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Corporate social responsibility and environmental sustainability: Evidence from India using energy intensity as an indicator of environmental sustainability

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Abstract Corporate social responsibility (CSR) expenditure is mandatory for select firms in India. This is an attempt to fix social and environmental responsibility at firm level. As a result of mandated CSR, it is expected that firms will address environmental concerns, which may ensure environmental sustainability. However, the empirical evidence on the role of engagement in CSR and firm's environmental performance is very limited and provides mixed views. This study, therefore, is an attempt to examine the relationship between CSR and one of the environmental sustainability indicators: energy intensity. For this, the study first measures energy intensity using the details of fuel-wise energy consumption. Using the data of 100 firms listed on the Bombay Stock Exchange (BSE) 100 over six years (2009–2010 to 2014–2015), the regression results suggest that at present CSR is not significantly associated with energy intensity. The study has implications for public policy and corporate managers.

Introduction

The current environmental trends are alarming. Thirteen million hectares of forests were lost in the last decade (2000–2010); 90% of water bodies have persistent toxic chemical pollutants; and greenhouse gases are projected to double in the next 50 years, leading to a rise in global surface temperature by 3°C to 6°C (2013).The World Bank estimates the annual cost of environmental degradation in India alone, at 5.7% of the country's GDP (World Bank, 2013). Environmental protection is an integral part of sustainable development, as environment and development are linked through a complex system of cause and effect (Brundtland, 1987). Thus, the sources of environmental degradation assume key importance in this regard and firms have been identified as one of the important stakeholders (others being consumers and the government) influencing environmental sustainability with their behaviour (Shrivastava, 1995). Firms are considered as the primary engine of economic development (Shrivastava, 1995), employment

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(WBSCD, 2014), and have access to financial, technological and institutional resources (Shrivastava, 1995).The process by which firms use "systems and practices to facilitate, maintain and improve the quality of the natural environment in the long term" is known as corporate environmental sustainability (Zoogah, 2014, p. 58). Engagement with corporate social responsibility (CSR) measures might start and even accelerate the process of ensuring environmental sustainability (Berkhout, 2005). This is so, because firms engaging in activities related to protection of natural environment as part of CSR, consider environment as one of their stakeholders and concern areas (Blowfield & Frynas, 2005; Burke, 2005; De Roeck & Delobbe, 2012), along with employment and human rights (Gillis & Spring, 2001). Public policies in developed nations have already considered the multi-stakeholder approach of CSR. However, polices in developing nations are still evolving as CSR is less formalised and more philanthropic (Jamali & Karam, 2016). For instance, the CSR expenditure in Indonesia was mandated in 2007 (Waagstein, 2011), while the CSR reporting in China was mandated for listed firms on the Shanghai and Shenzhen stock exchanges in 2008 (Hung, Shi & Wang, 2013).The CSR expenditure in India has been mandated at 2% of average net profits for selected firms based on turnover and profits under Section 135 of the Companies Act, 2013 (MCA, 2013).

The integration of social responsibility and ensuring environmental sustainability is likely to help firms manage environmental concerns alongside economic growth. However, the welfare impact of CSR on the social and natural environment has yielded mixed results (Lyon & Maxwell, 2008). There is some anecdotal evidence, however, from case-based research that firms improve their environmental performance by engaging in CSR. For instance, a recycled paper manufacturing firm in India reduced its waste water as a result of its engagement in CSR activities (Kanchan, 2010). However, this relationship has not been systematically examined using data extending over long time periods. The lack of empirical studies, particularly in the context of developing nations, may be attributed to the challenges associated in measuring the multidimensional nature of constructs like CSR and environmental sustainability. Therefore, the present study provides systematic and empirical evidence on the relationship using data from firms listed in the Bombay Stock Exchange (BSE) 100 index, over a six-year period from the financial year 2009–2010 to 2014–2015. We examine environmental sustainability using the lens of energy intensity, as energy intensity is one of the commonly used indicators to address environment and climate change concerns. In addition, reduction of energy intensity is not only one of the key elements for a sustainable enterprise (DeSimone & Popoff, 2000) but also is an objective measure (Boustead, 1999).

The findings of the study have implications for policymakers as well as managers. As we move towards mandated CSR information disclosure, the study helps in understanding the integration of CSR with environment aspects, particularly concerning energy management. This may be used for effective policy making and monitoring of social responsibility expenditure. The remaining sections of the study have been organised as follows: the next section presents the literature, including the development of hypotheses. This is followed by the section on research design and the method. Finally, the section on results and conclusions is presented.

