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Board gender diversity and stock price crash risk: Going beyond tokenism

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Abstract

We empirically examine the role of board gender diversity in influencing stock price crash risk at the firm-level in twelve (12) Asia-Pacific Markets. Using a dataset comprising data from 1021 listed firms over the period 2006−2016, we employ a random effect model in a regression setting. Controlling for the firm and market-level variables, we find that board gender diversity results in lowering the stock price crash risk of the firm. Bifurcating women directors on corporate board into numerical representation (token and critical mass representation), the results support our main conjectures and suggest that the economic significance of this relationship is higher for firms that have three or more women directors on the board as compared to the firms that have less than three women directors on the corporate board. Our results are robust to alternative measures of stock price crash risk, potential endogeneity and selection biases.

JEL classification: G11; G14; G34; M14

Keywords: Token representation; Critical mass; Women director; Information asymmetry; Stock price crash risk

1. Introduction

Stock price crash risk (SPCR) is a particularly unfavourable phenomenon in business. The asymmetry of variation in security returns, i.e., considerable changes in prices resulting in crashes rather than increases, may reduce the wealth of investors and affect the stability and development of the capital market (Yin & Tian, 2017). A large number of investors' wealth can be swept away due to a sudden decline in stock prices. Hence, it becomes the cause of discouragement to investors. Earlier studies have argued that SPCR occurs when managers announce unwelcoming news relating to compensation and career concerns. When this negative information reaches the market, it can cause a sudden decrease in stock prices. There are two main reasons behind these crashes. The first is agency conflict, where the management has personal incentives to store negative information for a prolonged period. The second reason relates to directors who may have some benefits from over-investing in negative NPV projects, but those projects are privately beneficial for them, so they hide information, which contributes to SPCR (Kim, Li, & Li, 2014).

Building on Agency Theory, Jin and Myers (2006) proposed a nexus between crash risk and information asymmetry between managers and shareholders. The idea of crash risk is explicitly linked to the bad news suppression by management, i.e., managers can control and manipulate firm-specific

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information; the primary motive is to gain abnormal private gains for instance, (inter alia) extended employment period, limiting litigation costs, and various compensations (Kothari, Shu, & Wysocki, 2009). However, managers can induce information asymmetry in the short-run but, in the longer term, once a threshold is reached, they are forced to give up the procrastinated information thus causing an unexpected decline in stock price causing stock crash risk. This mechanism is further validated by several studies.[1] Subsequently, although the literature rooted in crash risk is extensive, only an infinitesimal proportion of this literature places emphasis on corporate boards attributes and crash risk. The gender diversity is one of those attributes which our study considers. The literature lent support to the idea that the procrastination of bad news (causing information asymmetry) is more prevalent in gender homogenous management groups and vice versa. Thus, gender diversity (as a pivotal facet of corporate board) plays imperative role in mediating association of crash risk and information asymmetry. Henceforth, gender diversity gained considerable traction in recent past literature.

Consequently, extant literature documented several channels and theoretical premises via which gender-diversity on corporate boards curtial information asymmetry. For instance, a gender-diverse board improves transparency and reduces poor governance (Gul, Srinidhi, & Ng, 2011), provides better disclosures (Srinidhi, Gul, & Tsui, 2011), reduces managerial opportunities behaviour and information asymmetry (Usman, Farooq, Zhang, Makki, & Khan, 2019), reduces the severity of fraud (Cumming, Leung, & Rui, 2015), provides greater monitoring (Nguyen, 2020), and contributes to higher verification standards (Gul et al., 2011). Thus, considering literature, (inter alia) gender diversity likely plays pivotal role in influencing the association of information asymmetry and crash risk.

Existing studies document empirical and theoretical evidence on the role of BGD in influencing different economic, governance, environmental, and financial outcomes.[2] Jebran, Chen, and Zhang (2020) have recently examined the role of board diversity in reducing the SPCR by dividing board diversity into relation-oriented diversity − which includes gender and age − and task-oriented diversity − which includes tenure and education of directors using single country data. They found that a greater diverse board can minimize future SPCR by reducing the bad news concealed off by managers. Besides, their study unveils that firms with low institutional ownership and high information opacity have a stronger effect of board diversity on future SPCR.

We aim to empirically examine the role of BGD in reducing SPCR, thus contributing to the literature on the economic and financial consequences of BGD in three ways: First, our study departs from the current understanding on the role of BGD in altering the organizational outcomes by classifying the BGD through the numerical representation of women directors by building on the Token and Critical Mass perspective (Kanter, 1977). Kanter (1977) argued that women director abilities to affect organizational outcomes show that these depend on the numerical representation of women executive on corporate boards. Token representation envisions that corporate boards having one or more women directors may not be enough to bring about the change in the organizational outcomes. In contrast, the critical mass perspective developed by Kanter (1977) suggests that three or more women directors on board are essential for achieving organizational outcomes. Both the token and critical mass representation of women directors on corporate board underpin the underlying numeric reasoning and mechanism via which a specific group influences the outcomes of an overall group. For instance, in our study, women directors on boards are considered as a specific group within the general corporate board. The token representation argument suggests that the presence of one or two women directors on boards might not be enough to bring pivotal changes in organizational policies and conduct. On the contrary, the critical mass perspective suggests that three or more than three women directors on corporate board play a crucial role in significantly influencing organizational outcomes. We aim to establish the compositional threshold where a women director exerts enough influence to reduce the crash risk associated with an organization.

