Does Board Gender Diversity Affect Corporate Cash Holdings?

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Conflict of interest

The authors, Atif, Liu, and Huang declare that they have no conflict of interest.

Abstract

This paper examines whether board gender diversity affects corporate cash holdings using S&P 1,500 index firms in the US for the period 2006–2015. We document a significantly negative relationship between board gender diversity and cash holdings. We also find a strong negative effect of female independent directors consistent with monitoring function. Moreover, in accordance with the critical mass theory, we find a negative effect of female directors' presence and voice on cash holdings. Our findings are robust to alternative econometric specifications, alternative measures of cash holdings and corporate governance, difference-in-differences, propensity score matching, and two-stage least squares. This study offers useful insights to the current global debate on gender diversity and its implications for firms.

Keywords: corporate governance, cash holdings, gender diversity.

JEL Classification: G30, G34, J16

1 Introduction

Significant corporate scandals in recent times have raised an interesting question in the literature: would the scenario have differed substantially if more women were appointed as corporate leaders in the US and around the world (Adams & Funk, 2012)? There are strong reasons to believe an affirmative answer to this question. Prior literature suggests that female directors are less conformist and more vocal than their male counterparts (Carter, Simkins, & Simpson, 2003). Further, female directors can bring to the board diverse perspectives and experiences that help resolve complex issues through high-quality deliberations (Miller & Triana, 2009; Huang & Kisgen, 2013). In other words, gender diverse boards engage more in competitive discussion, and thus decision-making is less likely to suffer from groupthink

(Janis, 1982; Chen, Crossland, & Huang, 2016). More importantly, female directors enhance the legitimacy of firm practices (e.g., Hillman, Shropshire, & Cannella, 2007), improve board effectiveness due to their unique capabilities and workstyle, and serve as a substitute for corporate governance (e.g., Gul, Srinidhi, & Ng, 2011).

Extant literature also concurs that female directors make a significant difference in corporate decision making. Compared with male directors, female directors tend to focus more on corporate social responsibility (Shaukat, Qiu, & Trojanowski, 2016), negotiate acquisitions efficiently with lower bid premiums (Levi, Li, & Zhang, 2014), make less risky financing and investment choices (Faccio, Marchica, & Mura, 2016), spend more on research and development (R&D) (Miller & Triana, 2009), and enhance firm performance measured by return on assets and return on sales (Liu, Wei, & Xie, 2014).[i] In addition, female directors strengthen corporate governance mechanisms and are associated with higher dividend payouts (Chen, Leung, & Goergen, 2017), higher stock price informativeness (Gul et al., 2011), more audit efforts to ensure accountability (Gul, Srinidhi, & Tsui, 2008), and perform monitoring functions more diligently (Adams & Ferreira, 2009). The main drive for these studies is to establish board gender diversity as one of the corporate governance mechanisms that improves board efficiency and decision-making, a stream of research that has recently attracted a global focus.[ii]

Corporate cash holdings, as a key corporate decision, provide liquidity to firms for their operational necessities. However, excess cash holdings (non-operational cash holdings) are considered detrimental to shareholders' wealth due to lower returns and double taxation (Jensen, 1986; Opler et al., 2009; Tong, 2010). The most imperative reason to hold non-operational cash is said to be associated with the agency problem that arises from the opportunistic behaviour of managers (Jensen, 1986). Cash holdings (the most liquid asset) allow for managerial discretionary and self-perquisite spending; for example, opportunistic

managers use abundant cash reserves to shield themselves against market scrutiny (including the financial press and analysts) because firms do not have to submit to the external scrutiny of the capital market that occurs when external funding is needed (Jensen, 1986, Harford, Li, & Zhao, 2008, among others). Prior literature focuses on the role of corporate boards (as a whole) and on firm characteristics (e.g., Fama, 1980; Myers & Majluf, 1984; Ozkan & Ozkan, 2004; Harford et al., 2008; Tong, 2010) in mitigating the agency problem of cash holding decisions. However, little is known in the empirical literature about how board gender diversity as one of the corporate governance mechanisms can influence managerial opportunistic behaviour in cash holding decisions.

To the best of our knowledge, given the importance of cash holding decisions, there is no study that examines the relationship between board gender diversity and cash holdings except Zeng and Wang (2015). They find a positive association when examining the relationship between female CEOs and cash holdings using a sample of Chinese state-owned enterprises (SOE) and non-SOE firms. Their findings lend support to women's risk aversion behaviour, which in turn suggests that such behaviour in female corporate leaders may render firms less competitive in the market, and may create a glass ceiling for their career (Simpson, Ross-Smith, & Lewis, 2010). Nevertheless, their findings are limited to the Chinese corporate governance structure, which is characterised by its higher proportion of female executive directors, and lower level of board independence, compared with the US (see, Liu et al., 2014; Chen et al., 2017).

Board independence plays an important role in improving corporate governance mechanisms. In particular, female independent directors are associated with advisory and impartial advice. According to the resource dependence theory, female independent directors help manage to reduce external risks inherent to firms through their competencies (i.e., advice and council, legitimacy, and communication) (Hillman & Dalziel, 2003) compared with

female executive directors who are managers and cannot provide independent advice to firms. Further, input from female directors on the board may be considered to vary when they have a minority presence (Tanford & Penrod, 1984) and when the minority group increases to a certain size, then the influence of the group members on decision making also increases substantially (Bear, Rahman, & Post, 2010; Torchia, Calabro, & Huse, 2011). Kristie (2011) summarises this positive change in minority group as: one female director on the board as token, two are a presence and three are a voice (Liu et al., 2014) that may also affect cash holding decisions. These concerns have not been addressed in the prior study (i.e., Zeng & Wang, 2015). In this paper, we examine whether the presence of female directors on the board affects corporate cash holdings by answering three critical research questions that remain unanswered in literature: 1. Does board gender diversity affect corporate cash holdings in the US? 2. What channel of board gender diversity affects cash holding decisions? 3. Does the number of female directors on the board matter in cash holding decisions?

In this paper, using a panel of Standard & Poor's (S&P) 1,500 indexed firms with 11,360 firm-year observations for the period 2006–2015, we find that firm cash holdings are negatively associated with board gender diversity. We further test the gender diversity channel that influences cash holdings and find a pronounced effect of female independent directors. Finally, we find that boards with more than one female director have a stronger negative impact on cash holding decisions, supporting the critical mass theory. In our industry analysis, the results largely remain the same. We also document a higher market value for firms with gender diverse boards and a positive value of cash holdings. Our results are consistent with an alternative governance measure (*E index*). Overall, our findings offer important implications for policymakers and provide empirical evidence supporting the words of Karen J. Curtin, executive vice president of Bank of America (as quoted in Liu et

al., 2014 p. 183): "There is a real debate between those who think we should be more diverse because it is the right thing to do and those who think we should be more diverse because it actually enhances shareholder value. Unless we get the second point across, and people believe it, we're only going to have tokenism (Brancato & Patterson, 1999)". Our study empirically supports her second point.

To strengthen our findings on the board gender diversity and cash holdings relationship, we consider the often-stated concern of endogeneity. We employ difference-in-differences (DID), propensity score matching (PSM), and an instrumental variable approach (two-stage least squares – 2SLS). Using DID, we investigate the treatment effect (change in outcome) of female board appointments on cash holdings and find a negative impact of female-to-male appointments (a departing male director replaced by a female director) on cash holdings compared with male-to-male board appointments (a departing male director replaced by a male director). Using PSM and 2SLS, we find statistically similar results even after controlling for variations in explanatory variables and adjusting for the possible endogeneity of a female presence on the board.

The paper contributes to the literature in four ways. First, we extend the recent body of gender diversity literature by providing strong empirical evidence (based on large panel data) of the negative impact of board gender diversity on cash holdings – a key corporate decision consistent with the agency theory. Second, our study contributes to the growing research that links women on the board to monitoring intensity (e.g., Adams & Ferreira, 2009; Gul et al., 2011; Chen et al., 2017). We find that female independent directors are tough monitors, which suggests that monitoring intensity influences cash holding decisions consistent with the resource dependence theory. Third, we provide empirical evidence consistent with the critical mass theory that female 'presence' and 'voice' are strongly associated with cash

holding decisions. Finally, our study complements the current discussions over the usefulness of gender diversity in corporate boards, and offers insights for regulators considering gender diversity as an important governance mechanism.

The rest of the paper is organised as follows: Section 2 reviews the literature and develops the hypotheses. The sample selection and summary statistics are discussed in Section 3. Section 4 elaborates on the research method. Section 5 presents the relationship between gender diversity and cash holdings. Finally, Section 6 concludes the study.

2 Literature review and hypothesis development

A gender diverse board offers firms various benefits including strong monitoring, high-quality decision making through diverse experience, and innovative perspectives to solve complex issues (Cox, 1991). Prior studies that unfold the benefits of gender diverse boards mainly draw on three theories: agency theory (Jensen & Meckling, 1976), resource dependence theory (Pfeffer & Salancik, 1978), and the critical mass theory (Kanter, 1977).

2.1 Agency problem, board gender diversity and cash holdings

The motives for holding cash are mainly categorised into operational requirements and the agency problem. The operational requirements for holding cash, also known as the precautionary motive, occur when cash holdings are seen as a means for saving transaction costs and for shielding against future funding and underinvestment risk (Han & Qiu, 2007; Bates, Kahle, & Stulz, 2009). The agency problem, which causes excessive cash holdings, arises due to the separation of ownership and control of firms. The liquid asset (cash) provides latitude to managers in terms of how and when to spend, which may also lead to private benefits extraction (Jensen, 1986; Malmendier & Tate, 2008; Masulis et al., 2009). Managers maintain high cash levels to safeguard themselves from market discipline at the

expense of shareholders, and to avoid external scrutiny by the financial press and analysts. Thus, cash holdings driven by the agency conflict are a problem for firms (La Porta et al., 2000).

