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CEO-director ties and board gender diversity: US evidence

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ABSTRACT

The gender legislation enacted around the world has put enormous pressure on companies to increase the number of women on their boards. Employing US firm-specific data, we document a significant negative relationship between CEO-director ties and female representation on the board, suggesting that socially connected directors are detrimental to gender parity in senior management. We find that the situation improves in firms with female directors with valuable attributes while being moderated by CEO characteristics. Cross-sectional analyses reveal that the association is more pronounced during the low board gender diversity periods and for firms that are led by male CEOs or have weak monitoring mechanism. We rule out endogeneity concerns by performing a battery of analyses. The findings remain robust in a range of sensitivity tests. Our study offers practical implications for regulators and top management teams to improve board effectiveness, thus engendering lasting transformational change in the boardroom.

1. Introduction

In this study, we examine the impact of the social ties between CEOs and independent directors on the board gender diversity (BGD) of US firms. The motivation for this study comes from two major sources. First, the board of directors assumes a critical role in validating corporate decision-making and the composition of the board can have a significant impact on the quality of deliberations (Fama and Jensen, 1983). Long-standing evidence from the literature indicates that female directors exert greater effort through increasing board activity, which ultimately results in stricter oversight of managerial agenda (Adams and Ferreira, 2009; Farrell and Hersch, 2005). Therefore, board gender differences can affect board decisions and firm outcomes (Carter et al., 2003; Charness and Gneezy, 2012; Croson and Gneezy, 2009; Powell and Ansic, 1997) and a well-structured board needs to have gender diversity to boost board monitoring and efficiency (Cumming et al., 2015).

Second, although women's representation in the labour force has increased (Winkler, 2022), they remain underrepresented in boardrooms (Catalyst, 2022). Gender inequality of the board has been linked to the loss of trust in a company's board, diminished investors' confidence, damaged shareholder value and increased financial market instability (Cumming et al., 2018; Cumming et al., 2015; Johnson et al., 2009). Consequently, businesses are facing pressure from shareholders, politicians and communities to increase female representation in management roles.

Prior research explains that women's access to directorships relies on country's social, political and economic structures at the macro level (Carrasco et al., 2015; Low et al., 2015; Terjesen and Singh, 2008), sector and industry specifics at the meso level (Adams and Kirchmaier, 2016; Bianco et al., 2015; Nekhili and Gatfaoui, 2013) and recruitment and selection process at the micro level (Agarwal et al., 2016; Cai et al., 2022; DiTomaso et al., 2007; Van Knippenberg and Schippers, 2007).

Nonetheless, the association between CEO-director ties and BGD remains a puzzle. On the one hand, studies on the dark side of board connection provide unequivocal evidence that the social closeness between the CEO and directors goes against shareholders' interests, appearing to weaken corporate governance, leading to erosion of firm value (Fan et al., 2019), higher executive compensation (Barnea and

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Guedj, 2007; Hwang and Kim, 2009; Larcker et al., 2005) as well as distortions in director selection (Kuhnen, 2009), CEO retention decisions (Nguyen, 2012) and corporate investment (Güner et al., 2008).

On the other hand, studies on the bright side of board linkage indicate that network ties appear to enhance value (Barroso-Castro et al., 2016; Kim, 2005) and facilitate venture capital investment (Hochberg et al., 2007) and mutual fund investment (Fracassi, 2017). Surprisingly, though, the direct consequences of the linkages between the CEO and incumbent board members on one important indicator of efficient boards – BGD – remains an unopened black box. We fill this void by determining if, and to what extent, a CEO's social connection to a proportion of the board shapes a firm's propensity to appoint a female director to the board.

We offer two competing arguments concerning the possible link between CEO-director ties and female representation on the board. Referring to agency theory (Fama and Jensen, 1983; Kock et al., 2012) and social identity perspective (Tajfel and Turner, 2004; Westphal and Zajac, 1995; Windolf, 1998), we anticipate a negative impact of CEO-director ties on BGD, measured through female director representation on the board. Contrariwise, founded on resource dependence (Johnson et al., 1996; Reddy and Jadhav, 2019; Pfeffer and Salancik, 2003) and human capital approach (Bilimoria, 2000; Hillman et al., 2000; Terjesen et al., 2008), we do not rule out the possibility that CEO-director ties can promote BGD.

We empirically test the above-mentioned competing arguments on a large sample of US listed firms over the period from 2003 to 2018. Our empirical analyses utilising five regression techniques reveal a significant negative relationship between CEO-director ties and BGD, implying that a higher fraction of directors on their board who are socially connected with the CEO lowers female representation on the board. Furthermore, we find that board connection significantly reduces BGD irrespective of the female director type (i.e. executive, non-executive, independent or non-independent). We report that firms with female directors with valuable attributes, such as larger network size, higher qualifications or more experience, can rectify the situation. In further analyses, we find that CEO-director ties and the BGD relationship is stronger in firms where CEOs earn a higher pay and hold a larger share of ownership. The cross-sectional tests reveal that the association is more pronounced during a low BGD period, for firms that are led by male CEOs, have a lower number of analysts following them, smaller institutional shareholding and a lower level of corporate social responsibility. We perform a battery of analyses, including propensity score matching (PSM), Lasso selection models and two-stage least square (2SLS) using acquisition, CEO death, CEO turnover and CEO departure as exogenous shocks to changes in CEO-director ties to rule out endogeneity issues. We also check the robustness of our baseline results by including additional control variables, controlling for lifecycle and using alternative measures for CEO-director ties and BGD, confirming that board social linkages can explain the paucity of women on boards.

Our study makes a valuable contribution to two strands of the literature. First, we augment the growing body of research that explains women's access to boards (Carrasco et al., 2015; Terjesen and Singh, 2008; Adams and Kirchmaier, 2016; Bianco et al., 2015; Nekhili and Gatfaoui, 2013; Agarwal et al., 2016; Cai et al., 2022; DiTomaso et al., 2007; Van Knippenberg and Schippers, 2007) by identifying an important factor that drives BGD, namely, CEO-director social ties. Although appearing to contrast with Cai et al. (2022) who report the positive impact of the connections between successful candidate and the incumbent board, we, indeed, extend Cai et al. (2022) by examining another type of connection: the ties among CEO and board member as selectors in the recruitment. In Cai et al. (2012), connections between potential candidates and incumbent boards act as a bridge to facilitate coordination and reduce research costs, thus promote female entry into the boardroom. In our study, the ties between CEO and existing directors cushion the social identity of this elite group, thus act as a barrier to effective monitoring and women representation on the board. We further document consistent negative impact of the CEO and existing board director linkages on BGD across different female director types as well as the remedies presented by female attributes. Second, our research contributes to the longstanding debate on board effectiveness and monitoring. Previous studies demonstrate that board social linkages exhibit partiality in monitoring and that the decisions they make may be influenced, in part, by their allegiance to the CEO (Hochberg et al., 2007; Westphal, 1999). We compliment this strand of literature by highlighting the adverse influence of socially connected directors on boards' behaviour toward gender equality. This is an important contribution specifically in the corporate governance literature, where shareholders bear the onus of a negative relationship between BGD and CEO-director ties. Our study is also a timely response to public scrutiny on the linkages inside corporate boardrooms and a recent upsurge in calls for gender parity in corporate boards around the globe.

The paper is organised as follows. We present the review of prior literature and develop our hypothesis in Section 2. Section 3 presents the methodology of the paper, while Section 4 presents the results. Finally, we conclude this study in Section 5.

2. Background and hypothesis development

2.1. CEO-director ties

Corporate stakeholders have increasingly scrutinised the social relationships that exist between top managers and members of the board. A firm's CEO and directors may have social relationships in several ways. They may have worked together in their past careers as employees or directors. Managers and directors may be related as fellow members of a club, as trustees for the same non-profit organisation or by having graduated from the same institution or MBA program (Duchin and Sosyura, 2013; Fracassi and Tate, 2012). This practice has garnered a literature debate with two competing perspectives on both the dark and the bright sides.

On the one hand, CEO-director ties reduce effective monitoring, thereby engendering agency costs and resulting in erosion of firm value. Empirically, it is reported that CEO-director ties create opportunities for managers to engage in self-interested activity while reducing vigilant oversight on CEO performance, resulting in losses for shareholders. Based on a sample of 1696 publicly listed firms in the US. over the period of 2000–2014, Fan et al. (2019) explain that friendship ties exert a negative influence on firm value because of similar beliefs, attitudes and traits, and a strong psychological bond between individuals. Research has shown that friendship ties may lead to familiarity bias and undermine the quality of board monitoring and directors' fiduciary duties, including directors' ability to oversee corporate strategy and decisions (Westphal, 1999). Fracassi and Tate (2012) and Güner et al. (2008) offer support for this view and report that CEO-director relationships impair corporate governance, reduce firm value, lead to more value-destroying acquisitions and distort company investments. Kuhnen (2009) finds that connections affect the reciprocal hiring of directors, who are often hired through networks of existing directors. The author cites asymmetric information, moral hazard, costly search and favouritism as reasons why connections could distort such decisions. On director retention, Nguyen (2012) reports that when CEO and a number of directors belong to the same social networks, it is less likely that the CEO will be dismissed for poor performance. In the same vein, Hwang and Kim (2009) and Larcker et al. (2005) find that directors belonging to an inside and outside directors' network earn substantially higher levels of total compensation. Overall, the adverse effect of CEO-director ties is prevalent in prior literature that portrays the dark side of director linkage. detention.

On the other hand, other researchers have defended the bright side of board social connection by referring to the advising and resource dependency functions of the board rather than the well-conceived monitoring function (Pfeffer and Salancik, 2003). They argue that mutual trust and social obligations between CEOs and boards accelerate rather

than inhibit board collaboration and efficacy in governing a firm (Westphal, 1999). Kim (2005) finds that a positive association exists between board members of elite school networks and firm performance. Barroso-Castro et al. (2016) demonstrate that the overlap in tenure or shared experience of a company's board of directors positively influences its performance. Mosey and Wright (2007) show a positive association between founders' social networks and their start-ups' performance. In the same vein, Duchin and Sosyura (2013) report that in an information asymmetry environment, board connections increase investment efficiency and firm value by facilitating the transfer of useful information. Cai and Sevilir (2012) find that the link between CEO-director ties is crucial in corporate investments and contributes to value generation. Business ventures that are better connected have larger fund-raising capacities, perform better financially and are more likely to survive past their first investment cycle (Hochberg et al., 2007). Similarly, mutual fund managers' and corporate board members' shared education networks are an important mechanism through which information advantage flows into asset prices, resulting in firm outperformance in the stock market (Cohen et al., 2008). Although the above studies provide interesting insights into the effect of CEO-director ties, the impact of the linkages between CEO and management on BGD remains largely unexplored.

