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Sailing From Penalties to Accountability: Business Strategies and Governance for Firms to Innovate After Environmental Misconduct

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ABSTRACT

Firms' continuous pursuit of making a profit in the competitive market may ignore the actions related to environmental responsibilities. This set of actions for financial gains constitutes environmental misconduct, which not only harms ecosystems and communities but also brings reputational damage. Negative press and social media amplification damage brand legitimacy, erode stakeholder trust and deter investors. Although prior research has examined greenwashing, little attention has been given to how firms strategically respond once misconduct becomes visible. We propose that firms respond to environmental misconduct by increasing R&D spending as a corrective strategy to repair reputational damage. Using a longitudinal dataset of 117,112 firm-quarter observations that merges Violation Tracker with Compustat and ExecuComp for the years 2000–2025, we analyse how environmental misconduct influences firms' R&D spending. Employing high-dimensional fixed-effects models and the Gaussian copula approach to address endogeneity, we find that firms tend to increase R&D investment following misconduct. The decision to increase R&D spending signals a commitment to sustainability and helps rebuild stakeholder confidence. We further explore the moderating role of firm resources and industry structure. Our results show that firms with abundant organisational slack, financial and operational efficiency, or market power face less pressure to increase R&D spending.

1 | Introduction

Firms, by their very nature, are profit-driven entities as they want to survive in a highly competitive market. They may choose practices that generate immediate monetary benefits at the expense of environmental protection, which may lead to adverse outcomes on ecosystems and community welfare. These types of firms' actions have resulted in environmental misconduct. The environmental misconduct could be of several types, such as illegal dumping of hazardous waste, improper handling of industrial residues, unsustainable depletion of natural resources, or excessive emissions of greenhouse gases. Some firms create a false image in front of stakeholders and continue to exploit natural resources irresponsibly (Birindelli et al. 2025). The consequences of these violations are serious, such as worsening climate change, harming biodiversity, contaminating the ecosystem and exposing local communities to toxic substances. Commonly, weak implementation of environmental laws and legal ambiguities encourage companies to take shortcuts instead of investing in sustainable technologies (Liu et al. 2018). Furthermore, environmental misconduct can be deliberate as firms may misrepresent emissions or forge data to evade

oversight (Kakade and Haber 2020). Apart from environmental and health consequences, environmental misconduct also brings reputational damage (Zou et al. 2015).

Companies that are caught engaging in environmental misconduct quickly discover that the fallout is far more complicated than paying fines or settling lawsuits. Once the public becomes aware of such behaviour, the consequences spill across almost every aspect of the business (Beck 2019). In the past, firms could sometimes manage the story through carefully timed press releases or behind-the-scenes negotiations. That is no longer the case. Social media has completely changed how fast and how widely negative news spreads. Viral hashtags can amplify damaging narratives, which fuel consumers' anger and draw the attention of activist groups (Etter et al. 2019). What begins as a local issue can easily escalate into a global conversation. This affects a firm's reputation and also questions its legitimacy in the eyes of society. A firm should operate in line with accepted norms and values, which is fundamental for survival. Firms pay a high cost in the form of reputational damage and consumer boycotts. Once the trust is broken, reputational scars can linger for years (Lyon and Montgomery 2015). The financial community has also raised the stakes. Investors are also the active participants who diligently screen for environmental controversies. The growth of environmental investment means that a poor record on environmental responsibility can quickly translate into higher financing costs (Dyck et al. 2019). Institutional investors like BlackRock, State Street and Vanguard (The Big Three) announced that they will not allocate capital to environmentally irresponsible firms (Davis 2024). Announcements of these types incentivise firms to adopt genuine sustainability practices. Environmental responsibility is tied to a good reputation and long-term competitiveness in global markets. Faced with this pressure, many firms attempt quick fixes. CEOs may step up with heartfelt apologies, paired with shiny sustainability slogans or website revamps, but stakeholders see past the polish with these symbolic or greenwashing initiatives, longing for real steps toward change (Blazkova et al. 2023). These strategies may backfire and fuel further distrust. Thus, these actions are considered outdated, and firms look for meaningful strategies, which can bring long-term sustainability along with reputation recovery. Reputation rebuilding may take years, and even little slip-ups during the recovery period can be magnified (Zhang et al. 2021). Legal battles and regulatory sanctions often prolong negative attention, draining resources that could otherwise support innovation. On top of this, internal cultural shifts, such as redesigning incentives or retraining employees, take time and rarely proceed smoothly (Carlgren and BenMahmoud-Jouini 2022). Yet it would be misleading to view these crises only in negative terms. They can also serve as turning points. The sting of misconduct forces firms to dig deep, questioning their principles and reshaping their habits. Firms under crisis accelerate transformation and adopt circular economy models and sustainable practices. We investigate firms' strategies, which are adopted after the environmental misconduct.

Previous research extensively explores greenwashing (Peng et al. 2024; Shuang et al. 2024; Szabo and Webster 2021; Wang et al. 2023) but talks a little about how firms strategically respond to reputational threats once environmental misconduct has been exposed. We propose that firms involved in environmental misconduct often turn to increased R&D investment as a strategic response to overcome reputational damage. Firms' allocation in R&D helps in adopting green technologies and signals a strong commitment to environmental care. This strategic decision repairs the reputational damage and rebuilds the stakeholders' confidence. However, despite growing attention to corporate misconduct, a key omission in the literature is the absence of systematic evidence on how firms respond to environmental violations by reallocating R&D resources and how these adjustments vary across different resource endowments and industry settings. Our research fills this void by empirically examining the R&D repercussions of environmental misconduct through a comprehensive, longitudinal dataset. We focus on the following research questions:

Research Question 1: *What is the impact of environmental misconduct on firms' R&D spending?*

Research Question 2: *What firm-related factors influence the relationship between environmental misconduct and firms' R&D spending?*

We utilise a longitudinal database by merging Violation Tracker and Compustat from 2000 to 2025 to address these research questions. We use the high-dimensional fixed-effects method and the Gaussian copula for endogeneity correction to support our hypotheses empirically. We find that firms increase their R&D spending when involved in environmental misconduct. We also find that resource and industry-based factors moderate the relationship between environmental misconduct and R&D spending. More specifically, an increase in organisational slack, inventory turnover, financial efficiency and market concentration reduces the influence of environmental misconduct on firms' R&D spending.

Our study has several methodological, theoretical and managerial contributions. Methodologically, we apply a Gaussian copula correction approach to mitigate endogeneity concerns and provide more robust estimates than traditional instrumental variable techniques. In our analysis, we obtain a positive and significant coefficient of the Gaussian copula term. The significance of the copula term confirms potential endogeneity, and its inclusion strengthens the validity of our results. We use a longitudinal dataset merged from Violation Tracker and Compustat, which allows us to examine firm-related factors with misconduct data. This minimises the self-reporting bias and offers a more comprehensive and reliable view than prior studies reliant on self-reported sustainability metrics. Theoretically, we provide new avenues to the legitimacy theory by indicating that CSR campaigns or lobbying strategies during environmental misconduct can be replaced by adopting corrective strategies through increased R&D investment. Investing in innovation for green technologies signals responsibility to stakeholders and demonstrates a long-term commitment to sustainability. We highlight the moderating roles of firm resources and industry structure, suggesting firms with high operational and financial resources feel less pressure to increase R&D spending. However, firms with fewer financial and operational resources may feel greater pressure to increase R&D after misconduct. Conversely, dominant firms in

concentrated markets benefit from structural legitimacy and rely more on symbolic strategies. Finally, our study has practical implications for managers and policymakers. Firms' symbolic strategies should be balanced with innovation strategies to rebuild stakeholder trust. Policymakers should encourage transparency regulations, like mandatory disclosure of green innovation and increase accountability in firms' environmentally related actions.

The rest of the manuscript is structured as follows: Section 2 contains a theoretical framework where we propose hypotheses using prior literature and established theories. Section 3 describes the sample and research methods. We explain our datasets, variables and analysis method in this section. Section 4 explains the results related to hypothesis testing. Section 5 provides a discussion of results, methodological, theoretical and managerial implications. Section 6 contains the conclusion of our research.