The potential solution to the agency problem of excessive cash holdings is efficient monitoring by corporate boards (Fama & Jensen, 1983). Fama (1980) argues that a corporate board is an integral control mechanism to safeguard the interests of shareholders. Corporate governance quality, through board monitoring, impartial advice, and oversight, plays a seminal role in influencing cash holding motives[iii] (see, Dittmar, Mahrt-Smith, & Servaes, 2003; Harford et al., 2008). Similarly, prior studies (e.g., Boubaker, Derouiche, & Nguyen, 2015) find that internal governance leads to influencing firm cash holdings and managerial decision making. These studies concur that well-structured boards reduce the agency problem. Hence, the monitoring function of corporate boards plays a critical role in mitigating the agency problem of cash holdings.

Empirical studies on gender diverse boards concur that female directors monitor more actively and require accountability. For instance, Gul et al. (2008) and Adams and Ferreira (2009) find that female directors want more accountability and greater audit fairness in firms; thus women on boards are tough monitors (Chen et al., 2017). Gender diverse boards also help to avoid groupthink in corporate boards, thereby improving the quality of competitive discussion among board members (Gul et al., 2011), which leads to optimal decision making.[iv] Attributes such as monitoring and fairness can be traced back to women's democratic and better leadership skills (Johnson & Eagly, 1990). Their ability for high-quality deliberations lies in their diverse experiences and unique workstyle (Cox, 1994; Daily & Dalton, 2003). Hence, female directors enhance board capabilities in effectively performing monitoring duties.

These distinct characteristics of female directors, ranging from their monitoring capabilities to their unique workstyle, lead towards overcoming the agency problem. In sum, gender diverse boards enhance the monitoring and decision-making functions of the board, as one may expect that female directors affect the agency problem associated with excess cash holdings. Specifically, female directors can restrain the opportunistic behaviour of managers exercising discretionary power to limit the agency problem related to cash holding decisions. Therefore, better control, conservatism, and strong monitoring from gender diverse boards will reduce the agency problem of cash holdings and allow the firm easy access to external funding sources. Hence, we hypothesise as follows:

H1: Board gender diversity is negatively associated with corporate cash holdings.

2.2 Resource dependence theory, independent female director and cash holdings

Resource dependence theory (Pfeffer & Salancik, 1978) argues that, to survive, businesses depend on three external resources: advice and counsel, legitimacy, and communication. The external dependencies posit survival risks for businesses. In order to reduce the risks, resource dependence theory offers the rationale for the board's role in providing critical resources and external linkages to the firm. In this context, the board's influence on cash holding decisions is facilitated by its support and advisory roles as it requires counselling of management to efficiently deploy corporate resources (Hillman and Dalziel, 2003). More specifically, a corporate board necessarily provides a strong foundation in advisory, serving as a checks-and-balances mechanism to ensure that management acts in the best interests of shareholders (Fama, 1983; Haniffa & Cooke, 2005).

Around the world, to protect shareholder interests, corporate governance codes (e.g., Sarbanes–Oxley Act in the US) require that a board should be largely comprised of independent directors. The underlying concept is that the independent advisory of the board

relies on the effectiveness of the independent directors. A board with fewer independent directors should be viewed negatively by stakeholders compared with a board with more independent ones. Over time, a body of literature examining the impact of board independence and diversity on various firm-level outcomes (i.e., dividend payout, firm performance) has provided positive findings (e.g., Brickley et al., 1997; Kim & Lim, 2010; Pombo & Gutie´rrez, 2011; Chen et al., 2017). Therefore, stakeholders may reasonably suspect the effectiveness of the board if male directors (executive and independent directors) dominate the board. This may be due to the male directors being closely aligned with CEOs, resulting in groupthink and rendering advisory and monitoring functions weaker. In addition, the perception of a friendly board can also damage its effectiveness (Hermalin & Weisbach 1998). On the other hand, the presence of female directors on boards provides more deliberation for quality decision making and avoids groupthink. For instance, Terjesen et al. (2016) document that firms with more female directors have better firm performance. They further argue that female independent directors on the board play a different role than executive directors. Liu at al. (2014) find a positive relationship between the percentage of female independent directors and firm performance. Female executive directors (the agents), engaged as employees and managers of the firm, cannot perform the independent monitoring and advisory functions due to their positions.

Previous studies suggest a number of positive outcomes associated with female independent directors' board appointments. The presence of female independent directors on boards is associated with the lesser occurrence of financial fraud, increases in transparency, and a reduction in agency cost (Beasley, 1996; Erhardt et al., 2003). What's more, female independent directors are considered less tolerant towards managerial opportunism which can influence corporate policies (Chen et al., 2017), e.g., cash holdings. Female independent directors bring diverse and independent thinking to the board, due to their advisory role at

different levels and boards, which is crucial in resolving complex issues (Kravitz, 2003; Broadbridge, Hearn, Huse, & Grethe Solberg, 2006), thus providing impartial advice. Furthermore, appointment of female independent directors to the board helps legitimise firm policies in the eyes of stakeholders and investors in line with social norms and board independence expectations (Hillman et al., 2007). Female independent directors' appointments to corporate boards are critical to board effectiveness (Yermack, 1996) and serve as a response to the external pressure and expectations of greater board diversity and independence. Moreover, female independent directors – due to their involvement in different experiences sets, beliefs, and perspectives – are better able to communicate and connect their firms with other constituencies (e.g., female customers, suppliers, labour, and society) than their male counterparts. With the enhanced linkages of female independent directors to a range of external stakeholders, firms are enabled easy access to external resources and funding (e.g., debts, investments and credits) to support the firm's operational cash needs.

Overall, resource dependence theory supports the beneficial effects of female independent directors to effectively discharge the duties of counsel and impartial advice (Fama, 1980; Shleifer & Vishny, 1997; Liu, Wei, & Xie, 2014). Therefore, having female independent directors on boards is potentially a stronger governance mechanism to influence cash holding decisions (Chen et al., 2017). To test the relationship between female independent directors and cash holding decisions, we hypothesise as follows:

H1a: Female independent directors are negatively associated with corporate cash holdings.

2.3 Critical mass theory, number of female directors and cash holdings

Kanter (1977), who refers to the sole representative of a particular minority group (such as women) as "token", argues that observers are likely to view the image of a token woman in a negative light. He further suggests that dominant observers tend to distort female

image by molding women into a gender-role stereotype (Block, 1973; Sherrick et al., 2014) rather than valuing their individual leadership qualities. Such a distorted image with token status creates difficulties for women directors to be heard and, importantly, listened to on an equal footing to male board members (Terjesen et al., 2009). Therefore, the historical token status of women in top management underpins the stereotypes that women may have weaker attributes for serving in top positions compared to their male counterparts who consistently hold top positions (Powell & Butterfield, 2002; Lee & James, 2007).

Due to their perceived token status and gender-role stereotyping, female directors may be considered to have minimal power in influencing firm decisions (Kanter, 1977). Such traditional conventions may reinforce that the impact of one female director is limited; accordingly, she may encounter negative experiences (e.g., Goldenhar et al., 1998) or even be met with downright derision (Maass & Clark, 1984). The input of female directors on boards may vary when they have a majority rather than a minority presence (Tanford & Penrod, 1984). When the size of the token minority group increases to the point where the group is no longer considered as token, then the perspective of the group members and the nature of the relationship between minority and majority status changes substantially since women feel more comfortable, and less constrained (Terjesen et al., 2009; Bear et al., 2010; Torchia et al., 2011). Prior studies investigate the impact of critical mass on firm-level outcomes. For instance, Joecks et al. (2013) find a positive relationship between board gender diversity and firm performance when critical mass has been reached (about 3 women on a board). Similarly, Bear et al. (2010) find that higher numbers of women on boards have a positive impact on firm reputation. Schwartz-Ziv (2017) documents that boards with at least three directors of different genders are at least 79% more active at board meetings than those without such representation. Regarding critical mass theory, Kristie (2011) observes: “one is

token, two is a presence, and three is a voice" (Liu et al., 2014). We attempt to find the impact on cash holding decisions when critical mass is achieved. We hypothesise as follows:

H2: Female directors on the board are negatively associated with corporate cash holdings when critical mass (presence) is achieved.

3 Data and summary statistics

3.1 Sample

Our initial sample consists of S&P 500, S&P MidCap 400, and S&P SmallCap 600 (hence S&P 1,500) indexed firms collected from Bloomberg covering the period 2006–2015. We initially selected 14,494 firm-year observations with information on accounting variables and firm board characteristics such as the percentage of board gender diversity, board independence and size. Consistent with prior literature (e.g., Bates et al., 2009; Nikolov & Whited, 2014; Liu, Luo, & Tian, 2015), we exclude the firms in the financial services industry due to its specific and stringent regulatory conditions. We further require firm-years to have gender diversity and accounting data to be part of the sample. Our final sample consists of 11,360 firm-years of data on 1,395 firms.

3.2 Firm cash holdings

Following past studies (Bates et al., 2009; Nikolov & Whited, 2014; Liu et al., 2015), we measure the level of cash holdings as the ratio of cash and marketable securities to net assets, where net assets are defined as the book value of the total assets minus cash and marketable securities. Notably, such a measure of cash represents the cash reserves available at the disposal of managers in proportion to assets. In our sample period, the average cash holdings ratio are nearly 15% as shown in Table 2. However, the ratio for the subsample with women is 12%, as compared to 20% for the male-only subsample.

[Insert Table 1 about here]

[Insert Table 2 about here]

3.3 Board gender diversity measures

The variable of interest in this study is board gender diversity. Prior studies use the percentage of female directors on the board to measure gender diversity (e.g., Adams & Ferreira, 2009; Ahern & Dittmar, 2012; Huang & Kisgen, 2013; Faccio et al., 2016). Other studies use the number of female directors or use a dummy variable to measure the representation of females on the board based on the idea of what critical mass is needed to achieve effectiveness (Simpson et al., 2010). We measure board gender diversity using four variables: the percentage of female directors in the total number of directors, the number of female directors on the board, a set of dummy variables to measure the number of female directors, and female independent and executive directors.

Table 2 presents the summary statistics of gender diversity on the board. We find 13% of directors are women, based on the full sample. We also find that the average number of females on the board is 1.29. Other alternative measures of board gender diversity include the dummy variables *w1, w2,* and *w3*. The dummy variable *w1* (*w2, w3)* equals 1 when the board has one female director (two female, three or more female directors, respectively) and 0 otherwise. Female executive and independent directors are 0.90% and 11% on average respectively. In the full sample of 11,360 firm-year observations, about 36%, 26%, and 13% firm-years have one female director, two female, and three or more female directors on the board respectively, and the remaining 25% firm-year observations in the sample have male-only boards. The differences of mean comparisons in all the variables are significant at the 1% level, suggesting that two groups (with women and without women) are significantly different.

