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Responsibility of Indian firms**

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Abstract

This study examines the relationship between network centrality of women directors in Indian boards on their corporate social responsibility (CSR). While existing research primarily focuses on board gender diversity, we argue that the ability of women directors to affect firm decisions also depends on how well connected these directors are. Using the enforcement of mandatory CSR as a natural experiment on a sample of non-financial firms listed on the National Stock Exchange (NSE) in India during 2016-2023 we find that firms with higher women directors centrality exhibit higher CSR spending, stronger compliance with the CSR mandate and a greater likelihood of spending above their industry peers. The effects were stronger among firms that engage in CSR consistently and was also robust across alternative measures of network centrality and alternative specifications to address the endogeneity. Our findings contributed to the literature on gender diversity and CSR, by indicating that the network centrality constitute an important mechanism through which women directors influence CSR outcomes.

Keywords: *Women directors, Board networks, Corporate social responsibility, Board diversity*

JEL Codes: *G34, M14, D85, J16*

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INTRODUCTION

Consideration for the well-being of society within the commercial circles can be traced back through centuries (Carrol, 1999). Seminal work of Howard Bowen (1953) introduced the core idea of corporate social responsibility (CSR) as the obligations of businesses extending beyond profit-making to make decisions that are desirable for society. In contrast, Milton Friedman (1970) argues that the sole responsibility of business is to maximize profits and, therefore, rejected CSR as wasting shareholder funds. The "doing good" premise defines CSR as the commitment of firms to nurture society, safeguard the environment and uphold ethical standards, while striving for financial success (Carroll, 1999). Extending the conventional wisdom of firm's objective as "shareholder wealth maximisation" Jensen (2002) proposed "stakeholder value maximization" where firm's objective should be to consider tradeoffs among all stakeholders (employees, customers, communities) suggesting integration of CSR to achieve this maximization.

As firms increase their investment in the CSR, the corporate finance literature has evolved to understand if these decisions are strategic or under pressure from the shareholders integrating CSR as one of the key focus of corporate governance. Specifically, voluntary CSR is subject to much debate if managers spend in CSR activities at the expense of shareholders wealth. Under the central agency problem (Berle & Means, 1932) any voluntary spending is seen as self-dealing and governance mechanisms like board of directors can help addressing it. Empirical corporate governance literature examines the role of boards and its activities to reduce managerial opportunism in CSR by influencing CSR disclosure and performance through monitoring, oversight, diversity, and committees. Specifically, gender diversity and board independence positively influence overall corporate donations and CSR committees moderate the impact of gender diversity on CSR (Ahmed et al. 2025). Studies that link board gender diversity to CSR performance (e.g.,

Wang and Coffey, 1992; Willaims, 2003; Post et al., 2011; Bear et al., 2010) often attribute this relationship to the greater empathy, social awareness and stakeholder orientation of women directors. However, the literature on gender diversity typically treats women directors as a homogeneous group and focuses primarily on board composition and overlooks differences in influence among women directors.

In 2013, India pioneered mandatory CSR regulation as the world's first nation to do so. Unlike voluntary CSR regimes—where firms strategically adopt such expenditures for differentiation (Hart, 1995; Russo & Fouts, 1997; McWilliams & Siegel, 2001; Schnietz & Epstein, 2005; Albuquerque et al., 2019)—Section 135 of the Companies Act 2013 requires firms surpassing specified thresholds in net profit, net worth, or turnover to allocate at least 2% of their average net profits from the last three years to specific CSR activities, with penalties for noncompliance. Leveraging this natural experiment, recent research has probed mandatory CSR's impacts on spending and firm value (Dharmapala & Khanna, 2018; Manchiraju & Rajgopal, 2017; Rajgopal & Tantri, 2023), consistently documenting detrimental effects on the performance and valuation of mandated firms. At the same time in 2013, India joined a few countries to also enforce a gender quota by mandating at least one-woman director on boards of listed firms. Therefore, it is not clear if the findings on role of (voluntary) gender diversity on (voluntary) CSR that the existing literature documents is applicable to such an institutional environment where both are mandatory. By using this specific institutional setting and moving beyond numerical representation, we examine whether social capital of women directors is associated with firm's CSR behaviour beyond compliance. We measure influence through social capital. Social capital can play a crucial role in how effective a director is (Burt, 1992; Mizruchi, 1996). We use social network analysis to measure the network centrality of women directors in the director interlock networks.

Our findings suggest that firms with more central women directors exhibit higher CSR expenditure. This relationship is robust after accounting for potential endogeneity and across alternative specifications. Additionally, we find a stronger effect in firms with a sustained CSR orientation. Network centrality of women directors also increase the likelihood of firms complying with the CSR mandate and spending above the industry benchmarks. These findings suggest that the impact of board gender diversity on CSR depends on connectedness and influence of women directors, rather than their presence alone. In contrast to the critical mass theory—which posits that minority individuals must reach a threshold proportion to meaningfully influence group dynamics and outcomes—our findings underscore network connections as a pivotal channel to exert substantial governance impact. Specifically, a woman board member with high degree or betweenness centrality amplify CSR adoption and performance by facilitating information diffusion, resource mobilization, and cross-firm learning, irrespective of the legislative quota.

The rest of the study proceeds as follows. Section 2 reviews the literature on board gender diversity, director networks and CSR. Section 3 describes the data, variables and empirical strategy, including the construction of director networks. Section 4 presents the main results. Section 5 concludes.

LITERATURE REVIEW AND HYPOTHESIS

Motivation for Voluntary CSR

The concept of CSR has been deeply rooted in the business history through philanthropy and altruism. Initiation of the modern academic discourse on CSR is widely attributed to Howard R. Bowen who offered an early definition of businesses' social responsibilities as the pursuit of actions aligned with the society's values. Given his pioneering and foundational contributions, Carrol (1999) considers Bowen as the 'Father of Corporate Social Responsibility'. While definitions vary, the essence of CSR is the

firm's responsibility to contribute positively to society beyond mere legal compliance and profit-making. Carroll's (1979) seminal four-part model—economic, legal, ethical and philanthropic responsibilities—has become a foundational framework in the field of CSR (Carroll, 1979; Carroll 1999).

Voluntary CSR and Board Governance

This strand of literature focuses on firm specific characteristics as determinants of its CSR focus. Waddock and Graves (1997) find that stronger financial performance can enable firms to enhance their corporate social performance (CSP). Firm size matters for CSR as larger and more visible firms spent more on corporate philanthropy (Brammer & Millington, 2005). CSR activities help reveal aspects of a company's identity to the broader public. Therefore, investing in social initiatives can help firms foster positive attitudes and actions from stakeholders, such as purchasing products, applying for jobs or investing in the company. Over time, CSR can also contribute to building a strong corporate or brand image, reinforcing relationships with stakeholders and encouraging supportive behaviours like word-of-mouth promotion, employee commitment and proactive citizenship within the organization (Du et al., 2010). A strategic orientation allows CSR to align with business goals and generate deeper social impact than purely altruistic or compliance-driven initiatives. Therefore, firms benefit more by taking a strategic approach to CSR rather than being forced into it (Husted & de Jesus, 2006).

Reviewing CSR literature from 2000 to 2015, Jain and Jamali (2016) observed that larger boards generally nurture stronger CSR outcomes. While powerful or entrenched CEOs often resist such initiatives, more diverse boards encourage stronger engagement in corporate social responsibility initiatives. Incorporating diverse perspectives at the board can help effectively address and integrate the interests and concerns of a broad group of stakeholders. Bear et al. (2010) find that a higher number of women on the board is associated with stronger CSR ratings. The findings suggest that women board members also play a role in enhancing

corporate reputation by fostering a culture of ethical stewardship. Using a sample of Australian listed firms, Rao and Tilt (2016) also find that more diverse boards tend to perform better in CSR reporting, especially in areas related to social and environmental issues, compared to boards with less diversity. Additionally, several other studies (Wang and Coffey, 1992; Willaims, 2003; Post et al., 2011) have also suggested the existence of a positive association between higher proportion of women directors and socially responsible activities by the firm.

Interlocking directorates arise when a director sits on multiple corporate boards (Mizruchi, 1996). While interlocks do not universally explain interfirm dynamics, they serve as key indicators of network connections and resource dependencies among companies by creating pathways for the diffusion of norms, knowledge and governance practices. According to resource dependence theory (Pfeffer & Salancik, 2015), networks provide directors with access to information, resources and influence. Directors with many connections are exposed to what other firms are doing, including CSR standards and best practices. By bridging multiple boards, they help their firms respond to the growing demand for corporate accountability and stakeholder expectations, which strengthens the case for CSR. More central directors are better placed to access diverse information, broker resources and influence firm strategy (Bianchi et al., 2023). For women directors, who are scarce in number and are historically disadvantaged, occupying central network positions may balance the traditional scales of power in their favour. This can enable them to advocate more effectively for ethical and socially responsible practices.

Networks also serve as channels through which norms spread. Interlocked boards often mimic one another's strategies (eg. Davis, 1991; Haunschild, 1993). Directors who are well-connected act as the carriers of these practices. Additionally, prior research shows that women directors are often more responsive to stakeholder needs (Wang et al., 2022). When they are central in networks, these values are more likely to shape firm

decisions. This reflects insights from institutional theory, where firms adopt practices to gain legitimacy by aligning with what is seen as appropriate or expected in their environment (Meyer & Rowan, 1977).

