

# CORPORATE DIVERSIFICATION AND STOCK PRICE CRASH RISK: DO FEMALE DIRECTORS MATTERS? EVIDENCE FROM MALAYSIA

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## ABSTRACT

*This study examines the relation between corporate diversification and stock price crash risk and whether female directors moderate this relation. Using a sample of Malaysian publicly listed firms based on 2010–2016 data, our study finds diversification mitigates crash risk but only for highly diversified firms. Our study also finds that the mitigating effect of diversification is more pronounced for firms with higher proportion of female directors in the board in which it is aligned with the notion of gender diversity in promoting good corporate governance. Our findings are beneficial to stock investors in managing the “tail risk” in stock prices of conglomerates/diversified firms.*

**Keywords:** diversification, female director, gender diversity, stock price crash risk, Malaysia

## INTRODUCTION

Corporate diversification has long been considered as one of the most fundamental and yet important corporate strategic decisions with its huge implications on business strategic direction and performance. During 1980s–1990s, business diversification was a very popular corporate strategy for growth and seemingly a “way of life” for many publicly listed firms in many parts of the world.

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Publication date: 29 July 2022

To cite this article: Lee, K-T. (2022). Corporate diversification and stock price crash risk: Do female directors matters? Evidence from Malaysia. *Asian Academy of Management Journal of Accounting and Finance*, 18(1), 75–100. <https://doi.org/10.21315/aamjaf2022.18.1.4>

To link to this article: <https://doi.org/10.21315/aamjaf2022.18.1.4>

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In the U.S, at least two forceful waves of diversification trend were clearly observed in the past. The first wave occurred in the mid-1960s where many U.S firms started to venture into different business segments through merger and acquisition activities to form conglomerates. Subsequently, another wave of mega-merged conglomerates was seen during the mid-1980s before it was eventually dissipated in the 1990s amid economic recession. Likewise, in East Asian countries, an immense wave of corporate diversification exercise was observed during the 1970s to mid-1990s in which corporate diversification was seen as a catalyst for spurring the regional rapid economic growth also known as “East Asian Miracle” (World Bank, 1994). Paradoxically, corporate diversification was later put to blame partially for the 1997 Asian Financial Crisis where firms’ diversification activities were believed to be at the excessive level.

The massive scale of corporate diversification efforts that has taken place and a clear economic significance of these conglomerates has since attracted great attention from the academic researchers and practitioners alike for almost two and half decades from 1990s to mid-2010s. To date, the dominant topic has always been focusing on the financial performance and value impact of diversification (e.g, Berger & Ofek, 1995; Lins & Servaes, 2002; Fauver et al., 2003; Hoechle et al., 2012; Lee, 2013; Lee et al., 2012; Lee & Hooy, 2018a; 2018b) and there is still a lack of studies examining the risk aspect of corporate diversification in spite of its role played in the 1997 Asian Financial Crisis. In this study, we aim to examine whether diversified firms would experience higher or lower stock price crash risk.

Following Chen et al. (2001), crash risk is defined as the conditional skewness of return distribution, the third moment of return distribution. In the vast literature of stock price crash risk, the theoretical explanation offered for the stock price crash risk is predominantly based on the concept of “bad news hoarding” behaviours of managers proposed by Jin and Myers (2006). All these prior studies have argued that crash risk is attributed to the managers’ tendency to hoard or withhold enormous negative material information of their firms from investors for an extended period of time due to concerns for their own career or compensation prospects. The real problem set in when these managers eventually can no longer withhold the bad news and release them all at once to the market, where investors would react severely by massively selling off their shares that would lead to a plunge in these stock prices (Jin & Myers, 2006; Hutton et al., 2009; Kim et al., 2011a). According to Kothari et al. (2009),

managerial “bad news hoarding” behaviours that caused the stock price crash risk has echoed the agency conflict between managers and shareholders over information disclosure preferences which is part of a bigger framework of corporate governance issues.

Based on the extant literature of diversification, there is a long-standing concern that managers would tend to engage in business diversification activities to entrench themselves for their personal interests and gains (Shleifer & Vishny, 1989). In line with the agency perspective, it is rightfully argued that when managers engage in a diversification strategy seemingly as part of the control-enhancing means, but the diversification initiative may be used to conceal some bad news of the firms’ existing businesses. Thus, based on the agency perspective, it is predicted that diversification is positively associated with future stock price crash risk – diversification contributes to crash risk.

An equally compelling and also dominant counterargument in the literature, resource-based perspective, contends that diversification activities would generate various benefits for firms such as internal capital market creation and economic of scope. Also, the modern portfolio theory of Markowitz (1952) contends that portfolio diversification is vital in reducing investment risks, and thus it is fair to argue that diversified firms are able to minimise their risk exposure more effectively than non-diversified firms (Lubatkin & Chatterjee, 1994). Based on these two rationales, it is predicted that diversification is negatively associated with future stock price crash risk – diversification mitigates crash risk.

