahl Index indicates a more concentrated industry. |
| FSIZE | Natural logarithm of total assets at time t |
| BOOK_TO_MARKET | Book-to-market ratio (total common equity/market capitalisation) at time t |
| GOODWILL | Capitalised goodwill scaled by total assets at time t |
| SALES_GROWTH | One-year percentage change in total sales at time t |
| IND_GREEN_INTEN | Industry green intensity (proportion of firms reporting green revenue in the industry) at time t |
| POST | Dummy variable (1 for years after 2016, 0 otherwise) |
| TREATMENT | Dummy variable (1 for firms reporting green revenue for the first time in 2016 and continuing thereafter, 0 otherwise) |
| MARKETING | Marketing expenses scaled by total sales at time t |
| EMP | Total employee cost scaled by total sales at time t |
| R&D | Research and development expenses scaled by total sales at time t |

*Note:* All the continuous variables were winsorized at 1% and 99%.
Abbreviations: CoGS = cost of goods sold, IB = income before extraordinary item.

activities (Green Revenues Data Model Methodology 2024). While ***PCT_GREEN_REV*** is a proxy, it directly measures the impact of environmental activities on firms' value generation.

An increase in ***PCT_GREEN_REV*** indicates that firms engage in more environmental activities, as it is unlikely for firms with fewer such activities to produce more green revenue. However, due to relevant accounting standards, firms might not report green revenue if it does not exceed certain thresholds or is not considered significant in user decision-making (FASB 2023). Despite this, businesses can voluntarily report green revenue even if it does not meet the criteria. With the current global awareness about climate change, most industries tend to publicise companies' green efforts, leading to voluntary disclosure of this information.

Alternatively, we use ***GREEN_REV***, a dichotomous variable indicating whether a firm reports any green revenue (1) or not (0). The literature argues that environmental activities or initiatives drive green product innovation (Porter and Van der Linde 2002). Moreover, developing green products requires investment and environmental initiatives, which facilitate cost–benefit analysis. Thus, we employ ***ENV_PRODUCT*** (whether firms have any environmental product) as an alternative proxy for environmental activities as a robustness check.

#### 3.2.2 | Dependent Variables

Unlike traditional profitability metrics such as ROA or ROE that reflect net outcomes, CPDS focuses on margin retention per sales dollar, making it more sensitive to price–cost adjustments due to sustainability expenditures. Similarly, OP_COST_EFF reveals cost optimisation through internal processes, offering a clearer view of operational adjustments due to environmental strategies (Wang et al. 2021; Salandri et al. 2022). This approach is aligned with D'Angelo et al. (2023), who advocate for refined performance metrics that reflect sustainability strategies at the operational level.

Aligned with the research focus on understanding the cost dynamics associated with environmental activities, we measure ***contribution per dollar sale (CPDS)*** as the natural logarithm of the difference between revenue and the cost of goods sold (CoGS) scaled by total revenue. As Table 2 shows with hypothetical numerical values, if the incremental cost of environmental activities passes to the customer by increasing the sales price, ***CPDS*** will either increase or remain constant, assuming all others remain the same. On the other hand, if the business internalises some or all the costs rather than passing them on to the customer, ***CPDS*** will decrease. For instance, a firm like Patagonia may retain green premium prices while enhancing internal cost efficiency through supply chain innovations and HR-led sustainability training. This dual effect mirrors the trade-off observed in our results, where firms simultaneously pass on some costs and internalise others. This could be supported by stakeholders. Flammer (2013) provides empirical evidence that investors reward green action even without immediate cost recovery, supporting the long-term efficiency view.

Our second dependent variable, ***operating cost efficiency (OP_COST_EFF)***, measures the natural logarithm of the difference between ***CPDS*** and income before extraordinary items (IB), scaled by total revenue. We multiply this by −1 for clarity in explanation. A higher (lower) ***OP_COST_EFF*** value indicates greater (lesser) efficiency in managing operational costs relative to revenue.

#### 3.2.3 | Control Variables

Table 3 presents the list of study variables. Our primary dependent variables measure the difference between revenue and the CoGS, and its difference with income before extraordinary items (IB). Therefore, we control for variables affecting the selling price or product cost, thus impacting IB.

Firm size is associated with the costing system (Hadid and Hamdan 2022), influencing the contribution (Tan et al. 2017). Larger firms often benefit from economies of scale, so we control for firm size (***FSIZE***), measured as the natural logarithm of total assets. The book-to-market ratio (***BOOK_TO_MARKET***), calculated as total common equity divided by market capitalisation, reflects the market's valuation of a firm and its ability to charge higher prices (Daniel and Titman 2006). Additionally, we control for asset turnover (***ASSET_TURNOVER***), measured as revenue divided by total assets, as it impacts profit margins (Jansen et al. 2012). We argue that ***OP_COST_EFF*** and ***ASSET_TURNOVER*** are distinct measures, with the former measuring how efficiently firms reduce operational costs and the latter measuring how efficiently they utilise assets. All variables are measured at the end of the fiscal year.

Industry competition is a significant driver of pricing strategy (Porter 1980) and can influence managers' reporting behaviour (Balakrishnan and Cohen 2011). We argue that firms in less competitive industries have more freedom to pass costs onto customers, while those in more competitive industries strive for operational efficiency to gain a competitive advantage. We use the Herfindahl Index (***HERF***) as a proxy for industry competition, calculated by summing the squared market share of all companies (Cheng 2005).

We also control for the product life cycle using ***SALES_GROWTH*** as a proxy (Polli and Cook 1969) and for capitalised goodwill (***GOODWILL***), measured as capitalised goodwill in the balance sheet scaled by total assets, as it can impact pricing strategy and product contribution.

Firms' strategic orientation also influences ***CPDS*** and ***OP_COST_EFF*** (Ambec and Lanoie 2008). Firms with prospector or differentiator strategies allocate more resources to R&D, marketing, and human resources than those with defender or cost-focused strategies (Miles et al. 1978). We control for this using a composite measure (***STRATEGY***) based on six variables: (1) R&D to sales ratio, (2) employee to sales ratio, (3) 1-year percentage change in total sales, (4) marketing (SG&A) to sales ratio, (5) employee fluctuation and (6) capital intensity (Bentley et al. 2013; Ittner et al. 1997). We compute these variables using a rolling average over the previous 5 years, rank them into quintiles within each two-digit SIC industry year, and sum the scores for each company year, yielding a maximum score of 30

**TABLE 4** | Descriptive statistics.

| | Min | Mean | Max | p25 | Median | p75 | p90 | SD |
|---|---|---|---|---|---|---|---|---|
| | | | | $N = 17{,}735$ | | | | |
| CPDS | −3.27 | −0.92 | −0.05 | −1.23 | −0.85 | −0.48 | −0.24 | 0.59 |
| OP_COST_EFF | −1.53 | 0.94 | 3.26 | 0.49 | 0.95 | 1.36 | 1.80 | 0.74 |
| PCT_GREEN_REV | 0.00 | 5.13 | 100 | 0.00 | 0.00 | 0.00 | 10.93 | 17.53 |
| GREEN_REV | 0.00 | 0.18 | 1.00 | 0.00 | 0.00 | 0.00 | 1.00 | 0.38 |
| STRATEGY | 6.00 | 17.39 | 29 | 15.00 | 17.00 | 20.0 | 22.00 | 3.61 |
| ASSET_TURNOVER | 0.09 | 0.98 | 3.5 | 0.54 | 0.81 | 1.23 | 1.80 | 0.64 |
| HERF | 0.04 | 0.26 | 1.00 | 0.08 | 0.15 | 0.35 | 0.60 | 0.25 |
| FSIZE | −2.27 | 6.81 | 13.57 | 5.37 | 6.88 | 8.30 | 9.57 | 2.16 |
| BOOK_TO_MARKET | −1.04 | 0.46 | 2.55 | 0.19 | 0.37 | 0.63 | 0.99 | 0.48 |
| GOODWILL | 0.00 | 0.14 | 0.56 | 0.01 | 0.10 | 0.24 | 0.38 | 0.15 |
| SALES_GROWTH | −53.97 | 8.37 | 118.49 | −3.06 | 5.95 | 16.27 | 32.84 | 24.22 |

*Note:* The definitions of all variables are presented in Table 3.