Beyond traditional board structure and composition, recent scholarship underscores the critical role of social networks in corporate governance. Social network analysis enables examination of directors' positional power through metrics such as degree centrality—measuring direct connections—and betweenness centrality—capturing brokerage roles on shortest paths (Freeman, 1979). Westphal and Milton (2000) demonstrate that demographic minorities can surmount influence biases by leveraging prior board experience or director network ties, fostering perceived similarity with majority members. Similarly, directors' social capital and network-derived resources positively impact firm environmental performance (Glass et al., 2015; Kassinis & Vafeas, 2002; Walls & Hoffman, 2013). Yet, few studies explicitly connect network centrality measures to firm's CSR outcomes.

Research Gap and hypotheses

Mandatory CSR reshapes strategic incentives by flooding the market with socially engaged firms, thereby attenuating CSR's distinguishing power, despite the "comply or explain" flexibility allowing non-compliance. Notably, board characteristics that drive expenditures exceeding mandated thresholds remain largely unexamined. Although prior studies link women directors to enhanced CSR performance and networks to governance efficacy, the influence of gendered network centrality on CSR expenditure is largely unexamined especially in an environment where gender diversity is a mandatory requirement. Our analysis of India's mandatory CSR regime combined with gender quota offers the test of these dynamics. We hypothesize:

H0: Firms with higher network centrality among women directors exhibit greater CSR spending beyond mandatory levels.

DATA AND VARIABLES

Data

The dataset for this study comes from two secondary sources: CMIE Prowess and the Indian Boards Database. CMIE Prowess, maintained by the Centre for Monitoring Indian Economy, provides standardized financial data collected from company annual reports. We use Prowess to obtain information on firm characteristics, firm performance, corporate social responsibility and corporate governance.

The Indian Boards Database, maintained by NSE Primeinfobase, provides detailed information on the demographic and socio-economic characteristics of directors serving on the boards of NSE-listed companies. We obtain director-level data from the Indian Boards Database and use this information to construct board networks.

The sample includes NSE-listed, privately owned non-financial firms covered in Prowess during the post–Companies Act 2013 period from 2016 to 2023. We average director-level data at the firm level for the analysis. We exclude firms with boards consisting of fewer than four directors. We also exclude firms with missing CSR expenditure. Our final sample consists of an unbalanced panel of 1,307 firms observed over eight years (2016–2023), resulting in 7,059 firm-year observations.

Variables

Our primary dependent variable captures corporate social responsibility (CSR) activity at the firm level. We measure CSR using the natural logarithm of total CSR expenditure incurred by a firm during a given financial year. In additional specifications, we employ two alternative CSR measures. *CSR Above Industry Average* is an indicator equal to one if a firm's CSR expenditure exceeds the industry-year average and zero otherwise. *Compliance* is an indicator equal to one if a firm's CSR expenditure is at least 2% of the average net profits from the preceding three financial years, as mandated under Section 135 of the Companies

Act, 2013. This measure captures compliance with the statutory CSR spending requirement.

Our main explanatory variables capture the network centrality of women directors on corporate boards. We construct board interlock networks using director data from the Indian Boards Database and compute degree centrality and betweenness centrality for individual directors. Degree centrality reflects the number of direct connections held by a director while betweenness centrality captures the extent to which a director acts as a bridge between otherwise disconnected clusters in the network. In this study, we adjust for board size when calculating a director's degree centrality to retain only the direct connections the director has outside the firm. For each firm-year, we calculate the average degree centrality and average betweenness centrality of women directors on the board.

For additional analyses, we also compute the average degree and betweenness centrality of independent women directors to study their effect on CSR outcomes. For robustness, we use the average eigenvector centrality of women directors. Eigenvector centrality captures connections to influential directors.

All network centrality measures are min–max normalized on a year-wise basis by subtracting the minimum value and dividing by the range, such that the resulting measures lie between zero and one. This normalization ensures comparability across centrality measures.

We use the *Proportion of Women Directors from Elite Institutions* as an instrument for network centrality. It is defined as the proportion of women directors on the board who are the alumnae of elite institutions. In this study, we consider Indian Institute of Technology (IITs) and Indian Institute of Management (IIMs) as elite institutions in India (following Marisetty and Prasad, 2022). To account for global universities, we also

include the universities ranked among the global top 20 in the QS World University Rankings (2026) as elite institutions. We also compute the proportion of independent women directors from elite institutions for additional analyses.

We include several board-level controls that may influence CSR decisions. *Board Size* is measured as the total number of directors on the board. *Proportion of Women* is used to capture board diversity. It is defined as the ratio of women directors to total board size. *Board Independence* is measured as the ratio of independent directors to total board size. *CEO Duality* is a dummy variable that indicates whether the chief executive officer also serves as chair of the board. It is used as a proxy for a powerful CEO.

Following the prior literature, we control for firm characteristics that may affect CSR engagement. *Firm Size* is measured as the natural logarithm of total assets and *Firm Age* is measured as the natural logarithm of the number of years since incorporation. *Return on Assets* is measured as profit after tax divided by total assets. It is included as a measure of profitability. Finally, we use a proxy for Tobin's Q and is computed as the ratio of the sum of market capitalization, debt and paid-up preference capital to total assets. This is to capture the market valuation of the firm

Tangibility Ratio is defined net fixed assets less net of intangible assets divided by total assets. *Liquidity* is calculated as the ratio of current assets to current liabilities. *Sales Growth* measures the reflects the year-on-year change in revenue from non-financial operations scaled by total assets. *Leverage* is defined as the ratio of total borrowings to total assets. We also include *Dividend/Assets* and *Cash/Assets*, to control for dividend payout and cash holdings of the firm, respectively. Table A1 presents the complete list of variables and their definitions.

METHODOLOGY

Network centrality

Network centrality is a useful concept for understanding an individual's influence or strategic position within a social or organisational network. In the context of corporate boards, centrality can reflect a director's access to information. In this study, we compute two commonly used centrality measures—degree and betweenness centralities—for each director. These measures allow us to capture different dimensions of a director's influence with regard to their potential impact on CSR-related decision-making.

Degree Centrality

Degree centrality counts how many direct connections a given node (in this case, a director) has.

$$D_i = \sum_{j \neq i} X_{ij} \quad (1)$$

where, D_i is the degree centrality of node i and j indexes to all other nodes in the network. X_{ij} equals one if directors i and j are directly connected and zero otherwise.

To compute a director's external degree centrality, we subtract the number of internal board connections, which equals to board size minus one. This adjustment excludes connections with other directors on the same board and allows the measure to capture only the director's external connections. We then compute the average degree centrality of women directors of the firm, which serves as one of the main variables of interest in the study.

Betweenness centrality

Betweenness centrality captures the extent to which a director lies on the shortest paths between other pairs of directors. It quantifies the frequency with which a director serves as a bridge or intermediary in the network. Formally, the betweenness centrality of director i is defined as:

$$B_i = \sum_{j < k} \frac{P_{j-i-k}}{P_{j-k}} \quad (2)$$

where B_i is the betweenness centrality of node i , P_{j-k} is the total number of shortest paths between nodes j and k and P_{j-i-k} is the number of those shortest paths that pass through node i . This measure captures the role of a node as a broker connecting otherwise disconnected parts of the network. Nodes with high betweenness centrality are therefore critical for facilitating information flow across the network. We also calculate the average betweenness centrality of women directors of the firm. This is used as one of the key explanatory variables in the study.

Both the average degree centrality and the average betweenness centrality of women directors of the firm are normalized to lie between 0 and 1 using min–max normalization. That is, for each measure, the normalized value is obtained by subtracting the minimum observed value in the sample for a given year and dividing by the range (maximum minus minimum). This normalization places degree and betweenness centrality on a common scale and ensures comparability between the measures.

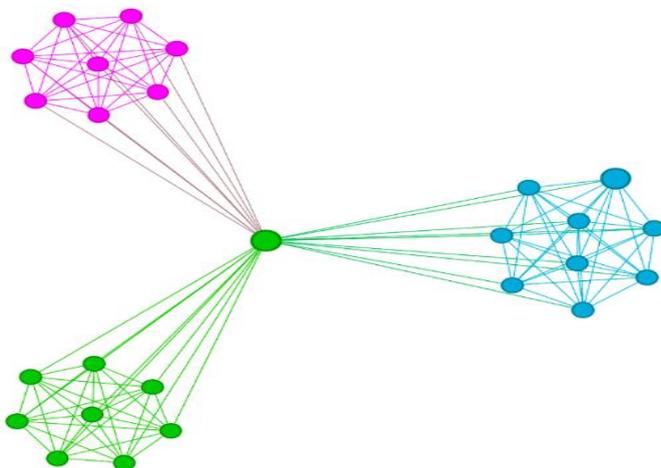
Social network of directors

In the present study, we construct the director network using board interlocks. Board interlocks refer to a situation when the director of one company serves on the board of another (Mizruchi, 1996). Directors form the nodes in this analysis. Edges are what connect two nodes; here, companies form the edges. This comes from the assumption that the members of the same board know each other and interact with each other.

Also, following Biswas et al. (2023), we construct the networks and compute the centrality using all the directors from NSE-listed firms of a given year. However, our main analysis excludes the directors of the financial and government owned enterprise. We also exclude firms with less than four directors and firms where CSR information is not available.

Figure 1 illustrates how board interlocks create connections across firms through shared directors. The figures focus on the boards of Allied Digital Services Ltd., Arihant Capital Markets Ltd. and Motilal Oswal Financial Services Ltd. in 2023. Figure 1 illustrates inclusion of a woman director into the network “bridges” the connectedness of the three boards. This allows directors from one firm to reach directors of another board through her. The figures illustrate the mechanism through which board interlocks generate director networks and facilitate the flow of information across firms.