To test these two opposing views of the plausible relation between diversification and stock price crash risk, this study examines how firms’ degree of diversification is associated with future stock price crash risk. The degree of diversification measure is based on the Herfindahl index (Berry, 1971). Following prior studies, firm-specific crash risk is measured by the negative skewness of firm-specific weekly returns and the asymmetric volatility of negative and positive stock returns (e.g., Chen et al., 2001). Using a sample of Malaysian publicly listed firms from 2010 to 2016, the study finds evidence of the association between high-degree (low-degree) of diversification with low (high) future stock crash price risk. The results are robust after controlling for other predictors of future stock price crash risk identified in prior studies and also employed two different metrics for the measurement of stock price crash risk.

In addition, we examine whether the proportion of female directors in the board (synonymous to board gender diversity) moderates the association between diversification and stock price crash risk. Serving as an empirically-proven vital aspect of corporate governance, female directors in the board may be an imperative component to reduce the probability of managers from committing bad news hoarding behaviour, thus should lead to better ability to reduce or mitigate crash risk. Based on the research studies of managerial behaviour and board gender diversity, the roles of women on corporate boards has attracted the attention of many practitioners and academic researchers alike. Previous studies indicate that the female top executives or directors in firms with predominant male counterparts significantly improve the corporate decision-making process and thus bringing positive impacts to firm's financial performance among other things (see, e.g., Barua et al., 2010; Huang & Kisgen, 2013; Faccio et al., 2016). The improved financial performance with higher female directors has suggested that women corporate participation greatly improve corporate governance practices (Kramer et al., 2006). Many studies also suggest that female directors are more risk-averse and serve effectively as a check and balance and monitoring mechanism in the board decision making process that could lead to better decisions are being made in the boards (Perryman et al., 2016). Overall, this notion is supported in our study where we find crash risk is lower for highly diversified firms with higher number of female directors in the board. The results are consistent with the notion that the role of female in the board diversity can boost the corporate governance level and thus reducing stock price crash risk.

In this study, the main reasons Malaysia is used as the sample for investigation is because of the rampantly high degree of business diversification among Malaysian publicly listed firms, the Malaysian unique institutional setting in terms of its corporate governance standards and practices particularly on the current development amid Malaysian government proactive effort in promoting gender board diversity for Malaysian public listed firms (Corporate Governance Strategic Priorities 2017–2020). In addition, it is our deliberate intention to examine the issue from a small and open economy perspective which could add more value to the literature.

Our study makes several important contributions to two strands of literature. First, our study adds to the growing literature on diversification and its economic consequences. As discussed earlier, much work in this area has focused on the impact of diversification on firm performance and, to a lesser extent, firm risk. We depart from these studies and focus on the unique role of

diversification in reducing crash risk, which captures asymmetry in risk or the third moment of stock return distribution. This role is distinct from the effect of diversification on stock return performance (first moment) or firm risk (second moment) documented in prior studies. Our results thus broaden our understanding of the implications of diversification on firms and investors. Second, our study extends the growing literature on stock price crash risk. We extend prior studies (e.g., Chen et al., 2001; Jin & Myers, 2006; Hutton et al., 2009; Kim et al., 2011a; 2011b) by identifying a new factor that predicts the future stock price crash risk. We contribute to this literature by showing that corporate diversification is significantly and negatively impacts stock price crash risk – an important factor to mitigate crash risk. Our study is useful to firms (and shareholders) who want to manage “tail risk” in the stock market and to investors who want to incorporate crash risk in their portfolio and risk management decisions.

## **LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT**

Our study is principally compelled by the convergence of two distinct strands of literature. First, we draw from the recent literature on the determinants of firm-specific crash risk originated from the theoretical arguments of Jin and Myers (2006). According to Jin and Myers (2006), managers may have the tendency to withhold and “hoard” the bad news up to a certain threshold level, in which managers will then forcefully reveal the accumulated bad news to the market as soon as the threshold is stretched, leading to an abnormally large plunge in the stock price. Many empirical studies have followed this rationale in an effort to determine the factors that predict stock price crash risk by focusing on the firms’ corporate activities and firm-specific characteristics. In most of the early studies on crash risk, scholars tend to explain crash risk from the perspective of investors’ various views on how information asymmetry can affect stock prices (e.g., Campbell & Hentschel, 1992; Chen et al., 2001; Hong & Stein, 2003). However, in more recent studies, scholars have gradually extended the explanation of information asymmetry to a wider scope based on agency theoretical framework in exploiting various factors on crash risk such as: earning management (Hutton et al., 2009); aggressive tax avoidance (Kim et al., 2011a); corporate social responsibility (Kim et al., 2014); corporate governance (Tarkovska, 2017); religion (Callen & Fang, 2015); corporate philanthropy (Zhang et al., 2016); takeover protection (Bhargava et al., 2017); business strategy (Habib & Hasan, 2017), and political connection (Luo et al., 2016; Tee, 2019; Tee et al., 2021).

