

**Women Director Interlocks and Firm Performance: Evidence from  
India**

**Shreya Biswas, Jayati Sarkar, Ekta Selarka**



**Indira Gandhi Institute of Development Research, Mumbai  
December 2023**

# Women Director Interlocks and Firm Performance: Evidence from India

Shreya Biswas, Jayati Sarkar, Ekta Selarka

[Email\(corresponding author\): jayati@igidr.ac.in](mailto:jayati@igidr.ac.in)

## Abstract

*This paper empirically examines the impact of network ties of women directors on firm value and sheds light on the unaddressed issue of whether such ties can serve as one of the channels through which women on board affect firm performance. In doing so, the study also seeks to provide a gendered perspective of the performance effects of interlocking directorates on which empirical evidence is scant. Using a panel of listed firms in India for the period 2010-2020 covering periods of pre and post institution of gender quota on company boards, our study finds that women director connectedness, as captured in select network centrality measures, has a positive and robust effect on firm value. We further find evidence that the positive relationship with firm value is driven by the information advantage and influence of women director networks. Finally, based on a director level analysis, we find that more connected women directors, including those who are independent, contribute to corporate governance through higher meeting attendance, and through their memberships in important committees. The findings of the paper highlight the unique role of women director interlocks in firm governance and performance.*

**Keywords:** Interlocking directors, Firm value, Woman Directors, Network centrality, India, Emerging Markets

**JEL Code:** G32, G34, G38

## Acknowledgements:

Authors would like to thank the participants of the Financial Markets and Corporate Governance Conference, 2023, Deakin Business School, Melbourne, of the 4th Annual Conference in Economics and Finance, BITS Pilani, Hyderabad, and of the Network Science in Management Conference 2022, Indian Institute of Management, Ahmedabad for their valuable comments and suggestions on the earlier versions of the paper. The usual disclaimer applies.

**Women Director Interlocks and Firm Performance:  
Evidence from India**

**Shreya Biswas**

Birla Institute of Technology and Science, Pilani, Hyderabad Campus

Email: [shreya@hyderabad.bits-pilani.ac.in](mailto:shreya@hyderabad.bits-pilani.ac.in)

**Jayati Sarkar**

Indira Gandhi Institute of Development Research, Mumbai

Email: [jayati@igidr.ac.in](mailto:jayati@igidr.ac.in)

**Ekta Selarka**

Madras School of Economics, Chennai

Email: [ekta@mse.ac.in](mailto:ekta@mse.ac.in)

## **Abstract**

This paper empirically examines the impact of network ties of women directors on firm value and sheds light on the unaddressed issue of whether such ties can serve as one of the channels through which women on board affect firm performance. In doing so, the study also seeks to provide a gendered perspective of the performance effects of interlocking directorates on which empirical evidence is scant. Using a panel of listed firms in India for the period 2010-2020 covering periods of pre and post institution of gender quota on company boards, our study finds that women director connectedness, as captured in select network centrality measures, has a positive and robust effect on firm value. We further find evidence that the positive relationship with firm value is driven by the information advantage and influence of women director networks. Finally, based on a director level analysis, we find that more connected women directors, including those who are independent, contribute to corporate governance through higher meeting attendance, and through their memberships in important committees. The findings of the paper highlight the unique role of women director interlocks in firm governance and performance.

JEL Codes: G32, G34, G38

Keywords: Interlocking directors, Firm value, Woman Directors, Network centrality, India, Emerging Markets.

## 1. Introduction

Interlocking directorates, formed as a consequence of directors sitting on the board of multiple firms, are argued to be important conduits through which the board of directors of a firm can impact its governance and performance. Notwithstanding the growing literature on board interlocks and firm outcomes, little distinction is made in it between the underlying networks of men and women directors sitting on company boards. Yet, numerous studies on women directors contend that, compared to their male counterparts, women directors have attributes, strengths, linkages, and experiences distinct from that of men, which can add value to board deliberations, decision making and monitoring of management (Adams and Ferreira, 2009, Davies , 2011; Rhode and Packel, 2014)<sup>1</sup>. For instance, drawing on resource dependence theories from a gendered perspective, it is argued that women directors by virtue of possessing unique behavioural characteristics, educational backgrounds and professional experiences and capabilities, have a wider range of social and human capital, a different chain of linkages with other firms, and a diverse set of opportunities (Sarabi et al., 2021; Hillman et al., 2007; Singh et al., 2008).<sup>2</sup> For instance, Hillman et al. (2007) hypothesize that women directors, with their different experience sets, beliefs, and perspectives, can link firms to other female owned businesses which can act as suppliers, as well as to investors who are committed to gender diversity. Several empirical studies have particularly highlighted differences in social networks by gender in terms of the scope and strength of network ties (Ibarra, 1993; 1997).

The objective of this paper is to extend the existing literature on director interlocks and performance by empirically examining the performance effect of women director interlocks using a panel of listed firms in India. The primary motivation for this analysis is to identify whether women director networks is one of the channels through which such directors can impact firm performance. Notwithstanding an increasing focus to estimate the causality between women directors and firm performance directly, there is only limited focus on establishing the underlying

---

<sup>1</sup> For instance, women are considered to be more “democratic, transformational and demonstrate trust-building leadership style,” are more risk averse in financial decision making, have higher ethical standards, are more conscientious, well-prepared and are ready to ask “awkward questions” (for background literature, see Srinidhi et al, 2011; Davies , 2011; Rhodes and Packel, 2014).

<sup>2</sup> Singh et al. (2008) for instance, in their comparative assessment of newly appointed director characteristics by gender, find for a sample of UK companies that as compared to their male counterparts, women directors are present on a wider variety of boards, including that of smaller firms, and of firms belonging to different sectors, thus accumulating significant and diverse human capital that can be utilised by larger corporations.

determinants of the causality, if any. These determinants are contended to be the constituents of the black box of board dynamics (Nielsen and Huse, 2010). Identifying these is important to reconcile the inconsistent empirical findings on the relationship between women directors and firm performance. While some studies do examine some of the elements of the black box, such as gender differences in leadership styles (Nielsen and Huse, 2010), monitoring abilities (Adams and Ferreira, 2009), and in human capital in terms of experiences and knowledge (Post and Byron, 2015), to the best of our knowledge, there has been little focus on women director networks being one of the channels through which women on board can impact firm performance.

A related motivation of our study is to highlight a largely unaddressed issue in the literature on director networks of whether the gender of a director is salient in impacting the relationship between interlocking directorates and firm performance. Early research on networks from a gendered perspective has focused on how and why managerial networks of men and women can be different in terms of their scale, scope and strength of ties (Brass, 1985; Ibarra, 1993; 1997) and can have implications for governance and performance (Benton, 2021; Owen & Temesvary, 2018). However social and professional networks of women were limited across both developing and developed countries, being both the cause and effect of endemic under-representation of women directors on company boards across both developing and developed countries (Perrault, 2015; Mateos de Cabo, et al., 2011). It is only with the growing presence of women on boards across companies, primarily on account of the institution of voluntary governance codes and mandatory gender quotas, that there has been an increasing focus on studies examining the evolution of women directorial networks, how these differ from that of male directors,<sup>3</sup> and how quotas have impacted the ‘centrality’ of women directors in directorial networks.<sup>4</sup> For instance, Seierstad and Opsahl (2011) and Strom (2019) exploring the effect of gender quotas on social capital in Norway find that the 40 per cent quota in the country not only increased the percentage of women directors with three or more directorships, it also created a small elite of women directors with substantial influence in the director network in terms of select network centrality measures, to the extent of weakening the ‘old boys network.’ In a similar vein, Mateos de Cabo et al. (2021), examining

---

<sup>3</sup> See for instance, Zenou et al. (2012); Rinaldi and Tagliazucchi (2022); Ginalski (2022). As Ginalski (2022) for instance notes that the issue of women in corporate networks has not received much attention in the literature, including that on women on boards.

<sup>4</sup> See for example, Seierstad and Opsahl (2011); Mateos de Cabo et al. (2021).

changing network links and social capital among women directors within the European board network over the period 1999-2014, find that following the adoption of gender quotas and corporate governance codes, the importance of women in director networks, as captured in network centrality measures, increased; gender quotas increased the betweenness centrality measure which captures the extent to which women directors have control over information flows across networks.

This paper attempts to take this line of research a step forward, moving on from characterizing women directorial networks using various social network metrics, to focusing on how an increase in women directorships by fiat can impact directorial interlocks and, via this, firm performance. Both theoretical models and empirical evidence on this question is sparse and interdisciplinary in nature. The primary hypothesis that we test in this paper, that network ties of women directors through interlocking directorates have a value proposition is based on underlying differences in the network characteristics of men and women managers posited in the literature on organisational sociology. With regard to scale and scope of ties, for instance, Owen & Temesvary (2018) finds in the case of bank boards in the US that the professional networks of male and female board members are different in terms of both extent and intensity, with the latter having a smaller number and shorter duration of connections with other board members as compared to male directors. This could have implications for the cohesiveness of the board to the extent to which women directors on company boards can contribute to board governance. Benton (2021) for instance highlights in the context of the US that while over time, women directors have occupied multiple board seats and accessed the male dominated inner circle, this has been symbolic in nature and has not led to their greater representation in board committees through which they could exercise more power and influence in corporate governance. With regard to the strength of ties, too, it is not *a priori* clear whether women in managerial positions have weak or strong ties (Ibarra, 1993; 1997; Talmud and Izraeli, 1999), and even for a particular type of ties, the direction of their effect on performance. For instance, if one starts with the premise that women directors, by virtue of their marginal presence on company boards are likely to have weak ties, then drawing on Granovetter's (1983) theory of the strength of weak ties, one can argue that such ties would perform a bridging function for the focal firm by bringing in instrumental benefits in the form of forging different chains of inter-industry and informational linkages with other firms, and making a diverse set of opportunities accessible compared to their male counterparts (Ibarra, 1993; Sarabi et al., 2021;

Hillman et al., 2007; O'Hagan; 2017).<sup>5</sup> This could have a positive impact on performance from the resource dependency point of view. However, as argued by Burt (1992), some of the instrumental advantages from weak ties apply least to women and are conditional on the extent of gender bias in institutional/organisational settings, then the net potential benefits of women director networks for firm performance are likely to be ambiguous (Ibarra, 1993; Benton, 2021; Broome et al., 2010).<sup>6</sup> Finally, it has been postulated that if one controls for relevant human and social capital factors and organisational contexts, gender may not be salient in determining the performance of directors on company boards (Talmud and Izraeli, 1999).

Given that the theoretical predictions on how women directors can bring value to company boards via their networks are *a priori* indeterminate, the impact of such networks on firm performance remains an empirical question. We seek to shed light on the question of how women directors can bring value to company boards via their networks by undertaking a case study of a panel of listed Indian firms for the period 2010-2020<sup>7</sup> comprising 21,421 unique directors classified by gender, with 1,33,754 directorship-year observations and 13,140 firm year observations. The study has three components. First, it examines the evolution of women director networks following the imposition of mandatory gender quotas and analyses, using standard network measures, how the centrality of women directors has changed in the post-quota regime as compared to the pre-quota regime. Second, using the first exercise to identify sharp changes in director level and network characteristics following the gender quota as the underlying motivation, we conduct a firm level analysis to estimate the impact of women director interlocks on firm performance and examine the possible channels through which women director networks affect firm value, namely, through better information as predicated by resource dependence theory (Bjørnskov and Sønderskov, 2013) and/or through being more influential in mitigating agency costs by virtue of being more

---

<sup>5</sup> Singh et al. (2008) for instance, in their comparative assessment of newly appointed director characteristics by gender, find for a sample of UK companies that as compared to their male counterparts, women directors are present on a wider variety of boards, including that of smaller firms, and of firms belonging to different sectors, thus accumulating significant and diverse human capital that can be utilised by larger corporations.

<sup>6</sup> Benton (2021) for instance highlights gender bias and lack of interaction by noting in the context of the US that while over time, women directors occupied multiple board seats and accessed the male dominated inner circle, this has been symbolic in nature and has not led their greater representation in board committees through which they could exercise more power and influence in corporate governance.

<sup>7</sup> Given that the reporting period of all financial and company related information is between April 1 of one year to March 31 of the next year, the year 2010 is actually 2009-10 and the year 2020 refers to 2019-2020. For brevity, in this paper, we will be using the convention of mentioning only the latter year.



connected (Adler and Kwon, 2002). Finally, in line with Adams and Ferreira (2009), we examine using director level data, whether networked women influence firm governance through their participation in board activities.

India is an appropriate setting to study whether gender moderates the impact of interlocking directorates on firm performance for the following reasons. First, the institutional and regulatory context of India is suitable for examining the conflicting predictions regarding the impact of women director interlocks on firm governance and performance. India is characterized by the long-standing presence of strong patriarchal norms (Naaraayanan and Nielsen, 2020), the persistence of a male-dominated director network (“inner circle”) and weak gender empowerment norms in general (Jain, 2022). Such norms and structural barriers can limit the scale and scope of women director networks and the instrumental benefits on firm performance that can be reaped from weak ties as discussed above (Ibarra, 1993; Zhang, 2020). On the other hand, mandatory gender quotas can provide firms with ‘regulatory legitimacy’ in appointing women directors on boards (Zhang, 2020), reduce social biases such as gender stereotyping, and help firms reap positive performance benefits from the increased scale, scope, and strength of ties of women director networks.

A second reason why India is an appropriate setting to examine the effect of women director networks is on account of the institution of gender quota legislation in India under Section 149(1) of the Companies Act, 2013. The regulation required all registered companies to appoint at least one woman director on company boards. Mandatory quotas push companies to appoint women, bring them to positions of power, increase their multiple directorships, and make them ‘unique bridges’ between sub-networks disconnected earlier (Mateos de Cabo et al., 2021). This has been the case in India too where the percentage of women director interlockers (those holding two or more directorships) in our sample companies jumped from 4.40 in 2014, the year of the enactment of the gender quota, to 11.34 in 2015, and has grown thereafter.<sup>8</sup> The large and discontinuous increases in women interlockers in India creates a suitable setting to detect any statistically significant effect of women directorial networks on firm performance. Additionally, the exogenously imposed quota in 2014, allows us to the problem of potential endogeneity arising from reverse causality/ omitted variable in the relationship from board interlocks to firm outcomes

---

<sup>8</sup> As mentioned above, the years 2014 and 2015 refer to 2013-14 and 2014-15, respectively.

