Stock Price Crash Risk in Emerging Markets: The Role of Corporate Governance and Price Informativeness

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ABSTRACT

This study examined the role of stock price informativeness and corporate governance in mitigating stock price crash risk. Despite the critical importance of information in financial markets, most prior studies have relied on traditional measures of informativeness, such as stock price synchronicity, which failed to account for the complexities of return distributions with fat tails. To address this limitation, this study introduced a novel copula-based measure of stock price informativeness that captured the nonnormal distribution of stock returns. The findings indicated that higher stock price informativeness reduced stock price crash risk in Pakistani firms. Additionally, the study revealed that large and independent boards were ineffective in enhancing the information environment in family-dominated firms, where information concealment contributed to increased crash risk. Moreover, institutional ownership was positively associated with crash risk, highlighting the passive role of institutional investors. These findings suggested that regulators in emerging markets, such as Pakistan, should prioritize ownership regulations over traditional boardroom governance to reduce information asymmetry and mitigate crash risk.

Keywords: Copula, Corporate Governance, Crash Risk, Informativeness, Emerging Market

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INTRODUCTION

Stock price crash risk refers to the negative skewness in individual stock returns, reflecting the probability of a sudden and significant price drop (Habib, Hasan, & Jiang, 2018; Hunjra, Mehmood, & Tayachi, 2020; Kim, Si, Xia, & Zhang, 2022). The 2008 financial crisis, triggered by the US subprime mortgage meltdown, underscored the imperative of developing a deeper understanding of stock price crashes. Stock market stability and reduced volatility are crucial for economic growth because of contagion risk factors in financial markets (Liu et al., 2022). Therefore, identifying the determinants of stock crashes is a priority for policymakers and practitioners. Despite extensive research, the relationship between corporate governance and stock price crash remains unclear. Existing studies provide conflicting evidence, suggesting that corporate governance may mitigate or fail to influence crashes (An & Zhang, 2013). This ambiguity highlights the need for a more nuanced exploration of the relationship, mainly through the lens of stock price informativeness.

The agency problem is widely recognized as a key driver of stock price crashes (Habib et al., 2018). Under the bad news hoarding theory, Jin and Myers (2006), argued that information asymmetry between internal and external stakeholders can lead to a sudden stock price collapse. Managers may use fraudulent window dressing of financial statements, earnings, or corporate social responsibility (CSR) disclosures to protect their personal interests (Alasmari, Ali, Khalid, Chuanmin, & Rasheed, 2025; Michaelides & Vafeas, 2023). This deliberate concealment of negative information inflates stock prices, increasing the likelihood of abrupt corrections. Effective corporate governance mechanisms are expected to mitigate opportunistic behavior and reduce crash risk (An & Zhang, 2013; Jeon, 2019). Earlier literature suggests a direct association between stock price informativeness and a stock's informational flow, which is also found to be influenced by various variables related to corporate governance (Dang, Li, & Wang, 2024). However, some scholars argued that the impact of corporate governance on crash risk is context-dependent. During times of crisis, governance structures may not function effectively to prevent price collapses (da Silva, 2019).

Another problem identified from the existing literature is the traditional measurement of stock price informativeness, which is often derived from

synchronicity, typically obtained by converting the R^2 of a market model into a non-bounded value. Since Roll (1988) pioneering work, the market model's R^2 has been utilized as an inverse measure of informativeness. Since Morck, Yeung, and Yu (2000), much of the literature has computed synchronicity using the R^2 of a market model, assuming normally distributed returns. The current investigation believed that this measure was inappropriate for analysis, given the randomness and deviation of stock return data from the normal distribution (Chan & Hameed, 2006). The linearity of measurement assumption appears overly restrictive, as it does not account for higher moments that are more prominent and stylized characteristics of stock returns (Chung, Johnson, & Schill, 2006). Using traditional measures of movements and dependence in the presence of nonlinear relationships may be misleading or unreliable (Cherubini, Luciano, & Vecchiato, 2004) and, hence leading to mixed findings in this avenue. Therefore, to address this issue, there is a need for a more general distribution for the computation of R^2. The copula family of functions presents one potential solution to this problem, which assumes various distributions.