[Insert Figures 1, 2 and 3 about here]

Figure 1 shows the board gender diversity from 2006 to 2015. Gender diversity increases from 9.29% in 2006 to 16% in 2015 *(%women_on_board)* and from 0.96 in 2006 to 1.60 in 2015 in number *(number_women_on_board)*. Figure 2 illustrates the idea of critical mass achievement by firms over the sample period: respectively, the percentage of firms with one female director increases from 32% to 40%; with two female directors, from 20% to 29%; and with three or more female directors, from 8.3% to 16%. Figure 3 presents the differences in cash holdings between the subsamples with women and without women. The former shows maximum cash holdings of 14%, the latter, 24%, which demonstrates succinctly that women are associated with less cash holdings.

3.4 Control variables measures

Our selection of control variables is based on previous studies (e.g., Adams & Ferreira, 2009; Liu et al., 2011; Chen et al., 2017). We group the control variables into two classes (governance and firm-specific) that may have an impact on cash holdings. The group of governance variables includes the board size *(board_size)*, CEO duality *(ceo_duality,* a dummy variable), the presence of independent directors *(independent_directors)* on the board, and entrenchment index (*E index*) introduced by Bebchuk et al. (2009) as an alternative governance measure.[v] From an agency perspective, independent directors are considered effective in controlling managers' opportunistic behaviour and therefore are likely to reduce the agency problem (Fama & Jensen, 1983); the CEO duality may affect the decision making due to managerial discretion on cash holdings. Table 2 exhibits the board size as 9.68, CEO duality as 0.48, board independence as 7.87, and *E index* as 2.43 on average. The firm-specific variables group includes leverage measured as book value of total debt (short- and long-term) to total assets *(levta),* with an average value of 0.23. The

relationship between cash holdings and leverage is ambiguous (Ozkan & Ozkan, 2004) because higher debt exposes the firm to bankruptcy while higher cash holdings are used to hedge the risk of financial distress by high-leveraged firms. Size of firm, measured as the natural logarithm of total assets *(ln_asset),* shows a mean value of 3.42. We predict a negative sign for size with respect to cash holdings. We measure net working capital as a ratio of working capital less cash and cash equivalents divided by total assets, which shows an average of 0.06 *(nwcta)*. Capital expenditure is the ratio of capital expenditure to total assets *(capexta)* with an average value of -0.04. Dividend payout is measured as dividend divided by total assets and shows a mean value of 0.01. We control the dividend because firms may determine the amount of cash to hold for disbursement to shareholders in the form of a dividend. Growth opportunities, measured by Tobin's Q *(tobin_q_ratio)*, shows an average of 1.90. Return on assets (*ROA*), measured by net income divided by total assets, has an average value of 0.10, and research and development (*R&D*) is measured by total R&D divided by total assets and has a mean value of 0.05.

3.5 Correlations among variables

Table 3 reports the correlations among variables in our regression model to check the multicollinearity problem. In our sample, the highest correlations exist among gender diversity measures such as *%women_on_board, number_women_on_board,* and the dummy variables highlighted in bold. As a general principle, correlations higher than 0.70 may indicate a multicollinearity issue (Liu et al., 2014). However, we use highly correlated variables in separate regressions instead of simultaneously; hence, high correlations among these variables are not an issue for our study. The remaining variables report no correlation coefficient value higher than 0.50. In addition, to test the potential effect of multicollinearity between these variables, we calculate the variance inflation factor (VIF). All the variables

have the VIF (un-tabulated) as less than 3.50 and the overall mean value is 3.55. This suggests that multicollinearity is not an issue in the model. [vi]

[Insert Table 3 about here]

4 Empirical methodology

4.1 Main model and estimation method

We test our hypotheses *(H1, H1a, H2)* using the following baseline regression model:

$$cash_{it} = \alpha + \beta_1(board\_gender\_diversity)_{it} + \beta_2(board\_characteristics)_{it} + \delta_3(firm\_characteristics)_{it} + \delta_4\sum(industry\ effects)_i + \delta_5\sum(year\ effects)_t + \varepsilon_{it} \quad (1)$$

We measure the *board_gender_diversity* employing the percentage of female directors on the board *(%women_on_board),* the number of female directors' representation on the board *(number_women_on_board)*, and a set of three dummy variables *(w1, w2, w3). Board_characteristics* include the board size *(board_size),* CEO duality *(ceo_duality)*, board independence *(independent_directors)*, and entrenchment index *(E index)*. *Firm_characteristics* are accounting variables such as leverage *(levta)* and net working capital *(nwcta)*. Industry effects are controlled using two-digit codes of Global Industry Classification Standards (GICS).

We use ordinary least square (OLS) as the baseline model, controlling for industry and year effects. Furthermore, to choose between the fixed effect and random effect, we perform a Hausman test in which the un-tabulated results confirm the suitability of the fixed effect (FE), which helps eliminate the omitted variable bias and controls for year fluctuations. [vii] Hence, we apply the panel fixed effect approach (the FE method). Additionally, we use one-year lagged board variables, replacing the contemporaneous variables. The rationale behind this specification is that female directors and board characteristics require time to influence

firm cash holding decisions. The standard errors are corrected for clustering of residuals at the firm level to control for heteroscedasticity (Petersen, 2009).

4.2 Robustness tests

Our study faces the challenge of potential endogeneity bias created by the motivation for boards to hire qualified female directors in response to regulatory pressure. The shortage of qualified female directors offers them an opportunity to select the boards of firms already performing better (Ferrel & Hersch, 2005), causing the endogeneity bias. Consequently, our independent variable *(%women_on_board)* may suffer from a self-selection bias and may not be systematically associated with our dependent variable *(ratio_ofcash)*.

We employ difference-in-differences (DID), and propensity score matching (PSM) to exploit the assumption of 'parallel trends': that is, two similar firms are expected to follow the same trend without any treatment. In case treatment occurs, the impact should be reflected in the difference between the changes of the two firms (i.e., the treatment and control groups) (Roberts & Whited, 2012). We also employ instrumental variable (IV) approach (two-stage least squares - 2SLS) to adjust for the potential endogeneity of the percentage of female directors on the board (Harford et al., 2008). In particular, this approach uses IV to extract the exogenous components from the board composition and then uses them to explain the cash holdings. These techniques are explained in Section 5.4 on robustness.

5 Results

5.1 Percentage of female directors and cash holdings

First, we examine whether the percentage of female directors on the board *(%women_on_board)* has a significant impact on firm cash holdings. Table 4 illustrates the main regression model where we measure gender diversity as the percentage of female directors on the board and cash holdings as a ratio of cash to net assets. Panel A in Table 4

(columns 1–3, respectively) presents the results of the baseline models OLS, FE, and lagged board for the percentage of female directors on the board. Year and industry effects are included in all the regression specifications.

[Insert Table 4 about here]

Our results suggest that female directors have a significant (at the 1% level) and negative impact on firm cash holdings. For instance, in the OLS, FE and lagged board specifications, a 1% increase in female directors on the board results in 0.59%, 0.69%, and 0.76% decreases in firm cash holdings, respectively, supporting *H1*. The economic significance of gender diversity on cash holdings is also important. For example, an increase in *%women_on_board* by one (sample) standard deviation (i.e., using Table 2) decreases cash holdings by approximately 0.49% in the FE method [%women on board (10.11) × -0.0069/ cash holdings (0.14) = -0.49].

As a robustness check, we re-define our dependent variable cash holdings *(ratio_ofcash)* as cash and cash equivalents to total assets *(cashta).*[viii] We re-estimate our model using this redefined variable and report our findings in Panel B in Table 4 (columns 4–6). We find that *%women_on_board* have a significantly negative impact on cash holdings *(cashta),* similar to that reported in Panel A. Our results are statistically significant across the three specifications (i.e., OLS, FE, and lagged board variables) and are consistent with prior literature (Tong, 2010; Chen et al., 2015). Our results once more support *H1*.

5.2 Female independent vs executive directors

The above analysis shows that the presence of female directors on the board decreases cash holdings in firms. In this section, we further test the channel that influences this relationship. We test for both monitoring and executive power channels following extant literature (e.g., Liu et al., 2014; Chen et al., 2017). We replace the gender diversity variables

in our regression with female executive directors *(%_women_executive)* and female independent directors *(%_independent_women_directors)* for executive power and monitoring channel, respectively. Female executive directors may influence the cash holdings through the executive power channel because of their influence in managerial matters and management skills, whereas female independent directors are likely to influence firm policies through the monitoring channel due to their independent and advisory role.

[Insert Table 5 about here]

Table 5 reports that female independent directors (*%_independent_women_directors*) have a significantly (at the 5% or better level) negative relationship with cash holdings across all three specifications, whereas female executive directors (*%_women_executive*) have no significant relationship. These findings suggest that female independent directors (i.e., the monitoring channel) are more likely to affect cash holding decisions than female executive directors.[ix] The difference in the coefficients test (the Wald test) indicates that the coefficient on *%_independent_women_directors* is significantly different from that of *%_women_executive* across the three methods.

In our channel analysis, we find that the impact of female independent directors is consistent with the argument of stronger governance and monitoring (Adams & Ferreira, 2009; Chen et al., 2017). Our results support the resource dependence theory, which argues that independent directors bring more value and external resources to the firm, supporting *H1a*.

