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Does Corporate Social Responsibility Improve Firm-Level Energy Efficiency? The Case of the Iron and Steel Industries in India

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ABSTRACT

We investigate the impact of corporate social responsibility (CSR) on energy efficiency for the Iron and Steel Industries of India. Using firm-level data, the panel fixed effects regression model shows an inverse relationship between CSR and energy intensity, suggesting that a strategic firm's involvement in CSR increases energy efficiency. In addition, businesses with higher CSR spending tend to be more energy efficient; however, the association is not consistently observed across all profit-making CSR firms. Our findings at the disaggregate level suggest that firms that spend beyond the threshold levels experience a visible impact on energy efficiency. Further, CSR expenditure of R&D-intensive firms tends to have higher energy efficiency than their counterparts. We conclude that CSR plays a significant role in enhancing the energy efficiency of a socially and environmentally responsible firm. Thus, environmental sustainability should be one of the priority investment areas for CSR-driven firms in India.

1 | Introduction

Pollution and ecological concerns have gained international attention in recent decades. Environmental sustainability practices (ESP) have emerged as a key component in achieving sustainable business excellence as they address the long-term viability and ethical responsibility of businesses (Dubey et al. 2017). Environmental sustainability practices are driven mainly by companies adopting green technologies, green cultures, and pro-environmental behaviors (Hossain et al. 2024). Corporate social responsibility (CSR) initiatives play a significant role in supporting environmental sustainability practices by integrating a company's values and operations with the broader social and environmental needs of the communities (Lund-Thomsen et al. 2016). CSR is an organizational commitment that helps socially responsible firms and benefits society. The notion of corporate social responsibility has immense potential to transform business growth in this competitive era. Thus, a strategic firm must link organizational vision with CSR to achieve sustainable business performance.

India's economy is shifting toward a high-quality development stage due to the country's ongoing adoption of sustainable development policies. In this regard, energy efficiency improvement through CSR can be one of the ways to promote a high-quality growth path. Indian companies are not new to CSR; it has a long history in the form of corporate philanthropy. However, these days, firms are transitioning toward strategic CSR by engaging in social and environmental activities to gain a competitive advantage. Under the Companies Act 2013,[1] it is compulsory for Indian companies to be above a threshold. CSR has grown in prominence in India in recent years, providing opportunities for businesses to enter a new market segment requiring corporate responsiveness and

action instead of the more conventional areas of philanthropy and charity. In the beginning, corporations adopted CSR as a voluntary strategy. However, section 135 of the Companies Act 2013[1] mandated the requirement for CSR in India, which came into force on 1 April 2014. As per the guidelines, companies that reach a certain financial threshold must spend on specific CSR activities in a financial year. This new trademark addresses social and environmental issues, advancing technology and creating a sustainable economic path that promotes social progress and good governance (Mishra 2021). India's CSR regulations broadly define CSR spending as supporting the nation's social and environmental developmental goals. The policy bodies set the guidelines for the investment area to be considered as CSR expenditure. These include environmental responsibilities like environmental sustainability, maintaining ecological balance, and conserving natural resources, as well as social responsibilities like gender equality, inclusive education, and health care. Thus, India's CSR regulation is a component of the corporate sustainability drive. It aligns with the Sustainable Development Goals (SDGs) to tackle the social and environmental challenges (Mishra 2021). It further helps to attain sustainable economic growth. Moreover, as part of their corporate social responsibility, modern businesses use low-energy systems or environmental sustainability practices to reduce the negative environmental impact.

Indian firms have started realizing the role of energy cost reduction as one of the mechanisms to accomplish green business goals. At the same time, environmental sustainability-related expenses are the second highest priority among Indian firms (Poddar et al. 2019). From a resource-based perspective, CSR might benefit internally by improving firm capability, particularly in technological development and energy use. Achieving energy efficiency targets may motivate an energy-intensive firm to engage in CSR activities by utilizing upgraded technologies and better management practices. The contribution of the Iron and steel industry is significant. India's Iron and Steel sector accounts for around 2% of the country's GDP and is the second-largest crude steel producer after China.[2] In recent decades, the leading steel companies have started engaging in socially and environmentally responsible activities to improve their sustainability efforts: corporate image and economic gain. By implementing an energy and environmental management strategy, the Indian Steel industry substantially decreased its average carbon emission intensity, roughly 2.6 T/tcs in 2020, as opposed to 3.1 T/tcs in 2005[2]. Furthermore, environmentally conscious firms have also achieved energy-saving certification by reducing energy consumption and carbon emissions in industrial production.

CSR expenditure has increased consistently among India's steel companies over the last financial years. For instance, Tata Steel allocated Rs. 481 crores to its CSR activities in the financial year 2022–2023, and addressing climate change is one of the priority areas of investment.[3] The company is committed to lowering its carbon footprint across the production process and product life cycle. Tata Steel is paving the way for a sustainable supply chain through energy-efficient tools and technological advancement in production. Therefore, under the compulsory CSR regime, the overall CSR expenditure intensity of Indian firms has improved significantly, although the spending rate varies between voluntary and compulsory spenders (Bansal et al. 2018; Nair and Bhattacharyya 2019). CSR strategies are primarily driven by stakeholder pressure, environmental and sustainability challenges, tax relief, customer demand, brand image, and value transfer. Even though the horizon of CSR has expanded recently in India, studies have shown that there are still several obstacles to successful implementation, including a lack of monitoring and evaluation systems, poor strategies, lack of accountability, greenwashing, financial constraints, and political instability (Samantara and Dhawan 2020).

While existing literature extensively examines the impact of CSR activities on firm financial performance, limited studies have explored its environmental implications. In the context of emerging economies like India, a systematic analysis of the role of CSR practices on firm sustainability is scant. Although scholarly research on various dimensions of CSR continues to grow exponentially, the role of CSR practices on corporate energy efficiency and environmental sustainability is unexplored in emerging market contexts. There is voluminous literature on CSR and firm performance in the Indian context, yet none has made efforts to link it with energy efficiency. Given that ensuring energy efficiency is one of the vital aspects of a sustainable business, investment in CSR may assist a firm in saving energy costs. So, it would be an interesting area of research to link CSR and energy efficiency in an emerging market context, which is understudied. The empirical evidence from the recent studies includes whether corporate social responsibility performance can be translated into improved energy efficiency. Interestingly, scholars have given very little attention to incorporating environmental benefits within the CSR framework.

In light of these research gaps, we seek to analyze the impact of CSR performance on firm energy efficiency in an emerging market economy context using large-scale firm-level data. This is significant for the global response to climate change and India's seeking to implement its emission reduction strategy. Using data from the Centre for Monitoring Indian Economy (CMIE) prowess, we develop a conceptual model to investigate the potential links among study variables. Based on the pollution index score, which is a function of the amount of resource use, emissions, and hazardous waste generated, the Ministry of Environment, Forest and Climate Change (MoEFCC) has classified the industrial sector into four categories such as red category, orange category, green category, and white category. We focus on India's iron and steel sector (NIC three-digit Classification[4]), which is resource-intensive and a highly polluted or red category subsector in India's manufacturing sector. Due to its substantial impact, this research focuses on the iron and steel sector, encompassing challenges such as pollution control and resource efficiency.

The reminder for the paper is as follows. In Section 2, the research provides the literature studies on the link between CSR and environmental sustainability. Then, we focus on the development of research hypotheses. The following section provides the data and empirical tools. Then, the penultimate section describes the empirical findings and discussion of the results. Finally, the paper concludes with limitations, policy implications, and future directions.

2 | Literature Review and Hypothesis Development

The cost-saving potential of efficient energy consumption is positively associated with a firm's environmental sustainability concerning energy efficiency (Lundgren and Zhou 2017). However, Klassen and Whybark (1999) noted that environmental investments can improve ecological performance if a business has a successful management strategy. Without this, environmental technologies harm a company's profitability since they necessitate managerial effort and resources to be diverted from the core business (Walley and Whitehead 1994; Lui et al. 2021). In this regard, corporate social responsibility (CSR) may act as a useful mediating mechanism by incentivizing companies to allocate capital toward environmental sustainability to achieve energy efficiency gains.