The concept of copula was first introduced by Sklar (1959) but gained popularity only a decade ago and had broad applications in financial markets, especially for risk and portfolio management. Copulas can be applied to find the dependence of nonlinear and complex multivariate distributions, while traditional correlation methods fail to do so. Copulas also allow us to find tail dependence, which can help investors deal with extreme returns (Bouri et al., 2018). The method is invariant to scaling and log transformations commonly used in financial studies from a set of copula families, specifically in finance, mainly employed Gaussian copula, T copula, or Archimedean family of copulas. These copulas have several advantages, but t-copula induces fatter tails compared to Gaussian copula, which assumes a normal distribution (Cossin et al., 2010). Lourme and Maurer (2017) also suggested student t-copula over Gaussian based on VaR. They further proved that the expected shortfall is inconclusive, and risk managers should consider copula models and risk measures. For modeling financial data, t-copula is most widely used due to its simplicity in estimation and calibration (Demarta & McNeil, 2005; Fang et al., 2002) and was therefore incorporated in the current undertaking. This will provide a more reliable and realistic view of the real-life mechanism related to stock price crash risk.

Pakistan's stock market presents a unique case for examining the relationship between corporate governance, informativeness, and crash risk due to its distinctive features. Pakistan's market is characterized by concentrated ownership, family-controlled firms, and weaker investor protection, which may exacerbate information asymmetry and, ultimately, crash risk (Rasheed, Fareena, & Yousaf, 2019). Second, Pakistan's economy is relatively less prone to changes in international financial shocks due to its limited size, offering a controlled environment to investigate relationships in emerging market settings. Lastly, Pakistan's governance structure significantly differs from developed markets, necessitating a more focused and contextualized analysis of crash risks.

The primary objective of this study was to investigate the impact of corporate governance and stock price informativeness on stock price crash risk in an emerging market setting like Pakistan. Second, to investigate the effectiveness of a novel copula-based measure of informativeness compared to traditional proxies. For this purpose, the study sought to answer the following research questions. How do corporate governance and stock price informativeness impact stock price crash risk? Moreover, does a copula-based measure of stock price informativeness provide a more accurate measurement than a traditional synchronicity measure?

This study makes several contributions to the literature. First, it integrated stock price informativeness as a mediating factor in the corporate governance–crash risk relationship, offering a more comprehensive understanding of this nexus. While prior studies have explored this relationship, they have largely overlooked the role of governance in influencing informational efficiency in financial markets. Second, the study introduced a novel copula-based approach to measuring stock price informativeness, addressing a key methodological gap in the existing literature. By considering multiple copula families, including the t-copula, this research provided a more accurate and robust measure of informativeness that better reflects financial market complexities. Third, by focusing on an emerging market like Pakistan, the study contributed to a growing body of research on corporate governance in developing economies, where institutional frameworks and market structures differ significantly from those in developed countries.

Beyond its theoretical contributions, this study has significant practical implications. Understanding the role of stock price informativeness in mitigating crash risk can help policymakers and investors develop more effective governance frameworks. If corporate governance mechanisms fail to enhance informational efficiency, their effectiveness in reducing crash risk may be limited. Thus, improving the flow of firm-specific information through better governance practices can be crucial in minimizing stock price crashes. By employing an advanced methodological approach and focusing on an underexplored market, this study aimed to provide deeper insights into the governance-informativeness-crash risk nexus, offering valuable implications for academics, practitioners, and policymakers alike.

LITERATURE REVIEW

In recent years, frequent stock market crashes have damaged all economic stakeholders, especially shareholders' wealth (Ring, 2023). Emerging equity markets are often characterized by excessive volatility and weaker corporate governance, in which crash risk is critical (Vo, 2020). This has garnered increased attention from financial economists (Kim & Zhang, 2016). The research attributes this excess volatility to the underlying agency problem in a business setting, where managers' interests may diverge from those of shareholders. The literature also suggests that downward market movements occur more frequently than upward movements due to managers withholding adverse information from outside investors (Guerron-Quintana, Hirano, & Jinnai, 2023; Tan, Rasheed, & Rasheed, 2024). To address the interplay between agency problems and information asymmetry, Jin and Myers (2006) introduced the theory of bad news hoarding, highlighting the informational imbalances between managers and external shareholders. These asymmetries empower managers to delay the disclosure of adverse news, motivated by factors such as executive compensation, job protection, and the desire to minimize litigation resulting from inadequate information disclosure. This information hoarding ultimately leads to an inflated market valuation. When the accumulated negative information is suddenly released, it triggers a rapid decline in stock prices and eventual market crashes. Empirical studies such as Al Mamun et al. (2020), An and Zhang (2013), Andreou et al. (2016), Jeon (2019), and Xiang et al. (2020) support this agency-based perspective on managers' bad news hoarding.