Second, we use firm-level data from a sample from 12 Asia-Pacific markets. Evidence shows that at least one-woman director is present on the corporate boards of all companies in our sample in the Asia-Pacific region[3] where tokenism and critical mass representation of women directors on corporate board. Thus, the utilization of token and critical representation in constructing a methodological framework for this study is justified. Third, from an empirical perspective, we split the firms based on numerical representations of women directors on their corporate board to provide a comparative interpretation of the economic and statistical significance of estimation of treatment responses validated by a propensity score matching approach.

Our results suggest a negative relationship between BGD and SPCR which implies that BGD reduces SPCR. In addition, the economic significance of this relationship is higher for

[1] For instance; opacity in firms financial statements are subjected to higher risk of stock price crash risks (Hutton et al., 2009), in anticipation of abnormal returns on option portfolio value of stock price of CEO's and CFO's induce bad news suppression causing crash risk (Kim, Li, & Zhang, 2011).

[2] For instance: BGD in managerial ability and over-investment (Habib & Hasan, 2017), short sales (Ni & Zhu, 2016), national culture via individualism (Dang et al., 2017), managerial ownership (Chen & Zhang, 2016), excessive information disclosure (Zhang & Nam, 2016), excess perks (Xu, Li, Yuan, & Chan, 2014), stock price synchronicity (Jin, Yan, Xi, & Liu, 2016), individual CEO & CFO's management styles (Liu, Wei, & Xie, 2014), political connections (Lee & Wang, 2017), takeover protection (Bhargava, Faircloth, & Zeng, 2017), trading time risks on stock investment return (Li, Dong, Yang, & Long, 2017), credit default swap (CDS) trading (Liu, Ng, Tang, & Zhong, 2019), corporate social responsibility (Kim et al., 2014), stock liquidity (Chauhan et al., 2017), corporate philanthropy (Zhang et al., 2016), financial management & financial reporting quality (Khan et al., 2017; Reguera-Alvarado et al., 2017; Wahid, 2019; Ward & Forker, 2017).

[3] Out of 1021 companies, most of the firms have at least one women director.

firms that have three or more women directors on the board as compared to the firms that have less than three women directors. The findings have important implications for the wealth of investors in making sound portfolio investment decisions. By understanding the source of SPCR, firms would be more able to safeguard their investments. The findings of this study are useful to regulators, managers, academic researchers, and entrepreneurs to consider the role of a woman on corporate boards.

The remaining paper is structured as follows: Section two of this study discusses the relevant literature and the main hypothesis. Section three details the sample, data and empirical strategies Section 4 contains the results of the study followed by the conclusion and implications in the last section of the study.

2. Relevant literature and hypothesis development

There has been a trend showing a significant increase in women's involvement on corporate boards, but the proportion of male directors on boards is still in the majority (Torchia, Calabrò, & Huse, 2011). Extant studies documented that the presence of women in an organization's top management can significantly influence its organizational outcomes (Khan, Hassan, & Marimuthu, 2017; Reguera-Alvarado, de Fuentes, & Laffarga, 2017). The shreds of evidence presented by extant studies are drawn on three key mechanisms that affect strategic decisions at the firm level, and through which firms can control organizational outcomes. These mechanisms are gender-based functional differences; discrimination; and role expectations (Cook & Glass, 2018). These three mechanisms are related to gender differences in the organizational setup. Besides the general differences between men and women, gender differences may also display fundamental limitations, cultural limitations, and biases that are present in the organizations and entrenched in gender stereotypes and norms (Acker, 1990).

Extant literature argues that the involvement of women directors on corporate boards is linked with several benefits to businesses.[4] For instance, a few other studies[5] investigate the effect of BGD on firm risk-taking. Many of these studies applied a dynamic model to test the relationship between BGD and firm risk-taking. Lenard, Yu, York, and Wu (2014) indicated that more BGD impacts firm risk and it contributes to lower variation in stock market return. Poletti-Hughes and Briano-Turrent (2019) show that the proportion of women director to board size significantly increases venture risk. In contrast, Bruna, Dang, Scotto, and Ammari (2019), Sila, Gonzalez, and Hagendorff (2016), and Loukil and Yousfi (2016) found no evidence of a significant relationship between BGD and firm risk-taking. Saeed, Mukarram, and Belghitar (2019) determine the impact of BGD on firm risk-taking in the context of Indian high-tech and non-high-tech firms. The results indicated that in comparison to counterpart women executives working in the non-high sector, women executives working in high-tech sectors take more risk. Khaw, Liao, Tripe, and Wongchoti (2016) find that corporate risk-taking behaviour is high where the boards have only male directors − lower gender diversity − in China.

The Agency theory perspective of Jonas and Blanchet (2000) and Lu, Richardson, and Salterio (2011) indicated that financial statement disclosed by companies should be clear, reliable, relevant, and transparent to curtail asymmetric information (Chen, Hope, Li, & Wang, 2011) and agency cost. In the presence of information asymmetry, managers have greater internal company knowledge compared to owners, causing a conflict of interest. On the other hand, if the companies do not have information asymmetry, the owners and managers have the same internal knowledge of the firm thus limiting conflict of interest (Pucheta-Martínez, Bel-Oms, & Olcina-Sempere, 2018). Kim, Li, Lu, and Yu (2016) argue that the comparability of companies that have weak financial statements is more disposed to crash risk. It is found that this relationship is much stronger in companies that have a lower quality of information and those that are not willing to give factual information in their financial reports. Similar results are also supported by Yin and Tian (2017). Kim and Zhang (2014) argue that the manipulation of financial reports is one of the reasons for crash risk in many firms. Henceforth a commitment-based process where each company assumes to disclose financial information is referred to as Financial Reporting Quality (FRQ). In this context, Khazanchi (1995) and Ruegger and King (1992) explicate that the composition of boards is pivotal in assuring the credibility and transparency of financial statements. FRQ may be enhanced by the inclusion of women directors on board since as compared to male directors, they behave more ethically and may recognize opportunistic behaviors in firms. Hutton, Marcus, and Tehranian (2009) measure the transparency of financial reporting using accruals, and the results show an inverse relationship between higher financial reporting quality and crash risk. Orazalin (2019) argues that the characteristics of an effective board including BGD, independent directors, and board size, serve as a control mechanism to enhance the FRQ. Wahid (2019) finds that there are fewer financial reporting mistakes as well as less engagement in fraud in gender-diverse boards.