2.1 | CSR and Environmental Sustainability: A Theoretical Background

A few theories have emerged to explain the relationship between corporate social responsibility and environmental sustainability. The idea starts with stakeholder theory, which focuses on stakeholders' value creation. The rationale behind the stakeholder theory is to hold companies accountable to all stakeholders involved. The theory suggests that companies should go beyond the economic objective of profit maximization by reducing their adverse effects on the environment. It addresses the social and environmental challenges by proactively engaging with stakeholders (Freeman 1994). The main goal of this approach is to adopt and operationalize sustainable development in a competitive business environment. According to the fundamental principle of the stakeholder approach, "firms should respond to pressures and demands from their stakeholders to achieve their strategic objectives" as they are players in the socio-environmental progress (Lozano et al. 2015).

For Indian manufacturing companies, achieving environmental sustainability is critical since stakeholders are putting growing pressure on businesses to adopt sustainable practices (Mathiyazhagan and Haq 2013; Mathivathanan et al. 2022). Mandatory CSR reporting often enhances stakeholder scrutiny and expectations, encouraging businesses to adopt proactive environmental initiatives as part of their strategic approach (Bauckloh et al. 2023). Environmental responsibilities result from stakeholders' pressure to incorporate sustainability practices into business operations (Delmas and Toffel 2004). Strategies that align with regulatory standards and stakeholders' expectations solve the external pressure and strengthen the company's credibility and stakeholders. Nowadays, investors are increasingly prioritizing sustainability in the company's decision-making. Good corporate reputations are highly influenced by CSR commitments and their interactions with key stakeholders such as employees, customers, and investors (Majoch et al. 2017). Environmentally responsible firms often attract socially responsible investments (SRI), encouraging them to enhance energy efficiency as part of their CSR strategies. Socially responsible investment (SRI) incorporates social and environmental goals into investment decisions (Camilleri and Camilleri 2017). Studies have also shown that firms with strong environmental CSR commitments experienced improved financial performance due to investor confidence and access to green financing (Ye and Dela 2023). CSR involvement benefits investors by reducing financial risk associated with environmental regulation and operational inefficiencies. Corporate environmental responsibility engagements help to reduce firm-level risk (Cai et al. 2016).

Furthermore, CSR components directly associated with a firm's primary stakeholders, such as employee relations, product characteristics, environment, and diversity, are more effective in reducing investment inefficiency than those with secondary stakeholders, such as human rights and community involvement (Benlemlih and Bitar 2018). From a regulatory perspective, the Companies Act of 2013 made CSR spending mandatory, directing firms to allocate a certain percentage of profit to sustainability initiatives, including environmental and energy-efficient practices. It may influence firms' CSR strategies by setting environmental standards and providing incentives for adopting energy-efficient technologies, which enhance compliance with sustainability policies.

Similarly, the Triple Bottom Line (TBL) paradigm of CSR stresses environmental sustainability by integrating environmental objectives with financial goals. On the other hand, institutional theory aids in analyzing how external pressure impacts organizational behavior. Stakeholders highly pressure businesses to consider their social and environmental impacts. So, this theory underscores the significance of understanding the broader institutional framework to cope with institutional pressures. By recognizing and responding to these pressures, a business can improve its reputation, legitimacy, and long-term viability while contributing to positive social and environmental outcomes.

On the other hand, the slack resources theory contends that CSR is not fully integrated. Companies can allocate more funds to social responsibility initiatives when they achieve better financial results. It provides a strategic scope to a certain extent, and social investment in product management, workforce diversity, and environmental issues offers favorable outcomes. Otherwise, social expenditure may not help achieve resource efficiency (Melo 2012). According to the resource-based perspective, firms can gain a sustained competitive advantage by employing rational managerial decisions, proper resource accumulation and deployment, and the correction of factor market imperfections (Oliver 1997). This resource-based view (RBV) approach mainly stresses how companies build capabilities to achieve both environmental objectives and business goals by focusing on key strategies such as pollution prevention and sustainable development (Hart 1995; Russo and Fouts 1997). In the context of CSR, this theory suggests that while CSR initiatives are primarily aimed at achieving broader social goals, the knowledge and expertise gained from such proactive environmental behavior can serve as a valuable resource to enhance a firm's operational efficiency and better environmental performance (McWilliams and Siegel 2001). The idea posits that companies can improve their competitive edge in environmental sustainability by using eco-friendly strategies like sustainable supply chains or innovative green

technologies. In addition, the Natural Resource-Based view of corporate social responsibility provides a framework for integrating environmental considerations into corporate strategy and decision-making.

2.2 | Studies on CSR and Environmental Sustainability

The philosophy of CSR is that business operations should avoid having a negative impact on the environment or society. Corporate sustainability has become imperative due to the current climate shocks. Environmental CSR initiatives are progressively helping to foster the development of a sustainable ecosystem through protecting and conserving the natural environment. Socio-environmental and political or institutional factors are the main drivers of environmental responsibility (Stjepcevic and Siksnelyte 2017). There are several motivations behind practicing environmentally responsible behaviors, which are composed of both economic (build corporate image, entry to the foreign market, corporate efficiency) and ethical (stakeholder engagement, employee satisfaction, and being a good citizen) (Cetindamar and Husoy 2007). The corporate sustainability model (CSM) provides evidence that the companies in the environmentally sensitive industries (ESI) group are dedicating more attention to various sustainability issues compared to non-ESI businesses (Jha and Rangarajan 2020). Corporate sustainability initiatives negatively correlate with carbon emission intensity and the overall intensity of greenhouse gas emissions. Climate-responsive strategies such as emission reduction activities, environmental innovation, and resource efficiency support enterprises in lowering industrial emissions and improving corporate carbon performance (Haque and Ntim 2022). Mandatory social investment supports community development and strengthens social governance while providing firm-specific advantages (Balon et al. 2022). CSR spending and increased environmental expenses are pivotal in enhancing firm-level energy efficiency, which further contributes to achieving net-zero targets and sustainable industrial development (Sahoo et al. 2024). As a result, stakeholders are now demanding corporate environmental responsibility from companies as a part of their sustainable business strategy. An environmental management system helps companies lower energy costs by implementing improved management techniques (Haider et al. 2020). It also verified that firms' environmentally sustainable activities positively impact profitability (Sardana et al. 2020). Similarly, Orazalin (2020) highlighted the significant role of effective CSR strategies in improving UK listed firms' environmental and social performance. The practical implementation of CSR helps to internalize the negative effect of production on society and the environment (Liu et al. 2010; Goyal and Kumar 2017). Studies have also shown that companies investing in CSR are more likely to adopt well-structured environmental management strategies. This is evident in emerging economies, where mandatory disclosure has significantly improved firm environmental performance (Frost 2007). Furthermore, CSR positively affects the adoption of green practices through the mediating role of environmentally sustainable development initiatives (Shahzad et al. 2020). However, the above recent works are focused on the environmental dimensions of CSR in well-developed parts of the global environment, and they have paid little attention to the specific effect of CSR, which is vital for competitive firms and policymakers in an emerging market prospect.

Nevertheless, the outcomes of the above empirical studies are primarily focused on well-developed nations compared to emerging economies. There is still a dearth of research on the importance of CSR in light of environmental concerns. However, numerous studies have investigated the effects of various CSR initiatives on corporate financial performance. Few research studies have examined the implications of CSR initiatives on environmentally sustainable development and energy efficiency. Therefore, efficiency analysis through CSR investment is crucial for an emerging country like India, where manufacturing is becoming the primary focus of economic development.

Furthermore, a study of the iron and steel industry is imperative compared to other industries since they cause substantial damage to the natural environment through their business activities. Thus, improving energy efficiency in industrial production, specifically for energy-intensive firms, is crucial for realizing green growth. Based on the discussions above, we developed the following hypotheses to observe the effect and verify the theoretical arguments.