Corporate Governance and Crash Risk

Corporate governance refers to the established mechanisms through which a business undertaking is conducted to protect and balance the interests of all stakeholders (Ellili, 2023). The existing literature identifies the agency problem as the primary cause of stock price crash risk (Callen & Fang, 2013). Consequently, effective corporate governance is crucial for mitigating managerial opportunism and reducing crash risk (An & Zhang, 2013). Addressing the agency problem through effective corporate governance leads to a subsequent reduction in stock price crash risk. At the apex of corporate governance is the management of the board of directors, primarily CEOs and CFOs. The literature on crash risk recognizes the significant role of various aspects, including age, gender, family, and the power of a firm's board.

Al Mamun et al. (2020) found that powerful CEOs can withhold adverse news, increasing firm-specific crash risk. Firms with higher agency risks will likely exhibit elevated firm-specific crash risk (Callen & Fang, 2013; Kim & Zhang, 2016). Chowdhury et al. (2020) concluded that higher CEO industry tournament incentives significantly reduced their ability to withhold adverse news, resulting in lower crash risk. Similarly, family-owned firms constrain family CEOs from withholding adverse news for an extended period, reducing crash risk (Jiang et al., 2020). Young CEOs tended to conceal negative operating performance, increasing crash risk (Andreou et al., 2017). CEO power and duality may not contribute to adverse news hoarding, but internal coalitions among directors and management encouraged such behavior, a key contributor to crash risk (Xu, Rao, Cheng, & Wang, 2020).

Another significant avenue in mitigating crash risk through corporate governance is the role of creditors and investors. The behavior of institutional shareholders also influenced managers' adverse news hoarding. Transient and inattentive institutional shareholders encouraged managers' adverse news-hoarding behavior through earnings management (Islam et al., 2018; Xiang, Chen, & Wang, 2020). Short-termism among institutional investors increased adverse news hoarding by managers, whereas dedicated institutional investors discouraged managers' ability to withhold adverse news (An & Zhang, 2013). Additionally, Xiang et al. (2020) found that if

institutional investors were distracted by outside events and inattentive to the firms, they caused an increase in crash risk. The relation was more pronounced for government firms and firms having dual CEOs (Rasheed, Kouser, & Ling, 2024).

Lastly, various studies also incorporated diverse corporate governance mechanisms and their interplay to report a significant impact of effective corporate governance practices to alleviate stock crash risk. Chauhan et al. (2017) noted that firm-level corporate governance reduced crash risk. Additionally, block-holding ownership aided in mitigating stock price crash risk by enhancing the information environment in the Indian context. Clearly defined corporate governance policies, more independent directors, and independent audit committees reduced the likelihood of crashes (Andreou et al., 2016). In contrast, the informal hierarchy in the board of directors increases managerial coordination and contributes to adverse news hoarding, increasing crash risk (Jebran, Chen, & Zhu, 2019; Khalid, Chuanmin, et al., 2024).

Furthermore, this relationship weakened in firms with larger boards and higher CEO status. Hu, Li, Taboada, and Zhang (2020) found a decrease in crash risk following corporate board reforms worldwide. The reduction in crash risk after the reforms was found to be stronger for firms with agency problems. Based on the evidence and the preceding discussion, this study considered several corporate governance variables related to crash risk and proposed that,

H_1: Effective corporate governance reduces stock price crash risk.

Stock Price Informativeness and Crash Risk

In addition to effective corporate governance, greater stock price informativeness has been shown to mitigate stock price crash risk. Information asymmetry exacerbates agency problems, particularly when managers had incentives to withhold negative news (Khalid, Mi, Ashraf, & Islam, 2024; Kothari, Shu, & Wysocki, 2009). The lower the information displayed by stock prices, the higher the probability of crash risk. Song et al. (2016) found that stock price informativeness improved with increased disclosures in banks. Kothari et al. (2009) proposed that information asymmetry enabled managers to withhold negative news for a prolonged

period, leading to stock price crashes when the news becomes public. Similarly, Hutton, Marcus, and Tehranian (2009) found that information opacity enhances managers' bad news-hoarding behavior and increases the probability of a crash. Douch et al. (2015) proposed that firms with better information tended to have a higher probability of producing fat-positive tails than fewer advisory firms. Kim and Zhang (2016) found that managers tend to withhold bad news to the extent that they have incentives to do so by manipulating the textual information. The degree of conditional accounting conservatism was negatively related to crash risk. Lobo, Wang, Yu, and Zhao (2020) suggested that internal control weaknesses facilitated the managers' bad news-hoarding behavior, which results in increasing information asymmetry. The increased information asymmetry between managers and shareholders increased crash risk. This study also expected that higher stock price information or lower synchronicity led to lower crash risk.

H_2: Stock price informativeness reduces stock price crash risk.