(Larcker et al., 2013; Fan et al., 2021). The exogenously imposed gender quota laws and regulations in India can be exploited to take account of any estimation bias in measuring the causal effect of women director interlocks on firm performance.<sup>9</sup>

Overall, the generalizability of the Indian case study lies in the fact that insights from this study can be useful for developing and developed countries that, with typically male-dominated networks historically, are in the process of imposing greater gender balance either through mandatory quotas or through voluntary corporate governance codes (refer to Mateos de Cabo et al., 2021 for specific country settings). The key findings of our paper are as follows. Our study finds that women director connectedness, as captured in select network centrality measures, is positively related to firm value. Women directors are found to bring value to the firm both through the number of connections with other directors and by acting as a bridge for information flows as well as influence. These results are robust to several sensitivity checks. Further, on investigating the channels through which women director interlocks impact firm performance, our analysis suggests that access to information through network ties as well as the influence of networked women, drive the results. Specifically, we find that firms with high information opacity, as proxied by high stock return volatility, and firms with potentially higher agency costs, as proxied by CEO duality, tend to benefit more from women director interlocks. Consistent with these findings, our director level analysis reveals that more connected women directors are more likely to attend higher number of board meetings, and are in a stronger position to influence board governance through their higher likelihood of presence in at least one of the critical board committees. All our results at director level estimated for women directors as such, are found to hold for independent women directors too. Overall the evidence is in line with network benefits associated with the resource dependence theory, as well as agency theory. The findings also highlight that providing legitimacy in the form of gender quotas may enable women to exert influence on firm policies.

The paper is organized as follows. Section 2 discusses the structure of women director interlocks in India. Section 3 describes the data, variables and estimation methodologies used in the empirical

---

<sup>9</sup> This is in line with studies in the US context that uses the enactment of the Sarbanes-Oxley Act (2002) as a natural experiment leading to exogenous variation in board structure and board network to address the endogeneity related to board network and firm outcomes (Coles et al., 2014; Chang and Wu, 2021; Fan et al, 2021).

analysis. Section 4 presents the empirical analysis along with the results. Section 5 presents robustness analysis and Section 6 concludes the paper.

## **2. Women Director Interlocks in India**

As in the case of other countries, a focus on either analysing the pattern of women director interlocks, or their value in inter-firm networks did not receive much attention in India, mainly on account of their marginal presence on company boards. Existing work on India is limited to exploratory analyses to determine the characteristics of social networks of Indian listed companies (Pramsankar et al., 2015)<sup>10</sup> and examining the performance effect of committee interlocks on firm performance (Edacherian et al., 2023). None of these, however, factor in the gender of the director in their analyses.

The enactment of the gender quota legislation for women directors under the Companies Act, 2013 (MCA, 2013), enforced since April 1, 2014, provided a fillip to their appointment on company boards. Specifically, under Section 149(1) of the Act, it was mandated that the Board of Directors of every company or classes of companies, as may be prescribed, must have at least one woman director on their board within six months of the notification of the law. Similar to other countries, the law in India, to begin with, did not specify the type of woman director, namely, grey or independent, to be appointed under the quota requirement. Later, in 2020, mandatory gender quota was set for independent women directors in large listed companies.<sup>11</sup>

Considering characteristics of women director networks between the pre-quota and post-quota years for all listed companies on NSE between the period 2010-2020, the period of our study, Table 1, Panel A clearly highlights some discrete changes in the characteristics both with respect

---

<sup>10</sup> Exploratory social network analysis of affiliation networks of Indian listed companies C. Prem Sankar, K. Asokan, K. Satheesh Kumar, *Social Networks* 43 (2015) 113–120

<sup>11</sup> A more stringent gender quota was introduced by the SEBI under the Listing Obligations and Disclosure Requirements (LODR) (Amendment) Regulations 2018 which required the top 1000 listed companies in India to have at least one independent woman director by April 1, 2020. The timeline for the implementation of the new regulation would be as follows: the top 500 listed entities shall have at least one independent woman director by April 1, 2019, and the Board of directors of the top 1000 listed entities shall have at least one independent woman director by April 1, 2020.

to women directors as well as their presence in director networks. As can be seen from Table 1, women directors as a percentage of total directors, while almost stable between 4.5 and 5.5 per cent prior to the mandatory quota, more than doubled in 2015 and steadily increased to 17.34 per cent by 2020. Further, there was a corresponding increase in the percentage of directorships held by women directors, from 4.61 in 2010 to 17.34.

The increase in the percentage of women directors and percentage of directorships held by women does not necessarily imply substantive changes in inter-directorial networks or inter-firm networks. What is critical in changing the scale and scope of women director networks is the extent of multiple directorships held by women directors. This is reflected in the estimates in Table 1 of women interlockers (i.e., directors with at least two directorships) as percentage of total interlockers; this percentage is seen to increase from an average of 3.82 in the pre-quota period to an average of 14 between 2015 and 2020 (along with an increasing trend). What is also striking is the sharp difference in the percentage of women big linkers (i.e., directors with three or more directorships) between the pre and post quota periods, similar to the case of interlockers.

The sharp increase in multiple board appointments of women as a percentage of such appointments across all directors imply a higher presence of women directors in inter-firm networks or interlocks. The extent to which such presence translates into the increased prominence of women in the networks in terms of their connectedness with other directors and their ability to access critical information across the network and forge new inter-directorial and inter-firm links can be captured in terms of some standard measures from social network analysis. Some select measures are presented in Table 1, Panel B, for the period of our study and are indicative of a growing prominence of women in the director networks of our sample companies. Defining the giant component as the largest interconnected component across directors, estimates in Panel B show that the presence of women directors in the giant component as percentage of total directors in the giant component, has registered a sharp increase with the enactment of the quota, from an average of around 5.5 in the pre-quota period, to an average of 14.11 and with a steadily increasing trend in the post quota period.

In Panel B of Table 1, we present estimates of degree centrality, defined as the total number of direct connections between a given director and all the other directors in a network (Freeman, 1979), and is considered as the simplest measure of connectedness. As is evident from the estimates in the Panel B, the relative importance of women directors among the top 100 directors in terms of their connectedness has increased with the adoption of mandatory quotas. If we consider the presence of women directors among the top 100 firms in terms of degree centrality, here too, the percentage of women directors among the directors in these firms have registered a discrete jump in 2015. If we consider another key measure of network centrality, betweenness, which reflects the importance of directors in controlling information flow within a network, a higher betweenness score signifies that information and resources flow must flow through him/her to get to other boards or directors (Freeman 1979). The estimates in Panel B indicate that the proportion of women directors among the top 100 directors by betweenness has also increased noticeably since 2015.

*[Insert Table 1 about here]*

Finally, the relative prominence of women directors in the director network can be captured by benchmarking the two key centrality measures, degree and betweenness, with that of male directors. Following Eckbo et al. (2016), we compute the power gap in degree and betweenness, between women and male directors as the ratio of mean centrality of women and mean centrality of male directors, and deducting this ratio from one. If the resultant gap is declining, it implies that the centrality measures of women directors are increasing relative to male directors, indicating increasing prominence of women directors to men in the director network. As is evident from Figure 1, which plots the power gaps for both degree centrality and betweenness, while the power gap with regard to the former has remained more or less stable, showing a marginal decline since 2018, the gap with regard to the latter has not only steadily declined over time, it became negative since 2018 indicating that in absolute terms the betweenness of women directors is more than that of male directors.

*[Insert Figure 1 about here]*

The above analysis of women director characteristics and their presence in the director network of our sample of listed companies clearly establishes, first, that the mandatory quota in India, although not as substantial in percentage terms compared to many other countries, has acted as an exogenous shock in increasing the presence of women directors in director networks and by

extension, firm networks. Second, the estimates in Table 1 do suggest that women director networks or interlocks are non-trivial and can potentially have measurable effects on firm governance and performance.

### **3. Data, Variables, and Methodology**

#### **3.1 Data**

The empirical analysis in this paper is based on two secondary databases containing information on firms in India. First is the Indian Boards database maintained by the Prime database. The Indian Boards dataset provides all relevant information on company directors along with their gender and appointment and cessation dates for the set of National Stock Exchange (NSE) listed firms and a few unlisted financial sector companies in India. Second, information on financial and various corporate governance variables are obtained from the Prowess IQ database maintained by the Centre for Monitoring Indian Economy (CMIE). In line with prior studies, we exclude government owned firms, firms with financial services as the main industry, firms with negative net worth, and those with missing information. Our final sample consists of a panel of 2058 non-financial Indian firms listed on the NSE for the period 2010-2020, which covers periods of pre and post gender quota, and comprises 21,421 unique directors classified by gender, with 1,33,754 directorship-year observations and 13,140 firm year observations.

#### **3.2 Variables**

##### **3.2.1 Dependent variable**

The dependent variables in our study are two firm performance measures, namely an adjusted Tobin's Q (*qratio*) and accounting measure, Return on Assets (*roa*). *qratio* is a market measure of performance defined as the ratio of market value of equity plus debt to replacement cost of assets. In India, debt primarily constitutes institutional debt that is not actively traded. Further, even assets value is reported at historical costs and not at replacement costs. Hence, we consider the book value of debt instead of market value of debt in the numerator and book value of assets in denominator similar to other studies on India (Sarkar and Selarka, 2021). On the other hand, *roa* is an accounting measure of performance and is defined as the ratio of profit before depreciation, interest, and tax to book value of assets.

### 3.2.2 Variables of Interest

Director network variables are our main variables of interest. For computing the network measures, we make use of all 252,092 directorships positions of 2085 NSE listed firms between 2010 and 2020. Note that the network is based on directorships in all listed companies in the Indian Boards database and not only for those in the sample. This comprises 1,33,754 directorship-year observations for the set of non-financial firms excluding government-owned firms.

For each year, in line with existing literature on women director networks (Mateos de Cabo et al., 2021; Ginalski, 2022; Rinaldi and Tagliazucchi, 2021), we compute two network centrality measures, namely degree and betweenness centrality. These are particularly relevant in the context of mandatory quotas which force companies to increase the number of women directors within a short window, the primary impact of which is in increasing the total number of connections and in increasing the number of times women directors occupy positions as unique bridges of information between hitherto sparsely connected parts of the director networks (Mateos de Cabo et al., 2021). While the former is captured by the degree centrality measure, the latter is captured by the betweenness centrality measure.

The degree measure gives the total number of connections of a director as given by the following equation:

$$d\_degree_{dt} = \sum_{j=1}^k connections_{djt} \quad (1a)$$

Where the  $d\_degree_{dt}$  denotes the degree centrality for  $d$ th director in year  $t$ .  $connections_{djt}$  takes the value one if the director  $d$  is connected to director  $j$  in year  $t$  on account of sharing board seats, and zero otherwise. This measure captures the director's access to resources.

From the director level degree measure, we obtain the firm level woman directors' degree ( $d\_outdegree$ ) by taking the average of  $d\_degree_{dt}$  for the woman directors on the board after subtracting the number of remaining board members and is calculated as follows:

$$w\_outdegree_{it} = \frac{1}{n} \sum_{d=1}^n [d\_degree_{dt} - (bs_{it} - 1)] \quad (1b)$$

Where  $w\_outdegree_{it}$  denotes the average number of outside connections of firm  $i$  in year  $t$  on account of having  $n$  woman directors on board.  $bs_{it}$  denotes the board size of firm  $i$  at the end of year  $t$ . The term  $bs_{it} - 1$  captures the connections of woman director  $d$  due to sitting on the board

of firm  $i$  during the year. In other words, for firms with one women director with no outside connections,  $w\_outdegree$  will be equal to zero.. This outdegree measure essentially captures the quantity of information available to the firm on account of having women directors who share board seats outside the firm.

The second centrality measure is the year-wise betweenness measure given by the sum of the number of paths that pass through a director for connecting any two directors in the network and is given as follows

$$d\_btwn_{dt} = \sum_{k \neq j: d \in (j,k)} \frac{P_d(jk)}{P(jk)} \quad (1c)$$

where  $d\_btwn_{dt}$  is the betweenness centrality of director  $d$  in year  $t$ .  $P_d(jk)$  denotes the number of shortest paths between any two directors  $j$  and  $k$  that passes through the director  $d$ , and  $P(jk)$  is the total number of shortest paths that connect the two directors  $j$  and  $k$ . It captures the importance of a director in the network.

A woman director can be considered to occupy an important position in the network if several paths cross through woman director since she remains crucial for information transmission in the network. Again from the director level betweenness measure, we compute the firm level betweenness for women directors by taking the average betweenness at the firm level as follows:

$$w\_between_{it} = \frac{1}{n} \sum_{d=1}^n d\_btwn_{dt} \quad (1d)$$

where  $n$  is the total number of women directors on the board.

### 3.2.3 Control variables

In our analysis, we also control for other firm specific factors that affect performance in line with the literature. Specifically, in line with existing literature, we control for firm size, age of the firm, leverage, promoter shareholding, board size, percentage of independent directors on the board, and CEO duality (Adams and Ferreira, 2009; Sarkar and Selarka, 2021; Saeed et al., 2016). Additionally, we include a time trend to capture the influence of the overall macroeconomic environment and market factors on performance. Table 2 provides the detailed description of all variables.

*[Insert Table 2 about here]*



### 3.3 Methodology

In estimating the relationship between women director interlocks and firm performance we first specify our baseline model in a standard panel data framework. As stated above, the performance measures which are the dependent variables are a market-based measure, namely *qratio*, and an accounting-based measure, namely *roa*. Our main variables of interest are the different measures of women director interlocks computed at the firm level and derived from network centrality measures computed using directors as nodes. These are, namely the firm degree measure for women directors on its board,  $w\_outdegree_{dt}$  (Equation 1b above), and  $w\_between_{it}$  (Equation 1d above), the betweenness measure capturing whether the woman director plays a brokering role in the network and the extent to which the woman director on board is crucial for the flow of information in the director network.