5.3 Critical mass and cash holdings

Following critical mass theory, we test the effect of the critical mass of board gender diversity on cash holdings using the number of female directors *(number_women_on_board)*

and three dummy variables representing one female director, two female directors, and three or more female directors on the board *(w1, w2, and w3),* respectively. We report the results in Table 6. The number of female directors on the board illustrates the same statistical results (columns 1–3 in the OLS, FE, and lagged board specifications, respectively) as the percentage of female directors on the board in Table 4. However, in this regression we focus on the three dummy variables *(w1, w2, and w3).*

[Insert Table 6 about here]

The findings in columns 4–6 suggest that one female director on the board *(w1)* has a marginally significant impact on cash holdings in the OLS specification (at the 10% level). However, this relationship statistically improves (the negative impact) with two female directors, and three or more female directors on the board at the significance level of 5% or higher. These findings, which are consistent with past studies such as those by Torchia et al. (2011) and Liu et al. (2014), reflect Kristie's (2011) summary statement of critical mass theory ("one is token, two is presence, and three is a voice"). That is, our results show a marginally significant coefficient on one female director, consistent with tokenism, and a more significant relationship consistent with the levels of presence and voice when there are higher numbers of female directors on boards. The difference in the coefficients test (the Wald test) indicates that the coefficient on *w1* is significantly different from that on *w2* and the coefficient on *w2* is significantly different from that on *w3* across the three regressions. Overall, our results support the hypothesis that two or more female representations on a board has a pronounced negative impact on cash holdings.

5.4 Robustness tests

Based on the extant literature (i.e., Liu et al., 2014; Chen et al., 2017; Alam et al., 2019), we use three econometrical techniques – DID, PSM and 2SLS – to address the endogeneity

concerns. First, we employ the DID estimator around the female appointments to explore the effect on cash holdings that actually results from female board representation. DID exploits the assumption of 'parallel trends' using two groups (i.e., treatment and control) to capture the change in the treatment group after female appointment. We implement the DID estimator using the following model.

$$cash_{it} = \alpha + \beta_1(w\_appointment \times post\ period)_{it} + \beta_2(w\_appointment)_{it} + \beta_3(post\ period)_{it} + \delta_4(controls)_{it} + \varepsilon_{it} \quad (2)$$

The variable *w_appointment* is a dummy variable equalling 1 when the firm is in the treatment group and 0 when the firm is considered to be part of the control group. The dummy variable of *post period* equals 1 in the period after the director appointment and 0 in the period before such appointment. We select our treatment and control groups based on firm-years one year before and one year after a director's appointments, excluding the year of appointment. To select our treatment group, we require that firms must appoint only one female director to replace the departing male director in the year of appointment to be included in the treatment group (we do not consider female-to-female and male-to-male replacements). We also require the departing male directors to be older than 60 to ensure that the director turnover is less likely to be driven by unobserved factors. With such scrutiny, we are able to identify 157 female director appointments during the sample period to include in the treatment group. For the control group, we require that firms have one newly appointed male director to replace a departing male director aged over 60.[x] After meeting such criteria, we are effectively able to identify 803 such appointments to form the control group. Then, we match the treatment and control firms using propensity score matching to ensure that the DID is not driven by firm characteristics.

The DID results are reported in Table 7. The coefficient on the interaction variable *(w_appointment × post period)* is negative and statistically significant (at the 5% level). The

results show that cash holdings in firms with female director appointments replacing outgoing male directors are significantly lower than cash holdings in firms without female appointments on the board.

Second, we implement the PSM estimator in two-steps (e.g., Rosenbaum & Rubin, 1983; Lennox, Lisowsky, & Pittman, 2013; Atif et al., 2019) to check whether changes in cash holdings occur as a result of women presence on the board. In the first step, we use a dummy variable *(w_dummy)* that equals 1 when one or more female directors are on the board and 0 otherwise. The firms with female directors are considered in the treatment group; the firms without female directors are part of the control group. We run a logistic regression for the *w_dummy* variable with explanatory variables including *independent_directors, ceo_duality, board_size* (Richardson, Lanis, & Taylor, 2015). The predicted estimates are used as the propensity scores for each firm-year observation.[xi] In the second step, using the propensity scores to form one-to-one matched pairs for *w_dummy*, we are able to effectively match 5,214 firm-year observations. [xii] These criteria show that our treatment and control groups are nearly identical, except for *%women_on_board*. After this matching, any difference in the outcome variable (i.e., *ratio_ofcash)* can be attributed to differences in the presence of female directors on the board (*%women_on_board)* rather than being due to explanatory variables.

[Insert Table 7 here]

We report the results based on the matched sample in Table 7. We find that the coefficient on the *%women_on_board* is negative and statistically significant at the 1% level for cash holdings. These results suggest that the decrease in cash holdings is attributable to systematic difference in the presence of female directors on the board. The coefficients on firm-specific variables are also significantly associated with cash holdings such as *board_size*, *nwcta* and *levta*.

Finally, we use the 2SLS approach to adjust for the endogeneity of women's presence on the board. The challenge of using this technique is the construction of an instrumental variable (IV) that should not have a direct or indirect relationship with the dependent variable (exogenous variable). Using the approach by Liu et al. (2014), we construct *w_ratio* the IV as the number of female directors on the board minus the total number of female directors on the board in its industry and divided by the number of the board members minus total number of board members in its industry. The idea of using *w_ratio* as the IV is based on the assumption that board gender diversity in a firm's industry may affect the firm's board gender diversity but does not have a direct relationship with the firm's cash holdings. In the first-stage regression, where *%women_on_board* is the dependent variable, *w_ratio* produces significant and positive results (not reported), establishing *w_ratio* as a valid instrument. In the second stage, we use the predicted percentage of female directors on the board from the first-stage regression (*%women_on_board-fitted*) with *ratio_ofcash*. The second-stage results, which we report in Table 7, are similar to the findings of our main model. Thus, after minimising the endogeneity concerns, we can safely infer that women on corporate boards reduce cash holdings. Other control variables, including independent directors, also have a significantly negative relationship with cash holdings. In firm characteristics, Tobin's Q is significantly positive; other variables such as leverage *(levta)* and net working capital *(nwcta)* are negative.

5.5 Additional Analysis

Our analyses in the previous sections are based on the full sample. We also examine the relationship between female directors on the board and cash holdings within each industry given that different industries may have different cash requirements. Panel A in Table 8 shows that women's presence on the board is negatively associated with cash holdings in *Consumer*, *Staples*, *Health*, *Industrial*, *Real Estate* and *Utilities* industries. However, such a

relationship is insignificant for *Energy* and is even positive (significant at the 10% level or higher) for *Information Technology* (IT) and *Materials*.[xiii]

[Insert Table 8 about here]

We also focus on excess industry cash holdings. Higher cash holdings than the industry average may indicate an agency problem. We follow, for example, Lie's (2000) study, which uses excess industry average funds in the event of dividend disbursement. After identifying firms with higher than average industry cash holdings, we examine such a relationship in the presence of female directors on the board. Panel B in Table 8 reports results showing that excess cash holdings in all types of industries have a negative relationship. This is consistent with the argument that gender diverse boards are tough monitors and limit managerial opportunistic behaviour.

[Insert Table 9 about here]

Furthermore, following past research (e.g., Arouri & Pijourlet, 2017; Hossain et al., 2019), we employ the firm's market value as the dependent variable to test the benefit of holding lower cash for firms with a gender diverse board. We replace our dependent variable with the firm's market value, defined as market capitalisation plus liabilities scaled by net assets (Dittmar & Mahrt-Smith, 2007; Arouri & Pijourlet, 2017). To form our independent variable of interest, we interact gender diversity with cash holdings to examine their effect on firm value. We also control for other firm and governance characteristics, as in model 1. Table 9 (columns 1–2, OLS and FE, respectively) reports our findings which show that cash holdings in the presence of female directors lead to higher market value for firms. These results, which are statistically significant, are consistent with previous studies.

Moreover, we examine the effect of board gender diversity on the value of cash holdings. We follow the Faulkender and Wang (2006) approach to investigate the value of cash holdings (further details on our methodology is available in the Online Appendix). This approach is widely used in the literature to examine the value of cash holdings (e.g., Tong, 2010; Lee & Powell, 2011; Orlova et al., 2017). We report the results in Table 9 (column 3). We find that the coefficient of interaction between board gender diversity and change in cash holdings is positively associated with the dependent variable (excess return). These findings are consistent and further support the argument that board gender diversity reduces the agency cost that leads to higher values of cash holdings.

Finally, we investigate whether the relationship between board gender diversity and cash holdings is affected by firm-level governance. If board gender diversity reduces the agency problem by lowering the cash holdings, then this negative effect should be more pronounced in firms with weak firm-level governance. We examine this relationship in the subsamples of firms with strong and weak governance as measured by the level of managerial entrenchment (*E index*).[xiv] Table 9 (columns 4 and 5) shows the results of the sample split into high and low entrenchment firms (based on median *E index*), respectively. The results show that the coefficient on board gender diversity is negative and statistically significant at the 5% level for high entrenchment firms. These findings suggest that board gender diversity offsets weak corporate governance.

6 Conclusion

This study extends the existing literature on board gender diversity by providing novel empirical evidence in relation to the effect of female directors on the board on cash holdings in the US. Our study also provides insights into the effect of gender diversity in corporate

boards. Our results suggest that the percentage of female directors are negatively associated with cash holdings. Our findings also indicate that female independent directors are tough monitors who play their role in mitigating the agency problem of cash holdings. Moreover, we find a pronounced negative effect on cash holdings of the presence of more than one female director, consistent with the critical mass theory. Our results are robust to different estimation techniques (i.e., DID, PSM, and 2SLS), documenting a negative impact of board gender diversity on cash holdings. We further confirm, in an additional analysis, that female directors on the board have a negative (positive) association with cash holdings (the value of cash holdings).

In recent years, the regulators in a number of developed countries around the world have been facing pressure from the public to enhance board gender diversity. In the world's largest developed economy, the US, policymakers and practitioners are actively addressing this contemporary issue. The most imperative policy implication of our study is that gender diverse boards affect firm cash policy in the current state of corporate governance in the US. As with corporate governance, having gender diverse boards enhances efficiency; moreover, this resultant effect may provide additional benefit to the firm over time. To enhance the effectiveness of boards and the efficient use of cash, firms with fewer women on their corporate boards now should look to add more female directors to their boards. Our findings provide implications for regulators and corporate decision makers concerning board gender diversity. However, we acknowledge the limitation and generalisability of our findings to a wider perspective due to several factors including differences in culture, institutional settings, and social backgrounds. Our study also does not consider the characteristics of female directors such as qualifications and experience.

Data availability statement: The data is sourced from Bloomberg which is publicly available and can be made available.