DATA AND METHODOLOGY

This study utilized data from all nonfinancial firms listed on the Pakistan Stock Exchange (PSX). The study excluded financial firms due to separate corporate governance guidelines and distinct contextual factors. The final sample comprised 264 nonfinancial firms from 12 different industries, with a total of 2,335 firm-year observations after the exclusion of financial firms and addressing the issue of missing data.

The Copula Models

Our traditional measure of informativeness assumed a normal distribution of returns, which was a restrictive assumption. In the presence of higher moments and non-normality, using R^2 assuming normal distribution may lead to misleading results (Douch, Farooq, & Bouaddi, 2015). To solve this issue, this study introduced a new approach to calculate the dependence of asset returns and market returns using copulas.

Volatility clustering, scaling behavior, heavy tails, and seasonality are some common stylized facts in high-frequency data of financial markets (Breymann, Dias, & Embrechts, 2003). With the developments of financial

markets and a considerable amount of data, data mining uses different tools to ascertain some valuable insights from the data. One way is to look beyond traditional normal distributions and observe tail behaviors. Copula models provide a variety of alternatives to build stochastic models, which are difficult in practice, like tail dependence and asymmetries. These powerful tools can be applied to nonlinear and tail-dependence structures without constraints of marginal distributions (Liu, Ji, & Fan, 2017). Many functional forms can be used as copulas. Which copula to be used is for a specific purpose depends on the type of distribution of the random variables (Embrechts, 2009). This study used different copulas and introduces the best-fitted copula for measuring the stock price informativeness.

Since the seminal work by Roll (1988), the market model R^2 has been used as an inverse measure of informativeness. A significant strand of literature supports the idea that lower synchronicity implies that firm-specific stock prices show less movement with the market and thus have high firm-specific information. Recent studies like DeLisle, French, and Schutte (2017); Ding, Hou, Kuo, and Lee (2017) and Fu, Liu, and Qin (2020) provide supporting evidence of lower price synchronicity as higher a piece of firm-specific information impounded into the stock price and better informativeness.

Baseline Model for Corporate Governance, Stock Price Informativeness, and Crash Risk

Following a large strand of the literature (Habib et al., 2018), this study constructed three firm-specific stock price crash risk measures to ensure robustness. To calculate measures of stock price crash risk, we used the extended market model with lead and lagged values of market return to estimate firm-specific weekly returns (Kim, Li, & Zhang, 2011).

$$r_{i,t} = \alpha + \beta_1 r_{m,t-1} + \beta_2 r_{m,t} + \beta_3 r_{m,t+1} + \varepsilon_{it} \quad (1)$$

Where r_{it} is individual stock return, rmt is weekly market return. After that, we calculated firm-specific weekly returns using residuals from equation 3 and define $R_{i,t}$ using the following equation 4.

$$R_{i,t} = \ln (1 + \varepsilon_{i,t}) \quad (2)$$

Using the firm-specific weekly returns from equation (2), we calculated three measures of crash risk. The detailed measures and equations can be found in the Appendix.

Jin and Myers (2006) found that stocks in transparent stock markets were less likely to exhibit crashes than opaque stock markets. They also foundthat higher R-Square was not caused by the higher likelihood of crashes. The study proposed the following baseline model:

$$CRASH_{it} = \alpha_{it} + \beta_1 INFO_{it} + \beta_2 CEO_{it} + \beta_3 BSIZE_{it} + \beta_4 BIND_{it} + \beta_5 INSTOWN_{it} + \beta_6 BLOCK_{it} + \beta_7 FAMILY + \beta_8 FSIZE_{it} + \beta_9 LEV_{it} + \beta_{10} ROA_{it} + \beta_{11} MB_{it} + \beta_{12} AGE_{it} + \beta_t INDUSTRY + \beta_t YEAR + \varepsilon_{it} \quad (3)$$

The detailed measurement of all variables is given in Appendix.

RESULTS AND DISCUSSIONS

Copulas

The estimation techniques for copula parameters are well established, but choosing specific copula functions is still an open problem. For most financial problems, the main problem is not to apply a specific multivariate distribution but to find a convenient type of distribution that describes the stylized facts of financial data (Frees & Valdez, 1998). From a set of copula families, specifically in finance, mainly employed Gaussian copula, T copula, or Archmedian family of copulas. These copulas have several advantages, but the t-copula induces fatter tails compared to the Gaussian copula, which assumes normal distribution (Cossin, Schellhorn, Song, & Tungsong, 2010). For modeling financial data, t-copula is most widely used due to its simplicity in estimation and calibration (Demarta & McNeil, 2005).