The extant literature on board network and firm outcomes has acknowledged the possibility of endogeneity of the board network variable owing to omitted variables or reverse causality (Larcker et al., 2013; Helmers et al; 2017; Biswas and Kumar, 2022). If the endogeneity is on account of omitted variables that are time-invariant, then estimating a fixed effects model will be sufficient to obtain the effect of the director network on firm performance. For example, one can argue that firms that are focused on growth will appoint well-connected woman directors and at the same time, exhibit superior performance. The empirical methodology employed in this paper is dictated by the need to address problems of omitted variable bias and unobserved heterogeneity in estimating the effect of interlocking directorates and firm performance. To address the omitted variable bias, we control for firm-specific characteristics such as size, promoter shareholding, board size, share of independent directors, firm age and leverage ratio, respectively. To account for unobserved heterogeneity, we use Fixed Effects (FE) estimation, employing both firm and time fixed effects.

To estimate the relationship between board network of women directors and firm performance, taking into account the omitted variable bias, we estimate the following fixed effects panel data model as our baseline regression:

$$y_{it} = a_i + \beta_1 w\_network_{it} + \sum_{j=2}^k \beta_j X_{jit} + \delta time\_trend + \varepsilon_{it} \quad (2)$$

Where  $y_{it}$  is the firm outcome measures given by  $qratio$  and  $roa$ .  $w\_network_{it}$  refers to the firm level degree measure ( $w\_outdegree$ ) and betweenness measure ( $w\_between$ ).  $X_{jit}$  is the set of control variables discussed earlier, whereas  $time\_trend$  is the time trend affecting all firms. The term  $a_i$  represents the firm fixed effects that accounts for time-invariant firm level unobservable factors that may affect firm performance, such as managerial skills, growth strategy, and motivation of employees, among others. Finally,  $\varepsilon_{it}$  is the random shock term in the model. We are interested in the estimate of  $\beta_1$  as it will give the relationship between women network and firm performance, if any.

In addition to the time invariant omitted variable bias, as widely suggested in the corporate governance literature, there is a potential endogeneity problem that could arise due to reverse causality as well as time varying omitted variables. Specifically, better-performing firms can create networking opportunities for women directors. To address such endogeneity, we use an instrument to identify the exogenous changes in the network. To this effect, we exploit the exogenous changes in the gender quota laws on company boards as per the Companies Act 2013 to address the endogeneity of woman director interlocks and estimate, using an instrumental variable fixed effects (IV-FE) methodology, the effect of interlocked women directors on firm performance.

To take into account the endogeneity associated with the  $w\_network_{it}$ , we employ a two-staged instrumental variable fixed effects estimation approach (IV-FE) which is a preferred estimation method adopted by several studies (Helmets et al; 2017; Biswas and Kumar, 2022). The instrument (IV) should be a variable that is correlated with our  $w\_network_{it}$  variable (relevance condition), but is otherwise unrelated to firm performance (exogeneity condition).

To construct our instrument for women directors irrespective of their types, we exploit the exogenous changes related to the representation of woman on board as per the Companies Act, 2013 (*Reform* in this case). As discussed in Section 2, the reform imposed a gender quota that mandated all listed firms to appoint at least one woman director on its board by the end of the financial year 2014. To construct the instrument that would be correlated to women network measures but unrelated to error term, we consider the board structure of the firms before the reform. The firms that did not have a woman on board prior to the reform were supposed to appoint at least

one woman director on their board post-reform, whereas the firms that already had a woman director on their board before the reform were not required to restructure their board. We refer to the former set of firms as treated firms and the latter as control firms. The instrument is defined as the interaction between  $Reform_t$  and  $Treated_i$  variables.  $Reform_t$  is a dummy that takes the value one from 2014 onwards and zero prior to the reform.  $Treated_i$  variable is a dummy that takes the value of one for treated firms and zero for control firms. Helmers et al. (2017) use a similar instrument in their study of board network on R&D practices of firms.

In the first stage we estimate the following equation:

$$w\_network_{it} = u_i + \alpha_1 Reform_t * Treated_i + \sum_{j=2}^k \alpha_j X_{jit} + \delta time\_trend + \epsilon_{it} \quad (3a)$$

Where  $Reform_t * Treated_i$  is the instrument and all other variable descriptions are the same as baseline equation 2. The instrument relevance criteria require the estimated  $\alpha_1$  to be positive and significant.

In the second stage, we estimate the following equation:

$$y_{it} = a_i + \beta_1 + w\_network_{it} + \sum_{j=2}^k \beta_j X_{jit} + \delta Time\_trend + \epsilon_{it} \quad (3b)$$

Where  $w\_network_{it}$  is the estimated  $w\_network_{it}$  obtained from the first stage regression. All other variables are the same as baseline equation 2.

Since the IV-FE estimator can potentially be biased if the instrument is not exogenous (not testable assumption), we employ two additional approaches to address this concern in our robustness analysis section. First, we relax the strict instrument exogeneity condition and re-estimate the model using the plausibly exogenous method (Conley et al., 2012). Second, we use a propensity score method to address the endogeneity and compare the performance for the set of matched firms as an alternate estimation technique.

Finally, we estimate various specifications of the baseline model and conduct sub-sample analyses, to examine the mechanisms through which women director networks impact firm performance. Additionally, we also conduct several robustness checks.

## 4. Estimation Results

### 4.1 Descriptive statistics

Table 3(a) presents summary statistics of variables used in the study. The average *qratio* is greater than one with significant deviation, whereas average *roa* is 11.89 per cent. On an average women directors are connected to four other directors outside the firm. However, again there is substantial variation as the minimum outside connections is zero, whereas the maximum is as high as 80. In terms of leverage, there is a large variation in our sample ranging from firms with no debt to highly levered firms as indicated by the minimum and maximum values, respectively. We observe that on average 39 per cent of the board constitutes of independent directors and close to 34 per cent firms have CEO duality.

*[Insert Table 3(a) about here]*

Next, if we look at the overtime mean of the two network measures, two facts emerge from Table 3(b). First, both *w\_outdegree* and *w\_between* measures have increased during the last decade. Second, 2015 onwards, the network measures more than doubled (which coincides with the post reform period) compared to the period up to 2014. This indicates that post the introduction of gender quota in India, women directors have become more connected in the network

*[Insert Table 3(b) about here]*

### 4.1 Main results

This section presents the results of estimations of the effect of women director interlocks on firm performance. The regression results are presented in Table 4 for both performance indicators and two network measures, namely out degree (*w\_outdegree*) and betweenness (*w\_between*) for women directors. Columns 1-4 of Table 4 presents the FE results of firm performance regression on women network measures and other firm controls. We observe that the coefficient of *w\_outdegree* is positively related to *qratio*, suggesting that the quantity of information available to the firm due to connections of women directors is valuable (Column (1)). We also find that the *w\_between* is positively related to *qratio* at a 1 per cent level of significance (Column (2)). In other words, if the woman director is crucial for information transmission in the network, then she is likely to be powerful in the network, which in turn is beneficial for firm value. Columns (3) and (4) report the regression output for *roa*. Contrary to *qratio* results, we do not find any relationship between the two network measures and *roa*. The fixed effects estimation indicates that the network

of women directors matter for market-based firm performance measure, whereas it does not seem to matter for accounting measure.

As discussed earlier, the FE estimator can be both biased and inconsistent if the omitted variable is time-varying or endogeneity is due to reverse causality. We, therefore, report the IV-FE results in columns (5)-(8) to address this issue. Column (5) indicates that an increase in  $w\_outdegree$  by 1 improves  $qratio$  by 0.22 per cent. Similarly, higher  $w\_between$  is also related to higher  $qratio$ , ceteris paribus (Column (6)). Note that the women's network does not seem to matter for the  $roa$ , similar to the FE estimation (columns (7)-(8)). The first stage coefficient is positive and significant at 1 percent level of significance, ascertaining a positive correlation between our endogenous network measures and the instrument. Further, the first stage F-statistic is greater than 10 which is also greater than the Stock-Yogo critical value, again pointing towards the fact that the instrument relevance condition is satisfied. Our baseline results indicate that women's network has a positive effect on firm performance given by  $qratio$ , even though it seems to be unrelated to  $roa$ .

*[Insert Table 4 about here]*

The difference in the effect of the centrality measures on a firm's market value and profitability measure can be on account of the fact that following the introduction of the mandatory quota, as seen in Section 2, there were discrete changes in the characteristics of women director networks whereas prior to the quota legislation, all relevant parameters were slow moving. Since  $roa$  is considered to be a backward looking measure reflecting a firm's past or short term performance, the effect, if any of these changes were not realised in the  $roa$  effect. In contrast, market measures such as the  $qratio$  are reflections of future or long term performance and are considered to incorporate all information and any network effect is likely to be captured in terms of market perception of the value of women directors and their networks. In a similar vein it is argued that immediate effects of regulation are likely to be captured mostly through market reaction as opposed to accounting measures like  $roa$ , which may take time to respond to regulatory changes (Higgs, 2003). Our results suggest that the market positively valued the increase in the centrality of women director interlocks following the quota legislation, both in terms of their centrality in the director network and the bridging function that they serve in the network.

Given that the two centrality measures have different scales, to assess the strength of the relationship of these centrality measures with firm performance, we consider the standardized centrality measures (having a zero mean and unit standard deviation) in order to meaningfully compare the effects of degree centrality and betweenness on firm performance. We undertake this exercise both for our FE and IV-FE estimations. The unreported FE estimators indicate that one standard deviation increase in  $w\_outdegree$  is related to 0.07 per cent increase in  $qratio$  whereas one standard deviation increase in  $w\_between$  centrality is related to 0.08 per cent increase. In other words, going by the FE results, comparing the strength of the relationship, it appears both degree and betweenness are equally crucial for Q-ratio.

Re-estimating the IV-FE models using the standardized degree and betweenness measures to compare the relative influence of the centrality measures on  $qratio$ , we find that one standard deviation increase in  $w\_outdegree$  increases by 2.14 per cent, whereas one standard deviation increase in  $w\_between$  leads to 2.56 per cent increase in  $qratio$ . It suggests that even though both women directors' outside connections and betweenness are sources of superior performance, betweenness appears to be more important. In other words, the quantity of information is important; however, the woman's position in the network and the importance of women for information transmission in the network appear to be more critical for firm performance in the Indian context.

The IV-FE results provide evidence that even though women directors have lower connections, their networks are beneficial for firm performance providing evidence in favour of the strength of weak ties hypothesis (Granovetter, 1983) that such ties are associated with instrumental benefits. In particular, our results indicate that women networks positively impact market value through interlocks with directors of other firms as captured by  $w\_outdegree$  and  $w\_between$ . While a positive effect of  $w\_outdegree$  indicates that greater connectedness of women directors of the focal firm with directors of other firms benefit the focal firm to access a broader pool of valuable and timely information, the positive effect of  $w\_between$  is evidence of women directors of the focal firm bringing value to the firm through acting as effective bridges between directors of other firms, hitherto unconnected, to facilitate the flow of relevant information to the focal firm. Even with

the pre-dominance of male directors in the director network, our results provide evidence that a women director's positioning in the network is not redundant.

In the following sub-section, drawing on the literature on director interlocks on firm governance as well as on gender and governance, we explore two specific mechanisms through which women director networks can positively impact firm performance by reducing agency costs, namely through reducing information opacity in firms and through better monitoring.<sup>12</sup>

#### **4.2 Channels of impact of women director interlocks**

As discussed in the introduction, the resource dependency theory of director interlocks posits that firms that are interconnected through shared directors can be a conduit for the transmission of timely and relevant information and diffusion of corporate practices and strategies among firms (Bizjak et al., 2009; Chiu, Teoh, and Tian, 2013; Helmers et al., 2017). In general, centrality of directors in interlocked networks yields benefits to the focal firm in terms of information, increased capabilities, learning, expertise, advising and monitoring (Gulati, 1999; Hillman et al., 1999; Zaheer and Bell, 2005). In our paper, in line with Amin et al. (2020), we specifically examine two channels through which women director interlocks can increase firm value, first through the impact of information transmitted via interlocks, and second, with respect to the influence of the interlocked directors on the power of the CEO of the focal firm.

As will be stated below, both these effects capture the power of women director interlocks and can manifest through the benefits hypothesized by the resource dependency theory and agency theory. These are particularly relevant for emerging economies like India characterised by imperfect markets, uncertainty, concentrated ownership and insider control, and weak corporate information environment, particularly with respect to the availability of relevant and reliable information about the true financial performance of listed firms (Khanna and Yafez, 2007; Pattnaik et al., 2013).

---

<sup>12</sup> The LODR regulations of 2018 which required at least one independent woman director on board. We separately estimate the effect of introducing an independent woman director on board and the results remain qualitatively similar.

While much of the arguments related to the information and influence channels through which the effects of interlocks on firm performance are put forward with respect to directors in general without distinguishing by gender, in line with the focus of the paper, we examine whether the positive effect of women director hold specifically for women directors. Further, our analysis, through using proxies associated with the information channel and influence channel, is limited to capturing their reduced form effect, and we do not attempt to disentangle the effects of the resource dependency and agency cost theories.

In the next subsections, we analyze whether the information channel and the influence channel explain the positive association between women director connections and firm value. The estimations are conducted by adding an interaction term between proxies of these channels and women director connectedness in our IV-FE specification (3).

#### **4.2.1 Information channel**

The existing literature on the information effect of interconnectedness of directors across firms highlights from a resource dependency perspective that connections between directors allow firms to access diverse, previously inaccessible information that can be valuable to the firm. Additionally, as Cai et al. (2014) as well as Chan et al. (2017) find evidence that voluntary corporate disclosure policies can diffuse via interlocked directors, which can in turn reduce information opacity and hence agency costs. The marginal effects of these benefits are likely to be more in focal firms that have high information opacity in terms of the information gap that exists about firm activities and performance between inside management and external parties such as outside shareholders, analysts, regulators and the like.

