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Board Characteristics as Drivers of Corporate Social Responsibility: Evidence from the Energy Sector

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ABSTRACT

This study explored the impact of board diversity on corporate social responsibility (CSR) performance in the Indian energy sector. The research examined how size of the board, gender diversity, duality of CEO on the board, and independence of board members influence firms' CSR spending of organisation. Secondary data were collected from annual reports of companies and website of Ministry of Corporate Affairs of top ten energy sector companies for ten-year period. Panel data analysis and fixed effects regression models were employed to determine the relationship between board diversity attributes and CSR outcomes. The fixed-effects results indicate that board size, women directors, CEO duality, and non-executive directors do not have a statistically significant influence on CSR expenditure because all coefficients are insignificant. This study contributes to governance and sustainability literature by providing empirical evidence from a developing economy.

Keywords: Board Diversity, Corporate Social Responsibility (CSR), Gender Diversity, Energy Sector
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1. INTRODUCTION:

Corporate governance has undergone a paradigmatic shift toward greater inclusivity and ethical accountability. Board diversity has emerged as a vital determinant of corporate social responsibility (CSR) engagement, particularly in the energy sector (Kasradze et al. 2023). The intersection between board composition and CSR practices has gained scholarly and policy attention due to its potential to enhance environmental stewardship, social inclusion, and transparency within energy-intensive industries (Menicucci & Paolucci, 2025; Bel-Oms & Pucheta-Martínez, 2025). Diverse boards are believed to foster a broader range of perspectives and ethical values, thereby driving strategic CSR initiatives and long-term sustainability performance (Zhao & Zhang, 2025; Tran, 2025).

The energy sector, given its environmental impact and economic prominence, stands at the forefront of CSR debates (Ibrahim, 2025; Jaiwani, Rajput, & Singh, 2025). Energy companies face growing scrutiny from stakeholders to balance profitability with social and environmental accountability. Consequently, firms with diverse boards whether in gender, ethnicity, expertise, or international experience are often better equipped to respond to these multidimensional challenges (Azyyati & Helmina, 2025; Vo, 2025). Empirical research suggests that board gender diversity, in particular, positively influences CSR disclosure, enhances ethical governance, and strengthens organizational legitimacy in socially sensitive sectors (Zhao & Zhang, 2025; Remo-Diez & Mendaña-Cuervo, 2025).

Board diversity contributes to improved ESG (Environmental, Social, and Governance) outcomes through the infusion of pluralistic perspectives into decision-making processes (Eliakim, 2025; Mishra & Mishra, 2025). Such diversity enhances board independence and mitigates groupthink. This leads to policies that prioritize social responsibility. CSR also depends on the business ethics that are being followed by an organization (Nassè et al.2024). As the global energy transition accelerates, diverse boards may act as catalysts for responsible innovation and stakeholder trust and positions CSR not only as compliance but as a strategic driver of competitive advantage. Stakeholders participation have positive impact on the social engagement (Upadhyay et al. 2025).

This study explores how board diversity functions as a driver of CSR performance in the energy sector (Ibrahim & Hanefah, 2016; Kasradze et al. 2023). This integrates insights from recent corporate governance literature and industry-specific data. It argues that board heterogeneity through gender, professional, and cultural diversity plays a pivotal role in shaping CSR outcomes.

2. LITERATURE REVIEW

Board size and CSR

Agency theory suggests that larger boards provide stronger monitoring and reduce managerial opportunism, thereby encouraging firms to allocate resources toward CSR investments that benefit stakeholders (Pfeffer & Salancik, 2015). Empirical evidence shows that firms with larger boards tend to disclose more CSR activities and allocate higher

CSR budgets, indicating a positive association between board size and CSR engagement. (Haniffa & Cooke, 2005).

Research conducted across multiple countries finds that larger boards are better equipped to understand stakeholder needs and promote CSR initiatives that require long-term financial commitmen. (Khan et al., 2013).

Studies focusing on firm-level governance show that larger boards improve decision-making quality and oversight, which often translates into increased CSR expenditure (Jizi et al., 2014).

Evidence from emerging markets demonstrates that larger boards encourage transparency and accountability, motivating firms to invest more in socially responsible programs (Said et al., 2009).

Meta-analytic research concludes that board size is consistently and positively linked with CSR outcomes, although the magnitude varies depending on institutional settings and board composition (Post et al., 2011).