H1. *CSR investment leads to greater energy efficiency at the firm level.*

H2. *Environmentally proactive CSR firms are more energy-efficient.*

H3. *The effect of CSR on energy efficiency is not homogeneous across the industry.*

3 | Research Methodology

3.1 | Data and Sample

Data are collected from the Centre for Monitoring Indian Economy (CMIE) prowess database of Indian Companies for 2009–2021. We collected the data from 2009 considering the introduction of the Voluntary Corporate Social Responsibility (VCSR) regulation in India. Furthermore, after a thorough cleaning, we employ the unbalanced panel data of 8852 firm-year observations for the Iron and Steel sector. Since this is one of the major sectors contributing to India's economic growth, the firms' active participation in CSR activities and energy efficiency targets motivates us to give special consideration; this study aims to analyze the impact of CSR on the energy efficiency of Iron and Steel firms in India. We used energy intensity (EI) as the power and fuel expenses ratio to net sales as the dependent variable, a proxy for energy efficiency. We have also tested the effect of CSR on firm performance by using Return on Assets (ROA) as a proxy. The primal independent variable of our study is the CSR dummy (1 for firms doing CSR expenditure; 0 otherwise). We have also created two more variables, namely CSRD 2 (1 for doing CSR and environmental and pollution control expenses; 0 otherwise) and CSRD 3 (1 for continuously, i.e., at least 3 years in the last 5 years engaged in CSR; 0 otherwise). The

control variables are firm age, size, profit margin, R&D intensity, environmental-related expenses to control or curb pollution in the production process, export intensity, and entity type (1 public entity; 0 otherwise). Bagchi and Sahu (2025a) have used sales, firm age, R&D, and export as determinants of energy efficiency measurement for Indian manufacturing firms. Firm size significantly influences CSR and firm performance (Mishra and Suar 2010).

Furthermore, firm size is a significant covariate for energy efficiency improvement (Laguir et al. 2019). Firm-specific control variables such as firm size and profitability are essential to measure carbon performance (Haque and Ntim 2022). Studies also found that export-intensive and technologically advanced firms are more energy efficient (Bagchi and Sahu 2020; Bagchi and Sahu 2025b). Similarly, R&D intensity helps to reduce the energy intensity of manufacturing firms in India. A higher profit margin at the firm level helps reduce energy intensity. Firm diversification into green investment leads to energy-efficient behavior (Sahu et al. 2022). We have also created a few interaction variables to test our hypothesis. A detailed description of the variables is presented in Table 1.

3.2 | The Empirical Framework

Our objective is to examine the impact of CSR on firms' energy efficiency. In the first phase of empirical analysis, we applied a panel regression technique with a fixed effects estimation. The empirical model can be represented as follows:

$$EI_{it} = \alpha_0 + \beta_1 CSR_{it} + \beta_K \overrightarrow{Z_{it}} + \mu_{it} \quad (1)$$

$$\mu_{it} = u_i + v_{it}$$

$$u_i \sim IID\left(0, \sigma_\mu^2\right) \text{ and } v_{it} \sim IID\left(0, \sigma_v^2\right)$$

where EI_{it}—Energy intensity of ith firms for tth time-period. CSR_{it}—Corporate Social Responsibility of ith firms for tth time-period. $\overrightarrow{Z_{it}}$—Vector of other independent variables. u_i—within-entity error term. v_{it}—Overall error term. μ_{it} represents the composite error term.

We start our analysis with fixed effect regression to understand the relationship between CSR and firm energy efficiency. However, the relationship may be subject to bidirectional causality and endogeneity. In this case, fixed effect regression can control for time-invariant unobserved heterogeneity, but it cannot fully address endogeneity arising from simultaneity or omitted time-varying factors. So, we use one-step GMM with internal instruments (lag values of endogenous variables) to control for reverse causality and omitted variable bias for more reliable results. This model has several advantages over basic fixed effects panel regression by producing more consistent and unbiased results. Thus, the study advances from

TABLE 1 | Variable description.

Sl. No	Variables	Symbolic	Definition	Expected sign
1	Energy intensity (as a proxy for energy efficiency)	EI	The ratio of fuel and power expenses to net sales	
2	Return on assets	ROA	Net profit/total assets of the company	
3	CSR intensity	CSR	CSR expenditure to net sales	+ve/−ve
4	Firm size	Size	Natural log of net sales	+ve
5	Age	Age	Number of years since the incorporation of the firms	+ve
6	Profit margin	PM	(Profit after Tax/Net sales) * 100	+ve
7	R&D intensity	RDI	Ratio of research and development expenditure to net Sales	+ve/−ve
8	Export intensity	EXI	Ratio of export of goods to net sales	+ve
Dummy variables				
9	CSR dummy	CSR	1 if doing CSR expenditure; 0 otherwise	+ve/−ve
10	EP-CSR dummy	CSRD2	1 for firms doing CSR expenditure as well as Environmental and pollution control expenses; 0 otherwise	+ve/−ve
11	Environmental disclosure dummy	END	1 if the firm reports on the environmental expenses; 0 otherwise	+ve
12	Continuous CSR dummy	CSRD3	1 for firms are doing at least three years from the last five years and 0 otherwise	+ve
13	Entity type dummy	ETD	1 for the public entity and 0 otherwise.	+ve/−ve

Source: Authors own tabulation.

analyzing static panel data compared to dynamic panel data because the former model ignored unobserved time-variant effects and endogeneity. So, the outcomes of the one-step system GMM method are unbiased and more efficient than those of other methods.

We adopt the Arellano and Bond (1991) dynamic panel model based on the generalized method of moments (GMM). Thus, our model can be expressed as follows.

$$EI_{it} = \alpha_0 + \beta\, EI_{it-1} + \gamma\, CSR_{it} + \delta\, \overrightarrow{Z_{it}} + u_i + \varepsilon_{it} \quad (2)$$

where EI_{it}—Energy intensity of ith firms for tth time-period. EI_{it-1} is 1 year lagged energy intensity. CSR_{it}—Corporate Social Responsibility of ith firms for tth time-period. $\overrightarrow{Z_{it}}$ is the vector of other independent variables. α_0 is the intercept. u_i—Individual specific effect or time-invariant unobserved heterogeneity. ε_{it}—Idiosyncratic error term.

4 | Empirical Results and Discussion

Figure 1 presents India's iron and steel sector's energy intensity (EI) trend for 2009–2021. This is one of the highly energy-intensive sectors. The graph confirms a decline in the energy intensity of the sector. The average energy intensity gradually declined from 0.069 in 2009 to 0.051 in 2021 due to the several energy reduction strategies adopted by the sector in the last two decades.[5] If we closely observe the trend, there is a significant decline in 2012 and again after 2014, which may be attributed to the implementation of energy-saving policies like Perform, Archive, and Trade (PAT) and policy interventions like the Mandatory Corporate Social Responsibility Act of 2013 in the direction of environmental sustainability. Figure 2 shows the CSR expenditure pattern of iron and steel companies in ratio to net sales. The trend indicates that the CSR intensity was very low during voluntary CSR (from 2009 to 2013). After the mandatory CSR guidelines, there was a significant increase in CSR expenditure. The sudden decline in CSR expenditure in 2020 was due to the COVID-19 crisis in India.

Table 2 displays the descriptive statistics for variables used in this study. The result shows that the average energy intensity of firms is 0.079, which is much higher than the energy intensity of the manufacturing sector at the aggregate level (Kumar et al. 2023), and the standard deviation is 0.105. Similarly, the average value for CSR intensity is very low due to the greater number of firms not engaged in CSR activities and a small proportion of their profit spent on associated activities. In the Indian context, the size and profit margin of the firm matter, as well as the compulsory involvement and disclosure of CSR activities (Dharmapala and Khanna 2018; Aggarwal and Singh 2019). We have also found no high degree of collinearity between explanatory variables, and overall statistics confirm that our data is suitable for further empirical analysis (Table A1 in Appendix A).