2 | Literature Review and Hypothesis Development

2.1 | Theoretical Framework

The legitimacy theory suggests that the firm should align its actions with the expectations of stakeholders, and society should perceive the firm as a legitimate firm (Crossley et al. 2021). The maintenance of legitimacy is essential for the continued operations of the firm (Boiral et al. 2022). The prior literature has consistently shown that a firm's legitimacy is a cornerstone for acquiring resources, managing stakeholder pushback and supporting long-term viability (Lounsbury and Glynn 2001; Shah 2011). Firms' legitimacy could be challenged when it is involved in unethical behaviour. As a response, firms typically engage in deliberate actions designed to rebuild their legitimacy (Smith et al. 2021). These actions can range from symbolic gestures like a public apology to substantive changes like investing in innovations. Thus, the legitimacy framework helps in understanding why firms adopt strategies to repair their reputation after involvement in unethical behaviour.

When a firm is involved in environmental violations like air pollution, hazardous waste or other ecological violations, its legitimacy is severely harmed in various ways (Habib and Bhuiyan 2017). At the regulatory level, these environmental violations lead to official scrutiny or intense monitoring by regulatory authorities, which signals to society that firms do not follow established standards (Chang et al. 2021). From a stakeholder standpoint, they may start boycotting the firms or divesting the investments because the firm is socially irresponsible (Hajmohammad et al. 2021). The environmentally sensitive customers and investors generally move to competitors if they find the focal firm is involved in environmental violations (Yalabik and Fairchild 2011). Third, there would be negative media attention, and activist groups may raise these environmental violation issues at the national level, which cements the perception of the firm's irresponsibility in society (Eilstrup-Sangiovanni and Bondaroff 2014). Lastly, from an internal perspective, employees may experience decreased motivation and be less motivated to associate with the firm that conducts environmental violations. Collectively, these consequences represent a broad loss of legitimacy, causing the firm to be perceived as misaligned with societal values and stakeholder expectations, which jeopardises its legitimacy to operate in the long run.

When firms are caught in environmental controversies, they invest more in R&D to restore their reputation and align with what stakeholders expect. Instead of shallow apologies, firms invest in research and innovation to develop eco-friendly technologies, refine their methods and show stakeholders they are serious about protecting the environment. When companies get flagged for environmental violations, they face more scrutiny from regulatory authorities. Hence, firms lean on R&D to come up with solutions that align with tougher standards and reduce the chance of sanctions. When stakeholders start turning away from companies due to environmental violations, they pour resources into R&D to develop green practices for rebuilding credibility and keeping them viable. Collectively, these factors suggest that businesses strategically invest in R&D following environmental misconduct to repair their image and secure their future operations. In this way, boosting R&D also helps fix the three types of legitimacy (Suchman 1995). First, pragmatic legitimacy is restored because stakeholders see the company making real, problem-solving investments that directly address their needs and concerns. Second, moral legitimacy increases as R&D demonstrates ethical commitment, indicating that the firm acknowledges its wrongdoing and is proactively advancing more sustainable technologies and practices. Third, cognitive legitimacy is bolstered as investments in environmental innovation align the firm with widely accepted standards of responsible organisational conduct, rendering its corrective measures both suitable and anticipated. These mechanisms render R&D a viable and theoretical avenue for restoring legitimacy following environmental transgressions. So, we suggest the following hypothesis:

H1. *Firms involved in environmental misconduct increase their R&D spending.*

2.2 | Resource-Based Moderators

2.2.1 | Organisational Slack

Organisational slack is the additional resource of a firm that is not tied to day-to-day operations (Khan and Mir 2019). These resources are useful for firms during critical moments. When a firm is involved in environmental violations, it is also a critical challenge for the firm. Firms' organisational slack allows them to invest in sustainable research efforts to regain legitimacy. Rather than cutting back on new ideas to handle immediate reputational hits, firms with additional resources keep up R&D spending to show they are focused on eco-friendly initiatives. Slack resources are like a safety net to absorb the financial and reputational damage of misconduct, helping firms regain the trust of stakeholders. Importantly, organisational slack acts as a buffer, which gives core innovation activities a pool of extra resources that protects them from short-term shocks (Bowen 2002). This buffering mechanism works as surplus capacity that absorbs the operational strain created by misconduct. By making this mechanism clearer, we want to stress that

slack protects R&D not by making the company look strong or credible, but by letting it move resources around internally without putting continuing innovation promises at risk. Therefore, a high level of organisational slack helps businesses avoid slashing R&D when facing environmental scandals, allowing firms to keep innovating and address legitimacy concerns. Thus, we propose the following hypothesis:

H2. *An increase in organisational slack reduces the influence of environmental misconduct on R&D spending.*

2.2.2 | Inventory Turnover Ratio

The inventory turnover ratio is the metric that shows the balancing of production with demand, avoiding excess inventory costs (Chen et al. 2023). A higher level of inventory turnover ratio suggests that the firm is efficiently selling out and restocking the products. We suggest that a high inventory turnover ratio may help a company secure investor confidence by absorbing the reputational damage from environmental violations and keeping R&D budgets intact. When a company turns over its inventory quickly, it sends a message to stakeholders that the firm is responsive to customer needs, which maintains stakeholder support even after a scandal. Environmental misconduct typically triggers legitimacy repair pressures, which may lead managers to enhance R&D spending on green innovation or other recovery strategies to regain the trust of stakeholders. When a firm has a high inventory turnover, it quickly converts the inventory into revenue and shortens the cash-conversion cycle, which creates a liquidity cushion to handle unexpected crises (Barinov 2014). At the same time, consistently fast inventory turns increase the credibility of the firm in the market during a crisis and reassure supply-chain partners that the firm's operations are reliable. So, stakeholders are more likely to perceive the misconduct as an isolated event, which can be mitigated by the firm's operational strength. Thus, a high inventory turnover creates a performance-based legitimacy, and stakeholders are less likely to demand big changes to R&D spending, even after an environmental violation. Therefore, by combining financial flexibility with a visible cue of operational excellence, a high inventory turnover ratio attenuates both the reputational and resource-constraint channels through which environmental misconduct would otherwise reshape R&D expenditure. Thus, we propose the following hypothesis:

H3. *An increase in the inventory turnover ratio reduces the influence of environmental misconduct on R&D spending.*

2.2.3 | Financial Efficiency

The financial efficiency is how a firm uses its financial resources to generate revenues without wasting resources (Ecer et al. 2017). Drawing on legitimacy theory, a higher financial efficiency equips the firm with buffering capacity and credibility to dampen the reputational damage due to environmental misconduct. First, a financially efficient firm keeps cash flowing steadily by managing its resources well without sacrificing long-term R&D projects. Second, the sustained financial efficiency signals pragmatic legitimacy through strong returns and quick cash flow, which convinces the stakeholders that the firm still delivers value even after the environmental violation. Third, a high financial efficiency is associated with robust management control systems, which support cognitive legitimacy (Li et al. 2025). The stakeholders can see this as a credible plan for fixing an environmental issue, ensuring R&D programs stay on track instead of being slashed for optics. Fourth, financial efficiency brings strong capital access and financial flexibility, reducing the risk of innovation cuts during the crisis. Finally, a financially efficient firm can finance environmental fixes through outsourcing and signal credible disclosures to stakeholders without destabilising the R&D spending. Based on these reasons, we propose the following hypothesis:

H4. *An increase in financial efficiency reduces the influence of environmental misconduct on R&D spending.*

2.3 | Industry-Based Moderator

2.3.1 | Market Concentration

When a firm operates in a highly concentrated market, it may influence the industry demand and consumer expectations through its strategic decisions (Cetorelli et al. 2007). In such markets, a firm can take a reputational hit from environmental issues, but they do not usually derail its focus on R&D spending. Most of the firms in these markets enjoy a form of taken-for-granted legitimacy, where they can dodge serious outside scrutiny due to their size and industry dominance. These firms set the industry's rules and hold the reins on major supply chains, so stakeholders tend to see them as stable, even when their environmental practices are questioned. As a result, these firms are not pushed as hard to invest in sustainable R&D to fix their image, compared with a less concentrated market where inappropriate moves can jeopardise their future. Additionally, firms in concentrated markets often use tactics like lobbying or feel-good CSR campaigns to stay legit, without diverting much cash from their R&D initiatives (DellaVigna et al. 2016). Hence, from a legitimacy theory perspective, market concentration acts as a shield, reducing the impact of environmental violations to intensify R&D spending for regaining social acceptance. Based on these arguments, we propose the following hypothesis:

H5. *An increase in market concentration reduces the influence of environmental misconduct on R&D expenditure.*

We propose five hypotheses in this section, which will be empirically tested in the next section. A diagram of the conceptual framework is presented in Figure 1.