Overall, existing literature supports the hypothesis that larger boards tend to contribute more effectively to CSR expenditure because they enhance monitoring, broaden resource access, and strengthen stakeholder engagement (Jizi et al., 2014).

H1: There is a positive relationship between board size and CSR expenditure.

Women on Board and CSR

Research indicates that female directors change board processes in ways that can strengthen monitoring and oversight, which in turn creates governance conditions favourable to greater CSR investment (Adams & Ferreira, 2009).

Empirical work finds that boards with more women are often associated with higher CSR ratings and greater CSR activity, suggesting a positive link between board gender composition and CSR outcomes (Bear, Rahman, & Post, 2010).

Theoretical accounts emphasize two complementary mechanisms: a monitoring/agency channel (women improve oversight) and a values/stakeholder channel (women bring greater communal orientation and stakeholder sensitivity), both of which plausibly increase CSR expenditure (Kanter, 1977).

Research from emerging markets and regulated industries finds that female directors' effects on monetary CSR investment (actual spending) can be particularly pronounced in state-owned firms or pollution-intensive industries, where stakeholder pressures and public scrutiny are high (Wei, 2017).

Systematic reviews and meta-analyses of board gender diversity and CSR report an overall positive relationship but emphasize substantial heterogeneity across studies driven by measurement (disclosure vs. expenditure), sample country, and estimation method (Wu et al., 2022).

Methodological critiques note potential endogeneity firms already committed to CSR may recruit more women and thus robust causal designs generally yield more modest but still positive effects (Post & Byron, 2015).

Evidence on mechanisms shows that women are more likely to serve on monitoring or sustainability-related committees and to bring relevant expertise or experience (including foreign experience), which helps translate board gender composition into higher CSR spending (Ullah, 2022).

Studies also document context-dependent moderators: board independence, ownership concentration, the presence of a CSR/sustainability committee, and legal mandates (for example, statutory CSR obligations) all influence whether and how board gender composition affects CSR expenditure (Setó-Pamies, 2015).

Recent empirical advances using panel data and more direct monetary CSR measures recommend testing for interaction effects (e.g., number/proportion of women × CSR committee; women × board independence) to capture the conditional nature of the relationship (Wu et al., 2022).

Taken together, the literature supports the hypothesis that a higher number of women on the board is positively associated with CSR expenditure — but the effect is conditional on critical-mass thresholds, board roles, firm ownership and industry context, and requires careful empirical strategies to address selection and endogeneity (Bear, Rahman, & Post, 2010).

H2: A higher number of women on the board is positively associated with CSR expenditure.

CEO Duality and CSR

Research around agency theory says that CEO duality where the CEO also serves as board chair. This concentrates decision-making power and reduces board monitoring and which can encourage managers to prioritize private gains over stakeholder-oriented investments such as CSR, implying a negative effect of duality on CSR expenditure (Jensen & Meckling, 1976).

Empirical studies frequently find that CEO duality is associated with weaker CSR outcomes or lower CSR disclosure, consistent with the governance-weakening prediction of agency theory (Guerrero-Villegas et al., 2018).

Several country-level and firm-level studies report a significant negative relationship between CEO duality and CSR reporting or CSR practices, suggesting that dual leaders may divert firm resources away from stakeholder investments (Voinea, 2022).

Research that explicitly examines CEO duality and CSR expenditure finds that duality reduces actual CSR activity and spending, particularly in mature or declining firms where powerful CEOs may reallocate resources toward private benefit (Bhaskar, 2024).

Meta-analytic and review evidence confirms a tendency for CEO duality to relate negatively to CSR outcomes, while also showing heterogeneity depending on institutional context and measurement of CSR (disclosure vs. monetary expenditure) (Guerrero-Villegas et al., 2018).Studies in state-owned and high-discretion environments show that CEO power (of which duality is a key component) can lead to CSR underinvestment or to CSR decisions that reflect CEO preferences rather than stakeholder needs (Nasir et al., 2023).

A contrasting strand invoking stewardship theory suggests CEO leadership concentration can sometimes enable decisive long-term investments, but empirical tests more often show that the entrenchment and reduced oversight of duality outweigh any decision-speed benefits for CSR spending (Donaldson & Davis, 1991; Ali et al., 2022).

Research using panel methods and robustness checks (fixed effects, alternative CSR measures) strengthens the negative-duality finding and highlights moderators such as board effectiveness, board independence, and external monitoring which can attenuate or reverse the negative effect (Ali et al., 2022).