Less transparent organizations may employ earning management practices and hide bad news from various stakeholders. This phenomenon leads to the hoarding of bad news, which is one of the principal causes of crash risk. Orazalin (2019) argues that reported earnings impact compensations of managers leading them to actively engage in earnings management. In contrast, effective and ethical corporate

[4] For instance, better environmental policy (Liu, 2018; Zahid et al., 2019), better adoption of CSR practices (Ben-Amar, Chang, & McIlkenny, 2017; Rao & Tilt, 2016), effective financial management (Ward & Forker, 2017), more entrepreneurial outcomes (Lyngsie & Foss, 2017), high return on equity (Low, Roberts, & Whiting, 2015), better dividend policy (Benjamin & Biswas, 2017), positive financial results and business performance (Salloum, Jabbour, & Mercier-Suissa, 2019; Wu, Yao, & Muhammad, 2017), enhancing the boards of directors' effectiveness (Terjesen, Couto, & Francisco, 2016), lower risk (Nadeem, Suleman, & Ahmed, 2019), bringing innovation (Teruel & Segarra, 2017) amongst others.

[5] Bruna et al. (2019), Lenard et al. (2014), Loukil and Yousfi (2016), Poletti-Hughes and Briano-Turrent (2019), Sila et al. (2016).

governance practices may lead to a decrease in aggressive earnings management, hence mitigating agency costs (García Lara, García Osma, Mora, & Scapin, 2017; Xie, Davidson III, & DaDalt, 2003). Thiruvadi and Huang (2011) show that earnings management practices are deterred by women directors on audit committees of companies from S&P Small Cap 600. Kyaw, Olugbode, and Petracci (2015), using European companies' data, unveil that BDG reduces earnings management in countries where the levels of gender equality are relatively high. Likewise, Arun, Almahrog, and Aribi (2015) find that companies adopt more restrained earnings management practices where the number of women and women independent directors is high in the UK. Orazalin (2019) also confirmed that companies with higher BGD are more effective in limiting earnings management. Prior studies[6] provided evidence of a negative relationship between the existence of women directors on board and earnings management practices. As opposed to these findings, using a sample of Chinese firms, Ye, Zhang, and Rezaee (2010) indicate that there is no relationship between the top executive gender diversity and earnings quality, results that are similar to those presented by Sun, Liu, and Lan (2011). Similarly, Waweru and Prot (2018) considering East African listed firms, find no impact of BGD on earnings management.

Francoeur, Labelle, and Sinclair-Desgagné (2008) posit that women directors could mitigate information bias while formulating strategies, as it is claimed that they are likely to have broad perception in looking at complex problems. Gul et al. (2011) noted that BGD results in a richer information environment. They argue that BGD reduces information asymmetry via more intensive oversight in comparison to the all-male board of directors. Upadhyay and Zeng (2014) find a negative association between board diversity and corporate opacity. Puthenpurackal and Upadhyay (2013) investigate the effect of information dissemination on the association between BGD and firm performance. They unveil the performance effect of women directors based on companies' information environments and their experience. In less opaque companies, women directors seem to be more helpful. Women directors with senior corporate experience are linked with higher performance. Hence, while deciding on the hiring of women directors, the companies seem to take into consideration their information environment. Finally, Lucas-Pérez, Mínguez-Vera, Baixauli-Soler, Martín-Ugedo, and Sánchez-Marín (2015) elucidate that BGD relates to better monitoring, resultantly in improved transparency, and a richer information environment.

Abad, Lucas-Pérez, Minguez-Vera, and Yagüe (2017) measure the association between BGD of companies and levels of asymmetric information in the security market. They argued that past literature recommends that the existence of women directors on boards maximize the quality of public disclosure; hence, they expect companies with higher BGD indicate lower levels of asymmetric information in the market. The study employed system Generalized Method of Moments (GMM) panel methodology and proxies for asymmetric information measured from high-frequency data using a Spanish sample. They reveal that there is a negative association between BGD and the level of asymmetric information in the security market. Thus, the results provide evidence that the existence of women directors on boards is associated with lower levels of asymmetric information and BGD enhances the information environment by improving the problems of adverse selection among market participants. In contrast, using data from Pakistan, Siddiqui and Atique (2020) find an insignificant relationship between corporate BGD and level of asymmetric information in Pakistan's security market. They further unveil that as compared to developed markets; the expectation is not the same for the underdeveloped market. They further argued that since listing regulations are a bit strict and at least one woman director requirement in the board is made compulsory in 2017.

Recently, Jeon (2019) investigated the association between corporate governance (characteristics of the board of directors) and SPCR. The study employed logit and OLS regression model using 3635 observations of Korean listed companies. The results show direct evidence for the association between SPCR and corporate governance characteristics of the board of directors. The study further reveals that there may have an effect of corporate governance on mitigation of SPCR when there is independent and expert directors present, irrespective of the size of the board. More recently, Jebran et al. (2020) examine the influence of board gender diversity on stock price crash risk. The study classifies the board diversity into relation-oriented diversity and task-oriented diversity − diversity in terms of gender and age, and tenure and education, respectively. Their findings suggest that greater diverse boards can minimize future SPCR. In addition, their study unveils that firms with low institutional ownership and high information opacity have stronger effects of board diversity on future SPCR.

