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Stock price crash risk: review of the empirical literature

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Abstract

We survey the burgeoning literature on the determinants and consequences of firm-specific future stock price crash risk. We synthesise a vast body of literature on the determinants of crash risk, identify weaknesses, and offer future research opportunities. We categorise the determinants into: (i) financial reporting and corporate disclosures, (ii) managerial incentives and managerial characteristics, (iii) capital market transactions, (iv) corporate governance mechanisms, and (v) informal institutional mechanisms. Despite a large body of research into the determinants of crash risk, very little research attention has been directed towards understanding the consequences of stock price crash.

Key words: Stock price crash risk; Financial reporting; Corporate governance; Non-formal institutions

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1. Introduction

We survey the burgeoning literature on the determinants and consequences of a firm-specific future stock price crash risk (hereafter crash risk) in the United States, as well as in countries outside the United States. We intend to synthesise a rather vast body of empirical literature on this topic that is built primarily upon the agency and institutional arguments for the accumulation of bad news—the catalyst for price crash. We also offer potential research opportunities for both the determinants and the consequences of crash risk. As we adopt a narrow perspective for defining firm-specific crash risk, our review is

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outside the purview of market-wide stock price crash literature (e.g. Amihud *et al*., 1990; Schwert, 1990) and jump literature[1] (e.g. Eraker *et al*., 2003; Santa-Clara and Yan, 2010).

The literature defines crash risk as related to negative skewness in the distribution of returns for individual stocks (Chen *et al*., 2001; Kim *et al*., 2014; Callen and Fang, 2015a). A number of approaches have been used to measure skewness in the crash risk literature (detailed in Section 2.2. below), and the bulk of the literature relates these estimates to a variety of explanatory variables in order to identify potential determinants of stock price crash risk. Crash risk captures higher moments of the stock return distribution – that is extreme negative returns (Kim *et al*., 2014; Callen and Fang, 2015a) – and hence has important implications for portfolio theories and for asset and option-pricing models (Kim and Zhang, 2015). Investors expect higher returns for stocks with more negative skewness, implying that skewness is a priced risk factor (Harvey and Siddique, 2000; Conrad *et al*., 2013). The stock market turmoil in recent years also indicates the significance of a crash risk to investors. Retail investors tend to concentrate investments in a small number of firms (Barber and Odean, 2013), and stock price crashes of firms in their portfolios can be highly detrimental to their personal wealth. Thus, understanding what affects investors' perceived crash risk has the potential to make a significant contribution towards protecting shareholder value.

The bulk of the recent empirical research on the determinants of crash risk follows the agency theoretical framework of Jin and Myers (2006), who argue that the existence of information asymmetries between corporate insiders and external stakeholders could contribute to crash risk. Asymmetric information allows managers to hide bad news for an extended period in order to maximise compensation, protect employment and minimise litigation concerns emanating from bad news disclosures (Kothari *et al*., 2009). When accumulated bad news comes out at once in the market, stock prices continue to fall, leading to a crash. Despite a proliferation of crash risk research over the last seven to 8 years, there is very little research on the consequences of crash risk. This is rather surprising, given that it is crucial to understand firms' responses, including those of the monitors, in order to mitigate future crash risk and to protect shareholders' value. We believe that empirical research on this important issue can make significant contributions to the literature in increasing our understanding of some of those responses and their ultimate success.

Our survey includes papers published since 2009 (the first empirical paper on crash risk, by Hutton *et al*., 2009 was published in 2009) in journals that

[1] Eraker *et al*. (2003, p. 1269) note that 'jumps in returns can generate large movements such as the crash of 1987, but the impact of a jump is transient: a jump in returns today has no impact on the future distribution of returns'.

ranked B and above as per the Australian Dean Business Council 2013 Journal Rankings.[2] This choice was deliberately made to ensure the quality of the reviewed papers. A total of 48 published papers were identified, of which 46 examined the determinants of crash risk, while only two investigated the consequences of crash risk. Of the 48 papers, only six were published in B-ranked journals, while the rest were in A* and A-ranked journals. Given the asset pricing nature of the survey topic, most of the surveyed papers have been published in finance journals (a total of 25 studies). However, accounting journals, too, have been attractive outlets for crash research (a total of 15 studies) as the 'bad news hoarding' phenomenon is one manifestation of the concealment of poor performance from published financial statements. The remaining papers appeared in journals belonging to the management and economics disciplines (e.g. *Economics Letters*, *Corporate Governance*: *An International Review* and *Journal of Business Ethics*).