Figure 1: Bridging Woman Director



Note: The boards of Allied Digital Services Ltd., Arihant Capital Markets Ltd. and Motilal Oswal Financial Services Ltd. in the year 2023 denoted by green, pink and blue respectively. The woman director who serves on all the three boards is denoted in the centre. Nodes represent directors, edges represent firms that connect these directors. The network visualized using Gephi (Bastian et al., 2009).

Baseline Regression Model

To examine the relationship between the network centrality of women directors and corporate social responsibility (CSR) expenditure, the baseline econometric model (Equation 3) is estimated with different measures of centrality. The measures of centrality are highly correlated

and hence we do not use degree and betweenness centrality as explanatory variables in the same model. We use industry fixed effects to control for time invariant unobserved factors specific to an industry. As there could be macroeconomic and temporal factors that affect all firms at a given time, we also use year fixed effects. However, since the main variables of interests are measures of centrality which are slow changing, we don't observe much within firm variation. Therefore, we do not use firm fixed effects. We cluster standard errors at firm level to control for heteroskedasticity and to allow for within firm correlation of errors. We estimate the following model as the baseline –

$$CSR_{it} = \alpha + \beta Centrality_{it-1} + \gamma Controls_{it-1} + \nu_j + \mu_t + \varepsilon_{it} \quad (3)$$

where CSR_{it} denotes firm i 's CSR expenditure in log terms at time t . $Centrality_{it-1}$ represents the key explanatory variable, the different measures of network centrality of the director (Degree and Betweenness). $Controls_{it-1}$ is a vector of the control variables used in the study ($Controls_{it}$ include, leverage, firm age, firm size, Tobin's Q, CEO duality, cash-to-assets ratio, dividend-to-assets ratio, return on assets (ROA), sales growth, liquidity, tangibility ratio, board size, proportion of women directors on the board and board independence). μ_t are year fixed effects, ν_j are the industry fixed effects and ε_{it} is the error term.

Additionally, the one year lags of all independent variables are used to allay potential reverse causality concerns. Moreover, all continuous variables are winsorized at the first and ninety-ninth percentile to mitigate the effect of outliers.

Instrument Variable Regressions

While examining the effect of network centrality of women directors on CSR expenditure, endogeneity can become a key concern. Endogeneity violates the Gauss-Markov assumptions, making the ordinary least squares

(OLS) estimator inconsistent. There are two main sources of potential endogeneity in this context – reverse causality and omitted variable bias. Firms that are more socially responsible are more likely to attract or appoint well-networked women directors. This may create a reverse causality where CSR spending and network centrality influence each other simultaneously. Additionally, omitted variable bias is also a concern. There may be unobserved confounding factors such as commitment to sustainability or pressure from stakeholders that affect both board composition as well as the firm’s corporate social responsibility. Therefore, in order to control for this potential endogeneity, we use instrument variable regressions.

For a variable to act as a suitable instrument, it should satisfy two conditions – instrument relevance and instrument exogeneity (Wooldridge, 2016). The first condition suggests that the instrument should be sufficiently correlated with the endogenous regressor.

$$Cov(Z, X) \neq 0 \tag{4}$$

where Z is the instrument and X is the endogenous regressor. On the other hand, instrument exogeneity recommends that the instrument should be uncorrelated with the dependent variable or the unobserved factors in the error term.

$$Cov(Z, u) = 0 \tag{5}$$

where Z is the instrument and u is the error term in the model.

In this study, we use the proportion of women directors who have attended elite institutions as an instrument for network centrality. This instrument is similar to that used by Amin et al. (2020), who employ the fraction of MBA graduates from elite institutions as an instrument for board networks. Following Marisetty and Prasad (2022), we classify all Indian Institute of Technology (IITs) and Indian Institute of Management (IIMs) as elite Indian institutions. However, restricting the definition of ‘eliteness’ to Indian institutions alone may be unduly narrow. Therefore, for completeness, we extend our definition of elite institutions to also include

the top 20 universities according to the latest QS Global University Rankings (2026).

This instrument can influence a director's network centrality because an elite institutional background may provide privileged access to influential social networks through shared alma mater and alumni ties. At the same time, the alma mater affiliation of the women directors would be plausibly exogenous to firm-level CSR decisions. Thus, the instrument would satisfy both the relevance and validity criteria required for an instrument.

For the instrument variable regression, we first adopt a two-stage least squares (2SLS) regression using the instrument variable discussed previously. 2SLS would break down the endogenous independent variable into endogenous and exogenous components. Here, through 2SLS we would be able to isolate the exogenous variation in the average centrality of women directors that arises from their elite educational background. We would estimate the first stage regression equation where the potentially endogenous regressor ($Centrality_{it-1}$) is regressed on the instrument ($EliteEdu_{it-1}$) and other exogenous controls ($Controls_{it-1}$):

$$Centrality_{it-1} = \pi_0 + \pi_1 EliteEdu_{it-1} + \pi_2 Controls_{it-1} + v_j + \mu_t + v_{it-1} \quad (6)$$

The predicted values of network centrality from the first stage estimation would be plugged into the regression of CSR expenditure on the independent variables.

$$CSR_{it} = \beta_0 + \beta_1 \widehat{Centrality}_{it-1} + \beta_2 Controls_{it-1} + v_j + \mu_t + \varepsilon_{it} \quad (7)$$

where, CSR_{it} is the CSR expenditure for firm i in year t . $\widehat{Centrality}_{it-1}$ represents, different measures of network centrality (lagged by one year),

which is the endogenous regressor in the model. $Controls_{it-1}$ is a vector of control variables, also lagged by one period, that capture other firm or director-specific characteristics that influence CSR. μ_t and ν_i are industry and time fixed effects respectively. 2SLS would allow us to obtain unbiased and consistent estimates for the impact of network centrality on CSR.

To ensure robust and efficient estimation in the presence of heteroskedasticity, we re-estimate Equation (6) and (7) using the Generalised Method of Moments (GMM). GMM provides consistent estimates even when the error terms are heteroskedastic and allows us to use additional moment conditions, improving efficiency.

Additional Analyses and Robustness Checks

We also conduct a series of additional analyses checks to assess the stability of the empirical findings. These additional analyses involve re-estimating Equations 6 and 7 with alternative measures and sub-samples to examine possible heterogeneity, sample composition concerns and specification issues. The procedures and their outcomes are discussed in the Results section.

SAMPLE DISTRIBUTION AND DESCRIPTIVE STATISTICS

Table 1 describes the sample. Panel A of Table 1 reports the distribution of firms in the present study, from the year 2016 to 2023. Panel B shows the number of firms that have complied with CSR expenditure requirement of Section 135 of the Companies Act for each year in the sample. The mandate requires eligible firms to spend at least 2% of average net profits of the preceding three years on CSR activities. We see that the number of firms that comply with the mandatory CSR spending requirement increases over the sample period, although noncompliance remains present throughout.

Table 1: Distribution of Firms Over Time and CSR Compliance

Panel A					
Year	Companies	Percent	Cumulative Percent		
2016	667	9.45	9.45		
2017	744	10.54	19.99		
2018	801	11.35	31.34		
2019	835	11.83	43.16		
2020	895	12.68	55.84		
2021	953	13.50	69.34		
2022	1027	14.55	83.89		
2023	1137	16.11	100.00		
Total	7059	100.00			

Panel B					
Year	Non- Compliance		Compliance		Total
	Frequency	Percent	Frequency	Percent	
2016	270	13.62	358	7.61	628
2017	264	13.32	431	9.16	695
2018	256	12.92	499	10.60	755
2019	237	11.96	553	11.75	790
2020	246	12.41	604	12.83	850
2021	163	8.22	747	15.87	910
2022	257	12.97	723	15.36	980
2023	289	14.58	792	16.83	1081
Total	1982	100	4707	100.00	6689

Note: Panel A presents the annual distribution of firm with available CSR expenditure data from 2016 to 2023. Panel B reports the number of firms classified as compliant or noncompliant with the CSR expenditure requirement under Section 135 of the Companies Act.

Descriptive Statistics

Table 2 presents summary statistics for the variables used in the study. The sample includes 7,059 firm-year observations from 2016 to 2023 with available information on CSR expenditure. Network centrality measures for women directors are available for 7,050 observations (firms with at least one woman director), while corresponding measures for independent women directors are available for 5,655 observations (firms with at least one independent woman director).

The log of CSR expenditure has a mean of 16.31, with substantial variation across firms. Network centrality measures are min-max normalized between zero and one and degree centrality is adjusted for board size. The average firm-level degree centrality of women directors is 0.15, while average firm-level betweenness centrality is 0.10. Eigenvector centrality of women directors is used for robustness and has an average value of 0.15. For independent women directors, average firm-level centrality equals 0.16 for degree and 0.12 for betweenness.

All measures of network centrality are positively skewed, consistent with patterns observed in real-world networks (Barbási & Albert, 1999). This indicates that most directors are moderately connected, with a few directors enjoying high centrality.

Boards consist of an average of 9.21 directors and women account for approximately 17 percent of board members. Board independence averages 0.53, CEO duality is observed in 6.4 percent of observations. Approximately 83 percent of firms are affiliated with Indian business groups and about 70 percent of the firms in the sample comply with the CSR mandate. On average, only about 2 percent of women directors in a firm are educated at elite institutions.

With respect to firm characteristics, return on assets averages 0.07 while Tobin's Q has a mean of 2.34. Both measures are positively skewed. This suggests the existence of a small subset of firms that report a very high profitability and market valuation.