Second, our study also relies on another strand of literature deliberates on the economic impacts of corporate diversification. Essentially, in the extant finance literature, agency theory has been the central theoretical explanations offered for the economic consequences of diversification. It is widely argued that diversification strategies undertaken by firms may not necessarily intend to benefit the firms, but more for the private benefits of managers or controlling shareholders (Denis & Sarin, 1997; Lins & Servaes, 2002; Aggarwal & Samwick, 2003). The extant literature shows the discounted value implying diversification is used for personal interest – implying diversification is may have agency problem leading to concealing information – higher crash risk. However, on the positive note, the benefits of pursuing diversification are well documented in the literature such as economies of scale and scope (Chandler, 1977; Teece, 1980), market power (Scott, 1982; Tirole, 1995; Villalonga, 2000), internal capital markets (Williamson, 1970; Stulz, 1990; Gertner et al., 1994; Stein, 1997), and coinsurance effect (Lewellen, 1971; Shleifer & Vishny, 1992).

Some other studies content that since diversified firms are required to report only limited accounting information for their business segments, managers will have substantial discretion in the resource allocation across business segments and have incentives to conceal certain information, leading to higher information asymmetry costs (Habib et al., 1997; Nanda & Narayanan, 1999). Yet, based on the portfolio theory, if a diversified firm's business represents a basket of securities, it is predicted that there would be a potential reduction in the severity of information problem and a reduction in the trading costs with greater corporate diversification (Hadlock et al., 2001; Gorton & Pennacchi, 1993; Subrahmanyam, 1991). These authors explain that combining individual securities into baskets may reduce the adverse selection costs of trading. The value of private information about the individual securities that constitute the basket will be diversified away, allowing market makers to set lower spreads and thereby reducing trading costs for uninformed traders in which they termed it as “information diversification hypothesis”.

Building on the literature of crash risk and the economic impacts of corporate diversification, on balance, we conjecture that diversification can mitigate crash risk as our first hypothesis as follow:

H1: The degree of diversification is negatively associated with future stock-price crash risk.

Gender diversity in the board has been the recent dominant theme in the literature of board characteristics and corporate governance (eg. Shrader et al., 1997; Carter et al., 2003). Despite the mixed findings from these prior researches, a general consensus has been established in proposing that female directors can effectively play an important role in creating value for firms or improving performance, or at the very least, it does not have any detrimental effect on firms. In general, it has been widely documented that beliefs, cognitive, attitudes, and functioning can be varied systematically between male and female as one of the demographic variables (Robinson & Dechant, 1997). A vast literature tends to support the notion of gender diversity is good in providing constructive differences between male and female in various aspects. Some suggest that females have significantly higher ethical standards than males (e.g. Roxas & Stoneback, 2004; Peterson et al., 2010), women are more trustworthy than men thus less likely to commit unethical acts (Heminway, 2007), females are more risk averse and conservative than men (e.g. Lenard et al., 2014), men and women respond and react differently to similar situations where female directors tend to demand for greater accountability than male directors (Lai et al., 2017), and female directors have better attendance behaviour than their male counterparts and effectively influence the attendance behaviour of male directors which is a very important aspect of obtaining necessary information and carrying out important duties such as monitoring and auditing roles from the governance perspective (Adams & Ferreira, 2009). All these findings on different aspects tend to point at the importance of the presence of female directors in the board dominated by the male directors. Furthermore, more studies have also suggested that the presence of female directors on board can effectively promote and contribute to a better corporate governance practice within a firm. For example, Levi et al. (2014) contend that females are more vigilant in making decisions and would enforce more oversight and monitoring on the business operation. Srinidhi et al. (2011) suggest that female directors can act as an internal governance mechanism provider to lessen the agency conflicts.

For the case of diversification, Lenard et al. (2014) find that female directors are more sensitive towards the requirements of new business segments. When firms are engaged in the diversification activities, female directors would enforce more adjustments and requirements just to make sure the business operation is in good order. In the study of Lenard et al. (2014), they also find that firms with less gender diversity on board tend to be less competitive and proactive in taking actions that may benefit their diversification efforts. In another study, Hillman et al. (2007) contend that the presence of female directors in the board is vital for the success of diversified firms.

Resources dependence theory contends that gender diversity is important in making effective corporate decisions. A considerable body of literature have suggested that effective corporate governance mechanisms can curb suboptimal managerial decision-making (Shleifer & Vishny, 1997), and bad news hoarding is such suboptimal managerial decision. These findings imply that effective corporate governance mechanisms help to reduce opportunistic or entrenched managerial behaviour, and thus lower the firm-specific stock price crash risk. In this research context, gender board diversity with more female directors on board may be an imperative component to reduce the probability of managers from committing bad news hoarding behaviour, thus should lead to better ability to reduce stock price crash risk. Based on this, our second hypothesis is:

H2: Female directors in the board moderate the relationship between diversification and crash risk. The higher the number of female directors in the board, the lower the crash risk level in a diversified firm.