One important consideration for any literature review is whether to include unpublished working papers along with published studies. We excluded working papers from our primary review because (i) the papers have not been adequately vetted by the review process; (ii) it is difficult to identify all working papers, thus exclusion of some of them may generate selection bias; and (iii) unpublished papers may be subsequently published.[3]

We proceed as follows. In the next section, we provide a theoretical overview of stock price crash, along with the measurement issues. In Section 3, we synthesise the literature on the determinants of crash risk. We categorise the determinants into five groups: (i) financial reporting and corporate disclosures; (ii) managerial incentives and managerial characteristic; (iii) capital market transactions; (iv) corporate governance mechanisms, with a particular emphasis on formal governance mechanisms; and (v) informal institutional mechanisms. In Section 4, we discuss the empirical research on the consequences of crash risk. Section 5 concludes the paper.

2. Stock price crash risk: theory and measurement

2.1. Theory of crash risk

Conceptually, crash risk is based on the argument that managers have a tendency to withhold bad news for an extended period, allowing bad news to stockpile. If managers successfully block the flow of negative information into the stock market, the distribution of stock returns should be asymmetric

[2] http://www.abdc.edu.au/pages/abdc-journal-quality-list-2013.html

[3] To conserve space, we opt not to provide a comprehensive list of the unpublished working papers. However, interested readers could refer to the SSRN version of this manuscript available at https://papers.ssrn.com/sol3/Papers.cfm?abstract_id = 2811256, to retrieve the list of working papers.

(Hutton *et al.*, 2009; Kothari *et al.*, 2009). When the accumulation of bad news passes a threshold, it is revealed to the market at once, leading to a large negative drop in stock price.

Although financial reporting opacity and its effect on crash risk has become the standard research approach, certain other mechanisms could also generate price crash. In the Bleck and Liu (2007) model, historical cost financial reporting allows a manager to continue with a poor investment project, thus receiving compensation prior to the project's maturity. This is facilitated because of outsiders' inability to assess the project's market value until maturity. The Benmelech *et al.* (2010) model proposes that managers with equity-based contracts continue with negative NPV projects to maximise the value of their compensation packages. Both these models hint towards managerial incentives for hoarding bad news—the precursor for a price crash. Eventually, the manager has to disclose the bad news, causing a large stock price drop.

Hong and Stein (2003) develop a model that incorporated heterogeneity in investors' beliefs, one of the key drivers of stock price crash. Investor heterogeneity has the potential to reveal the private signals of relatively pessimistic investors. This model begins with the observation that a group of investors (e.g. mutual funds) cannot short-sell stocks. Such constraints inhibit the revelation of negative information known to the pessimistic investors in stock prices. However, if other previously optimistic investors exit the market, the former group of investors may become the marginal buyers. Thus, previously hidden bad news surfaces and results in a price crash.

Cao *et al.* (2002) propose an 'information blockage' model as another theoretical framework for explaining price crash. In this model, an upward price trend prompts favourably informed investors to engage in active trading. In contrast, less informed traders are naturally sceptical about the true nature of the signals and hence delay trading until the price drops. Price correction is therefore inevitable when the economic outlook becomes pessimistic and the less informed marginal investors enter the market. Information blockage therefore generates negative returns skewness following price increases but positive skewness following price decreases (Zhu, 2016). Another source of crash risk is volatility feedback effects (e.g. French *et al.*, 1987; Campbell and Hentschel, 1992), whereby 'big price movements could cause investors to reassess market volatility and increase required risk premia. An increased risk premium reduces equilibrium prices, which reinforces the impact of bad news but offsets the impact of good news, thus generating negative skewness' (Hutton *et al.*, 2009, p. 68).