Table 2: Summary Statistics

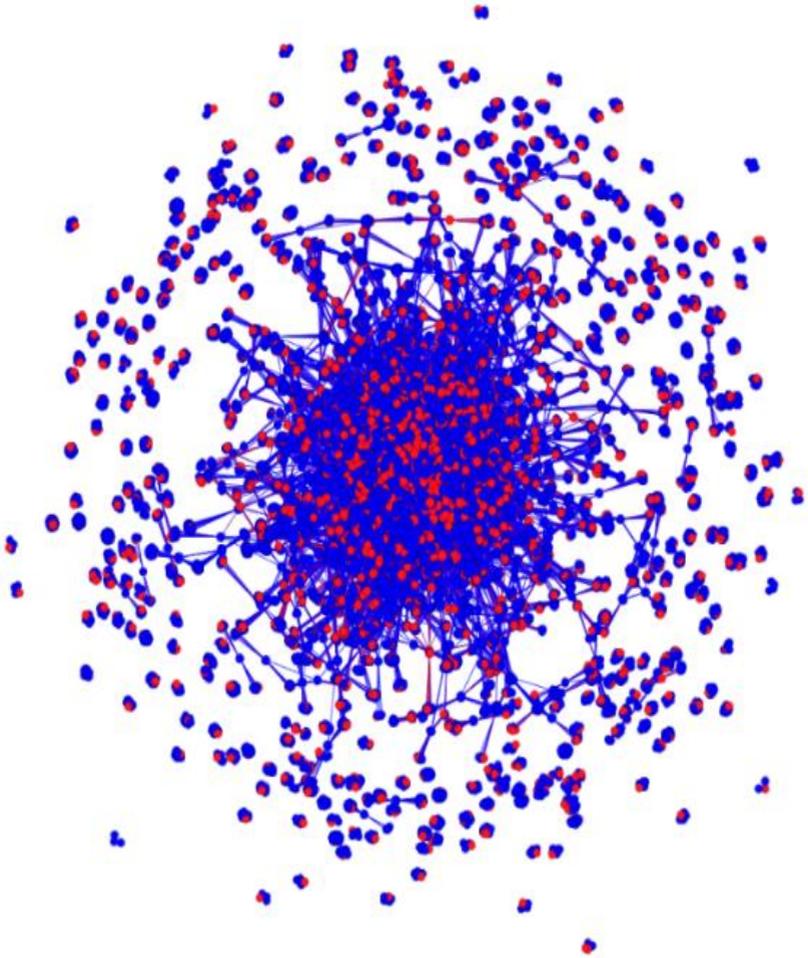
Variables	N	Mean	SD	Min	Median	Max
Log of CSR	7059	16.314	1.751	12.206	16.275	21.192
Average Degree of Women Directors	7050	0.145	0.232	0	0	1
Average Betweenness of Women Directors	7050	0.097	0.194	0	0	1
Average Degree of Independent Women Directors	5655	0.159	0.233	0	0	1
Average Betweenness of Independent Women Directors	5655	0.12	0.213	0	0	1
Return on Assets	7059	0.068	0.067	-0.229	0.059	0.315
Tobin's Q	7059	2.338	2.4	0.202	1.461	17.006
Dividend/Assets	7059	0.017	0.034	0	0.006	0.261
Leverage	7059	0.206	0.164	0	0.185	0.689
Cash/Assets	7059	0.001	0.003	0	0	0.029
Firm Age	7059	3.455	0.606	0	3.497	5.075
CEO Duality	7059	0.064	0.245	0	0	1
Tangibility Ratio	7059	0.257	0.175	0	0.233	0.841
Sales Growth	7049	0.116	0.297	-0.725	0.085	2.288
Liquidity	7056	2.547	2.324	0.429	1.734	18.01
Firm Size	7059	7.204	1.48	2.724	7.079	13.787
Board Size	7059	9.213	2.623	4	9	24
Proportion of Women	7059	0.17	0.079	0	0.143	0.556
Board Independence	7059	0.526	0.093	0	0.5	0.875
Compliance	6689	.704	0.457	0	1	1
Indian Business Group	7059	.828	0.377	0	1	1
Proportion of Women Directors from Elite Institutions	7059	.022	0.050	0	0	.333
Proportion of Independent Women Directors from Elite Institutions	7059	.017	0.043	0	0	.333

Pairwise correlations among the variables are reported in Table A2. None of the correlations suggest severe multicollinearity concerns. Variance inflation factor (VIF) is also examined to assess multicollinearity and are all below commonly accepted thresholds.

Network Characteristics

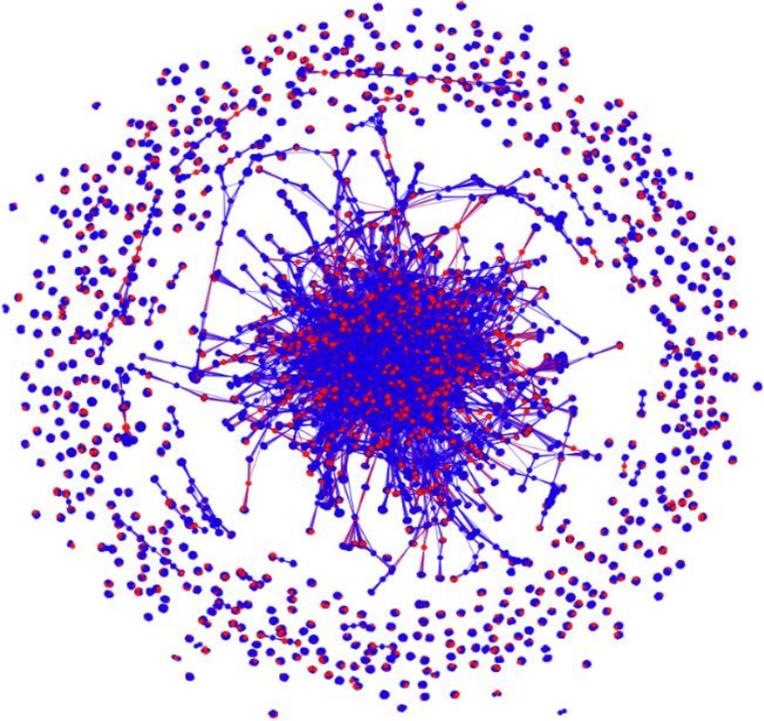
Figures 2 and 3 provide visual representations of the board interlock networks of directors of NSE-listed firms in 2016 and 2023. The figures illustrate the how network size and structure have changed over time.

Figure 2: Board interlock network for directors of all the NSE listed companies for the year 2016



Note: Nodes represent directors and edges indicate shared board memberships. Male directors are shown in blue and women directors in red. The network is visualized using Gephi (Bastian et al., 2009) with the Yifan Hu proportional layout algorithm.

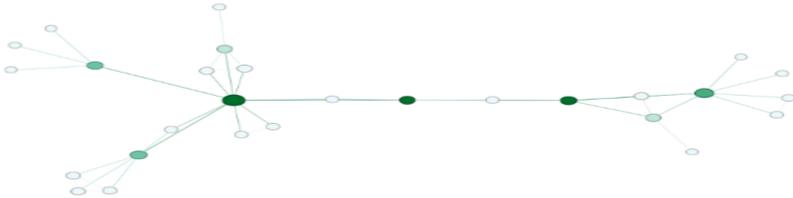
Figure 3: Board interlock network for directors of all the NSE listed companies for the year 2023



Note: Nodes represent directors and edges indicate shared board memberships. Male directors are shown in blue and women directors in red. The network is visualized using Gephi (Bastian et al., 2009) with the Yifan Hu proportional layout algorithm.

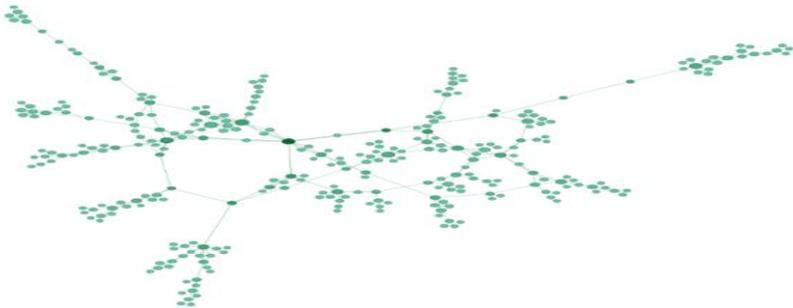
Additionally, Figures 4 and 5 depict the largest connected component of the women-director sub-graphs in the board interlock network for 2016 and 2023. The size of the largest component increases over time. Because, the subgraph consists only of women directors, this increase also indicates a rise in women-to-women board connections over time.

Figure 4: Largest connected component of the women-director subgraph of board interlock network (2016)



Note: The figure depicts the largest connected component in the women-director subgraph of the board interlock network for the year 2016. Node size is proportional to degree centrality and while darker nodes indicate higher betweenness. The network is visualized using Gephi (Bastian et al., 2009).

Figure 5 Largest connected component of the women-director subgraph of board interlock network (2023)



Note: The figure depicts the largest connected component in the women-director subgraph of the board interlock network for the year 2023. Node size is proportional to degree centrality and while darker nodes indicate higher betweenness. The network is visualized using Gephi (Bastian et al., 2009).

Table 3 illustrates firms in the sample whose women directors rank high in degree and betweenness centralities in 2016 and 2023. Firms such as ABB India Ltd., Bosch Ltd., Uno Minda Ltd., Schaeffler India Ltd., Whirlpool of India Ltd. and CG Power and Industrial Solutions Ltd exhibit a persistent influence.