The existing literature suggests that board gender diversity indeed plays a crucial role in the reduction of information asymmetry which resultantly reduces SPCR. We extend this line of inquiry using the same premises used by Jebran et al. (2020). Our work, however, departs from the current understanding of Jebran et al. (2020) by decomposing the numerical classifications of gender diversity contrary to relation-oriented diversity (gender and age) and task-oriented diversity using the premises of Kanter (1977). Kanter (1977) argues women directors' abilities to effects organizational outcomes show that these depend on the numerical representation of women on executive corporate boards. Token representation envisions corporate boards that have one or more women directors may not be enough to bring about the change in the organizational outcomes. In contrast, a critical mass premise of (Kanter, 1977) suggests that three or more women directors' existence on board is essential for achieving organizational outcomes. We, therefore, hypothesize that:

[6] For instance: García Lara et al. (2017), Gavious, Segev, and Yosef (2012), Gull, Nekhili, Nagati, and Chtioui (2018), Harakeh, El-Gammal, and Matar (2019), and Triki Damak (2018).

H1. Firms with three or more women directors will have less future stock price crash risk than firms with one or two women directors.

3. Data and empirical approach

3.1. Data collection and sample size

The sample size for this study comprises of 1021 companies in the Asia-Pacific Region from 2006 to 2016. The Asia Pacific region constitutes 12 well-integrated equity markets segregated in two distinct groups, i.e., emerging markets and advance equity blocks (Tan, Cheah, Johnson, Sung, & Chuah, 2012). There are several rationales behind selecting the Asia-Pacific region as a sample. Firstly, to enjoy the benefits of foreign investments, the governments of the Asia Pacific region ensured financial integration to remove the majority of financial impediments. Secondly, in conjuncture with the former point, the financial crisis or post-financial crisis recovery will be homogenously transmitted in the region, thus limiting heterogeneity in the analysis (Click & Plummer, 2005). The sample of the Asia-Pacific is based under the assumption of at least partial homogeneity in governance mechanisms, integration of stock markets business environment that would help achieve reliable results as compared to choosing heterogeneous samples driven by the different business environment, governance mechanisms, and integration of stock markets. The data have been collected from Thomson Reuters. The sample has been drawn from twelve different countries in the Asia-Pacific Region: Australia, Hong Kong, Taiwan, South Korea, India, China, Malaysia, New Zealand, Singapore, Indonesia, Thailand, and the Philippines. The study considers all available data on Thomson Reuters for companies in the Asia-Pacific Region. The distribution of sample size across the countries and sectors is given in Table 1 (Panel A and Panel B). Panel A represents the distribution of the sample across the countries. Almost 66.3% of the samples used in the study are obtained from South Korea, Taiwan, Hong Kong, and Australia. Panel B presents the sample distribution across sectors. In Panel B, the industrial sector shows the most substantial proportion of the sectors with 76.2%.

Table 1
Sample composition.

Panel A: Sample Distribution across Countries		
Countries	**N**	**%age**
Australia	323	31.6
Hong Kong	141	13.8
Taiwan	115	11.3
South Korea	98	9.6
India	80	7.8
China	74	7.2
Malaysia	43	4.2
New Zealand	37	3.6
Singapore	33	3.2
Indonesia	32	3.1
Thailand	29	2.8
Philippines	16	1.6
Total	1021	100
Panel B: Sample Distribution across Sectors		
Industry	**N**	**%age**
Industrial	778	76.2
Consumer services	50	4.9
Basic material	37	3.6
Consumer goods	37	3.6
Technology	33	3.2
Utilities	27	2.6
Healthcare	24	2.4
Oil &Gas	20	2.0
Telecom	15	1.5
Total	**1021**	**100**

3.2. Variable measurement

3.2.1. Dependent variable: future stock price crash risk ($SPCR_{it}$)

Based on previous studies, we employ two different methods of measuring SPCR, namely, negative conditional skewness (NCSKEW) and down-to-up volatility (DUVOL). We used the following mathematical expression (1) to measure NCSKEW.

$$NCSKEW_{i,t} = -n(n-1)^{\frac{3}{2}} \sum W_{i,t}^3 \Big/ \left[(n-1)(n-2)\left(\sum W_{i,t}^2\right)^{\frac{3}{2}}\right] \quad (1)$$

NCSKEWi,t is the negative conditional skewness of firm i in time t and n represents the number of observations for the firm i during the year t. Whereas Wi,t = ln (1+ εi,t), while εi,t is the residual of equation (2). Wi,t is taken as the firm-specific weekly return. We use Equation (1) to find out the NCSKEW. NCSKEWi,t is the negative conditional skewness of firm i in time t and n represents the number of observations for the firm i during the year t. In this way, we have NCKEW for each year or annual basis, which matches the frequency of the final equation. NCSKEWi,t is the negative conditional skewness of firm i in time t and n represents the number of observations for the firm i during the year t. In this way, we got NCKEW for each year or annual basis, which matches the frequency of the final equation.

A greater value of the $NCSKEW_{i,t}$ means that the stock is subject to greater crash risk (Callen & Fang, 2015). We run the following expanded market model regression to calculate residual $\varepsilon_{i,t}$ for each week to measure $W_{i,t}$.

$$r_{i,t} = \alpha + \beta_{1i} r_{m,t-2} + \beta_{2i} r_{m,t-1} + \beta_{3i} r_{m,t} + \beta_{4i} r_{m,t+1} + \beta_5 r_{m,t+2} + \varepsilon_{i,t} \quad (2)$$

In the above equation (2), $r_{i,t}$ stands for the returns on the stock of firm i in week t, while $r_{m,t}$ is the value-weighted market return in week t. In the regression model, we also include the lead and lag terms of the value-weighted market return.