To examine whether women director interlocks positively impact firm value via the information channel, we examine the whether the effect of such interlocks on performance varies with the extent of information opacity of the focal firm. As discussed above, information opacity can reduce either through new information on account of the centrality and betweenness of women directors, and/or through the diffusion of disclosure practices via women director interlocks. As argued in the empirical literature on corporate governance and corporate finance, information opacity is higher in firms that have high stock return volatility (Bushee and Noe, 2000; Leuz and



Verrecchia, 2000; Kothari et al., 2009; Goldstein and Liyan, 2017). Therefore, if women director networks bring in more transparency, we expect such firms with more connected woman directors will be able to perform better. Following Amin et al. (2020), we use *Highvol* as a dummy variable that equals 1 if firm has a higher stock return volatility compared to sample average where volatility is measured as a 52 week rolling standard deviation. Our main variable of interest is the interaction between information opacity proxy and women director connectedness.

Table 5 presents the results for information advantage of women director connections. As shown in columns 1 and 2, positive and significant interaction term with respect to both degree and betweenness centrality ( $w\_outdegree * highvol$  and  $w\_between * highvol$ ) is consistent with the information effect of women director connections in terms of both number as well as their strength in the network. Therefore, our results are consistent with the finding that network benefit of women directors facilitating better flow of information through their network are more pronounced in firms with high information opacity<sup>13</sup>.

As the coefficients on the women director connectedness in terms of both  $w\_outdegree$  and  $w\_between$  are positive and significant (columns 1-2), our results suggest that the benefit of women director networks in terms of both the centrality measures in the entire director network, as well as in terms of bridging information gaps, is more pronounced in the firms where it is costly to acquire information. Thus, one explanation for the positive relationship that we find between interlocked women directors and firm value is the information effect that their networks have in firms where acquisition of information is costly. This result is consistent with the findings by Amin et al. (2020) who examine whether the information channel explains the positive effect of board connectedness of all directors irrespective of their gender, and CSR performance.

*[Insert Table 5 about here]*

---

<sup>13</sup> In unreported results, following Amin et al. (2020), we also use low foreign institutional investors (FII) ownership as the second proxy of information opacity. Again we find that the network benefit of women directors facilitating better flow of information through their network are more pronounced in firms with low FIIs, i.e., higher information opacity.

#### **4.2.2 Influence channel of woman director connections**

As mentioned earlier, the influence channel through which director networks can impact the governance and performance of a firm, is also rooted in resource dependency and agency theory. Networked directors, by virtue of having multiple directorships and often forming a bridge between hitherto unconnected groups can put them in a position to gain more influence and/or power to impact the governance of the focal firm through their engagement in its board activities and leveraging their knowledge and expertise gained in other firms (Adler and Kwon, 2002). The increase in influence associated with multiple directorships is particularly pertinent for women directors appointed by virtue of mandatory gender quotas, as that can discontinuously increase the number of directorships held by them and their centrality in the director network. In India for instance, as Table 1, there has been a discontinuous increase in the percentage of women interlockers and big linkers following the institution of the gender quota in 2014. Additionally as seen in the Table, following the quota, women directors in India have become more central in the top 100 firms both in absolute as well as in relative terms. Further, as Huse (2011) has noted in the context of Norway, gender quotas can give rise to the ‘golden skirts phenomenon’ whereby women director positions, especially those of independent directors, available on boards by virtue of the quota end up going to a relatively few women directors, and thereby put such directors in positions of power and influence relative to other directors, including men.<sup>14</sup>

One of the ways in which influence of directors on boards, including that of women directors, can work is by exerting power over the CEO, and board members in general, to push for governance measures that would reduce the incentives of inside managers to extract private benefits at the expense of shareholders and thereby mitigate agency costs. Such costs, as highlighted by agency theory (Fama and Jensen, 1983) are particularly exacerbated in family firms. As discussed in Sarkar and Selarka (2021) in the context of emerging economies like India, where family run corporations dominate, family members in such firms are in a position to expropriate outside minority shareholders through having control rights that are in excess of cash flow rights (Anderson and Reeb, 2003; Masulis et al, 2009) and by occupying key management positions like the CEO or

---

<sup>14</sup> Huse (2011) hypothesises that in the limit such ‘elite’ women directors may become influential enough to replace the “old boys’ network.”

chairperson that give them ‘sufficient power’ to affect corporate decisions (Allen and Panian, 1982).

The question that is relevant in the present context is whether interlocked women directors positively impact firm value through exercising their influence on company boards to reduce agency costs. In line with Amin et al. (2021), we use CEO chair duality (*ceo\_chair*) as a proxy for a powerful CEO.<sup>15</sup> The variable *ceo\_chair* is a dummy variable that equals 1 if CEO and board chair are the same person. If the independent effect of *ceo\_chair* on firm value is negative, this is indicative of agency costs in the presence of a powerful CEO. On the other hand, if the independent effect is positive, this is indicative of the convergence hypothesis which holds that concentrated ownership and control of insiders beyond a threshold level of ownership can align the interests of the CEO with that of the outside shareholders. Our main variable of interest is the interaction between these proxies of powerful CEO and women director connectedness. A positive coefficient of the interaction term would imply either the mitigation of agency costs due to the influence interlocked women directors, or evidence of them strengthening the stewardship capabilities of a powerful CEO in governance in a way to promote a firm’s reputation and work for its betterment as posited by the stewardship theory (Davis et al., 2007). The latter is particularly pertinent in family firms such as those in India, where the CEO and Chairperson position is typically occupied by family owners.<sup>16</sup>

Columns 3-4 of Table 5 report the results for *qratio* and women network with regard to CEO duality. We first note that when we consider the out degree of women directors as the network measure, the independent effect of *ceo\_chair* is statistically not different from zero. However, as is evident from the estimates of Column 3, the coefficient on *w\_outdegree \* ceo\_chair* is positive and significant suggesting that women directors with more connections positively influence a powerful CEO to act in the interest of outside shareholders. Such influence effect is not observed in the case of the betweenness measure, *w\_between*; while the independent effect of *w\_between* continues to be positive and significant, the interaction effect is insignificant. This implies that the

---

<sup>15</sup> Amin et al. (2021) conducts the analysis in terms of less powerful CEOs who do not hold a dual position.

<sup>16</sup> As Sarkar and Selarka (2021) have noted in the context of Indian listed firms, about 51 percent of the boards have a founding family member occupying both the positions of CEO and chairperson and more than 90 percent of firms are family firms with family ownership exceeding 20 percent.

influence/power effect, in the context of our case study, works essentially through the number of connections (via board positions) that women directors have, leveraging their knowledge and stature that they acquire from multiple board position, rather than through the influence and power acquired through their bridging function<sup>17</sup>.

Overall, our analysis of the possible mechanisms through which women director networks positively impact firm value shows that they do so both through bringing in valuable information and resources to the focal firm as well as through exerting their influence as monitors on the board to mitigate agency costs.

### **4.3 Women Director Networks and Governance**

The evidence presented in Section 4.2 highlights that women directors' network has a positive effect on performance as they bring informational advantage along with improving firm governance owing to greater influence/power. To provide finer evidence on the positive impact of interlocked women directors on firm performance, we focus on their impact on board governance *per se*. Specifically, we examine whether more connected women directors perform better in terms of certain board governance activities vis-à-vis less connected women as well as more connected male counterparts. To undertake this exercise, in line with Adams and Ferreira (2009), we use director-level data to examine the relationship between women director network on two board activities, namely attendance in board meetings, and committee memberships.

If information or resources owing to the women directors' network influence the firm's governance and, in turn, performance, it should necessarily be the case that these connected women directors attend board meetings. Even if networked women directors improve performance by becoming better monitors (influence channel), the mechanism through which it can be expected to work is through attendance in meetings. Board meetings are the forums where firm level strategies are discussed and eventually ratified. Hence, attending board meetings is a necessary condition for director networks to matter for firm policies and outcomes. We measure the board attendance

---

<sup>17</sup> In unreported results, we use presence of at least a controlling insider owner on board as a proxy for the power of insider control on board which may lead to agency costs. Again, the estimation results are similar to that obtained with regard to CEO duality.

(*sh\_meeting*) as the number of board meetings attended by each director divided by total number of meetings held during the year.

Next, we analyze the relationship between women director network and committee memberships. The board committees are primarily responsible for performing the monitoring tasks, including appointing auditors, auditor's pay, executive compensation, risk management practices of the firm, among others. If the connected women directors are a part of board committee, they are more likely to be heard and involved in specific goal-setting activities and their information base and/or influence are likely to matter. We define important committee membership (*imp\_committee*) as total number of memberships of the important committees (i.e. risk management committee, nomination and remuneration committee, audit committee, corporate social responsibility committee and stakeholder relationship committee) .

To examine the relationship between woman director network and board inputs, we estimate the following equation at the directorship level:

$$y_{idt} = a_i + \alpha_1 female_{idt} + \alpha_2 female_{idt} * d\_network_{idt} + \alpha_3 d\_network_{idt} + \sum_{j=2}^k \beta_j X_{kjdt} + \delta_t + u_{idt} \quad (4)$$

Where  $y_{idt}$  is the dependent variable that measures the board activity in terms of meeting attendance (*sh\_meeting*), and number of important committee memberships (*imp\_committee*) of a director  $d$  in  $i$  th firm in year  $t$ . *female* is a dummy variable that takes the value one for woman director and zero otherwise, and *d\_network* captures the network of the  $d$  th director (irrespective of gender) given by out degree and betweenness centrality measures of the individual directors, namely (*w\_outdegree* and *w\_between*), respectively. Our primary variable of interest is the interaction between *female* and *d\_network* that measures the incremental effect of a woman director's network on their board activities. In line with the literature, we also control for age of the director (*dir\_age*), experience (*dir\_agesq*), tenure (*tenure*), whether the director is an independent director (*indepdir*) or not (Adams and Ferreira, 2009; Low et al, 2015; Saeed et al., 2016). To control for unobserved firm heterogeneity we estimate the above model with firm and time fixed effects.

Columns (1) - (4) of Table 6 indicate that the coefficients of the interaction terms are positive and significant for the *sh\_meeting* regression for both degree and betweenness measures. It suggests that well-connected women directors are better at attending meetings, and as a result, their information and/or influence are more likely to matter for the firm. These results run counter to some evidence in the literature that sitting on multiple boards can make the directors too busy to devote time to the functions of any particular firm (Ferris et al., 2003). Next, in columns (5) – (8) of Table 6, we report the regression results for board activities in terms of the number of members of the top five committees. Negative and significant coefficient of *female* suggests that woman directors hold less positions in important committees vis-à-vis their male counterparts. However, positive and significant coefficients of the interaction term (*female\*d\_network*) suggests that network connections of women directors are associated with an increase in number of top committee memberships for them. It underscores the fact that women director network is likely to matter as these women directors are found to sit on more committees and also on committees that are important from a monitoring perspective, enabling them to exert their influence on the firm. This finding is in contrast to the findings of Benton (2021), wherein the paper finds that even though women’s board representation has increased in the US firms, their participation in board committees and influence has not improved over time.

*[Insert Table 6 about here]*

Next, we extend our main analyses to investigate the relationship between women director network and board activities when we consider the type of woman director. Ideally, to explore the impact of more networked women independent directors, we should use LODR 2018 as an instrument and estimate the IV-FE regressions for the period 2015-2020. As most of the firms have complied with the Companies Act 2013 and appointed one woman director, the firm-level director centrality shows little variation. This could be due to the fact that compliance with this new regulation is extended by the regulator due to the pandemic scenario, due to which most of the firms continued to have one woman director in our sample between 2019 and 2020. This lack of variation in the independent variable limits us from the firm-level estimation which we address by carrying out the director level estimation.

Specifically, we investigate the effect of independent women director network centrality on board activities. This additional analysis also aligns with Clause 17(1)(a) of the LODR in 2018 of SEBI, which mandates the top 1000 listed firms to appoint at least one woman independent director on their board by 2020. Much of the arguments with regard to the informational, strategic and governance benefits of interlocking directorships are relevant for independent directors rather than with respect to inside directors on board. This is particularly relevant for insider controlled firms with founding family members occupying board positions and their incentives to expropriate minority shareholders through mechanisms such as tunneling. Chen et al. (2014) for instance highlight the role of independent director networks, arguing that such directors are likely to be more connected than most inside directors and that they are expected to have a stronger monitoring role than inside directors, especially when insiders also typically occupy the CEO/Chairperson position.

Thus, to the extent data permits, examining the governance effects of independent women directors is particularly relevant. We do so with data on these directors that are available only for a sub-period, 2014-2020. The increasing importance of independent women director interlocks in Indian firms is reflected in our sample. With the institution of the gender quota in 2014 and LODR 2018 regulations, we find that the percentage of independent women directors among all independent directors registered a jump from 4.36 percent in 2014, to 9.51 percent in 2015, and then increased to 14.74 percent in 2020. Similar trends are noticeable for independent women director interlockers and big linkers. Additionally, the percentage of independent women directors among total directors of top listed 50 firms jumped from around 5 percent in 2014 to 9.22 percent in 2015 to around 14 percent in 2020. Finally, the importance of independent women directors in the director network is evident from the fact that the number of women directors featuring among the top 100 directors in terms of centrality measures exhibited an increasing trend as time progressed from 2014 to 2020, from 4 to 11 in the case of degree centrality and 6 to 12 in the case of betweenness centrality.

The model specification is similar to Equation (4) above, but is estimated for a sub-sample of women directors for the time period 2014-2020.

$$y_{idt} = a_i + \alpha_1 d\_network_{idt} + \alpha_2 indepdir_{idt} * d\_network_{idt} + \alpha_3 indepdir_{idt} + \sum_{j=2}^k \beta_k X_{k_{idt}} + \delta_t + u_{idt} \quad (5)$$

The dependent, independent and control variables are same as specified above in equation (4). Our primary variable of interest is the interaction between *indepdir* and *d\_network* that measures the incremental effect of an independent woman director's network on their board activities vis-à-vis a non-independent woman director's network.

Table 7 presents these results. Columns (1) - (4) presents the regression results for *sh\_meeting* as the outcome variable. As shown in the table, the significant and positive sign of interaction term indicates that more networked independent woman directors attend more board meetings. Columns (5) - (8) indicate that, independent networked women directors hold more positions in the important committees. The negative and significant coefficient of independent director (*indepdir*) with respect to only share of meetings attended and not with top committee memberships could be due to the busyness of these women independent directors. As there are limited number of independent women directors, and post-2018 they are likely to be appointed in multiple boards, the negative effect on board meeting attendance could be the reflection of their busyness. On the other hand, while independent woman director is likely to be appointed on important committees, their connectedness encourages their committee memberships. Further, these findings also support that regulations that mandate firms to appoint independent woman directors, can add value if the independent woman director is well-connected.<sup>18</sup>

*[Insert Table 7 about here]*

Overall, the results of our director level analysis, both for all types of directors as well as specifically for independent directors, are consistent with our results obtained with respect to the benefits to the focal firm flowing via the information and influence channels of women director interlocks, all of which together drive the positive relationship between such interlocks and firm value.