Table 1: Copula Model Fitness

Copula type	Parameters	Log-likelihood	AIC	SBC	No. of Obs
t-copula	10.981	17550	-35096	-35073	712338
Clayton	0.221	12970	-25939	-25927	712338
Gumbel	1.134	13344	-26687	-26675	712338

Table 1 reports the attempted copula's parameters and related AIC and SBC values. Based on the AIC and SBC criteria, the best-fitted copula is that which has the lowest values (Bhatti & Nguyen, 2012; Bouri, Gupta, Lau, Roubaud, & Wang, 2018; Nguyen & Bhatti, 2012). Following the literature, after comparing the AIC and SBC, the t-copula attained the minimum values among all the attempted copulas and hence seemed best fitted on our dataset (Yoshiba, 2018). The AIC value of the t-copula was much lower than that of Clayton and Gumbel copulas. For a bivariate linear relationship, the R-squared can be calculated simply by taking the square of the Pearson correlation. According to Sklar's Theorem, any joint probability distribution can be decomposed into a marginal distribution and a copula. The copula component captures the dependence structure among the variables. Hence, the equitable R-squared measure should be copula-based (Ding & Li, 2013). This study also used the copula-based equitable measure chosen from the best-fitted copula, i.e., t-copula. The selection of t-copula was consistent with earlier findings of de Melo Mendes and de Souza (2004), who also found that student t-copula remains the best-fitted copula in the US and Brazilian markets

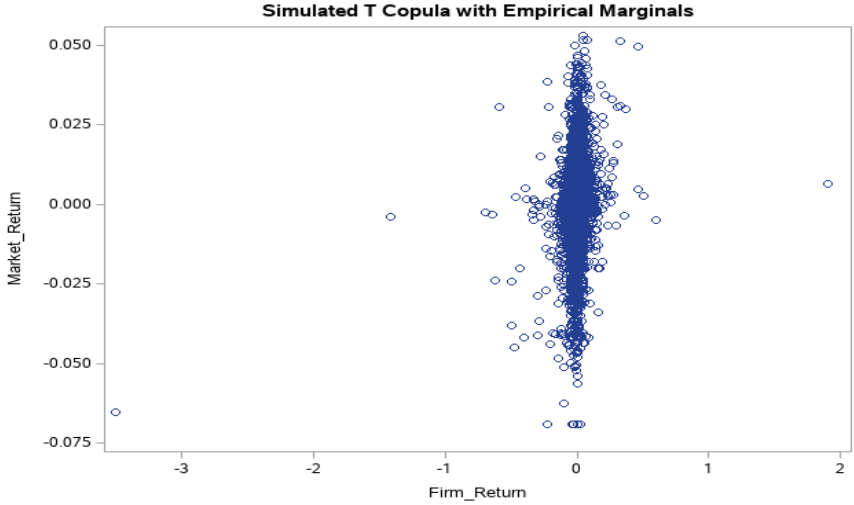

Figure 1: Marginals of t-Copula

Table 2: Descriptive Statistics

Variable	Mean	Std	Min	Max	Skew	Kurt
Copula Stock Price Informativeness (INFO)	-4.260	2.940	-12.750	-0.010	-0.815	3.03
Negative Conditional Skewness (*NCSKEW*)	0.091	0.853	-1.273	2.082	0.640	2.967
Down to Up Volatility *(DTUVOL)*	0.004	0.410	-0.684	0.858	0.316	2.459
Crash Risk *(COUNT)*	0.075	0.671	-1.000	1.000	-0.088	2.216
CEO Duality (*CEO*)	0.180	0.384	0.000	1.000	1.667	3.779
Board Size (*BSIZE*)	8.000	1.535	5.000	16.000	2.062	7.900
Board Independence (*BIND*)	62.15	17.271	28.571	90.000	-0.124	2.151
Institutional Ownership (*INSTOWN*)	0.159	0.194	0.000	0.093	2.122	7.765
Block Shareholders (*BLOCK*)	2.390	1.944	0.000	9.000	0.680	2.969
Family Ownership *(FAMILY)*	0.757	0.429	0.000	1.000	-1.197	2.432
Log of Assets *(FSIZE)*	8.427	1.691	3.856	13.349	0.220	2.841
Leverage (*LEV*)	0.362	12.290	593.035	3.739	1.332	6.641
Market to Book Ratio (*MB*)	1.474	2.930	-2.132	21.421	4.664	28.861
Firm Age (*AGE*)	38.236	21.401	2.000	157.000	1.779	8.629
Return on Assets (*ROA*)	0.038	4.867	-54.085	214.196	34.860	1623.399

Notes: This table reports descriptive statistics of all the variables used in this study. All these variables are defined in the Appendix.