3 | Sample and Research Method

3.1 | Sample

We use the Violation Tracker database to capture the firms' environmental violations. The Violation Tracker dataset offers a valid and reliable proxy to monitor environmental violations. Good Jobs First compiles a detailed set of records on penalties from a variety of US federal and state bodies.

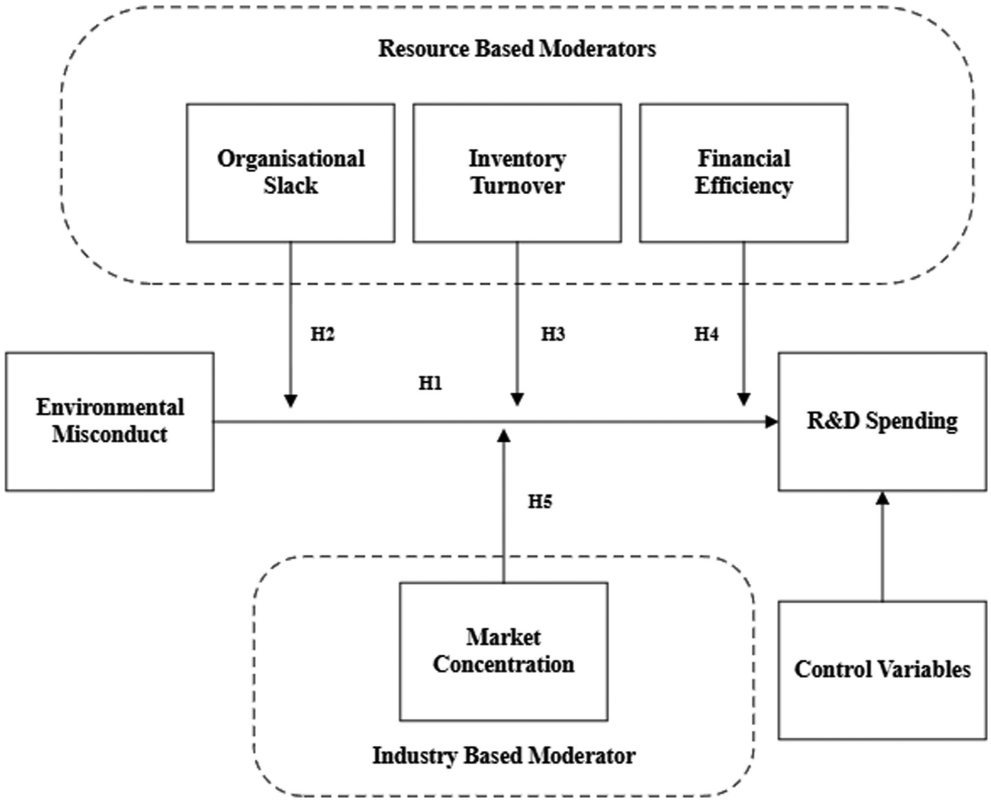

FIGURE 1 | Conceptual framework.

Its broad perspective ensures comprehensive documentation of environmental violations across various sectors and timeframes. By using publicly available government data rather than company self-reports, this dataset has a minimal risk of self-reporting bias and enhances the reliability of environmental violations for the analysis. Prior research also uses the Violation Tracker dataset to support their hypotheses (Shevchenko 2021; Dong et al. 2024). We also use Compustat to capture firm-related variables and merge these two datasets, resulting in a longitudinal dataset from 2000 to 2025. This broad time span and diverse longitudinal data coverage let us examine long-term trends in how firms innovate after environmental wrongdoing.

We align the Violation Tracker database with the firm's appropriate fiscal quarter using the Compustat dataset. We use the environmental misconduct dataset and match each violation event to the quarterly level financial data that goes with it. This makes sure that the date of the violation is correctly linked to the firm-quarter observation. The sample contains 40,811 firm-quarters where an environmental violation took place. We add a control group of firms matched with the same sectors as the focal firms. This approach ensures that our results are not driven solely by industry-specific shocks or market conditions affecting all firms in an industry. By comparing focal firms to their industry peers without violations, we can more clearly see the impact of environmental violations on their outcomes while keeping industry-wide factors constant. We use propensity score matching to create the control group of peer firms that are not involved in environmental violations. We use the natural logarithm of total assets as a proxy for firm size, along with a comprehensive set of lagged firm characteristics, to create the propensity scores for each firm. The rationale behind selecting these variables is based on two reasons. First, a firm's size is a well-established factor for environment-related decision making and financial outcomes, so taking it into account reduces bias. Second, matching firms in the same industry and quarter accounts for similar market competition, regulatory policies and macroeconomic conditions. By forming a matched set along these lines, we improve the internal validity of the analysis and distinguish the impact of environmental violations from confounding firms and industry-level factors. After performing the analysis in Stata 19 using nearest neighbour matching with one neighbour, we retain only those control firms that have positive weights assigned by the *psmatch2* algorithm. Following this step, we have a total number of 131,835 firm-quarter observations. However, we use the forward $(t+1)$ R&D spending for the analysis. Hence, we have a total number of 117,112 firm-quarter observations in our analysis and all regressions are estimated on the matched sample.

3.2 | Endogeneity Correction

Our independent variable is environmental misconduct measured by the penalty amount, which can be influenced by unobserved firm-related factors. Hence, there may be an endogeneity issue in our analysis. To address this concern, we use the Gaussian copula correction method (Park and Gupta 2012). The Gaussian copula method offers a semi-parametric way to address endogeneity without relying on external instrumental

variables, which are usually difficult to validate in environmental misconduct scenarios. We estimate an auxiliary regression for environmental misconduct using lagged environmental misconduct, firm size, industry and quarter fixed effects to create the Gaussian copula term for our analysis. We first use the equation below for obtaining the residuals:

$$Environmental\ Misconduct_{it} = \pi_0 + \pi_1 * Environmental\ Misconduct_{i(t-1)} + \pi_2 * \lambda_{i(t-1)} + \eta_{it} \quad (1)$$

where $\lambda_{i(t-1)}$ represents control variables (firm size, industry and quarter fixed effects) for the auxiliary regression. The auxiliary regression shows that all independent variables are very good predictor of environmental misconduct ($p < 0.05$), and the model accounts for a substantial variation in the dependent variable. The residual values obtained from Equation (1) are transformed into the Gaussian copula term ($\widehat{G(EM)}_{it}$) and included in the primary analysis. Thus, we address the endogeneity concern using this Gaussian copula term.

3.3 | Variables

3.3.1 | Dependent Variable

We use the ratio of firms' R&D expenditure to sales as a proxy for R&D spending. This ratio is widely regarded as the most reliable proxy for R&D spending (Mirza and Ahsan 2020; Resutek 2022). We cannot consider the absolute values of R&D spending because this investment may differ according to the size of organisations. Standardising R&D expenditures by sales accounts for differences in firm size and delivers a uniform measure for the analysis. This provides a meaningful metric for assessing how much firms commit resources to developing new knowledge and technologies relative to their economic performance.

3.3.2 | Independent Variable

We use the penalty amount imposed by the authorities on firms as a proxy for environmental misconduct. We know that environmental violations can be different in different areas, like air, water and waste pollution. However, in our dataset, these types of offences are almost evenly spread out, and the penalties do not change much between these groups. In other words, the type of violation or the level of severity does not cause differences in the levels of fines or the results for firms. Because there is not much variation, adding the type or severity of the offence would not change the construct or the meaning of our results. So, we keep the penalty amount as the main and most useful sign of environmental wrongdoing. We use a natural log transformation of the penalty amount to reduce the influence of extreme outliers and make the distribution more symmetric (Chakrabarty et al. 2024). Additionally, it enables us to view penalties in relative terms rather than absolute amounts, consistent with how companies perceive the impact of violations. Applying a log transformation helps us in comparing firms of different sizes, which enables the log of the penalty measure to be a more reliable proxy for environmental violations.