## **DATA AND METHODS**

### **Sample Selection**

Our study utilises a sample of all Malaysian publicly listed firms with multi-segment (based on 2-digit SIC) on the main board of the Kuala Lumpur Stock Exchange (KLSE) excluding financial and utility firms over the period 2010–2016. The finance and utilities sectors are excluded in this study due to different set of rules and regulations are used to govern these two sectors that making them incomparable to other sectors. Firms' stock prices, returns, and firms' financial data are collected from Thomson Reuters Datastream. To determine the proportion of female directors on board, we hand collect these data from the annual reports of each firm. Our final sample consists of 5,545 firm-year observations and the total number of firms in the observation is 792 collected from 2010 to 2016.

### **Variables and Measures**

#### ***Measures of stock-price crash risk***

This study employs two measures of stock-price crash risk based on firm-specific weekly returns estimated as the residuals from the market model. The firm-specific returns reveal firm-specific factors that lead to crash risk rather than

broad market factors. Specifically, this study estimates the following expanded market model regression:

$$r_{j,s} = \alpha_j + \beta_{1,j} r_{m,s-1} + \beta_{2,j} r_{m,s} + \beta_{4,j} r_{m,s+1} + \varepsilon_{j,s} \quad (1)$$

where  $r_{j,s}$  is the return on stock  $j$  in week  $s$ , and  $r_{m,s}$  is the return on the KLCI value-weighted market index in week  $s$ . The lead and lag terms for the market index return is included to allow for nonsynchronous trading (Dimson, 1979). The firm-specific weekly return for firm  $j$  in week  $s$  ( $W_{j,s}$ ) is calculated as the natural logarithm of one plus the residual return from Equation (1). Using the firm-specific weekly returns, this study calculates crash risk by the negative conditional skewness of the weekly returns over the fiscal year (*NCSKEW*). *NCSKEW* is calculated by taking the negative of the third moment of firm-specific weekly returns for each year and normalising it by the standard deviation of firm-specific weekly returns raised to the third power. Specifically, for each firm  $j$  in year  $t$ , *NCSKEW* is calculated as:

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

where  $W_{j,s}$  is firm-specific weekly return as defined above, and  $n$  is the number of weekly returns during year  $t$ . A negative sign is put in front of the third moment such that a higher value of *NCSKEW* indicates higher crash risk.

The second measure of crash risk is the down-to-up volatility measure (*DUVOL*) of the crash likelihood. For each firm  $j$  over year  $t$ , firm-specific weekly returns are separated into two groups: “down” weeks when the returns are below the annual mean, and “up” weeks when the returns are above the annual mean. Standard deviation of firm-specific weekly returns is calculated separately for each of these two groups, and *DUVOL* is the natural logarithm of the ratio of the standard deviation in the “down” weeks to the standard deviation in the “up” weeks.

$$DUVOL_{j,t} = \log \left\{ (n_u - 1) \sum_{down} W_{j,s}^2 / (n_d - 1) \sum_{up} W_{j,s}^2 \right\} \quad (3)$$

where  $n_u$  and  $n_d$  are the number of up and down weeks in year  $t$ , respectively. A higher value of *DUVOL* indicates greater crash risk. As suggested in Chen et al. (2001), *DUVOL* does not involve third moments, and hence is less likely to be overly influenced by extreme weekly returns.

### ***Measure of diversification***

The term *diversification* in this study is defined as a form of corporate growth strategy by which a firm expands from their core business into other lines of business (or equivalently as segments or industries). We use the Berry's modified (1971) Herfindahl index of diversification (*HERFINDAHL*), where this measure was used in many studies such as Schoar (2002), Villalonga (2004a; 2004b), and Jara-Bertin (2015). The Herfindahl index of diversification is calculated as follows for each company *i*:

$$HERFINDAHL = 1 - \sum \left( \frac{\text{Sales per segment}}{\text{Total sales}} \right)^2 \quad (4)$$

Based on Berry's modified Herfindahl index of diversification measure, the values range from 0 to 1, and the higher this variable value, the higher is the level of diversification of the firm.

### ***Measure of the proportion of female directors on board***

This study operationally constructs the variable of female directors on board based on the proportion of female directors on board (*FEMALE\_DIRECTOR*),

$$FEMALE_{DIRECTOR} = \frac{\text{Female directors}}{\text{Total directors}} \quad (5)$$

Where *Female directors* is the number of directors who are female, and *Total directors* is the total number of directors on board.

### ***Measures of control variables***

*FIRMSIZE<sub>t</sub>* is measured by the natural logarithm of total assets of year *t*. Prior studies reports a firm size is positively related to future crash risk (Chen et al., 2001; Hutton et al., 2009; Callen & Fang, 2013; De Fond et al., 2015). *LEVERAGE<sub>t</sub>* is measured by the ratio of long-term debt to total assets of year *t*, which is shown to be negatively associated with future crash risk (Hutton et al., 2009; Kim et al., 2011a; 2011b). *MTBV<sub>t</sub>* is measured by market-to-book value of year *t*, and Chen et al. (2001) and Hutton et al. (2009) show that growth stocks are more prone to future crash risk. *ROA<sub>t</sub>* is measured by return on total assets in which Hutton et al. (2009) and Callen and Fang (2013) report firms with good financial performance are steadier and are less likely to experience crashes. Additionally, the model controls for stock performance variables,