Regression Analysis

Table 3 presents the regression results examining the relationship between corporate governance and crash risk incorporating the copula-based measure of informativeness. Stock price informativeness (INFO) exhibited negative and statistically significant coefficients across all three measures of crash risk, indicating an inverse relationship between the two variables. Since this study used synchronicity as a reverse measure of informativeness, these findings confirmed that firms with better information environments were less likely to experience stock price crashes. The results aligned with the previous studies (Chen, Xie, You, & Zhang, 2018; Chowdhury, Hodgson, & Pathan, 2020; Song, Du, & Wu, 2016). An improved information environment curtails managers' tendency to withhold negative news, reducing crash risk. This relationship remained robust across all three measures of crash risk, with coefficients of similar magnitudes.

Furthermore, CEO duality exhibited positive and significant coefficients with NCSKEW, and DTVOL remained insignificant for the

COUNT measure of crash risk. This finding supported the notion that a dual CEO structure consolidated decision-making power, allowing executives greater control over information dissemination, which increases the likelihood of prolonged bad news hoarding (Al Mamun, Balachandran, & Duong, 2020). Regarding board characteristics, board size (BSIZE) was significantly associated with crash risk across all models except for DTUVOL. While traditional theories suggested that larger boards enhanced information efficiency and mitigate crash risk, our findings indicated that larger boards tended to be ineffective in reducing crash risk. This aligned with Jensen (1993) argument regarding the free-rider problem and board inefficiencies. These results are also consistent with recent findings of Wu, Fang, and Chen (2020). Similarly, board independence (BIND) showed insignificant coefficients, consistent with Wu et al. (2020), who argued that independent directors often served on multiple corporate boards, limiting their monitoring effectiveness and ultimately increasing stock price crash risk.

Consistent with Andreou, Antoniou, Horton, and Louca (2016) and An and Zhang (2013), our study also found a positive and significant relationship between institutional ownership and crash risk. This relationship couldbe attributed to the short-term focus of institutional investors in the Pakistani market, where they have limited incentives to engage in active monitoring (Callen & Fang, 2013; Rasheed et al., 2024). Wu et al. (2020) similarly found that institutional investors' speculative and short-term profit-seeking behavior exacerbated crash risk.

Block shareholders (BLOCK) with more than 5% ownership showed a significant negative relation with DTUVOL and insignificant for the NCSKEW and COUNT measures. Andreou et al. (2016) argued that outside block holders restrict managerial discretion in withholding negative news, reducing crash risk. Similarly, Chauhan, Kumar, and Pathak (2017) found blockholder ownership discouraged bad news hoarding and lowers crash risk. Family ownership (FAMILY), measured as a dummy variable, remained largely insignificant across crash risk measures, except for the COUNT measure. This suggested that family-controlled firms had more substantial incentives to withhold negative news, and when such information was eventually disclosed, stock prices experienced sharp declines, leading to crashes.

Surprisingly, most control variables were insignificant, except for firm size (FSIZE), which exhibited a negative and significant relationship with crash risk. This finding contradicted An and Zhang (2013), who documented a positive association between firm size and crash risk, but was consistent with Chauhan et al. (2017), who reported a significant negative relationship in the Indian market. A possible explanation is that larger firms with more stable cash flows generated fewer surprises when negative news emerged, as they were better positioned to withstand adverse situations.

Table 3: Regression Results

Dependent Variable: *NCSKEW*			*DTUVOL*		*COUNT*	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
INFO	-.029*** (0.00)	.007	-.0176*** (0.00)	.003	-.011* (0.07)	.006
CEO	.132*** (0.00)	.050	.0749*** (0.00)	.024	.049 (0.20)	.038
BSIZE	.026** (0.05)	.013	.010 (0.13)	.006	.024** (0.02)	.010
BIND	-.004 (0.96)	.010	.001 (0.84)	.005	-.005 (0.47)	.008
IO	.2468*** (0.00)	.091	.1234*** (0.01)	.044	.1601** (0.03)	.073
BLOCK	-.014 (0.12)	.009	-.0089** (0.04)	.004	-.0061 (0.40)	.007
FAMILY	.010 (0.82)	.043	-.002 (0.91)	.021	.0249 (0.46)	.033
FSIZE	-.043*** (0.00)	.013	-.0167*** (0.01)	.006	-.0314*** (0.00)	.010
LEV	-.081 (0.19)	.061	-.0340 (0.24)	.029	-.1207** (0.01)	.045
MB	-.005 (0.37)	.005	-.002 (0.38)	.003	.009 (0.81)	.004
AGE	-.001 (0.93)	.001	-.009 (0.81)	.040	-.003 (0.96)	.060
ROA	-.003 (0.40)	.003	-.002 (0.32)	.002	.001 (0.57)	.002
Constant	.149 (0.36)	.166	.004*** (.00)	.080	.176 (0.17)	.130
Observations	2335		2335		2335	
R^2	.026		.032		.014	
F-Statistics (p>F)	4.73 (.000)		5.69 (.000)		2.83 (.000)	

Industry and Firm Year Fixed Effects

The literature suggested that simple regression estimates may be biased due to the presence of reverse causality and endogeneity (Kim et al., 2011). Following Jebran, Chen, and Zhang (2020), this study employed industry and firm-year fixed effects to address these concerns.