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Data set: https://www.bloomberg.com/company/announcements/category/data/

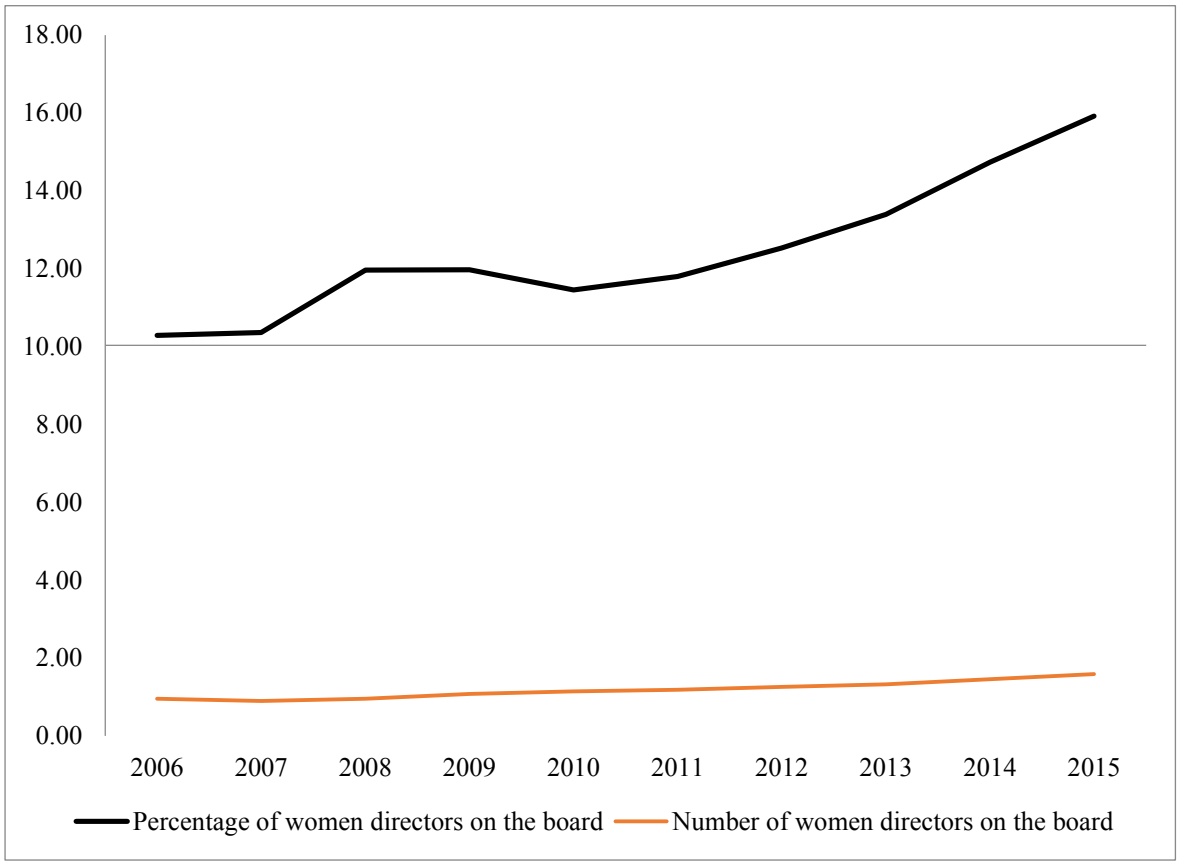

Figure 1. Percentage and number of female directors on the board.

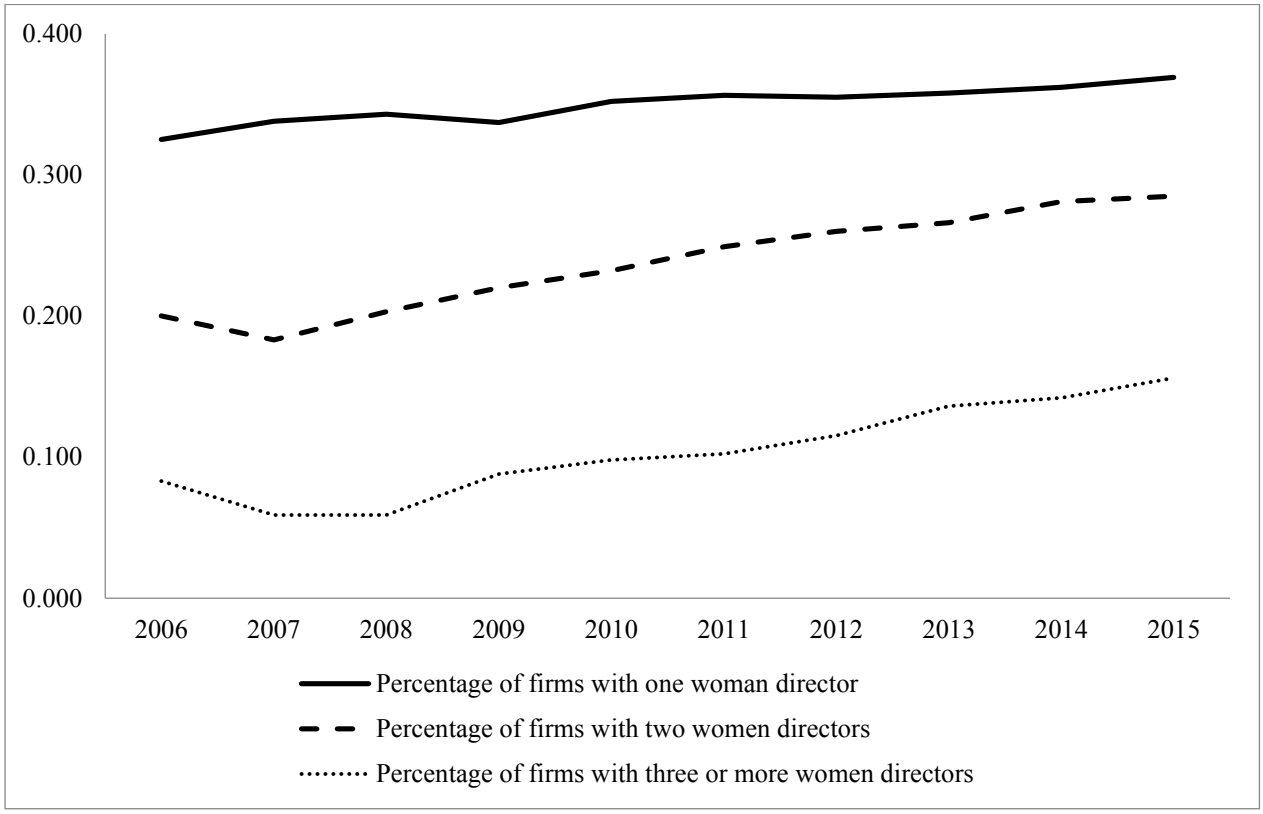

Figure 2. Percentage of firms with one female, two female, and three or more female directors on the board.

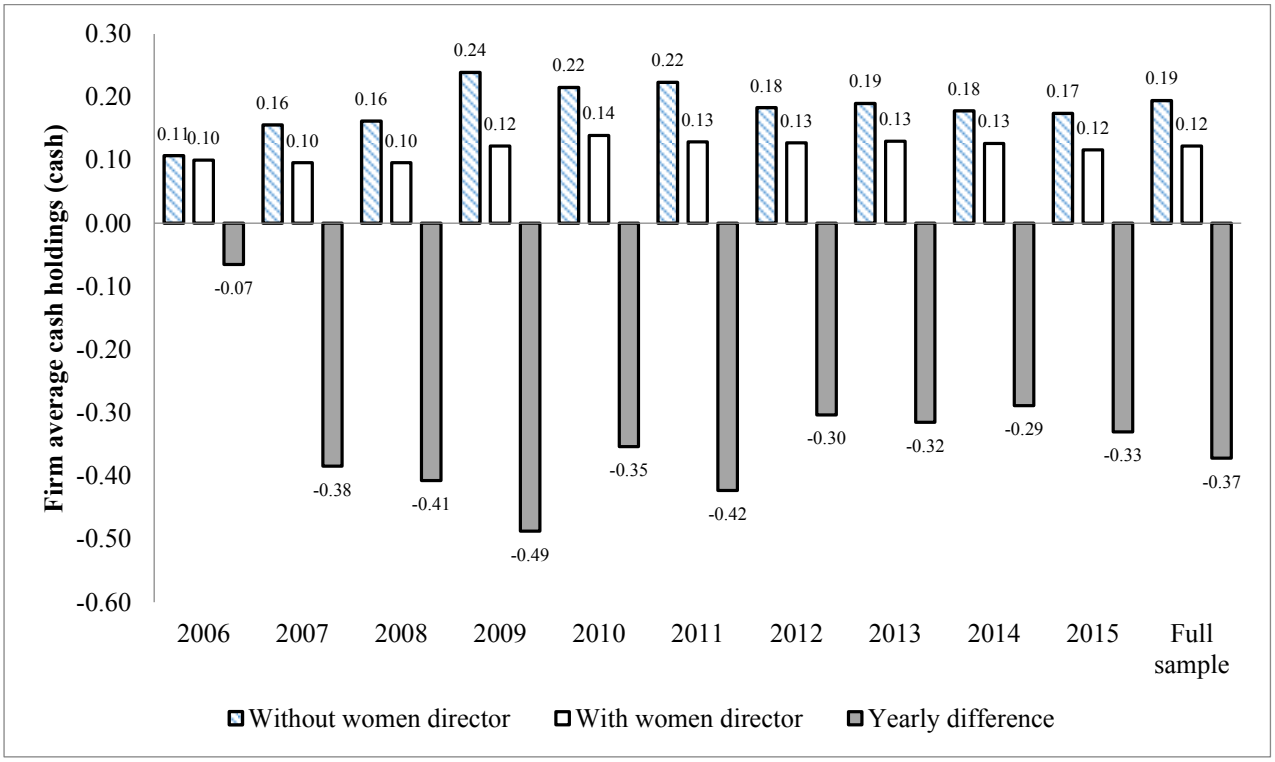

Figure 3. Difference in firms' yearly cash holdings in subsamples of with women and that without women directors on the board.