The default risk-based explanation for crash risk rests on the notion that firms with higher default risks are more likely to release extremely bad news or extremely good news, because they will either fail or continue as a going concern. Prior literature used firm size and leverage as proxies for default risk, but failed to find support for this proposition (Hutton *et al.*, 2009; Kim *et al.*,

2011a,b). On the contrary, a negative association between leverage and crash risk is documented when in reality leverage should be positively associated with bankruptcy risk (Campbell *et al*., 2008). One potential explanation for this surprising result may be the fact that high leverage firms are initially underpriced by investors, thereby making it less likely that price crashes will follow. Consistent with this explanation, Campbell *et al*. (2008) show that high leverage firms generate higher future mean returns than low leverage firms (Zhu, 2016, p. 355).

Yet another reason for price crash may be the fact that some stocks are potentially more prone to crash due to the fundamental nature of their operations. For example, resource companies (e.g. the oil price collapse a few years ago), insurance companies incurring very large claims, legal action, shifts in the competitive environment, and government actions are all events that may cause crashes, and exposure to such events may vary across stocks. Future research may test industry-wide variation in crash risk to identify crash-prone industries.

As will be evident from the survey to follow, extant research relies heavily on agency theory-based arguments for managerial incentives for hoarding bad news. Yet, from an investor perspective, heterogeneous investor belief could cause price crash. Whether bad news hoarding—that is lack of transparency—increases heterogeneity among investors remains to be tested empirically. Developing a direct measure of heterogeneous investor belief is a challenging task which may have prevented research from investigating the role of investor heterogeneity in causing a crash. With respect to default risk as a precursor for a price crash, a more refined proxy for default risk—for example debt covenant violation instead of firm size or firm leverage—could be useful in better understanding why firms with high default risk are more prone to crash risk.

2.2. Measurement of crash risk

Extant literature uses four measures of firm-specific crash risk. These measures are based on the firm-specific weekly returns, estimated as the residuals from the market model (Chen *et al*., 2001). This ensures that crash risk measures reflect firm-specific factors rather than broad market movements. Specifically, the following expanded market model regression is the starting point:

$$r_{j,\tau} = \alpha_j + \gamma_{1,j} r_{m,\tau-2} + \gamma_{2,j} r_{m,\tau-1} + \gamma_{3,j} r_{m,\tau} + \gamma_{4,j} r_{m,\tau+1} + \gamma_{5,j} r_{m,\tau+2} + \varepsilon_{j,\tau}. \quad (1)$$

where $r_{,j,\tau}$ is the return of firm j in week τ and $r_{m,\tau}$ is the return on the CRSP value-weighted market return in week τ. The lead and lag terms for the market index return are included to allow for non-synchronous trading (Dimson, 1979). The firm-specific weekly return for firm j in week τ is calculated as the natural logarithm of one plus the residual return ($w_{j,\tau} = \ln(1 + e_{j,\tau})$) from

Equation (1) above. In estimating Equation (1), each firm-year is required to have a certain amount of weekly stock returns data to alleviate the thin trading concern.

The first measure is a binary crash risk measure, coded one if a firm experiences one or more firm-specific weekly returns falling at least 3.09 standard deviations below its mean value in a given year, and zero otherwise. According to Hutton *et al.* (2009), the cut-off of 3.09 standard deviations is chosen to generate 0.1 percent of the distribution. This variable is designed to indicate instances of rather substantial stock price drops in a week.

The second measure of crash risk initially proposed by Chen *et al.* (2001) is based on skewness (*NSKEW*). This measure captures the asymmetry of the return distribution and is frequently used in the literature. Negative (positive) values for the skewness indicate data that are skewed to the left (right). *NSKEW* 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 τ, *NSKEW* is calculated as:

$$NSKEW = -\left[n(n-1)^{3/2}\sum w_{j,\tau}^3\right] / \left[(n-1)(n-2)\left(\sum w_{j,\tau}^2\right)^{3/2}\right]. \qquad (2)$$

This measure is multiplied by -1 so that a higher value corresponds to greater crash risk.