In the literature, the second measure of SPCR is down-to-up volatility (DUVOL). For this, firms' weekly returns are split into two categories, the first being "up" weeks and the

second being "down" weeks. Up weeks are when the returns are higher than the annual mean and down weeks are when the returns are below. Standard deviation is calculated separately for each of these groups. Again standard deviation, which is the aggregation function (group function) is calculated separately for each of these groups for a given year for down and up the week and take the log of their ratio (Dang, Faff, Luong, & Nguyen, 2017). The mathematical expression of this DUVOL is given in equation (3); its frequency is annual.

$$DUVOL_{i,t} = \ln\left\{\frac{\left[(n_u - 1)\sum_{Down} W_{i,t}^2\right]}{\left[(n_d - 1)\sum_{Up} W_{i,t}^2\right]}\right\} \quad (3)$$

3.2.2. Independent variable: board gender diversity (BGD_{it})

We measure BGD based on critical mass and token representation of women directors on board, which suggests that three or more women directors (BGD) should be present on the board to be capable of performing their tasks efficiently. We categorize the organizations in this way using our dataset. We formulated a dummy variable in this study (0/1) for women representation on corporate boards. The dummy is coded with value '1' if that case exists, and if not, it is coded with '0'. Firms that have three or more women on the board are coded as '1' and those with fewer than three women on the board are coded as '0' (Cook & Glass, 2018; Joecks, Pull, & Vetter, 2013; Torchia et al., 2011). Furthermore, to compare the effect of the existence of two thresholds of the existence of women on board, we also categorize the BGD as a dummy variable and coded as 1 if firms have at least one woman director otherwise it is coded as 0.

3.2.3. Control variables

Based on previous studies, control variables of this study include trading volume (DTURN), return (RET), market-to-book ratio (MB), firm size (SIZE), leverage (LEV), return on asset (ROA), SIGMA, and discretionary accruals (DACC) (Chauhan, Kumar, & Pathak, 2017; Jia, 2018; Zhang, Xie, & Xu, 2016). The first is the trading volume which measures the firm's share turnover in year t, RET shows the firm stock return. Firm size (SIZE), which can be explained as the natural logarithm of the total assets (TA), and it is measured at the end of the fiscal year. Market-to-book ratio (MB) is a measure of the market value of equity divided by the total book value of equity. In previous studies, the relationship between firm size and SPCR is reported as positive, which means that if firm size increases, the crash risk will also increase (Chen & Zhang, 2016; Hutton et al., 2009). The next control variable is leverage (LEV). This is calculated at the end of the year by dividing long-term debt and TA, and the link between leverage and SPCR is negative. Organizations with less crash risk can borrow more and, therefore, leverage is related to lowering crash risk, and there is a pessimistic association between them (Callen & Fang, 2015; Hutton et al., 2009).

ROA is the third control variable, which can be calculated by dividing net income by the lagged TA. The relationship between them is negative, meaning that the company is efficiently converting assets into profit and having better financial performance. Firms with good performance are less likely to face crash risk. The management, therefore, made the best decisions to earn high returns on investment and show better performance. Thus, the whole team focuses on its activities and attempts to work in the best way. Because of their inspirational performance, they do not have anything they need to hide from the market, and there is, therefore, a negative relationship between them (Callen & Fang, 2015; Hutton et al., 2009). The last control variable is discretionary accruals, which can be measured using the model proposed by McNichols and Stubben (2008).

$$\Delta AR_{i,t} = \beta_0 + \beta_1 \Delta Sales_{i,t} + \varepsilon_{i,t} \quad (4)$$

In the above equation (4), ΔAR shows the annual change in accounts receivable, i is the firm and t represents the year. Also, ΔSales shows the change in annual sales revenue where i show the company and t shows the year. All terms are scaled by lagged total assets.

3.3. Model specification and estimation procedure

In our estimations, ordinary Least Squares (OLS) does not apply to data because of the structure of panel data as it does not account for dependence between manifold observations from similar firms and possibly will not give consistent coefficient estimates (Greene, 2008). One possible solution for this is to use a fixed-effects model.[7] We applied Hausman (1978) to choose between fixed effects or random effects. We expect the following equation (5) to observe the effect of BGD on SPCR, based on the Hausman test, we employ a random-effects model. In respect to the estimation procedure, the random-effects model is applied.

$$\begin{aligned} SPCR_{i,t+1} = {} & \alpha i, t + \beta_1\, BGD_{i,t} + \beta_2 DTURN_{i,t} \\ & + \beta_3 NCKEW/DUVOL_{i,t} + \beta_4 RET_{i,t} + \beta_5 MB_{i,t} \\ & + \beta_6 SIZE_{i,t} + \beta_7 LEV_{i,t} + \beta_8 ROA_{i,t} + \beta_9 SIGMA_{i,t} \\ & + \beta_6 DACC_{i,t} + \varepsilon_{i,t} \end{aligned} \quad (5)$$

In the above equation (5), stock price crash risk ($SPCR_{i,t+1}$) is measured with two proxies (NCSKEW and DUVOL), and BGD is measured at two different thresholds of women on board (First, when at least one woman is on board and, second, when three or more women on the board). We separately estimate equation (5) for two proxies of SPCR and WOB. All other control variables are explained in Appendix 1. According to our hypothesis, we expect that $\beta_1 < 0$, which indicates that there is a negative association between BGD and SPCR.

[7] For instance; Fixed effect model permits estimations to produce a powerful casual argument related to the association among variables by indirectly controlling for all time-invariant firm-specific characteristics (Allison, 1982).