(prospector/differentiator) and a minimum score of 6 (defender/cost-focused).

### 3.3 | Regression Models

We estimate the effect of ***PCT_GREEN_REV*** and ***GREEN_REV*** on ***CPDS*** and ***OP_COST_EFF*** using ordinary least squares (OLS) models, controlling for factors that might affect these variables. If the incremental cost of environmental activities is passed on to the customer, ***CPDS*** should remain constant or increase. Conversely, if businesses internalise these costs, ***CPDS*** should decrease. Based on Hypothesis 1, we expect a negative relationship between ***PCT_GREEN_REV*** and ***CPDS***. On the other hand, engaging in environmental activities may lead to operational efficiency and reduced costs, so we expect a positive relationship between ***PCT_GREEN_REV*** and ***OP_COST_EFF***, as per Hypothesis 2. We use the dichotomous variable ***GREEN_REV*** instead of ***PCT_GREEN_REV*** in the regression models (1) and (2) as a robustness check. All regression analyses control for year and industry fixed effects (two digit SIC) and cluster standard errors at the firm level.

$$\begin{aligned} \textbf{CPDS} = {} & \beta 0 + \beta 1\ \textbf{PCT\_GREEN\_REV} + \beta 2\ STRATEGY \\ & + \beta 3\ ASSET\_TURNOVER + \beta 4\ HERF + \beta 5\ FSIZE \\ & + \beta 6\ BOOK\_TO\_MARKET + \beta 7\ GOODWILL \\ & + \beta 8\ SALES\_GROWTH + Industry\ Fixed\ Effects \\ & + Year\ Fixed\ Effects + \varepsilon \end{aligned} \quad (1)$$

$$\begin{aligned} \textbf{OP\_COST\_EFF} = {} & \beta 0 + \beta 1\ \textbf{PCT\_GREEN\_REV} \\ & + \beta 2\ STRATEGY + \beta 3\ ASSET\_TURNOVER + \beta 4\ HERF \\ & + \beta 5\ FSIZE + \beta 6\ BOOK\_TO\_MARKET + \beta 7\ GOODWILL \\ & + \beta 8\ SALES\_GROWTH + Industry\ Fixed\ Effects \\ & + Year\ Fixed\ Effects + \varepsilon \end{aligned} \quad (2)$$

Table 4 provides descriptive statistics for all variables used in our regression model equations. The mean ***CPDS*** suggests that, on average, contributions from sales are around 40% ($e^{-0.92} \approx 0.398$). Similarly, the mean ***OP_COST_EFF*** is 40% ($e^{-0.94} \approx 0.391$).[3] The proportion of revenue from environmental sources is notably low, with a ***PCT_GREEN_REV*** mean of 5.13 and significant variability (SD = 17.53), indicating that environmental initiatives are not a major revenue component for most firms. Only 18% of firms report green revenue (mean ***GREEN_REV*** is 0.18), suggesting limited engagement in environmental activities. Firms exhibit a balanced strategic orientation, with a mean ***STRATEGY*** score of 17.39, positioning them between defender and prospector strategies. ***ASSET_TURNOVER*** reflects moderate efficiency (mean 0.98). The ***HERF***, with a mean of 0.26, indicates a competitive market environment with low to moderate industry concentration. ***FSIZE*** mean is 6.81, while the ***BOOK_TO_MARKET*** mean is 0.46, showing that market values generally surpass book values. ***GOODWILL*** relative to total assets is limited (mean 0.14). ***SALES_GROWTH*** shows substantial variability, with a mean of 8.37% and a high standard deviation of 24.22, indicating diverse growth trajectories among firms.

The pairwise correlation matrix (Table 5) offers several critical insights into the relationships between key variables. ***HERF*** is positively significant with ***PCT_GREEN_REV***, indicating that industry competition drives green revenue. ***PCT_GREEN_REV*** also correlates with ***FSIZE***, suggesting that larger firms adopt green revenue more than smaller firms. ***BOOK_TO_MARKET*** and ***SALES_GROWTH*** are insignificant with ***PCT_GREEN_REV***, and there is inconsistent evidence for ***GOODWILL***, which is negatively significant with ***PCT_GREEN_REV*** but not with ***GREEN_REV***.

***BOOK_TO_MARKET*** shows no significant relationship with ***PCT_GREEN_REV*** but is significantly associated with ***CPDS*** negatively and ***OP_COST_EFF*** positively. This indicates that firms with higher ***BOOK_TO_MARKET*** tend to have lower sales

**TABLE 5** | Pairwise correlation matrix.

| Variables | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) CPDS | 1.00 | | | | | | | | | | |
| (2) OP_COST_EFF | −0.57* | 1.00 | | | | | | | | | |
| | (0.00) | | | | | | | | | | |
| (3) PCT_GREEN_REV | −0.18* | 0.06* | 1.00 | | | | | | | | |
| | (0.00) | (0.00) | | | | | | | | | |
| (4) GREEN_REV | −0.18* | 0.18* | 0.61* | 1.00 | | | | | | | |
| | (0.00) | (0.00) | (0.00) | | | | | | | | |
| (5) STRATEGY | 0.25* | −0.38* | 0.04* | 0.00 | 1.00 | | | | | | |
| | (0.00) | (0.00) | (0.00) | (0.91) | | | | | | | |
| (6) ASSET_TURNOVER | −0.38* | 0.41* | −0.09* | −0.09* | −0.25* | 1.00 | | | | | |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | | | | | | |
| (7) HERF | −0.26* | 0.27* | 0.07* | 0.04* | −0.24* | 0.24* | 1.00 | | | | |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | | | | | |
| (8) FSIZE | −0.07* | 0.33* | 0.03* | 0.22* | −0.01 | −0.15* | 0.10* | 1.00 | | | |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.09) | (0.00) | (0.00) | | | | |
| (9) BOOK_TO_MARKET | −0.20* | 0.12* | 0.00 | −0.02 | −0.11* | 0.00 | 0.08* | −0.08* | 1.00 | | |
| | (0.00) | (0.00) | (0.72) | (0.04) | (0.00) | (0.70) | (0.00) | (0.00) | | | |
| (10) GOODWILL | 0.20* | −0.06* | −0.04* | 0.04* | −0.03* | −0.22* | −0.02* | 0.27* | −0.08* | 1.00 | |
| | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | | |
| (11) SALES_GROWTH | 0.11* | 0.00 | 0.02 | −0.01 | 0.21* | −0.03* | −0.05* | −0.02* | −0.13* | 0.05* | 1.00 |
| | (0.00) | (0.91) | (0.02) | (0.14) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | (0.00) | |

*Note:* The definitions of all variables are presented in Table 3.
*Shows significance at $p < 0.01$.

contributions to operating performance but higher operating cost efficiency. ***SALES_GROWTH*** is positively correlated with ***CPDS***, suggesting that increased market demand and sales growth enable managers to either pass costs onto customers or reduce sales costs through economies of scale. However, ***SALES_GROWTH*** shows no significant association with ***OP_COST_EFF***.