The findings from the fixed-effect models in Table 4 remained primarily consistent, except that the CEO duality became insignificant. A plausible explanation is that CEOs exert substantial control over the flow of information in specific dominant industries. However, this relationship became insignificant after controlling for industry and time effects (Yang & Zhao, 2014).

Table 4: Fixed Effects Results

Dependent Variable: *NCSKEW*			***DTUVOL***		***COUNT***	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
INFO	-.016** (0.04)	.008	-.012*** (0.00)	.004	-.019* (0.09)	.011
CEO	.041 (0.41)	.049	.034 (0.14)	.023	-.026 (0.77)	.091
BSIZE	.029** (0.04)	.014	.010 (0.101)	.006	.0276 (0.59)	.051
BIND	-.001 (0.18)	.001	-.005 (0.304)	.004	-.001 (0.65)	.002
INSTOWN	.156* (0.09)	.091	.089** (0.04)	.044	-.118 (0.73)	.343
BLOCK	.004 (0.69)	.009	.006 (0.88)	.004	.007 (0.52)	.011
FAMILY	.002 (0.96)	.046	-.010** (0.01)	.022	-.010 (0.94)	.132
FSIZE	-.043*** (0.00)	.012	-.016*** (0.01)	.006	-.034 (0.19)	.026
LEV	-.129** (0.03)	.058	-.060** (0.03)	.027	-.138** (0.02)	.058
MB	.005 (0.37)	.006	.002 (0.48)	.003	.008 (0.75)	.005
AGE	.008 (0.32)	.008	.002 (0.47)	.004	.004** (0.03)	.002
ROA	-.002 (0.59)	.003	-.001 (0.56)	.002	-.002 (0.95)	.005
Observations	2335		2335		2335	
R^2	.129		.148		.027	
F-Statistics (p>F)	10.16 (.000)		12.25 (.000)		3.70 (.000)	

Robustness Tests

The fixed effect model adequately addressed the endogeneity concerns; however, reverse causality remained a potential issue. To mitigate this concern, we employed a two-stage least square (2SLS) regression approach using instrumental variables. Following Yeung and Lento (2018) and Chen, Chan, Dong, and Zhang (2017), we used industry averages as instrumental variables. In the first stage, we estimated predicted board size (*BSIZE*) values using industry average board size and firm-level control variables. In the second stage, we utilized these predicted values to estimate the regression models, with the results presented in Table 5.

The findings as in Table 5 confirmed that our results from the fixed effect models remained robust to reverse causality concerns. The robustness test further demonstrated that higher stock price informativeness reduced stock price crash risk, reinforcing the argument that improved corporate governance enhanced a firm's information environment and mitigates crash risk (Chauhan et al., 2017). Consistent with Callen and Fang (2013) and Andreou et al. (2016), our results indicated a significant positive relationship between institutional investors and crash risk. This suggested that the presence of inattentive institutional investors exacerbated the stock crash risk (Xiang et al., 2020).

Regarding control variables, most exhibited no significant impact on crash risk across robustness tests, except for leverage, which consistently showed a significant negative relationship with crash risk across all alternative measures of crash risk. The negative coefficients suggested that higher debt levels were an effective monitoring mechanism, reducing bad news hoarding and, consequently, crash risk.