The third measure of crash risk is the down-to-up volatility measure (*DUVOL*) of the crash likelihood. For each firm j over a fiscal-year period τ, 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. The standard deviation of firm-specific weekly returns is calculated separately for each of these two groups. *DUVOL* is the natural logarithm of the ratio of the standard deviation in the 'down' weeks to the standard deviation in the 'up' weeks:

$$DUVOL_{j,\tau} = \log\{(n_u - 1)\sum_{Down} w^2{}_{j,\tau} / (n_d - 1)\sum_{Up} w^2{}_{j,\tau}\}. \qquad (3)$$

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.

The fourth measure, implied volatility smirks (*IV_SKEW*), was introduced in the crash literature by Kim and Zhang (2014), who validate the measure by documenting a positive association with financial reporting quality and accounting restatements. The implied volatility of an option contract is the volatility implied by the market price of the option based on an option pricing — for example the Black-Scholes model. It is the volatility that equates the Black-

Scholes formula to the market price of the option. Kim and Zhang (2014) defined the implied volatility smirk (*IV-SKEW*) as the difference between the implied volatility of OTM puts (IV^{OTMP}) and that of ATM calls (IV^{ATMC}):

$$IV - SKEW = IV^{OTMP} - IV^{ATMC}. \quad (4)$$

where OTM puts are defined as put options with a delta value between −0.375 and −0.125, and ATM calls are defined as call options with a delta value between 0.375 and 0.625. To obtain an annual measure of the volatility smirk, they average the daily *IV-SKEW* over the 12-month period ending 3 months after the fiscal year end.

Existing research has not provided any justification for which of these four measures is superior and should be used in empirical research. For example, Kim *et al*. (2016b) used implied volatility smirks in their test of financial statement comparability and crash risk without providing any justification for why other measures were not used. The bulk of the empirical studies uses *NSKEW* and *DUVOL* together and suggests the similarity in the sign and significance of the coefficients across the two measures warrant their inclusion. These crash proxies are used in crash research unreservedly in countries outside the United States, despite obvious differences among stock exchanges in processing and disseminating information.

3. Review of the extant literature

This section reviews the literature on the determinants of crash risk. A large number of determinants, all framed from an agency perspective, have been tested. The surveyed studies are categorised into five groups, as discussed below. We discuss the relevant studies, point out the limitations of the studies to the greatest extent possible, and identify potential research opportunities. A section summary appears at the end of Section 3.

3.1. Financial reporting, corporate disclosures and crash risk

The predominant literature on the determinants of crash risk relies on the theoretical model of Jin and Myers (2006), which naturally required empirical validation. Hutton *et al*. (2009) address this by accumulated accruals, a proxy for firm-level earnings management, to document that firms with more opaque financial reporting are more prone to crash risk. However, research has found that managers have switched from accruals management to real earnings management (REM) in the post-Sarbanes-Oxley (SOX) period (Cohen *et al*., 2008). If REM reflects managerial opportunism, as accruals management does, it can be hypothesised that in the post-SOX regime, REM will have greater explanatory power than accruals for explaining crash. Francis *et al*. (2016) investigate this proposition and find that firms that engage in REM are prone

to price crash and, importantly, the effect is more pronounced in the post-SOX era. However, a value-enhancing perspective of REM finds that current-period REM improves subsequent performance (Gunny, 2010). Future research should consider this competing perspective and identify settings where opportunism (informativeness) is better captured by REM actions. Chen *et al.* (2017b) find that a higher degree of earnings smoothing is associated with greater crash risk. However, this association is less pronounced for firms with a greater analyst following and higher institutional shareholdings.

The aggregate earnings management proxy, however, has a limitation. This measure fails to document the specific methods and/or combination of methods used by managers to manage earnings. One such technique for managing earnings and thereby withholding bad news is corporate tax avoidance. Kim *et al.* (2011b) find that corporate tax avoidance increases crash risk, supporting the contention that aggressive tax strategies and planning provides managers with a means to conceal negative information, thereby increasing crash risk. However, auditor-provided tax services constrain tax expense management and tax avoidance, thereby reducing the propensity for crash (Habib and Hasan, 2016). An avenue for future research would be to test whether tax accrual quality (Choudhary *et al.*, 2015) affects crash risk, and whether auditor-provided tax services moderate the association between the two.