Table 3: Most central firms based on women director network centrality in 2016 and 2023

S. No.	Degree				Betweenness			
	2016 Firm	2016 Average Centrality	2023 Firm	2023 Average Centrality	2016 Firm	2016 Average Centrality	2023 Firm	2023 Average Centrality
1	A B B India Ltd.	62	Computer Age Mgmt. Services Ltd.	82	N C C Ltd.	0.014501	Computer Age Mgmt. Services Ltd.	0.0091
2	Sobha Ltd.	61	Tata Consumer Products Ltd.	63	Schaeffler India Ltd.	0.014501	Kfin Technologies Ltd.	0.005738
3	Bosch Ltd.	60	Onmobile Global Ltd.	57	Uno Minda Ltd.	0.014501	Sutlej Textiles & Inds. Ltd.	0.005738
4	Rallis India Ltd.	59	Whirlpool Of India Ltd.	56	A B B India Ltd.	0.009215	Whirlpool Of India Ltd.	0.005738
5	Uno Minda Ltd.	58	Motherson Sumi Wiring India Ltd.	54	Bosch Ltd.	0.009215	E I H Associated Hotels Ltd.	0.00533
6	Jubilant Foodworks Ltd.	56	Sutlej Textiles & Inds. Ltd.	54	Torrent Pharmaceuticals Ltd.	0.008849	J K Lakshmi Cement Ltd.	0.005033
7	Schaeffler India Ltd.	56	Kfin Technologies Ltd.	53	L T Foods Ltd.	0.008215	C G Power & Indl. Solutions Ltd.	0.004987
8	Eveready Industries (India) Ltd.	55	Britannia Industries Ltd.	49	Torrent Power Ltd.	0.008035	Sun Pharmaceutical Inds. Ltd.	0.004444
9	P I Industries Ltd.	55	C G Power & Indl. Solutions Ltd.	49	Atul Ltd.	0.007817	V S T Industries Ltd.	0.004444
10	Wipro Ltd.	55	E I H Associated Hotels Ltd.	48	Apollo Tyres Ltd.	0.007635	Motherson Sumi Wiring India Ltd.	0.004191

Note: The table reports the most influential non-financial, non-government NSE-listed firms based on the average degree and betweenness centralities of women directors for 2016 and 2023.

RESULTS

Women Director Network Centrality and CSR

To examine the relationship between women director network centrality and CSR expenditure, we estimate the baseline econometric model specified in Equation (3). Because the network centrality measures are highly correlated, we estimate Equation (3) separately using the average degree and betweenness centralities of women directors. All explanatory variables are lagged by one year to mitigate potential endogeneity.

Standard errors are clustered at the firm level to account for within-firm correlation over time. We also include industry and year fixed effects to control for unobserved heterogeneity across sectors and over time. In addition, we winsorize all continuous variables at the first and ninety-ninth percentiles. Table 4 reports the regression results.

Across both the specifications, women director network centrality is positively associated with CSR expenditure. In column (1), average degree centrality has a positive coefficient that is statistically significant at the 1 percent level. This result indicates that firms that have women directors with higher number of direct connections allocate greater resources to CSR. Similarly, in column (2), average betweenness centrality is positive and statistically significant. These findings suggest that firms whose women directors are able to bridge the network and connect otherwise disconnected clusters tend to display a higher commitment towards CSR. Because the centrality measures are min–max normalized and range from zero to one, the estimates reflect the association across the full range of variation in women director network centrality.

The control variables behave largely in line with the literature. Firm performance and market valuation, measured by return on assets and Tobin’s Q, are positively associated with CSR expenditure. Firm size, board size and board gender diversity also show a positive and significant association with CSR spending. These findings remain robust across alternative specifications that include only industry fixed effects, only year fixed effects or neither. For brevity, we do not report these additional results.

Table 4: Average Women Director Network Centrality and Firm's CSR Expenditure.

VARIABLES	(1)	(2)
	Log of CSR	Log of CSR
WD Avg. Degree	0.292*** (0.0735)	
WD Avg. Betweenness		0.259*** (0.0869)
Return on Assets	8.376*** (0.479)	8.335*** (0.479)
Tobin's Q	0.0300*** (0.00860)	0.0312*** (0.00858)
Dividend/Assets	0.743 (0.551)	0.815 (0.552)
Leverage	-1.069*** (0.143)	-1.079*** (0.143)
Cash/Assets	5.935 (5.671)	6.112 (5.717)
Firm Age	0.0425 (0.0330)	0.0439 (0.0331)
CEO Duality	0.0566 (0.0671)	0.0521 (0.0676)
Tangibility Ratio	0.698*** (0.138)	0.686*** (0.138)
Sales Growth	-0.233*** (0.0549)	-0.232*** (0.0551)
Liquidity	-0.00126 (0.00957)	-0.00143 (0.00956)
Firm Size	0.891*** (0.0189)	0.898*** (0.0185)
Board Size	0.0198** (0.00810)	0.0189** (0.00810)
Proportion of Women	0.484** (0.204)	0.469** (0.205)
Board Independence	-0.145 (0.182)	-0.137 (0.183)
Constant	9.073*** (0.186)	9.048*** (0.187)
Observations	5,598	5,598
R-squared	0.770	0.770
Industry and Time FE	Yes	Yes
Cluster	Firm	Firm

Note: This table reports baseline regression results that examine the association between women director network centrality and CSR expenditure of firms. The dependent variable is the logarithm of CSR expenditure. The main explanatory variables are the average degree and betweenness centrality of women directors computed from the board interlock network. All independent variables are lagged by one year. Industry and year fixed effects are included. Standard errors clustered at the firm level are reported in parentheses. All continuous variables are winsorized at the first and ninety-ninth percentiles. *** p < 0.01; ** p < 0.05; * p < 0.1.

Instrument Variable Regressions

We estimate Equations (6) and (7) using two-stage least squares (2SLS) and generalized method of moments (GMM) to address potential endogeneity in women director network centrality. The proportion of women directors from elite institutions is used as the instrument. The instrumental variable models retain the same dependent variable, set of controls and fixed effects as the baseline model. Table 5 reports the second-stage estimates. Columns (2) and (5) present the 2SLS results and columns (3) and (6) reports the GMM estimates.

The results suggest that, degree centrality exhibits a positive and statistically significant association with CSR expenditure. Betweenness centrality is also positive and significant, with a larger coefficient relative to degree centrality. Because the model is exactly-identified, the 2SLS and GMM estimators yield identical coefficients. We report both for completeness. They differ only in the estimated standard errors.

The other covariates like firm performance, market valuation, firm size, board size and board diversity exhibit positive and statistically significant effects. Board independence is negatively associated with CSR expenditure. This suggests that monitoring-oriented boards may constrain discretionary social investments.

Additionally, the Anderson LR test and the Cragg–Donald F-statistic indicate that the first stage regression is strong and that the instrument is relevant. The Durbin-Wu Hausman test suggests that endogeneity present in the baseline model. Because, the specification is exactly identified, exogeneity cannot be empirically tested.

Therefore, after addressing endogeneity concerns through an instrumental variable strategy, we still find that women director network centrality has a positive and statistically significant effect on CSR expenditure.

Table 5: Women Director Network Centrality and Corporate Social Responsibility: Instrument Variable Estimations

	(1)	(2)	(3)	(4)	(5)	(6)
	First Stage	Second Stage (2SLS)	Second Stage (GMM)	First Stage	Second Stage (2SLS)	Second Stage (GMM)
VARIABLES	WD Avg. Degree	Log of CSR	Log of CSR	WD Avg. Betweenness	Log of CSR	Log of CSR
WD Avg. Degree		1.122*** (0.307)	1.122*** (0.296)			
WD Avg. Betweenness					1.857*** (0.527)	1.857*** (0.513)
Prop. WD Elite Edu.	0.813*** (0.0615)			0.491*** (0.0527)		
Return on Assets	-0.243*** (0.0637)	8.575*** (0.269)	8.575*** (0.353)	-0.113** (0.0545)	8.511*** (0.274)	8.511*** (0.356)
Tobin's Q	0.00665*** (0.00148)	0.0232*** (0.00652)	0.0232*** (0.00673)	0.00397*** (0.00127)	0.0233*** (0.00674)	0.0233*** (0.00689)
Dividend/Assets	0.282*** (0.105)	0.455 (0.438)	0.455 (0.478)	0.0722 (0.0898)	0.637 (0.444)	0.637 (0.485)
Leverage	-0.102*** (0.0229)	-0.989*** (0.0976)	-0.989*** (0.108)	-0.0718*** (0.0196)	-0.970*** (0.103)	-0.970*** (0.113)
Cash/Assets	1.735	4.531	4.531	1.254	4.151	4.151

	(1.079)	(4.408)	(4.437)	(0.924)	(4.581)	(4.692)
Firm Age	0.00918*	0.0376*	0.0376*	0.00344	0.0415*	0.0415*
	(0.00519)	(0.0211)	(0.0216)	(0.00444)	(0.0218)	(0.0221)
CEO Duality	0.00817	0.0531	0.0531	0.0245**	0.0169	0.0169
	(0.0119)	(0.0482)	(0.0482)	(0.0102)	(0.0513)	(0.0525)
Tangibility Ratio	-0.0587***	0.760***	0.760***	-0.0291	0.748***	0.748***
	(0.0217)	(0.0908)	(0.0951)	(0.0186)	(0.0933)	(0.0968)
Sales Growth	0.00168	-0.231***	-0.231***	-0.00334	-0.223***	-0.223***
	(0.0118)	(0.0479)	(0.0572)	(0.0101)	(0.0497)	(0.0586)
Liquidity	-0.00280*	0.000804	0.000804	-0.00232*	0.00197	0.00197
	(0.00153)	(0.00627)	(0.00716)	(0.00131)	(0.00654)	(0.00744)
Firm Size	0.0522***	0.843***	0.843***	0.0353***	0.836***	0.836***
	(0.00239)	(0.0201)	(0.0203)	(0.00204)	(0.0226)	(0.0227)
Board Size	-0.00357***	0.0226***	0.0226***	-9.60e-05	0.0187***	0.0187***
	(0.00128)	(0.00530)	(0.00544)	(0.00110)	(0.00539)	(0.00557)
Proportion of Women	-0.300***	0.640***	0.640***	-0.223***	0.718***	0.718***
	(0.0419)	(0.177)	(0.162)	(0.0359)	(0.191)	(0.176)
Board Independence	0.113***	-0.258*	-0.258**	0.109***	-0.334**	-0.334**
	(0.0309)	(0.132)	(0.130)	(0.0264)	(0.145)	(0.142)
Constant	-0.324***	9.358***	9.358***	-0.215***	9.411***	9.411***
	(0.0428)	(0.202)	(0.214)	(0.0366)	(0.217)	(0.233)
Observations	5,598	5,598	5,598	5,598	5,598	5,598