2.2. Board gender diversity

The existing literature examines the implications of gender diversity on corporate boards from multiple perspectives, giving broader insight into the subject matter. Looking at how board gender composition affects organisational outcomes, scholars have uncovered an innegligible effect on financial performance and the social and ethical aspects of firms. On firm financial performance, positive relationships are found in many studies (Burke, 2000; Carter et al., 2003; Erhardt et al., 2003). For UK firms, Gregory et al. (2013) find that markets react less responsively to trades by female directors in the short term but recognize these trades as informative in the long term. BGD has also been linked with a better information environment, which delivers greater information-sharing with investors, resulting in enhanced earnings quality (Gul et al., 2011), higher analysts' earnings forecast accuracy and lower analysts' earnings forecast dispersion (Gul et al., 2013). BGD is found to translate into better transparency (Upadhyay and Zeng, 2014), a higher corporate social responsibility rating (Bear et al., 2010; Hussain et al., 2018), a reduced likelihood of financial manipulation (Wahid, 2019), a higher propensity to disclose voluntary information of greenhouse gas emissions, as well as greater extensiveness of that disclosure (Liao et al., 2015). On corporate decisions, several studies find a positive effect of female directors on corporate innovation (Galia and Zenou, 2012; Miller and del Carmen Triana, 2009), a lower likelihood to make acquisitions and lower bid premium (Chen et al., 2016; Levi et al., 2014) and fewer workforce reductions (Matsa and Miller, 2013).

In looking at the positive impact of BGD, studies are often based on the premise that there are gender differences in the ethical orientation of directors, and that female directors are more ethical (Cumming et al., 2015; Mason and Mudrack, 1996). Empirical evidence shows that women exhibit higher ethical standards in the workplace (Lund, 2008) and are more likely to raise their voices against unethical behaviour (Singh et al., 2002; Vermeir and Van Kenhove, 2008). Prior literature also has examined the corporate governance implications of female representation on boards and generally has concurred that board diversity improves corporate governance. For example, Adams and Ferreira (2009) reveal that board diversity has a positive impact on governance metrics and gender-diverse boards are more likely to hold CEOs accountable for weak stock performance. Fondas and Sassalos (2000) find that mixed-gender corporate boards were more effective than male-only boards in influencing management decisions of managerial selection and compensation, management succession, long-term planning, capital expenditures and corporate structure than male-only boards. Singh et al. (2002) and Perrault (2015) report that women break up all-male director networks, thereby enhancing perceptions of the board's relational and moral legitimacy, which in turn fosters shareholders' trust.

Despite the potential benefits to firms, women's access to the boardroom has been incomplete. Scholars have sought to understand the drivers of board gender composition. At the macro level, research recognizes that women's access to boards is influenced by key factors, such as the social, political and economic structures of individual countries (Carrasco et al., 2015; Low et al., 2015; Terjesen and Singh, 2008) shareholders (Doldor et al., 2016; Marquardt and Wiedman, 2016), stock exchanges, professional associations of company directors, lobbying groups and the media who can serve as agents of change, influencing the norms surrounding women's board representation (Sheridan et al., 2014) and the customer base (Brammer et al., 2007).

Meso-level studies argue that different types of businesses may or may not benefit from having women on their boards, and that, indeed, female representation is not uniformly spread across different business types, boards and industries. For example, female directors are more prevalent in firms with large boards and with foreign institutional investors (Bianco et al., 2015). Sectoral variation also plays a role in determining the number of female directors, as more female directors are found in the retail industry and service sector (Martin et al., 2008) and fewer in the STEM and finance industries (Adams and Kirchmaier, 2016; Geiger and Marlin, 2012).

At the micro-level, other studies examine the processes through which candidates for board positions are recruited. Studies from the homogeneous perspective (DiTomaso et al., 2007; Van Knippenberg and Schippers, 2007; Williams and O'Reilly III, 1998) argue that incumbent board members have a tendency to recommend candidates who resemble themselves demographically, and thus women are underrepresented on boards. For example, studies have highlighted the importance of social networks, including playing golf as a social network tool, for women's board access (Agarwal et al., 2016; Hodigere and Bilimoria, 2015). In another instance, Cai et al. (2022) use a sample of 9801 director appointments during 2003–2014 to examine the connections between appointee and incumbent boards. Nonetheless, whether and to what extent, the linkages among CEO and incumbent board members have an impact on BGD remnants an empirical question. In the following discussion, we present two competing arguments for the possible theoretical links between board connection and female representation on the board.

2.3. CEO-director ties and board gender diversity

Our first argument leans on the dark side of board connection to speculate that firms with more CEO-tied directors are associated with lower female representation on the board. *Agency theory* posits that corporate boards provide a crucial safeguard for stakeholders, and the composition of the board determines its effectiveness (Fama and Jensen, 1983; Kock et al., 2012). Managers, who are hired by shareholders to act on their behalf and to run a firm, may behave opportunistically if they are motivated by their own interests, such as private remuneration, job security and status. Social relations between CEOs and independent directors have been blamed for a board's passivity and ineffectiveness by corporate governance reform activists (Cohen et al., 2008; Fracassi and Tate, 2012). Scholars also note that because CEOs dominate the nomination and remuneration of directors, the norm of reciprocity creates a sense of social obligation on the part of directors, who are beholden to their CEO (Daily and Dalton, 1993). In addition, since directors are socially connected to the CEO, they may be reluctant to exercise their monitoring role because such action could strain their ties with the CEO (Hochberg et al., 2007; Westphal, 1999). Consequently, socially connected directors compromise their loyalties and personal connection with their monitoring function, which leads to irrational behaviour and impairs boards' vigilant oversight of managerial decisions and

governance practices (Kuang and Lee, 2017; Lim et al., 2020).

Social identity theorists go further and explain that because CEOs and boards have considerable latitude in selecting new directors, in-group biases lead them to favour candidates that reproduce the existing demographic composition (Westphal and Zajac, 1995, 1997), as well as to ease group tension and facilitate common goals (DiTomaso et al., 2007; Van Knippenberg and Schippers, 2007; Williams and O'Reilly III, 1998). Individuals tend to consider themselves and others as either in-group or out-group members, giving preferential treatment to the in-group and making it difficult for out-group members to join these groups (Tajfel and Turner, 2004). A board is an elite group of directors who share power and act as a socially cohesive group (Westphal and Zajac, 1995; Windolf, 1998). Nonetheless, Izraeli (2000) comments that women are likely to take the role seriously, preparing conscientiously for meetings, a finding echoed by (Huse and Solberg, 2006). Female directors ask more questions than their male counterparts, meaning that decisions are less likely to be nodded through. Therefore, board diversity can be perceived negatively by the board as being more conflictual, having trouble communicating and splitting into factions. Overall, the ties between CEOs and directors may encourage boards to keep their elite group closed to avoid the challenges brought by female directors (Bertrand and Mullainathan, 2003). Accordingly, we expect that a fraction of directors socially connected with the CEOs would be associated with lower female director representation.

Our alternative stand favours the bright side of CEO-director ties and predicts that socially connected boards improve BGD. Based on a *resource dependence* framework, we argue that the board of directors is responsible for providing strategic oversight and securing resources from the organizational environment (Hillman et al., 2000; Johnson et al., 1996). Pfeffer and Salancik (2003) contend that directors bring four benefits to corporations: advice and counsel, access to information, preferential access to resources and legitimacy. It is argued that the connection among individuals within the board of directors "facilitates the acquisition of resources critical to the firm's success" (Johnson et al., 1996, p. 411) and enables them to act as a bridge to important constituencies in the external environment, resulting in greater access to more talent (Reddy and Jadhav, 2019). Especially, channelling valuable resources can be the focus of socially connected directors who face extra shareholders' scrutiny because of their connection with the CEOs. This is because appointing women to boards signals legitimacy and adherence to social values by conveying unobservable information to stakeholders (Broome and Krawiec, 2008), obedience to corporate governance best practices and avoidance of fraudulent activities or short-sighted decisions. Echoing this, Brown et al. (2002) comment that Canadian institutional shareholders are interested in board diversity, as they prefer to invest in firms with sound governance. From another angle, Cai et al. (2022) find that the connections between appointee and the existing board promote resource inflow, thus increasing the presence of female directors on the board. Overall, recruiting female directors could be an effective solution to please the public, given the increasing external normative pressures from investors and gender equity advocates on firms to meet gender equality targets.

Studies utilising the *human capital* perspective examine what female directors bring to the boardroom to argue that female directors are a valuable resource (Jensen, 2010). Even though male directors generally have more experience financially and managerially, female directors are more likely to have obtained advanced degrees and other desirable qualifications (Hillman et al., 2002; Terjesen et al., 2008). Previous studies have also argued that female leaders promote a leadership style that emphasises trust, cooperation and information exchange (Cohen et al., 1998). In the same vein, prominent studies (Adams and Ferreira, 2009; Barber and Odean, 2001; Croson and Gneezy, 2009) posit that female directors tend to approach risk-propensity in a more comprehensive manner than their male counterparts. In fact, women bring diverse perspectives, experience and networks to the table, which leads to higher board oversight ability and effectiveness (Nielsen and Huse, 2010; Post and Byron, 2015; Wahid, 2019), and they design policies that benefit multiple stakeholders (Gul et al., 2011). Further, the promotion of women to strategic positions in management sends important positive signals to the product and labour markets that a corporation values the success of its women, thus helping achieve legitimacy (Bilimoria, 2000). Analogously, it can be argued that the presence of socially connected directors encourages the board to acquire resources valuable to the firm, thereby actively seeking talented female directors.

Taken together, competing theoretical views and conflicting empirical evidence concerning the impact of CEO-director ties on BGD provide deviating predictions and a useful setting to investigate the following non-directional hypothesis:

H1. : Ceteris paribus, CEO-director ties are likely to be associated with BGD.