From an accounting standards perspective, little research has examined the impact of accounting standards on crash risk. DeFond *et al.* (2015) is the only available study that investigates the impact of accounting standards on crash risk. They find that the adoption of international financial reporting standards (IFRS) has reduced crash risk among non-financial firms. It is important to note that IFRSs vary, in terms of their degree of complexity and hence the opportunities for withholding bad news. Therefore, the development of a more refined proxy to determine firm-level variation in IFRS complexity and its impact on crash risk remains an open empirical question. Donelson *et al.* (2012) develop an instrument that measures the extent to which a standard contains rules-based characteristics (RBC). One may sort firms according to their use of the RBC, and investigate whether greater RBC leads to higher crash risk.

The information contained in the annual reports, although of paramount importance, is plagued with serious concerns about the readability of those reports (SEC, 1998). In terms of economic consequences of the less readable annual reports, Ertugrul *et al.* (2016) (forthcoming) find that firms with larger 10-K file sizes and a higher proportion of uncertain and weak modal words in 10-Ks are associated with greater crash risk.

In the financial institutions setting, Cohen *et al.* (2014) find that earnings management (as proxied by discretionary loan loss provisions and/or by discretionary realisations of security gains or losses) accentuates crash risk for banks during crises but not during periods of economic boom. Using data from 37 countries, Song *et al.* (2016) also find that banks experience lower crash risk

if their information environment is more transparent. The banking sector plays an important role in allocating resources to economies around the world. Given that the banking industry is highly regulated and subject to the scrutiny of various government agencies, and the financial statements of the bank are reviewed by various internal and external parties, further research on the determinants of crash risk that are unique to the banking sector is demanded.

Managers may also use voluntary disclosures opportunistically to conceal bad news for an extended period. However, such disclosures can also reduce information asymmetry and lessen the need for bad news hoarding. Corporate social responsibility (CSR) disclosures are one such voluntary disclosure tool. Kim *et al.* (2014) reveal that firms with better CSR disclosures have a lower crash risk. However, such disclosures instead of actual CSR investments may allow managers to engage in 'impression management' to conceal poor performance. Using a sample of firms listed on the Taiwan stock exchange, Lee and Lee (2016) also show that CSR significantly mitigates Taiwanese stock price crash risk. Zhang *et al.* (2016) examine the effects of corporate philanthropic action (a component of CSR) on crash risk in China, and confirm that corporate philanthropic action reduces crash risk. However, this effect is less pronounced for SOEs and is also less pronounced after the 2007 split share reform act.

However, the negative coefficient of CSR in itself does not inform readers about the bad news hoarding theory. It is therefore important to examine the channels through which CSR curbs bad news hoarding and crash risk. For example, prior research suggests that CSR proactive firms engage less in tax avoidance (Lanis and Richardson, 2012), but tax avoidance increases crash risk (Kim *et al.*, 2011b). Therefore, tax avoidance could be considered as a channel that may explain the CSR–crash relationship. It is important that future research provides explicit tests to isolate the direct and indirect contribution of chosen variables in affecting crash risk.

Given the widespread use of earnings manipulation (Graham *et al.*, 2005) and its adverse effects on crash risk with direct consequences for investors, it becomes imperative to understand the financial reporting-related mechanisms for constraining such opportunistic reporting behaviour and hence crash risk.

Conditional conservatism, a desirable attribute of financial reporting (Basu, 1997; Watts, 2003a,b; Ball and Shivakumar, 2005) is one such constraint. Conservatively audited earnings attenuate (accelerate) managerial incentives to release positive (negative), but unverifiable, information. Kim and Zhang (2015) find that crash risk decreases for firms with more conservative accounting policies. Financial statement comparability (DeFranco *et al.*, 2011), another desirable characteristic of financial reporting, has also been found to attenuate crash risk (Kim *et al.*, 2016b). This is premised on the following argument:

> By having access to and being able to understand information from comparable firms, investors can not only gain a better understanding of a firm's performance

> but also obtain some of the bad news about it through inferences based on the performance and/or disclosures of its comparable peers [. . .] Since investors may have already obtained some of the undisclosed bad news about a firm by analyzing its comparable peer firms, the benefits to managers from bad news hoarding are likely to be smaller [. . .](Kim *et al*., 2016b, p. 295).