Furthermore, we expect the magnitude of β1 to be higher when the threshold of BGD is three or greater than three relative to the magnitude of β1 is higher when the threshold of BGD is at least one.

4. Results

Descriptive statistics—mean, standard deviation (Std. Dev.), minimum, and maximum—of this study are reported in Table 2. For the mean and Std. Dev. of the NCSKEW, the first measures of SPCR are 0.013 and 0.082, respectively. The DUVOL value of the mean is 0.008 and Std. Dev. is 0.06. The mean value of DTURN is 10.506, whereas RET mean value is 0 and its Min and Max are −0.017 and 0.027, respectively. MB and firm size mean value are 0.96 and 0.956 respectively. Moving forward in the table, the mean and Std. Dev. values of financial leverage are 0.0.58 and 0.011, respectively. Other control variables, including Return on Asset and SIGMA, have a mean value of 0.49 and −0.011, respectively. Finally, mean value of discretionary accruals is 0.002.

An initial and intuitive analysis to examine the association between WOB and SPCR, univariate analysis is used to analyze the mean value of the SPCR proxies. The research identified that this value is less in the organizations with three or more women directors on the board compared to those with fewer than three. Table 3 shows the mean value of two proxies of the SPCR, and also shows the value of the *t*-test. As we predicted, the mean values of the NCSKEW and DUVOL are significantly lower for firms with three or more women directors on the board. In line with our expectations, these results show that the firms that have more than three women on the board have lower SPCR.

Table 2
Descriptive statistics.

VARIABLES	N	Mean	SD	Min	Max
NCSKEW	7744	.013	.082	-.537	.611
DUVOL	6779	.008	.06	-.461	.5
DTURN	8153	10.506	1.674	−2.771	16.051
RET	7382	0	.003	-.017	.027
MB	8118	.96	1.347	−49.604	54.695
SIZE	8483	.956	.091	.12	1.242
LEV	8483	.058	.011	.037	.202
ROA	7213	.049	.009	.018	.099
SIGMA	8470	-.011	.061	-.249	.122
DACC	8483	.002	.003	0	.06

Table 3
Mean differences in stock price crash risk between firms with fewer than three women director and firms with three or more women director on corporate boards.

	Fewer than Three Women Directors	Three or More Women Directors	T-stat
NCSKEW	0.251 (0.017)	0.141 (0.023)	3.799***
	4801	2943	
DUVOL	0.163 (0.013)	0.050 (0 .017)	5.174***
	4801	2943	

The effect of the company's characteristics is nonetheless not controlled by this preliminary analysis. In addition, this test does not consider other factors that affect SPCR. Therefore, by considering Eq. (5) we individually regress both proxies (NCSKEW and DUVOL) of SPCR on the BGD to control the other firm characteristics and to consider other factors that are missing in a preliminary test.

Table 4 shows the estimation results of Eq. (5) using NCSKEW and DUVOL as a dependent variable. Column (1) shows the relationship between the first proxy of SPCR (NCSKEW) with the BGD (at least one woman director). We found that the coefficient of the NCSKEW and BGD is negative and significant. Similarly, in column (2), the same pattern is seen in DUVOL and BGD, and their coefficient is also negative and significant. These results show that the existence of BGD reduces the organization's SPCR.

Furthermore, we estimate the results of Eq (5) using NCSKEW and DUVOL as a dependent variable. But this time BGD is coded as 1, if a firm with three or more women on board. We also find a negative and significant coefficient of BGD with two proxies of SPCR i.e NCSKEW and DUVOL reported in Table 5. However, when we compare the coefficients of BGD in Column 1 and Column 2 of Table 4 with the coefficients of BGD in Column 1 and Column 2 of Table 5, we find the higher magnitudes when BGD is coded as 1, if a firm with three or more women on board relative to when BGD is code as 1, if a firm with at least one women on board. Overall, these findings support our hypothesis which is based on the notation that the threshold of three or more BGD is more effective and influential in determining the firm-level crash risk. When three or more women are present on the board, there is less chance of acing a substantial SPCR. According to CM theory, corporate boards should have three or more women directors to make a significant effect on the firm's operations. So, the regression model results confirm that if organizations have three or more women directors, the crash risk will be significantly reduced.

Table 4
Influence of Board Gender Diversity (BGD) on Stock Price Crash Risk (SPCR) (***Threshold of at least one women on the board***).

VARIABLES	(1)	(2)
	FNCSKEW	FDUVOL
BGD	−0.010 (0.002)***	−0.009 (0.002)***
DTURN	0.000 (0.001)	0.000 (0.001)
NCSKEW	0.014 (0.014)	
RET	1.187 (0.366)***	1.250 (0.279)***
MB	0.000 (0.001)	0.000 (0.001)
SIZE	0.037 (0.021)*	0.002 (0.018)
LEV	−1.362 (0.311)***	−1.267 (0.255)***
ROA	0.681 (0.225)***	0.478 (0.180)***
SIGMA	−0.247 (0.045)***	−0.195 (0.038)***
DACC	0.362 (0.563)	0.590 (0.456)
DUVOL		−0.016 (0.014)
CONSTANT	0.018 (0.023)	0.049 (0.020)**

Note: Standard errors in Parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All other variables are defined in Appendix 1.

Table 5
Influence of Board Gender Diversity (BGD) on Stock Price Crash Risk (SPCR) (***Threshold of at least three or more women on the board***).