Several studies therefore recommend governance reforms that separate the CEO and chair roles (non-duality) to strengthen monitoring and improve stakeholder outcomes, including higher and better-targeted CSR expenditure (Bhaskar, 2024; Voinea, 2022).

Taken together, the literature supports the hypothesis that CEO duality tends to have a negative effect on CSR expenditure — although the size and significance of the effect vary by institutional setting, firm lifecycle stage, and the presence of effective mitigating governance mechanisms (Guerrero-Villegas et al., 2018; Bhaskar, 2024).

H3: CEO duality has a negative effect on CSR expenditure.

Non-executive Directors and CSR

Non-executive directors (NEDs) are generally perceived as independent monitors who safeguard stakeholder interests, making them influential in decisions regarding CSR expenditure (Hillman & Dalziel, 2003).

Empirical research frequently finds a positive association between the proportion of non-executive directors and CSR engagement, suggesting that greater board independence encourages firms to allocate more resources to CSR (Khan, Muttakin, & Siddiqui, 2013) .Studies show that boards with a higher number of NEDs exhibit stronger monitoring and transparency, which leads to more responsible environmental and social spending (Michelon & Parbonetti, 2012).

Non-executive directors often demand clearer accountability from management, which pushes firms to invest in CSR activities that enhance legitimacy and long-term sustainability (Jo & Harjoto, 2011).

Research from both developed and emerging markets demonstrates that non-executive directors play a crucial role in improving CSR expenditure by aligning managerial actions with stakeholder expectations (Post, Rahman, & Rubow, 2011).

Studies also reveal that non-executive directors bring wider external expertise and networks, enabling boards to recognize the strategic value of CSR in enhancing reputation and stakeholder relations (Hillman, Cannella, & Paetzold, 2000).

Meta-analytic evidence suggests that board independence primarily represented by non-executive directors has a consistently positive effect on CSR outcomes such as disclosure quality and monetary CSR investments (Walls, Berrone, & Phan, 2012)

Taken together, existing literature shows that a higher number of non-executive directors strengthens board independence, enhances monitoring quality, and ultimately increases CSR expenditure (Jo & Harjoto, 2011).

H4: A higher number of non-executive directors positively influences CSR expenditure.

3. METHODOLOGY

This study employed a quantitative explanatory research design to investigate the influence of board diversity on corporate social responsibility (CSR) expenditure within the Indian energy sector. A panel dataset was made by collecting information from top 10 energy companies listed in NIFTY Energy index in march 2025 and over a 10-year period i.e. from financial year 2014-2015 to 2023-2024 (Ibrahim & Hanefah, 2016). The companies are Reliance industries Ltd, Oil and Natural Gas Corporation Limited, Coal India Ltd, NTPC (National Thermal Power Corporation) Ltd, Power Grid Corporation of India Ltd, GAIL (India) Ltd, Siemens Ltd, CG Power and Industrial Solutions Limited, Tata Power Company Limited, Suzlon Energy Ltd (NIFTY Energy, 2025).

Panel data methods were chosen because they allow the model to control for unobservable firm-specific heterogeneity and provide more reliable estimates compared to pure cross-sectional or time-series analyses (Hsiao, 2022).

Secondary data serve as the basis of this research. Board characteristics including board size, number of women directors, CEO duality and number of non-executive directors were extracted manually from companies' annual reports, corporate governance disclosures which are commonly used data sources in corporate governance research (Mallin, 2019). CSR expenditure data were obtained from the Ministry of Corporate Affairs (MCA) website specifically through CSR-related filings under the Companies Act, 2013 (Ministry of Corporate Affairs, 2023).

The dependent variable for this study is annual CSR expenditure, while the independent variables include board size, number of women on the board, CEO duality, and number of non-executive directors. These governance variables are widely recognized in literature examining the relationship between board composition and CSR expenditure (Bear et al., 2010; Post & Byron, 2015). Although control variables such as firm size, and profitability are often used in governance CSR models, this study focuses primarily on board diversity indicators due to the specific objectives of the research (Harjoto et al., 2014). The panel regression model used to evaluate the relationships is expressed as:

$CSR\_it = \beta0 + \beta1(BSIZE\_it) + \beta2(WOMEN\_it) + \beta3(DUALITY\_it) + \beta4(NONEXE\_it) + \beta5(MARCAP\_it) + \beta6(EBITDA\_it) + \mu\_i + \varepsilon\_it$

Where i = 1,2,...,10 represents firms, t = 2015,…,2024 represents years, μ_i= unobserved firm-specific effect, ε_{it}= error term. The dependent variable is CSR_it represents CSR expenditure and independent variables are BSIZE_it representing Board size, WOMEN_it representing Number of women on the board, DUALITY_it representing CEO duality (dummy: 1 = dual role, 0 = separate roles), NONEXE_it representing Number of non-executive directors (Beji et al., 2020; Endrikat et al., 2020). Control variables are MARCAP_it representing market capitalization and EBIDTA_it representing profitability.