Although external stakeholders would benefit from more comparable financial information, it is likely that there are significant proprietary costs of comparability in the face of intense competition. This occurs because managers rely on information from their competitors' financial reports as inputs to develop their competitive strategies (e.g. Bagnoli and Watts, 2010; Beatty *et al*., 2013). Consequently, managers of firms operating in competitive industries would have incentives to lessen financial statement comparability. Seavey *et al*. (2016) find support for this proposition. It would be interesting to explore whether firms operating in highly competitive industries are more likely to experience crash risk given the supply of less comparable financial statements.

Although documenting an association between financial reporting opacity and crash risk is informative, this stream of research does not tell us much about the particular incentives that drive a managerial decision to withhold bad news. We now review the strand of research that addresses this concern.

3.2. Managerial incentives, managerial characteristics and crash risk

An oft-cited incentive for earnings management, and hence asymmetric disclosure of news, is to maximise the incentives-based compensation. Kim *et al*. (2011a) investigate the relative contribution of CEO versus CFO equity incentives for crash risk and find that the ratio of the CFO option portfolio value to stock price increases the crash risk. He (2015) investigates the impact of another form of compensation: CEO inside debt. Inside debt refers to debt in the form of pensions and deferred compensation that resembles debt contracts, representing a fixed obligation for a firm to make future payments to CEOs. The general consensus from the literature is that inside debt motivates managers to commit to high-quality financial reporting. Consistent with this argument, He (2015) finds that inside debt reduces future crash risk.

We encourage future research on the compensation and crash risk association with look at the compensation incentives of the top management team (TMT) rather than the CEO and CFO alone. The TMT may act as a monitoring mechanism (an internal governance tool) over CEO actions (Cheng *et al*., 2016). Therefore, it can be hypothesised that crash risk will be lower for firms where subordinates have the capacity to influence CEO/CFOs in delivering high-quality financial reporting. In a similar vein, the role of tournament incentives in affecting crash risk can also be subject to empirical testing. Park (2017) finds that greater pay disparity increases REM due to the extreme competition among the top executive team members to advance to the CEO position.

A shortcoming of the extant empirical research relating crash risk to managerial incentives is the absence of a test that isolates the direct and indirect effects of such incentives. For example, managerial incentives to engage in upward earnings management due to compensation incentives are well documented in the literature. A direct and indirect test would require decomposing the effects into direct (i.e. the effect of managerial incentives in explaining crash risk) and indirect (e.g. opaque reporting, through which managerial incentives effect crash risk). However, such a test is missing from the existing literature.

Do managerial traits or styles have implications for crash risk? This line of enquiry is important because it is the idiosyncratic characteristics of managers that shape their decision choices regarding the withholding of bad news, the primary predictor of crash risk. Kim *et al.* (2016a) consider 'CEO overconfidence' as one such managerial trait and find that overconfident CEOs are more likely to experience stock price crash. Demerjian *et al.* (2013) reveal that more able managers provide better quality earnings and thus should reduce the propensity for crash. However, more able managers could also be overconfident, hence entangling these two constructs, indicating that their relative contribution to crash risk would be a valuable contribution to the crash literature. Andreou *et al.* (2017) find that firms with younger CEOs are more likely to experience stock price crashes, implying that CEOs have financial incentives to hoard bad news earlier in their career, which increases future crashes.

Nonetheless, a direct association between managers and crash risk requires the development of a manager fixed effects model, tracking managers who move across firms. Researchers also need to incorporate firm fixed effects to consolidate the direct association between managers and crash risk. We encourage further research on this important 'human dimension' to explain crash risk. Moreover, like individual CEOs, individual auditors have styles (Francis *et al.*, 2014). Future research may examine whether auditor fixed effects affect crash risk.