3. Sample and methodology

3.1. Sample selection

We obtained corporate governance data from the BoardEx database for the period from 2003 to 2018. The data for the study consisted of current and past employment, job title, corporate board membership and educational background (institutions, graduation years and degrees). We calculated the number of ties each CEO had to other board members, which allowed us to create a continuous measure of CEO-director ties as the percentage of the board members with whom the CEO had a connection. We matched this CEO-ties data and corporate governance data with the data relating to the number of female directors based on the company sample. The data related to female directors we obtained from BoardEx, while the firm-level accounting variables were collected from Compustat. After merging the datasets, we removed observations that contained missing variable information necessary for the regression. The final sample consisted of 51,176 firm-year observations. The distribution of firms across industry classifications based on Compustat Standard Industrial Classification (SIC) are un-tabulated to conserve space.

3.2. Variable measurements

The main independent variable of interest in this study is CEO-director ties. Following Fracassi and Tate (2012) and Khedmati et al. (2019), we construct a comprehensive measure that encompasses all of the existing and past connections between CEOs and independent directors. The employment ties (PTIEEMP) are based on prior employment in any firm other than the firm for which the CEO is currently working, irrespective of his/her roles. Current employment ties capture any external directorships the CEO and the independent director hold in the same firm. Additionally, educational ties (PTIEEDU) determine the ties between the CEO and a director when they graduate from the same educational institution. Finally, other ties (PTIEOTHER) captures if CEOs and directors share memberships of social organisations, such as golf clubs, charities, trusts and or other non-professional or voluntary associations, either currently or in the past. We follow Khedmati et al. (2019) to construct the collective measure of CEO-director ties (PTIES) as the percentage of independent directors who have at least one linkage with the CEO based on education, employment or other friendship activities.

We use several multifaceted measures of the number and fraction of female directors on the boards as our proxies for BGD. The main dependent variable for BGD is the dummy variable (DFDIR) which takes the value of one if a firm has a gender-diverse board and zero otherwise. We also use alternative measures of BGD, including the percentage of female directors on the board (PFDIR), appointment of female directors (FAPPOINT), number of (non)executive female directors (NEXECFDIR) and the number of (non)independent female directors (NINDFDIR). We

include several control variables, including the governance variables (board size, time on board and network size) and financial characteristics (leverage, cash holdings, return on assets, natural logarithm of market capitalization, number of analysts and sales growth) of sample firms.

3.3. Analytical models

To investigate our hypothesis on the influence of CEO-director ties on firms' BGD, we employ binary logit regression to estimate the following regression model:

$$\theta_{it} = \Pr(\text{DFDIR}_{it} = 1 | \text{Observed variables}) = \Pr(\alpha\beta_0 + \beta_1 PTIES_{it} + \beta_2 BLEV_{it} + \beta_3 CASH_{it} + \beta_4 ROA_{it} + \beta_5 MCAP_{it} + \beta_6 ANALYSTS_{it} + \beta_7 SALE_{it} + \beta_8 NETWORKSIZE_{it} + \beta_9 TIME\_ON\_BOARD_{it} + \beta_{10} BDSIZE_{it} + \sum Year + \sum Industry + \varepsilon_{it}), \quad (1)$$

where $DFDIR_{it}$ is a binary variable representing the gender diversity status of the firm's board and takes the value of one if the board is gender diverse, and zero otherwise.

The main proxy for CEO-director ties ($PTIES_{it}$) is the percentage of independent directors that have either employment ties, educational ties or friendship ties with the CEO at the end of the year prior to the year of the 10-K filling. We also control for a range of variables mechanically correlated to BGD, in addition to our variable of interest. We control for market capitalization (MCAP), leverage (LEV), cash holdings (CASH), profitability (ROA) for capturing firm's financial position and performance. For firms' governance, we control for board size (BDSIZE), measured as the logarithm of the total number of directors on the board and the average time of directors on the board (TIME_ON_BOARD) We control for the size of the network (NETWORKSIZE) to capture the ability of participants to access information and resources from their social and professional structures (Adler and Kwon, 2002; Ginesti et al., 2017). Finally, we control for year and industry effects to account for the

Table 1
Descriptive statistics.

	Mean	Std. Dev.	Min	Median	Max
Panel A: Dependent and independent variables					
DFDIR	0.3014	0.4583	0.0000	0.0000	1.0000
PFDIR	0.1253	0.1628	0.0000	0.1000	2.7000
FAPPOINT	0.0891	0.2849	0.0000	0.0000	1.0000
EXECFDIR	0.0230	0.0722	0.0000	0.0000	2.4000
NEXECFDIR	0.1023	0.1373	-0.4286	0.0833	2.6667
INDFDIR	0.0910	0.1289	0.0000	0.0000	2.6667
NINDFDIR	0.0343	0.0899	-0.7500	0.0000	2.4000
PTIEALL	0.2254	0.2951	0.0000	0.1111	1.0000
PTIEEDU	0.0050	0.0346	0.0000	0.0000	1.0000
PTIEEMP	0.1658	0.2824	0.0000	0.0000	1.0000
Panel B: Firm characteristics					
BLEV	0.2705	1.6756	0.0000	0.1716	280.3359
CASH	0.1883	0.2201	0.0000	0.0952	1.0000
ROA	0.0050	1.1284	-20.3000	0.0002	210.9500
MCAP*	4300.5690	19162.9400	0.0013	482.6794	790050.1000
ANALYSTS	1.4999	1.0421	0.0000	1.6094	4.0254
SALE	5.7563	2.4016	-6.9078	5.8910	13.0889
Panel C: Governance characteristics					
NETWORKSIZE	9.0063	1.0932	1.3863	9.1165	13.1202
TIME_ON_BOARD	7.0844	4.6353	0.0000	6.3000	44.5000
BDSIZE	8.3869	2.6062	1.0000	8.0000	33.0000
CEO_DUALITY	0.5125	0.4998	0.0000	1.0000	1.0000
CEO_AGE*	67.3892	8.6003	21.0000	67.0000	101.0000
CEO_TENURE	4.4871	3.4305	1.0000	3.0000	19.0000
CEO_TURNOVER	0.1850	0.3883	0.0000	0.0000	1.0000
CEO_RELIG	0.7845	0.4112	0.0000	1.0000	1.0000
FEMALE_CEO	0.0301	0.1709	0.0000	0.0000	1.0000
INSTO	0.4104	0.3858	0.0000	0.3739	18.6971
CSR	0.4535	2.2482	-9.0000	0.0000	18.0000
EINDEX	1.1938	1.8370	0.0000	0.0000	6.0000
NANALYSTS	1.4999	1.0421	0.0000	1.6094	4.0254
Panel D: Female attributes and role					
FNETWORKSIZE	7.2642	1.5806	0.6931	7.5175	11.8353
FIVY	0.3792	0.8031	0.0000	0.0000	16.0000
FCFA	0.0060	0.0891	0.0000	0.0000	2.0000
FCPA	0.1771	0.5236	0.0000	0.0000	12.0000
FMAEXP	0.1104	0.5795	0.0000	0.0000	12.0000
FFINEXP	0.8764	1.3508	0.0000	1.0000	36.0000
FINDEXP	0.4295	0.7589	0.0000	0.0000	12.0000
FACCEXP	0.0978	0.5117	0.0000	0.0000	15.0000
FLEGALEXP	0.3088	0.6618	0.0000	0.0000	9.0000
FMGREXP	0.9481	1.2017	0.0000	1.0000	30.0000
FACADEXP	0.2174	0.7493	0.0000	0.0000	21.0000
Panel E: Instruments and additional variables					
DACQ	0.1711	0.0803	0.0000	0.0000	1.0000
CEO_DEATH	0.0007	0.0260	0.0000	0.0000	1.0000
CEO_TURNOVER	0.0901	0.2863	0.0000	0.0000	1.0000
CEO_DEPARTURE	0.0194	0.2437	0.0000	0.0000	4.0000

This table presents the descriptive statistics for the main dependent and independent variables in Panel A, firm characteristics control variables in Panel B, governance characteristics in Panel C, female attributes and role in Panel D and instruments and additional variables in Panel E. We provide variables definitions in the Appendix.
*We use log values of MCAP and CEO_AGE in analysis.

influences stemming from year-specific and industry-specific factors. We provide a description of the variables in the Appendix.

We also run four alternative models with the given set of control variables. First, we run the linear probability model with firm fixed effect to control for time invariant firm characteristics. Second, we replace the main independent variable ($PTIEALL_{i,t}$) in Eq. (1) with the one-period lagged values of annual change in CEO-director ties ($\Delta PTIEALL_{i,t-1}$). Third, we run a panel regression logit model with firm fixed effects. Under this model, industry fixed effects are dropped from the Eq. (1) to avoid collinearity. Finally, we employ the Fama and MacBeth (1973) approach to control for the potential cross-sectional correlation of the regression residuals.

4. Analyses and results

4.1. Descriptive statistics

Table 1 reports descriptive statistics for the variables used in this study. In Panel A, the mean of the gender diversity dummy is 0.30, indicating that around 30% of firms in the sample database have gender-diverse boards. The mean percentage of female directors on the board is 0.12. Generally, female directors on boards are more likely to be non-executive (10.23%) and independent directors (0. 91%) than executive (0.23%) and non-independent directors (0. 34%). The CEO connects with 22.54% of the independent members of the board on average, which is made up of 16.58% of employment ties and 0.50% of educational ties. These are similar to that of prior studies (Fan et al., 2019; Khanna et al., 2015).

Panel B reports the financial statistics of the firms. In our sample, a typical firm has a market capitalization of $4.3 million, 18.83% of cash holding, a leverage ratio of 27.05% and makes 0.50% of ROA. Turning to corporate governance in Panel C, the average board size in our sample is about eight directors with each serving around seven years on the board. The mean (median) logarithm network size between CEO and outside director is 9.00 (9.11). Female attributes and roles are reported in Panel D. Average network size of firms' female directors on the board is 7.26, while the maximum number of female directors on the board with IVY league education averages to 0.38. Finally, Panel E presents additional instrumental variables used in our analysis. It reports that there are 17.11% of our sample involved in M&A deals, 0.07% experiencing CEO death, 9.01% and 1.94% record CEO turnover and CEO departure because of other reasons, respectively.