Data analysis includes descriptive statistics, correlation analysis, and panel regression estimation. Both fixed effects (FE) and random effects (RE) models were estimated (Abang'a & Tauringana, 2023). This was followed by the application of the Hausman test to

determine the more appropriate model for interpretation (Wooldridge, 2010). The statistical analyses were conducted using EViews 12 software (Mohammadi et al., 2020).

Because the study relies entirely on publicly available secondary data, no ethical approval or participant consent was required. However, all data sources were properly acknowledged to maintain transparency and academic integrity.

4. DISCUSSION

The statistical analysis was done on the basis of secondary data to find out the result of regression analysis.

Descriptive Analysis

Table 1

	CSR	BSIZE	WOMEN	DUALITY	NONEXE	MARCAP	EBIDTA
Mean	205.4201	11.32000	1.300000	0.050000	6.920000	1794507.	259398.9
Median	93.22500	11.00000	1.000000	0.000000	7.000000	846178.7	133854.3
Maximum	922.0000	17.00000	3.000000	1.000000	11.00000	20106846	1664490.
Minimum	0.000000	6.000000	0.000000	0.000000	2.000000	678.0000	-860.0000
Std. Dev.	258.8714	2.788432	0.717741	0.219043	2.406557	3396110.	328315.0
Skewness	1.290349	0.378221	-0.016474	4.129483	-0.255183	3.858044	1.884119
Kurtosis	3.574288	2.309432	2.628604	18.05263	2.002749	18.29739	6.870419
Jarque-Bera	29.12420	4.371207	0.579251	1228.301	5.229099	1223.117	121.5823
Probability	0.000000	0.112410	0.748544	0.000000	0.073201	0.000000	0.000000
Sum	20542.01	1132.000	130.0000	5.000000	692.0000	1.79E+08	25939888
Sum Sq. Dev.	6634426.	769.7600	51.00000	4.750000	573.3600	1.14E+15	1.07E+13
Observations	100	100	100	100	100	100	100

The table 1 presents the descriptive statistics for all variables used in the panel dataset comprising 100 firm-year observations from 10 energy-sector companies over 10 years. The results provide insights into the distribution, central tendency, and variability of CSR expenditure and the board- and performance-related variables included in the study.

CSR expenditure shows substantial variation across firms and years, with a mean of ₹205.42 crore and a median of ₹93.23 crore, indicating that the distribution is right-skewed. The maximum value (₹922 crore) is considerably higher than the mean, suggesting that a few large firms spend disproportionately more on CSR. The high standard deviation (258.87) further confirms wide dispersion. The skewness (1.29) and kurtosis (3.57) indicate a positively skewed, moderately leptokurtic distribution. The Jarque–Bera test is significant ($p < 0.01$), confirming non-normality.

Board size ranges from 6 to 17 directors, with a mean of 11.32, showing relatively stable board structures in the sector. The distribution is approximately symmetric (skewness 0.38) and mesokurtic (kurtosis 2.30). The Jarque–Bera probability (0.112) indicates that BSIZE is fairly normally distributed.

The number of women on the board ranges from 0 to 3, with a mean of 1.30. The median of 1 implies that most boards have at least one woman director, consistent with regulatory requirements after 2013. The distribution is almost symmetric (skewness –0.01) with normal kurtosis, and the Jarque–Bera test ($p = 0.748$) confirms normality. CEO duality is a binary variable, with a mean of 0.05, indicating that only 5% of observations reflect cases

where the CEO also holds the chairperson position. Since the variable is categorical, skewness (4.13) and kurtosis (18.05) are expected to be high. The Jarque–Bera test is significant ($p < 0.01$) due to the binary nature of the variable.