Literature review

Corporate environment sustainability and corporate social responsibility

Sustainable development is an integration of the social, economic and environment aspects of development (Brundtland, 1987) and has emerged as an important topic of discussion amongst various units of society such as corporates, the government, the media, non-profit organisations, and consumers. The placement of sustainability in the objective function of the government in the twelfth five year plan of India (2012–2017) described as "faster, sustainable and more inclusive growth" is indicative of the efforts that would be directed towards achieving this goal. Environmental sustainability is an integral aspect of sustainable development. Environment is an important stakeholder for firms, along with shareholders, employees, customers and the community because of their dependence on the environment. As such, firms' activities influence the environment in significant ways. With the growing importance of environmental threats, firms have responded at: (a) a group level – by forming associations to interact with institutions; and (b) an individual level – by initiating and integrating sustainability issues in their mission and strategy (Pogutz, 2008). Bansal and Roth (2000) identified three motivations for firms responding to environmental issues: legitimation, competitiveness, and ecological responsibility. Firms motivated by legitimation focus on complying with norms and regulations to ensure the smooth running of their operations. They focus on the government, local community and their stakeholders. Firms motivated to achieve competitive advantage, aim for profitability through low cost and differentiation (Reinhardt, 1999). Their decision involves cost-benefit analysis with focus on the needs of the customers and investors. Further, firms motivated by ecological responsibility aim at boosting corporate morale. Environmental sustainability indicators provide information on the firms' progress, depending on how the construct of environment sustainability is defined. For instance, Zoogah (2014) defines environmental sustainability in terms of the processes and the practices used by firms that improves the quality of the natural environment in the long term. Haden, Oyler and Humphreys (2009) define corporate environmental sustainability in terms of the environmental practices of green organisations while Siegel (2009) includes environmentally friendly practices. Cowan et al. (2010) explain environmental sustainability in terms of resource management, energy management, and product sustainability. Firms such as Walmart have included waste, energy and product development to indicate their environmental sustainability efforts (Walmart, 2014). One of the indicators widely used in literature as well as in practice, to examine the environmental progress of firms is energy intensity (Cowan et al., 2010; Ranganathan, 1998; Walmart, 2014). Energy intensity is defined as total energy consumption divided by firms' sales (Golder, 2011; Kumar, 2003; Sahu & Narayanan, 2011). The industrial energy consumption is currently dependent upon non-renewable sources of energy such as coal, petroleum and gas (Prasad & Mishra, 2017) and the reduction in energy consumption is likely to reduce energy related environmental threats in the form of pollution, acidification and global warming (Brundtland, 1987).

Similar to the multiple dimensions of environmental sustainability, CSR also leads to varied interpretation with many studies focussing on its meaning and dimensions (Carroll, 1999; Dahlsrud, 2008; Lee, 2008). Carroll (1979) defined social responsibility in terms of voluntary contribution to the community apart from meeting economic and legal requirements. Freeman (2010) explained CSR in the light of firm's responsibility towards the broader group of stakeholders rather than to shareholders alone. Aguinis (2011, p. 855) defines CSR as "context-specific organisational actions and policies that take into account stakeholders' expectations and the triple bottom line of economic, social, and environmental performance."

Economics of corporate social responsibility and corporate environment sustainability

While there are a variety of measures that a firm may adopt to ensure environmental sustainability, including the environment as part of the CSR strategy is argued to contribute positively towards being sustainable (Pogutz, 2008). As both constructs, environmental sustainability and social responsibility, aim at reducing the impact of firms' activities on the environment, there is a complementarity in the definitions that results from both theoretical perspectives and practical perspectives (Pogutz, 2008). Williamson, Lynch-Wood and Ramsay (2006) note that social responsibility includes ensuring environmental sustainability, as the aim of CSR is to integrate social and environmental concerns into the firms' business model. This has also been noted in the Indian CSR regulation, as part of the Companies Act 2013.

The theoretical complementarity between environmental sustainability and social responsibility has been termed as "environmental CSR" that involves firms going beyond compliance to engage in actions that are environment-friendly (Lyon & Maxwell, 2008). The demand for environmental CSR is driven by the level of competition in the market, socially responsible investors, morally motivated employees and pressure from international markets (De Roeck & Delobbe, 2012; Jamali & Karam, 2016; Lyon & Maxwell, 2008). The supply side factors influencing environmental CSR include government regulation and improvement in environmental efficiency to reduce costs (Lyon & Maxwell, 2008). The empirical evidence on the association between social responsibility and impact on environment is scant (Lyon &, Maxwell,2008) and mixed, as some firms in spite of adopting cleaner production and branding themselves as green, continue to derive a major part of their revenues from their previous operations (Portney, 2008). Portney attributes the lack of empirical evidence in this domain to the challenges in measuring and aggregating environmental impacts caused by the firms as well as the lack of consensus on CSR measurement. Previous studies have predominantly focussed on the business case for engaging in CSR. Some studies have examined the impact of CSR on firm value (Crisóstomo, Freire & Vasconcellos, 2011; Jo & Harjoto, 2011; Servaes & Tamayo, 2013) while others have examined the impact on the financial performance (Brammer, Jackson & Matten, 2012; Lin, Yang & Liou, 2009; Pava & Krausz, 1996; Tsoutsoura, 2004). Moreover, most of the previous studies investigating CSR, its determinants, and relationship with other constructs are in the context of developed nations (Brammer et al., 2012; Crisóstomo et al., 2011; Jo & Harjoto, 2011; Lin et al., 2009; Pava & Krausz, 1996; Servaes & Tamayo, 2013; Tsoutsoura, 2004). Findings from these studies may offer limited insights into developing nations as developed nations are subject to many environmental regulations that influence firms' decision to engage in environmental actions. On the other hand, developing nations suffer from either a lack of environmental regulations or their poor enforcement (Reinhardt & Stavins, 2010). Developing nations have a different economic structure and institutional set-up making their case distinctly different from that of their developed counterparts (Jamali & Karam, 2016; Prasad & Mishra, 2017). For instance, in India, businesses are mainly family-style management with weak implementation of CSR guidelines and poor reporting (Kansal, Joshi & Batra, 2014). Further, firms have been found to disclose environmental information in their annual reports to secure legitimacy (Prasad, Mishra & Kalro, 2016).