4.2. CEO-director ties and board gender diversity

We estimate Model 1 to test our hypothesis, and the results are presented in columns 1–5 of Table 2. The standard errors were adjusted for heteroscedasticity and clustered at the firm level. We also include a range of control variables and dummy variables for industry and year effects in columns 2, 4 and 5 and year effects along with firm fixed effects in columns 1 and 3. In all specifications in Table 2, the coefficients on our main variable of interest are negative and significant. For example, in columns 1 and 2, the coefficients on PTIEALL are negative (−0.5104 and −0.2184, respectively) and significant at 1% (p-value = 0.00). In column 4, where CEO-director ties are measured by $\Delta PTIEALL_{t-1}$, we find qualitatively similar results (coefficient = −0.0135, p-value = 0.00). This suggests that PTIEALL is significantly negative with BGD. Our results also have economic significance. For instance, if CEO-director ties increase by one standard deviation (standard deviation = 0.2951 in Table 1), the probability that the firm has at least one female director on the board decreases relative to its sample mean (standard deviation = 0.4583 in Table 1) by 33.37% ([0.5184 ×0.2951]/ 0.4583).

Table 2
CEO-director ties and appointment of female directors: Baseline regression models.

	(1) FE Logit DV=DFDIR	(2) Logit DV=DFDIR	(3) LPM DV=DFDIR	(4) ΔModel DV= ΔPFDIR	(5) Fama-McBeth DV=DFDIR
PTIEALL	-0.5104 * **	-0.2184 * **	-0.0226 * **	-	-0.0435 * *
	(0.00)	(0.00)	(0.00)		(0.04)
$\Delta PTIEALL_{t-1}$	-	-	-	-0.0135 * **	-
				(0.00)	
LEV	-0.5125 * **	-0.0991 * *	0.0006	-0.0001	-0.0192
	(0.00)	(0.02)	(0.57)	(0.59)	(0.22)
CASH	0.1681	-0.2405 * **	-0.0443 * **	-0.0035	-0.0073
	(0.48)	(0.00)	(0.00)	(0.15)	(0.81)
ROA	2.1043	-0.0140	-0.0011	-0.0003	7.6818
	(0.64)	(0.74)	(0.45)	(0.41)	(0.20)
MCAP	0.0852 * *	0.0827 * **	0.0173 * **	0.0003	-0.0019
	(0.03)	(0.00)	(0.00)	(0.51)	(0.90)
ANALYSTS	0.1500 * **	-0.0215	-0.0070 * *	0.0036 * **	0.0095
	(0.00)	(0.26)	(0.01)	(0.00)	(0.47)
SALE	-0.0129	0.0177 *	0.0041 * **	-0.0001	0.0131 *
	(0.75)	(0.10)	(0.00)	(0.84)	(0.07)
NETWORKSIZE	1.0672 * **	0.8736 * **	0.0999 * **	0.0050 * **	0.1014 * **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TIME_ON_BOARD	-0.0081	0.0042	-0.0009 * *	0.0003 * **	0.0009
	(0.34)	(0.14)	(0.02)	(0.00)	(0.42)
BDSIZE	0.4294 * **	0.2546 * **	0.0432 * **	0.0002	0.0481 * **
	(0.00)	(0.00)	(0.00)	(0.29)	(0.00)
Constant	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	No	Yes	No	Yes	Yes
Firm fixed effects	Yes	No	Yes	No	No
R^2	0.2067	0.2537	0.2451	0.0222	0.2546
N	51,176	51,176	51,176	51,176	51,176

This table presents the regression results of CEO-director ties and BGD with other control variables. Model 1 presents the logit model; Model 2 presents the linear probability model (LPM); Model 3 presents the model with annual change in CEO-director ties (ΔPTIEALL) as independent variable; Model 4 presents panel regression logit model with firm fixed effects; Model 5 presents two-stage Fama and MacBeth (1973) model. P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively. We present the variable definitions in the Appendix.

These findings, therefore, provide strong support for H1. Compared to Cai et al. (2022) who report a positive impact of connection between successful director candidates and the incumbent board on BGD, we provide new evidence on how BGD is affected by another type of connection, namely the ties between CEO and incumbent board. Cai et al. (2022) prove that successful candidate – incumbent board connection acts as a bridge to enable resources and human capital inflow, whereas our findings picturise the barrier made by CEO-director linkage that challenges female director access to a management role. Our results are consistent with the agency and social identity theoretical predictions that as director ties are associated with agency costs and the board is considered to be an elite group, the presence of socially connected directors – due to their concerns about self-interest and being reluctant to foster female director representation – leads to gender disparity in the boardroom.

Regarding the control variables, we find some evidence that firms with higher cash and debt are associated with lower female director representation, as the coefficient estimates on CASH and LEV are negative and significant. Conversely, larger firms by market capitalization and high-growth firms by sales are associated with better BGD, as the coefficient estimates on MCAP and SALE are positive and statistically significant. In terms of corporate governance, firms with a larger board size and larger network size and with more analysts following are more gender diverse.

4.3. Endogeneity correction

We now take into account that endogeneity biases often plague the relationship between corporate board dynamics and corporate performance because of the black-box nature of corporate boards (Baghdadi et al., 2020; Jain and Jamali, 2016). One must address the issue of causation in the board connection and corporate gender diversity nexus when asserting a correlation (Wintoki et al., 2012). In this study, we recognize three potential sources of endogeneity: self-selection bias, omitted variable bias and a multicollinearity problem. First, in situations where a female director's appointment is not random, self-selection bias is likely to occur. This tendency can be explained through a demand- and supply-side framework (Sila et al., 2016). The demand-side argument suggests that riskier firms or firms in need of legitimacy may appoint more female directors. A supply-side argument suggests that women, who by nature of their gender may be more risk-averse than men, may self-select themselves onto the boards of particular firms, making directors' appointments a non-random process (Sila et al., 2016). Second, although we have included a comprehensive set of control variables in our main models to mitigate the effects of omitted variable bias, it is possible that some other variables might influence our model's results. For example, corporate culture, a relatively difficult-to-observe phenomenon, may drive both BGD orientation (Carrasco et al., 2015; Sila et al., 2016) and board social connection (Davidson et al., 2015). Third, the high-dimensionality regression models used in our study include explanatory variables which can be prone to a multicollinearity problem that could potentially blur the results (Belloni et al., 2017; Tibshirani, 1996). Therefore, we follow prior studies (Carrasco et al., 2015; Sila et al., 2016; Wintoki et al., 2012) and implement three relatively more sophisticated estimators, namely, the PSM, Lasso selection model and instrumental variable 2SLS regression to account for endogeneity concerns.

4.3.1. Propensity score matching approach

We employ a PSM analysis to control for the difference in observable firm-related characteristics and the potential functional misspecification (Armstrong et al., 2010; Rosenbaum and Rubin, 1983). To conduct our PSM analysis, we define firms whose proportion of independent directors who are socially connected with the CEO above the industry and year median value as the treatment group. The control firms are those whose ratio is below the cut-off point. To ensure that our treated and control firms are comparable, we match treatment and control firms using a PSM procedure, where we utilise the nearest neighbour with replacement matching. The matching is undertaken based on all control variables that are used in the baseline regressions in Table 2. We report the results in Table 3. Panel A of Table 3 reports the univariate mean comparisons between treatment and control firms' characteristics and their corresponding t-statistics. The results demonstrate that the average values of most of the matching variables are qualitatively similar across the treatment and control firms. The average value of the female director representation measure (DFDIR), however, is found to be significantly different between the treatment and control firms. To examine whether

Table 3
Propensity score matching analysis. Panel A: Mean differences between control and matched groups.

	High PTIEALL (treated group)	Low PTIEALL (control group)	**Difference test**	
	Mean	Mean	*t*-statistic	*P*-value
DFDIR	0.2904	0.3497	-14.62	0.00
LEV	0.2459	0.2549	-1.41	0.16
CASH	0.1805	0.1812	-0.40	0.69
ROA	-0.0006	-0.0024	2.00	0.05
MCAP	6.5599	6.5647	-0.25	0.80
ANALYSTS	1.6445	1.6447	-0.02	0.98
SALE	5.9537	5.9613	-0.35	0.73
NETWORKSIZE	9.1496	9.1588	-1.00	0.32
TIME_ON_BOARD	6.6105	6.7074	-2.62	0.01
BDSIZE	8.8065	8.7864	0.86	0.39

Panel B: Propensity score matching regression results

	First stage	**Second stage**
	(1)	**(4)**
	DV=DPTIEALL	**DV=DFDIR**
DPTIEALL	-	-0.0019 * *
		(0.0007)
LEV	-0.0746 * **	0.0007
	(0.0172)	(0.0009)
CASH	-0.6016 * **	-0.0240 * **
	(0.0523)	(0.0044)
ROA	-0.0136	0.0001
	(0.0146)	(0.0069)
MCAP	0.1995 * **	0.0037 * **
	(0.0096)	(0.0008)
ANALYSTS	0.0195	-0.0034 * **
	(0.0152)	(0.0013)
SALE	-0.1693 * **	0.0031 * **
	(0.0076)	(0.0006)
NETWORKSIZE	0.0657 * **	0.0463 * **
	(0.0115)	(0.0010)
TIME_ON_BOARD	-0.0414 * **	0.0008 * **
	(0.0022)	(0.0002)
BDSIZE	0.1277 * **	0.0048 * **
	(0.0049)	(0.0004)
CONSTANT	-59.6533 * **	-0.3829 * **
	(4.5940)	(0.0084)
Year Fixed Effects	Yes	Yes
Industry Fixed Effects	Yes	Yes
Pseudo R^2 / R^2	0.0734	0.1629
N	51,176	37,134

This table presents the propensity score matching results of CEO-director ties and BGD with other control variables. Panel A reports the mean differences of dependent and independent variables between the control group and matched group. Panel B reports the regression estimates using these two groups. Standard errors are in parenthesis. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

this variation is due to the presence of CEO-director ties, we perform PSM regressions using the post-matched sample in Panel B of Table 3 (coefficient = −0.0019, p < 0.00). The results indicate that the presence of socially connected directors increases the propensity of BGD. These findings are consistent with our baseline results, showing that firms with directors socially connected to the CEOs promote female director representation on the board.

4.3.2. Model selection through the Lasso method

We employ the machine learning method of the least absolute shrinkage and selection operator (lasso) for strengthening the baseline regression models. This method provides a more robust analysis that allows for finding the important variables in a large set of potential determinants (Belloni et al., 2017; Tibshirani, 1996). The method makes the results easier to interpret, resolves the problem of multicollinearity and provides a narrow set of important variables by shrinking the regression coefficients. The criteria for shrinkage of the coefficients are based on the factor which penalizes their magnitude (Meinshausen and Yu, 2009).