3.3.3 | Moderating Variables

We use the ratio of selling, general and administrative expenses to sales as a proxy for organisational slack. A higher SG&A-to-sales ratio indicates a larger pool of easily reallocated resources, indicating the availability of organisational slack. Prior studies also operationalise the same measure as slack resources in the context of innovation and performance (Kim and Bettis 2014). Although there are several ways to measure slack (Bourgeois 1981), the SG&A-to-sales ratio is the optimal way to measure organisational slack in this case because it shows how easily managers can move around discretionary operating resources after environmental misconduct. SG&A-based slack is different from liquidity or equity-based measures, and it shows the flexible budgetary capacity that directly helps R&D stability and recovery. We use the ratio of costs of goods sold to average inventory as a proxy for the inventory turnover ratio. This is a common metric used for the inventory turnover ratio, which measures how efficiently firms transform inventory into sales (Gaur and Kesavan 2008). We use return on assets (ROA) as a proxy for financial efficiency by dividing firms' net income by total assets (Houqe et al. 2024; Liu and Kong 2021). The ROA measure normalises income relative to firm size, which allows us to compare this metric across firms. We calculate the Herfindahl–Hirschman Index (HHI) with respect to firm sales and SIC codes within each industry quarter to measure market concentration. Using sales as a foundation of firms' market shares offers a direct economic indicator of a firm's market presence, aligning with previous studies in economics and strategy (Naldi and Flamini 2018).

3.3.4 | Control Variables

We add a share issuance variable, which is measured as the fractional change in common shares outstanding (Pontiff and Woodgate 2008). Firms can raise capital by issuing new shares and expand the pool of resources available for innovation. We include the debt ratio calculated by dividing total debt by total assets (Malshe and Agarwal 2015). A high debt level may constrain the resource allocation to R&D spending. We include the liquidity ratio, measured as the ratio of total current assets to total liabilities (Sun and Price 2016). A high liquidity ratio suggests that firms have additional resources to allocate to long-term investments like R&D spending. These are the control variables we included in our analysis. We use winsorisation at the 1st and 99th percentiles for all non-binary variables to reduce the influence of outliers, which can affect our analysis (Ahsan et al. 2023). The process of winsorisation replaces the extreme values with the 1st and 99th percentiles cutoff values (Sraer and Thesmar 2023). Hence, the datapoints are not removed, and the overall sample size is preserved.

3.4 | Statistical Method

We use a high-dimensional fixed-effects method for estimation due to the longitudinal nature of the dataset. This method

absorbs firm and time-level fixed effects and accounts for unobserved heterogeneity across firms over time. The high-dimensional fixed-effects model is superior to the traditional fixed-effects method due to its computational efficiency and is widely acknowledged as an optimal method for handling complex panel data with multiple levels of fixed effects (Guimaraes and Portugal 2010). This method ensures that our estimates remain free from bias caused by unobserved firm-specific or time-based variables. The iterative algorithm of the high-dimensional fixed-effects partials out the variation due to fixed effects, and the regression is run on the residual variation of independent variables.

We use the following equation for estimation:

$$\begin{aligned} R\&D\ Spending_{i(t+1)} = {} & \delta_0 + \delta_1 * Environmental\ Misconduct_{it} + \delta_2 * Environmental\ Misconduct_{it} * Organisational\ Slack_{it} \\ & + \delta_3 * Environmental\ Misconduct_{it} * Inventory\ Turnover_{it} + \delta_4 * Environmental\ Misconduct_{it} * Financial\ Efficiency_{it} \\ & + \delta_5 * Environmental\ Misconduct_{it} * Market\ Concentration_{it} + \delta_6 * Organisational\ Slack_{it} + \delta_7 * Inventory\ Turnover_{it} \\ & + \delta_8 * Financial\ Efficiency_{it} + \delta_9 * Market\ Concentration_{it} + \delta_{10} * Share\ Issuance_{it} + \delta_{11} * Debt\ Ratio_{it} \\ & + \delta_{12} * Liquidity\ Ratio_{it} + \delta_{13} * \widehat{G(EM)}_{it} + \varepsilon \end{aligned} \quad (2)$$

We analyse the dataset using Equation (2) and present our results in the next section.

4 | Results

4.1 | Descriptive Statistics

Table 1 shows the operationalisation of the variables we use for the analysis. The first column suggests the list of constructs we use in the conceptual framework. The second specifies how each variable is measured. The third column identifies the data sources, which are primarily Compustat and Violation Tracker. Table 2 reports the correlation matrix and descriptive statistics

TABLE 1 | Operationalisation of variables.

Variables	Measure	Data source
R&D Spending	Ratio of R&D spending to sales	Compustat
Environmental Misconduct	Natural log of the penalty amount	Violation Tracker
Organisational Slack	Ratio of selling, general and administrative expenses to sales	Compustat
Inventory Turnover	Ratio of costs of goods sold to average inventory	Compustat
Financial Efficiency	Return on assets (ROA)	Compustat
Market Concentration	Herfindahl index	Compustat
Share Issuance	Fractional change in common shares outstanding	Compustat
Debt Ratio	Ratio of total debt to total assets	Compustat
Liquidity Ratio	Ratio of total current assets to total liabilities	Compustat

TABLE 2 | Correlation and descriptive statistics (*$p < 0.01$).

		1	2	3	4	5	6	7	8	9
1	R&D Spending	1.00								
2	Environmental Misconduct	−0.07*	1.00							
3	Organisational Slack	0.34*	−0.05	1.00						
4	Inventory Turnover	−0.03	0.11*	−0.07*	1.00					
5	Financial Efficiency	−0.01	−0.02	−0.01	0.04	1.00				
6	Market Concentration	0.24*	0.06	0.15*	0.08*	−0.01	1.00			
7	Share Issuance	0.08	−0.01	0.07*	−0.01	0.01	−0.02	1.00		
8	Debt Ratio	−0.12*	0.17*	−0.01	0.26*	0.02*	0.07*	0.03	1.00	
9	Liquidity Ratio	0.29*	−0.05	0.12*	−0.04	−0.01	0.02*	0.06*	−0.16*	1.00
	Mean	0.62	1.84	0.55	2.55	0.77	0.32	0.12	0.42	2.31
	SD	0.22	0.35	0.28	1.37	0.19	0.22	0.09	0.41	2.09
	Sample Size	117,112	117,112	117,112	117,112	117,112	117,112	117,112	117,112	117,112

of the variables present in Table 1. The significant correlations are marked by an asterisk (*), and the level of significance is at 1% level. The means, standard deviations and sample size are also reported at the end of the table.

4.2 | Main Results

We run the model given in Equation (2) and report the results in Table 3. Model 1 shows the high-dimensional fixed-effect regression of R&D spending on environmental misconduct, along with fixed effects and a Gaussian Copula term. Model 2 includes all control variables present in the study. Model 3 presents our original results for supporting the hypotheses. We discuss the results with respect to each hypothesis.

4.2.1 | Empirical Support for H1

The coefficient of environmental misconduct is positive and significant ($\delta = 0.08$, $p < 0.01$). To assess economic significance, we also calculate the effect of a one-standard deviation increase in environmental misconduct. We find that a one-standard deviation increase in environmental misconduct leads to a 7.6% increase in R&D intensity, suggesting a substantial rise in the investment for R&D. Hence, H1 is supported. Therefore, firms engaged in environmental misconduct increase their R&D spending.

4.2.2 | Empirical Support for H2

The coefficient of the interaction of environmental misconduct and organisational slack is negative and significant ($\delta = -0.04$, $p < 0.01$). Hence, H2 is supported. Thus, enhanced organisational slack reduces the influence of environmental misconduct on R&D spending.

4.2.3 | Empirical Support for H3

The coefficient of the interaction of environmental misconduct and inventory turnover is negative and significant ($\delta = -0.04$, $p < 0.05$). Hence, H3 is supported. Thus, a high inventory turnover ratio diminishes the effect of environmental misconduct on R&D spending.

4.2.4 | Empirical Support for H4

The coefficient of the interaction of environmental misconduct and financial efficiency is negative and significant ($\delta = -0.25$,

TABLE 3 | Main results, DV: R&D spending.