VARIABLES	(1)	(2)
	FNCSKEW	FDUVOL
BGD	−0.017 (0.002)***	−0.016 (0.002)***
DTURN	−0.000 (0.001)	−0.000 (0.001)
NCSKEW	0.013 (0.014)	
RET	0.977 (0.366)***	1.042 (0.278)***
MB	0.000 (0.001)	−0.000 (0.001)
SIZE	0.034 (0.021)	−0.001 (0.018)
LEV	−1.124 (0.312)***	−1.040 (0.256)***
ROA	0.726 (0.225)***	0.521 (0.179)***
SIGMA	−0.192 (0.045)***	−0.145 (0.038)***
DACC	0.427 (0.561)	0.673 (0.454)
DUVOL		−0.018 (0.014)
CONSTANT	0.010 (0.023)	0.042 (0.019)**

Note: Standard errors in Parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All other variables are defined in Appendix 1.

The control variables' coefficients are included in the regression model (Table 4), and all of them show the expected signs per the previous literature. Secondly, in most cases, they are also significant. The coefficient of the Return and size is positive and significant, which shows a positive relationship between NCSKEW and DUVOL with return and size. Large firms and firms with higher returns have higher SPCR (Chen & Zhang, 2016; Hutton et al., 2009). Moving towards the return on asset, the relationship between the ROA and SPCR is Positive. The relationship that exists between them is significant. This indicates that firms that have a high return on the asset are more prone to SPCR. ROA shows that a company is proficiently converting its assets into profit and showing better financial performance. Therefore, firms showing good performance are less likely to face a crash risk (Callen & Fang, 2015; Hutton et al., 2009). However, the financial leverage ratio does not show a significant relationship with the dependent variable.

5. Robustness check

5.1. Propensity score matching

Our investigation shown in Table 6 indicates that firms with three or more women directors on the board, in comparison to firms with fewer, engage less in bad news hoarding and show less negative down-to-up volatility (DUVOL) and skewness (NCSKEW), with our proxies for SPCR. Here, we used the propensity score matching (PSM) technique to assuage concerns that any recognized upshots are merely the consequence of three or more women directors deviating methodically from fewer than three women directors on the board is thus to improve the ability to draw causal inferences. Explicitly, the following steps have been used for our PSM analysis. Firstly, we use a treatment variable, i.e., BGD_DUMMY (a dichotomous proxy for three or more women director), to calculate our propensity score. These propensity scores are the predicted probabilities from logit regression with NCSKEW and DUVOL as a dependent variable, and a set of covariates that are proxies of SPCR (TRADVOLUM, RET, MB, SIZE, LEV, ROA, SIGMA, and ACCRUALS). Secondly, we match observations in the three or more women director groups with those with fewer than three women directors based on the propensity scores calculated in the first step. For these two subsets of matched firm/year observations, we then calculated the mean of NCSKEW and DUVOL and tested for statistical changes in these distinctions. The results are shown in Table 6.

Table 6
Stock price crash risk in the firm with three or more women director (propensity matching analysis).

Variables	Estimation method	WOB	LFD	ATT	t-Stat
NCSKEW	ATT with the nearest neighbour matching method	1461	3462	−0.002	−6.19
	ATT with kernel matching	1461	3462	−0.002	−8.45
	ATT with radius method	1461	3462	−0.002	−10.40
DUVOL	ATT with the nearest neighbour matching method	1461	3462	−0.008	−7.29
	ATT with kernel matching	1461	3462	−0.007	−10.33
	ATT with radius method	1461	3462	−0.008	−12.33

To report the results for each of the two dependent variables (NCSKEW and DUVOL), we use three estimation methods to calculate the average treatment effect on the treated (ATT) (i.e., three or more women directors): (i) the nearest neighbour matching method; (ii) the kernel matching method; and (iii) the radius method. All three methods used show that the mean value of the two dependent variables is reliably lower in the firm with three or more women directors than the firm with fewer. These results add more confidence to the main empirical test results, showing that three or more women directors in the firm lowers the SPCR and is more negative than firms with fewer than three women directors.

5.2. Integration of Global Financial Crises (GFC) into a benchmark model

We estimate the following equation (6) to observe the effect of BGD on SPCR by taking Global Financial Crises (GFC) into account. For that, we add dummy variable of D_{GFC} in the model. DGFC is a dummy indicator variable for the start of the global financial crisis period (i.e 2008 and 2009).

$$\begin{aligned} SPCR_{i,t+1} = {} & \alpha i, t + \beta_1\, BGD_{i,t} + \beta_2 DTURN_{i,t} \\ & + \beta_3 NCKEW/DUVOL_{i,t} + \beta_4 RET_{i,t} + \beta_5 MB_{i,t} \\ & + \beta_6 SIZE_{i,t} + \beta_7 LEV_{i,t} + \beta_8 ROA_{i,t} + \beta_9 SIGMA_{i,t} \\ & + \beta_6 DACC_{i,t} + \beta_1\, DGFC_{i,t} + \varepsilon_{i,t} \end{aligned} \tag{6}$$

In the above equation (6), stock price crash risk ($SPCR_{i,t+1}$) is measured with two proxies (NCSKEW and DUVOL), and BGD is measured at two different threshold of women on board (First, when at least one women is on board and, second, when three or more women on board). We separately estimate equation (6) for two proxies of SPCR and

Table 7
Influence of board gender diversity (BGD) on stock price crash risk (SPCR).