The growing importance of context dependent CSR coupled with the lack of empirical evidence on the impact of social responsibility on environment motivated us to examine the relationship in the Indian context. India is an emerging economy facing the twin challenges of managing economic growth and environmental concerns. It is now mandated for firms to incur CSR expenditure in order to improve firms' accountability towards stakeholders, including accountability to the environment. As per the guidelines in the Companies Act, 2013, eligible firms (based on specified turnover or net profit) should constitute a CSR committee of the Board and spend at least 2% of the average profits earned in three immediately preceding years, on CSR activities (MCA, 2013). The regulation came into effect in April 2014. This government regulation is likely to shift the supply of environmental CSR upwards, forcing firms to engage in environmental CSR at the same level of production. This is likely to help firms improve their environmental performance as a result of investment in environmental actions as part of the CSR strategy (Lys, Naughton & Wang, 2015). Social responsibility and environment performance in this case will have a positive relationship. However, one of the dimensions of CSR is its voluntary nature (Williamson et al., 2006) and so, even within the mandate to incur social responsibility expenditure, firms have the discretion to select specific areas for investment. In India, firms may invest in various areas such as the environment, education, sanitation, and community development as part of their social responsibility. Given the voluntary nature of the CSR activities, firms may diversify into areas other than the environment, if they do not expect the demand for environmental CSR to increase. In such a scenario, firms are likely to invest in the improvement of the environment when they have excess resources, thereby making their engagement an act of charity and this would suggest no association between social responsibility and environmental improvement (Lys et al., 2015). Rai & Bansal, 2014 note that in the context of India, firms incur more CSR spending in the social sector as compared to the environment. Their claim is based on a qualitative study of annual reports of firms from diverse industries. Further, a longitudinal study of social responsibility expenditure of 30 companies of the BSE Sensex showed that environment is not a priority area for CSR in India (Verma & Kumar, 2014). However, these studies were

conducted before the CSR regulation as part of the Companies Act, 2013, and it is likely that firms may have increased allocation to environment in the post regulation period. For the year 2014–2015, the CSR expenditure of the top 20 Indian firms shows that ensuring environmental sustainability is the third most focussed area, accounting for around 20% of total CSR expenditure, after education and healthcare (PIB, 2015).

Research design

This is a descriptive study examining the association between corporate social responsibility and corporate environment sustainability. The unit of analysis is "firm".

Selection of variables

We operationalise the concept of corporate environmental sustainability using the lens of energy intensity as:

$$EI_{it} = EC_{it}/Sales_{it}$$

Where *i* represents firm, *t* indicates time period

EI_{it} is energy intensity of firm *i* in period *t*
EC_{it} is energy consumption by firm *i* in period *t*
$Sales_{it}$ is sales of firm *i* in period *t*

We measure energy consumption as both an economic unit and a physical unit. As an economic (monetary) measure, it is calculated as power and fuel expenditure divided by sales. Most of the previous Indian studies on energy, have defined energy intensity in monetary units (Golder, 2011; Kumar, 2003; Sahu & Narayanan, 2011), probably due to inconsistent data available on energy consumption in physical units. However, it is possible that energy prices may influence the expenditure on energy consumption depending upon the contracts of the firms, making energy intensity in economic units a biased indicator. In order to address this concern, we also calculate energy intensity based on physical energy consumption, in case of firms that have disclosed energy details. Section 217(1)(e) of Companies (Disclosure of Particulars in the Report of Board of Directors) Rules, 1988 requires firms from 21 specified manufacturing industries to disclose details of energy consumption in their annual reports (1988).

Firms consume energy from various fuels and report information in different units such as kilo-watt, tonne, and kilolitre. In order to arrive at an aggregate physical energy consumption, we follow the procedure similar to Prasad and Mishra (2017) to convert physical units of energy consumption into comparable energy units across firms.

1. Classification: The fossil fuel sources of energy are classified into solid, liquid, and gaseous fuels. Solid fuels include coal and coal variants, while liquid fuels include furnace oil, liquefied petroleum gas, high speed diesel, light diesel oil and kerosene. The fuel classification used in the present study is shown in Table 1.

2. Consolidation: Firms use different units for reporting, including physical units such as tonnes, volume units such as kilolitres and energy units such as kilo-watt hour (kwh). In order to make different units comparable we first convert volume units into physical units and then convert the physical units into energy units. Volume units are converted into physical units using their specific gravity/relative density with water. Physical units are converted into energy units using their net calorific value (NCV) (refer to Table 1 for details of NCV). In case of electricity consumption, the firms have reported consumption in kilowatt-hour, which is converted into gigajoules. Finally, all energy units are aggregated to arrive at one figure expressed in gigajoules.