Independent variables	Model 1	Model 2	Model 3
Environmental Misconduct	0.003** (0.001)	0.004*** (0.001)	0.08*** (0.01)
Environmental Misconduct * Organisational Slack			−0.04*** (0.01)
Environmental Misconduct * Inventory Turnover			−0.04** (0.02)
Environmental Misconduct * Financial Efficiency			−0.25*** (0.08)
Environmental Misconduct * Market Concentration			−0.27*** (0.03)
Organisational Slack		0.75*** (0.07)	0.76*** (0.07)
Inventory Turnover		0.11*** (0.02)	0.11*** (0.02)
Financial Efficiency		0.002 (0.01)	0.002 (0.01)
Market Concentration		3.51*** (0.12)	3.53*** (0.21)
Share Issuance		0.54*** (0.14)	0.55*** (0.13)
Debt Ratio		−0.02 (0.09)	−0.02 (0.08)
Liquidity Ratio		0.15*** (0.02)	0.15*** (0.02)
Gaussian Copula Term	0.50*** (0.02)	0.45*** (0.02)	0.45*** (0.02)
Firm fixed effects	Present	Present	Present
Time fixed effects	Present	Present	Present
R^2	0.64	0.66	0.66
_cons	1.61*** (0.03)	−0.02 (0.09)	−0.03 (0.10)

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

$p < 0.01$). Hence, H4 is supported. Thus, an improvement in financial efficiency reduces the impact of environmental misconduct on R&D spending.

4.2.5 | Empirical Support for H5

The coefficient of the interaction of environmental misconduct and market concentration is negative and significant ($\delta = -0.27$, $p < 0.01$). Hence, H5 is supported. Thus, higher market concentration levels buffer the influence of environmental misconduct on R&D spending.

In this way, all of our hypotheses are supported. The high value of R^2 suggests the explanatory power of firms and time absorbed effects. The firm and time dummies also explained the variation in R&D spending. However, we report the overall R^2 in Table 3. The value of R^2 is 0.66, suggesting that our independent, moderating and control variables explain 66% of the variation in R&D spending. We made all of the moderation plots by finding the predicted values of the R&D spending at one standard deviation below and above the mean of each moderator (Figure 2).

4.3 | Robustness Checks and Additional Analyses

4.3.1 | Alternative Estimation Methods

We utilise a high-dimensional fixed-effects model as a primary analysis to support our hypotheses. The fixed-effects model is optimal to address unobserved heterogeneity with respect to firms and time. However, we employed other estimating methodologies to validate the robustness of our findings. First, we use a random effects model, which assumes that explanatory variables are not associated with unobserved individual effects (Yang 2022). We also use the traditional OLS (ordinary least squares) method to re-estimate our models. The results of these alternate estimations are shown in Table 4. Model 1 shows the results of the random effects model. Two of our hypotheses are not supported. Model 2 suggests the results of OLS estimation. One of the hypotheses is not supported. The variation in hypothesis support among models probably stems from the different methods employed to address unobserved heterogeneity and variable correlation. Our primary high-dimensional fixed-effects model addresses the issues related to unobserved firm-specific and time-specific characteristics. Hence, the omitted

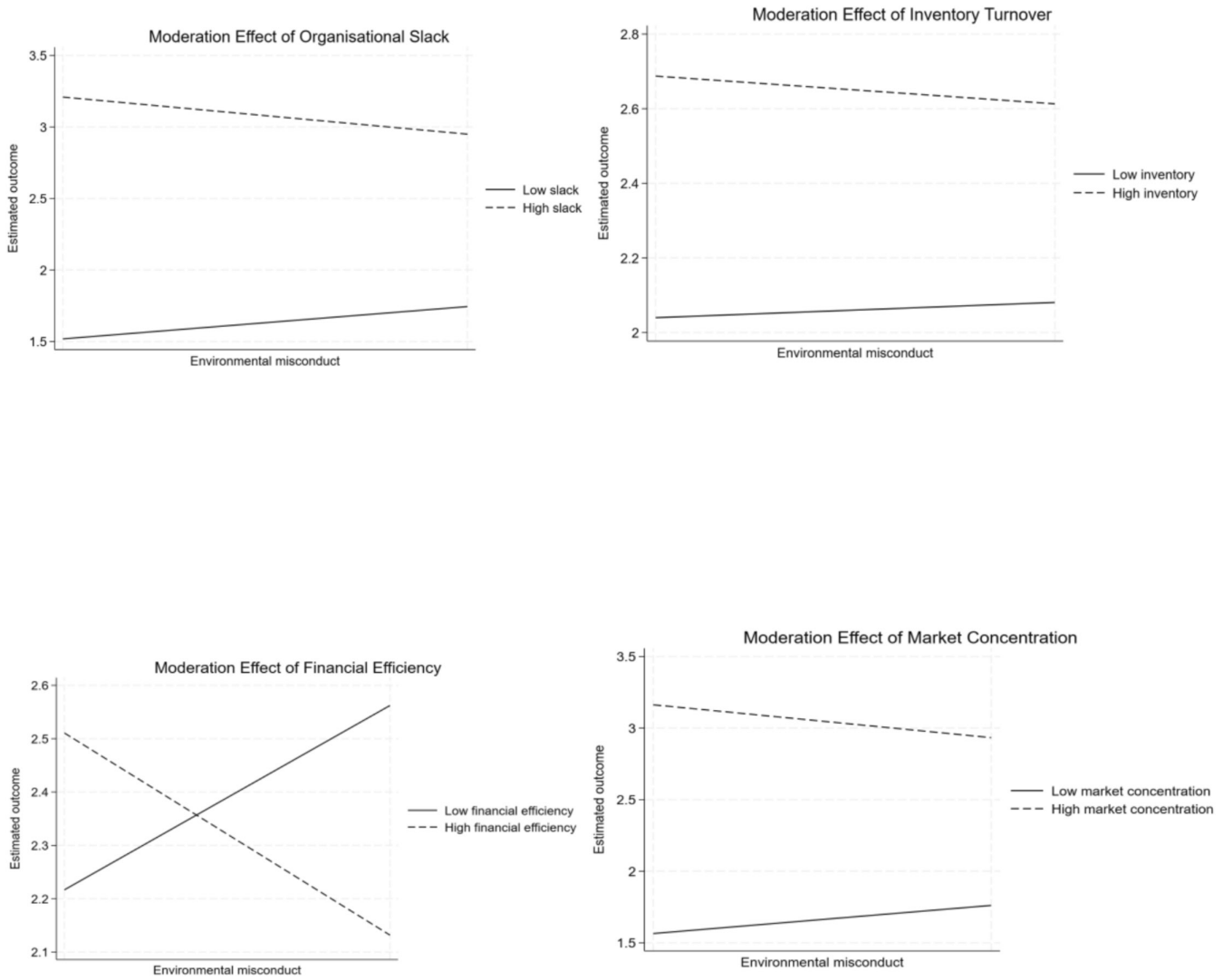

FIGURE 2 | Interaction plots.

TABLE 4 | Robustness tests.

Independent variables	Model 1: Random effects model	Model 2: OLS	Model 3: Additional control variables
Environmental Misconduct	0.09*** (0.02)	0.10*** (0.03)	0.08*** (0.007)
Environmental Misconduct * Organisational Slack	−0.05 (0.03)	−0.09** (0.04)	−0.04*** (0.01)
Environmental Misconduct * Inventory Turnover	−0.05** (0.02)	−0.08*** (0.02)	−0.04** (0.02)
Environmental Misconduct * Financial Efficiency	−0.03 (0.42)	−0.58 (0.54)	−0.17** (0.07)
Environmental Misconduct * Market Concentration	−0.32*** (0.08)	−0.55*** (0.10)	−0.28*** (0.02)
Organisational Slack	0.84*** (0.02)	1.15*** (0.02)	0.75*** (0.06)
Inventory Turnover	0.04*** (0.002)	0.04*** (0.01)	0.11*** (0.01)
Financial Efficiency	0.002 (0.01)	0.01 (0.01)	0.003 (0.005)
Market Concentration	3.67*** (0.07)	5.14*** (0.08)	3.52*** (0.21)
Share Issuance	0.76*** (0.10)	2.42*** (0.12)	0.57*** (0.14)
Debt Ratio	−0.06 (0.04)	−1.38*** (0.03)	0.12 (0.08)
Liquidity Ratio	0.23*** (0.01)	0.42*** (0.01)	0.16*** (0.02)
GDP Growth			−0.02* (0.01)
Inflation Rate			0.07*** (0.01)
CEO Experience			0.002 (0.02)
TMT Size			−0.003 (0.02)
Gaussian Copula Term	0.49*** (0.004)	0.83*** (0.005)	0.45*** (0.02)
Firm fixed effects			Present
Time fixed effects			Present
R^2	0.36	0.38	0.67
_cons	0.02 (0.05)	−1.07*** (0.03)	−0.30** (0.12)

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

variable bias is mitigated. However, the random effects and OLS models do not consider the impact of unobserved factors on the regressors. This breach of assumption may be the possible reason for the loss of statistical significance for certain hypotheses in these alternative models.