However, one should note that Lasso models are inherently selection models. This group of models select covariates and estimates coefficients without providing standard errors (Bühlmann and Van De Geer, 2011). Accordingly, we employ a double-selection Lasso method (modified version of the Lasso model) for inference and to derive the standard errors, as well as the significance of the coefficients in this study. The double-selection method uses selected control variables in the inference model to estimate effects for variables of interest (Belloni et al., 2014).

We present three models based on the Lasso selection method in Table 4, Panel A, for CEO-director ties and BGD. Three different types of Lasso selection models (adaptive Lasso, cross-validation and plug-in methods) were used for the selection of the control variables. We observe that most of the variables of interest report similar coefficients to baseline regression. Most of the explanatory variables also hold their respective coefficient signs in the Lasso selection model. Therefore, we can conclude that the selection of variables is well justified and does not significantly affect the impact of CEO-director ties on BGD.

Panel B of Table 4 presents Lasso inference models based on double-selection Lasso logistic regression. Control variables are selected by the Lasso model for the variables of interest to be included in the model. Adaptive, cross-validation and plug-in methods are used for Models (1−3), respectively, within the double-selection inference. One should note that double selection does not provide estimates of the coefficients on the control variables or their standard errors (Belloni et al., 2014). Therefore, no estimation results can be reported for the control variables. However, all of the three Lasso inference models report significantly negative coefficients, which supports the findings of baseline regression results.

Table 4
Lasso selection models.

Panel A: Lasso selection models			
	(1)	(2)	(3)
	DV=DFDIR		
PTIEALL	-0.6250	-0.6757	-0.2619
LEV	0.0048	X	0.0147
CASH	0.1477	0.1555	0.0953
ROA	0.0680	0.0694	0.0598
MCAP	0.8387	0.8584	0.7508
ANALYSTS	X	0.2454	X
SALE	-0.0496	-0.0360	X
NETWORKSIZE	0.1923	0.1936	0.1167
TIME_ON_BOARD	-0.1500	-0.1586	X
BDSIZE	0.2405	X	0.2167
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
N	51,176	51,176	51,176
Panel B: Lasso inference models			
	(1)	(2)	(3)
	DV=DFDIR		
PTIEALL	-0.6979***	-0.6978***	-0.6969***
	(0.00)	(0.00)	(0.00)
Controls	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes
N	51,176	51,176	51,176

This table presents the results of the Lasso selection model for CEO-director ties and BGD. The Lasso model selection method (Panel A) is used to estimate effects for potential independent and control variables to be included in the model. Model 1 uses adaptive Lasso selection model; Model 2Lasso selection model with cross-validation method (CV); Model 3 employs plug-in method. Omitted variables by the Lasso selection are denoted as (X). Panel B presents Lasso inference models based on double-selection Lasso logistic regression.

4.3.3. Instrumental variables: M&A deals, CEO turnover, CEO death and CEO departure

We employ 2SLS regression to address endogeneity concerns arising from omitted unobservable variables that are correlated with CEO-director ties which can also affect BGD. We follow prior studies (Cai et al., 2022; Fracassi and Tate, 2012) to exploit exogenous shocks that can significantly change CEO-director ties, namely M&A deals, CEO death and CEO turnover. We also create the unified CEO departure score to comprehensively consider all types of CEO departures for different reasons, including death, illness, job performance and other dismissals due to personal issues such as CEO's violation of company HR policy or expense account cheating. It is expected that recent M&A deals lead to CEO-director ties expansion, whereas CEO death, CEO turnover and CEO departure result in network contraction (Cai et al., 2022; Fracassi and Tate, 2012), thus causing disruptions to the existing barrier to BGD. We identify these four types of events in the previous year and calculate the difference in CEO-director ties in the reporting year. Such events either increase or decrease CEO-director ties (the endogenous regressor) because it is unlikely that firms can immediately replace existing tied CEO and directors with equally linked new CEO and directors (Fracassi and Tate, 2012). However, these variables cannot be expected to have a direct link to BGD (the error term) except through the expansion or contraction director network. Therefore, M&A deals, CEO death, CEO turnover and CEO departure meet the exclusion condition and can be considered as strong and valid candidates for instrumental variables. We then implement 2SLS in the change in CEO-director ties and BGD regressions with four instrumental variables that capture exogenous shocks to the linkages between CEO and board members.

Table 5 reports the first-stage and second-stage regression results. In the first stage, we regress change in CEO-director ties (ΔPTIEALL) in the current year on four exogenous events of the previous year ($DACQ_{t-1}$, CEO_DEATH_{t-1}, $CEO\_TURNOVER_{t-1}$ and $CEO\_DEPARTURE_{t-1}$) with control variables from Eq. 1. The results of the first-stage regression shows that the M&A variable enter the model with a positive coefficient on change CEO-director ties, confirming the predicted network gains due to M&A. In contrast, the coefficients of CEO death, CEO turnover and CEO departure are significantly negative, suggesting the network loss due to these events. For example, in terms of economic significance, a one standard deviation of CEO turnover results in a decrease in CEO-director ties of 2.69% ([−0.0278 ×0.2863]/ 0.2951). Considering the PTIEALL average values of 0.2254, this decrease can be considered economically important, thereby confirming the relevance of the instrument. The Kleibergen-Paap rk Wald F statistics for testing weak identification are significant (p-value = 0.00), providing sufficient statistical support for the validity our instruments.

We obtain the predicted value using the coefficients generated by the first-stage regression and use it ([IV]ΔPTIEALL) as the main variable of interest in the second-stage model. The results of the second stage in Table 5 show that the coefficients on all four measures of CEO-director ties (instrumented) are negative and statistically significant at the 10% level or lower. It is worth to note that the coefficients generated by these instrumented variables are in large magnitudes (−4.5343, −1.6130,

Table 5
Instrumental variables.

	Panel A: M&A		Panel B: CEO death		Panel C: CEO Turnover		Panel D: CEO departure	
	First Stage	Second Stage	First Stage	Second Stage	First Stage	Second Stage	First Stage	Second Stage
	DV= ΔPTIEALL	DV=DFDIR	DV= ΔPTIEALL	DV=DFDIR	DV= ΔPTIEALL	DV=DFDIR	DV= ΔPTIEALL	DV=DFDIR
[IV]ΔPTIEALL	-	-4.5343 *	-	-1.6130 *	-	-0.6405 * *	-	-1.0785 * *
		(0.08)		(0.09)		(0.04)		(0.01)
$DACQ_{t-1}$	0.0023 *	-	-	-	-	-	-	-
	(0.07)							
CEO_DEATH_{t-1}	-	-	-0.0238 * *	-	-	-	-	-
			(0.04)					
$CEO\_TURNOVER_{t-1}$	-	-	-	-	-0.0278 * **	-	-	-
					(0.00)			
$CEO\_DEPARTURE_{t-1}$	-	-	-	-	-	-	-0.0103 * **	-
							(0.00)	
LEV	-0.0028 * **	-0.0144	0.0014	-0.0052	0.0075	-0.0496	-0.0024 * **	0.0007
	(0.00)	(0.11)	(0.71)	(0.52)	(0.11)	(0.38)	(0.00)	(0.94)
CASH	-0.1077 * **	-0.3259 * **	-0.0029	-0.0676	0.0553	-0.3155 * **	-0.1030 * **	0.2538 * **
	(0.00)	(0.00)	(0.57)	(0.00)	(0.39)	(0.00)	(0.00)	(0.00)
ROA	-0.0012	-0.0115	0.1873	3.7115	1.3667 * **	24.3033 * **	-0.0012	-0.0047
	(0.25)	(0.54)	(0.76)	(0.00)	(0.03)	(0.01)	(0.24)	(0.80)
MCAP	0.0301	0.1151 * **	-0.0010	-0.0099	0.0209 * **	-0.0168	0.0286	-0.0448 * *
	(0.20)	(0.00)	(0.25)	(0.00)	(0.00)	(0.30)	(0.24)	(0.05)
ANALYSTS	-0.0069 * **	-0.0412 * **	0.0002	-0.0029	-0.0095 * **	-0.0519 * *	-0.0069 * **	-0.0025
	(0.00)	(0.00)	(0.89)	(0.00)	(0.00)	(0.02)	(0.00)	(0.85)
SALE	-0.0270 * **	-0.0381 *	0.0009	0.0148	-0.0013	0.1123 * **	-0.0268 * **	0.1125 * **
	(0.00)	(0.08)	(0.26)	(0.00)	(0.86)	(0.00)	(0.00)	(0.00)
NETWORKSIZE	-0.0104 * **	0.4213 * **	0.0006	0.0854	0.0022 * **	0.6076 * **	-0.0104 * **	0.4806 * **
	(0.00)	(0.00)	(0.00)	(0.29)	(0.05)	(0.00)	(0.00)	(0.00)
TIME_ON_BOARD	-0.0105 * **	-0.0233 * **	0.0007	0.0006	-0.0016 * **	-0.0156 * **	-0.0106 * **	0.0353 * **
	(0.00)	(0.01)	(0.02)	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)
BDSIZE	0.0152 * **	0.1774 * **	-0.0009	-0.0049	0.0072 * **	0.1148 * **	0.0151 * **	0.0936 * **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CONSTANT	0.0058 * **	-90.1888 * **	1.7627	0.0027	2.6102 * **	-59.6214 * **	0.0055 * **	-29.3158 * **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.2691	-			0.1412	-	0.2631	-
N	51,176	51,176	51,176	51,176	51,176	51,176	51,176	51,176
Weak identification test								
Kleibergen-Paap rk Wald *F* statistic	96.03	-	4.68	-	11.34	-	84.19	-
p-value	(0.00)		(0.00)		(0.00)		(0.00)	
Test of endogeneity: Wald chi-squared test of exogeneity								
χ^2 statistics	-	11.99	-	26.68	-	4.84	-	28.56
p-value		(0.00)		(0.00)		(0.03)		(0.00)

This table reports the endogeneity-corrected regression results by employing the probit model with instrumental variable. First-stage regression output uses the regression of change in CEO-director ties with the exogenous events, including M&A (DACQ) in Panel A, CEO turnover (CEO_TURNOVER) in Panel B, CEO death (CEO_DEATH) in Panel C and CEO total departure (CEO_DEPARTURE) in Panel D as instrumental variables with other control variable. In the second-stage regression output, BGD is regressed on the instrumentedCEO-director ties and other control variables. P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

−0.6405 and −1.0785 respectively for M&A deals, CEO death, CEO turnover and CEO departure). These results confirm that our main finding on the negative impact of CEO-director ties on BDG remains robust after accounting for the endogeneity concerns. Our Wald chi-squared test of exogeneity suggests significant incremental explanatory power contributed by our instrumental variable.