Table 1. Variables definitions

Notation	Variable name	Measure
Panel A: Cash holdings		
ratio_of cash	Cash holdings	Ratio of cash and marketable securities to net assets
cashta	Cash holdings	Ratio of cash and marketable securities to total assets
Panel B: Gender diversity variables		
%Women_on_board	Percentage of female directors	The percentage of female directors on the board
number_women_on_board	Number of female directors	The number of female directors on the board
w1	Female dummy 1	A dummy variable equals1 if firm has one female director on the board and 0 otherwise
w2	Female dummy 2	A dummy variable equals1 if firm has two female directors on the board and 0 otherwise
w3	Female dummy 3	A dummy variable equals1 if firm has three or more female directors on the board and 0 otherwise
%_independent_women_directors	Female independent directors	The number of female independent directors divided by board size
%_women_executive	Female executive directors	The number of female executive (inside) directors divided by board size
Panel C: Governance variables		
board_size	Board size	The number of directors on the board
ceo_duality	CEO duality	A dummy variable equals1 if CEO is also the board chairperson and 0 otherwise
Independent_directors	Board independence	The number of independent directors on the board

E index	Entrenchment index	An index based on six antitakeover provisions as defined by Bebchuk et al. (2009). The six provisions include staggered boards, limits to shareholders by law amendment, poison pills, golden parachutes, and majority requirement for mergers and amendments. The counts the number of antitakeover provision in place.
Panel D: Firm-specific variables		
levta	Leverage	Total debt divided by total assets
ln_asset	Firm size	Natural log of total assets
nwcta	Net working capital	Current assets minus current liabilities scaled by total assets
capexta	Capital expenditure	Total capital expenditures scaled by total assets
div_payout	Dividend payout	Dividend paid scaled by total assets
tobin_q_ratio	Growth opportunities	Market value divided by book value of equity
ROA	Return on assets	Net income divided by total assets
R&D	Research and development	Research and development divided by total assets

Table 2. Descriptive statistics

	Full sample $N = 11,360$		With women $N = 8,962$		Without women $N = 2,398$			
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean Diff	*t*-stat
ratio_ofcash	0.1484	0.4617	0.1221	0.1791	0.1946	0.3898	-0.0725***	-10.9890
%women_on_board	13.0816	10.1100	17.3000	78.9900	0.0000	0.0000	17.3000***	110.0230
number_women_on_board	1.2990	1.0886	1.7509	0.8979	0.0004	0.0000	1.7508***	84.1160
w1	0.3574	0.4793	0.4816	0.4997	0.0004	0.0199	0.4816***	44.8660
w2	0.2559	0.4364	0.3450	0.4754	0.0000	0.0000	0.3449***	35.8730
w3	0.1285	0.3347	0.1732	0.3785	0.0000	0.0000	0.1732***	23.5610
%_women_executive	0.9000	0.3100	0.0110	0.0390	0.0000	0.0000	0.0110***	105.4320
%_independent_women_directors	11.2000	0.0810	15.8000	0.0670	0.0000	0.0000	15.8000***	29.8720
board_size	9.6818	2.4400	10.2480	2.3274	7.9383	1.8965	2.3097***	47.8420
ceo_duality	0.4875	0.4999	0.5001	0.5000	0.4471	0.4973	0.0530***	15.3720
independent_directors	7.8784	2.4205	8.4545	2.2501	6.1023	2.0341	2.3522***	23.9490
E index	2.4320	1.2591	2.5380	1.2110	2.4323	1.2465	0.1057***	10.2101
levta	0.2323	1.1679	0.2344	0.1937	0.1978	0.1987	0.0366***	7.5110
ln_asset	3.4241	0.6894	3.6495	0.6678	3.1255	0.5136	0.5240***	56.2200
nwcta	0.0658	1.0935	0.0576	0.1491	0.1100	0.1709	0.0524***	12.1400
capexta	-0.0469	0.0592	-0.0444	0.0526	-0.0525	0.0715	0.0081***	7.1200
div_payout	0.0196	0.0608	0.0199	0.0379	0.0166	0.0428	0.0033***	10.4370
tobin_q_ratio	1.9088	1.3026	1.8702	1.1987	1.9902	1.4367	-0.1200***	-4.8320
ROA	0.1042	0.0285	0.0864	0.0272	0.0689	0.0325	0.0175***	4.3201
R&D	0.0573	1.3553	0.0248	0.0479	0.0382	0.0677	-0.0134***	-5.2734

Table 2 presents the descriptive statistics on the full sample and subsamples of with women and without women. Refer to Table 1 for variable definitions.

Table 3. Correlation matrix

	Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	ratio_ofcash	1.0000																
2	%women_on_board	-0.0626	1.0000															
3	number_women_on_board	-0.0998	**0.9359**	1.0000														
4	w1	-0.0521	0.0185	0.0589	1.0000													
5	w2	-0.0043	0.0502	0.0534	0.4223	1.0000												
6	w3	0.0053	0.0130	0.0113	0.0037	**0.8763**	1.0000											
7	board_size	0.2359	0.3351	0.5043	0.1808	0.0833	-0.0364	1.0000										
8	ceo_duality	-0.0191	-0.0452	-0.0885	-0.0349	-0.0290	0.0364	-0.1025	1.0000									
9	independent_directors	0.1625	0.3771	0.5112	0.1357	0.1340	-0.0603	0.5038	-0.0233	1.0000								
10	levta	-0.2419	0.1271	0.1451	0.0211	-0.0532	0.0558	0.1821	-0.0242	0.1797	1.0000							
11	ln_asset	0.1142	0.3249	0.4259	0.0358	0.0699	-0.0117	0.4873	-0.1650	0.3918	0.1840	1.0000						
12	nwcta	-0.1742	-0.0549	-0.0759	0.0258	0.0099	-0.0417	-0.0973	0.0250	-0.0918	-0.0440	-0.0973	1.					

2		0.06	0.18	0.23	0.05	0.02	0.05	0.23	0.00	0.21	0.26	0.24	0.00					
		39	39	97	22	71	11	85	07	81	24	10	00					
													0.01					
			-0.15	-0.16	-0.08	-0.12	-0.08	-0.06	-0.00	-0.06	-0.01	-0.03	40	1.00				
13	capexta	0.24	98	57	81	84	43	49	62	53	72	28	60	00				
			-0.19	-0.21	-0.11	-0.11	-0.09	-0.11	-0.10	-0.10	-0.05	-0.19	0.08	0.13	1.00			
14	div_payout	0.10	09	46	34	04	16	38	80	16	10	46	40	14	00			
					-0.11	-0.01				-0.01	-0.13		0.05	-0.17	-0.19	1.00		
15	tobin_q_ratio	0.13	0.08	0.08	0.06	0.01	0.04	0.03	0.01	0.01	0.13	0.19	70	07	69	00		
			-0.08	-0.11	-0.01	-0.05	-0.05	-0.03	-0.15	-0.02	-0.15	-0.27	0.07	0.02	0.05	-0.23	1.00	
16	ROA	0.26	54	77	38	90	01	63	39	65	97	13	91	44	93	10	00	
			-0.17	-0.16	-0.05	-0.07	-0.01	-0.10	-0.17	-0.03	-0.19	-0.03	0.06	0.25	-0.05	0.40	-0.03	1.00
17	R&D	0.36	80	70	59	52	86	57	43	40	16	97	17	06	26	09	20	00

The table presents the correlation matrix among all the variables used in this study. Refer to Table 1 for variable definition.

Table 4. Females on the board and cash holdings

	Panel A: ratio_ofcash			Panel B: cashta		
Variables	(1) OLS	(2) FE	(3) Lagged board	(4) OLS	(5) FE	(6) Lagged board
%women_on_board	-0.0059***	-0.0069***	-0.0076***	-0.0023***	-0.0031**	-0.0032**
	(-2.81)	(-2.40)	(-3.01)	(-2.42)	(-2.16)	(-2.18)
board_size	-0.0058***	-0.0150***	-0.0023*	-0.0039***	-0.0023**	-0.0020**
	(-3.15)	(-2.69)	(-1.86)	(-3.12)	(-2.19)	(-2.14)
ceo_duality	0.0116**	0.0104	0.0201**	0.0013	0.0012	0.0019**
	(2.10)	(1.47)	(2.19)	(1.63)	(1.56)	(2.03)
independent_directors	-0.0024	-0.0017*	-0.0214*	-0.0015*	-0.0013	-0.0016*
	(-1.68)	(-1.90)	(-1.86)	(-1.94)	(-1.54)	(-1.99)
E index	0.0012**	0.0027*	0.0117*	0.0021**	0.0012*	0.0211**
	(2.08)	(1.93)	(1.89)	(2.19)	(1.87)	(2.01)
levta	-0.1076***	-0.1076***	-0.1313***	-0.0912***	-0.1023***	-0.1322***
	(-3.14)	(-7.13)	(-3.85)	(-3.19)	(-5.03)	(-5.13)
ln_asset	-0.0413***	-0.0123***	-0.0278***	-0.0143***	-0.0113***	-0.0133***
	(-4.52)	(-3.12)	(-4.33)	(-3.41)	(-3.13)	(-3.14)
nwcta	-0.1101***	-0.1401***	-0.1340***	-0.0562***	-0.1120***	-0.1019***
	(-3.19)	(-4.89)	(-4.13)	(-4.69)	(-3.13)	(-4.19)
capexta	0.1248***	0.1462***	0.1246***	0.1652***	0.1902***	0.1802***
	(4.83)	(2.57)	(4.77)	(5.13)	(2.82)	(2.98)
div_payout	-0.0215***	-0.0123***	-0.0198***	-0.0431***	-0.0183*	-0.0210**
	(-3.42)	(-2.89)	(-3.11)	(-6.29)	(-1.86)	(-2.13)
tobin_q_ratio	0.0234***	0.0344***	0.0371***	0.0112***	0.0019***	0.0014***
	(4.14)	(3.27)	(2.43)	(6.01)	(4.21)	(2.82)
ROA	0.1304**	0.1201***	0.1410***	0.1112**	0.1009**	0.0910**
	(2.02)	(2.27)	(2.31)	(2.13)	(2.01)	(2.11)
R&D	-0.0012*	-0.0013	-0.0032**	-0.0114*	-0.0120	-0.0019**
	(-1.89)	(-1.27)	(-2.05)	(-1.87)	(-1.10)	(-2.11)
Industry	Y		Y	Y		Y
Year	Y	Y	Y	Y	Y	Y
Constant	0.2334***	0.1921***	0.2103***	0.1970***	0.1684***	0.1101***
	(2.93)	(4.16)	(4.19)	(4.17)	(3.64)	(4.18)
N	11,360	11,360	10,141	11,360	11,360	10,141
adj. R-sq	0.249	0.204	0.231	0.281	0.233	0.327

This table presents the regression results of model 1:

$$cash_{it} = \alpha + \beta_1(board\_gender\_diversity)_{it} + \beta_2(board\_characteristics)_{it} + \delta_3(firm\_characteristics)_{it} + \delta_4\sum(industry\ effects)_i + \delta_5\sum(year\ effects)_t + \varepsilon_{it}$$

where gender diversity is measured by the percentage of female directors on the board *(%women_on_board)*. Panel A presents the results when cash holdings are measured by the ratio of cash and cash equivalents to net assets. Panel B presents the results when cash holdings are measured by cash and cash equivalents to total assets. The OLS method employs the regressions with industry and firm-year effects. The FE method employs regressions with year effects. The lagged board method employs the industry and year effects estimations where contemporaneous board variables are replaced by lagged variables in the regression model. The robust *t*-statistic of each coefficient is shown in parentheses. Standardised beta coefficients are denoted at the 1%, 5% and 10% levels of significance by ***, **, * respectively.