The negative correlation between ***CPDS*** and ***OP_COST_EFF*** suggests that firms with higher sales contributions typically have lower operating cost efficiency. These firms often allocate more resources to R&D, SG&A, and human capital, impacting cost efficiency. This relationship is further supported by the positive association between ***CPDS*** and ***STRATEGY***, indicating that these firms prioritise market differentiation and innovation. Additionally, goodwill, representing business reputation, is positively related to ***CPDS*** and negatively related to ***OP_COST_EFF***. Firms with a strong market reputation leverage higher pricing strategies, which, although beneficial for sales contributions, require significant investments in SG&A, thereby reducing operating cost efficiency.

The results in Table 6 highlight significant differences between green and non-green revenue generators. Firms generating green revenue exhibit a lower mean ***CPDS*** of −1.15 compared with −0.87 for non-green firms, indicating that green revenue firms have lower sales contributions (mean difference −0.27, $t = -23.8$). However, green revenue firms have a higher ***OP_COST_EFF*** mean of 1.19 versus 0.88 for non-green firms, reflecting superior operating cost efficiency (mean difference 0.30, $t = 21.3$). The mean difference in ***STRATEGY*** between the two groups is negligible (mean difference −0.07, $t = -1.00$), suggesting that strategic market positioning does not drive green activity.

Furthermore, green revenue firms have a lower ***ASSET_TURNOVER*** mean than non-green firms (mean difference −0.14, $t = -11.55$), indicating that firms with higher asset utilisation are less engaged in generating green revenue. The mean differences in ***HERF*** (mean difference 0.04, $t = 7.60$) and ***FSIZE*** (mean difference 1.04, $t = 24.8$) indicate that environmental activity is more prevalent among larger firms and those in highly competitive industries. Additionally, the mean differences in ***BOOK_TO_MARKET*** (mean difference −0.02, $t = -2.10$) and ***GOODWILL*** (mean difference 0.03, $t = 8.50$) suggest that firms with higher market confidence and goodwill are more likely to engage in environmental activities.

**TABLE 6** | *t*-Statistics by green revenue generator.

| | Green revenue generators (Obs. 3158) | Non-green revenue generators (Obs. 14,577) | | |
|---|---|---|---|---|
| | Mean (M1) | Mean (M2) | M1–M2 | *t* value |
| CPDS | −1.15 | −0.87 | −0.27 | −23.8*** |
| OP_COST_EFF | 1.19 | 0.88 | 0.30 | 21.3*** |
| STRATEGY | 17.33 | 17.41 | −0.07 | −1.00 |
| ASSET_TURNOVER | 0.86 | 1.00 | −0.14 | −11.55*** |
| HERF | 0.29 | 0.25 | 0.04 | 7.60*** |
| FSIZE | 7.66 | 6.63 | 1.04 | 24.8*** |
| BOOK_TO_MARKET | 0.44 | 0.46 | −0.02 | −2.10** |
| GOODWILL | 0.17 | 0.14 | 0.03 | 8.50*** |
| SALES_GROWTH | 7.86 | 8.48 | −0.62 | −1.30 |

*Note:* The definitions of all variables are presented in Table 3.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

Finally, the negative mean difference in ***SALES_GROWTH*** (mean difference −0.62, $t = -1.30$) between green and non-green firms suggests that environmental initiatives do not strongly drive market demand and growth. This finding is supported by the observation that only 5.13% of total revenue is green in our sample period. The data reveal that larger, market-leading firms in competitive industries are more likely to adopt environmental activities, but this adoption is not significantly linked to strategic market positioning or sales growth.

## 4 | Empirical Results

### 4.1 | Analysis of Revenue Channel: Who Pays for It?

The regression results presented in Table 7 provide crucial insights into who bears the cost of environmental activities. The analysis reveals that ***PCT_GREEN_REV*** (−0.01, [−5.48]) and ***GREEN_REV*** (−0.19, [−6.68]) are negatively associated with ***CPDS***.[4] For every percentage increase in green revenue, there is approximately a 1% ($e^{-0.01} - 1 \approx 1 - 0.01 = -0.00995$) decrease in the contribution generated from each dollar of sale. If a firm transitions from non-green to green revenue generation, there is a 17.3% ($e^{-0.19} - 1 \approx 1 - 0.173 = -0.173$) reduction in each dollar's sales contribution. These findings suggest that firms internalise part or all of the costs of environmental activities rather than passing them on to customers, negatively affecting ***CPDS***.

Further, the regression results show that ***CPDS*** is positively associated with ***STRATEGY*** (0.02 [7.36]), ***GOODWILL*** (0.46 [7.26]) and ***SALES_GROWTH*** (0.00 [2.63]) in Column 1 (using ***PCT_GREEN_REV***) and ***STRATEGY*** (0.02 [6.89]), ***GOODWILL*** (0.48 [7.47]) and ***SALES_GROWTH*** (0.00 [2.48]) in Column 2 (using ***GREEN_REV***). Also, ***CPDS*** is negatively associated with ***ASSET_TURNOVER*** (−0.25 [−8.67]), ***HERF*** (−0.12 [−2.23]), ***FSIZE*** (−0.03 [−4.44]) and ***BOOK_TO_MARKET*** (−0.20 [−9.26]) in Column 1 and ***ASSET_TURNOVER*** (−0.24 [−8.12]), ***HERF*** (−0.14 [−2.62]), ***FSIZE*** (−0.02 [−3.47]) and ***BOOK_TO_MARKET*** (−0.20 [−8.95]) in Column 2. In both models, the signs and significance of variables remain consistent with similar coefficients, ensuring the robustness of our results.

The results indicate that firms focusing on differentiation or prospector strategies (***STRATEGY***) with higher goodwill (***GOODWILL***) and market growth (***SALES_GROWTH***) tend to have higher sales contributions. This is because their market orientation and goodwill allow them to charge higher prices while maintaining production costs. Conversely, firms with higher asset turnover (***ASSET_TURNOVER***), operating in more competitive industries (***HERF***), and having lower market confidence (***BOOK_TO_MARKET***) and size (***FSIZE***) have lower sales contributions. Lower market confidence and higher competition limit their ability to charge higher prices, while efficient and larger firms may focus on economies of scale and lower prices for a competitive advantage.