4.4. Additional analysis

4.4.1. Female director types

In our theoretical and empirical analyses so far, we have established that CEO-director ties deteriorate BGD. To corroborate that our observed relationship between CEO-director ties and BGD is not driven by the role of existing female directors, we identify two potential settings where biases are likely to exist when a firm has female directors who are executive, non-executive, independent and non-independent. These settings also account for the fact that while female independent directors may be better monitors, female executive directors have more influence over corporate policies due to their involvement in management and close proximity to business operations (Liu et al., 2014). Thus, to the extent that strict monitoring reduces managerial opportunism, we apply two strategies to replace our main dependent variable with (a) the percentage of executive and non-executive female directors and (b) the percentage of independent and non-independent female directors. The results are presented in Panel A and Panel B of Table 6 for strategies (a) and (b), respectively. The coefficients on our four dependent variables (EXECFDIR, NEXECFDIR, INDFDIR and NINDFDIR) are consistently negative, ranging from − 0.0238 to − 0.0074, and significant at the 1% level in all columns, suggesting that the relationship holds regardless of whether a female director is executive, non-executive, independent or non-independent.

4.4.2. Female director attributes

A recent study by Lara et al. (2017) reports that BGD only influences corporate policies (e.g., earnings management) in firms that discriminate against women in the access to directorships, suggesting that

Table 6
Female director types.

	Panel A: Executive and non-executive directors		Panel B: Independent and non-independent directors	
	(1) DV=EXECFDIR	(2) DV=NEXECFDIR	(3) DV=INDFDIR	(4) DV=NINDFDIR
PTIEALL	-0.0074 * **	-0.0238 * **	-0.0215 * **	-0.0097 * **
	(0.00)	(0.00)	(0.00)	(0.00)
LEV	0.0002	-0.0001	-0.0000	0.0002
	(0.22)	(0.85)	(0.88)	(0.36)
CASH	0.0037 * *	-0.0115 * **	-0.0090 * **	0.0013
	(0.02)	(0.00)	(0.00)	(0.53)
ROA	-0.0001	-0.0005	-0.0005	-0.0002
	(0.61)	(0.26)	(0.26)	(0.61)
MCAP	0.0006 * *	0.0024 * **	0.0021 * **	0.0010 * **
	(0.04)	(0.00)	(0.00)	(0.01)
ANALYSTS	0.0032 * **	0.0021 * *	0.0039 * **	0.0014 * *
	(0.00)	(0.01)	(0.00)	(0.02)
SALE	0.0009 * **	0.0028 * **	0.0032 * **	0.0005 *
	(0.00)	(0.00)	(0.00)	(0.10)
NETWORKSIZE	0.0084 * **	0.0310 * **	0.0273 * **	0.0120 * **
	(0.00)	(0.00)	(0.00)	(0.00)
TIME_ON_BOARD	0.0005 * **	-0.0002 *	-0.0004 * **	0.0007 * **
	(0.00)	(0.07)	(0.00)	(0.00)
BDSIZE	-0.0020 * **	0.0050 * **	0.0045 * **	-0.0015 * **
	(0.00)	(0.00)	(0.00)	(0.00)
CONSTANT	2.3845 * **	-9.6301 * **	-9.6375 * **	2.3918 * **
	(0.00)	(0.00)	(0.00)	(0.00)
Year Fixed Effects	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes
R^2	0.0341	0.1825	0.1812	0.0392
N	51,176	51,176	51,176	51,176

This table presents the CEO-director ties and BGD by female director types. Model 1 uses percentage of executive female directors (EXECFDIR), Model 2 non-executive female directors (NEXECFDIR), Model 3 independent female directors (INDFDIR) and Model 4 non-independent female directors (NINDFDIR) as dependent variables. P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

discriminate and non-discriminating firms provide different contexts in BGD research. We therefore, limit our sample to firms that have at least one female directors and explore among 15,360 firms years observation how female director attributes moderate the CEO-director ties and BGD relationship.

The existing literature claims that executive effectiveness reflects the ability and judgement that a manager brings to the company and these managerial abilities play an influential factor in the recruitment process (Withers et al., 2012). Following this argument, one would expect female director attributes to play a mediating role in the relationship between CEO-director ties and female director representation. To this end, we interact CEO-director ties with a wide range of female director attributes, including network size (FNETWORKSIZE), qualifications such as IVY league education (FIVY), CFA qualification (FCFA) and CPA qualification (FCPA), financial services industry experience (FFINEXP), experience in the same Fama-French 48 industry (FINDEXP), has a past M&A committee role (FMAEXP), past executive roles (FACCEXP), past legal roles (FLEGALEXP), past political roles (FPOLEXP), managerial experience (FMGREXP) and past academic experience (FACADEXP). In Table 7, all of our interaction terms show significant positive associations with female director representation on the board at the conventional and above levels. It appears that high-quality female directors play an efficient monitoring and advising role, which remedies the CEO-director ties and BGD relationship.

4.4.3. *The moderating role of CEO characteristics*

We have established that CEO-director ties are negatively related to female director representation; however, many studies highlight the influence of CEO characteristics on a firm's board gender orientation (Ahmadi et al., 2018; Benkraiem et al., 2017; Frye and Pham, 2018). Therefore, we next investigate the moderating effect of various CEO characteristics on the relationship between CEO-director ties and BGD. We first consider the role of a CEO's religion because religion makes individuals risk-averse and religious individuals are less likely to engage in unethical activities (Adhikari and Agrawal, 2016; Shu et al., 2012). We examine the impact of CEO power because "CEOs can be change agents for gender diversity in their organizations by hiring female top managers and pushing for better representation of women on boards" (Guldiken et al., 2019). We also consider CEO compensation because it is argued that greater CEO pay reflects CEO dominance in influencing a board's decisions (Bebchuk et al., 2002; Luong et al., 2021). Furthermore, a CEO who owns a substantial fraction of equity in the firm has substantial authority to influence important board decisions while reducing the influence exercised by other board members (Gunasekarage et al., 2020; Mio et al., 2016). Similarly, CEOs' age can contribute to board decisions through the experience they gain and the decision-making and communication skills they develop as they grow older and become mature (Huang et al., 2012). Finally, we find that CEO managerial ability is also negatively associated with BGD.

The results in Table 8 show that the coefficients of the interaction terms between CEO-director ties with CEO religion, CEO power and CEO age are positive and significant, while that of the interaction terms with CEO compensation and CEO ownership carry negative and significant coefficients on BGD which are significant at the 5% level or higher in all columns. Our findings indicate that CEO characteristics moderate the impact of CEO-director ties on female director representation.

4.4.4. *Cross-sectional analyses*

We next conduct a range of cross-sectional analyses on factors that could moderate the main relationship uncovered in the study. Prior studies report that BGD changes over time results (Li, 2023) during which low BGD period can be considered as a period of deterioration in public trust and confidence (Cumming et al., 2018; Cumming et al., 2015; Johnson et al., 2009). This raises the concern that high and low BGD periods may alter our baseline. Therefore, to account for this possible influence, we visualise how BDG evolves over time. Fig. 1 shows

Table 7
CEO-director ties and board gender diversity: Female director attributes.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
FNETWORKSIZE×PTIEALL	0.0001 * ** (0.00)	-	-	-	-	-	-	-	-	-	-
FIVY× PTIEALL	-	0.7391 * ** (0.00)	-	-	-	-	-	-	-	-	-
FCFA× PTIEALL	-	-	1.2262 * ** (0.00)	-	-	-	-	-	-	-	-
FCPA× PTIEALL	-	-	-	1.1363 * ** (0.00)	-	-	-	-	-	-	-
FMAEXP× PTIEALL	-	-	-	-	0.8071 * ** (0.00)	-	-	-	-	-	-
FFINEXP× PTIEALL	-	-	-	-	-	0.6350 * ** (0.00)	-	-	-	-	-
FINDEXP× PTIEALL	-	-	-	-	-	-	0.3595 * ** (0.00)	-	-	-	-
FACCEXP×PTIEALL	-	-	-	-	-	-	-	0.8133 * ** (0.00)	-	-	-
FLEGALEXP×PTIEALL	-	-	-	-	-	-	-	-	0.6476 * ** (0.00)	-	-
FMGREXP×PTIEALL	-	-	-	-	-	-	-	-	-	0.7574 * ** (0.00)	-
FACADEXP×PTIEALL	-	-	-	-	-	-	-	-	-	-	0.6331 * ** (0.00)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.0602	0.0782	0.0572	0.0580	0.0829	0.0658	0.0653	0.0615	0.0805	0.0566	0.0627
N	15,360	15,360	15,360	15,360	15,360	15,360	15,360	15,360	15,360	15,360	15,360

This table presents the regression results of mediating role of female director attributes in CEO-director ties and BGD. Female director attributes are proxied by various variables representing female directors' expertise, network size, education, experience and qualifications.

Table 8
The role of CEO characteristics.