R-squared	0.215	0.760	0.760	0.156	0.743	0.743
Industry and Time Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Cragg-Donald Wald F	174.3			86.83		
Anderson LM Chi-sq	171.4			86.72		

Note: This table presents the results from instrument variable regressions. The sample comprises non-financial non-government NSE-listed companies from 2016 to 2023. We have used the proportion of women directors who attended elite institutions the instrument for women director network centrality measures. The dependent variable is the logarithm of CSR expenditure incurred in a year, obtained from CMIE Prowess database. First stage regression results are presented in Columns (1) and (4). Columns (2) and (5) report 2SLS estimates, while columns (3) and (6) report GMM estimates. All independent variables are lagged by one year and continuous variables are winsorized at the first and ninety-ninth percentiles. Standard errors, reported in parentheses, are heteroskedasticity-robust for the GMM specifications in columns (3) and (5). *** p < 0.01; ** p < 0.05; * p < 0.1.

Additional Analyses

Independent Women Director Networks and CSR

Executive directors typically hold a greater operational influence than independent directors. In contrast, independent directors are expected to play a stronger monitoring role and their incentives for directorships differ from those of inside directors (Fama & Jensen, 1983). Therefore, in this section, we focus on whether the average network centrality of independent women directors would affect a firm's CSR expenditure.

We address potential endogeneity by instrumenting the centrality of independent women directors with the proportion of independent women directors who are graduates of elite institutions. Table 6 reports the results from estimating Equations (6) and (7) using the average network centralities of independent women directors as the key explanatory variables.

The results indicate that the average degree and betweenness of independent women directors are also positively and statistically significant. Therefore, firms with more connected independent women directors exhibit higher CSR expenditure. In contrast, the proportion of independent directors on the board, including both men and women, is negative and statistically insignificant in this specification. This indicates that board independence per se may not improve CSR expenditure of the firm, but women independent director centrality can still have an influence on CSR expenditure.

Table 6: Independent Women Director Networks and CSR

	(1)	(2)	(3)	(4)
	First Stage	Second Stage (2SLS)	First Stage	Second Stage (2SLS)
VARIABLES	IWD Avg. Degree	Log of CSR	IWD Avg. Betweenness	Log of CSR
	SS			
IWD Avg. Degree		1.086*** (0.290)		
IWD Avg. Betweenness				1.792*** (0.502)
Prop. WD Elite Edu.	1.013*** (0.0751)		0.614*** (0.0700)	
Return on Assets	-0.168** (0.0719)	8.280*** (0.285)	-0.0924 (0.0671)	8.263*** (0.298)
Tobin's Q	0.00714*** (0.00164)	0.0238*** (0.00685)	0.00593*** (0.00153)	0.0209*** (0.00750)
Dividend/Assets	0.176 (0.117)	0.566 (0.463)	-0.00969 (0.109)	0.774 (0.479)
Leverage	-0.0950*** (0.0266)	-0.918*** (0.107)	-0.0595** (0.0249)	-0.915*** (0.112)
Cash/Assets	0.300 (1.254)	4.613 (4.917)	1.106 (1.170)	2.957 (5.180)
Firm Age	0.0146** (0.00586)	0.0481** (0.0230)	0.0109** (0.00546)	0.0444* (0.0242)
CEO Duality	0.0230* (0.0137)	0.0604 (0.0542)	0.0402*** (0.0128)	0.0133 (0.0598)
Tangibility Ratio	-0.0582** (0.0257)	0.829*** (0.104)	-0.0165 (0.0240)	0.796*** (0.107)
Sales Growth	-0.00873 (0.0134)	-0.200*** (0.0526)	-0.0163 (0.0125)	-0.180*** (0.0558)
Liquidity	-0.00304* (0.00178)	0.00131 (0.00705)	-0.00247 (0.00166)	0.00243 (0.00743)
Firm Size	0.0455*** (0.00280)	0.861*** (0.0189)	0.0329*** (0.00261)	0.851*** (0.0221)
Board Size	-0.00683*** (0.00146)	0.0264*** (0.00610)	0.00272** (0.00136)	0.0141** (0.00611)
Proportion of Women	-0.464*** (0.0461)	0.835*** (0.213)	-0.113*** (0.0430)	0.534*** (0.192)
Board Independence	-0.00525 (0.0366)	-0.172 (0.143)	0.0178 (0.0341)	-0.210 (0.151)

Constant	-0.129** (0.0524)	9.078*** (0.212)	-0.197*** (0.0489)	9.291*** (0.244)
Observations	4,376	4,376	4,376	4,376
R-squared	0.216	0.766	0.156	0.743
Industry and Time Fixed Effects	Yes	Yes	Yes	Yes
Cragg-Donald Wald F	182.2		76.93	
Anderson LM Chi-sq	178		76.98	

Note: This table presents the results from the 2SLS estimation results with average degree and betweenness centralities of independent women directors as the main variables of interest. The sample comprises non-financial non-government NSE-listed companies from 2016 to 2023. We have used the proportion of independent women directors who attended elite institutions as the instrument for independent women director network centrality measures. The dependent variable is the logarithm of CSR expenditure incurred in a year, obtained from CMIE Prowess database. Columns (1) and (3) present the first stage results while Columns (2) and (4) report the second stage results of the two stage least squares regression. All independent variables are lagged by one year and continuous variables are winsorized at the first and ninety-ninth percentiles. Standard errors are reported in parentheses. *** p < 0.01; ** p < 0.05; * p < 0.1.

Sub-sample analysis

We next examine whether the relationship between the network centrality of women directors and CSR expenditure differs across business group firms and other firms. We define business group firms as those affiliated with Indian business groups. On the other hand, the comparison sample consists of stand-alone firms and firms affiliated with foreign business groups. We re-estimate the baseline instrumental variable specification separately for each subsample and the results are reported in Table 7. The results show that greater direct connections (degree) as well as brokerage roles (betweenness) among women directors are associated with higher CSR expenditure in business group affiliated firms. However, the network centrality of women directors is not associated with CSR spending for non-business group firms.

Table 7: Subsamples defined by business group affiliation

	(1)	(2)	(3)	(4)
	Business Group Firms		Standalone Firms	
VARIABLES	Log of CSR			
WD Avg. Degree	1.251*** (0.287)		-3.790 (8.988)	
WD Avg. Betweenness		2.175*** (0.526)		-2.855 (5.606)
Constant	9.272*** (0.218)	9.369*** (0.242)	9.249*** (2.064)	9.845*** (0.682)
Observations	4,710	4,710	888	888
R-squared	0.742	0.713	0.699	0.794
Controls	Yes	Yes	Yes	Yes
Industry and Time FE	Yes	Yes	Yes	Yes
Estimator	2SLS	2SLS	2SLS	2SLS

Note: The table reports instrument variable regression (2SLS) results examining the relationship between network centrality of women directors and Corporate Social Responsibility (CSR) performance, across subsamples defined by Indian business group affiliation. The percentage of women directors who attended elite institutions is used as the instrument. Columns (1)–(2) present results for 4,710 firm-year observations of business group firms. Columns (3)–(4), on the other hand, present results for 888 non-business group firm-year observations. The dependent variable is the logarithm of CSR expenditure. All independent variables are lagged by one year and continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Women Director Networks and Compliance with the CSR Mandate

We next examine whether the network centrality of women directors is associated with a firm's compliance with the CSR mandate. Compliance is defined as a binary indicator equal to one, if the firm meets the spending requirement under Section 135 of the Companies Act, 2013 and zero otherwise. The act requires eligible firms to spend in a given year is at least two percent of the average net profit of the previous three years on CSR activity.

Given the binary nature of the dependent variable and the potential endogeneity of network centrality, we estimate an IV-probit

model. We use the same instrument and the same set of controls as in the baseline instrumental variable specification. The average marginal effects are reported in Table 8.

The results indicate a positive and statistically significant association between women director network centrality and compliance with the CSR mandate. Degree and betweenness centralities are positively related to the likelihood of complying with the CSR mandate. The magnitude of average marginal effects is larger, for betweenness. The findings suggest that the networks of women directors are associated not only with higher CSR expenditure but also with a higher likelihood of meeting statutory CSR requirements.

Table 8: Compliance with Section 135 of the Companies Act with respect to CSR expenditure

VARIABLES	(1) Compliance	(2) Compliance
WD Avg. Degree	0.982** (0.493)	
WD Avg. Betweenness		1.562** (0.774)
Observations	5,327	5,327
Controls	Yes	Yes
Industry and Time FE	Yes	Yes
Estimator	IV - Probit	IV - Probit

Note: The table reports the average marginal effects for the IV-Probit regression examining the relationship between network centrality of women directors and the compliance with the CSR spending requirement according to the Section 135 of the Companies Act. The proportion of women directors who attended elite institutions is used as the instrument. The dependent variable is a binary indicator for compliance. All independent variables are lagged by one year and continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

CSR Spending Above Peers

Due to imitation, social learning and peer effects (Bikhchandani et al., 1992; Manski, 1993) firms may benchmark their CSR decisions against industry peers. Therefore, in this section, we examine whether the network

centrality of women directors is associated with firms exceeding prevailing industry norms in CSR spending.