### 4.2 | Analysis of Cost Channel: Impact of Green Revenue on Operational Cost Efficiency

Following the conceptual framework, we estimate the regression model (Equation 2) to determine whether firms benefit from adopting environmental activities through cost channels. Table 8 shows the estimates using ***PCT_GREEN_REV*** and ***GREEN_REV***. Our results show that both variables are positively associated with ***OP_COST_EFF***, with coefficients (*t*-stats) of 0.00 (2.39) and 0.14 (6.08), respectively.[5] For every percentage increase in green revenue, there is approximately a 0.15% ($100 \times (1.0015272 - 1) \approx 100 \times 0.0015272 \approx 0.15272\%$) increase in operational cost efficiency per dollar of sales. If a firm transitions from non-green to green revenue generation, there is a 15.03%

**TABLE 7** | Green revenue's impact on *CPDS*.

| | CPDS | CPDS |
|---|---|---|
| PCT_GREEN_REV | −0.01*** | |
| | (−5.48) | |
| GREEN_REV | | −0.19*** |
| | | (−6.68) |
| STRATEGY | 0.02*** | 0.02*** |
| | (7.36) | (6.89) |
| ASSET_TURNOVER | −0.25*** | −0.24*** |
| | (−8.67) | (−8.12) |
| HERF | −0.12** | −0.14*** |
| | (−2.23) | (−2.62) |
| FSIZE | −0.03*** | −0.02*** |
| | (−4.44) | (−3.47) |
| BOOK_TO_MARKET | −0.20*** | −0.20*** |
| | (−9.26) | (−8.95) |
| GOODWILL | 0.46*** | 0.48*** |
| | (7.26) | (7.47) |
| SALES_GROWTH | 0.00*** | 0.00** |
| | (2.63) | (2.48) |
| INTERCEPT | −0.58*** | −0.69*** |
| | (−3.16) | (−4.25) |
| Observations | 17,735 | 17,735 |
| *R*-squared | 0.44 | 0.43 |
| Adj. $R^2$ | 0.43 | 0.43 |
| Industry and year FE | Yes | Yes |
| Clustered std. err. | Yes | Yes |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

**TABLE 8** | Green revenue's impact on *OP_COST_EFF*.

| | OP_COST_EFF | OP_COST_EFF |
|---|---|---|
| PCT_GREEN_REV | 0.00** | |
| | (2.39) | |
| GREEN_REV | | 0.14*** |
| | | (6.08) |
| STRATEGY | −0.06*** | −0.06*** |
| | (−24.09) | (−24.04) |
| ASSET_TURNOVER | 0.45*** | 0.45*** |
| | (17.73) | (17.49) |
| HERF | 0.10* | 0.10* |
| | (1.89) | (1.90) |
| FSIZE | 0.14*** | 0.13*** |
| | (24.06) | (23.22) |
| BOOK_TO_MARKET | 0.18*** | 0.18*** |
| | (9.72) | (9.74) |
| GOODWILL | −0.32*** | −0.33*** |
| | (−4.99) | (−5.19) |
| SALES_GROWTH | 0.00*** | 0.00*** |
| | (13.59) | (13.65) |
| INTERCEPT | 0.50*** | 0.49*** |
| | (3.07) | (2.95) |
| Observations | 17,735 | 17,735 |
| *R*-squared | 0.58 | 0.59 |
| Adj. $R^2$ | 0.58 | 0.58 |
| Industry and year FE | Yes | Yes |
| Clustered std. err. | Yes | Yes |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

($e0.14 - 1 \approx 1.1503 - 1 = 0.1503$) increase in operational cost efficiency per dollar of sales. These findings demonstrate that green revenue-generating firms achieve operational efficiency, reducing operating costs.

Moreover, ***OP_COST_EFF*** is negatively associated with ***STRATEGY*** (−0.06 [−24.09]) and ***GOODWILL*** (−0.32 [−4.99]) in Column 1, and ***STRATEGY*** (−0.06 [−24.04]) and ***GOODWILL*** (−0.33 [−5.19]) in Column 2. Also, ***OP_COST_EFF*** is positively associated with ***ASSET_TURNOVER*** (0.45 [17.73]), ***HERF*** (0.10 [1.89]), ***FSIZE*** (0.14 [24.06]), ***BOOK_TO_MARKET*** (0.18 [9.72]) and ***SALES_GROWTH*** (0.00 [13.59]) in Column 1 and ***ASSET_TURNOVER*** (0.45 [17.49]), ***HERF*** (0.10 [1.90]), ***FSIZE*** (0.13 [23.22]), ***BOOK_TO_MARKET*** (0.18 [9.74]) and ***SALES_GROWTH*** (0.00 [13.65]) in Column 2. Similar to our previous result in both columns, the coefficient's sign remains the same, and the magnitude is similar, which ensures our result's robustness.

Complementary to our previous findings, firms focusing on differentiation or prospector strategies allocate more resources to research and development, marketing, and employees, leading to reduced operating cost efficiency. Firms with higher goodwill are also associated with lower cost efficiency. Conversely, larger firms in competitive industries focus on economies of scale and efficiency to remain competitive. Production efficiency leads to cost savings; firms achieving this competitive advantage experience higher sales growth, which is positively associated with operational cost efficiency.

### 4.3 | Net Economic Consequence of Environmental Activity

Our results show that while ***OP_COST_EFF*** is positively significant, ***PCT_GREEN_REV*** and ***GREEN_REV*** are negatively significant with ***CPDS***. To understand the net economic consequence of environmental activity, we measure ***NIPDS*** as IB scaled by total revenue. As ***CPDS*** measures the difference between total revenue and the CoGS scaled by total revenue, and ***OP_COST_EFF*** is measured by the difference between IB and ***CPDS***, ***NIPDS*** effectively measures the difference between ***CPDS*** and ***OP_COST_EFF***.[6]

$$\begin{aligned}\textbf{NIPDS} &= \beta 0 + \beta 1\ \textbf{PCT\_GREEN\_REV} \\ &+ \beta 2\ \text{STRATEGY} + \beta 3\ \text{ASSET\_TURNOVER} \\ &+ \beta 4\ \text{HERF} + \beta 5\ \text{FSIZE} + \beta 6\ \text{BOOK\_TO\_MARKET} \\ &+ \beta 7\ \text{GOODWILL} + \beta 8\ \text{SALES\_GROWTH} \\ &+ \text{Industry Fixed Effects} + \text{Year Fixed Effects} + \varepsilon\end{aligned} \tag{3}$$

Table 9 shows the estimation of the regression model. The result shows that ***NIPDS*** (−0.00, [−1.64] in Column 1 and −0.03, [−1.18] in Column 2) is negative but insignificant, indicating that firms with lower ***CPDS*** due to environmental activities have higher ***OP_COST_EFF***, and these two effects offset each other. As a result, the net economic impact of adopting environmental activities is insignificant.

### 4.4 | How Do Businesses Achieve Operational Cost Efficiency?

To further understand how firms achieve operational efficiency, we examine the behaviour of operating costs in three dimensions: marketing (***MARKETING***), employee (***EMP***) and research and development (***R&D***), using similar DID settings. We measured ***MARKETING*** as a marketing expense, ***R&D*** as a research and development expense, and ***EMP*** as employee numbers, a proxy for employee cost scaled by total revenue at time t. We estimate the impact of environmental activity adoption on these costs over 2 and 3 years before and after 2016 using the following regression equations:

$$\begin{aligned}\textbf{MARKETING} &= \beta 0 + \beta 1\ \text{POST} + \beta 2\ \text{TREATMENT} \\ &+ \textbf{β3 POST\#TREATMENT} + \text{CONTROLS} + \varepsilon\end{aligned} \tag{4}$$

$$\begin{aligned}\textbf{EMP} &= \beta 0 + \beta 1\ \text{POST} + \beta 2\ \text{TREATMENT} \\ &+ \textbf{β3 POST\#TREATMENT} + \text{CONTROLS} + \varepsilon\end{aligned} \tag{5}$$

$$\begin{aligned}\textbf{R\&D} &= \beta 0 + \beta 1\ \text{POST} + \beta 2\ \text{TREATMENT} \\ &+ \textbf{β3 POST\#TREATMENT} + \text{CONTROLS} + \varepsilon\end{aligned} \tag{6}$$

Table 10 summarises the results for two control groups: non-reporters and early adopters. Across the models (Control Group = Non-Reporter), we find that ***MARKETING*** is significantly reduced after adopting environmental activities, as ***POST#TREATMENT*** is negatively significant with ***MARKETING*** over 2 (−0.04, [−2.98]) and 3 years (−0.04, [−3.94]). However, ***EMP*** is positive but not significant in a 2-year comparison (0.00, [1.62]) and positively significant in a three-year comparison (0.00, [2.30]).[7] ***R&D*** exhibits a negative sign but is not significant for a 2-year (−0.01, [−1.55]) and 3-year (−0.01, [−1.48]) comparison. These findings suggest that firms respond to regulatory pressure by adjusting their marketing and employee costs rather than expenditures in R&D. Specifically, they reduce around 4% of their marketing expenses relative to sales to offset the incremental costs associated with environmental activities. The coefficient of the increase in employee cost is very marginal.