	(1) DV=DFDIR	(2)	(3)	(4)	(5)
	Panel A: CEO Religion	Panel B: CEO Power	Panel C: CEO Compensation	Panel D: CEO Ownership	Panel E: CEO Age
PTIEALL	-0.3039 * ** (0.00)	-0.5174 * ** (0.00)	-0.3197 * ** (0.00)	-0.3368 * ** (0.00)	-0.6494 * ** (0.00)
CEO_RELIG	-0.1622 * ** (0.00)	-	-	-	-
PTIEALL×CEO_RELIG	0.2673 * * (0.01)	-	-	-	-
CEO_POWER	-	-0.0200 (0.39)	-	-	-
PTIEALL×CEO_POWER	-	0.3296 * ** (0.00)	-	-	-
CEO_TCOMP	-	-	0.3809 * ** (0.00)	-	-
PTIEALL×CEO_TCOMP	-	-	-0.1607 * (0.05)	-	-
CEO_OWNER	-	-	-	0.4093 * ** (0.00)	-
PTIEALL×CEO_ OWNER	-	-	-	-0.3469 * ** (0.00)	-
CEO_AGE	-	-	-	-	-0.0122 (0.62)
PTIEALL×CEO_AGE	-	-	-	-	0.5653 * ** (0.00)
Constant controls	Yes	Yes	Yes	Yes	Yes
Year & Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.2494	0.2903	0.2967	0.3003	0.2944
N	26,921	28,917	24,982	23,020	24,634

This table presents the role of CEO characteristics (CEO religion, power, compensation, ownership and age) in CEO-director ties and BGD. P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

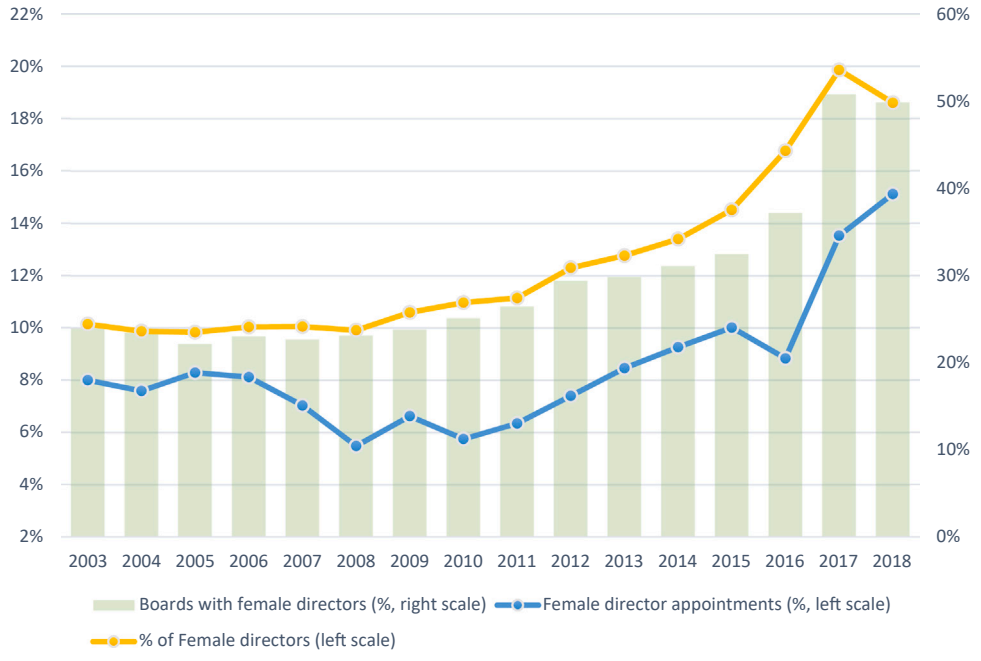

Fig. 1. Corporate board gender diversity (2003–2018). This graph presents the dynamics of corporate board gender diversity over time.

that the BGD increases gradually and becomes steeper during the later years. This observation motivates us to split our sample period into high and low BGD periods using the sample BGD median as the cut-off points. Next, we re-estimate Eq. (1) in these two subsamples. The results in Panel A of Table 10 show that CEO-director ties carry negative and significant coefficients on BGD which are significant at the 1% level in the low BGD period while being insignificant in the high BGD subsample. This makes a great deal of sense, as it supports our prediction that during a time when it is more challenging for women to enter the board room, the ties between CEO and board member will add another layer of barrier, which otherwise becomes more accessible during better times of board gender equality.

Table 9
Cross-sectional analyses.

	Panel A: High and low BGD periods		Panel B: CEO Gender		Panel C: Number of analysts		Panel D: Institutional ownership		Panel E: Level of CSR	
	Low Diversity (1) DV=DFDIR	High Diversity (2) DV=DFDIR	Female CEO (3) DV=DFDIR	Male CEO (4) DV=DFDIR	Low number of Analysts (5) DV=DFDIR	High number of Analysts (6) DV=DFDIR	Low INSTO (7) DV=DFDIR	High INSTO (8) DV=DFDIR	Low Diversity (9) DV=DFDIR	High Diversity (10) DV=DFDIR
PTIEALL	-0.0252 * **	-0.0057	0.0910	-0.2802 * **	-0.8219 * **	-0.7172 * **	-1.2536 * **	-0.8272 * **	-0.6148 * **	-0.3621 * **
	(0.00)	(0.17)	(0.56)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Diff in coeff. and χ^2	4.29 * *		6.42 * *		8.75 * **		32.01 * **		319.00 * **	
	(0.04)		(0.01)		(0.00)		(0.00)		(0.00)	
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FF	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FF	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.2597	0.1464	0.2637	0.2582	0.1643	0.2491	0.2871	0.2611	0.2171	0.2901
N	23,865	27,305	1590	49,161	27,708	23,466	25,588	23,540	18,967	32,211

This table presents the cross-sectional analysis of CEO-director ties and BGD by high and low gender diversity periods (Panel A), CEO gender (Panel B), high and low number of analysts following (Panel C), high and low institutional shareholdings (Panel D) and corporate social responsibility (Panel E). P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

Table 10
Industry lifecycle.

	(1) DV=DFDIR	(2)	(3)	(4)	(5)
	Panel A: Introduction st.	Panel B: Growth st.	Panel C: Maturity st.	Panel D: Shakeout st.	Panel E: Decline st.
PTIEALL	-0.5688 * **	-0.2674 * **	-0.1491	-0.7037 * **	-0.2397 *
	(0.00)	(0.00)	(0.42)	(0.00)	(0.09)
LEV	-0.3570 * **	-0.4199 * **	-0.3643 * **	-0.4101 * **	0.0170 * *
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
CASH	0.3016 *	-0.2165	-0.1926	-0.7019 * **	-0.6379 * **
	(0.06)	(0.13)	(0.34)	(0.00)	(0.00)
ROA	-0.0089	-0.3550	4.5638	-4.9367	-0.0829
	(0.82)	(0.96)	(0.43)	(0.76)	(0.95)
MCAP	0.0332	0.0356	0.0076	0.0392 * *	0.0085
	(0.31)	(0.13)	(0.85)	(0.05)	(0.80)
ANALYSTS	0.0778	-0.2230 * **	0.1540 * *	-0.0628 * *	-0.0749
	(0.18)	(0.00)	(0.03)	(0.02)	(0.17)
SALE	0.0462 * *	0.2330 * **	-0.0895 * **	0.1404 * **	0.1483 * **
	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)
NETWORKSIZE	0.8802 * **	1.0534 * **	1.1809 * **	1.0106 * **	1.1280 * **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
TIME_ON_BOARD	-0.0263 * *	0.0114 * *	-0.0209 *	0.0105 * **	-0.0214 * *
	(0.01)	(0.04)	(0.08)	(0.01)	(0.01)
BDSIZE	0.2157 * **	0.1804 * **	0.1582 * **	0.2152 * **	0.1607 * **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
CONSTANT	-85.9504 * **	-60.4480 * **	-116.1212 * **	-122.6313 * **	-54.4675 * **
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
R^2	0.1703	0.2286	0.1843	0.2637	0.2722
N	7657	15,770	4673	24,980	6630

This table presents the CEO-director ties and BGD in different industry lifecycle stages. P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

Second, considering prior evidence that boards of female CEOs are structured for more monitoring (Ahmadi et al., 2018; Benkraiem et al., 2017; Frye and Pham, 2018), we empirically examine the role of CEO gender on our baseline findings. Panel A of Table 9 reports the results on the CEO gender moderator. We find that the coefficient of the PTIEALL variable is negative and significant at the 1% level for the male CEO subsample while being positive but insignificant for the female CEO subsample. Additionally, the magnitudes of PTIEALL coefficients are much larger for the male CEO group. This finding implies that the negative influence of CEO-director ties on BGD is more pronounced for companies led by male CEOs.

Third, prior studies suggest that the number of analysts following (Brennan and Subrahmanyam, 1995; Guay et al., 2016; Lang and Stice-Lawrence, 2015), institutional ownership (Edmans and Holderness, 2017) and corporate social responsibility (CSR) (Buchanan et al., 2018) have differential impacts on firms with varying levels of overall governance quality. To test these arguments empirically, we split our sample into subgroups of firms with high and low number of analysts following, high and low institutional ownership, and high and low level of CSR. We re-estimate Eq. (1) for each and present results in Panel C, D

and E of Table 9. In Panel C, we find that the coefficients on BGD proxies for firms with a lower number of analysts following are more pronounced than that in the counter-sample (coefficient = −0.8422 and −0.7179, respectively) and the difference is significant at the 1% level ($p < 0.01$). Panel D reports that the coefficients of CEO-director ties on BGD are more negative in the low level of the CSR subsample, meaning that the CEO-director ties and BGD relationship is more pronounced when there is less commitment to CSR. Therefore, we conclude that CSR appears to reduce the impact of CEO-director ties on BGD. We find similar results in Panel E, evidencing that the CEO-director ties and BGD relationship is more pronounced in the low institutional ownership sample. Considering the number of analysts following, the level of CSR and institutional ownership as governance mechanisms, these results suggest that socially connected directors serve as a substitution for weak governance concerning BGD.

4.4.5. Does industry lifecycle matter?

A potentially confounding factor related to our investigation of the relation between CEO-director ties and BGD is that the lifecycle of a corporation has significant implications for corporate performance, financing and investment policies, risk-taking incentives, resources, competition, internal and external complexities, capabilities, strategies and structures (DeAngelo et al., 2010; Dickinson, 2011), risk-taking (Habib and Hasan, 2017) and a firm's strategy for growth and productivity (Irvine et al., 2016). It has been established that female directors are more prevalent in smaller firms (Martin et al., 2008). Therefore, we anticipate that the negative impact of CEO-director ties varies according to industry lifecycle. To empirically test our prediction, we follow prior studies (Gort and Klepper, 1982) to classify and split our sample into five groups. The first stage is the introduction stage, where firms focus on introducing new products and services to their markets. In the growth stage, a firm aims to dramatically increase its market share. In the maturity stage, a firm's capacity reaches its maximum. In the shake-out stage, firms have limited corporate assets or have downgraded them and hence productivity declines. In the decline stage, firms focus on survival strategies with essentially a zero net entry (Gort and Klepper, 1982). We estimate Eq. (1) separately for these five groups. Table 10 reports results. We find that the coefficients on the BGD proxy remain negative and significant across columns 1, 2, 4 and 5; however, the coefficients for the maturity subsample exhibit an insignificant level. Nonetheless, the reported evidence mainly corroborates that our main results are robust to industry variations and that CEO-director ties are detrimental to gender diversification in the board.