Table 5: Two Stage Least Square (2SLS)
Instrument Variable: Average Board Size

Dependent Variable: *NCSKEW*			*DTUVOL*		*COUNT*	
	Coefficient	**SE**	**Coefficient**	**SE**	**Coefficient**	**SE**
*BSIZE**	-.106 (0.32)	.107	-.036 (0.49)	.052	-.051 (0.55)	.084
INFO	-.016** (0.04)	.008	-.0118*** (0.00)	.004	-.012*** (0.00)	.004
CEO	-.007 (0.90)	.054	.016 (0.54)	.026	-.034 (0.42)	.044
BIND	-.009 (0.41)	.011	-.003 (0.52)	.005	-.001 (0.22)	.008
INSTOWN	.181* (0.06)	.096	.098** (0.03)	.046	.160** (0.053)	.078
BLOCK	.011 (0.32)	.010	.003 (0.54)	.005	.005 (0.52)	.008
FAMILY	-.062 (0.33)	.064	-.033 (0.29)	.031	-.008 (0.88)	.051
FSIZE	-.009 (0.73)	.027	-.005 (0.72)	.013	-.010 (0.65)	.022
LEV	-.02*** (0.00)	.002	-.009*** (0.00)	.001	-.001*** (0.00)	.002
MB	.009 (0.18)	.007	.003 (0.31)	.003	.008* (0.09)	.005
AGE	.002 (0.12)	.001	.001 (0.25)	.004	.001 (0.258)	.001
ROA	-.001 (0.68)	.004	-.001 (0.63)	.002	.002 (0.45)	.003
Observations	2335		2335		2335	
R^2	.09		0.128		.032	

CONCLUSION

Effective corporate governance remains a critical challenge for scholars in strategic management and corporate finance, as well as corporate regulators. This study introduced a novel approach by introducing a copula-based measure of stock price informativeness, which better captures the dependence structure of stock returns, particularly for fat-tailed return distributions. Among the various copula models tested, the t-copula emerged as the best fit, offering significant applications in financial analysis. The t-copula helped to explain the dependence structure of stock returns and has significant applications in finance. Using the results from the t-copula, we developed an improved measure of stock price informativeness. Our findings suggested that traditional measures of informativeness were limited due to their inability to account for the nonnormal distribution of stock returns. In contrast, the copula-based measure can serve as a better alternative.

Empirical results demonstrated that an improved information environment is negatively associated with stock price crash risk. Higher stock price informativeness, measured through the copula-based method, reduced the probability of extreme negative returns. These findings remained robust when used in various tests and multiple crash risk measures. Consistent with the characteristics of emerging markets, the Pakistani market remains dominated by family-controlled firms, where board structures and governance exhibit inefficiencies. Our results indicated that large boards and independent directors were ineffective in improving the information environment. Furthermore, family ownership exhibits mostly insignificant crash risk, suggesting that information concealment by family-controlled firms exacerbated the crash risk. Similarly, institutional investors tend to play a passive role, choosing to exit rather than exert monitoring pressure, further destabilizing stock prices and increasing the likelihood of crashes.

Our findings provide helpful practical and policy implications for Pakistani financial markets. The findings emphasize the need for more regulatory intervention to strengthen investor protection and reduce information asymmetry. Traditional corporate governance mechanisms may be inadequate in emerging markets like Pakistan, where ownership structures are highly concentrated. Regulators should focus on enhancing disclosure standards and ensuring that independent directors monitor more

effectively. Additionally, policies should be designed to encourage long-term institutional investment to promote market stability. Institutional investors should be incentivized to monitor and govern rather than rely on short-term strategies actively. Finally, the study provides key insights for investors. They should prioritize firms with strong governance and transparent disclosures, as higher informativeness reduces crash risk. Given the inefficiencies in Pakistan's corporate governance structure, investors must be cautious and diversify their portfolios to mitigate potential price crashes.

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APPENDIX A

Variable Name	Explanation
Copula Stock Price Informativeness (INFO)	A nonlinear measure of synchronicity using copula models
Negative Conditional Skewness (*NCSKEW*)	The negative conditional skewness of firm weekly return for every year
Down to Up Volatility *(DTUVOL)*	Down to up volatility is the ratio of the number of weeks firm returns are down to the number of weeks returns are above its mean value.
Crash Risk *(COUNT)*	Number of times firm-specific weekly returns fall below the 3.09 standard deviation.
CEO Duality (*CEO*)	A dummy variable that equals 1 if the CEO is also serves as the chairman of the board, otherwise it is 0.
Board Size (*BSIZE*)	Total number of directors serving on the board.
Board Independence (*BIND*)	The proportion (in percentage) of independent directors serving on the board.
Institutional Ownership (*INSTOWN*)	The percentage of shares held by institutions.
Block Shareholders (*BLOCK*)	The number of shareholders who own more than 5% of the Firm's total outstanding shares.
Family Ownership *(FAMILY)*	A dummy variable that equals 1 if a family is the largest shareholder of the Firm.
Firm Size *(FSIZE)*	The natural logarithm of the Firm's total assets of the Firm at the end of the year.
Leverage (*LEV*)	The Firm's total liabilities divided by its total assets.
Return on Assets (*ROA*)	A measure of profitability calculated as net income devided by total assets.
Market to Book Ratio (*MB*)	The ratios of the frim's market value of equity to its book value of total assets at the end of the year.
Firm Age (*AGE*)	The number of years since the Firm's incorporation.