3. Comparison: To calculate energy intensity for comparison across firms, we use the energy consumption (expressed in gigajoules) arrived at in step 2 and divide it by the firm's sales. The calculated energy intensity is used as measure to understand environmental sustainability.

Corporate social responsibility is measured by aggregating expenditure on account of donations, social and community expenses, and environment and pollution control related expenses. This indicator has been used in a few other Indian studies as well (Rai & Bansal, 2014; Verma & Kumar, 2014). In addition, we examine standalone reports such as business responsibility/sustainability reports/CSR annual reports of companies and corporate websites for CSR expenditure. Expenditure on CSR is adjusted for firm size by dividing the social responsibility expenditure with firm sales (as a measure of size).We examine the relationship between social responsibility and energy intensity by including and excluding pollution control expenses to control for any compliance driven expenditure.

Apart from the main variables of interest, literature suggests that there may be other firm specific characteristics that might influence the relationship between social responsibility and environmental sustainability indicators. We use the variables – industry, size, age and R&D – as control variables in our model as these variables have been used in most of the previous energy related studies in the Indian context.

Table 1 Fuel conversion: calorific value and density for mass conversion.

Solid fuel (coal and coal variants)	Net calorific value (NCV) (GJ/ton)	Fuel density for mass conversion. (ton/kl)
Coal	19.33	
Lignite	16.75	
Coke	28.20	
Coking coal	24.06	
Non-coking coal	19.14	
Steam coal	19.14	
Liquid fuels		
Liquefied petroleum gas	47.26	0.5602
Furnace oil	41.19	0.9337
High speed diesel	43.28	0.8263
Light diesel oil	41.30	0.8532
Kerosene	43.70	0.7782
Gaseous fuels		
Refined liquefied natural gas	0.038	
Gas	0.038	

Source: Prasad and Mishra (2017).
Electricity conversion factor (from kilowatt-hour to gigajoule): 0.0036.

Industry: Firms belonging to high pollution intensive industries incur higher social and environmental expenditure to secure legitimacy from society (Patten, 2002; Prasad et al., 2016). In India, Kansal et al. (2014) also found industry to be a significant variable in influencing CSR reporting in a sample of 80 companies. In addition, firms from high pollution intensive industries may be motivated to allocate a higher proportion of their CSR towards environment concerns as compared to firms from nonpollution intensive sectors. Patten (2002) found that firms from the environmental sensitive industry and non-environmental sensitive industry exhibited different relationship with environment performance and disclosures in the case of the US firms. This suggests that an interaction term between industry and CSR expenditure may also be important in the Indian context. Our study uses the classification scheme of Red, Orange, and Green (in decreasing order of severity of pollution) of the Ministry of Environment, Forest and Climate Change (MOEF, 1999) to classify firms as high pollution intensive. The categorisation of firms was obtained from online databases of the various State Pollution Control Boards.

Size: Larger firms have been found to invest in environment improvement as they are likely to attract public pressure on their environmental impact (Patten, 2002). They are more likely to thus reduce their impact on the environment by reducing consumption of resources such as energy. In India too, large firms have attracted environmental regulations in form of (a) CSR regulation as part of the Companies Act, 2013 (MCA, 2013) (b) Business Responsibility Report to be furnished as part of listing agreement by Securities and Exchange Board of India (SEBI, 2012) and (c) targets to reduce energy intensity under Perform-Achieve-Trade scheme (BEE, 2012). Moreover, large firms enjoy economies of scale and scope that may help them reduce their energy intensity (Cowan et al., 2010; Kansal et al., 2014). However, Mandal and Madheswaran (2011) highlight that as size is a measure of market power, it may also result in X-inefficiencies in production and lead to higher energy consumption. Golder (2011) found significant negative relationship between size and energy intensity in case of Indian manufacturing firms but no significant relationship in a sub-sample of energy intensive firms. This suggests a mixed relationship between size and environmental sustainability indicator. Further, some studies in the Indian context have also found support for a non-linear relationship between size and energy intensity (Sahu & Narayanan, 2011); and size and energy efficiency (Mandal & Madheswaran, 2011).

Age: Previous studies in India suggest mixed results between age and energy intensity of firms. Some studies find a positive relationship between age and energy intensity (Golder, 2011; Sahu & Narayanan, 2011) indicating that older firms with longer years into operation are likely to have higher energy intensity on account of older technology and lower flexibility to adapt to new technological changes. However, Mandal and Madheswaran (2011) find a positive relationship between age and energy efficiency suggesting that older firms enjoy the benefits of experience and learning, and thus, they are likely to have lower energy intensity. Further, Kumar (2003) did not find age to be significantly associated with energy intensity in a sample of manufacturing firms.