4.4.6. Additional controls and alternative measures

We further conduct a range of sensitivity tests and report the results in Table 11. In Panel A, we add a number of CEO-specific characteristics to our regression models as additional controls. In Panel B, we use the percentage of BGD (PFDIR), at least 3 female directors (3FDIR), annual change in the number of female directors CHFDIR and total number of female directors hired each year (HIREFDIR) as dependent variables. In Panel C, we use the appointment of female directors (FAPPOINT) and a change in CEO-director ties as the main explanatory variable in column 6 and educational ties, employment ties and other ties as the main explanatory variable in columns 6–9.

In column 1 of this table, the addition of CEO characteristics (CEO duality, CEO tenure, CEO turnover and CEO age) does not alter the relationship between CEO-director ties and BGD. The four alternative BGD measures generate negative coefficients which are significant at the 1% levels. The three alternative CEO-director ties measures enter the regression models with negative coefficients, which are significant at the 5% and 10% levels in column 6, 8 and 9. Overall, our sensitivity tests provide re-assurance on what was uncovered in previous tests.

Table 11
Additional controls and alternative measures.

	Panel A: Additional controls	Panel B: Alternative measures of BGD					Panel C: Alternative measures of CEO-director ties		
	(1) DV=DFDIR	(2) DV=PFDIR	(3) DV= 3FDIR	(4) DV=CHFDIR	(5) DV=HIREFDIR	(6) DV=FAPPOINT	(7) DV=DFDIR	(8) DV=DFDIR	(9) DV=DFDIR
PTIEALL	-0.2306 * ** (0.00)	-0.0142 * ** (0.00)	-0.1826 * ** (0.00)	-0.0585 * ** (0.00)	-0.3968 * ** (0.00)	-	-	-	-
ΔPTIEALL$_{t-1}$	-	-	-	-	-	-0.0318 * * (0.01)	-	-	-
PTIEEDU	-	-	-	-	-	-	-0.3371 (0.31)	-	-
PTIEEMP	-	-	-	-	-	-	-	-0.2398 * ** (0.00)	-
PTIEOTHER	-	-	-	-	-	-	-	-	0.1505 * * (0.04)
CEO_DUALITY	0.0506 * * (0.04)	-	-	-	-	-	-	-	-
CEO_TENURE	0.0059 (0.19)	-	-	-	-	-	-	-	-
CEO_TURNOVER	-0.1057 * ** (0.00)	-	-	-	-	-	-	-	-
CEO_AGE	0.0028 * (0.09)	-	-	-	-	-	-	-	-
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.1812	0.1754	0.2656	0.0128	0.0620	0.1431	0.2692	0.2706	0.2692
N	51,176	51,176	50,965	46,775	46,770	51,176	51,176	51,176	51,176

This table presents the regression results of the effect of CEO-director ties on BGD after controlling for additional CEO characteristics in Panel A. Panel B uses alternative measure of BGD: the percentage of female director (PFDIR) in column (2); at least 3 female directors (3FDIR) in column (3); annual change in the number of female directors (CHFDIR) in column (4). total number of female directors hired each year (HIREFDIR) in column (5); and the appointment of female directors (FAPPOINT) in column (6). Panel C uses alternative measure of CEO-director ties: the educational ties (PTIEEDU) in column (7); the employment ties (PTIEEMP) in column (7); and the other ties (PTIEOTHER) in column (7). P values for robust two-tailed t-statistics clustered by firm are presented in parentheses. The superscripts * ** , * * and * correspond to statistical significance at the 1%, 5% and 10% levels, respectively.

5. Conclusion

Our original study examines the extent to which the presence of CEO-director ties determines the level of a firm's BGD. Utilising a large sample of US listed firms over the period from 2003 to 2018, we demonstrate a strong and negative association between CEO-director social connections and female director representation on the board. Furthermore, we explore whether the negative association between CEO-director ties and BGD varies across various types of female directors and CEO, board and firm characteristics. Our results indicate that CEO-director ties significantly reduce BGD irrespective of the female director type (i.e. executive, non-executive, independent or non-independent). We also find evidence that the negative association between CEO-director ties and BGD is contingent on period of high and low BGD, CEO characteristics, board monitoring mechanisms and firm life-cycle. Our results remain robust in a series of robustness tests and after addressing endogeneity concerns.

Our study makes important contributions to the literature. First, it expands a growing body of research on BGD by examining the role of CEO-director ties. Prior literature demonstrates that women's access to boards is influenced by the social, political and economic structures of individual countries (Carrasco et al., 2015; Terjesen and Singh, 2008) shareholders (Marquardt and Wiedman, 2016), firm size (Nekhili and Gatfaoui, 2013) or personal contacts and recommendations (Sheridan and Milgate, 2003, 2005). We identify an important characteristic of the board, namely, CEO-director ties, which diminishes firms' BGD.

Second, we extend the literature focusing on the CEO-director connection and its consequences for firms. The majority of prior studies report the mixed impact CEO-director ties in firm value, board monitoring, advising and resource dependency roles and directors' fiduciary duties, investment decisions and hiring process (Barroso-Castro et al., 2016; Cai and Sevilir, 2012; Fracassi and Tate, 2012; Güner et al., 2008; Kim, 2005; Pfeffer and Salancik, 2003). We add to this strand of literature by demonstrating the negative consequences of CEO-director ties on BGD, a finding that remains consistent and robust in a battery of analyses.

Our findings are meaningful given the recent regulatory changes and recent media attention to the issue of gender diversity on corporate boards which have led to calls for change by stakeholders and policy-makers. These developments, along with the development of good corporate governance practices, underscore the importance of understanding the relationship between CEO-director ties and female director representation in order to promote responsible business practices.

Author Statement

The authors declare that there are no financial, personal or belief that could affect their objectivity in conducting this research and that there is no conflict of interest with a third party (s) or with any other author or publisher.

Appendix: Definitions of variables

Variable	Definition
Main Variables of Interest	
DFDIR	Dummy variable that takes the value of one if there is at least one female director on the board, and zero otherwise.
PFDIR	The percentage of female directors on the board divided by the size of the board.
NFDIR	The number of female directors on the board.
FAPPOINT	Dummy variable that takes the value of one if there was no female directors at time t-1 and at least one female director at time t.
EXECFDIR	Percentage of executive female directors
NEXECFDIR	Percentage of non-executive female directors
INDFDIR	Percentage of independent female directors
NINDFDIR	Percentage of non-independent female directors
PTIEALL	The proportion of independent directors who share at least one connection with the CEO based on education, employment or other friendship activities.
Firm Characteristics	
LEV	Firm's short-term debt plus current portion of long-term debt plus long-term debt divided by total assets.
CASH	Firm's total cash holdings divided by total assets.
ROA	Firm's return on assets is equal to the income before extraordinary items scaled by the book value of assets.
MCAP	The natural logarithm of the firm's market capitalization.
ANALYSTS	Natural logarithm of the number of analysts
SALES	Firm's ratio of change in sales to prior-year sales
Governance characteristics	
NETWORKSIZE	The natural logarithm of the number of connections the CEO has with outside directors.
TIME_ON_BOARD	The average time the board of directors on the board.
BDSIZE	The natural logarithm of total number of directors of the firm.
Other variables	
PTIEEMP	The proportion of independent directors who share an overlapping prior employment in any firm other than the firm that the CEO is currently working for, irrespective of their role.
PTIEEDU	The proportion of independent directors who graduated from the same educational institution with the CEO.
PTIEEDU	The proportion of independent directors who share memberships of social organisations, such as golf clubs, charities, trusts and or other non-professional or voluntary associations, either currently or in the past with the CEO.
CEO_RELIGION	The religiosity ratio of the county where the CEOs received their undergraduate degree byHilary and Hui (2009) andShu et al. (2012) to capture CEOs' religious beliefs.
CEO_POWER	The CEO Power index is computed based on CEO duality, CEO's tenure, CEO's title (i.e. education degree), CEO's age, CEO's equity shareholdings. CEO duality is measured as a dummy variable that takes the value of 1 if the CEO serves as the chairman of the board, and 0 otherwise. CEO's tenure, title, age, and equity shareholdings are dummy variables that takes the value of 1 if observation is higher than the sample median, and 0 otherwise. We then add all four of these variables and create a composite index of CEO power by converting the natural logarithm of the total score received by each firm.
CEO_AGE	The natural logarithm of the CEO's age.
CEO_COMPENSATION	CEO total compensation
CEO_OWNER	CEO ownership of firm's common stock
CEO_DUALITY	Indicator variable that takes the value of one if both CEO and chair positions are held by the same person, and zero otherwise.
CEO_TENURE	Tenure time of the CEO.
FEMALE_CEO	Dummy variable that takes the value of one if there is female CEO, and zero otherwise.
DACQ	Dummy variable that takes the value of one if there is at least one acquisition made by the company in the previous year and zero otherwise.
CEO_DEATH	Dummy variable that takes the value of one if there is CEO died in the previous year, and zero otherwise.

(*continued on next page*)

(*continued*)

Variable	Definition
CEO_TURNOVER	Dummy variable that takes the value of one if there is CEO turnover in the previous year, and zero otherwise.
CEO_DEPARTURE	CEO departure aggregate score, calculated if there are CEO departures in the previous year due to death, illness, job performance and other, dismissed due to personal issues for example where the CEO violated company HR policy, expense account cheating, etc.
Female director attributes and role	
FNETWORKSIZE	Total network size of firm's female directors on the board.
FIVY	Maximum number of female directors on the board with IVY league education.
FCFA	Maximum number of female directors on the board with CFA qualification.
FCPA	Maximum number of female directors on the board with CPA qualification.
FMAEXP	Number of female directors who have served on an M&A committee of the board of any firms in the past.
FFINEXP	Number of female directors who have been employed in the financial services industry, in a finance-related role (Accountant, Chief Financial Officer, Treasurer, or Vice President of Finance), or in a top-tier auditing firm (Pricewaterhouse, Deloitte, Ernst & Young, KPMG, Arthur Andersen, Coopers, Peat Marwick, Touche Ross), using data from BoardEx.
FINDEXP	Number of female directors who have served as a manager or director in the same Fama-French 48 industry.
FACCEXP	Number of female directors who have served on CEO, CFO, CIO, CDO and Chief Executives roles of any firms in the past.
FLEGALEXP	Number of female directors who have served as consultant, lawyer, attorney and judge roles in the past.
FMGREXP	Number of female directors who have served in senior managerial roles in the past.
FACADEXP	Number of female directors who have academic experience.

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