4.3.2 | Additional Control Variables

Our analysis may be affected by larger macroeconomic factors. For instance, an increase in inflation may prompt firms to pay more for inputs and operational activities, thereby affecting their R&D allocation. Similarly, a country's GDP growth encourages investors to allocate more capital to new ideas. To consider these contextual elements, we collect yearly GDP growth and inflation rates from the World Bank's website for the US spanning 25 years (Balk et al. 2022). We merge these variables with our firm-level dataset to account for these variables in our empirical analysis. Another probable element that could affect our study is the traits of executives. For example, CEOs with more experience may formulate an optimal strategy associated with R&D allocation. Additionally, the size of the top management team (TMT) influences the decision-making during environmental misconduct. Therefore, we collect the data of CEO experience and size of TMT from the ExecuComp dataset for the duration of 25 years and merge the same with our original dataset to address these concerns. We again run our analysis, and the results are reported in Table 4 (Model 3). We find that these additional factors do not dominate our results, and all of the hypotheses are supported.

4.4 | Multicollinearity and Heteroskedasticity

The mean variance inflation factor is 3.22, which is less than 10. The mean value of VIF suggests that multicollinearity is not a concern in the analysis. Thus, our estimated coefficients

are more reliable because the explanatory variables are less correlated. We use robust standard errors clustered at the firm level to account for unobserved heterogeneity that could distort results. Hence, our model reduces the likelihood of Type I and Type II errors by addressing heteroskedasticity and reducing multicollinearity. The corrective measures we implement enhance the accuracy of the statistical inference. The coefficient of the Gaussian copula term (Table 3, Model 3) used in the main model is positive and significant ($\delta = 0.45$, $p < 0.01$). The significance of the term indicates the endogeneity in the base model. However, we add the Gaussian copula term in the analysis, which addresses the potential bias. Hence, our estimated effects of the explanatory variables are more reliable and consistent.

4.5 | Assessing Robustness to Omitted Variable Bias

One possible concern could be related to the opposite signs of correlation and beta coefficients between environmental misconduct and R&D intensity. One of the possible reasons is the incorporation of firm- and quarter-fixed effects in the regression model, which provides a positive beta coefficient of firms' environmental misconduct in the analysis. However, another possibility could be the omitted variable bias. The basic correlation coefficient does not account for this bias. There are several factors that can contribute to the analysis, and it is crucial to include those factors. By controlling for these attributes using firm and time fixed effects, a previously concealed positive relationship may be uncovered, obscured by negative cross-sectional heterogeneity. We use Oster's (2019) method to evaluate the robustness of the positive association against unobserved confounding variables. Oster's δ (delta) estimates how strong the selection on unobservables needs to be compared with the selection on observables to make the coefficient zero. The delta values for the main effect and interactions are presented in Table 5. The estimated δ values range from 0.60 to 4.08. The main effect and three interactions have delta values greater than 1, which suggests that the unobservables are least influential as the observed controls and less likely to overturn the positive coefficient. However, the delta value of the interaction of environmental misconduct and inventory turnover is less than 1, which suggests modest exposure to potential omitted-variable effects.

TABLE 5 | Oster δ estimates assessing the stability of regression coefficients.

Variable	Delta (δ)
Environmental Misconduct	3.18
Environmental Misconduct * Organisational Slack	4.08
Environmental Misconduct * Inventory Turnover	0.60
Environmental Misconduct * Financial Efficiency	2.78
Environmental Misconduct * Market Concentration	3.47

That said, the value of delta is greater than 0.5, and by looking at the other delta values, we can say that there is less possibility of omitted variable bias in our analysis. Hence, the Oster δ analysis provides a validation that our results are robust to plausible degrees of unobserved heterogeneity.

5 | Discussion and Conclusion

5.1 | Discussion of Results

This research investigates the impact of environmental misconduct on firms' R&D spending and how resource and industry-based moderators can influence this relationship. By integrating legitimacy theory with resource-based and industry-based perspectives, we enrich the understanding of corporate misconduct, innovation strategy and organisational legitimacy in the literature. Our results reliably indicate that environmental misconduct prompts firms to increase R&D expenditure to recover legitimacy and restore stakeholder confidence. At the same time, the influence of environmental misconduct on R&D spending is reduced when firms have higher levels of organisational slack, inventory turnover, financial efficiency and market concentration.

Our first hypothesis suggested that firms committing environmental misconduct increase their R&D spending. The results validate this expectation, as environmental violations are significantly and positively linked to higher R&D investments. This result aligns with legitimacy theory, suggesting that firms under regulatory, customer or stakeholder scrutiny adopt measures to repair their legitimacy (Suchman 1995). The prior studies suggest that greenwashing strategies would be better initiatives after the violation (Lyon and Maxwell 2011). However, we provide evidence of increasing R&D spending as another alternative strategy. This finding diverges from prior studies that questioned the sincerity of corporate actions following misconduct. For instance, Pizzetti et al. (2021) contend that companies often use greenwashing tactics that fall short of impactful changes. In contrast, our results indicate that firms should introduce innovative, eco-friendly products rather than symbolic responses when involved in environmental violations. This is especially critical in cases of environmental misconduct, where stakeholders seek genuine technological solutions instead of superficial rhetoric (Berrone et al. 2017).

We find that a high level of organisational slack reduces the influence of environmental misconduct on R&D spending. This finding contributes to the literature in two ways. First, it is consistent with the resource-based theory (Barney 1991), which regard slack as a protective layer allowing businesses to withstand shocks. However, slack resources appear to insulate companies from the demand to escalate innovation spending after environmental misconduct rather than promoting R&D. This suggests that firms with high organisational slack resources can rely on their reputational reserves. Second, though prior researchers suggest that organisational slack encourages innovation (Chen and Miller 2007), we provide an additional insight in the context of environmental misconduct. Slack resources mitigate the push to invest in R&D spending during environmental misconduct. This variation highlights the fact that organisational slack can be channelised to absorb the reputational damage when legitimacy is jeopardised.

Hypothesis 3 predicted that an increase in the inventory turnover would reduce the impact of environmental misconduct on R&D spending. The findings confirm this, indicating that efficient inventory management creates operational legitimacy and reassures stakeholders even after violations. This aligns with prior research suggesting that operational efficiency builds trust and reduces reputational damage (Hendricks and Singhal 2005). Our findings improve upon Barinov (2014), who showed that high inventory turnover reflects financial flexibility. We extend beyond this finding and suggest that operational performance reduces the reputational damage during environmental misconduct. By quickly converting inventory into sales, firms generate liquidity and credibility, which lessens the need to drastically adjust R&D spending to address legitimacy concerns. Thus, our study provides evidence that operational excellence can substitute for reactive innovation spending after misconduct.

Hypothesis 4 argues that financial efficiency weakens the positive relationship between misconduct and R&D spending. Our empirical results also support the hypothesis. Financially efficient firms may bring stronger returns during the time of environmental misconduct and are perceived as competent and resilient by the stakeholders. This complements findings by Ecer et al. (2017), who suggested the positive role of financial efficiency in sustaining long-term innovation. Our study expands their perspective by showing that efficiency supports innovation as well as buffers reputational shocks. A financially efficient firm does not depend on R&D spending to restore legitimacy at the time of environmental misconduct compared with a financially weaker firm. Instead, their strong financial performance itself signals credibility and stability. This insight also diverges from Li and Tang (2010), who suggested that financially constrained firms may cut R&D after negative events. Our findings indicate that financial efficiency diminishes the pressure to increase R&D spending, which demonstrates that financial efficiency moderates the legitimacy-restoring function of innovation.