Research and development (R&D): R&D is a measure of firm innovativeness. Firms that invest in R&D are expected to be more innovative and include better technological advancements that may include technologies for cleaner production (Clarkson, Li, Richardson & Vasvari, 2008). This is likely to result in lower energy intensity. Some of the previous studies set in the Indian context, have found a mixed relationship between R&D intensity and energy intensity. Golder (2011) found significant negative relationship between R&D intensity and energy intensity using data of manufacturing firms, but not in the case of a sub-sample from the energy intensive sector. Sahu and Narayanan (2011) report a positive relationship between R&D intensity and energy intensity using a sample of manufacturing firms and suggest that the nature of research expenses is as important as the amount of R&D to understand the relationship. In addition, there are studies that have not found R&D intensity to be significantly related to energy intensity (Kumar, 2003). Prasad and Mishra (2017) also do not find significant relation between research expenditure and energy related carbon dioxide emissions in the case of Indian steel firms.

Table 2 presents the measurement of variables along with the posited relationship with energy intensity.

Table 2 Description and measurement of variables.

Variables	Measurement	Posited relationship with energy intensity
Energy intensity	(a) Economic unit – power and fuel consumption divided by sales (b) Physical unit – energy consumption in gigajoules divided by sales	
Social responsibility expenditure	Expenditure on account of donations, social and community expenses, and environment and pollution control related expenses.	+/− or no significant relationship
Industry	Binary variable (1/0) to indicate whether the firms belong to environmental sensitive industry and non environmental sensitive industry	+
Size	Sales expressed in natural log	+/−
Age	Difference between year of incorporation and the year of study	+/−
R&D	Expenditure towards research and development divided by sales	+/−

Data sample

We selected firms listed on the BSE 100 index as they represent large and listed firms. These firms are likely to spend towards CSR in order to comply with recent guidelines that mandate firms to spend on social responsibility activities (MCA, 2013). Apart from regulatory compliance, these firms are expected to spend towards CSR in order to secure legitimacy from multiple stakeholders (Ahmad & Tower, 2011). Out of these 100 firms, we excluded banking and financial services firms, as they did not disclose energy consumption data (in either monetary or physical units). This reduced the final sample to 81 firms. The time period of the study covers six years from 2009-2010 to 2014-2015. This period includes two phases for Indian firms - pre- and post-CSR expenditure regulation. Firm data is obtained from the CMIE Prowess database (2017) and their annual reports from the website.

Econometric model

We use panel data regression to examine the relationship between energy intensity and social responsibility, modelled as:

$$E_{it} = \alpha_0 + \beta_1 CSR_{it} + \beta_2\ Industry_{it} + \beta_3\ Size_{it} + \beta_4 (Size_{it})^2 + \beta_5\ R\&D\ Intensity_{it} + \beta_6\ CSR_{it} X\ Industry_{it} + \varepsilon_{it}$$

Where *i* indicates firm

t indicates time period from 2009-2010 to 2014-2015
E is energy intensity for firm *i* in period *t*
CSR is corporate social responsibility expenditure of firm *i* in period *t*
Industry is a dummy variable to indicate a firm in Red and Orange categories.
Size is measured as natural log of sales of firm *i* in period *t*
R&D intensity is research and development expenditure of firm *i* in period *t* divided by the sales of firm *i* in period *t*
CSR × Industry is an interaction term to capture the influence of social responsibility expenditure made by firms belonging to pollution intensive industries.

Results and discussion

Energy consumption in economic units (INR) was available for 81 firms in the sample while energy consumption in physical units was available for sub-sample of 40 firms. Thus, we run two regression analyses: the first analysis uses energy intensity in economic units as a dependent variable. The second analysis uses energy intensity in physical units as a dependent variable and supplements the results of the first regression by providing insights from the sub-sample. This is discussed under the section: Regression analysis using energy intensity in physical unit

Descriptive statistics

Mean corporate social responsibility expenditure as a proportion of sales has been constant over the financial years 2011 to 2014 at 1% and has increased to 4% in FY2015. On the

Table 3 Descriptive statistics.

	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015
Energy intensity (monetary unit)						
Mean	0.05	0.05	0.05	0.05	0.06	0.05
Median	0.01	0.01	0.01	0.01	0.01	0.02
St. dev	0.11	0.13	0.14	0.14	0.17	0.13
CSR/sales						
Mean	0.02	0.01	0.01	0.01	0.01	0.04
Median	0.00	0.00	0.00	0.00	0.00	0.00
St. dev	0.08	0.03	0.03	0.02	0.06	0.21
Size (log)						
Mean	4.68	4.80	4.87	4.94	5.00	5.02
Median	4.76	4.84	4.94	4.98	5.03	5.05
St. dev	0.94	0.87	0.86	0.82	0.80	0.80
Age (log)						
Mean	3.43	3.47	3.51	3.55	3.59	3.58
Median	3.50	3.53	3.56	3.58	3.61	3.64
St. dev	0.77	0.72	0.69	0.66	0.64	0.73
R&D intensity						
Mean	0.01	0.03	0.05	0.01	0.01	0.01
Median	0.00	0.00	0.00	0.00	0.00	0.00
St. dev	0.02	0.22	0.38	0.03	0.03	0.03
Industry						
Mean	0.43	0.43	0.43	0.43	0.43	0.43
Median	0.00	0.00	0.00	0.00	0.00	0.00
St. dev	0.50	0.50	0.50	0.50	0.50	0.50

$n = 81$.

other hand, energy intensity (monetary unit), remained around 0.05 for the period under study. Forty-three per cent of the sample firms belong to pollution intensive industries (in either the Red category or Orange category). Mean size of the firm has increased from INR 107.66 million to INR 151.66 million, while average age of the firms has increased from 30.86 years to 35.76 years. R&D intensity is 1% in FY2010 and has increased to 3% and 5% in FY2011 and FY2012, respectively. However, it declined to 1% for the last three years of the study. Table 3 presents the summary statistics.