Table 5. Females on the board: channel analysis

Variables	OLS	FE	Lagged board
%_women_executives	-0.0002	0.0007	0.0017
	(-1.69)	(1.42)	(1.11)
%_independent_women_directors	-0.0052***	-0.0059**	-0.0063***
	(-2.54)	(-2.16)	(-2.32)
board_size	-0.0042***	-0.0030***	-0.0012**
	(-3.16)	(-2.86)	(-2.12)
ceo_duality	0.0019***	0.0039*	0.0230**
	(2.45)	(1.93)	(2.01)
E index	0.0117**	0.0019*	0.0123**
	(2.01)	(1.99)	(2.19)
Levta	-0.1083***	-0.0923***	-0.1466***
	(-3.12)	(-3.98)	(-3.19)
ln_asset	-0.0402***	-0.0513***	-0.0503***
	(-4.21)	(-4.14)	(-5.90)
nwcta	-0.2103***	-0.1920***	-0.1132***
	(-3.82)	(-5.20)	(-4.16)
capexta	0.1732***	0.1237***	0.1420***
	(4.12)	(4.10)	(5.12)
div_payout	-0.0113***	-0.0129*	-0.0223**
	(-4.20)	(-1.95)	(-2.07)
tobin_q_ratio	0.0203***	0.0145***	0.0173***
	(2.45)	(3.12)	(6.93)
ROA	0.0914***	0.1145**	0.1320***
	(2.72)	(2.17)	(2.63)
R&D	-0.0114*	-0.0021	-0.0112***
	(-1.99)	(-1.64)	(-2.95)
Industry	Y		Y
Year	Y	Y	Y
Constant	0.1431***	0.1260***	0.1332***
	(5.14)	(4.89)	(4.23)
N	9,716	9,716	8,950
adj. R-sq	0.232	0.217	0.239
Diff. in Coefficients test	[9.11]	[8.31]	[10.30]

This table presents the results of model 1 where the gender diversity measure is replaced by the percentage of female executives *(%_women_executives*) and the percentage of female independent directors *(%_independent_women_directors*). See Table 1 for variable definitions and Table 4 for the description of OLS, FE, and lagged board methods. Industry and firm-year fixed effects are controlled in all regressions. The robust *t*-statistic of each coefficient is shown in parentheses. Standardised beta coefficients are denoted at the 1%, 5% and 10% levels of significance by ***, **, * respectively.

Table 6. Critical mass and cash holdings

Variables	(1) OLS	(2) FE	(3) Lagged board	(4) OLS	(5) FE	(6) Lagged board
number_women_on_board	-0.0032***	-0.0043**	-0.0118***			
	(-2.74)	(-2.12)	(-2.39)			
w1				-0.0162*	-0.0142	-0.0113
				(-1.90)	(-1.62)	(-1.70)
w2				-0.0098**	-0.0087**	-0.0067***
				(-2.18)	(-2.11)	(-2.31)
w3				-0.0020***	-0.0019***	-0.0025***
				(-2.84)	(-2.59)	(-2.62)
board_size	-0.0031***	-0.0202***	-0.0019***	-0.0036**	-0.0118**	-0.0012***
	(-3.01)	(-4.12)	(-2.81)	(-2.06)	(-2.02)	(-3.07)
ceo_duality	0.0102***	0.0021*	0.0098**	0.0113**	0.0042	0.0118*
	(2.63)	(1.90)	(2.17)	(2.11)	(1.47)	(1.92)
independent_directors	-0.0029*	-0.0042*	-0.0032*	-0.0022*	-0.0063**	-0.0027**
	(-1.96)	(-1.88)	(-1.90)	(-1.92)	(-2.13)	(-2.18)
E index	0.0020**	0.0011*	0.0212**	0.0038**	0.0029*	0.0018**
	(2.14)	(1.91)	(2.12)	(2.19)	(1.94)	(2.01)
levta	-0.1002***	-0.1432***	-0.1645***	-0.2001***	-0.1212***	-0.1616***
	(-3.49)	(-4.87)	(-3.71)	(-4.10)	(-3.14)	(-4.13)
ln_asset	-0.0364***	-0.0321***	-0.0321***	-0.0471***	-0.0328***	-0.0324***
	(-3.15)	(-2.90)	(-3.62)	(-3.11)	(-3.25)	(-3.12)
nweta	-0.1314***	-0.1612***	-0.1179***	-0.2109***	-0.1896***	-0.1439***
	(-2.89)	(-3.16)	(-4.12)	(-7.16)	(-6.02)	(-4.10)
capexta	0.2109***	0.2715***	0.2012***	0.2012***	0.2301***	0.3202***
	(4.18)	(6.70)	(5.19)	(4.11)	(3.09)	(5.10)
div_payout	-0.0212***	-0.0162***	-0.0211***	-0.0222***	-0.0432***	-0.0342***
	(-4.80)	(-2.91)	(-4.10)	(-4.02)	(-4.13)	(-2.83)
tobin_q_ratio	0.0202***	0.0443***	0.0374***	0.0202***	0.0343***	0.0121***
	(4.12)	(3.88)	(4.20)	(2.92)	(3.92)	(4.01)
ROA	0.0102**	0.0121**	0.0210***	0.0122**	0.0190**	0.0199**
	(2.12)	(2.07)	(2.99)	(2.01)	(2.16)	(2.01)
R&D	-0.0019*	-0.0030*	-0.0123**	-0.0142*	-0.0130**	-0.0132**
	(-1.89)	(-1.94)	(-2.09)	(-1.99)	(-2.14)	(-2.29)
Industry	Y		Y	Y		Y
Year	Y	Y	Y	Y	Y	Y
Constant	0.1602***	0.2002***	0.1406***	0.2850***	0.2108***	0.1902***
	(3.10)	(3.09)	(3.19)	(4.17)	(4.52)	(4.18)
N	11,360	11,360	9,704	11,360	11,360	9,704
adj. R-sq	0.223	0.189	0.242	0.237	0.197	0.223
Diff. in Coefficients w1-w2				[7.20]	[6.93]	[8.03]
Diff. in Coefficients w2-w3				[6.78]	[5.10]	[7.19]

This table presents the results of model 1 where gender diversity is replaced by the number of female directors on the board and three dummy variables equal 1 in case of one female director, two female directors, and three or more female directors on the board *(w1, w2, w3)*, respectively. See Table 1 for variable definitions and Table 4 for the description of OLS, FE, and lagged board methods. Industry and year effects are controlled in all regressions. The robust *t*-statistic of each coefficient is shown in parentheses. Standardised beta coefficients are denoted at the 1%, 5% and 10% levels of significance by ***, **, * respectively.

Table 7. Robustness

Variables	DID	PSM	2SLS
w_appointment × post period	-0.0312**		
	(-2.17)		
w_appointment	-0.0312		
	(-1.62)		
post period	0.0233		
	(1.21)		
%women_on_board		-0.0039***	
		(-2.32)	
%women_on_board-fitted			-0.0016***
			(-2.62)
board_size	-0.0192***	-0.0023*	-0.0128
	(-2.92)	(-1.98)	(-1.61)
ceo_duality	0.0137	0.0025	-0.0213**
	(1.57)	(1.37)	(-2.19)
independent_directors	-0.0143*	-0.0011	-0.0055**
	(-1.99)	(-1.74)	(-2.12)
E index	0.0015**	0.0021*	0.0020**
	(2.12)	(1.96)	(2.21)
levta	-0.1023***	-0.1372***	-0.1342***
	(-5.10)	(-5.15)	(-3.13)
ln_asset	-0.0542***	-0.0273***	-0.0433***
	(-3.26)	(-6.18)	(-5.32)
nwcta	-0.2203***	-0.2104***	-0.1983***
	(-3.11)	(-2.92)	(-4.10)
capexta	0.1204***	0.2012***	1.1342***
	(3.16)	(2.98)	(6.24)
div_payout	-0.0310**	-0.0339***	-0.0141*
	(-2.14)	(-7.12)	(-1.72)
tobin_q_ratio	0.0455***	0.0444***	0.0321***
	(3.23)	(3.10)	(4.12)
ROA	0.1123**	0.0921**	0.1497**
	(2.12)	(2.14)	(2.20)
R&D	-0.0112*	-0.0152	-0.0119
	(-1.99)	(-1.09)	(-1.21)
Industry	Y	Y	Y
Year	Y	Y	
Constant	0.1304***	0.2117***	0.2421***
	(6.10)	(4.21)	(2.99)
N	1,920	5,214	9,695
adj. R-sq	0.216	0.249	0.223

The column 1 in this table presents the results difference-in-differences based on model 2:

$$cash_{it} = \alpha + \beta_1(w\_appointment \times post\ period)_{it} + \beta_2(w\_appointment)_{it} + \beta_3(post\ period)_{it} + \delta_4(controls)_{it} + \varepsilon_{it}$$

where gender diversity is replaced by female-to-male and male-to-male appointments and post period is a dummy variable that equals 1 after the appointment and 0 otherwise to observe the change as a result of women appointments (treatment and control groups). Column 2 shows the results of propensity score matching and column 3 presents the second-stage regression of 2SLS. The industry and year effects are controlled. The robust *t*-statistic of each coefficient is shown in parentheses. Standardised beta coefficients are denoted at the 1%, 5% and 10% levels of significance by ***, **, * respectively.