However, the impact of green revenue generation on ***MARKETING***, ***EMP*** and ***R&D*** between regulatory compliance-driven and non-regulatory-driven green revenue-generating firms is not statistically significant. This result suggests that the same revenue and cost dynamics exist regardless of regulatory pressure.

**TABLE 9** | The net economic consequence of green activity.

| | NIPDS | NIPDS |
|---|---|---|
| PCT_GREEN_REV | −0.00 | |
| | (−1.64) | |
| GREEN_REV | | −0.03 |
| | | (−1.18) |
| INTERCEPT | −0.46*** | −0.50*** |
| | (−3.32) | (−4.01) |
| Observations | 17,735 | 17,735 |
| *R*-squared | 0.26 | 0.26 |
| Adj. $R^2$ | 0.25 | 0.25 |
| Controls | Yes | Yes |
| Industry and year FE | Yes | Yes |
| Clustered std. err. | Yes | Yes |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

### 4.5 | Endogeneity

Endogeneity arises from potential reverse causality as firms with high-cost efficiency may be more likely to invest in green strategies or omitted variable bias due to unobservable management quality. The use of 2SLS addresses these through IVs that correlate with green revenue but not with the error term in the performance equations. Therefore, to address potential endogeneity concerns in our regression models, we employed 2SLS IV regression using industry green intensity (***IND_GREEN_INTEN***) as the instrument, consistent with prior literature (e.g., Safiullah and Shamsuddin 2019; Shalev et al. 2013; Trinh et al. 2024; Xu and Xu 2023). This is suitable for two reasons: (i) it is likely correlated with the ***PCT_GREEN_REV*** of the observed firm, as firms in the same year and industry may follow their peers in green activities; (ii) a change in one firm's ***CPDS*** and ***OP_COST_EFF*** is likely uncorrelated with ***IND_GREEN_INTEN*** and other variables.

**TABLE 10** | How managers achieve operating cost efficiency.

| | MARKETING | EMP | R&D | MARKETING | EMP | R&D |
|---|---|---|---|---|---|---|
| | Control group = non-reporters | | | Control group = early reporters | | |
| | 2 years before and after | | | | | |
| POST | 0.03** | −0.00 | 0.00 | 0.11 | 0.00 | 0.05 |
| | (2.19) | (−0.77) | (0.66) | (0.61) | (0.47) | (0.93) |
| TREATMENT | −0.04** | 0.00 | −0.02*** | −0.20* | 0.00 | −0.08 |
| | (−2.42) | (0.19) | (−3.02) | (−1.70) | (0.36) | (−1.35) |
| POST#TREATMENT | −0.04*** | 0.00 | −0.01 | −0.08 | −0.00 | −0.02 |
| | (−2.98) | (1.62) | (−1.55) | (−0.62) | (−0.28) | (−0.71) |
| INTERCEPT | 0.63*** | 0.01*** | 0.14*** | 1.07** | 0.01*** | 0.27 |
| | (7.86) | (4.72) | (4.19) | (1.98) | (2.90) | (1.25) |
| Observations | 1356 | 1356 | 1356 | 964 | 964 | 964 |
| *R*-squared | 0.44 | 0.43 | 0.34 | 0.17 | 0.23 | 0.14 |
| Adj. $R^2$ | 0.42 | 0.41 | 0.31 | 0.14 | 0.20 | 0.11 |
| | 3 years before and after | | | | | |
| POST | 0.03*** | −0.00** | 0.01 | 0.04 | 0.00 | 0.01 |
| | (2.84) | (−2.28) | (1.11) | (0.56) | (0.39) | (0.25) |
| TREATMENT | −0.05*** | 0.00 | −0.02*** | −0.16 | 0.00* | −0.07 |
| | (−2.95) | (0.97) | (−3.12) | (−1.49) | (1.81) | (−1.34) |
| POST#TREATMENT | −0.04*** | 0.00** | −0.01 | −0.11 | −0.00 | −0.03 |
| | (−3.94) | (2.30) | (−1.48) | (−0.94) | (−0.84) | (−0.83) |
| INTERCEPT | 0.51*** | 0.01*** | 0.13*** | 0.44 | 0.00** | 0.12 |
| | (9.69) | (3.92) | (4.00) | (0.92) | (2.35) | (0.61) |
| Observations | 1806 | 1806 | 1806 | 1236 | 1236 | 1236 |
| *R*-squared | 0.48 | 0.48 | 0.35 | 0.17 | 0.24 | 0.15 |
| Adj. $R^2$ | 0.47 | 0.46 | 0.33 | 0.15 | 0.22 | 0.13 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry and year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustered std. err. | Yes | Yes | Yes | Yes | Yes | Yes |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

This variable represents the ratio of firms reporting green revenue within each three-digit SIC code industry annually. We constructed the IV variable ***IND_GREEN_INTEN*** as the total number of firms reporting green revenue in each three-digit SIC code industry each year divided by the total number of firms in that industry. To assess instrument strength, we report the first-stage F-statistic of 27.4, which exceeds the commonly accepted threshold of 10 (Staiger and Stock 1997), indicating that the instrument is not weak and supports the validity of our 2SLS estimates. Table 11 shows the IV regression results. ***PCT_GREEN_REV*** remains negatively significant with ***CPDS*** (−0.01, [−7.95]), positively significant with ***OP_COST_EFF*** (0.01, [6.52]), and insignificant with ***NIPDS*** (0.00, [0.29]).[8] These findings align with our previous results, confirming that green revenue generation decreases contribution margins but enhances operational cost efficiency, offsetting each other. Finally, in unreported analysis, we test the model's dynamic endogeneity by adding the lag value of CPDS, OP_COST_EFF, and NIPDS measures. The results remain consistent.