---

<sup>18</sup> We also estimated models specified in equation 4 and 5 for the membership of the audit committee. The results show that while women independent directors positively associated with audit committee memberships their network connections do not matter. Results are available on request.



## **5. Robustness checks**

We perform a battery of robustness checks to ensure that we are indeed capturing the effect of women's networks on firm performance. Specifically, we estimate the model by considering alternate outcome variable, lagged variables and employing alternate estimation methods like propensity score matching and plausibly exogenous instrumental variable method.

### **5.1 Alternate outcome variable**

Our main findings suggest that network of women directors is positively related to market measure of firm performance given by *qratio*. Next, we also estimate the baseline regressions using the market to book value (MBVR) ratio as an alternate market measure of performance. The results given in Table 8 indicate that the coefficient of the network measures (both degree and betweenness) are positive and statistically significant using the FE and IV-FE methods. It ascertains that the positive relation is not purely driven by the choice of the market measure of performance.

*[Insert Table 8 about here]*

### **5.2 Lagged variables**

We re-estimate the main models using the IV-FE method along with lagged interest variables. Using lagged variables also addresses endogeneity concerns, as unobserved factors that affect women's network at t-1 are unlikely to influence one year ahead firm performance. This approach was also followed by Larcker et al. (2013) while examining the effect of board network on firm performance. The results of this exercise again indicate a positive and significant relationship between the network measures and *qratio*, whereas there is no effect of women's network for *roa* (Table 9). We observe using this alternate specification yields qualitatively similar results.

*[Insert Table 9 about here]*

### **6.2 Propensity score matching method**

In the absence of experimental data, Rosenbaum and Rubin (1983) suggest that the propensity score matching (PSM) method based on observed covariates can allow researchers to obtain a causal effect of treatment. This strategy has been used in firm studies to obtain causal estimates

(Yasar and Rejesus, 2005; Chang and Shim, 2015; Lindemanis et al., 2022). The treatment in our case is the *high\_outdegree* or the *high\_btwn* dummies. The former is defined as one if the *w\_outdegree* is greater than the mean value and zero otherwise. Similarly, *high\_btwn* is defined as one for observations having *w\_between* value greater than the mean level and zero otherwise. We match the firms with high and low values of women network measures on the set of observed characteristics using one-to-one nearest neighbour matching with a caliper of 0.001. For the sample of matched firms, we compare the performance measures using t-tests (Table 10). We find that the Q-ratio of the treated firms is statistically higher than the control firms (firms with less networked women directors). Even *roa* also appears to be higher for the treatment firms vis-à-vis the control firms when the treatment is the *high\_btwn* dummy. This alternate estimation technique provides credence to our results and reiterates that we are indeed able to capture the effect of women’s network on firm performance in India.

[Insert Table 10 about here]

### 6.3 Plausibly exogenous method

The IV-FE estimators will capture the effect of women’s network only if the instrument satisfies the exogeneity condition. Since, in our case, the equation is exactly identified (and not overidentified), it is statistically not feasible to test the validity of this assumption. However, if the instrument is not exogenous, the estimates can be biased. Conley et al. (2012) developed a methodology wherein one can relax the strict instrument exogeneity condition and test whether the results remain qualitatively similar when the instrument is plausibly exogenous and not fully exogenous. This method has been used by Biswas and Kumar (2022) to check the validity of IV results while examining the effect of board network on financial stability of banks in India. We adopt Conley et al.’s (2012) framework and estimate the following equation:

$$y_{it} = \beta_0 + \gamma Reform_t * Treated_i + \sum_{j=2}^k \beta_j X_{jit} + a_i + \delta Time\_trend + \varepsilon_{it} \quad (6)$$

Where  $y_{it}$  are two firm performance measures,  $Reform_t * Treated_i$  is the instrument,  $X_{jit}$  are the firm characteristics,  $Time\_trend$  is the time trend variable,  $a_i$  is the firm fixed effect and  $\varepsilon_{it}$  is the random error term. In IV-FE estimation, we assume that  $\gamma = 0$ ; however, in this framework, we let  $\gamma$  to be different than zero and check whether it is possible to obtain the effect of the endogenous variable even with non-zero  $\gamma$ . For this, we estimate the reduced form equation given above, where

we directly estimate the relationship between the instrument and the outcome variable, excluding the endogenous variable (i.e., women's network variable). Using the range  $\gamma$  between zero and estimated  $\gamma$  ( $\hat{\gamma}$ ), we obtain the bounds for the effect of women's network on *qratio*. Further, we find the maximum value of  $\gamma$  ( $\gamma_{max}$ ) for which the effect of *W\_outdegree* and *W\_between* on *qratio* is positive. Table 11 suggests that the  $\hat{\gamma}$  is 0.81 and if gamma lies between 0 and 0.81 then there is no effect of women's network on Q-ratio; however, if instead gamma lies between 0 and 0.363 ( $\gamma_{max}$ ), then one would be able to observe a positive effect of network variables on the *qratio*. In other words, even if we relax the strict exogeneity condition and allow 45.1% endogeneity (0.363/0805) in the instrument, the qualitative results will remain unchanged. Hence, our results are not entirely dependent upon the strict exogeneity of the chosen instrument.

*[Insert Table 11 about here]*

## 6. Conclusion

This paper empirically analyzes, for a sample of Indian listed firms, the effect of women director interlocks on firm performance and seeks to establish whether network connections of women directors act as one of the channels through which women on board impact firm performance. In doing so, the paper sheds light on the question of whether gender matters in the relationship between interlocking directorates and firm outcomes, as well as on the question of whether director networks matter in explaining the relationship between gender and board outcomes.

In the backdrop of the gender quota legislation in India, and using two key network measures that capture the centrality of women directors, one in terms of the number of connections, that is degree, and the other in terms of the control over information flows across the network, i.e., betweenness, we find that women director connectedness, both in terms of degree and betweenness, are positively associated with the firm value in Indian firms. The result is robust, addressing endogeneity concerns that arise due to unobserved firm heterogeneity and reverse causality, as well as holding under alternative model specifications.

Our main result of a positive relationship between women director network and firm value is consistent with the benefits of director interlocks postulated by the social network theory juxtaposed with resource dependence theory and agency theory. We also explore the two channels

through which the boards impact the economic outcomes at the firm level. Grounded in the resource dependence and agency theory, these are information advantages and power to monitor through the directors' network. We find that firms that have high stock return volatility and have CEO duality tend to benefit more from women director connections. Therefore, our results find support for both the channels through which the women directors impact firm value by virtue of their connectedness.

We also undertake a directorship level analysis to confirm the source of our firm-level findings as the gender of the director. Specifically, we explore if well-connected women directors vis-à-vis their male counterparts contribute to the superior board activities. Our findings confirm that women directors, specifically independent directors, with more connections are associated with higher board attendance, and memberships of important committees like risk management, audit, stakeholder responsibility, nomination and remuneration and CSR committees. These results strengthen the case for gender diversity on company boards.

Our results on the beneficial effect of women director networks can address policy concerns related to the absence of a critical mass of women directors required to add value to board decision making, notwithstanding mandatory quotas. As Torchia et al. (2011) and others have argued that even if women directors have unique capabilities compared to male directors, to the extent that women directors are a small minority, they may not be empowered enough to effectively contribute to board decisions and would just have a token presence. Further, Benton (2021) also finds that over time, the representation of women in corporate boards has increased with no improvements in their representation in important board committees, suggesting towards tokenism. Under such circumstances, if women directorial networks, on average, bring at the margin, valuable resources to the board and have the power to mitigate agency costs through positively influencing board governance so as to add to firm value, adding women directors to the board who are central to the director and firm network can be an effective substitute for appointing a critical mass of women directors. This, in turn, can perhaps explain why women directors are found to positively impact firm value in countries such as India where the mandatory quota requirements are relatively low in percentage terms, and on average amounts to less than the critical mass.

## References

- Adams, R. B., & Ferreira, D. (2009). Women in the boardroom and their impact on governance and performance. *Journal of Financial Economics*, *94*(2), 291–309.  
<https://doi.org/10.1016/j.jfineco.2008.10.007>
- Adler, P. S., & Kwon, S.-W. (2002). Social Capital: Prospects for a New Concept. *Academy of Management Review*, *27*(1), 17–40. <https://doi.org/10.5465/amr.2002.5922314>
- Allen, M. P., & Panian, S. K. (1982). Power, Performance, and Succession in the Large Corporation. *Administrative Science Quarterly*, *27*(4), 538–547. <https://doi.org/10.2307/2392529>
- Amin, A., Chourou, L., Kamal, S., Malik, M., & Zhao, Y. (2020). It's who you know that counts: Board connectedness and CSR performance. *Journal of Corporate Finance*, *64*, 101662.  
<https://doi.org/10.1016/j.jcorpfin.2020.101662>
- Anderson, R. C., & Reeb, D. M. (2003). Founding-Family Ownership, Corporate Diversification, and Firm Leverage. *The Journal of Law and Economics*, *46*(2), 653–684.  
<https://doi.org/10.1086/377115>
- Benton, R. A. (2021). Women in the Inner Circle: Gender and Director Networks After the Fracturing of the Corporate Elite. *Organization Science*, *32*(6), 1492–1522.  
<https://doi.org/10.1287/orsc.2021.1433>
- Biswas, S., & Kumar, R. (2022). Bank board network and financial stability in emerging markets. *Emerging Markets Review*, *51*, 100884. <https://doi.org/10.1016/j.ememar.2022.100884>
- Bizjak, J., Lemmon, M., & Whitby, R. (2009). Option Backdating and Board Interlocks. *The Review of Financial Studies*, *22*(11), 4821–4847. <https://doi.org/10.1093/rfs/hhn120>
- Bjørnskov, C., & Sønderskov, K. M. (2013). Is Social Capital a Good Concept? *Social Indicators Research*, *114*(3), 1225–1242. <https://doi.org/10.1007/s11205-012-0199-1>
- Brass, D. J. (1985). Men's and Women's Networks: A Study of Interaction Patterns and Influence In an Organization. *Academy of Management Journal*, *28*(2), 327–343.  
<https://doi.org/10.5465/256204>

- Broome, L. L., Conley, J. M., & Krawiec, K. D. (2010). Dangerous Categories: Narratives of Corporate Board Diversity. *North Carolina Law Review*, 89, 759.
- Burt, R. S. (1992). *Structural Holes: The Social Structure of Competition*. Harvard University Press. <https://www.jstor.org/stable/j.ctv1kz4h78>
- Bushee, B. J., & Noe, C. F. (2000). Corporate Disclosure Practices, Institutional Investors, and Stock Return Volatility. *Journal of Accounting Research*, 38, 171–202.  
<https://doi.org/10.2307/2672914>
- Cai, Y., Dhaliwal, D. S., Kim, Y., & Pan, C. (2014). Board interlocks and the diffusion of disclosure policy. *Review of Accounting Studies*, 19(3), 1086–1119.  
<https://doi.org/10.1007/s11142-014-9280-0>
- Chan, A. L.-C., Lee, E., Petaibanlue, J., & Tan, N. (2017). Do board interlocks motivate voluntary disclosure? Evidence from Taiwan. *Review of Quantitative Finance and Accounting*, 48(2), 441–466. <https://doi.org/10.1007/s11156-016-0557-1>
- Chang, C.-H., & Wu, Q. (2021). Board Networks and Corporate Innovation. *Management Science*, 67(6), 3618–3654. <https://doi.org/10.1287/mnsc.2020.3587>
- Chang, S.-J., & Shim, J. (2015). When does transitioning from family to professional management improve firm performance? *Strategic Management Journal*, 36(9), 1297–1316.  
<https://doi.org/10.1002/smj.2289>
- Chen, Y., Wang, Y., & Lin, L. (2014). Independent directors' board networks and controlling shareholders' tunneling behavior. *China Journal of Accounting Research*, 7(2), 101–118.  
<https://doi.org/10.1016/j.cjar.2013.09.002>
- Chiu, P.-C., Teoh, S. H., & Tian, F. (2013). Board Interlocks and Earnings Management Contagion. *The Accounting Review*, 88(3), 915–944. <https://doi.org/10.2308/accr-50369>
- Coles, J. L., Daniel, N. D., & Naveen, L. (2014). Co-opted Boards. *The Review of Financial Studies*, 27(6), 1751–1796. <https://doi.org/10.1093/rfs/hhu011>

- Conley, T. G., Hansen, C. B., & Rossi, P. E. (2012). Plausibly Exogenous. *The Review of Economics and Statistics*, 94(1), 260–272. [https://doi.org/10.1162/REST\\_a\\_00139](https://doi.org/10.1162/REST_a_00139)
- Davies, E. M. (2011). Women on Boards. An Independent Review into Women on Boards. Technical Report. London: Department for Business Innovation and Skills
- Davis, J. H., Schoorman, Lex, Schoorman, F. D., & Lex, D. (2007). Toward a Stewardship Theory of Management. In *Business Ethics and Strategy, Volumes I and II*. Routledge.
- Eckbo, B. E., Nygaard, K., & Thorburn, K. S. (2016). *Does Gender-Balancing the Board Reduce Firm Value?* (SSRN Scholarly Paper 2766471). <https://papers.ssrn.com/abstract=2766471>
- Edacherian, S., Richter, A., Karna, A., & Gopalakrishnan, B. (2023). Connecting the right knots: The impact of board committee interlocks on the performance of Indian firms. *Corporate Governance: An International Review*, n/a(n/a). <https://doi.org/10.1111/corg.12523>
- Fama, E. F., & Jensen, M. C. (1983). Separation of Ownership and Control. *The Journal of Law and Economics*, 26(2), 301–325. <https://doi.org/10.1086/467037>
- Fan, Y., Boateng, A., Ly, K. C., & Jiang, Y. (2021). Are bonds blind? Board-CEO social networks and firm risk. *Journal of Corporate Finance*, 68, 101922. <https://doi.org/10.1016/j.jcorpfin.2021.101922>
- Ferris, S. P., Jagannathan, M., & Pritchard, A. C. (2003). Too Busy to Mind the Business? Monitoring by Directors with Multiple Board Appointments. *The Journal of Finance*, 58(3), 1087–1111. <https://doi.org/10.1111/1540-6261.00559>
- Freeman, L. C., Roeder, D., & Mulholland, R. R. (1979). Centrality in social networks: Ii. experimental results. *Social Networks*, 2(2), 119–141. [https://doi.org/10.1016/0378-8733\(79\)90002-9](https://doi.org/10.1016/0378-8733(79)90002-9)
- Ginalski, S. (2022). How women broke into the old boys' corporate network in Switzerland. *Business History*, 0(0), 1–22. <https://doi.org/10.1080/00076791.2022.2034788>
- Goldstein, I., & Yang, L. (2017). Information Disclosure in Financial Markets. *Annual Review of Financial Economics*, 9(1), 101–125. <https://doi.org/10.1146/annurev-financial-110716-032355>