Table 4 presents the correlation amongst the variables. As seen in the table, the correlations between independent variables are very low, in the range of 0.10–0.30.

Regression analysis using energy intensity in monetary unit

We estimated the results using pooled ordinary least square (POLS), fixed effect and random effects. The results are presented in Table 5. White standard errors (robust standard errors) are used as heteroskedasticity was found to be present in all the models. In addition, multicollinearity was not significant with mean variance inflation factor at 1.44 under POLS.

Model 1 presents results of pooled OLS. The coefficient of the CSR intensity is not significant, suggesting that CSR is not associated with energy intensity. However, the interaction term of industry and the CSR intensity has a significant negative relationship. This suggests that for firms from pollution intensive industries, the CSR expenditure is associated with lower energy intensity. Size has a significant negative coefficient while size square is positively related to energy intensity. Firm age is negatively associated with energy intensity although the coefficient is not significant. On the other hand, R&D intensity is negatively related to energy intensity, implying that firms that spend more on R&D are likely to

Table 5 Regression results.

Variables	POLS	Fixed effect	Random effect
	Model 1	Model 2	Model 3
CSR intensity	0.0799	0.0358	0.0397
	(0.249)	(0.0343)	(0.0297)
Size	−0.403***	−0.197	−0.233
	(0.142)	(0.154)	(0.145)
Age	−0.00866	−0.00946	−0.00652
	(0.00995)	(0.0214)	(0.0172)
R&D intensity	−0.148***	−0.0844*	−0.0924*
	(0.0430)	(0.0443)	(0.0481)
Industry	0.0112		0.0131
	(0.00982)		(0.0181)
$(\text{Size})^2$	0.0382***	0.0152	0.0194
	(0.0137)	(0.0169)	(0.0144)
CSR × industry	−1.129***	−0.611*	−0.675*
	(0.298)	(0.348)	(0.358)
D1	0.0115	0.00977	0.00977
	(0.0165)	(0.00743)	(0.00736)
D2	0.0176	0.0174	0.0170
	(0.0177)	(0.0112)	(0.0105)
D3	0.0191	0.0214	0.0204*
	(0.0180)	(0.0129)	(0.0118)
D4	0.0262	0.0289	0.0277
	(0.0210)	(0.0185)	(0.0171)
D5	0.0221	0.0262	0.0247*
	(0.0146)	(0.0164)	(0.0143)
Constant	1.099***	0.661*	0.720*
	(0.355)	(0.360)	(0.375)
Observations	486	486	486
R^2	0.301	0.120	0.120
Number of firms		81	81

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 4 Correlation matrix.

	Energy intensity	CSR intensity	Size	Age	R&D intensity	Industry	Size^2	CSR × industry
Energy intensity	1							
CSR intensity	0.244	1						
	0.000***							
Size	−0.361	−0.361	1					
	0.000***	0.000***						
Age	−0.092	−0.072	0.268	1				
	0.042**	0.116	0.000***					
R&D intensity	−0.033	0.050	−0.236	−0.173	1			
	0.463	0.269	0.000***	0.000***				
Industry	−0.031	−0.073	0.220	−0.118	0.107	1		
	0.495	0.110	0.000***	0.010**	0.018**			
Size^2	−0.304	−0.308	0.984	0.262	−0.188	0.250	1	
	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***		
CSR × industry	−0.025	0.282	−0.248	−0.189	0.214	0.102	−0.187	1
	0.579	0.000***	0.000***	0.000***	0.000***	0.025**	0.000***	

The first value represents the correlation coefficient while the second value represents the *p*-value.
*** represents significance at 1%, ** at 5% and * at 10%.

experience improvements in terms of clean technologies that reduce energy intensity. The results support earlier findings (Clarkson et al., 2008; Golder, 2011).

Model 2 presents the results of fixed effect regression. The results suggest that the CSR intensity is not significantly associated with energy intensity although the coefficient is positive, supporting the results of Model 1. The interaction variable of CSR intensity and industry has significant negative relation with energy intensity, suggesting that firms from pollution intensive industries spend towards energy reduction measures as part of their social responsibility. Size and age coefficients are not significant after controlling for firm fixed effects in fixed effect regression. Industry has been dropped due to multicollinearity issues. R&D intensity is negatively associated with energy intensity.

The results of random effect regression under Model 3 suggest no significant association between CSR intensity and energy intensity. Further, the interaction term of CSR intensity and industry have significant negative influence on energy intensity. R& D intensity is negatively associated with energy intensity. Year dummies D3 and D5 are significant. D3 is the time period dummy for year 2012–2013, the year when the CSR expenditure was mandated; and D5 is the time period dummy for year 2014–2015, the year when mean CSR expenditure of firms is highest post the mandate. In order to select the estimates of fixed effect and random effect, we conducted Hausman test with null hypothesis that the differences in coefficients are not systematic and could not be rejected at χ^2 value of 5.48 (*p-value:* 0.906), implying that results from random effect estimators are appropriate.