including stock returns ( $RETURN_t$ ), which is calculated as the mean of firm-specific weekly returns over the fiscal year  $t$ . In prior studies, it has shown that there is a positive association between firm-specific stock return and stock price crash risk, indicating that stocks with high past returns could have accumulated many stochastic bubbles and thus are subject to higher crash risk (Harvey & Siddique, 1999; Chen et al., 2001). Stock volatility ( $SIGMA_t$ ), which is calculated as the standard deviation of firm-specific weekly returns over the fiscal year  $t$ . Prior studies show more volatile stocks are more likely to experience stock price crashes in the future (Chen et al., 2001; Kim et al., 2011a).  $DTURNOVER_t$ , which is calculated as the average monthly share turnover in year  $t$  minus the average monthly share turnover in  $t - 1$ , where Chen et al. (2001) indicate that this variable is used to measure differences of opinion among shareholders and is positively related to crash risk.

### Empirical Regression Models

This study develops a regression model by controlling for firm fundamental variables and stock price variables as shown in Equation 6.

$$\begin{aligned}
 CRASH\_RISK_{j,t+1} = & \beta_0 + \beta_1 FIRM SIZE_{j,t} + \beta_2 LEVERAGE_{j,t} + \\
 & \beta_3 MTBV_{j,t} + \beta_4 ROA_{j,t} + \beta_5 RETURN_{j,t} + \\
 & \beta_6 SIGMA_{j,t} + \beta_7 DTURNOVER_{j,t} \\
 & + \beta_8 CRASH\_RISK_{j,t} + \beta_9 HERFINDAHL_{j,t} \\
 & + \varepsilon_{j,t}
 \end{aligned} \tag{6}$$

where the dependent variable of  $\{CRASH\_RISK_{t+1}\}$  is proxied by  $NCSKEW_{t+1}$  or  $DUVOL_{t+1}$ , which represents stock-price crash risks of year  $t + 1$ . The lagged variable of crash risk ( $CRASH\_RISK_t$  represents  $NCSKEW_t$  and  $DUVOL_t$ ) are included in the model to control for potential serial correlation and to predict for next year stock price crash risk. Corporate diversification is measured using the Herfindahl index ( $HERFINDAHL_t$ ) to assess the concentration of diversification. Following prior studies (such as Chen et al., 2001; Kim et al., 2011a; 2011b), several firm fundamental variables are controlled in the model.

To further test the moderating effect of proportion of female directors on board on the relationship between diversification and stock crash risk, this study extends Equation 6 by adding the female directors variable  $\{FEMALE\_DIRECTORS_t\}$  and the interaction terms of  $HERFINDAHL_t$  and  $\{FEMALE\_DIRECTORS_t\}$ , as shown in Equation 7.

$$\begin{aligned}
CRASH\_RISK_{j,t+1} = & \beta_0 + \beta_1 FIRMSize_{j,t} + \beta_2 LEVERAGE_{j,t} \\
& + \beta_3 MTBV_{j,t} + \beta_4 ROA_{j,t} + \beta_5 RETURN_{j,t} \\
& + \beta_6 SIGMA_{j,t} + \beta_7 DTURNOver_{j,t} \\
& + \beta_8 CRASH\_RISK_{j,t} + \beta_9 HERFINDAHL_{j,t} \\
& + \beta_{10} FEMALE\_DIRECTORS_{j,t} \\
& + \beta_{11} (HERFINDAHL_{j,t} \times FEMALE\_DIRECTORS_{j,t}) \\
& + \varepsilon_{j,t}
\end{aligned} \tag{7}$$

## EMPIRICAL RESULTS

### Descriptive Statistics

Table 1 presents the summary statistics for all variables used in the analysis. The means of  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ , are  $-0.305$  and  $-0.194$ , respectively. The mean value of  $HERFINDAHL_t$  is  $0.538$  with a standard deviation of  $0.32$  for the level of diversification among Malaysian firms. The mean of natural logarithm of total assets is  $13.092$ . The mean of leverage is  $0.095$ . The mean of market-to-book is  $1.176$ , indicating positive future growth opportunity of the sample, and this is supported by the positive mean of return of assets ( $ROA_t$ ), which is  $0.049$ .

Table 1  
*Descriptive statistics*

Variables	Percentile					
	N	Mean	SD	25th	50th	75th
$NCSKEW_t$	5541	-0.305	0.591	-0.731	-0.262	0.155
$DUVOL_t$	5545	-0.194	0.563	-0.548	-0.182	0.132
$FirmSize_t$	5404	13.092	1.652	11.952	12.864	14.002
$Leverage_t$	5388	0.095	0.124	0.002	0.041	0.132
$MTBV_t$	5275	1.176	1.432	0.523	0.812	1.347
$Return_t$	5361	0.005	0.014	0.002	0.001	0.012
$Sigma_t$	5359	0.062	0.055	0.033	0.052	0.062
$DTurnover_t$	5164	0.004	0.091	-0.014	0.003	0.011
$ROA_t$	5235	0.049	0.103	0.012	0.052	0.091
$Herfindahl_t$	4510	0.538	0.324	0.000	0.316	0.652
$Female\_Directors_t$	5259	0.095	0.115	0.002	0.003	0.174

*Note:* This table reports the descriptive statistics for stock-price crash risk variables, diversification variable, female directors in board variable, and the control variables. N represents the number of observations, and SD stands for standard deviation.