- Granovetter, M. (1983). The Strength of Weak Ties: A Network Theory Revisited. *Sociological Theory*, 1, 201–233. <https://doi.org/10.2307/202051>
- Gulati, R. (1999). Network location and learning: The influence of network resources and firm capabilities on alliance formation. *Strategic Management Journal*, 20(5), 397–420. [https://doi.org/10.1002/\(SICI\)1097-0266\(199905\)20:5<397::AID-SMJ35>3.0.CO;2-K](https://doi.org/10.1002/(SICI)1097-0266(199905)20:5<397::AID-SMJ35>3.0.CO;2-K)
- Helmers, C., Patnam, M., & Rau, P. R. (2017). Do board interlocks increase innovation? Evidence from a corporate governance reform in India. *Journal of Banking & Finance*, 80, 51–70. <https://doi.org/10.1016/j.jbankfin.2017.04.001>
- Higgs, D. (2003). Review of the role and effectiveness of non-executive directors.
- Hillman, A. J., Shropshire, C., & Cannella, A. A. (2007). Organizational Predictors of Women on Corporate Boards. *Academy of Management Journal*, 50(4), 941–952. <https://doi.org/10.5465/amj.2007.26279222>
- Hillman, A. J., Zardkoohi, A., & Bierman, L. (1999). Corporate political strategies and firm performance: Indications of firm-specific benefits from personal service in the U.S. government. *Strategic Management Journal*, 20(1), 67–81. [https://doi.org/10.1002/\(SICI\)1097-0266\(199901\)20:1<67::AID-SMJ22>3.0.CO;2-T](https://doi.org/10.1002/(SICI)1097-0266(199901)20:1<67::AID-SMJ22>3.0.CO;2-T)
- Huse, M. (2011, December). The golden skirts: Changes in board composition following gender quotas on corporate boards. In *Australian and New Zealand Academy Meeting, Wellington, NZ*.
- Ibarra, H. (1993). Personal Networks of Women and Minorities in Management: A Conceptual Framework. *Academy of Management Review*, 18(1), 56–87. <https://doi.org/10.5465/amr.1993.3997507>
- Ibarra, H. (1997). Paving an Alternative Route: Gender Differences in Managerial Networks. *Social Psychology Quarterly*, 60(1), 91–102. <https://doi.org/10.2307/2787014>
- Jain, R. (2022). Gender diversity, gender norms and firm performance: Evidence from India. *Economic Systems*, 46(4), 101006. <https://doi.org/10.1016/j.ecosys.2022.101006>



Khanna, T., & Yafeh, Y. (2007). Business Groups in Emerging Markets: Paragons or Parasites? *Journal of Economic Literature*, 45(2), 331–372. <https://doi.org/10.1257/jel.45.2.331>

Kothari, S. P., Li, X., & Short, J. E. (2009). The Effect of Disclosures by Management, Analysts, and Business Press on Cost of Capital, Return Volatility, and Analyst Forecasts: A Study Using Content Analysis. *The Accounting Review*, 84(5), 1639–1670. <https://doi.org/10.2308/accr.2009.84.5.1639>

Larcker, D. F., So, E. C., & Wang, C. C. Y. (2013). Boardroom centrality and firm performance. *Journal of Accounting and Economics*, 55(2), 225–250. <https://doi.org/10.1016/j.jacceco.2013.01.006>

Leuz, C., & Verrecchia, R. E. (2000). The Economic Consequences of Increased Disclosure. *Journal of Accounting Research*, 38, 91–124. <https://doi.org/10.2307/2672910>

Lindemanis, M., Loze, A., & Pajuste, A. (2022). The effect of domestic to foreign ownership change on firm performance in Europe. *International Review of Financial Analysis*, 81, 101341. <https://doi.org/10.1016/j.irfa.2019.04.004>

Low, D. C., Roberts, H., & Whiting, R. H. (2015). Board gender diversity and firm performance: Empirical evidence from Hong Kong, South Korea, Malaysia and Singapore. *Pacific-Basin Finance Journal*, 35, 381-401.

Masulis, R. W., Wang, C., & Xie, F. (2009). Agency Problems at Dual-Class Companies. *The Journal of Finance*, 64(4), 1697–1727. <https://doi.org/10.1111/j.1540-6261.2009.01477.x>

Mateos de Cabo, R., Grau, P., Gimeno, R., & Gabaldón, P. (2022). Shades of Power: Network Links with Gender Quotas and Corporate Governance Codes. *British Journal of Management*, 33(2), 703–723. <https://doi.org/10.1111/1467-8551.12454>

Mateos de Cabo, R. M., Gimeno, R., & Escot, L. (2011). Disentangling Discrimination on Spanish Boards of Directors. *Corporate Governance: An International Review*, 19(1), 77–95. <https://doi.org/10.1111/j.1467-8683.2010.00837.x>

Naaraayanan, S. L., & Nielsen, K. M. (2020). *Winds of Change: Gender Quota on Boards in the Face of Patriarchy* (SSRN Scholarly Paper 3751111). <https://doi.org/10.2139/ssrn.3751111>

Nielsen, S., & Huse, M. (2010). The Contribution of Women on Boards of Directors: Going beyond the Surface. *Corporate Governance: An International Review*, 18(2), 136–148.  
<https://doi.org/10.1111/j.1467-8683.2010.00784.x>

O'Hagan, S. B. (2017). An exploration of gender, interlocking directorates, and corporate performance. *International Journal of Gender and Entrepreneurship*, 9(3), 269–282.  
<https://doi.org/10.1108/IJGE-09-2016-0032>

Owen, A. L., & Temesvary, J. (2018). The performance effects of gender diversity on bank boards. *Journal of Banking & Finance*, 90, 50-63. Pattnaik, C., Chang, J. J., & Shin, H. H. (2013). Business groups and corporate transparency in emerging markets: Empirical evidence from India. *Asia Pacific Journal of Management*, 30(4), 987–1004.  
<https://doi.org/10.1007/s10490-011-9273-5>

Perrault, E. (2015). Why Does Board Gender Diversity Matter and How Do We Get There? The Role of Shareholder Activism in Deinstitutionalizing Old Boys' Networks. *Journal of Business Ethics*, 128(1), 149–165. <https://doi.org/10.1007/s10551-014-2092-0>

Post, C., & Byron, K. (2015). Women on Boards and Firm Financial Performance: A Meta-Analysis. *Academy of Management Journal*, 58(5), 1546–1571.  
<https://doi.org/10.5465/amj.2013.0319>

Prem Sankar, C., Asokan, K., & Satheesh Kumar, K. (2015). Exploratory social network analysis of affiliation networks of Indian listed companies. *Social Networks*, 43, 113–120.  
<https://doi.org/10.1016/j.socnet.2015.03.008>

Rhode, D. L., & Packel, A. K. (2014). Diversity on Corporate Boards: How Much Difference Does Difference Make. *Delaware Journal of Corporate Law*, 39, 377.

Rinaldi, A., & Tagliazucchi, G. (2022). Women directors in Italy: 1913–2017. *Business History*, 0(0), 1–25. <https://doi.org/10.1080/00076791.2021.2015332>

ROSENBAUM, P. R., & RUBIN, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, 70(1), 41–55.  
<https://doi.org/10.1093/biomet/70.1.41>

- Saeed, A., Belghitar, Y., & Yousaf, A. (2016). Firm-level determinants of gender diversity in the boardrooms: Evidence from some emerging markets. *International Business Review*, 25(5), 1076–1088. <https://doi.org/10.1016/j.ibusrev.2016.01.002>
- Sarabi, Y., Smith, M., McGregor, H., & Christopoulos, D. (2021). Gendered brokerage and firm performance – An interlock analysis of the UK. *International Journal of Productivity and Performance Management*, 72(2), 306–330. <https://doi.org/10.1108/IJPPM-01-2021-0022>
- Sarkar, J., & Selarka, E. (2021). Women on board and performance of family firms: Evidence from India. *Emerging Markets Review*, 46, 100770. <https://doi.org/10.1016/j.ememar.2020.100770>
- Seierstad, C., & Opsahl, T. (2011). For the few not the many? The effects of affirmative action on presence, prominence, and social capital of women directors in Norway. *Scandinavian Journal of Management*, 27(1), 44–54. <https://doi.org/10.1016/j.scaman.2010.10.002>
- Singh, V., Terjesen, S., & Vinnicombe, S. (2008). Newly appointed directors in the boardroom: How do women and men differ? *European Management Journal*, 26(1), 48–58. <https://doi.org/10.1016/j.emj.2007.10.002>
- Srinidhi, B., Gul, F. A., & Tsui, J. (2011). Female Directors and Earnings Quality\*. *Contemporary Accounting Research*, 28(5), 1610–1644. <https://doi.org/10.1111/j.1911-3846.2011.01071.x>
- Strøm, R. Ø. (2019). The Norwegian Gender Balance Law: A Reform that Failed? *Annals of Corporate Governance*, 4(1), 1–86. <https://doi.org/10.1561/109.00000014>
- Talmud, I., & Izraeli, D. N. (1999). The relationship between gender and performance issues of concern to directors: Correlates or institution? *Journal of Organizational Behavior*, 20(4), 459–474. [https://doi.org/10.1002/\(SICI\)1099-1379\(199907\)20:4<459::AID-JOB924>3.0.CO;2-J](https://doi.org/10.1002/(SICI)1099-1379(199907)20:4<459::AID-JOB924>3.0.CO;2-J)
- Torchia, M., Calabrò, A., & Huse, M. (2011). Women Directors on Corporate Boards: From Tokenism to Critical Mass. *Journal of Business Ethics*, 102(2), 299–317. <https://doi.org/10.1007/s10551-011-0815-z>

Yasar, M., & Rejesus, R. M. (2005). Exporting status and firm performance: Evidence from a matched sample. *Economics Letters*, 88(3), 397–402.

<https://doi.org/10.1016/j.econlet.2005.05.001>

Zaheer, A., & Bell, G. G. (2005). Benefiting from network position: Firm capabilities, structural holes, and performance. *Strategic Management Journal*, 26(9), 809–825.

<https://doi.org/10.1002/smj.482>

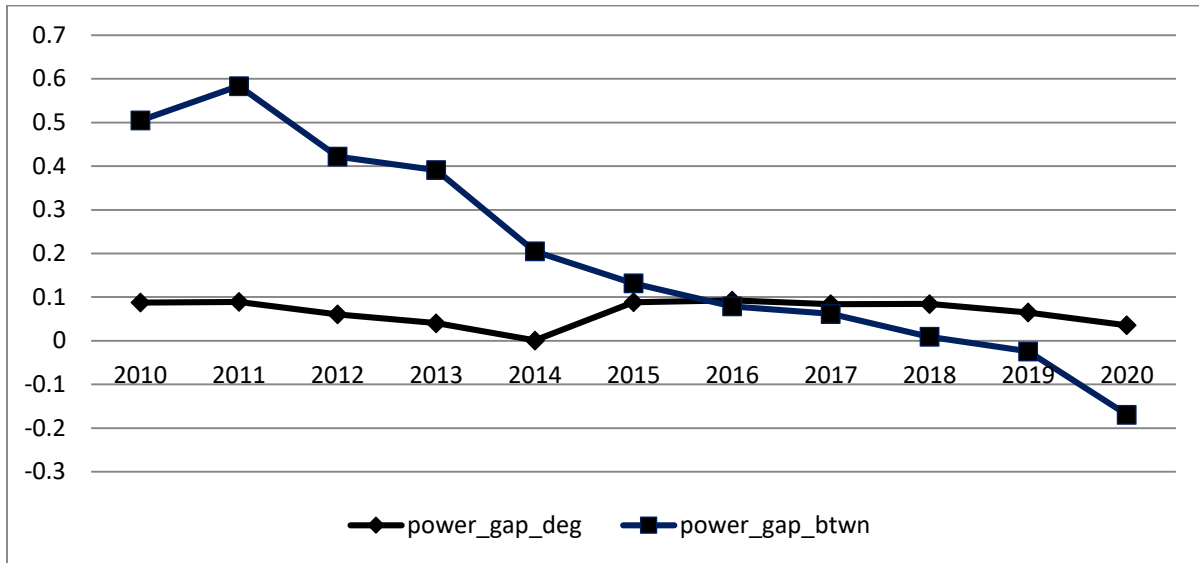
Zhang, L. (2020). An Institutional Approach to Gender Diversity and Firm Performance.