We also examined the nature of pollution control expense in order to understand whether the nature of pollution control expense affects the implications of the study. Though the firms have not disclosed the nature of this expense, preliminary analysis suggests that it is voluntary in nature. If the expense was indeed compliance driven, it is very likely that all firms belonging to a particular sector would have incurred the expenditure to meet the compliance norms. However, this is not the case here. Of the 81 firms in our sample, only six firms have disclosed information on "pollution control expenses" and this is not a significant portion of their total social responsibility expenditure. Besides this, we have statistically re-examined the validity of our results. The correlation between the CSR expenditure before and after including pollution expenses suggests a high correlation with Pearson correlation coefficient at 0.994 (*p-value:* $\leq$ 0.001). Further, the null hypothesis of zero mean difference amongst the CSR intensity measures, before and after excluding pollution expenses, could not be rejected (*t-value*: −0.0661; *p-value*: 0.947). This suggests that including or excluding pollution control expense from social responsibility does not influence the relationship between social responsibility and energy intensity.

Regression analysis using energy intensity in physical unit

In order to supplement the initial results, we use energy consumption in physical unit for a sub-sample that has disclosed details of fuel-wise energy consumption. The sub-sample data of 40 firms over FY2010 to FY2015, is an unbalanced panel with the mean energy intensity of 170 gigajoule per million of rupee sales and standard deviation of 284.425. The large value of standard deviation suggests the wide variation in energy consumed across firms as the firms belong to diverse industries. The descriptive statistics of the sub-sample, in comparison to the overall sample, is presented in Table 6. Firms in the sub-sample are much larger as compared to overall sample firms with higher age. Further, 61% of the sub-sample firms belong to pollution intensive industries. There is a moderate positive correlation between the two measures of energy intensity (physical unit and monetary unit) with the Pearson product-moment correlation coefficient at 0.545 (*p-value:* $\leq$0.001).

The result of regression using energy intensity (in physical unit) is presented in Table 7. Year dummies have not been included as the coefficients were found to be insignificant. In addition, the hypothesis about coefficients of year dummy jointly being equal to zero could not be rejected at 1% (*p-value*: 0.155).

Model 4 presents the results of pooled OLS regression where CSR intensity is positively associated with energy intensity. Size has a significant positive coefficient while size square has a significant negative coefficient suggesting an inverse U shape relationship with energy intensity. Age is negatively associated with energy intensity suggesting older firms have lower energy intensity. R&D intensity is negatively associated with energy intensity, which in turn suggests that firms spending higher on research and

Table 6 Descriptive statistics of sub-sample and overall sample.

	Sub-sample		Total sample	
	Mean	Standard deviation	Mean	Standard deviation
No. of firms	40		81	
Industry (pollution intensive)	0.61	0.49	0.43	0.50
CSR intensity	0.002	0.003	0.014	0.099
R&D intensity	0.015	0.032	0.021	0.180
Age (years)	3.76	0.53	3.53	0.68
Size (Rs million)	11.68	1.41	4.89	0.85
Energy intensity (economic unit)	0.050	0.055	0.052	0.137
Energy intensity (physical unit) (GJ/INR million sales)	170.06	284.42		

Table 7 Regression results of sub-sample.

Variables	POLS model	Fixed effect	Random effect
	Model 4	Model 5	Model 6
CSR intensity	13.45*	1.567	1.063
	(6.868)	(1.762)	(1.400)
Size	1.169***	0.153	0.185
	(0.137)	(0.171)	(0.143)
Age	−0.0915***	−0.576*	−0.174
	(0.0301)	(0.290)	(0.147)
R&D intensity	−3.891***	1.961**	−0.662
	(0.482)	(0.782)	(0.470)
Industry	0.306***		0.162
	(0.0365)		(0.109)
CSR × industry	−16.00	8.237	4.818
	(12.25)	(9.424)	(11.63)
Size square	−0.0486***	−0.00709	−0.00966
	(0.00559)	(0.00672)	(0.00612)
Constant	−6.547***	1.490	−0.0894
	(0.798)	(0.951)	(0.819)
Observations	202	202	202
R-squared	0.428	0.320	
Number of firms		40	40

Robust standard errors in parentheses.
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.
Dependent variable: energy intensity expressed in terajoule/million sales.

development are likely to reduce their energy consumption. Industry is positively associated with energy intensity implying that firms from pollution intensive industries are energy intensive. The interaction term of CSR and industry is not significant.