In the baseline empirical models, we examine the impact of CSR expenditure on firm performance. The results are presented in Table 3. We initially investigated whether a firm is profitable post-CSR activities before analyzing the effect of CSR on energy efficiency because an enterprise first needs to be profitable to function sustainably in a competitive market environment. In Model 1, our study confirms that CSR significantly impacts firms' financial performance. Our findings are consistent with prior studies: a significant positive relationship between corporate social responsibility and corporate financial performance (Cherian et al. 2019; Bhagawan and Mukhopadhyay 2024). Furthermore, we also observe that the

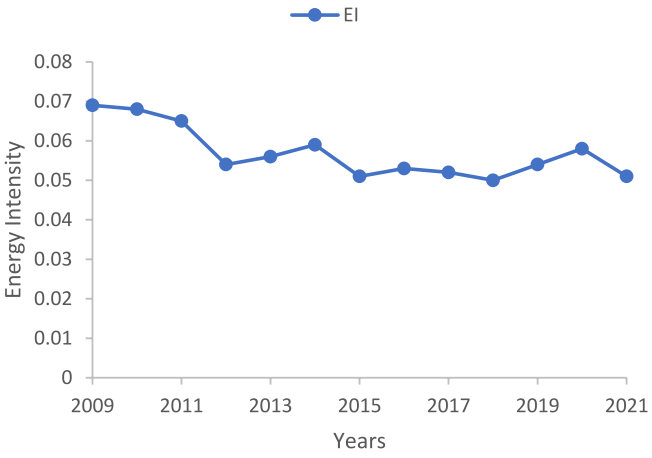

FIGURE 1 | The trend of energy intensity (EI) in the iron and steel sector. *Source:* CMIE Prowess Database.

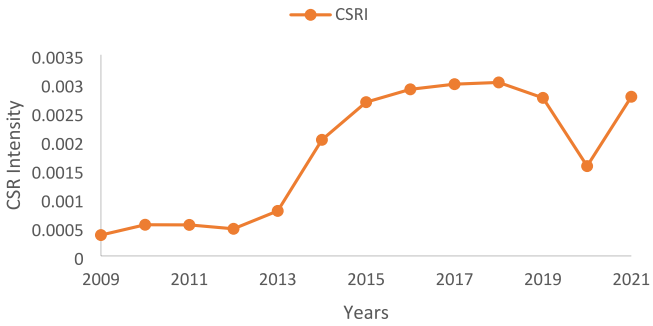

FIGURE 2 | The trend of CSR expenditure intensity in the iron and steel sector. *Source:* CMIE Prowess Database.

TABLE 2 | Descriptive statistics.

Variables	Mean	SD	Min	Max
Energy intensity (EI)	0.079	0.105	0.0004	5.12
CSR intensity	0.00136	0.0152	0	0.599
Firm age	23.377	14.143	1	131
Firm size	2.101	0.741	0.017	4.884
Technology import intensity	0.0008	0.0071	0	0. 3809
R&D intensity	0.003	0.0046	0	0.376
Profit margin	−0.076	1.105	−54.789	4.040
Export intensity	0.0722	0.180	0	2.263

Note: Total firm-year observations: 8552.
Source: CMIE Prowess Database.

TABLE 3 | The impact of CSR on firm performance.

	(1)	(2)	(3)
Variables	**Baseline model**	**Extended model**	**Interactive model**
CSR	0.0124***	0.0132***	0.0671***
	(0.00439)	(0.00491)	(0.0194)
Age	−0.00516**	−0.00502***	−0.00501***
	(0.00209)	(0.00192)	(0.00192)
Size	0.0939**	0.0936**	0.0943**
	(0.0402)	(0.0392)	(0.0395)
PM	0.0246*	0.0246*	0.0241*
	(0.0127)	(0.0127)	(0.0126)
ETD	0.155***	0.154***	0.154***
	(0.0255)	(0.0257)	(0.0257)
RDI	—	0.959***	0.943***
		(0.129)	(0.122)
END	—	0.000411	0.000379
		(0.00784)	(0.00785)
EXI	—	0.0307	0.0282
		(0.0425)	(0.0422)
Size*CSR	—	—	−0.0207***
			(0.00641)
PM*CSR	—	—	0.110*
			(0.0602)
Constant	−0.172***	−0.177***	−0.179***
	(0.0553)	(0.0596)	(0.0603)
Time effect	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes
Hausman test statistics	231.64**	235.28***	227.68***
Observations	8552	8552	8552
R-squared	0.036	0.036	0.038

Note: Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: CMIE Prowess Database.

positive relationship between CSR practices and firm performance is valid in the presence of other firm-level variables. More precisely, the interactive model shows that enterprises with bigger sizes and higher profit margins perform better after engaging in CSR initiatives.

Table 4 presents the relationship between CSR and firms' energy intensity (as a proxy for energy efficiency). The model 1 illustrates the fundamental link between energy intensity and CSR. The empirical finding reveals an inverse relationship between energy intensity and CSR, suggesting that a strategic firm's involvement in CSR increases energy efficiency. The panel fixed effects result shows that the CSR variable negatively influences energy intensity, indicating that they are energy efficient. Similarly, Haque and Ntim (2022) have found that corporate sustainability initiatives are inversely associated with firm-level carbon emission intensity. Climate-responsive strategies such as resource efficiency, emission reduction initiatives, and environmental innovation enable organizations to reduce firm-level emission intensity and improve carbon performance. For French SMEs, Laguir et al. (2019) observed a similar conclusion that companies become highly energy efficient by engaging in social, economic, and environmental corporate activities. In the subsequent Model 2, we introduced the interactive dummy, and the result is insignificant.

TABLE 4 | The impact of corporate social responsibility (CSR) on energy efficiency.

	(1)	(2)	(3)	(4)
Variables	**Baseline model**	**Interactive model**	**Full model**	**Environmental proactive model**
CSR	−0.0635**	−0.0657**	−0.0640**	−0.0636**
	(0.00343)	(0.00366)	(0.00346)	(0.00352)
Age	0.00260***	0.00253***	0.00250***	0.00251***
	(0.000628)	(0.000577)	(0.000635)	(0.000594)
Size	−0.0690***	−0.0694***	−0.0687***	−0.0687***
	(0.0194)	(0.0198)	(0.0194)	(0.0198)
ETD	−0.0580***	−0.0576***	−0.0574***	−0.0575***
	(0.0162)	(0.0160)	(0.0134)	(0.0132)
PM	−0.0137***	−0.0137***	−0.0137***	−0.0137***
	(0.00434)	(0.00435)	(0.00434)	(0.00434)
RDI	—	—	−0.106**	−0.105**
			(0.0132)	(0.0132)
EX	—	—	−0.0180***	−0.0181***
			(0.00617)	(0.00624)
Size*CSR	—	0.000646	—	—
		(0.00115)		
PM*CSR	—	0.00626	—	—
		(0.00728)		
CSRD2	—		—	−0.00579**
				(0.00279)
CSRD3	—		—	−0.00541*
				(0.00536)
Constant	0.202***	0.204***	0.205***	0.205***
	(0.0350)	(0.0371)	(0.0343)	(0.0359)
Time effect	Yes	Yes	Yes	Yes
Industry effect	Yes	Yes	Yes	Yes
Hausman test statistics	177.25***	183.25***	136.68***	152.63***
Observations	8552	8552	8552	8552
R-squared	0.128	0.128	0.129	0.129

Note: Robust standard errors in parentheses, ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.
Source: CMIE Prowess Database.

In the full model (Model 3), the direction of the result remains unaltered after including technological capabilities and international orientation variables. However, it indicates that export-oriented and R&D-intensive firms' CSR expenditure helps them lower their energy intensity. In Model 4, we incorporate the environmentally proactive CSR firms using a dummy variable (CSRD2) and also for firms that are doing continuous CSR (CSRD3) as another dummy variable. These models aim to observe specific effects on a firm's energy intensity. The empirical estimate demonstrates that a strategic firm's CSR and environmental and pollution control expenses lead to greater energy efficiency. This might be due to businesses being able to reduce their energy use by investing additional funds in environmental sustainability channels and technologies and adopting better management practices through CSR. Firm diversification into green investment leads to energy-efficient behavior (Sahu et al. 2022). Furthermore, firms' continuous engagement in CSR also helps achieve energy efficiency. So, it can be concluded that CSR improves the energy efficiency capability of a socially and environmentally responsible firm in a sustainable business

environment. Hence, environmental sustainability ought to be one of the priority areas for CSR expenditure for firms in India.