H5 suggests that a high market concentration moderates the relationship between environmental misconduct and R&D spending. The results support this prediction. Firms in a high-concentration market attain a reasonable market power, which allows them to face less pressure to signal commitment through innovation during environmental misconduct. This finding supports prior research, which suggests that firms in oligopolistic markets are protected from stakeholder inspection (Karuna 2007). It also aligns with DellaVigna et al. (2016), who suggested that dominant firms are involved in lobbying and CSR activities to deflect reputational damage. However, our results extend this literature by empirically showing that firms with high market power do not need to increase R&D spending significantly after misconduct, unlike firms in competitive markets. Compared with Yalabik and Fairchild (2011), who showed that customers often shift away from polluting firms, our study highlights that this effect is weaker in concentrated industries. Firms in the concentrated market can effectively manage reputational risks without shifting substantial assets to R&D and preserve stakeholder trust even after the environmental misconduct.

5.2 | Methodological Contributions

Beyond the substantive results, our study makes an important methodological contribution by employing a Gaussian copula correction to address endogeneity. Prior researchers mainly use the instrumental variable approach to address endogeneity in the context of R&D investment (Aghion et al. 2013; Czarnitzki and Hottenrott 2011). However, the identification of a valid instrument is challenging because it could be either weak or fail the exclusion restriction. To overcome this challenge, we adopt the Gaussian copula method proposed by Park and Gupta (2012). This approach allows us to correct for endogeneity without strictly following the assumptions of exclusion restrictions. The significance of the Gaussian copula term suggests that there could be endogeneity in our analysis. We provide more reliable estimates of the relationship between environmental misconduct and R&D investment by including a copula term in the analysis. This methodological rigour provides novelty to our work from prior studies and strengthens the robustness of our findings. With the use of a large longitudinal panel from Violation Tracker and Compustat databases, we are able to capture a comprehensive view of environmental misconduct alongside detailed firm-level financial and innovation indicators. This integration enables us to move beyond narrower datasets or self-reported measures of sustainability that have characterised much of the prior literature (Clarkson et al. 2008). Importantly, the use of government-verified violation data minimises self-reporting bias and enhances the validity of our misconduct construct. In doing so, our study provides a more rigorous empirical foundation for examining how firms strategically adjust R&D behaviour in response to misconduct.

5.3 | Theoretical Contributions

Our results enhance the development of legitimacy theory by showing that R&D investment strategies differ across companies depending on situational factors during environmental misconduct. The prior literature mainly focused on symbolic actions associated with greenwashing or lobbying after the ethical violations. While these symbolic strategies play an important role, our results show that firms may also adopt substantive strategies, particularly through adjustments in their R&D spending. Essentially, these strategies are determined by resource and industry-based conditions. Firms with greater financial capabilities are better positioned to undertake corrective innovation, whereas firms facing constraints may be unable to do so. This holistic approach provides new avenues to legitimacy theory by suggesting that R&D spending could be another alternative to restore stakeholders' confidence. Prior research has emphasised the negative outcomes of ethical violations and firm innovation (Xie et al. 2019). Our research also aligns with this literature and indicates that environmental misconduct may increase firms' R&D spending when used as a corrective mechanism. This implies that environmental misconduct may be harmful to firms' reputation, but it may simultaneously trigger firms to demonstrate their long-term commitment to stakeholders through enhanced innovation efforts. Such remedial innovation functions as a robust signal of responsibility and complements symbolic strategies. Environmental misconduct may bring reputational

damage, but it also serves as a potential catalyst for innovation. Finally, our results have meaningful implications for stakeholder theory. Stakeholder theory proposes that firms should align their goals with stakeholders' interests (Freeman 2010). We provide evidence that stakeholders' reactions to environmental misconduct depend on firm resources and industry concentration. In highly concentrated industries, dominant firms benefit from structural legitimacy and have less pressure to increase R&D investment, even after misconduct. However, firms with less market power are more likely to adopt corrective innovation strategies in response to environmental misconduct to restore their reputation. These findings provide additional insights to researchers by suggesting that firm and market-related factors influence the relationship between environmental misconduct and innovation. We provide an enhanced understanding of how firms strategically navigate legitimacy-threatening events in the eyes of their stakeholders.

5.4 | Practical Implications

Our findings have various implications for managers and policymakers regarding environmental misconduct. One of the important aspects of our study is that environmental violations should not be interpreted as a liability. Instead, they can be transformed into opportunities for firms to demonstrate a genuine commitment to innovation and sustainability. Our evidence indicates that stakeholders respond positively when firms back their promises with substantive corrective action, such as investing in eco-innovation. This is particularly relevant in light of research that warns against the limits of symbolic actions like greenwashing. Stakeholders increasingly demand genuine technological solutions to environmental problems. Managers should realise that R&D spending can rebuild stakeholders' trust after the environmental violation. Our findings highlight the contingent role of organisational resources. Firms with high organisational slack mitigate the pressure to increase R&D in response to misconduct. Managers should recognise that organisational slack complements innovation-based legitimacy repair after environmental misconduct. Similarly, high inventory turnover and financial efficiency reduce the pressure to escalate R&D spending. Managers should formulate strategies focusing on long-term sustainability that align with the expectations of stakeholders. They should strategically allocate resources to operational and financial efficiencies with visible innovation commitments. Our findings suggest that the dominant firms rely on lobbying or CSR campaigns to manage reputational threats and feel less pressure to increase R&D after misconduct. While this provides temporary protection, managers must recognise the growing influence of regulators and activist groups, who may push dominant firms to go beyond symbolic actions. However, firms operating in competitive markets should work on R&D strategies in order to retain stakeholders' trust. Managers in such contexts must be prepared to respond with substantive R&D investments to avoid customer defection. Managers should learn to balance between symbolic and substantive responses. While public communication and CSR disclosures remain relevant tools, relying solely on symbolic responses may lead to further reputational damage. Managers should therefore combine symbolic strategies with substantive investments in R&D. For instance, managers can launch CSR campaigns, including green innovation, to ensure that communication aligns with concrete actions. Campaigns of these types can maximise legitimacy in the long term.

Our findings raise important concerns about fairness and accountability in environmental governance. Policymakers should carefully examine the symbolic actions of dominant firms in concentrated industries because they have less pressure from stakeholders. The environmental misconduct can be reduced through increasing transparency in R&D spending after breaches. Policymakers should implement measures that require more transparent reporting of R&D allocation after the environmental misconduct to ensure genuine corrective innovation rather than mere symbolic changes. Furthermore, policies can be designed to encourage proactive innovation even before violations occur. For instance, they can provide tax incentives or innovation grants along with green innovation to consider long-term sustainability more deeply in their strategies. Our models show that when companies do something wrong, they respond by shifting resources towards innovation. Regulatory authorities should tie targeted incentives, like tax credits, to encourage preventive investment. Regulators may start industry-level benchmarking for green innovation and ensure that dominant firms also follow those initiatives. Policymakers can implement rules against overreliance on greenwashing and promote substantive innovation by aligning incentives with stakeholder expectations. Managers should perceive environmental misconduct as a significant event in determining corporate strategy. They should focus more on those actions that are aligned with stakeholders' interests. They should avoid symbolic responses because stakeholders increasingly reward authenticity and penalise opportunism. Managers should view environmental misconduct as a catalyst to rebuild innovation systems, which can bring legitimacy and long-term advantage.

5.5 | Multi-Level Implications for Firms

Our findings have nuanced implications for firms at the micro-, meso- and macro-levels. By situating the results of environmental misconduct and subsequent R&D adjustments within these levels of analysis, we can provide more fine-grained insights for corporate strategy, governance and industry evolution. This three-level approach allows businesses to predict stakeholder needs, manage risks to their legitimacy and leverage misconduct into moments for strategic progress.