VARIABLES	(1)	(2)	(3)	(4)
	FNCSKEW	FDUVOL	FNCSKEW	FDUVOL
BGD (Three or more women on board)	−0.012 (0.002)***	−0.012 (0.002)***		
BGD (When at least one women on board)			−0.007 (0.002)***	−0.006 (0.002)***
DTURN	−0.000 (0.001)	−0.000 (0.001)	−0.000 (0.001)	0.000 (0.001)
NCSKEW	0.015 (0.014)		0.016 (0.014)	
DUVOL		−0.015 (0.014)		−0.013 (0.014)
RET	0.479 (0.377)	0.636 (0.286)**	0.476 (0.378)	0.636 (0.287)**
MB	0.000 (0.001)	−0.000 (0.001)	0.001 (0.001)	0.000 (0.001)
SIZE	0.040 (0.021)*	0.004 (0.017)	0.043 (0.021)**	0.008 (0.017)
LEV	−1.277 (0.312)***	−1.171 (0.255)***	−1.459 (0.309)***	−1.356 (0.253)***
ROA	0.761 (0.224)***	0.554 (0.179)***	0.741 (0.224)***	0.538 (0.179)***
SIGMA	−0.219 (0.045)***	−0.169 (0.038)***	−0.260 (0.044)***	−0.208 (0.038)***
ACCRUALS	0.476 (0.558)	0.718 (0.451)	0.447 (0.559)	0.679 (0.452)
D_{GFC}	−0.013 (0.002)***	−0.011 (0.002)***	−0.017 (0.002)***	−0.015 (0.002)***
Constant	0.014 (0.023)	0.045 (0.019)**	0.020 (0.023)	0.051 (0.019)***

Note: Standard errors in Parentheses. ***p < 0.01, **p < 0.05, *p < 0.1. All other variables are defined in Appendix 1.

WOB. All other control variables are explained in Appendix 1. Overall, our results in Table 7 (by taking into consideration the GFC) support the notion build earlier that that threshold of three or more BGD is more effective and influential in determining the firm level crash risk. When three or more women are present on the board, there is less chance of acing a substantial SPCR.

6. Conclusions and implications

This study observes the effect of board gender diversity on stock price crash risk. We use 1021 companies from the Asia-Pacific region as a sample over the period 2006−2016 to examine the association between BGC and SPCR. We take two different proxies—down-to-up volatility and negative conditional skewness— for SPCR to link it with the BGD based token and critical mass representations of women directors. We find that SPCR is significantly and negatively related to BGC, suggesting that firm have more gender-diverse board faces less SPCR than the firm having a less gender-diverse board. The findings reveal that females reduce unwelcome news hoarding, which is the leading cause of SPCR. The results from our analysis show that greater diversity in BGC reduces the organization's SPCR. When three or more women are present on the board, there is less chance of facing a substantial SPCR. According to the critical mass argument, corporate boards should have three or more female directors to make a significant effect on the firm's operations. Therefore, the results of the regression model confirm the implication of critical mass argument. The coefficients of the control variables in the regression model show the expected signs per the previous literature, and in most of the cases, they are significant. The coefficient of the size is positive and significant, which shows that there is a positive relationship between the SPCR and size, which is consistent with (Chen & Zhang, 2016; Hutton et al., 2009).

Similarly, the return on the asset has a negative relationship between the ROA and SPCR, which indicates that firms are proficiently converting their assets into profit and showing better financial performance. Therefore, they are less likely to face a crash risk (Callen & Fang, 2015; Hutton et al., 2009). However, the financial leverage ratio does not show a significant relationship with the dependent variable.

The results from this research have implications for regulators, managers, researchers, and entrepreneurs in the Asia-Pacific region where the financial markets are well integrated. The present study shows evidence that the presence of three or more women on corporate boards can significantly reduce crash risk. Thus, considering these results, this study proposes; Firstly, companies should increase their recruitment of women directors. Secondly, policymakers may find the findings useful for governance mechanisms. They would be able to set their policies while keeping in mind the importance of BGD concerning SPCR and to control this risk with increased female participation on the board. Thirdly, BGD may also signal to investors how much risk a company is facing, so they can make better decisions about their investments. In the future, this work can be extended through empirically exploiting the causal mechanisms through which BGD reduces the information asymmetry. One such mechanism may include a firm's level engagement in corporate social responsibility and full disclosure.

Declaration of competing interest

The authors declare no conflicts of interest.

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Appendix 1.

Description of Variables

Variables	Labels	Description	Data Source
Dependent variable			
Stock price crash risk	SPCR	Measured by negative conditional skewness, down-to-up volatility measure and crash count	Thomson Reuter
negative conditional skewness	NCSKEW	Negative of the third moment of return distribution/standard deviation of firm-specific weekly returns for each year.	Thomson Reuter
Down-to-up volatility measure	DUVOL	The log of the down day returns standard deviation to the up day returns standard deviation. Categorised as up-week, and down-week returns series when the returns are above and below the daily average returns, respectively.	Thomson Reuter
Independent variable			Thomson Reuter
Board gender diversity	BGD	We measured BGD in two different ways. First, WOB is coded as 1, if company with at least one women on board otherwise as 0. Second, WOB is coded as 1, if company with at three or more women on board otherwise as 0.	Thomson Reuter
Control Variables			
Trading Volume	DTURN	It measure the firms share turnover in year t.	Thomson Reuter
Return	RET	It shows the firm's stock return in year t.	Thomson Reuter
SIGMA	SIGMA	It shows the Standard deviation of firms return.	Thomson Reuter
Market to book ratio	MB	Market value of equity is divided by book value of equity.	Thomson Reuter
Firm size	SIZE	It shows the natural logarithm of sales.	Thomson Reuter
Leverage	LEV	Long term debt is divided by total assets.	Thomson Reuter
Return on asset	ROA	Net income is divided by Total assets.	Thomson Reuter
Accruals	ACCRUALS	$\Delta AR_{i,t} = \beta_o + \beta_1 \Delta Sale_{i,t} + \varepsilon_{i,t}$. Following the McNichols and Stubben (2008), we estimated the residuals of the above equation to measure accruals	Thomson Reuter

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