3.3. Capital market determinants of crash risk

While studies predominantly contend that stock price crash occurs when accumulated bad news is released all at once in the capital market, some studies document that such bad news hoarding may be reflected in stock trade volume and return, an observation that could provide a reasonable indication of future crash risk. For example, Chen *et al.* (2001) argue that trade volume reflects disagreement among investors and, as such, an increase in trading volume relative to trend over the prior 6 months indicates that some investors are aware of pending bad news, resulting in higher trading between informed and uninformed investors.

In addition, studies also show that the capital market itself provides an incentive to hoard bad news, which increases the likelihood of a future price crash. Chang *et al.* (2016) (forthcoming) use stock liquidity as a proxy for such an incentive and find a positive association between crash risk and stock liquidity, supporting the notion that bad news disclosures may lead transient investors to sell their stock. However, the extent to which stock liquidity affects crash risk directly and indirectly (through the transient investor channel) is not clear from their analysis. Callen and Fang (2015a) document that short interest in stocks predicts future crash risk. This is consistent with the view that short sellers are able to detect managerial bad news hoarding activities, prompting them to take short positions of stock in anticipation of price crashes. Using a regulatory change in China as an exogenous shock, Ni and Zhu (2016) document that the removal of short-sales constraints increases stock price crash risk. Using a composite strategy score, Habib and Hasan (2017) document that firms following innovative business strategies (prospectors) are more prone to future crash risk than defenders. Furthermore, prospectors are more prone to equity overvaluation which, in turn, increases future crash risk.

3.4. Corporate governance and crash risk

3.4.1. Internal corporate governance mechanisms and crash risk

Corporate governance attributes have an important role in financial disclosure and reporting quality (Xie *et al.*, 2003; Bedard *et al.*, 2004; Larcker *et al.*, 2007) and hence in reducing crash risk. Andreou *et al.* (2016) show that a high proportion of independent directors on the audit committee, adequate auditor industry expertise and a clearly defined corporate governance policy reduce the likelihood of crash.

Prior research on stock price crash risk in China has investigated some of the determinants of crash risk, including excess perks in state-owned enterprises (SOEs). Xu *et al.* (2014) report that excess perks in SOEs motivate managers to withhold bad news over extended periods for personal gain, resulting in a high crash risk. Meanwhile, they find that low financial reporting quality—that is earnings management and a low level of conservatism—worsens this relationship.

The extent to which the above-discussed mechanisms are effective in curbing crash risk depends a lot on the internal control quality level in an organisation. Firms with ineffective internal control over financial reporting disseminate less reliable financial information emanating from accruals manipulation (Doyle *et al.*, 2007a,b; Ashbaugh-Skaife *et al.*, 2009; Feng *et al.*, 2009). Chen *et al.* (2017b) focus on the strength of internal control of Chinese listed firms and find that high-quality internal control alleviates crash risk. The quality of internal control is measured with a composite index evaluated on five components (i.e.

control environment, risk assessment, control activities, information and communication, and monitoring).

3.4.2. External corporate governance mechanisms and crash risk

Extant studies suggest that monitoring by the institutional owners constrains a manager's ability to manage abnormal accruals opportunistically and hence improves earnings quality (e.g. Mitra and Cready, 2005; Velury and Jenkins, 2006). As better quality earnings reduce crash risk, research examining the effect of institutional monitoring on crash risk shows that institutional holding by dedicated (transient) investors reduces (increases) crash risk (An and Zhang, 2013). Callen and Fang (2013) show that institutional investor stability is associated negatively with crash risk.

Studying the separation of voting and cash-flow rights (excess control) of French listed firms, Boubaker *et al*. (2014) report a positive relationship between excessive control and stock price crashes, which is consistent with their argument that controlling shareholders with excessive control tend to withhold bad news in order to cover up their expropriation of minority shareholders' interest. Andreou *et al*. (2016), on the other hand, find insignificant (significant) effects of outside block shareholdings (insider ownership) on crash risk.