The number of non-executive directors has a mean of 6.92, with values ranging from 2 to 11. The distribution is approximately symmetric (skewness –0.25) and slightly platykurtic (kurtosis 2.00). The Jarque–Bera test ($p = 0.073$) indicates marginal but acceptable normality. Market capitalisation shows extremely high dispersion, with a mean of ₹1,794,507 crore and a very large standard deviation (3,396,110). The maximum value far exceeds the mean, reflecting the presence of very large firms in the sample. The variable is positively skewed (3.86) and highly leptokurtic (18.29), indicating concentration of extremely high values. The distribution is not normal ($p < 0.01$).

EBITDA also exhibits large variability, with a mean of ₹259,398 crore and a standard deviation of 328,315, suggesting substantial differences in profitability among firms. The variable is positively skewed (1.88) and exhibits high kurtosis (6.87), indicating a right-tailed distribution with a few very high-profit firms. The Jarque–Bera statistic ($p < 0.01$) confirms non-normality.

Correlation Analysis

Table 2

	CSR	BSIZE	WOMEN	DUALITY	NONEXE	MARCAP	EBIDTA
CSR	1.000000	0.372979	0.034571	0.056866	0.094221	0.726819	0.887536
BSIZE	0.372979	1.000000	0.229136	0.205068	0.714331	0.334902	0.410496
WOMEN	0.034571	0.229136	1.000000	0.224872	0.411693	0.182529	0.170925
DUALITY	0.056866	0.205068	0.224872	1.000000	0.065151	0.014782	0.165025
NONEXE	0.094221	0.714331	0.411693	0.065151	1.000000	0.175225	0.167709
MARCAP	0.726819	0.334902	0.182529	0.014782	0.175225	1.000000	0.825477
EBIDTA	0.887536	0.410496	0.170925	0.165025	0.167709	0.825477	1.000000

The Pearson correlation matrix provides preliminary evidence on the association between CSR expenditure and the explanatory variables. EBITDA exhibits the strongest positive correlation with CSR expenditure ($r = 0.8875$), indicating that more profitable firms tend to allocate higher resources to CSR activities. Market capitalisation is also strongly and positively correlated with CSR spending ($r = 0.7268$), suggesting that larger firms face greater stakeholder pressure and regulatory visibility. Board size shows a moderate positive correlation with CSR expenditure ($r = 0.3729$), implying that larger boards may support higher CSR engagement. In contrast, women directors, non-executive directors, and CEO duality display weak positive correlations with CSR, indicating limited direct association at the bivariate level.

Among the independent variables, board size is strongly correlated with non-executive directors ($r = 0.7143$), and EBITDA is strongly correlated with market capitalisation ($r = 0.8255$), reflecting structural relationships within firms. Other correlations remain moderate to low, suggesting that multicollinearity concerns are limited and can be further assessed using variance inflation factors.

POLS Regression
Table 3

Dependent Variable: CSR
Method: Panel Least Squares
Date: 11/30/25 Time: 09:20
Sample: 2015 2024
Periods included: 10
Cross-sections included: 10
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	17.10166	53.03091	0.322485	0.7478
BSIZE	10.74451	6.841134	1.570574	0.1197
WOMEN	-29.48259	18.80193	-1.568062	0.1203
DUALITY	-108.7056	58.00072	-1.874211	0.0640
NONEXE	-10.34495	7.806047	-1.325248	0.1883
MARCAP	-2.30E-06	6.27E-06	-0.366411	0.7149
EBIDTA	0.000718	6.78E-05	10.58951	0.0000

R-squared	0.811965	Mean dependent var		205.4201
Adjusted R-squared	0.799834	S.D. dependent var		258.8714
S.E. of regression	115.8188	Akaike info criterion		12.40936
Sum squared resid	1247502.	Schwarz criterion		12.59172
Log likelihood	-613.4680	Hannan-Quinn criter.		12.48317
F-statistic	66.93159	Durbin-Watson stat		0.777733
Prob(F-statistic)	0.000000			

Table 3 presents the results of the Pooled Ordinary Least Squares (POLS).

The model demonstrates strong explanatory power, with an R-squared of 0.812, indicating that approximately 81% of the variation in CSR expenditure is explained by the independent variables. The adjusted R-squared (0.799) remains high, confirming the robustness of the model after adjusting for the number of predictors. The model is statistically significant overall, as shown by the F-statistic (66.93, $p < 0.001$), indicating that the included variables jointly explain CSR expenditure.

Board size shows a positive but statistically insignificant relationship with CSR expenditure (Coefficient: 10.7445, $p = 0.119$). This suggests that although larger boards may be associated with slightly higher CSR spending, the effect is not strong enough to be statistically validated in the pooled model.