The dependent variable is a binary indicator equal to one if a firm's CSR expenditure in a given year exceeds the industry-average CSR spending (calculated after excluding the firm itself) and zero otherwise. Table 9 reports the average marginal effects from the IV-Probit model. The results show that both degree and betweenness centrality of women directors are positively and significantly associated with the likelihood of CSR spending above industry peers. Betweenness centrality exhibits a larger coefficient in this specification as well. These findings, therefore, suggest that the networks of women directors are associated with a greater likelihood of adopting CSR strategies that exceed industry standards.

Table 9: Women Director Networks and CSR Spending Above Industry Peers

VARIABLES	(1) > Industry CSR	(2) > Industry CSR
WD Avg. Degree	1.304** (0.516)	
WD Avg. Betweenness		2.103*** (0.789)
Observations	5,572	5,572
Controls	Yes	Yes
Industry and Time FE	Yes	Yes
Estimator	IV - Probit	IV - Probit

Note: This table reports the average marginal effects for the IV-Probit regression examining the relationship between network centrality of women directors and the CSR spending above industry benchmark. The proportion of women directors who attended elite institutions is used as the instrument. The dependent variable is a binary indicator equal to one if the firm's CSR expenditure exceeds the industry-average CSR in a given year. All independent variables are lagged by one year and continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

ROBUSTNESS CHECKS

Consistency of CSR Reporting

Firms that report positive CSR expenditure in every year in the sample may have a strong internal CSR culture. These firms treat CSR activities as part of their corporate philosophy and not just as a response to regulation or short-term pressure. As a result, CSR decisions in these firms may depend more on governance processes and less on external mandates.

Re-estimating the baseline IV model (Equations 6 and 7) using a balanced panel of firms with positive CSR expenditure throughout the sample period therefore allows us to examine whether the network centrality of women directors matters even in firms where CSR engagement is already institutionalised. Table 10 presents the regression results. Both degree and betweenness centrality of women directors exhibit positive and statistically significant links with CSR expenditure. These results are consistent with the main findings.

The larger coefficients in the balanced panel suggest that well-connected women directors have a stronger influence in firms where CSR culture is in place. In these firms, higher centrality translates more effectively into greater CSR spending. As before, betweenness centrality has a much larger effect than degree centrality.

Table 10: Effects of Networks in a Balanced Panel with Positive CSR

VARIABLES	(1)	(2)
	Log of CSR	Log of CSR
WD Avg. Degree	2.261*** (0.495)	
WD Avg. Betweenness		4.180*** (1.025)
Constant	9.793*** (0.271)	9.776*** (0.301)
Observations	3,597	3,597
R-squared	0.745	0.680
Controls	Yes	Yes
Industry and Time Effects	Yes	Yes
Estimator	2SLS	2SLS

Note. The table reports instrument variable regression results examining the relationship between network centrality of women directors and Corporate Social Responsibility (CSR) performance, over a subsample of firms that report a positive CSR in every year from 2016 to 2023. The proportion of women directors who attended elite institutions is used as the instrument. The dependent variable is the logarithm of CSR expenditure. All independent variables are lagged by one year and continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Alternative measure of centrality

To further understand whether the baseline findings are sensitive to the centrality measure used, we re-estimate the models using the average eigenvector centrality of women directors in a firm as the key explanatory variable. Eigenvector centrality captures both the number of connections a director has and the quality of these connections. The centrality measure assigns greater weight to ties with other well-connected individuals. Eigenvector centrality is defined as:

$$E_i = \lambda \sum_j w_{ij} E_j \quad (8)$$

where E_i represents the eigenvector centrality of node i , w_{ij} refers to the strength of the connection between nodes i and j and λ is the largest eigenvalue of the network's adjacency matrix. E_j represents the eigenvector centrality of node j .

We re-estimate Equations (6) and (7) by replacing degree and betweenness centrality with the average eigenvector centrality of women directors at the firm level. As with the other centrality measures, we normalise eigenvector centrality to range between zero and one to ensure comparability across centrality measures. We keep the empirical specification unchanged and continue to use an instrumental variable regression to address potential endogeneity. Table 11 reports the results. The coefficient of eigenvector centrality of women directors is positive and statistically significant at the one percent level. This result supports the main findings by showing that firms with women directors connected to prominent and well-networked directors are associated with a higher CSR spending.

Table 11: Eigenvector Centrality of Women Directors and CSR

VARIABLES	Log of CSR
WD Avg. Eigenvector	1.335*** (0.365)
Return on Assets	8.637*** (0.273)
Tobin's Q	0.0217*** (0.00667)
FirmSize	0.825*** (0.0245)
Board Size	-0.00142 (0.00759)
Proportion of Women	0.430*** (0.166)
Board Independence	-0.278** (0.133)
Constant	9.685*** (0.276)
Observations	5,598
R-squared	0.761
Other Controls	Yes
Industry and Time FE	Yes
Estimator	2SLS

Note: The table reports the instrument variable regression results examining the effect of eigenvector centrality of women directors on the firm's CSR expenditure. The proportion of women directors who attended elite institutions is used as the instrument. The dependent variable is the logarithm of CSR expenditure. All independent variables are lagged by one year and continuous variables are winsorized at the 1st and 99th percentiles. Standard errors are reported in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

DISCUSSION

This study shows that the network centrality of women directors plays an important role in determining a firm's CSR behaviour. Firms with more connected women directors spend more on CSR. Additionally, the centralities of independent women directors are also positively associated with a higher CSR spending by firms.

The results also show that firms with women board members who have high degree and betweenness centrality are more likely to comply with the government-imposed CSR mandate. These firms are also more likely to exceed the industry average CSR spending. In firms that already show strong CSR commitment, the effect of the networks of women directors becomes much stronger. The results remain robust when we use eigenvector centrality to measure social capital of the directors.

In line with the prior studies, we also find a positive relationship between board diversity and CSR. However, this study demonstrates that the effect of women directors on CSR is not uniform, with the results revealing a clear heterogeneity in influence. For, structurally disadvantaged groups, informal mechanisms like networks can be a proxy for power and influence. Women directors who are more connected can propel firms towards socially responsible behaviour. The results suggest that influence can complement representation.

We also observe that board independence is negatively associated with the CSR spending. Independent directors are considered better monitors than non-independent directors and hence a superior solution to the agency problem in corporate governance. Additionally, independent directors are often executives of other firms. They take up additional directorships to enhance their human capital through reputation and by signalling to the market their ability as a competent director (Fama & Jensen, 1983). Therefore, independent directors might be unwilling to risk their reputation by approving of discretionary spending such as CSR.

However, independent women director who possess a greater network centrality show a different pattern. Firstly, independent women directors may have higher stakeholder orientation compared to independent male directors. And secondly, independent women director who are central can obtain information they need from their networks, offsetting information asymmetry. And hence they might be able to approve of higher CSR spending with reduced risk of reputational loss. Still, the effect of centrality of women directors in general is larger than that of independent women directors.

The results also demonstrate that the network centrality of women directors increase the probability of firms spending above the industry average. Betweenness centrality shows the strongest effect. Bikhchandani et al. (1992) suggest that different groups can fall into different informational cascades. However, people who connect groups can transmit new information and disrupt local norms. Women directors with high betweenness centrality play this bridging role in board networks. They observe practices across multiple firm clusters, rather than one local circle. This broader exposure helps them bring alternative CSR standards into the firm. As a result, they can weaken low-CSR norms and shift firms toward higher CSR spending.

In addition, the robustness check using eigenvector centrality strengthens these conclusions. While degree centrality captures the number of connections and betweenness captures brokerage roles, eigenvector centrality reflects connections to influential and well-connected actors. Therefore, the positive association between eigenvector centrality of women directors and CSR spending indicates that access to powerful networks further amplifies influence.

We also observe that, the effect of betweenness centrality of women was relatively higher across all models. This indicates the quality

of ties may matter more than the number of ties. Betweenness centrality, as we mentioned previously, is associated with bridging disconnected parts of the network. Those with a higher betweenness centrality be acquainted with people outside their immediate circle, exposing them to novel ideas and information. Granovetter (1973) in his work on the strength of weak ties observes the importance of acquaintances and their role in equipping a person with valuable knowledge and resources that one's closer ties may lack. This strengthens our argument that the quality of connections matter, not just the count.

Some limitations of the study should be acknowledged. The analysis focuses solely on listed non-financial firms. We also rely on board interlocks to construct networks, which may not capture informal ties. Consequently, future research could explore other institutional settings and alternative pathways through which directors can be connected, such as alma mater or family ties.

CONCLUSION

Corporate boards operate within broader social structures. The impact of women directors may depend not only on their presence but also on their influence. This study shows that the centrality of women directors in board interlock networks can shape a firm's CSR behaviour. Using a sample of NSE-listed non-financial non-government firms from 2016–2023, we find that degree and betweenness centrality of women directors are positively associated with CSR expenditure. Instrument variable estimations confirm that the relationship among the variables hold, even after accounting for reverse causality and omitted variable bias. Robustness checks further show that, even in heterogeneous environments with different governance structures and varying internal or external conditions, social capital of women directors enables them to shape the firm's social and ethical orientation.