*Organization Science*, 31(2), 439–457. <https://doi.org/10.1287/orsc.2019.1297>

Zenou, E., Allemand, I. and Brullebaut, B. (2012), "Chapter 8 At the Origins of Female Directors' Networks: A Study of the French Case", Kensinger, J.W. (Ed.) *Research in Finance (Research in Finance, Vol. 28)*, Emerald Group Publishing Limited, Bingley, pp. 177-192. [https://doi.org/10.1108/S0196-3821\(2012\)0000028011](https://doi.org/10.1108/S0196-3821(2012)0000028011)

**Figure 1: Power Gap between Women and Male Directors: 2010-2020**

The figure presents the director network power gap between male and female directors. *power\_gap\_deg* and *power\_gap\_btwn* indicate power gap between male and female directors based on the network power based on the *degree* and *betweenness* centrality, respectively. Following Eckbo, Nygaard and Thorburn (2006) power gap is measured as one minus the ratio of mean women network power to male network power. Network power is the centrality score for each year and director in the network, scaled by the maximum score in that year. Centrality score is measured for each director every year as *degree* and *betweenness*, respectively. Description of director level and firm level *DEGREE* and *BETWEENNESS* are detailed in Section 3.2.2. The figure is drawn using the universe of 133,754 directorship-years for 21,421 unique directors in 2085 firms listed on National Stock Exchange (NSE) between 2010-2020.



**Table 1: The presence of women directors in the director network**

The table reports the distribution of the presence of women directors in the network over the study period 2010-2020. Panel A reports the distribution of directors and directorships and Panel B reports the distribution of selective network characteristics. *Giant component* is defined as the largest interconnected component across directors. A component is a subset of the network that is connected; that is, any director in a component can reach other directors in the component through links. *Interlocker* is a director with at least two directorships. *Big linker* is a director with three or more directorships. Description of director level and firm level *degree* and *betweenness* are detailed in Section 3.2.2. The table is drawn using the universe of 133,754 directorship-years for 21,421 unique directors in 2085 firms listed on National Stock Exchange (NSE) between 2010-2020.

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
<b>A. Director level</b>											
Total number of directors	7982	8709	9186	9238	9176	9343	9667	10040	10518	10625	10703
Proportion of women directors (% of total directors)	5.07	5.15	5.24	5.30	5.7	12.86	14.13	14.64	15.30	16.34	17.05
Proportion of directorships of women directors (% of total directorships)	4.61	4.63	4.81	4.93	5.44	12.54	13.83	14.45	15.11	16.33	17.34
Proportion of women interlockers (% of total interlockers)	3.30	3.37	3.82	4.21	4.40	11.34	12.59	13.10	13.84	15.70	17.27
Women big linkers as (% of big linkers)	2.81	2.71	3.35	3.80	4.75	12.36	14.51	15.13	15.01	17.27	19.71
<b>B. Network characteristics</b>											
Size of giant component (director as nodes)	5843	6256	6513	6650	6310	6164	6384	6485	6737	6627	6446
Women directors as percentage of directors in giant component	5.11	5.23	5.51	5.44	6.01	12.25	13.36	13.85	14.31	14.97	15.95
Number of women directors in top 100 directors by degree centrality	4	4	4	5	6	10	11	13	16	19	19
Number of women directors in top 100 directors by betweenness	2	1	2	4	6	13	18	20	18	19	21
Women directors as percentage of all directors in top 100 firms by degree centrality	4.39	5.01	5.54	6.18	6.03	10.75	11.59	12.00	13.69	14.20	15.93

**Table 2: Description of Variables**

<b>Variables</b>	<b>Definition</b>
	<b><u>Dependent variables</u></b>
<i>qratio</i>	(Market value of common equity + total debt+ preference equity)/Book value of asset
<i>roa</i>	Profit before depreciation, interest, taxes and amortisation (PBDITA) / total assets
	<b><u>Explanatory variables</u></b>
<i>w_outdegree</i>	Degree centrality measure for women directors at the board level for each firm every year
<i>w_between</i>	Betweenness centrality measure for women directors at the board level for each firm every year
	<b><u>Board variables</u></b>
<i>ln_boardsize</i>	Natural log of total number of directors on a firm's board of directors
<i>sh_indepdir</i>	The proportion of independent directors on a firm's board of directors
<i>ceo_chair</i>	A dummy variable equal to 1 if the CEO is a chairman of the board and 0 otherwise
	<b><u>Ownership variables</u></b>
<i>promoters_pct</i>	Total shareholdings of promoters in a firm
<i>group</i>	A dummy variable equal to 1 if the firm is affiliated to a business group and 0 otherwise
	<b><u>Firm-specific variables</u></b>
<i>leverage</i>	Total debt / total assets.
<i>firm_size</i>	The natural logarithm of total assets
<i>firm_age</i>	The difference between the observation year and firm's incorporation year
<i>vol</i>	Stock's volatility measured as rolling 52-week standard deviation of a stock's return
<i>Highvol</i>	A dummy variable equal to 1 if stock's volatility is above sample mean in a year
	<b><u>Director-level variables</u></b>
<i>sh_meeting</i>	Number of board meetings attended by each director / total number of meetings held during the year
<i>imp_commitee</i>	A dummy variable equal 1 if the director is a member of any of the following committees - Risk Total number of memberships in top five committees - Management, Nomination and Remuneration, Audit, Corporate Social Responsibility or Stakeholder Relationship Committees

**Table 3 (a): Summary statistics of variables**

The table reports the summary statistics for our final sample, which comprises 13,140 firm-year observations over the period 2010–2020. Director level statistics are generated from 131,572 directorships-year for 21,163 unique directors in 2040 firms. Table 2 above defines the variables.

<b>Variables</b>	<b>No of Observations</b>	<b>Mean</b>	<b>Std dev</b>	<b>Min</b>	<b>Max</b>
<i>qratio</i>	13,117	1.407	1.518	0.130	9.202
<i>roa</i>	13,129	0.119	0.087	-0.094	0.416
<i>firm_size</i>	13,129	8.977	1.572	5.357	13.216
<i>w_outdegree</i>	13,140	4.001	9.790	0	80
<i>w_between</i>	13,140	0.0004	0.001	0	.0174
<i>promoters_sh</i>	13,113	55.061	15.914	0	99.03
<i>firm_age</i>	13,129	33.406	21.074	4	106
<i>leverage</i>	13,117	1.612	3.476	0	22.561
<i>ln_bodysize</i>	13,140	2.028	0.322	0	3.091
<i>ceo_chair</i>	13,058	0.338	0.473	0	1
<i>sh_indepdir</i>	13,140	0.391	0.248	0	1
<i>vol</i>	11,953	0.069	0.029	0.0015	0.475
<i>female</i>	131,572	0.106	0.308	0	1
<i>outdegree</i>	131,572	16.124	15.521	1	149
<i>betweenness</i>	131,572	0.0007	0.002	0	0.029
<i>sh_meeting(%)</i>	72,356	83.089	25.372	0	100
<i>imp_committee</i>	131,572	0.903	1.282	0	5



**Table 3 (b): Year-wise statistics of women director network**

The table reports the distribution of women director centrality for our final sample, which comprises 13,140 firm-year observations over the period 2010–2020. *w\_outdegree* is the mean of DEGREE centrality and *w\_between* is the BETWEENNESS centrality of women directors in each firm in each year. Degree centrality is adjusted for board firm\_size. Description of director level and firm level *DEGREE* and *BETWEENNESS* are detailed in Section 3.2.2.

<b>Year</b>	<b>No of Observations</b>	<b>w_outdegree</b>	<b>w_between</b>
2010	1037	1.6925	0.0001
2011	1137	1.5119	0.0001
2012	1184	1.7191	0.0001
2013	1193	1.7452	0.0001
2014	1175	2.3538	0.0002
2015	1128	5.4972	0.0005
2016	1167	5.7681	0.0006
2017	1221	5.9245	0.0006
2018	1285	5.6557	0.0005
2019	1297	5.6028	0.0005
2020	1316	5.7131	0.0005

**Table 4: Women directors network and firm performance – Baseline (FE) and Reverse Causality (IV-FE)**

This table reports the results of women director connectedness on firm's performance using the fixed effects regression. Columns 1 to 4 report fixed effects estimation results for baseline model specification and columns 5 to 8 reports Instrumental Variable Fixed Effects estimation results to address the reverse causality in the women directors network. Our sample includes non financial NSE listed firms from 2010 to 2020. The dependent variables in columns 1,2,5 and 6 are Q-ratio and in columns 3,4,7 and 8 are ROA. The main independent variable of interest is  $w\_network$  which is captured by degree ( $w\_outdegree$ ) and betweenness centrality ( $w\_between$ ) respectively. Description of derivation of firm level  $DEGREE$  and  $BETWEENNESS$  from individual director level are detailed in Section 3.2.2. Table 2 defines all variables. Our final sample is 13,140 firm-year observations over the period 2010-2020 comprising 1,31,572 directorship-years for 21,163 unique directors in 2040 unique firms listed on National Stock Exchange (NSE) between 2010-2020. Dependent and firm-specific control variables are winsorized at both the 1% and 99% levels. Robust standard errors appear in parentheses. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

Independent variables	Fixed Effects				Instrumental Variable Fixed Effects			
	(1) Q-ratio	(2) Q-ratio	(3) ROA	(4) ROA	(5) Q-ratio	(6) Q-ratio	(7) ROA	(8) ROA
$w\_outdegree$	0.009** (0.004)		0.000 (0.000)		0.219*** (0.024)		0.001 (0.001)	
$w\_between$		53.622*** (16.993)		0.911 (0.748)		2,097.815*** (269.350)		6.229 (12.258)
$firm\_size$	-0.191* (0.098)	-0.192** (0.097)	-0.012 (0.010)	-0.013 (0.010)	-0.351*** (0.122)	-0.482*** (0.144)	-0.013 (0.011)	-0.013 (0.011)
$promoters\_sh$	0.010*** (0.003)	0.010*** (0.003)	0.000 (0.000)	0.000 (0.000)	0.009** (0.004)	0.009 (0.006)	0.000 (0.000)	0.000 (0.000)
$firm\_age$	-0.070 (0.088)	-0.070 (0.086)	-0.001 (0.004)	-0.001 (0.004)	-0.044 (0.196)	-0.051 (0.162)	-0.001 (0.004)	-0.001 (0.004)
$leverage$	-0.027*** (0.003)	-0.027*** (0.003)	-0.006*** (0.000)	-0.006*** (0.000)	0.001 (0.008)	0.015 (0.011)	-0.005*** (0.000)	-0.005*** (0.000)
$ln\_bodsize$	0.457*** (0.116)	0.462*** (0.116)	0.015** (0.007)	0.015** (0.007)	0.312* (0.185)	0.426* (0.227)	0.014** (0.007)	0.015** (0.007)
$ceo\_chair$	0.040 (0.088)	0.039 (0.088)	0.006 (0.004)	0.006 (0.004)	0.086 (0.115)	0.092 (0.131)	0.006 (0.004)	0.006 (0.004)
$sh\_indepdir$	0.247*** (0.062)	0.247*** (0.062)	0.004 (0.006)	0.004 (0.006)	0.032 (0.106)	-0.078 (0.122)	0.003 (0.005)	0.003 (0.005)
$time\ trend$	0.094 (0.088)	0.096 (0.086)	-0.001 (0.004)	-0.001 (0.004)	-0.042 (0.195)	-0.029 (0.161)	-0.002 (0.004)	-0.002 (0.004)
Constant	3.360 (2.555)	3.379 (2.525)	0.238* (0.141)	0.238* (0.141)	4.271 (5.487)	5.513 (4.593)	0.240* (0.139)	0.244* (0.143)
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	13,030	13,030	13,030	13,030	13,030	13,030	13,030	13,030
R-squared	0.018	0.018	0.023	0.024				
Number of companies	1,710	1,710	1,710	1,710	1,710	1,710	1,710	1,710
1 <sup>st</sup> stage statistics					3.677***	0.0003***	3.677***	0.0003** *
Reform*Treated					(0.228)	(0.000)	(0.228)	(0.000)
Kleinbergen-Paap					260.590	152.732	260.590	152.732
Wald F-stat								
Stock-Yogo					16.38	16.38	16.38	16.38
critical values			48					

**Table 5: Women director network and firm performance: Information and Monitoring**

This table reports the results of two channels of the impact of women director connectedness on firm's performance. These are information opacity (columns 1&2) and CEO Influence/monitoring (columns 3&4). The estimation is Instrumental Variable Fixed Effects regression to address endogeneity. The dependent variable in all the models is Q-ratio. The proxies for information opacity and CEO influence are *Highvol* and *ceo\_chair*. Our variables of interest are  $w\_network*Highvol$  and  $w\_network*ceo\_chair$  in the baseline model specification.  $w\_network$  is presented in terms of degree ( $w\_outdegree$ ) and betweenness ( $w\_between$ ). Columns 1&3 report results for degree centrality ( $w\_outdegree*HighVol$  and  $w\_outdegree*ceo\_chair$ ) and columns 2&4 report results for betweenness centrality ( $w\_between*Highvol$  and  $w\_between*ceo\_chair$ ) respectively. Description of computation of firm level *DEGREE* and *BETWEENNESS* from individual director level are detailed in Section 3.2.2. Our final sample is 13,140 firm-year observations over the period 2010-2020 comprising 1,31,572 directorship-years for 21,163 unique directors in 2040 unique firms listed on NSE. Dependent and firm-specific control variables are winsorized at both the 1% and 99% levels. Robust standard errors appear in parentheses. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

	Information Channel		Influence/Monitoring Channel	
	(1) Highvol	(2) Highvol	(3) CEO Chair	(4) CEO Chair
<i>w_outdegree</i>	0.207*** (0.023)		0.196*** (0.023)	
$w\_outdegree*Highvol$	0.032* (0.017)			
<i>w_between</i>		1,965.414*** (248.597)		1,952.772*** (263.628)
$w\_between*Highvol$		465.397* (246.237)		
$w\_outdegree*ceo\_chair$			0.102** (0.048)	
$w\_between*ceo\_chair$				595.088 (486.881)
<i>firm_size</i>	-0.333*** (0.123)	-0.458*** (0.143)	-0.339*** (0.125)	-0.476*** (0.149)
<i>promoters_sh</i>	0.009** (0.004)	0.008 (0.005)	0.010** (0.004)	0.010* (0.006)
<i>firm_age</i>	-0.064 (0.198)	-0.072 (0.160)	-0.052 (0.184)	-0.054 (0.158)
Leverage	-0.002 (0.008)	0.012 (0.012)	0.000 (0.008)	0.015 (0.011)
<i>ln_bodsize</i>	0.304* (0.184)	0.407* (0.227)	0.284 (0.184)	0.415* (0.229)
<i>ceo_chair</i>	0.087 (0.116)	0.098 (0.132)	-0.219 (0.195)	-0.084 (0.204)
<i>sh_indepdir</i>	0.037 (0.105)	-0.077 (0.122)	0.049 (0.110)	-0.061 (0.124)
time trend	-0.021 (0.196)	-0.008 (0.159)	-0.038 (0.183)	-0.029 (0.157)
Constant	4.700 (5.523)	5.983 (4.549)	4.529 (5.166)	5.607 (4.492)
Firm FE	Y	Y	Y	Y
Observations	13,030	13,030	13,030	13,030
Number of companies	1,710	1,710	1,710	1,710