The number of women directors has a negative and statistically insignificant effect on CSR expenditure (Coefficient: –29.4826, $p = 0.120$). Although the coefficient suggests that firms with more women on the board may spend slightly less on CSR, the result is not significant and should be interpreted with caution.

CEO duality shows a negative effect on CSR expenditure and is marginally significant at the 10% level (Coefficient: –108.7056, $p = 0.064$). This implies that when the CEO also serves as the board chair, CSR spending tends to decrease. The finding aligns with agency theory, which argues that concentration of power reduces monitoring and may weaken CSR commitment.

The number of non-executive directors shows a negative but insignificant relationship with CSR expenditure (Coefficient: –10.3449, $p = 0.188$). This suggests that simply increasing the number of non-executive members does not necessarily enhance CSR engagement in these firms.

Market capitalisation has a negative and statistically insignificant relationship with CSR spending (Coefficient: –2.30E–06, $p = 0.714$). Given the strong correlation observed earlier between MARCAP and CSR, this insignificance suggests possible multicollinearity with EBITDA or omitted variable effects, which the fixed/random effects models may clarify.

EBITDA shows a positive and highly significant relationship with CSR expenditure (Coefficient: 0.000718, $p < 0.001$). This indicates that more profitable firms consistently spend more on CSR, supporting the slack resource theory, which states that financial strength enables firms to pursue socially responsible activities.

Lagrange Multiplier- Breusch-Pegan
Table 4

Table 4 shows the Breusch–Pagan Lagrange Multiplier (LM) test was conducted to assess whether the Pooled OLS model is appropriate or whether there are significant random effects across firms or over time in the panel dataset.

The LM test evaluates the null hypothesis:

H_0: No panel effects (Pooled OLS is sufficient)
H_1: Random effects are present (Random Effects Model is preferred)

The Cross-Sectional Effect shows Breusch–Pagan LM statistic: 12.20436 and p-value: 0.0005. Since the p-value is below 0.01, the null hypothesis of no cross-sectional effects is strongly rejected. This indicates that unobserved firm-specific heterogeneity exists across the 10 energy companies.

The Time Effect shows LM statistic: 2.26849 and p-value: 0.1320. The p-value is greater than 0.05, meaning the time-specific effects are not statistically significant. CSR expenditure does not differ systematically by year after controlling for the independent variables.

Joint (Both Effects) shows LM statistic: 14.47285 and p-value: 0.0001. The highly significant p-value indicates that panel effects exist overall, confirming that Pooled OLS is inappropriate. So random effect is applied.

Random Effect Model

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided
    (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	12.20436	2.268490	14.47285
	(0.0005)	(0.1320)	(0.0001)
Honda	3.493474	1.506151	3.535269
	(0.0002)	(0.0660)	(0.0002)
King-Wu	3.493474	1.506151	3.535269
	(0.0002)	(0.0660)	(0.0002)
Standardized Honda	5.311788	1.800131	1.033712
	(0.0000)	(0.0359)	(0.1506)
Standardized King-Wu	5.311788	1.800131	1.033712
	(0.0000)	(0.0359)	(0.1506)
Gourieroux, et al.	--	--	14.47285
			(0.0003)

Table 5

Dependent Variable: CSR
Method: Panel EGLS (Cross-section random effects)
Date: 11/30/25 Time: 10:25
Sample: 2015 2024
Periods included: 10
Cross-sections included: 10
Total panel (balanced) observations: 100
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	39.81740	32.33823	1.231279	0.2213
BSIZE	15.24409	4.888425	3.118406	0.0024
WOMEN	-20.82613	10.06651	-2.068852	0.0413
DUALITY	-49.19730	31.69183	-1.552365	0.1240
NONEXE	-16.81062	5.820239	-2.888303	0.0048
MARCAP	-4.80E-06	3.95E-06	-1.214708	0.2276
EBIDTA	0.000569	4.65E-05	12.21820	0.0000

Effects Specification		
	S.D.	Rho
Cross-section random	28.12079	0.1809
Idiosyncratic random	59.83674	0.8191

Weighted Statistics			
R-squared	0.613170	Mean dependent var	114.6791
Adjusted R-squared	0.588213	S.D. dependent var	152.7000
S.E. of regression	97.98855	Sum squared resid	892963.4
F-statistic	24.56928	Durbin-Watson stat	0.841140
Prob(F-statistic)	0.000000		

Unweighted Statistics			
R-squared	0.768653	Mean dependent var	205.4201
Sum squared resid	1534856.	Durbin-Watson stat	0.489367

The Random Effects estimation (table 5) reveals that the model explains a substantial proportion of the variation in CSR expenditure, with a weighted R^2 of 0.613, and is statistically significant overall (F-statistic $p < 0.001$). Among the governance variables, board size shows a positive and statistically significant influence on CSR spending ($\beta = 15.24$, $p = 0.002$), indicating that larger boards are associated with higher CSR expenditure.