The sample has a firm-specific weekly return ( $SIGMA_t$ ) of 0.062, indicating that the Malaysian market has very low volatility level. Supportively, the mean of monthly share turnover is also very low at 0.004. Our summary of descriptive statistics show that board diversity in female directors ( $FEMALE\_DIRECTORS_t$ ) has a low mean value of 0.095, with a standard deviation of 0.115. It indicates that female directors sitting in the boardroom is not a Malaysian corporate norm.

In Table 2, it shows that the consumer product sector has the highest Herfindahl index on average, i.e., 0.602, followed by industrial production, properties, plantations, construction, trading/services, and technologies sector. Overall, all sectors have more than a 0.5 Herfindahl index, indicating that corporate diversification is a popular corporate strategy among Malaysian firms.

Table 2  
*Distribution of Herfindahl index, by sector*

Sector	Observations	Herfindahl index
Consumer products	996	0.602
Construction	359	0.532
Industrial productions	580	0.591
Plantations	310	0.535
Properties	751	0.582
Technologies	1045	0.504
Trading/Services	1478	0.530

In Table 3, we observe a pattern of increasing Herfindahl index over the sample period. This indicates that Malaysian firms continue to expand their businesses into more variety of sectors in the recent years. The trend of corporate diversification becomes increasingly significant over time.

Table 3  
*Distribution of the mean of Herfindahl index, by year*

Year	Mean of HERFINDAHL, by year
2010	0.517
2011	0.518
2012	0.530
2013	0.533
2014	0.553
2015	0.567
2016	0.569

*Note:* The classification of sector is according to Bursa Malaysia.

## Main Results

Table 4 reports the regression results about the relationship between Herfindahl index and stock-price crash risk. In all the regression specifications, we include industries and year fixed effects allowing to control for unobservable time-invariant factors across industries, and any unobservable changes over time in terms of firm heterogeneity within each industry. First,  $HERFINDAHL_t$  shows a significant negative relationship with both measures of stock-price crash risk,  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ ,  $-0.0772$  and  $-0.0892$ , respectively. This result indicate that, for every 1 unit rise in the Herfindahl index, stock-price crash risk would reduce by 0.0772 to 0.0892 units. This result shows in support of our hypothesis H1, and is also in line with the resource-based perspective and portfolio theory in predicting that diversification can efficiently minimise the risks of the firms.

Most of the estimates of control variables are consistent with our expectations.  $FIRMSIZE_t$  shows a significant positive relationship with  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ , respectively.  $LEVERAGE_t$  shows a negative relationship with  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ , but only the estimate in the regression with  $NCSKEW_{t+1}$  as dependent variable is statistically significant.  $MTBV_t$  shows a significant positive relationship with  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ , respectively, and the lags of  $NCSKEW_t$  and  $DUVOL_t$  show a significant positive relationship with  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ , respectively. Nevertheless,  $ROA_t$  does not have a significant effect on  $NCSKEW_{t+1}$  or  $DUVOL_{t+1}$ . As for stock performance variables,  $SIGMA_t$  and  $DTURNOVER_t$ , do not show consistent effects toward both measures of stock-price crash risk, while the effects are not statistically significant.

Table 4

Regression results on the relationship between diversification and stock-price crash risk

	$NCSKEW_{t+1}$	$DUVOL_{t+1}$
$HERFINDAHL_t$	-0.0772** (0.0168)	-0.0892*** (0.0008)
$FIRMSIZE_t$	0.0215*** (0.0067)	0.0188** (0.0113)
$LEVERAGE_t$	-0.1796* (0.0726)	-0.1506 (0.1226)
$MTBV_t$	0.0304*** (0.0021)	0.0205** (0.0141)
$RETURN_t$	-0.8705 (0.6286)	-2.5587 (0.1104)
$ROA_t$	-0.1835 (0.1594)	-0.1615 (0.1555)
$SIGMA_t$	0.2514 (0.4297)	0.9076*** (0.0060)
$DTURNOVER_t$	0.0827 (0.5385)	-0.0054 (0.9512)
$NCSKEW_t$	0.0607*** (0.0004)	
$DUVOL_t$		0.0326** (0.0433)
Constant	-0.6558*** (0.0000)	-0.5664*** (0.0000)
Industry dummies	Yes	Yes
Year dummies	Yes	Yes
Standard errors clustered by observations	Firms 4055	Firms 4046
Adjusted R <sup>2</sup>	0.280	0.326

The numbers inside parentheses are  $p$ -values, based on standard errors adjusted by firms. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.10$ .