We analyzed the full sample to examine the relationship between CSR and energy intensity at the aggregate level. However, the effect may not be homogeneous for all firms across sectors. Therefore, a subsample analysis is performed. In the first phase of disaggregate analysis, we divide our aggregate sample into two categories based on their profit level. We consider the average profit margin as the threshold to segregate the sample. This helps us explain the behavior of profit-intensive firms concerning CSR and energy efficiency.

Table 5 demonstrates the impact of CSR on firm energy efficiency at different profit margin levels. We have used the one-step System GMM method to obtain robust findings (Lahouel et al. 2019). The results indicate that high-profit firms' CSR activities help decrease energy intensity levels. However, low-profit margin firms experience a negative effect with a lower coefficient value, and the effect is not highly significant. It might be because achieving increased energy efficiency in industrial production through CSR initiatives necessitates significant profit margins to divert additional resources toward environmental sustainability. The insignificant Hansen test statistics confirm that the instruments are valid, and the AR(2) indicates no serial autocorrelation in the models.

Table 6 reports the effect of CSR on energy intensity subject to the volume of CSR expenditure as a part of their business strategy. We divided samples into two groups, such as the above-threshold firms and just-threshold firms, based on the mandatory CSR guidelines in India. In this case, the threshold point is 0.02. Then, we consider firms above the threshold whose annual CSR expenditure is more than the point of threshold. In comparison, the firms in the just-threshold category have annual CSR expenditures that are less than or equal to 2% or 0.02 of their net profit. The empirical results reveal that above-threshold firms' CSR expenditure negatively affects energy intensity levels. However, the relationship is insignificant for firms that only maintain the threshold level of CSR expenditure under regulation. This finding suggests that merely meeting the regulatory threshold may not enhance energy efficiency outcomes. The insignificance of CSR spending at the threshold level highlights that CSR investments must go beyond the regulatory minimum to yield tangible improvements in energy efficiency. Our empirical results suggest that a competitive firm needs to increase the proportion of CSR expenditure in the direction of environmental sustainability to gain energy efficiency in industrial production. In other words, to achieve a lower energy cost in production, firms need more environmentally proactive CSR funds as part of the average annual profit.

Table 7 illustrates the R&D-intensive and non-R&D-intensive firms' energy intensity with respect to CSR. The findings indicate that R&D-intensive firms' CSR expenditure helps them gain energy efficiency. Although participating in CSR activities can make non-R&D-intensive companies profitable, they fail to enhance their energy efficiency. So, we conclude that innovative firms actively engage in CSR (specifically environmental CSR) to attain a competitive market advantage. In addition, the export

TABLE 5 | CSR—Energy efficiency links: The role of firm's profit.

	High-profit margin firms			Low-profit margin firms		
Variables	**Coefficients**	**Robust S. E**	***t*-Statistics**	**Coefficients**	**Robust S. E**	***t*-Statistics**
EI_{it-1}	0.64629***	0.06252	10.34	0.17588***	0.027432	6.41
CSR	−0.0875***	0.02303	−3.80	−0.0256*	0.016982	−1.51
Age	0.00014**	0.000073	2.00	0.00136*	0.000805	1.69
Size	−0.00462***	0.001446	−3.20	−0.05854**	0.026235	−2.23
ETD	0.0043**	0.001930	2.26	0.030488	0.022674	1.34
RDI	0.253376	0.256635	0.99	−3.909244	4.45530	−0.88
END	0.00066	0.003248	0.21	−0.026175	0.039578	−0.66
EX	−0.00193	0.00440	−0.44	−0.06321	0.046904	−1.35
Constant	2.44548***	0.46102	5.30	7.98243	10.95185	0.73
Year dummy	Yes			Yes		
F statistics	654.37***			97.09***		
AR2 (*p*-value)	0.211			0.356		
Hansen test (*p*-value)	0.356			0.739		
Number of instruments	22			20		
Observations	6012			566		

Note: All the models are estimated using the Arellano and Bover (1995) and Blundell and Bond (1998) one-step system GMM estimations (Stata xtabond2 command). The *p*-values ***, **, and *indicate significance at 1%, 5%, and 10% levels, respectively, and the robust standard errors are reported. The time dummy is included, and Hansen test results are also reported.
Source: CMIE Prowess Database.

TABLE 6 | CSR—Energy efficiency links: The role of CSR spending behavior.

	Above-threshold CSR firms			Just threshold CSR firms		
Variables	**Coefficients**	**Robust S. E**	***t*-Statistics**	**Coefficients**	**Robust S.E**	***t*-Statistics**
EI_{it-1}	0.79122***	0.07976	9.92	0.6889***	0.14938	4.61
CSR	−0.0595**	0.03006	−1.98	0.16966	0.17249	0.98
Age	0.0000194	0.000082	0.23	0.00024*	0.00016	1.51
Size	−0.002073	0.003821	−0.54	0.00205	0.0038	0.53
PM	0.060913*	0.050112	1.22	−0.0135*	0.01148	−1.18
ETD	−0.001104	0.003206	−0.34	0.00033	0.00433	0.08
RDI	0.331745	0.631352	0.53	0.2961	0.94626	0.31
END	−0.002029	0.003506	−0.58	0.00792	0.01205	0.66
EX	0.005521*	0.004732	1.17	0.01419**	0.001575	9.00
Constant	1.6774*	1.46240	1.15	2.4505*	2.31073	1.06
Year Dummy	Yes			Yes		
F Statistics	358.29***			150.57***		
AR2 (*p*-value)	0.327			0.221		
Hansen test	0.786			0.249		
Number of instruments	30			33		
Observations	227			323		

Note: All the models are estimated using the Arellano and Bover (1995) and Blundell and Bond (1998) one-step system GMM estimations (Stata xtabond2 command). The *p*-values ***, **, and *indicate significance at 1%, 5%, and 10% levels, respectively, and the robust standard errors are reported. The time dummy is included, and Hansen test results are also reported.
Source: CMIE Prowess Database.

TABLE 7 | CSR—Energy efficiency links: The role of R&D expenditure.

	R&D intensive firms			Non R&D intensive firms		
Variables	**Coefficients**	**Robust S. E**	***t*-Statistics**	**Coefficients**	**Robust S. E**	***t*-Statistics**
EI_{it-1}	1.0699***	0.1410	7.58	0.27315***	0.05513	4.95
CSR	−0.02264*	0.01180	−1.91	0.006053	0.013654	0.44
Age	0.000028	0.000075	0.38	0.000378**	0.0001659	2.27
Size	−0.00070	0.001260	−0.56	−0.0156***	0.004164	−3.77
PM	−0.042689*	0.023356	−1.83	−0.0180***	0.004846	−3.74
ETD	0.00180	0.004253	0.42	0.0122**	0.0041571	2.95
END	0.02496**	0.01025	2.44	−0.00303	0.005748	−0.53
EX	−0.00700	0.00759	−0.92	−0.0144	0.0093871	−1.54
Constant	−0.82536	2.24101	−0.37	3.1192**	0.988686	3.15
Year Dummy	Yes			Yes		
F Statistics	969.56***			188.61***		
AR2 (*p*-value)	0.196			0.359		
Hansen test	0.282			0.193		
Number of instruments	22			22		
Observations	379			6615		

Note: All the models are estimated using the Arellano and Bover (1995) and Blundell and Bond (1998) one-step system GMM estimations (Stata xtabond2 command). The *p*-values ***, **, and *indicate significance at 1%, 5%, and 10% levels, respectively, and the robust standard errors are reported. The time dummy is included, and Hansen test results are also reported.
Source: CMIE Prowess Database.

coefficient of firms indicates that more innovative firms' CSR expenditure helps them enter the international market through strategic CSR investments.

Furthermore, the environmental expenditure dummy is significant for R&D-intensive firms and insignificant for non-R&D-intensive firms. This indicates that more innovative firms are also active in advanced environmental technology and green innovation through CSR to gain a competitive advantage. The AR(2) results confirm that the models are free from serial autocorrelation and that the moment conditions are correctly specified. In addition, the insignificant Hansen test indicates that the instruments are valid.