Furthermore, as a commitment to the Paris Agreement in 2015, the United States introduced the Clean Power Plan (CPP) in August 2015 (US EPA 2015). However, generating green revenue was not a mandatory outcome of compliance, as firms could reduce carbon emissions or toxic substances without

**TABLE 11** | IV regression.

| Instrument = IND_GREEN_INTEN | CPDS | OP_COST_EFF | NIPDS |
|---|---|---|---|
| PCT_GREEN_REV | −0.01*** | 0.01*** | 0.00 |
| | (−7.95) | (6.51) | (0.29) |
| INTERCEPT | −0.40 | 0.23 | −0.56*** |
| | (−1.54) | (0.89) | (−3.44) |
| Observations | 17,735 | 17,735 | 17,735 |
| *R*-squared | 0.41 | 0.54 | 0.25 |
| Adj. $R^2$ | 0.41 | 0.54 | 0.25 |
| Controls | Yes | Yes | Yes |
| Industry and year FE | Yes | Yes | Yes |
| Clustered std. err. | Yes | Yes | Yes |
| MODEL | IV REG | IV REG | IV REG |
| First-stage F-statistic | 27.4 | 27.4 | — |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

**TABLE 12** | *t*-test of mean difference between treatment and control group.

| | Mean (M1) Treatment group | Mean (M2) Control group | M1–M2 | *t* value |
|---|---|---|---|---|
| | PSM sample by FSIZE | | | |
| | *N* = 678 | *N* = 678 | | |
| STRATEGY | 17.35 | 16.96 | 0.39 | 2.20** |
| ASSET_TURNOVER | 0.96 | 1.02 | −0.06 | −1.80* |
| HERF | 0.27 | 0.28 | −0.01 | −1.05 |
| FSIZE | 7.78 | 7.79 | −0.01 | −0.10 |
| BOOK_TO_MARKET | 0.42 | 0.42 | 0.00 | 0.05 |
| GOODWILL | 0.20 | 0.18 | 0.01 | 1.40 |
| SALES_GROWTH | 7.74 | 7.41 | 0.33 | 0.35 |

*Note:* The definitions of all variables are presented in Table 3.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

necessarily producing green revenue (Karim et al. 2021). Thus, green revenue generation can be viewed as a by-product of these regulations. As a result of the Paris Agreement, there was a sharp increase in green revenue (Klausmann et al. 2024). Our dataset reveals that between 2008 and 2023, a net of 309 firms transitioned from non-green revenue reporters to green revenue reporters.[9] Out of the net changes in the number of firms reporting green revenue, 28% (204) reported green revenue for the first time in 2016. Consequently, we designated 2016 as the environmental regulation shock year for the DID regression (Klausmann et al. 2024; Ramadorai and Zeni 2024; Seltzer et al. 2022). We excluded 2016 to avoid noise and set ***POST*** = 1 for years after 2016 and ***POST*** = 0 for years before 2016, a technique used in prior literature (e.g., D'Lima et al. 2022; Fall et al. 2011; Wang et al. 2019).

In our DID analysis, firms that reported green revenue for the first time in 2016 formed the treatment group. We assigned this group ***TREATMENT*** = 1 if they continued reporting green revenue thereafter. We used two control groups. The first consisted of firms that had never reported green revenue before or after 2016. To ensure that our treated and control firms are comparable, we match treatment and control firms using propensity score matching (PSM) based on their size, where we utilise the nearest neighbour with replacement matching.[10] We report the result in Table 12.

The second control group comprised early green revenue reporters. These firms had already adopted green revenue reporting, facilitating like-for-like comparison, so we did not employ the PSM technique. Hamschmidt and Dyllick (2001) argued that the average payback period for environmental management systems (EMS) post-ISO 14001 adoption is approximately 2.2 years. Also, Jo et al. (2015) found that environmental costs take at least 1 or 2 years to enhance the benefit. Therefore, to understand the impact of green revenue on revenue and cost in our analysis, we ran the DID estimates at least 2 years before and after 2016. As a robustness check of our results, we extended the analysis to 3 years but not beyond that timeframe because of the COVID-19 impact on the market.[11] We estimate the following DID models over 2- and 3-year periods around 2016[12]:

$$\mathbf{CPDS} = \beta 0 + \beta 1\mathrm{POST} + \beta 2\mathrm{TREATMENT} + \mathbf{\beta 3 POST\#TREATMENT} + \mathrm{CONTROLS} + \mathrm{Year\ FE} + \mathrm{Industry\ FE} + \varepsilon \quad (7)$$

$$\mathbf{OP\_COST\_EFF} = \beta 0 + \beta 1\ \mathrm{POST} + \beta 2\ \mathrm{TREATMENT} + \mathbf{\beta 3\ POST\#TREATMENT} + \mathrm{CONTROLS} + \mathrm{Year\ FE} + \mathrm{Industry\ FE} + \varepsilon \quad (8)$$

$$\mathbf{NIPDS} = \beta 0 + \beta 1\ \mathrm{POST} + \beta 2\ \mathrm{TREATMENT} + \mathbf{\beta 3\ POST\#TREATMENT} + \mathrm{CONTROLS} + \mathrm{Year\ FE} + \mathrm{Industry\ FE} + \varepsilon \quad (9)$$

Table 13 presents the DID estimations of regression Equations (4)–(6) over 2 and 3 years before and after 2016. Columns 1 and 2 reflect the DID estimations using the PSM-matched sample of non-reporters as a control group, while Columns 3 and 4 show the DID estimations using early reporters as a control group. For the non-reporters control group, ***CPDS*** demonstrates a significant negative relationship with ***POST#TREATMENT*** over the 2-year (−0.08, [−2.82]) and

**TABLE 13** | DID analysis.

| | CPDS | OP_COST_EFF | NIPDS | CPDS | OP_COST_EFF | NIPDS |
|---|---|---|---|---|---|---|
| | Control group = non-reporters | | | Control group = early reporters | | |
| | 2 years before and after | | | | | |
| POST | 0.05* | −0.06* | 0.00 | 0.03 | 0.01 | 0.03 |
| | (1.70) | (−1.79) | (0.09) | (0.66) | (0.11) | (0.59) |
| TREATMENT | −0.16*** | 0.18*** | −0.00 | 0.11 | 0.12* | 0.14** |
| | (−4.12) | (3.85) | (−0.26) | (1.55) | (1.78) | (2.35) |
| POST#TREATMENT | −0.08*** | 0.09*** | 0.00 | −0.05 | 0.03 | −0.03 |
| | (−2.82) | (2.59) | (0.10) | (−1.22) | (0.53) | (−0.97) |
| INTERCEPT | −0.87*** | 0.73*** | −0.29*** | −1.09*** | 0.77*** | −0.62** |
| | (−4.58) | (2.94) | (−3.68) | (−3.31) | (2.74) | (−2.04) |
| Observations | 1356 | 1356 | 1356 | 964 | 964 | 964 |
| *R*-squared | 0.64 | 0.58 | 0.19 | 0.50 | 0.55 | 0.27 |
| Adj. $R^2$ | 0.454 | 0.473 | 0.15 | 0.312 | 0.423 | 0.25 |
| | 3 years before and after | | | | | |
| POST | 0.04* | −0.06* | −0.01 | 0.03 | −0.04 | 0.03 |
| | (1.72) | (−1.91) | (−0.47) | (0.64) | (−0.82) | (0.96) |
| TREATMENT | −0.16*** | 0.17*** | −0.01 | 0.07 | 0.09 | 0.12** |
| | (−3.89) | (4.04) | (−0.58) | (0.87) | (1.41) | (1.98) |
| POST#TREATMENT | −0.08*** | 0.07** | −0.00 | −0.06 | 0.04 | −0.03 |
| | (−2.94) | (2.27) | (−0.15) | (−1.13) | (0.81) | (−0.98) |
| INTERCEPT | −0.75*** | 0.77*** | −0.16*** | −1.28*** | 0.93*** | −0.38 |
| | (−3.33) | (3.31) | (−2.66) | (−4.24) | (3.74) | (−1.27) |
| Observations | 1806 | 1806 | 1806 | 1236 | 1236 | 1236 |
| *R*-squared | 0.64 | 0.61 | 0.20 | 0.48 | 0.55 | 0.25 |
| Adj. $R^2$ | 0.63 | 0.59 | 0.18 | 0.47 | 0.54 | 0.23 |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes |
| Industry and year FE | Yes | Yes | Yes | Yes | Yes | Yes |
| Clustered std. err. | Yes | Yes | Yes | Yes | Yes | Yes |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

3-year (−0.08, [−2.94]) periods. For the same control group over 2 and 3 years, ***OP_COST_EFF*** (0.09, [2.59] and 0.07, [2.27]) shows statistically significant positive associations, while ***NIPDS*** remains insignificant. This result confirms that firms adopting environmental activities internalise costs, reducing ***CPDS*** while increasing ***OP_COST_EFF***, thus offsetting each other.