5.5.1 | Micro-Level Implications

The research supports the strategic decision-making to tackle environmental misconduct at the micro-level. Environmental violations provide opportunities for firms to reconfigure their internal capabilities. In the first hypothesis, we propose that R&D spending can be a vehicle for legitimacy repair, and firms should recognise that misconduct events provide unique opportunities for reorganising knowledge and improving abilities, enabling firms to stay competitive. They can establish dedicated innovation cross-functional teams to incorporate eco-friendly regulations into product creation cycles swiftly. These teams would work on fixing issues while also identifying emerging

opportunities in sustainable markets. We also suggest incorporating environmental risks into the core of strategic planning systems. The environmental misconduct demonstrates the interdependence of compliance and innovation and indicates that their integration for environmental considerations can enhance anticipatory governance. Tools such as scenario analysis, environmental audits and predictive analytics should be institutionalised to prevent misconduct and to prepare rapid innovation responses if breaches occur. The environmental misconduct should also be seen as a determinant of cultural shifts in organisations. A high level of organisational slack could be helpful for firms during the misconduct, but firms should also continue to invest in green technologies for long-term sustainability. Firms should manage their slack not only on defensive strategies but also on green innovation. These innovative strategies, such as promoting green innovation and rewarding sustainability champions, enhance a firm's resilience and strengthen its authenticity. The Volkswagen Dieselgate scandal, for instance, shows how weak internal controls and a lack of forward-looking governance can lead to problems with legitimacy around the world (Kano et al. 2023). Large firms (like Volkswagen), which are involved in diverse opportunities using technological adoption, should be able to respond with major changes to their R&D instead of just symbolic actions. On the other hand, smaller companies with limited R&D resources may be better off using targeted symbolic or process-oriented fixes.

5.5.2 | Meso-Level Implications

At the meso-level, our research shows that the way industries are organised and relationships between organisations shape how firms regain trust. The objective of structural legitimacy is unreliable for firms in competitive industries, and they should use R&D spending for product differentiation. They can collaborate with other firms for green technologies or eco-innovation, which can help them retain their legitimacy. An active collaboration with industry partners signals to stakeholders that firms are pursuing systemic and corrective measures. Moreover, different levels of market concentrations suggest the uneven distribution of legitimacy pressures across industries. In the oligopolistic markets, firms can use symbolic actions like CSR campaigns or lobbying, but these actions would not work for all firms. Actions of dominant firms may affect the reputation of smaller firms as stakeholders perceive industry-level irresponsibility. Hence, the meso-level governance system should implement fair monitoring arrangements and mechanisms of equality in codes of conduct to ensure that corrective innovation is widely adopted.

Our findings' sector-level contributions also extend to logistics chains and partners in the broader ecosystem. Misconduct by a single company can send shockwaves to the close networks like suppliers, distributors and partners, who share reputational ties. This network system indicates that corrective actions should move beyond the single firms and extend to the whole supply chain system. Adoption of transparent solutions can minimise reputational harm and build stronger industry networks. We also explain that the impact of the negative news of environmental misconduct is amplified by stakeholder intermediaries such as NGOs, rating agencies and the media. These actors provide the information in a subjective manner. Hence, firms can use third-party verification in order to shape the narratives given in these intermediaries. They can also partner with environmental NGOs or communities, which can help them at the time of accusations of opportunistic greenwashing. The chemical industry's experience with DuPont's PFAS contamination is a good example at the meso-level (Cheremisinoff 2016). The case shows how damage to a company's reputation can spread to other companies in the same industry, bringing in suppliers and peers for more scrutiny. Industries with strong interdependencies, like chemicals, energy and pharmaceuticals, often have more pressure to respond to R&D requests in a meaningful way. On the other hand, companies in fragmented sectors may find that symbolic approaches are more common because the effects of spillover are weaker.

5.5.3 | Macro-Level Implications

At the macro-level, our research highlights that environmental violations are interrelated with societal expectations and industry norms simultaneously. Therefore, firms' strategy formulation for green technologies should contribute to the sustainability standards across the community. Such actions can shape the 'rules of the game' by elevating expectations of eco-innovation and embedding environmental performance as a competitive benchmark. One macro-level implication is the impact of violations on regulatory norms. Regulators often increase monitoring and environmental standards in response to environmental violations. Firms' spending on green technologies helps them follow those high standards and provides them with a high status in the industry. Thus, aligning actions with ethical standards during legitimacy-threatening events provides a strategic advantage to firms. Environmental misconduct also connects with evolving public perspectives on ecological responsibility. Different stakeholders expect authentic action for environmental crises. Firms can utilise the opportunity of misconduct to reposition themselves as more sustainable firms in society. This will bring a macro-level cultural shift toward sustainability and rebuild the damaged reputation over time. Furthermore, macro-level legitimacy is associated with regulatory frameworks at the global level. Multinational firms should follow global initiatives like the UN Sustainable Development Goals (SDGs) and align their innovation strategies accordingly. This alignment enhances legitimacy in global markets and builds a global reputation for firms. Firms should understand that misconduct can drive big-picture social learning at the macro-level. Violations of environmental standards highlight vulnerabilities in how goods are produced and consumed. Firms' response to substantive innovation shifts firms' defensive posture to one that drives forward the cause of environmental vitality.

6 | Conclusion

Our study shows that environmental misconduct increases firms' R&D spending, but the extent of this increase is moderated by organisational slack, inventory turnover, financial efficiency and market concentration. Companies' readiness and capacity to address legitimacy issues through innovation rely on their internal strengths and external industry structures.

By combining legitimacy theory with resource-based and industry perspectives, we highlight that innovation investments do more than patch up a company's image; it is a strategic way to restore stakeholder confidence while making the most of a company's strengths and industry environment. With a comprehensive dataset spanning multiple years, we can track how firms respond to misconduct dynamically, going beyond static views that might miss their adaptation efforts. We address the endogeneity concern using a Gaussian copula correction and incorporating industry-time fixed effects to strengthen causal inferences. These advanced-level statistical techniques increase the reliability of our findings and create a standard for future studies focused on environmental misconduct and restoring legitimacy. We contribute to this field by expanding legitimacy theory by suggesting that redirecting resources to innovation investments can help in restoring legitimacy. Our results enhance the resource-based view by showing how a firm's internal resources can also help in reducing pressure on R&D during challenging times. Our findings build on the industry-based perspective by showing how factors like market concentration influence the competitive pressures that push firms to invest in R&D. Our insights come together to create a richer understanding of how innovation prompted by misconduct is embedded in a system of organisational, financial and industry influences.

6.1 | Limitations and Future Research Directions

Our study has a few limitations which offer opportunities for future investigations. We rely on a secondary panel dataset to test how environmental misconduct leads to innovation. Our method is primarily quantitative. While our dataset helps us spot trends over time and avoid issues about short-term changes, it does not completely show the reasons, choices or strategic thinking behind firms' responses. Researchers can interview managers and executives to provide a clearer view of how external pressures and organisational dynamics affect resource allocation after misconduct. We use the dataset of US publicly traded companies, which is a consistent and transparent dataset because firms' annual financial statements are publicly available. Consequently, the reactions to environmental misconduct on R&D allocation may diverge from those of private enterprises because mandatory disclosure rules are different for privately held firms. Similarly, firms in other countries may face different cultural attitudes or regulatory pressures when it comes to environmental wrongdoing. Emerging markets may be more driven by local communities than by environmental rules. Researchers may collect multinational samples and conduct a comprehensive study across various ownership frameworks, institutional settings or cultural contexts. Our study mainly focuses on how companies respond internally, but it does not systematically consider the opinions of external stakeholders. Future work could use surveys to gather insights from diverse stakeholders like investors, regulators, customers, staff and community reps to understand their opinions on firms' corrective innovation efforts. Such surveys could reveal whether stakeholders view corrective innovation as sincere progress or as symbolic greenwashing. Grasping these perceptions is essential because the success of corrective innovations in repairing legitimacy needs acceptance. Finally, while we concentrate on total R&D expenditures as a holistic organisational response to environmental malfeasance, there could be various types of R&D investments. Researchers can categorise the R&D expenditures like green innovation, utility or design patents and identify the impact of environmental misconduct on these categories. This differentiation may yield enhanced understanding regarding whether companies' direct corrective investments are specifically towards sustainable technologies. Future research could include comprehensive green-innovation metrics to evaluate whether augmentations in R&D expenditure result in authentic sustainable innovation rather than mere adjustments in R&D practices.

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