Our findings indicate that a firm's CSR investment helps to achieve better energy efficiency, aligning with global trends observed in similar studies. Our results align with the findings of the previous studies (Clarkson et al. 2008; Qian and Schaltegger 2017; Moussa et al. 2020), which suggest a positive association between corporate environmental disclosure and corporate environmental (carbon) performance. Additionally, an extensive firm-level study was conducted across 12 European countries to observe the impact of corporate sustainability initiatives on environmental performance, specifically emission intensity. The research concluded that corporate sustainability strategies, including emission reduction activities, environmental innovation, and resource efficiency, support enterprises in lowering industrial emissions and improving corporate carbon performance (Haque and Ntim 2022). Furthermore, corporate social responsibility strategies in emerging economies have been identified as a key driver in enhancing environmental performance by reducing energy consumption and minimizing waste. A firm's green business strategy also helps strengthen this relationship for manufacturing companies (Li 2022). Similarly, Shanyu (2022) found that CSR positively relates to sustainable business performance in BRICS countries.

However, our findings contrast with several recent studies (Delmas et al. 2013; Haque and Ntim 2018) that argue corporate sustainability initiatives, such as policies, strategic planning, and disclosures, often serve as symbolic gestures without leading to tangible reductions in firm-level emissions. Moreover, our results challenge the arguments presented in other studies (Ramus and Montiel 2005; Cong and Freedman 2011), which suggest that corporate sustainability efforts are often driven by greenwashing or impression management rather than a genuine commitment to environmental sustainability.

5 | Conclusion, Limitations and Policy Recommendations

Energy efficiency is the core of the business strategy in emerging economies nowadays. Energy efficiency improvement through CSR could be a strategic tool for a pollution-intensive industry (i.e., iron and steel) to gain economic profit and maintain environmental sustainability. To address this research gap, we examine the impact of CSR on firm energy efficiency within the context of an emerging market economy. Using data from CMIE prowess for iron and steel industries, we develop a conceptual model to investigate the potential links between CSR and energy efficiency at the firm level. Our study mainly focuses on India's iron and steel sector, a resource-intensive and heavily polluting or red category subsector under manufacturing. Moreover, reaching energy efficiency goals without compromising profitability is one of the critical challenges confronting this sector. Therefore, it is essential to investigate the CSR practices of this sector from the sustainability viewpoint.

We find an inverse relationship between energy intensity and CSR investment using the panel regression techniques. This suggests that a strategic firm's involvement in CSR increases energy efficiency. In addition, the one-step System GMM models were used to obtain robust findings at disaggregate levels. The results indicate that the CSR expenditure of high-profit companies contributes to a decrease in energy intensity. The findings also reveal that above-threshold firms' CSR expenditure negatively affects the level of energy intensity at the firm level. However, the relation is insignificant for firms that only maintain the threshold level of CSR expenditure to compel the guidelines. The R&D-intensive firm's CSR expenditure helps them to achieve energy efficiency gain. Although participating in CSR activities can make R&D-intensive companies profitable, they fail to enhance their energy efficiency. Companies' environmentally proactive CSR strategies and continuous engagement help them get better energy efficiency scores. So, we conclude that CSR investment helps to improve the energy efficiency capability of a socially and environmentally responsible firm in a sustainable business environment. However, energy efficiency requires a large share of profit and an innovative strategy. So, environmental sustainability should be a priority investment area for CSR-focused firms in India, particularly for companies in pollution-intensive industries. These results highlight the connection between CSR investment and operational sustainability, especially regarding energy use.

The empirical analysis significantly contributes to academic and practical policy implications. These analyses are preliminary investigations to view CSR as a resource from a sustainability viewpoint. It provides empirical evidence on the relationship between CSR and energy efficiency, a perspective often overlooked in previous research. Our findings could enhance the existing body of literature by adding the role of CSR in improving firms' sustainable performance. We considered a resource-intensive sector to provide insights into the sustainability literature. Policy bodies should develop robust enforcement mechanisms and ensure that CSR initiatives align with sustainable goals and environmental objectives. This alignment is essential for translating CSR policies into tangible environmental improvements and fostering long-term sustainable development. Reinforcing the regulatory framework to ensure transparency in CSR reporting and incentivizing environmentally proactive CSR expenditure can further support firms in improving their energy efficiency scores.

Furthermore, businesses should also focus on integrating CSR activities into their core strategies and addressing environmental challenges. Therefore, this research suggests that firms should adopt environmental CSR to reduce energy use

and attain corporate sustainability. This study also encourages Indian firms to invest their CSR funds in an environmentally sustainable direction to gain competitive advantages. We suggest integrating energy and CSR policies for these industrial sectors to provide better outcomes. The guidelines for CSR investment need to be comprehensive in relation to the nature of the industry and economic activities. Furthermore, this recommends that Indian companies enhance their CSR disclosures by providing specific breakdowns into philanthropic, environmental, and R&D-related categories. More comprehensive guidelines and robust reporting could offer deeper insights into the differentiated effects of various CSR initiatives on firm-level environmental sustainability, particularly energy efficiency. Future studies could incorporate longitudinal data to monitor CSR investments and their long-term effect on energy efficiency, carbon footprint, and overall firm performance. A longitudinal approach would help track whether firms are genuinely committed to sustainable practices or merely engaging in greenwashing.

Additionally, a structured framework could explore the underlying causal mechanisms and the role of mediating factors, such as technological innovation, market competitiveness, and regulatory compliance, in determining the long-term effectiveness of CSR strategies. Furthermore, future scholarly research can also evaluate the quality and transparency of CSR disclosure to understand its role in sustainability transitions. Moreover, firms' long-term commitment to environmental initiatives rather than one-time CSR spending could help distinguish between substantive sustainability and short-term compliance-driven strategies. Furthermore, extensive comparative studies across pollution-intensive sectors, such as cement and chemical, or emerging and developing economies could enhance the generability of our findings. Furthermore, Primary evidence could provide a deeper insight into this relationship from several directions. Thus, integrating these areas in future research can strengthen policy implications and provide firms with strategic guidance on maximizing CSR's impact on energy efficiency and long-term sustainability goals. Our study used energy intensity as an indicator to measure energy efficiency due to the unavailability of data at the firm level. Further studies could be conducted by developing a comprehensive index to measure environmental sustainability in the Indian setting. Comparative analysis across industries might help in understanding the effect and its variability, and extensive data on the firm-wise specific dimensions of CSR activities in the Indian context could produce advantageous outcomes.

Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] As per the Companies Act 2013, a firm with a net worth ≥ 500 crores, turnover ≥ 1000 crores, and net profit ≥ 5 crores during the last financial year is mandated to spend at least 2 percent of its average net profit in listed CSR activities.

[2] Ministry of Steel Annual Report 2022-23.

[3] TATA Steel Annual Report 2022-23.

[4] National Industrial Classification 2008.

[5] Energy Conservation Act, 2001; Perform Achieve and Trade under the National Mission for Enhanced Energy Efficiency, 2008; Paris Agreement, 2015.

References

Aggarwal, P., and A. K. Singh. 2019. "CSR and Sustainability Reporting Practices in India: An In-Depth Content Analysis of Top-Listed Companies." *Social Responsibility Journal* 15, no. 8: 1033–1053. https://doi.org/10.1108/SRJ-03-2018-0078.

Arellano, M., and S. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* 58, no. 2: 277–297. https://doi.org/10.2307/2297968.

Arellano, M., and O. Bover. 1995. "Another Look at the Instrumental Variable Estimation of Error-Components Models." *Journal of Econometrics* 68, no. 1: 29–51. https://doi.org/10.1016/0304-4076(94)01642-d.

Bagchi, P., and S. K. Sahu. 2020. "Energy Intensity, Productivity and Pollution Loads: Empirical Evidence From Manufacturing Sector of India." *Studies in Microeconomics* 8, no. 2: 194–211. https://doi.org/10.1177/2321022220930968.

Bagchi, P., and S. K. Sahu. 2025a. "Energy Intensity Policies Should Be Measure-Specific: A Learning From Indian Manufacturing." *Environmental Claims Journal*: 1–31. https://doi.org/10.1080/10406026.2025.2464008.