Conversely, ***POST#TREATMENT*** does not exhibit statistical significance for the early reporters' control group with ***CPDS***, ***OP_COST_EFF*** and ***NIPDS***.[13] These firms have already embraced environmental activities and undergone similar processes. The findings show no difference in the cost–benefit dynamics between regulatory compliance-driven and self-motivated environmentally engaged firms.

## 4.6 | Alternative Proxy Measure

To complement our analysis, we introduce an alternative measure: ***ENV_PRODUCT***, defined as 1 if a company offers any environmental product and 0 otherwise. This measure provides a unique perspective distinct from green revenue, reflecting firms' engagement in environmental initiatives beyond revenue

**TABLE 14** | Tabulation of ENV_PRODUCT vs. GREEN_REV.

| | GREEN_REV | | |
|---|---|---|---|
| **ENV_PRODUCT** | **0** | **1** | **Total** |
| 0 | 5251 | 643 | 5894 |
| 1 | 2593 | 1761 | 4354 |
| Total | 7844 | 2404 | 10,248 |

*Note:* The definitions of all variables are presented in Table 3.

generation. After merging ***ENV_PRODUCT*** data from EIKON, our sample size is reduced by 7487 observations, resulting in a final sample of 10,248 observations.

The data reveals that while ***ENV_PRODUCT*** and ***GREEN_REV*** are correlated, they are not identical. This discrepancy suggests that some firms report green revenue without specific environmental products, possibly due to environmental processes integrated with existing products. Conversely, some firms offer environmental products without reporting green revenue, potentially due to revenue thresholds or voluntary disclosure practices. Under ASC 280 guidelines, companies are mandated to report segmented revenue if it constitutes 10% or more of total revenue, profit/loss, or assets (FASB 2023). However, even if firms do not report green revenue in their financial statements below this threshold, they might disclose it in other reports to manage stakeholder expectations, demonstrate transparency, or showcase environmental initiatives.

Table 14 shows that, in our updated sample, 25.3% of firms have environmental products without reporting green revenue, while 6.27% report green revenue despite lacking environmental products. Additionally, 17.12% of firms report both environmental products and green revenue, with 38.61% reporting less than 10% of total revenue as green revenue. This variability underscores the subjective nature of green revenue reporting, influenced by accounting standards and firms' strategic considerations, thus justifying the use of ***ENV_PRODUCT*** as an alternative proxy.

The observed misalignment between firms reporting green revenue and those disclosing environmental products likely reflects differences in disclosure thresholds, strategic positioning, and reporting frameworks. As Zhou et al. (2022) suggest, ESG reporting often exceeds the scope of actual product-level alignment, driven by reputational signalling motives. Some firms may classify revenues from activities such as renewable energy sourcing, carbon offset trading, or process-based innovations as 'green' under broader sustainability frameworks, even if these do not result in explicitly labelled environmental products. Conversely, other firms may offer environmentally beneficial products but choose not to label revenues as green due to the absence of regulatory incentives, inconsistent standards, or concerns over greenwashing accusations. This heterogeneity in sustainability strategies—where some firms prioritise operational greening while others focus on market-facing green product positioning—is consistent with prior research emphasising the variability of strategic environmental disclosure (Wang et al. 2021; Bentley et al. 2013; D'Angelo et al. 2023). Together, these factors help explain the partial overlap between the ENV_PRODUCT and green revenue variables, highlighting the need for more consistent sustainability reporting standards and nuanced interpretations of green performance indicators.

**TABLE 15** | Alternative measure of green activity.

| | CPDS | OP_COST_EFF |
|---|---|---|
| ENV_PRODUCT | −0.08*** | 0.08*** |
| | (−3.61) | (3.70) |
| INTERCEPT | −0.85*** | 0.49*** |
| | (−5.77) | (3.26) |
| Observations | 10,248 | 10,248 |
| *R*-squared | 0.50 | 0.60 |
| Adj. $R^2$ | 0.50 | 0.59 |
| Controls | Yes | Yes |
| Industry and year FE | Yes | Yes |
| Clustered std. err. | Yes | Yes |

*Note:* The definitions of all variables are presented in Table 3. *t*-values are in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

Table 15 shows the estimation of regression Equations (1) and (2), replacing ***PCT_GREEN_REV*** with the alternative proxy ***ENV_PRODUCT***. The results indicate that ***ENV_PRODUCT*** is negatively significant with ***CPDS*** (−0.08, [−3.61]) and positively significant with ***OP_COST_EFF*** (0.08, [3.70]). These findings reinforce our earlier conclusions, demonstrating that firms' engagement in environmental products correlates with cost behaviour and operational efficiency.

## 5 | Discussion

Our findings indicate that companies reporting green revenue generate lower contributions from their sales. The negative relationship between the percentage of green revenue and contribution per dollar sale suggests that firms do not pass on the incremental costs of environmental activities to customers through higher sales prices. If these costs had been passed on, contributions from sales would have increased or remained constant. This addresses a fundamental question in the literature (Ambec and Lanoie 2008): who bears the cost? Companies lack confidence in the societal valuation of ESG as an esteemed value and, thus, are hesitant to pass these costs on to customers. Being green alone is not sufficient to justify a price premium. Our findings support existing literature indicating that customers are not tolerant of low-quality, high-priced green products or services (Cahaya et al. 2023; D'Souza et al. 2006).

From the stewardship theory perspective, this raises questions about how managers engage in environmental activities and mitigate the impact of lower contributions from sales. Consistent with the literature (Ambec and Lanoie 2008; Dangelico 2016; Salandri et al. 2022; Ullah 2021), we find that

environmental activities can lead to operational efficiency, reducing operating costs and thus offsetting the lower sales contributions. We also explore whether engagement in environmental activities grants businesses access to new markets, potentially leading to overall economic benefits. Our results indicate that while environmental activities may open new markets and increase sales revenue, they do not necessarily lead to significant improvements in overall financial performance (Driessen et al. 2013; Duque-Grisales et al. 2020).

Additionally, our results show no significant behavioural differences between self-motivated and compliance-driven environmentally engaged firms. From the stewardship perspective, this raises further questions: why do self-motivated businesses engage in environmental activities if there is no substantial new market, customers are unwilling to pay more, and the net economic benefit is insignificant? It may seem paradoxical that businesses pursue environmental activities for competitive advantage while believing no such market exists. However, our results show that businesses reduce marketing costs through environmental engagement, seeing it as a strategy to enhance their brand image (Hildebrand et al. 2011; Brønn and Vidaver-Cohen 2009). We argue that these businesses are creating the market by integrating ESG into their brand image, providing them a competitive advantage. Our results show that businesses do not cut R&D expenditure to remain competitive. Furthermore, recognising the reputational risks of employee layoffs and the positive correlation between strong ESG brand image and employee retention, businesses maintain employee retention.