Our empirical methodology includes the use of system GMM estimator (Wintoki et al., 2012; Roodman, 2009). By using this estimator, we avoid problems associated with unobserved heterogeneity and potential endogeneity of regressors. The system GMM estimator is also considered as more efficient than other instrumental variable techniques in controlling for the possible endogeneity of explanatory variables. The results generated based on GMM model reported in Table 5 in this study are similar to FE models.

To further examine the possible nonlinear effect from different levels of diversification on stock-price crash risk, we divide our sample firms into four categories based on the percentile of Herfindahl index (Pctile below 30, Pctile 30–50, Pctile 50–70, and Pctile above 70). In our Table 6, we show that a low percentile Herfindahl index, i.e.,  $DHERFINDAHL\_Pctile\ 30t$ , has a significant positive relationship with both measures of crash risk,  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ . On the opposite, our results show the highest percentile Herfindahl index, i.e.,  $DHERFINDAHL\_Pctile\ 70$ , has a significant negative relationship with both  $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ , respectively. Lastly, as for the middle-level of diversification, i.e.,  $DHERFINDAHL\_Pctile\ 30-50$  and  $DHERFINDAHL\_Pctile\ 50-70$  do not show any significant effects on stock-price crash risk. Based on these results shown in Table 6, our study shows that the risk-minimisation effect from diversification is more pronounced for highly diversified firms, and this effect would gradually dissipate as the level of diversification is becoming lower. Our findings are consistent with the priori for the degree of relatedness of diversification, in which firms with a lower (higher) number of businesses are likely to be more related (unrelated) diversifiers than those with a higher (lower) number of businesses. Thus, as for a firm with lower level of diversification, even though it is “diversified”, the close relatedness in its multiple business segments would have led to indifferent results as of a non-diversified firm, that is, crash risk is higher.

Table 5

Regression results on the relationship between diversification and stock-price crash risk using GMM models

	$NCSKEW_{t+1}$	$DUVOL_{t+1}$
$HERFINDAHL_t$	-0.0545* (0.0825)	-0.0653* (0.0732)
$FIRMSIZE_t$	0.0768** (0.0279)	0.0516** (0.0317)
$LEVERAGE_t$	-0.0876 (0.8168)	0.2826 (0.3232)
$MTBV_t$	0.0202 (0.2152)	0.0136 (0.2245)
$RETURN_t$	-9.4705 (0.2039)	-9.0877** (0.0228)
$SIGMA_t$	3.4835** (0.0373)	3.4785*** (0.0013)
$DTURNOVER_t$	-0.5627 (0.2558)	-0.5394* (0.0922)
$ROA_t$	0.2291 (0.3625)	-0.0508 (0.7552)
$CRASH\_RISK_t$	-0.089 (0.1968)	-0.1561** (0.0402)
$N$	4404	4391
$p$ -value of AR1	0.0000	0.0000
$p$ -value of AR2	0.3590	0.1760
$p$ -value of Hansen test	0.3370	0.4060

Notes: This table rewrites the regression model in Eq. (6) as a dynamic panel by including lagged value of crash risk as a regressor, and estimate with GMM model. Year dummies are included in the regressions (not reported to conserve space). Figures in parentheses are standard errors, while  $p$ -values are reported in square brackets.  $AR(1)$  and  $AR(2)$  tests are under the null of no first-order and second-order serial correlation, respectively, in the first-differenced residuals. The Sargan and Hansen tests of over-identification are under the null that all instruments are valid.  $N$  denotes the number of observations. \*\*\*, \*\* and \* denote statistical significance at the 1%, 5% and 10% levels, respectively.

Table 6

*The effects of different classes of percentile for Herfindahl index on stock-price crash risk*

Panel A: Dependent Variable is  $NCSKEW_{t+1}$

	[PERCENTILE]			
	Pctile below 30	Pctile 30–50	Pctile 50–70	Pctile above 70
$DHERFINDAHL\_ [PERCENTILE]_t$	0.0402** (0.0323)	0.0162 (0.5140)	-0.0335 (0.1492)	-0.0431* (0.0647)
Control Variables	Yes	Yes	Yes	Yes
Industry Dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Standard Errors clustered by	Firms	Firms	Firms	Firms
Obs	4367	4367	4367	4367

Panel B: Dependent Variable is  $DUVOL_{t+1}$

$DHERFINDAHL\_ [PERCENTILE]_t$	0.0526*** (0.0013)	-0.0050 (0.8189)	-0.0282 (0.1857)	-0.0476** (0.0238)
Control variables	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Standard errors clustered by	Firms	Firms	Firms	Firms
Observations	4367	4367	4367	4367

*Notes:*  $DHERFINDAHL\_ [PERCENTILE]_t$  is a dummy variable giving a value of one for different classes of  $HERFINDAHL_t$  (for the classes of percentile below 30 (pctile30), between 30 and 50 (pctile30–50), between 50 and 70 (pctile50–70), and above 70 (pctile70)), and giving a zero value otherwise. The numbers inside parentheses are  $p$ -values, based on standard errors adjusted by firms. \*\*\* $p < 0.01$ , \*\* $p < 0.05$ , \* $p < 0.10$ . Control variables are not reported here.