Women directors exhibit a negative but significant effect ($\beta = -20.83$, $p = 0.041$), suggesting that an increase in female board representation is linked to marginally lower CSR spending within the sample period. The number of non-executive directors also has a significant negative impact on CSR ($\beta = -16.81$, $p = 0.004$), implying that greater board independence does not necessarily enhance CSR engagement in these firms. CEO duality remains negative but statistically insignificant. Regarding firm-level controls, EBITDA shows a strong and highly significant positive effect on CSR ($\beta = 0.000569$, $p < 0.001$), confirming that profitability is a key driver of CSR spending in the energy sector. Market capitalisation remains insignificant. Overall, the random effects model highlights that both internal governance structures and financial capacity meaningfully shape CSR expenditure across energy firms, with profitability and board size playing the most influential roles.

Hausman test and Fixed Effect Model
Table 6

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	162.400806	6	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
BSIZE	-4.947839	15.244092	41.112366	0.0016
WOMEN	-1.184927	-20.826127	6.175173	0.0000
DUALITY	14.751571	-49.197295	76.588757	0.0000
NONEXE	2.741863	-16.810616	61.137634	0.0124
MARCAP	0.000002	-0.000005	0.000000	0.0070
EBIDTA	0.000121	0.000569	0.000000	0.0000

Cross-section random effects test equation:
Dependent Variable: CSR
Method: Panel Least Squares
Date: 11/30/25 Time: 10:51
Sample: 2015 2024
Periods included: 10
Cross-sections included: 10
Total panel (balanced) observations: 100

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	208.2012	39.70898	5.243176	0.0000
BSIZE	-4.947839	8.062820	-0.613661	0.5411
WOMEN	-1.184927	10.36870	-0.114279	0.9093
DUALITY	14.75157	32.87797	0.448676	0.6548
NONEXE	2.741863	9.747452	0.281290	0.7792
MARCAP	1.99E-06	4.68E-06	0.425242	0.6717
EBIDTA	0.000121	6.58E-05	1.844816	0.0686

Effects Specification			

Cross-section fixed (dummy variables)

R-squared	0.954667	Mean dependent var	205.4201
Adjusted R-squared	0.946572	S.D. dependent var	258.8714
S.E. of regression	59.83674	Akaike info criterion	11.16676
Sum squared resid	300756.5	Schwarz criterion	11.58359
Log likelihood	-542.3382	Hannan-Quinn criter.	11.33546
F-statistic	117.9311	Durbin-Watson stat	1.504162
Prob(F-statistic)	0.000000		

The p value is less than 0.05 then reject null hypothesis and go for fem regression.

The Hausman test was conducted to determine whether the Random Effects model or the Fixed Effects model provides consistent and efficient estimates. The test yielded a highly significant Chi-square statistic of 162.40 (p < 0.001), leading to the rejection of the null hypothesis that the Random Effects estimator is appropriate. This indicates the presence of correlation between the regressors and the unobserved firm-specific effects, meaning that the Random Effects estimates are biased and inconsistent. Therefore, the Fixed Effects model is the preferred and more reliable specification for analysing the determinants of CSR expenditure in the sampled energy companies (Abang'a & Tauringana, 2023).

The Fixed Effects estimation (table6) demonstrates a strong overall fit, with an R² of 0.95, indicating that approximately 95% of the variation in CSR expenditure is explained after controlling for firm-specific heterogeneity. The model is statistically significant as shown by the F-statistic (p < 0.001), confirming that the selected governance and financial variables jointly influence CSR spending. Within the governance variables, board size, women directors, and non-executive directors all exhibit statistically insignificant coefficients, suggesting that within-firm changes in these board characteristics over time do not substantially influence CSR expenditure. CEO duality, although positive, is also insignificant, implying that shifts in leadership structure do not meaningfully alter CSR commitments within firms. For firm-level controls, EBITDA shows a positive coefficient (β = 0.000121), marginally significant at the 10% level (p = 0.068), indicating that increases in profitability are associated with modest increases in CSR spending, consistent with resource-based arguments. Market capitalisation remains insignificant, reflecting that size-driven variations across firms are absorbed by firm fixed effects. Overall, the Fixed Effects model underscores that unobserved firm-specific characteristics—such as corporate culture, long-term strategic orientation, or stakeholder pressures—play a dominant role in shaping CSR expenditure, while year-to-year changes in observable board structures exert limited influence.