**Table 6: Women director network and board activities**

This table reports the regression results for model specified in equation (4) using the director-level data. The sample consists of 1,31,572 directorship-years in 2040 unique firms listed on National Stock Exchange (NSE) between 2010-2020. The dependent variable in columns 1 to 4 is the % share of meetings attended (*sh\_meeting*) and in columns 5 to 8 is the total number of top 5 committees (*imp\_committee*). Variable of interest is *female\*d\_network*. *female* is a dummy variable equal to 1 if the director is a woman and 0 otherwise. Director centrality is measured in terms of *out degree(outdegree)* & *betweenness (btwn)*. Description of director level *DEGREE* and *BETWEENNESS* are detailed in Section 3.2.2. The specifications in Columns 1, 2, 5 and 6 include industry fixed effects based on two-digit national industrial classification (NIC). The specifications in columns 3,4,7 and 8 include firm fixed effects. All the specifications include the constant term, time dummies and director-specific control variables such as age (*director\_age*), age squared (*director\_agesq*), tenure (*tenure*), and whether the director is an independent director or not (*indepdir*). Table 2 defines all variables. Robust standard errors appear in parentheses. The effect of the constant term is omitted in reporting. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

	Dependent variable: % Share of meetings attended ( <i>sh_meeting</i> )				Dependent variable: # of Top 5 Committee Memberships ( <i>imp_committee</i> )			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outdegree	0.006 (0.008)		-0.029*** (0.010)		-0.001*** (0.000)		-0.001*** (0.000)	
Female	-4.145*** (0.413)	-4.011*** (0.388)	-4.357*** (0.402)	-4.213*** (0.378)	-0.319*** (0.015)	-0.316*** (0.015)	-0.348*** (0.015)	-0.341*** (0.014)
female*outdegree	0.080*** (0.025)		0.074*** (0.025)		0.001 (0.001)		0.002** (0.001)	
Between		-73.541 (64.904)		-247.530*** (69.926)		-14.708*** (2.118)		-17.015*** (2.204)
female*between		643.251*** (180.677)		564.990*** (180.588)		10.693 (7.449)		14.247** (7.237)
Indepdir	-1.726*** (0.272)	-1.645*** (0.273)	-1.426*** (0.273)	-1.401*** (0.272)	0.723*** (0.010)	0.727*** (0.010)	0.740*** (0.010)	0.746*** (0.010)
director_age	0.182*** (0.068)	0.186*** (0.068)	0.239*** (0.070)	0.239*** (0.070)	0.004 (0.002)	0.004 (0.002)	-0.004* (0.002)	-0.004* (0.002)
director_agesq	-0.001 (0.001)	-0.001 (0.001)	-0.001** (0.001)	-0.001* (0.001)	-0.000 (0.000)	-0.000 (0.000)	0.000*** (0.000)	0.000*** (0.000)
Tenure	0.261*** (0.013)	0.261*** (0.013)	0.315*** (0.015)	0.315*** (0.015)	0.016*** (0.001)	0.016*** (0.001)	0.022*** (0.001)	0.022*** (0.001)
Industry FE	Y	Y	N	N	Y	Y	N	N
Firm FE	N	N	Y	Y	N	N	Y	Y
Sample	All directors	All directors	All directors	All directors	All directors	All directors	All directors	All directors
Observations	50,216	50,216	50,209	50,209	68,950	68,950	68,936	68,936
R-squared	0.037	0.037	0.149	0.149	0.331	0.331	0.411	0.411

**Table 7: Independent Women director network and board activities**

This table reports the regression results for model specified in equation (5) using director-level data. The sample consists of only women directorships drawn from 1,31,572 directorship-years in 2040 unique firms listed on National Stock Exchange (NSE) between 2014-2020. The dependent variable in columns 1 to 4 is the % share of meetings attended (*sh\_meeting*) and in columns 5 to 8 is the total number of top 5 committees (*imp\_committee*). Variable of interest is *indepdir\*d\_network* where *indepdir* is a dummy variable equal to 1 if the directorship is independent and 0 otherwise. *d\_network* is the director centrality measured in terms of *out degree(outdegree)* & *betweenness (btwn)*. Description of director level *DEGREE* and *BETWEENNESS* are detailed in Section 3.2.2. The specifications in Columns 1, 2, 5 and 6 include industry fixed effects based on two-digit national industrial classification (NIC). The specifications in columns 3,4,7 and 8 include firm fixed effects. All the specifications include the constant term, time dummies and director specific control variables such as age (*director\_age*), age squared (*director\_agesq*) and tenure (*tenure*). Table 2 defines all variables. Robust standard errors appear in parentheses. The effect of the constant term is omitted in reporting. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

	Dependent variable: % Share of meetings attended ( <i>sh_meeting</i> )				Dependent variable: # of Top 5 Committee Memberships ( <i>imp_committee</i> )			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outdegree	-0.142** (0.060)		-0.138 (0.092)		-0.003** (0.002)		-0.002 (0.003)	
Between		-1,580.713** (625.113)		-1,139.227 (834.707)		-41.092** (16.566)		-51.265** (23.858)
Indepdir	0.184 (0.860)	0.642 (0.826)	-4.051** (1.704)	-2.833* (1.644)	0.627*** (0.033)	0.643*** (0.031)	0.426*** (0.053)	
Indepdir*outdegree	0.267*** (0.066)		0.300*** (0.102)		0.007*** (0.002)		0.006** (0.003)	
Indepdir*between		2,369.624*** (649.842)		1,632.272* (890.114)		59.339*** (18.318)		58.670** (25.076)
director_age	0.799*** (0.220)	0.813*** (0.219)	0.872** (0.423)	0.905** (0.424)	0.005 (0.008)	0.005 (0.008)	0.019 (0.013)	0.020 (0.013)
director_agesq	-0.007*** (0.002)	-0.007*** (0.002)	-0.008** (0.004)	-0.008** (0.004)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Tenure	0.579*** (0.054)	0.575*** (0.054)	0.921*** (0.124)	0.916*** (0.124)	0.026*** (0.002)	0.026*** (0.002)	0.036*** (0.004)	0.035*** (0.004)
Industry FE	Y	Y	N	N	Y	Y	N	N
Firm FE	N	N	Y	Y	N	N	Y	Y
Sample	Women directors	Women directors	Women directors	Women directors	Women directors	Women directors	Women directors	Women directors
Observations	7,124	7,124	7,031	7,031	8,247	8,247	8,144	8,144
R-squared	0.090	0.090	0.410	0.410	0.251	0.250	0.641	0.641

**Table 8: Women director network and firm performance – Robustness check using alternate dependent variable**

The table estimates the baseline model with FE and IV-FE using MBVR as the alternate dependent variable. The dependent variables in columns 1 and 2 reports the FE estimators whereas columns 3 and 4 present the IV-FE estimator. The main independent variable of interest is  $w\_network$  which is captured by degree ( $w\_outdegree$ ) and betweenness centrality ( $W\_between$ ) respectively. Columns 1 and 3 report results for degree centrality and columns 2 and 4 report results for betweenness centrality. Description of computation of firm level *DEGREE* and *BETWEENNESS* from individual director level are detailed in Section 3.2.2. Table 2 defines all variables. Our final sample is 13,140 firm-year observations over the period 2010-2020 comprising 1,31,572 directorship-years for 21,163 unique directors in 2040 unique firms listed on National Stock Exchange (NSE) between 2010-2020. Dependent and firm-specific control variables are winsorized at both the 1% and 99% levels. Robust standard errors appear in parentheses. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$

	(1)	(2)	(3)	(4)
	FE	FE	IV-FE	IV-FE
	MBVR	MBVR	MBVR	MBVR
$w\_outdegree$	0.009** (0.004)		0.214*** (0.024)	
$w\_between$		53.622*** (16.993)		2,053.361*** (265.606)
$firm\_size$	-0.191* (0.098)	-0.192** (0.097)	-0.390*** (0.121)	-0.519*** (0.143)
$promoters\_pct$	0.010*** (0.003)	0.010*** (0.003)	0.009** (0.004)	0.008 (0.005)
$firm\_age$	-0.070 (0.088)	-0.070 (0.086)	-0.034 (0.191)	-0.041 (0.157)
$leverage$	-0.027*** (0.003)	-0.027*** (0.003)	-0.015** (0.007)	-0.001 (0.011)
$\ln\_bodsize$	0.457*** (0.116)	0.462*** (0.116)	0.313* (0.183)	0.425* (0.224)
$ceo\_chair$	0.040 (0.088)	0.039 (0.088)	0.093 (0.114)	0.099 (0.130)
$sh\_indepdir$	0.247*** (0.062)	0.247*** (0.062)	0.021 (0.104)	-0.086 (0.120)
Time trend	0.094 (0.088)	0.096 (0.086)	-0.039 (0.189)	-0.026 (0.157)
Constant	3.360 (2.555)	3.379 (2.525)	4.118 (5.339)	5.334 (4.478)
Firm FE	Y	Y	Y	Y
Observations	13,030	13,030	13,030	13,030
Number of co_code	1,710	1,710	1,710	1,710

**Table 9: Women director network and firm performance – Robustness check using lagged explanatory variables**

The table estimates the baseline model with IV-FE 2 SLS method with all the independent and control variables expressed as one year lagged values. The dependent variables in columns 1 and 3 are Q-ratio and in columns 2 and 4 are ROA. The main independent variable of interest is *w\_network* which is captured by degree (*w\_outdegree*) and betweenness centrality (*w\_between*) respectively. Columns 1 and 3 report results for degree centrality and columns 2 and 4 report results for betweenness centrality. Description of computation of firm level *DEGREE* and *BETWEENNESS* from individual director level are detailed in Section 3.2.2. Table 2 defines all variables. Our final sample is 13,140 firm-year observations over the period 2010-2020 comprising 1,31,572 directorship-years for 21,163 unique directors in 2040 unique firms listed on National Stock Exchange (NSE) between 2010-2020. Dependent and firm-specific control variables are winsorized at both the 1% and 99% levels. Robust standard errors appear in parentheses. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

	(1)	(2)	(3)	(4)
	<i>qratio</i>	<i>roa</i>	<i>qratio</i>	<i>roa</i>
L.w_outdegree	0.445*** (0.071)	0.004 (0.003)		
L.w_between			3,996.344*** (705.208)	32.479 (29.735)
L.firm_size	-0.375** (0.189)	-0.028*** (0.006)	-0.654** (0.259)	-0.030*** (0.006)
L.promoters_sh	0.006 (0.009)	0.000 (0.000)	0.006 (0.011)	0.000 (0.000)
L.firm_age	0.126 (0.428)	0.000 (0.005)	0.074 (0.315)	-0.000 (0.005)
L.leverage	0.019 (0.018)	-0.002 (0.001)	0.046 (0.032)	-0.001 (0.001)
L.ln_bodsize	-0.027 (0.385)	0.009 (0.008)	0.404 (0.463)	0.013* (0.008)
L.ceo_chair	0.224 (0.180)	0.008* (0.004)	0.252 (0.195)	0.008* (0.004)
L.sh_indepdir	0.600*** (0.184)	0.007 (0.006)	0.460** (0.218)	0.006 (0.006)
Constant	0.964 (11.704)	0.338** (0.146)	4.140 (8.783)	0.363*** (0.136)
Time trend	Y	Y	Y	Y
Observations	11,292	11,292	11,292	11,292
Number of co_code	1,622	1,622	1,622	1,622

**Table 10: Women director network and firm performance Robustness check using propensity score matching method**

The table estimates the baseline model using PSM method. The treatment group is created from *high\_outdegree* or the *high\_btwn* dummies where *high\_outdegree* equals to 1 if the *w\_outdegree* is greater than the mean value and zero otherwise. Similarly, *high\_btwn* is defined as one for observations having *w\_between* value greater than the mean level and zero otherwise. We match the firms with high and low values of women network measures on the set of observed characteristics using one-to-one nearest neighbour matching with a caliper of 0.001. Description of computation of firm level *DEGREE* and *BETWEENNESS* from individual director level are detailed in Section 3.2.2. Our final sample is 13,140 firm-year observations over the period 2010-2020 comprising 1,31,572 directorship-years for 21,163 unique directors in 2040 unique firms listed on National Stock Exchange (NSE) between 2010-2020. Dependent and firm-specific control variables are winsorized at both the 1% and 99% levels. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

	Treated	Control	Difference	T-statistic
Matching based on high and degree				
Q-ratio	2.064	1.582	0.482	6.60***
ROA	0.129	0.123	0.006	1.57
Matching based on high and betweenness				
Q-ratio	2.192	1.779	0.413	4.51***
ROA	0.1378	0.128	0.010	2.49**



**Table 11: Women director network and firm performance – Robustness check using plausibly exogenous IV regressions**

The table estimates the gives the output of plausibly exogenous method. The main independent variable of interest is  $w\_network$  which is captured by degree ( $w\_outdegree$ ) and betweenness centrality ( $w\_between$ ) respectively. Description of computation of the network measures from individual director level are detailed in Section 3.2.2. Our final sample is 13,140 firm-year observations over the period 2010-2020 comprising 1,31,572 directorship-years for 21,163 unique directors in 2040 unique firms listed on National Stock Exchange (NSE) between 2010-2020. Dependent and firm-specific control variables are winsorized at both the 1% and 99% levels. \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

	<i>qratio</i>	
Gamma	0.805***	
	(0.059)	
Plausibly exogenous regressions		
	<i>w_outdegree</i>	<i>w_between</i>
Beta hat (LB)	-.1376143	-1359.3377
Beta hat (UB)	.15886926	1570.9576
Gamma (Max)	0.363	0.363
% endogeneity permissible	45.1	45.1