Bagchi, P., and S. K. Sahu. 2025b. "The Conundrum of Porter Hypothesis, Pollution Haven Hypothesis, and Pollution Halo Hypothesis: Evidence From the Indian Manufacturing Sector." *Clean Technologies and Environmental Policy* 27, no. 1: 205–217. https://doi.org/10.1007/s10098-024-02886-z.

Balon, V., S. Y. Kottala, and K. S. Reddy. 2022. "Mandatory Corporate Social Responsibility and Firm Performance in Emerging Economies: An Institution-Based View." *Sustainable Technology and Entrepreneurship* 1, no. 3: 100023. https://doi.org/10.1016/j.stae.2022.100023.

Bansal, S., M. Khanna, and S. Jain. 2018. "Corporate Social Responsibility Rules in India: An Assessment." *Economic and Political Weekly* 53, no. 14: 44–51.

Bauckloh, T., C. Klein, T. Pioch, and F. Schiemann. 2023. "Under Pressure? The Link Between Mandatory Climate Reporting and Firms' Carbon Performance." *Organization and Environment* 36, no. 1: 126–149. https://doi.org/10.1177/10860266221083340.

Benlemlih, M., and M. Bitar. 2018. "Corporate Social Responsibility and Investment Efficiency." *Journal of Business Ethics* 148: 647–671. https://doi.org/10.1007/s10551-016-3020-2.

Bhagawan, P., and J. P. Mukhopadhyay. 2024. "Does Mandatory Expenditure on CSR Affect Firm Value? Empirical Evidence From Indian Firms." *Journal of Accounting Literature*. https://doi.org/10.1108/JAL-10-2023-0184.

Blundell, R., and S. Bond. 1998. "Initial Conditions and Moment Restrictions in Dynamic Panel Data Models." *Journal of Econometrics* 87, no. 1: 115–143. https://doi.org/10.1016/s0304-4076(98)00009-8.

Cai, L., J. Cui, and H. Jo. 2016. "Corporate Environmental Responsibility and Firm Risk." *Journal of Business Ethics* 139: 563–594. https://doi.org/10.1007/s10551-015-2630-4.

Camilleri, M. A., and M. A. Camilleri. 2017. "Socially Responsible and Sustainable Investing." In *Corporate Sustainability, Social Responsibility and Environmental Management: An Introduction to Theory and Practice With Case Studies*, 61–77. Springer. https://doi.org/10.1007/978-3-319-46849-5_4.

Cetindamar, D., and K. Husoy. 2007. "Corporate Social Responsibility Practices and Environmentally Responsible Behavior: The Case of the

United Nations Global Compact." *Journal of Business Ethics* 76, no. 2: 163–176. https://doi.org/10.1007/s10551-006-9265-4.

Cherian, J., M. Umar, P. A. Thu, T. Nguyen-Trang, M. S. Sial, and N. V. Khuong. 2019. "Does Corporate Social Responsibility Affect the Financial Performance of the Manufacturing Sector? Evidence From an Emerging Economy." *Sustainability* 11, no. 4: 1182. https://doi.org/10.3390/su11041182.

Clarkson, P. M., Y. Li, G. D. Richardson, and F. P. Vasvari. 2008. "Revisiting the Relation Between Environmental Performance and Environmental Disclosure: An Empirical Analysis." *Accounting, Organizations and Society* 33, no. 4–5: 303–327. https://doi.org/10.1016/j.aos.2007.05.003.

Cong, Y., and M. Freedman. 2011. "Corporate Governance and Environmental Performance and Disclosures." *Advances in Accounting* 27, no. 2: 223–232. https://doi.org/10.1016/j.adiac.2011.05.005.

Delmas, M., and M. W. Toffel. 2004. "Stakeholders and Environmental Management Practices: An Institutional Framework." *Business Strategy and the Environment* 13, no. 4: 209–222. https://doi.org/10.1002/bse.409.

Delmas, M. A., D. Etzion, and N. Nairn-Birch. 2013. "Triangulating Environmental Performance: What Do Corporate Social Responsibility Ratings Really Capture?" *Academy of Management Perspectives* 27, no. 3: 255–267. https://doi.org/10.5465/amp.2012.0123.

Dharmapala, D., and V. Khanna. 2018. "The Impact of Mandated Corporate Social Responsibility: Evidence From India's Companies Act of 2013." *International Review of Law and Economics* 56: 92–104. https://doi.org/10.1016/j.irle.2018.09.001.

Dubey, R., A. Gunasekaran, T. Papadopoulos, S. J. Childe, K. Shibin, and S. Wamba. 2017. "Sustainable Supply Chain Management: Framework and Further Research Directions." *Journal of Cleaner Production* 142: 1119–1130. https://doi.org/10.1016/j.jclepro.2016.03.117.

Freeman, R. E. 1994. "The Politics of Stakeholder Theory: Some Future Directions." *Business Ethics Quarterly* 4, no. 4: 409–421. https://doi.org/10.2307/3857340.

Frost, G. R. 2007. "The Introduction of Mandatory Environmental Reporting Guidelines: Australian Evidence." *Abacus* 43, no. 2: 190–216. https://doi.org/10.1111/j.1467-6281.2007.00225.x.

Goyal, P., and D. Kumar. 2017. "Modeling the CSR Barriers in Manufacturing Industries." *Benchmarking* 24, no. 7: 1871–1890. https://doi.org/10.1108/BIJ-09-2015-0088.

Haider, S., M. H. Adil, and P. P. Mishra. 2020. "Corporate Environmental Responsibility, Motivational Factors, and Effectiveness: A Case of Indian Iron and Steel Industry." *Journal of Public Affairs* 20, no. 2: e2032. https://doi.org/10.1002/pa.2032.

Haque, F., and C. G. Ntim. 2018. "Environmental Policy, Sustainable Development, Governance Mechanisms and Environmental Performance." *Business Strategy and the Environment* 27, no. 3: 415–435.

Haque, F., and C. G. Ntim. 2022. "Do Corporate Sustainability Initiatives Improve Corporate Carbon Performance? Evidence From European Firms." *Business Strategy and the Environment* 31, no. 7: 3318–3334. https://doi.org/10.1002/bse.3078.

Hart, S. L. 1995. "A Natural-Resource-Based View of the Firm." *Academy of Management Review* 20, no. 4: 986–1014. https://www.jstor.org/stable/258963.

Hossain, M. I., T. S. Ong, M. I. Tabash, and B. H. Teh. 2024. "The Panorama of Corporate Environmental Sustainability and Green Values: Evidence of Bangladesh." *Environment, Development and Sustainability* 26, no. 1: 1033–1059.

Jha, M. K., and K. Rangarajan. 2020. "The Approach of Indian Corporates Towards Sustainable Development: An Exploration Using Sustainable Development Goals Based Model." *Sustainable Development* 28, no. 5: 1019–1032. Portico. https://doi.org/10.1002/sd.2053.

Klassen, R. D., and D. C. Whybark. 1999. "The Impact of Environmental Technologies on Manufacturing Performance." *Academy of Management Journal* 42, no. 6: 599–615. https://doi.org/10.2307/256982.

Kumar, A., A. Mittal, and A. K. Pradhan. 2023. "Magnitude and Determinants of Energy Intensity: Evidence From Indian Firms." *Environmental Science and Pollution Research* 30, no. 2: 3270–3281.

Laguir, I., R. Stekelorum, J. Elbaz, and D. Duchamp. 2019. "Getting Into the Energy Efficiency Scene: Does Corporate Social Responsibility Matter for Energy Efficiency in SMEs?" *Applied Economics* 51, no. 47: 5191–5204.

Lahouel, B. B., B. Gaies, Y. B. Zaied, and A. Jahmane. 2019. "Accounting for Endogeneity and the Dynamics of Corporate Social–Corporate Financial Performance Relationship." *Journal of Cleaner Production* 230: 352–364.

Li, Y. 2022. "Corporate Social Responsibility of Chinese Manufacturing Companies' Effect on Green Business Strategy, Innovation and Performance." *Technium Social Sciences Journal* 31: 522.