Based on the Hausman test results (χ² = 162.40, p < 0.001), the fixed effects model is appropriate, and hypothesis testing should rely on the fixed-effects estimates. The results show that none of the four hypotheses are statistically supported. Specifically, H1 is rejected because board size (BSIZE) has a negative coefficient (β = −4.95) and is statistically insignificant (p = 0.541), indicating no evidence of a positive relationship with CSR expenditure. H2 is rejected as the number of women directors (WOMEN) also shows a negative and insignificant coefficient (β = −1.18, p = 0.909), failing to support a positive association with CSR expenditure. H3 is rejected because CEO duality (DUALITY) has a positive coefficient (β = 14.75), which is contrary to the hypothesized negative effect, and it is statistically insignificant (p = 0.655). Finally, H4 is rejected since non-executive directors (NONEXE) exhibit a positive coefficient (β = 2.74) as hypothesized, but the effect is not statistically significant (p = 0.779). Overall, while the model is jointly significant, the individual board characteristics examined do not have a statistically significant impact on CSR expenditure in the sample.

5. CONCLUSION

This study examined the influence of board characteristics and firm-level financial factors on CSR expenditure among the top energy companies in India using balanced panel data from 2015 to 2024. The analysis began with descriptive statistics, which revealed substantial variation in CSR spending, profitability, and market size across firms. The board structures remained relatively stable over time. Correlation analysis showed that profitability and market capitalisation were strongly associated with CSR expenditure but the board attributes

showed comparatively weaker relationships. Diagnostic tests confirmed the presence of significant cross-sectional effects in the data, making the Pooled OLS model unsuitable. Then the Hausman test demonstrated that Random Effects estimates were inconsistent due to correlation between regressors and unobserved firm characteristics. That's why the Fixed Effects model is selected as the preferred estimator.

Findings from the Fixed Effects model showed that the selected board characteristics board size, women directors, non-executive directors, and CEO duality are not statistically significant to impact within-firm effects on CSR expenditure. This suggests that year-to-year changes in governance structure do not substantially alter CSR commitments in energy firms. Profitability emerged as the most meaningful determinant and EBITDA also displayed a positive and marginally significant impact on CSR spending, supporting the slack resources theory that financially stronger firms have greater ability to allocate funds toward social responsibility (Zhang et al., 2025). Market capitalisation was found to be insignificant once firm-specific effects were controlled for which indicate that size differences across firms are largely time-invariant. The final results show that CSR expenditure in the Indian energy sector is driven more by firm-specific characteristics and financial capacity than by changes in board composition.

The study's findings suggest that policymakers should focus on strengthening incentive mechanisms that actually encourage financially strong firms to invest more meaningfully in CSR. As profitability and not the board structure has emerged as the key driver of CSR expenditure. Regulators may also explore sector-specific guidelines to promote more strategic CSR engagement,
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while companies should prioritize embedding CSR into their long-term strategic framework, improving internal governance processes, and aligning CSR initiatives with broader sustainability goals rather than relying solely on board composition changes.

The limitation of this study is that it has only studied 10 companies for 10 years. If the number of companies and time period is increased result may change and can be studied. Future research can build on this study by taking into account the qualitative factors such as the perceptions and the attitudes of board members and mangers. Researchers may also see the other factors such as education of the board members, leverage or foreign funding level that may affect CSR spending. Researchers may also examine the impact of ESG disclosure quality, regulatory changes, and environmental performance, or employ advanced econometric techniques to address potential endogeneity and deepen understanding of the governance and CSR relationshipThe limitation of this study is that it has only studied 10 companies for 10 years. If the number of companies and time period is increased result may change and can be studied. Future research can build on this study by taking into account the qualitative factors such as the perceptions and the attitudes of board members and mangers. Researchers may also see the other factors such as education of the board members, leverage or foreign funding level that may affect CSR spending. Researchers may also examine the impact of ESG disclosure quality, regulatory changes, and environmental performance, or employ advanced econometric techniques to address potential endogeneity and deepen understanding of the governance and CSR relationship..

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