The panel data regression results are presented under Model 5 and Model 6.Model 5 presents the results of fixed effect regression. CSR intensity has a positive coefficient but is not significantly related to energy intensity. This suggests that after controlling for firm fixed effects, the initial relationship observed between CSR intensity and energy intensity is not significant. Size and size square are not significantly related to energy intensity while age has a negative significant coefficient similar to POLS results. R&D intensity is positively related to energy intensity. This is in contrast to the negative relationship found in Models (1–4). After controlling for firm fixed effects, the positive relationship may be due to the nature of expense incurred under R&D. Firms could be spending more in areas other than energy reduction as part of their research and development efforts. Model 6 presents the results of random effect regression. CSR intensity is not significantly associated with energy intensity although the sign of coefficient is positive. The other control variables size, age, industry and R&D intensity are also not significant. Hausman test was conducted to examine the fit of the model, and the null hypothesis that the random-effects model adequately models the individual level-effects is rejected at $\chi^2 37.89$ (*p-value:* ≤ 0.001) in favour of the fixed effects model.

Overall, the panel data regression results using both monetary and physical units of energy intensity suggest that there is no significant relation between CSR intensity and energy intensity. Further, industry is not significantly associated with energy intensity, and this suggests that the firms from pollution as well as nonpollution intensive sectors may have high energy intensity. Size coefficient is insignificant, and a plausible reason could be that the sample data is drawn from BSE 100 firms that represent large firms from individual sectors. Further, Golder (2011) also reports a similar result in case of energy intensive firms. When using the economic measure of energy intensity, the interaction term of industry and CSR intensity is negatively related to energy intensity. This suggests that firms from the pollution intensive industry use social responsibility expenditure to reduce their energy intensity. However, when the physical measure of energy intensity is used in case of the sub-sample, the regression results indicate that the interaction term is not significant. This is because the social expenditure as a proportion of sales, incurred by firms in the sub-sample (mean CSR intensity: 0.2%) is much lower when compared to the total sample (mean CSR intensity: 1.4%). Further age, in case of the overall sample, is not significantly associated with energy intensity, supporting the findings of Kumar (2003). However, in case of the sub-sample, age is negatively related to energy intensity. This suggests that older firms may use their experience and expertise in better input allocation and process design that reduces energy intensity. Mandal and Madheswaran (2011) also find positive relationship between age and energy efficiency in the case of Indian cement companies. In case of the sub-sample, R & D intensity is negatively associated with energy intensity in case of pooled regression. However, after controlling for firm fixed effects, R&D intensity is positively related to energy intensity. On the other hand, the coefficient of R&D intensity is significantly negative in case of the overall sample. This suggests that higher R & D expenditure leads to innovation that reduces energy consumption. However, as the firms have not disclosed the nature of research expenses, it is possible that in case of the sub-sample, the firms are focussing more on other areas. This, in turn, leads to higher energy consumption. Sahu and Narayanan (2011) also report a positive relationship between R&D intensity and energy intensity in case of manufacturing firms.

Conclusion

Expenditure on CSR has been mandated in India to improve firms' accountability and to encourage incorporation of sustainable strategies. Firms may use CSR expenditure to improve their environmental performance as CSR focuses on social and environmental aspects. However, the link between CSR and environmental sustainability has not been investigated in detail. The present study, therefore, examines the relationship between CRS and corporate environmental sustainability using the concepts of economics of environmental CSR. Firms' investment in social responsibility is measured using size adjusted CSR. Environmental sustainability is examined through energy consumption: energy intensity, measured in both monetary and physical units. Panel regression results based on firm data of BSE 100 index over the time period FY 2009–2010 to FY 2014–2015 suggests no significant association between CSR and energy intensity.

However, there is a negative relationship between social responsibility expenditure and energy intensity (monetary unit) for firms belonging to pollution intensive industries.

The study has implications for policymakers and company managers. Policymakers may leverage the CSR mechanism to fix environmental responsibilities at firm level. For this, the enforcement and monitoring of CSR disclosure regulation may be strengthened. The expenditure on CSR has increased in year 2014–2015, the first year of compliance by BSE 100 index firms, suggesting the influence of institutional pressure. However, there is no significant association between CSR and energy intensity. This suggests that firms have to be incentivised to invest in environmental improvement as part of their social responsibility. One of the approaches may include supplementing the principles of national voluntary guidelines (the basis for selecting areas for incurring social responsibility expenditure) to include details on energy conservation and energy efficiency initiatives. Further, there should be programmes for firms, informing them about various environmental issues and ways in which they may contribute in reducing environmental degradation. The Bureau of Energy Efficiency presently mandates energy labelling for selected categories of products and energy audits for firms covered under the Perform, Achieve, Trade (PAT) programme. These initiatives may be extended to other products and firms from industries that are not covered under PAT so that all firms are encouraged to undertake environmental initiatives. In addition, firms may be incentivised to spend more towards research and development as it helps firms to reduce energy consumption. Company managers may use the findings of the study for benchmarking purposes. Firms may invest in environmental improvement as part of CSR and gain competitive advantage. Further, they may communicate their efforts through disclosures in their annual report/ business responsibility report/CSR report to signal their environmental responsiveness.

The study has some limitations as well. First, the study has examined the relationship between social responsibility expenditure and environmental sustainability in the case of large and listed firms. This may be extended to include small and medium enterprises as they also contribute to environmental degradation. Second, the role of institutional pressure may be examined in detail, as an influence on CSR. Third, we have used energy intensity as an indicator for environmental sustainability. Future studies may extend this to include other indicators such as emissions and waste, depending upon the availability of data.

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