Environmental regulation is a key driver in creating the new green market, with 28% of sample firms engaging in environmental activities due to regulation. This supports the idea that regulatory initiatives benefit society by compelling businesses to engage in environmental activities. Our findings indicate no significant differences between regulatory compliance-driven firms and self-motivated environmentally engaged firms, suggesting that regulatory requirements align with existing industry norms, making them realistic and attainable. Businesses adopt environmental practices due to these regulations, benefiting society, unless these efforts are superficial or misleading. While greenwashing lies beyond the scope of this paper, it is important to note that if left unchecked, it can undermine consumer trust and distort perceptions of brand authenticity.

## 6 | Conclusion

This study examines the economic implications of environmental activities through revenue and cost channels, addressing a significant gap in the literature. Our findings reveal that companies do not pass on the costs of environmental investments to consumers, resulting in reduced sales contributions. Instead, firms enhance operating cost efficiency to mitigate this impact and maintain profitability. This supports previous research that suggests consumers are often unwilling to bear the costs of sustainability unless directly tied to visible product attributes. At the same time, it contrasts with studies that assume green premiums can consistently be passed on to customers, highlighting a more complex reality for firms. This highlights the challenges businesses face in monetising environmental activities, especially when consumers do not perceive their direct benefits.

Our research aligns with stewardship theory, suggesting that managers engage in environmental activities to maximise long-term shareholder wealth. While environmental initiatives may not yield immediate financial gains, they contribute to a company's brand image and future competitive advantage through cost reductions, particularly in marketing. This finding extends the literature by offering empirical evidence that cost-side benefits, especially in marketing and operational expenses, can offset lost contribution margins.

This study has implications for policymakers, emphasising the importance of regulatory frameworks in driving corporate environmental engagement. It also highlights the need for transparent disclosure of environmental investments' costs and benefits, aiding investors and stakeholders in assessing their net benefits. For standard setters like the ISSB, our findings highlight the importance of incorporating metrics like contribution per dollar sale and operating cost efficiency per dollar sales into new standards such as S1 and S2, which mandate comprehensive disclosures on environmental targets and performance metrics. Clear metrics are essential for investors and stakeholders to accurately assess the net benefits of these investments.

For businesses, this study offers insights into strategically implementing environmental initiatives that comply with regulations and improve operational efficiency, leading to cost savings and enhanced profitability. This underscores the value of integrating sustainability into core business strategies for long-term success.

Our findings contribute to the strategic management literature by demonstrating how firms strategically absorb the costs of environmental activities through operational efficiencies rather than passing them on to consumers. This complements previous work emphasising environmental cost as a barrier to competitiveness by showing that firms can, in fact, turn sustainability into a source of internal strength. This aligns with the RBV, where environmental initiatives are not just cost centres but strategic resources that can lead to sustained competitive advantage when leveraged effectively. By showing how firms can use environmental activities to enhance operational capabilities, this study expands our understanding of how sustainability is integrated into long-term strategic objectives. Thus, while the cost absorption mechanism aligns with established efficiency-based theories, our evidence on the limited pass-through to consumers adds a novel angle on pricing constraints under green strategies. Additionally, it highlights the importance of balancing immediate cost concerns with long-term value creation, providing firms with a roadmap to incorporate sustainability into their strategic frameworks without sacrificing profitability.

This study contributes to both theory and practice by demonstrating how green investments materialise through dual pathways: pricing strategies and operational efficiency, and by reinforcing the value of integrating stewardship theory with the RBV. The findings illustrate that internal managerial commitment and strategic resource alignment can produce both sustainability and cost-efficiency gains, thereby advancing the theoretical integration of stewardship and RBV. For policymakers, the results

emphasise the relevance of incorporating direct performance metrics, specifically contribution per dollar sale and operational cost efficiency, into ESG disclosure frameworks. These measures, which are both implementable using existing enterprise resource planning systems and reflective of firms' sustainability execution, address a current gap in capturing internal process improvements alongside external sustainability outcomes. However, to ensure practical adoption, standardised definitions and cross-sectoral comparability of these indicators will be essential.

One limitation of this study is its exclusive focus on US-based firms, which may constrain the generalisability of the findings to other countries with different regulatory regimes, cultural expectations, and institutional frameworks. Future research could extend the analysis to cross-country settings to assess the robustness of the observed relationships in diverse environmental, governance, and policy contexts. Additionally, while this study employs a quantitative approach to capture firm-level performance outcomes, qualitative research could offer deeper insights into the managerial decision-making processes underlying green investment strategies. Future studies might also explore how specific environmental initiatives such as carbon offset programmes or circular economy models affect a broader range of firm outcomes, including innovation, stakeholder engagement or brand value.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### Conflicts of Interest

The authors declare no conflicts of interest.

### Endnotes

[1] In California's Cap-and-Trade programme, companies often choose to buy allowances for carbon emissions instead of investing in expensive new technologies to reduce emissions within the set cap (California Air Resources Board 2022).

[2] EIKON have data record for green revenue of S&P 500 from 2003 and MSCI World from 2008. Although we started the sample from 2003 but because of the missing financial data for the *STRATEGY*, after merging with COMPUSTAT our final sample retain from fiscal year 2008 to 2023.

[3] Before inverse the log, we normalised the value by multiplying with −1; as for the interpretation purpose we multiplied the variable with the −1 before.

[4] We used coefficient and [t-stat] in parentheses to describe results.

[5] The coefficient of PCT_GREEN_REV is precisely 0.0015261, which is truncated to 0.00 in two decimal places.

[6] Please see Table 2 for details.

[7] We used coefficient and [t-stat] in parentheses to describe results.

[8] We used coefficient and [t-stat] in parentheses to describe results.

[9] Some firms also abandoned reporting green revenue. Therefore, we calculated the net change.

[10] We check the mean difference of matched samples for 3 years. All the samples demonstrate demonstrates similar characteristics.

[11] For 3 years, the post-intervention period covers 2017, 2018 and 2019. COVID-19 hit the United States at the beginning of 2020.

[12] Over 2 years, we matched 342 observations in the pre-intervention phase and 336 in the post-intervention phase, totalling 678 observations each in the non-reporter control and treatment groups. Over 3 years, the non-reporter matched group consisted of 445 pre-intervention and 448 post-intervention observations, totaling 903 observations each in the treatment and control groups. For early reporters with a 2-year time frame around the shock event, 128 observations in the control group in the pre-intervention period and the same number of observations in the post-intervention period (total 256 observations), 358 observations in the pre-intervention period and the same number of observations in the post-intervention period for the treatment group (total 708 observations). For 3 years with the early reporter, 144 observations in pre-intervention and the same number of observations in the post-intervention for the control group (total 288 observations), 474 in pre-intervention and the same number of observations in the post-intervention for the treatment group (total 948 observations).

[13] In an unreported analysis using the same DID settings over 2 and 3 years, we explored the possibility that environmentally engaged firms have overall increased profitability because of increased sales, thus even lower contribution aggregate to higher profitability. We used ROA and ROE measured by IB sales by total asset and market value of equity. We found no significant relationship, thus indicating that environmental engagement is not economically profitable for the business.

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