### Analysis of the Influence of Female Director in Board

The progressive increase in female directors in the board of publicly listed firms is mainly attributed to the active role played by the Malaysian government in promoting corporation board gender diversity and female corporate leadership in recent years (for example, a speech made by the prime minister then, Najib Razak, 2015). Using our collected sample data, we calculate the proportion of female directors in board over the period 2010–2016 as shown in Table 7.

Table 7

*Percentage of female directors in board among Malaysian publicly listed firms*

Year	Percentage (%)
2010	8.30
2011	8.70
2012	8.90
2013	9.60
2014	10.20
2015	10.80
2016	12.50

In Table 8, our results show that the interaction term between *FEMALE\_DIRECTORS<sub>i</sub>* and *DSHERFINDAHL\_Pctile70<sub>i</sub>* is negative which is statistically significant. It indicates that increasing board diversity in gender negatively affects the relationship between Herfindahl index and stock-price crash risk, but the effect of the interaction term is only applicable with a high degree of diversification. This means that increasing the number of female directors can bring a reduction in stock crash risk exposure, but the merit of increasing the number of female directors is only significantly seen in firms that have diversified into many business segments. Firms that instead have a lower degree of diversification do not enjoy the benefits from increasing the number of female directors in a boardroom.

## CONCLUSIONS

This study adds to the body of literature of stock-price crash risk, where our findings provide new insights of the effect of corporate diversification on stock-price crash risk. The findings of this study imply that firms with lower degrees of diversification may not prevent managers from adopting bad-news hoarding behaviour. Our study result implies that idiosyncratic risk of stock returns for (highly) diversified firms is lower than lower-degree diversified firms as well as non-diversified firms. Thus, our finding suggests that investors should consider to hold stocks of some highly diversified firms in their investment portfolio if they desire to reduce their idiosyncratic risk. This study also adds to the literature that the risk-minimisation effect of corporate diversification is two-fold and is non-linear.

Table 8  
*The influence of female directors in board on different classes of diversification and stock-price crash risk*

	Petile30		Petile30-50		Petile50-70		Petile70	
	$DUVOL_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$NCSKEW_{t+1}$
$DHERFINDAHL\_PERCENTILE]_t$	0.0422* (0.0802)	0.0528** (0.0110)	-0.0215 (0.4922)	-0.0236 (0.4101)	-0.0422 (0.1635)	-0.0448 (0.1048)	-0.0042 (0.8816)	-0.0178 (0.4922)
$FEMALE\_DIRECTORS_t$	0.1015 (0.3475)	0.0948 (0.3441)	0.0262 (0.7725)	0.0646 (0.4542)	0.0723 (0.4392)	0.0672 (0.4392)	0.1921** (0.0372)	0.1767** (0.0296)
$FEMALE\_DIRECTORS \times DHERFINDAHL\_PERCENTILE]_t$	0.0072 (0.9634)	0.0382 (0.7945)	0.37752 (0.0820)	0.1878 (0.3162)	0.1160 (0.5532)	0.1582 (0.3771)	-0.4392** (0.0153)	-0.3471* (0.0548)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Standard errors clustered by	Firms	Firms	Firms	Firms	Firms	Firms	Firms	Firms

Notes: This table presents the regression results of the influences of female directors in board on the relation between Herfindahl index ( $DHERFINDAHL_t$ ) and stock-price crash risk ( $NCSKEW_{t+1}$  and  $DUVOL_{t+1}$ ).  $DHERFINDAHL\_PERCENTILE]_t$  is a dummy variable giving a value of one for different classes of  $DHERFINDAHL_t$  [for the classes of percentile below 30 (petile30), between 30 and 50 (petile30-50), between 50 and 70 (petile50-70), and above 70 (petile70)], and giving a zero value otherwise. Odd numbered columns show the effect of female directors on the relation between  $DHERFINDAHL\_PERCENTILE]_t$  and  $DUVOL_{t+1}$ , while columns with even numbers show the effect of female directors on the relation between  $DHERFINDAHL\_PERCENTILE]_t$  and  $NCSKEW_{t+1}$ . Standard errors are clustered by firms, and  $p$ -values are reported in parentheses. \*\*\*,  $p < 0.01$ , \*\*,  $p < 0.05$ , \*,  $p < 0.10$ .

Our further analysis indicates that female directors on board can intensify the mitigation effect of the stock-price crash risk of diversification, but such influence is only applicable in highly-diversified firms. This implies that increasing the number of female directors in a boardroom may be a way to counter the self-interested behaviours of managers amid the characteristics of female directors can be effectively used to balance the shareholders' benefits in risk-taking decisions and also serve as a corporate monitoring mechanism to reduce agency costs. Future research may look into the policy implications that arise from this study, particularly focusing on the formation of heterogeneous boards for better governance over risky investments by diversified firms.

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