The requirements for modern corporations to be socially responsible continues to grow stronger as the decisions of powerful corporations resonate far and wide, affecting people across nations (Bowen, 1953). Even as Friedman (1970) championed profit as the ultimate aim of business, modern thought and stakeholder theory advocate for corporate actions that focus on the well-being of employees, customers and communities. By embracing socially responsible practices, firms not only honour their ethical and societal obligations but also strengthen their ability to create and sustain long-term value (Jensen, 2002). Therefore, corporate social responsibility in the present day and age, is no longer merely just an act of benevolence or altruism; it has become a strategic necessity. Our findings provide an evidence of strategic CSR decisions in a setting where CSR is mandatory requirement.

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Appendix A1: Variable definitions

Variables	Definitions
Board Level Variables	
Average Degree of Women Directors	Average degree centrality of women directors on the board of a firm. Degree centrality captures the number of direct connections held by a director. The centrality measure is min–max normalized on a year-wise basis and therefore range between zero and one.
Average Betweenness of Women Directors	Average betweenness centrality of women directors on the board of a firm. Betweenness centrality captures the ability of a director to bridge otherwise disconnected clusters. The centrality measure is min–max normalized on a year-wise basis and therefore range between zero and one.
Average Eigenvector of Women Directors	Average eigenvector centrality of women directors on the board of a firm. Eigenvector centrality captures connections to influential directors in the network. The centrality measure is min–max normalized on a year-wise basis and therefore range between zero and one.
Average Degree of Independent Women Directors	Average degree centrality of independent women directors on the board of a firm. The centrality measure is min–max normalized on a year-wise basis and therefore range between zero and one.
Average Betweenness of Independent Women Directors	Average betweenness centrality of independent women directors on the board of a firm. The centrality measure is min–max normalized on a year-wise basis and therefore range between zero and one.
Board Size	The number of directors on the board of a firm
Proportion. of Women	Ratio of women directors to total board size.
Board Independence	Ratio of independent directors to total board size.
Proportion of Women Directors from Elite Institutions	Proportion of women directors on the board who have attended elite institutions. Elite institutions, as defined in this study, include any of the Indian Institute of Technology (IITs), any of the Indian Institute of Management (IIMs) and universities ranked in the global top 20 of the QS World University Rankings (2026).
Proportion of Independent Women	Proportion of independent women directors on the board who have attended elite institutions. Elite institutions, as defined in this study, include

Directors from Elite Institutions	any of the Indian Institute of Technology (IITs), any of the Indian Institute of Management (IIMs) and universities ranked in the global top 20 of the QS World University Rankings (2026).
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CSR Related Variables

CSR Expenditure	Natural logarithm of total corporate social responsibility expenditure incurred by the firm during the year.
CSR Above Industry Average	Indicator equal to one if a firm's CSR expenditure exceeds the industry-year average and zero otherwise.
Compliance	Indicator equal to one if a firm's CSR expenditure is at least 2% of the average net profits from the preceding three financial years, as required under Section 135 of the Companies Act, 2013. This measure captures compliance with the CSR spending requirement.

Firm Level Variables

Tangibility Ratio	Ratio of net fixed assets (net of intangible assets) to total assets. Tangibility is computed as the difference between net fixed assets and net intangible assets. Tangibility is divided by total assets to arrive at the tangibility ratio
Liquidity	Ratio of current assets to current liabilities.
CEO Duality	Indicator equal to one if the CEO also serves as chair of the board and zero otherwise
Firm Age	Natural logarithm of the number of years since the incorporation of the firm
Firm Size	Natural logarithm of total assets.
Sales Growth	Annual growth in income from non-financial operations. Increase or decrease in the income from non-financial operations from the previous year
Q Ratio	Proxy for Tobin's Q, computed as the ratio of the sum of market capitalization, debt and paid-up preference capital to total assets
Return on Assets	Ratio of profit after tax to total assets.
Leverage	Ratio of total borrowings (non-current liabilities and short-term borrowings) to total assets.
Dividend/Assets	Dividends divided by total assets
Cash/Assets	Cash balance divided by total assets

A2: Pairwise Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Log of CSR	1									
(2) WD Avg. Degree	0.33	1								
(3) WD Avg. Betweenness	0.271	0.891	1							
(4) Return on Assets	0.33	0.049	0.036	1						
(5) Tobin's Q	0.294	0.148	0.112	0.532	1					
(6) Dividend/Assets	0.321	0.119	0.084	0.53	0.428	1				
(7) Leverage	-0.154	-0.045	-0.023	-0.431	-0.287	-0.269	1			
(8) Cash/Assets	-0.02	0.001	-0.01	0.015	0.029	-0.008	-0.028	1		
(9) Firm Age	0.202	0.1	0.083	0.018	-0.005	0.101	-0.021	-0.003	1	
(10) CEO Duality	0.003	-0.008	0.018	0.016	-0.018	-0.017	-0.004	-0.033	0.007	1
(11) Tangibility Ratio	-0.007	-0.031	-0.011	-0.108	-0.132	-0.136	0.342	-0.039	0.058	0.004
(12) Sales Growth	-0.005	0.008	0.009	0.236	0.126	0.008	-0.038	-0.01	-0.07	0.007
(13) Liquidity	0.005	-0.039	-0.043	0.275	0.119	0.177	-0.45	-0.022	-0.041	0.017
(14) Firm Size	0.777	0.351	0.293	0.008	0.098	0.113	0.091	-0.035	0.199	-0.008
(15) Board Size	0.393	0.153	0.157	0.065	0.086	0.109	0.018	-0.025	0.187	-0.017
(16) Board Diversity	-0.036	-0.064	-0.07	0.013	0.05	0.024	-0.061	-0.042	-0.077	-0.011
(17) Board Independence	-0.037	0.035	0.039	-0.041	-0.062	-0.053	0.049	0.008	0.038	0.102

Variables	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) Log of CSR							
(2) WD Avg. Degree							
(3) WD Avg. Betweenness							
(4) Return on Assets							
(5) Tobin's Q							
(6) Dividend/Assets							
(7) Leverage							
(8) Cash/Assets							
(9) Firm Age							
(10) CEO Duality							
(11) Tangibility Ratio	1						
(12) Sales Growth	-0.034	1					
(13) Liquidity	-0.304	-0.014	1				
(14) Firm Size	-0.005	0.014	-0.153	1			
(15) Board Size	0.105	-0.02	-0.108	0.431	1		
(16) Board Diversity	-0.099	0.038	0.107	-0.081	-0.27	1	
(17) Board Independance	0.029	-0.009	-0.007	-0.012	-0.089	0.003	1

Note: The table presents the pairwise correlations among the variables used in the study.

Table A3: Elite Global Universities

Sl. No.	Ranking	College	Country/Area	Alumnae
1	1	Massachusetts Institute of Technology (MIT)	United States of America	18
2	2	Imperial College London	United Kingdom	7
3	3	Stanford University	United States of America	57
4	4	University of Oxford	United Kingdom	68
5	5	Harvard University	United States of America	362
6	6	University of Cambridge	United Kingdom	79
7	7	ETH Zurich (Swiss Federal Institute of Technology)	Switzerland	0
8	8	National University of Singapore (NUS)	Singapore	5
9	9	UCL (University College London)	United Kingdom	0
10	10	California Institute of Technology (Caltech)	United States of America	0
11	11	The University of Hong Kong	Hong Kong SAR, China	9
12	12	Nanyang Technological University, Singapore (NTU Singapore)	Singapore	3
13	13	University of Chicago	United States of America	0
14	14	Peking University	China (Mainland)	2
15	15	University of Pennsylvania	United States of America	363
16	16	Cornell University	United States of America	93
17	17	Tsinghua University	China (Mainland)	0
18	17	University of California, Berkeley (UCB)	United States of America	14
19	19	The University of Melbourne	Australia	54
20	20	The University of New South Wales	Australia	11

Note: Table presents the list of the top 20 global universities according to the QS rankings and the number of women directors who are alumnae of these institutions.

MSE Monographs

- * Monograph 36/2017
Underlying Drivers of India's Potential Growth
C.Rangarajan and D.K. Srivastava
- * Monograph 37/2018
India: The Need for Good Macro Policies (*4th Dr. Raja J. Chelliah Memorial Lecture*)
Ashok K. Lahiri
- * Monograph 38/2018
Finances of Tamil Nadu Government
K R Shanmugam
- * Monograph 39/2018
Growth Dynamics of Tamil Nadu Economy
K R Shanmugam
- * Monograph 40/2018
Goods and Services Tax: Revenue Implications and RNR for Tamil Nadu
D.K. Srivastava, K.R. Shanmugam
- * Monograph 41/2018
Medium Term Macro Econometric Model of the Indian Economy
D.K. Srivastava, K.R. Shanmugam
- * Monograph 42/2018
A Macro-Econometric Model of the Indian Economy Based on Quarterly Data
D.K. Srivastava
- * Monograph 43/2019
The Evolving GST
Indira Rajaraman
- * Monograph 44/2025 Landscape Analysis of the Labour Market of the Freight Logistics Sector in India
Gopal Krishna Roy, Brinda Viswanathan, Ashrita. B, Madhuritha Murali and Mohit Sharma
- * Monograph 45/2025 The Fisc and India's Energy Transition
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Devlina and Santosh Kumar Sahu
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Srikanth Pai, Akila Hariharan, and Naveen Srinivasan
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Early Detection of ESG Policy Violations Using Machine Learning Techniques
Gautami Parate and Arpita Choudhary
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Stock Market Reactions to COP26 and Climate Change Exposures of Indian Firms
Saumitra N Bhaduri, Ekta Selarka and Alankrti Aggrwal
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European Union Regulations in Indian Tyre Industry
Ekta Selarka and Subrata Sarkar