Table 8 Industry analysis

	Panel A: Industry wise		Panel B: Industry excess cash	
Industry	OLS	FE	OLS	FE
Consumer Discretionary	-0.0020**	-0.0018**	-0.0114**	-0.0010*
	(-2.21)	(-2.12)	(-2.15)	(-1.89)
Staples	-0.0033*	-0.0019**	-0.0290**	-0.0014**
	(-1.99)	(-2.20)	(-2.11)	(-2.10)
Energy	-0.0106	-0.0047	-0.0191*	-0.0198*
	(-1.45)	(-1.12)	(-1.99)	(-1.87)
Health	-0.0061***	-0.0029**	-0.0443**	-0.0212**
	(-3.10)	(-2.12)	(-2.13)	(-2.16)
Industrial	-0.0023**	-0.0052**	-0.0201***	-0.0132**
	(2.11)	(-2.10)	(-2.65)	(-2.01)
Information Technology	0.0066	0.0022**	-0.0612*	-0.0059
	(1.23)	(2.19)	(-1.99)	(-1.70)
Materials	0.0089*	0.0012	-0.0111**	-0.0029*
	(1.89)	(1.00)	(-2.11)	(-1.99)
Real Estate	-0.0018*	-0.0012*	-0.0312**	-0.0193*
	(-1.88)	(-1.91)	(-2.12)	(-1.99)
Utilities	-0.0026**	-0.0023**	-0.0168**	-0.0230***
	(-2.14)	(-2.09)	(-2.12)	(-2.36)
Other controls	Y	Y	Y	Y
Year effect	Y	Y	Y	Y

This table presents the results of gender diversity on cash holdings in each industry (two-digit GICS) in Panel A. Panel B reports the results for excess cash holdings compared to industry peers and the effect of female presence on the board. See Table 1 for variable definitions and Table 4 for the description of OLS and FE methods. Firm-year effects are controlled in all regressions. The robust *t*-statistic of each coefficient is shown in parentheses. Standardised beta coefficients are denoted at the 1%, 5% and 10% levels of significance by ***, **, * respectively.

Table 9. The effect on firm value and alternative governance

	Market value		Excess return	High *E index*	Low *E index*
	(1)	(2)	(3)	(4)	(5)
%women_on_board × ratio_ofcash	0.0033***	0.0031***			
	(3.23)	(3.01)			
%women_on_board × Δratio_ofcash			0.2310**		
			(2.21)		
%women_on_board	-0.0012**	-0.0010	0.0101**	-0.0113**	-0.0010
	(-2.11)	(-1.19)	(2.14)	(-2.20)	(-1.19)
ratio_ofcash	0.0119**	0.0227**	0.0101		
	(2.15)	(2.20)	(1.69)		
Δratio_ofcash			0.0113		
			(1.64)		
board_size	-0.0034**	-0.0023	0.0010	-0.0192***	-0.0101*
	(-2.12)	(-1.12)	(1.34)	(-2.95)	(-1.85)
ceo_duality	-0.0063	-0.0057	-0.0097*	0.0104**	0.0121
	(-1.43)	(-1.41)	(-1.91)	(2.17)	(1.62)
independent_directors	0.0012	-0.0007	0.0012*	-0.0180*	-0.0231*
	(1.12)	(-1.05)	(1.85)	(-1.98)	(-1.88)
E index	-0.0011**	-0.0009*	-0.0012*	-	-
	(-2.01)	(-1.87)	(-1.97)	-	-
levta	0.0037	0.0020	-0.2021**	-0.0936	-0.0832
	(1.03)	(1.09)	(-2.20)	(-1.23)	(-1.10)
ln_asset	0.0372***	0.0223***	0.0121**	0.0128**	0.0110
	(4.12)	(3.01)	(2.19)	(2.10)	(1.19)
nwcta	0.0110	0.0302	0.0019	0.0190	0.0101
	(1.50)	(1.52)	(1.19)	(1.46)	(1.72)
capexta	-0.0339	0.0448	1.0204**	-0.0310*	0.0273
	(-1.67)	(1.47)	(2.03)	(-1.88)	(1.02)
div_payout	-0.0076	-0.0045	-0.1015**	-0.0184**	0.0119*
	(-1.23)	(-1.49)	(-2.19)	(-2.19)	(1.92)
tobin_q_ratio	0.1052***	0.1233***	-0.0213	0.0187	0.0212*
	(3.73)	(4.31)	(-1.10)	(1.20)	(1.96)
ROA	0.1042**	0.1322**	0.0125*	0.0972*	0.0632*
	(2.01)	(2.20)	(1.84)	(1.91)	(1.87)
R&D	-0.0053*	-0.0134*	0.0112*	-0.0023*	0.0134*
	(-1.87)	(-1.99)	(1.90)	(-1.99)	(1.88)
levta × Δratio_ofcash *t*-1			0.2310		
			(1.43)		
ratio_ofcash × Δratio_ofcash *t*-1			0.4210*		
			(1.90)		
Industry	Y			Y	Y
Year	Y	Y		Y	Y
Constant	-0.1101**	-0.0130**	0.0132***	0.0111***	0.0101***
	(-2.01)	(-2.12)	(3.12)	(3.54)	(3.83)
N	7,109	7,109	7,109	6,134	5,226
adj. R-sq	0.302	0.262	0.212	0.218	0.197

This table presents the results (columns 1 and 2) where gender diversity is replaced by an interaction variable *(%women_on_board × ratio_ofcash)* to show the effect on market value of the firm (market value is measured as market capitalisation plus liabilities scaled by net assets). Column 3 shows the effect of board gender diversity on the value of cash holdings (excess return). Columns 4 and 5 show the effect of board gender diversity on cash holdings in the subsample of high/low managerial entrenchment. The robust *t*-statistic of each coefficient is shown in parentheses. Standardised beta coefficients are denoted at the 1%, 5% and 10% levels of significance by ***, **, * respectively.

[i] Carter, D'Souza, Simkins, and Simpson (2010) find no significant relationship between gender diversity and firm performance, which is consistent with Farrell and Hersch (2005). Gyapong et al. (2016) examines the relationship between gender and ethnic diversity with firm value and report a positive association.

[ii] For instance, Norway promoted board gender diversity by mandating that 40% of board members be female and implemented the policy in 2008. Spain mandated the same quota which was met in 2015. Belgium, France, Germany, Netherlands, Sweden and the UK are considering the feasibility of imposing a gender quota on their corporate boards. In the US, multiple research agencies, such as the Interfaith Center on Corporate Responsibility and the National Association of Corporate Directors Blue Ribbon Commission, all highly recommend board gender diversity to remove hurdles in women's career advancement.

[iii] Dittmar and Mahrt-Smith (2007) observe higher cash holdings in the countries where investor protection is very poor, suggesting that internal governance is a strong pillar to implement rational cash reserves. Similarly, Harford et al. (2008) show that managers disgorge cash by investing in negative NPV projects where corporate governance mechanisms are not in place. Chung et al. (2015) find a correlation between lower cash holdings in firms with higher information asymmetry.

[iv] Prior research (e.g., Huang and Kisgen, 2013) also supports the notion that female directors are more conservative and less confident than their male counterparts.

[v] The E index is based on the six provisions that set constitutional limits on the voting power of shareholders and strengthen the protection against takeovers. Four provisions set limits on shareholder voting power including staggered boards, limits to shareholder amendments of the bylaws, supermajority requirements for mergers and supermajority for charter amendments. The other two provisions strengthen the protection that managers have against takeovers and are poison pill and golden parachute arrangements. Each company is given a certain score from 0 to 6 based on these provisions in a given year. The higher the index value, the more entrenched managers are likely to be in the firm (Bebchuk et al., 2009).

[vi] Lardaro (1993) suggests that multicollinearity can cause an issue if VIF exceeds 10.

[vii] The technique is commonly suggested for panel data estimation (see, Wooldridge, 2002 for detail). FE was supported with large panel and extended time (see, Wooldridge, 2002), which is the case of our study with n = 1,395 and t = 10.

[viii] As a robustness check, we also employ an alternative econometric specification (i.e., Tobit regression) in Panel A and B following prior literature (e.g., Chen et al., 2017; Hossain et al., 2019) and find statistically similar results as in Table 4. Our results (un-tabulated) remain consistent if we include sales growth, return on sales (*ROS*), and market-to-book-ratio as control variables in our regressions.

[ix] We also test this relationship by excluding female executive directors in the regression model as the monitoring function is unlikely to apply to the female executive directors. We find consistent findings. In addition, we also run a regression including additional variables of female chairperson or equivalent (a dummy variable equals 1 if the chairperson is female and 0 otherwise), director tenure and age in our regression model. Our results (un-tabulated) remain consistent with female independent directors' monitoring intensity.

[x] We require the departing male director to be aged over 60 to ensure that the director turnover is not driven by unobserved factors, such as firm policy changes. Our results are consistent if we require the departing male director to be aged over 65.

[xi] To verify that the firms in the treatment and control groups are indistinguishable in terms of observable characteristics, we conduct a diagnostic test (un-tabulated) that examines the differences in the mean value of each observable characteristic between the treatment and control firms. We find that none of the differences between the firm observable characteristic of the treatment and control groups are statistically significant.

[xii] As a robustness test, we also use nearest neighbour matching, multiple firms matching, and matching by changing the caliper from 0.1% to 0.5%. The results remain the same.

[xiii] We also test the relationship in growth firms employing interaction between gender diversity and growth opportunities following previous studies. We find consistent results (un-tabulated).

[xiv] We also split the sample based on high and low board independence. We find a significantly negative relationship (un-tabulated) between board gender diversity and cash holdings in the latter.