Liu, X., Q. Yu, T. Fujitsuka, B. Liu, J. Bi, and T. Shishime. 2010. "Functional Mechanisms of Mandatory Corporate Environmental Disclosure: An Empirical Study in China." *Journal of Cleaner Production* 18, no. 8: 823–832. https://doi.org/10.1016/j.jclepro.2009.12.022.

Lozano, R., A. Carpenter, and D. Huisingh. 2015. "A Review of 'Theories of the Firm' and Their Contributions to Corporate Sustainability." *Journal of Cleaner Production* 106: 430–442.

Lui, A. K., C. K. Lo, E. W. Ngai, and A. C. Yeung. 2021. "Forced to Be Green? The Performance Impact of Energy-Efficient Systems Under Institutional Pressures." *International Journal of Production Economics* 239: 108213.

Lundgren, T., and W. Zhou. 2017. "Firm Performance and the Role of Environmental Management." *Journal of Environmental Management* 203: 330–341. https://doi.org/10.1016/j.jenvman.2017.07.053.

Lund-Thomsen, P., A. Lindgreen, and J. Vanhamme. 2016. "Industrial Clusters and Corporate Social Responsibility in Developing Countries: What We Know, What We Do Not Know, and What We Need to Know." *Journal of Business Ethics* 133: 9–24.

Majoch, A. A., A. G. Hoepner, and T. Hebb. 2017. "Sources of Stakeholder Salience in the Responsible Investment Movement: Why Do Investors Sign the Principles for Responsible Investment?" *Journal of Business Ethics* 140: 723–741.

Mathivathanan, D., V. Agarwal, K. Mathiyazhagan, T. Saikouk, and A. Appolloni. 2022. "Modeling the Pressures for Sustainability Adoption in the Indian Automotive Context." *Journal of Cleaner Production* 342: 130972. https://doi.org/10.1016/j.jclepro.2022.130972.

Mathiyazhagan, K., and A. N. Haq. 2013. "Analysis of the Influential Pressures for Green Supply Chain Management Adoption-An Indian Perspective Using Interpretive Structural Modeling." *International Journal of Advanced Manufacturing Technology* 68, no. 1–4: 817–833. https://doi.org/10.1007/s00170-013-4946-5.

McWilliams, A., and D. Siegel. 2001. "Corporate Social Responsibility: A Theory of the Firm Perspective." *Academy of Management Review* 26, no. 1: 117–127. https://doi.org/10.5465/AMR.2001.4011987.

Melo, T. 2012. "Slack-Resources Hypothesis: A Critical Analysis Under a Multidimensional Approach to Corporate Social Performance." *Social Responsibility Journal* 8, no. 2: 257–269.

Mishra, L. 2021. "Corporate Social Responsibility and Sustainable Development Goals: A Study of Indian Companies." *Journal of Public Affairs* 21, no. 1: e2147. https://doi.org/10.1002/pa.2147.

Mishra, S., and D. Suar. 2010. "Does Corporate Social Responsibility Influence Firm Performance of Indian Companies?" *Journal of Business Ethics* 95: 571–601.

Moussa, T., A. Allam, S. Elbanna, and A. Bani-Mustafa. 2020. "Can Board Environmental Orientation Improve US Firms' Carbon Performance? The Mediating Role of Carbon Strategy." *Business Strategy and the Environment* 29, no. 1: 72–86.

Nair, A. K., and S. S. Bhattacharyya. 2019. "Mandatory Corporate Social Responsibility in India and Its Effect on Corporate Financial Performance: Perspectives From Institutional Theory and Resource-Based View." *Business Strategy & Development* 2, no. 2: 106–116.

Oliver, C. 1997. "Sustainable Competitive Advantage: Combining Institutional and Resource-Based Views." *Strategic Management Journal* 18, no. 9: 697–713.

Orazalin, N. 2020. "Do Board Sustainability Committees Contribute to Corporate Environmental and Social Performance? The Mediating Role of Corporate Social Responsibility Strategy." *Business Strategy and the Environment* 29, no. 1: 140–153. https://doi.org/10.1002/bse.2354.

Poddar, A., S. A. Narula, and A. Zutshi. 2019. "A Study of Corporate Social Responsibility Practices of the Top Bombay Stock Exchange 500 Companies in India and Their Alignment With the Sustainable Development Goals." *Corporate Social Responsibility and Environmental Management* 26, no. 6: 1184–1205.

Qian, W., and S. Schaltegger. 2017. "Revisiting Carbon Disclosure and Performance: Legitimacy and Management Views." *British Accounting Review* 49, no. 4: 365–379.

Ramus, C. A., and I. Montiel. 2005. "When Are Corporate Environmental Policies a Form of Greenwashing?" *Business & Society* 44, no. 4: 377–414. https://doi.org/10.1177/0007650305278120.

Russo, M. V., and P. A. Fouts. 1997. "A Resource-Based Perspective on Corporate Environmental Performance and Profitability." *Academy of Management Journal* 40, no. 3: 534–559.

Sahoo, B., S. K. Sahu, and K. Malakar. 2024. "Corporate Social Responsibility and Energy Efficiency: Empirical Evidence From the Manufacturing Sector of India." *Corporate Social Responsibility and Environmental Management* 32, no. 2: 1–22. https://doi.org/10.1002/csr.3020.

Sahu, S. K., P. Bagchi, A. Kumar, and K. H. Tan. 2022. "Technology, Price Instruments and Energy Intensity: A Study of Firms in the Manufacturing Sector of the Indian Economy." *Annals of Operations Research* 313, no. 1: 319–339.

Samantara, R., and S. Dhawan. 2020. "Corporate Social Responsibility in India: Issues and Challenges." *IIMS Journal of Management Science* 11, no. 2: 91–103.

Sardana, D., N. Gupta, V. Kumar, and M. Terziovski. 2020. "CSR 'Sustainability' Practices and Firm Performance in an Emerging Economy." *Journal of Cleaner Production* 258: 120766. https://doi.org/10.1016/j.jclepro.2020.120766.

Shahzad, M., Y. Qu, S. A. Javed, A. U. Zafar, and S. U. Rehman. 2020. "Relation of Environment Sustainability to CSR and Green Innovation: A Case of Pakistani Manufacturing Industry." *Journal of Cleaner Production* 253: 119938. https://doi.org/10.1016/j.jclepro.2019.119938.

Shanyu, L. 2022. "Corporate Social Responsibilities (CSR) and Sustainable Business Performance: Evidence From BRICS Countries." *Economic Research-Ekonomska Istraživanja* 35, no. 1: 6105–6120. https://doi.org/10.1080/1331677X.2022.2047085.

Stjepcevic, J., and I. Siksnelyte. 2017. "Corporate Social Responsibility in Energy Sector." *Transformations in Business and Economics* 16, no. 1: 21–33.

Walley, N., and B. Whitehead. 1994. "It's Not Easy Being Green." *Reader in Business and the Environment* 36, no. 81: 4.

Ye, J., and E. Dela. 2023. "The Effect of Green Investment and Green Financing on Sustainable Business Performance of Foreign Chemical Industries Operating in Indonesia: The Mediating Role of Corporate Social Responsibility." *Sustainability* 15, no. 14: 11218.

Appendix A

TABLE A1 | Correlation matrix and VIF results.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	VIF
(1) EI	1.000							—
(2) CSR	−0.035*	1.000						1.01
	(0.001)							
(3) AGE	0.063*	0.078*	1.000					1.04
	(0.000)	(0.000)						
(4) SIZE	−0.128*	−0.042*	0.148*	1.000				1.05
	(0.000)	(0.000)	(0.000)					
(5) PI	−0.268*	0.011	−0.011	0.119*	1.000			1.02
	(0.000)	(0.296)	(0.302)	(0.000)				
(6) RDI	0.014	−0.003	0.045*	0.004	0.006	1.000		1.02
	(0.203)	(0.772)	(0.000)	(0.698)	(0.560)			
(7) EX	−0.034*	−0.016	0.114*	0.095*	0.020	0.020	1.000	1.00
	(0.002)	(0.135)	(0.000)	(0.000)	(0.065)	(0.061)		

Note: *Significant at 5%.
Source: CMIE Prowess Database.