The role of financial analysts as a governance mechanism in generating and disseminating firm-specific information has been a topic of intense research. Piotroski and Roulstone (2004) argue and find supportive evidence that analysts are primarily involved in producing industry and/or market-wide information rather than idiosyncratic private information. A recent study by Crawford *et al*. (2012) argues that analyst coverage initiation has varying effects on price synchronicity depending on the timing of coverage initiation.

Analyst coverage could affect firm-specific crash risk in two opposing ways. On the one hand, financial analysts are expected to mitigate information asymmetry between investors and managers by revealing their findings, from both public and private sources, to the markets. As analyst coverage increases, more effort and resources are devoted to uncovering firm-specific private information. This private information acquisition and reporting process likely reduces information asymmetry to a greater extent when firms have bad, rather than good, news, because managers tend to delay the release of bad news (Kothari *et al*., 2009). Thus, this view suggests that greater analyst coverage reduces stock price crash risk.

On the other hand, the market pressure to meet or beat analysts' forecasts fosters the culture of managers withholding bad news. Higher analyst coverage draws more investor attention and makes analyst forecasts more salient as benchmarks for managers. Increased analyst coverage could thus increase the pressure on managers to focus overly on short-term results (e.g. He and Tian, 2013; Irani and Oesch, 2016), potentially leading to bad news hoarding

behaviour. These arguments suggest a positive association between changes in analyst coverage and changes in future firm-specific crash risk.

Consistent with the latter view, Xu *et al*. (2013a,b), using Chinese data, find that stock price crash risk increases with an increase in a firm's analyst coverage, and that this is more pronounced when analysts are more optimistic and are affiliated with investment banks and brokerage firms. Xu *et al*. (2016) provide evidence that firms with disproportionately more analysts herding in their coverage are associated with higher crash risk in China. Their result is consistent with the proposition that information production, rather than monitoring, is the primary mechanism behind the positive association between herding and crash risk.

Despite the importance of financial analysts in information processing and dissemination that influences the behaviour of stock prices, surprisingly little research has been carried out in the crash risk domain. For example, the extent of analysts' private information acquisition and its impact on crash risk can be a topic for future research. Compared with the analyst coverage measure, private information acquisition is a more refined proxy for analyst activities (Barron *et al*., 1998).

One of the important information sources used both by analysts and other information users is the published financial statements. The credibility of those statements depends to a great extent on the quality of the financial statements' verification by the external auditors. Robin and Zhang (2015) find that the information intermediary and corporate governance roles of the auditor industry specialisation reduce crash risk. They also show the channels (e.g. opacity, accounting conservatism and tax avoidance) through which industry-specialist auditors reduce the crash risk. Callen and Fang (2016) show that auditor tenure increases auditors' client-specific knowledge and hence enhances auditors' ability to detect and deter bad news hoarding activities by clients, thus reducing crash risk. All the published studies on the association between audit quality and crash risk have been conducted in a single audit firm setting. However, some countries require (while others permit) financial statements to be audited by more than one audit firm (joint audit practice). Given the conventional wisdom that two heads are better than one, the role of joint audit, compared to single audit, in constraining crash risk can be explored in an international setting. Furthermore, within a joint audit regime, future studies may investigate whether crash risk is affected more by joint audits involving two Big 4 auditors compared to those involving one Big 4 and one small auditor.

Unlike the above mechanisms, which have a long-standing tradition in the corporate governance literature, D&O insurance, which incorporates D&O insurance underwriters' forward-looking assessment of a company's litigation likelihood and damage magnitude, has recently become a topic of research interest (Cao and Narayanamoorthy, 2011, 2014). Yuan *et al*. (2016) investigate the effect of D&O insurance on crash risk using data from Chinese listed

companies. They argue that D&O insurers serve as an external monitoring mechanism owing to weak corporate governance at firm level and poor investor protection at country level. As expected, they find a negative association between D&O insurance and crash risk.

In a macrosetting, Bhargava *et al.* (2017) investigate whether takeover protection arising from state anti-takeover laws affects crash risk. They find that takeover protection reduces crash risk by mitigating bad news hoarding activities. This relationship is more pronounced in the presence of information asymmetry and product market competition. Aman (2013) investigates the associations between media coverage and stock price crashes and jumps using data from Japanese stock markets and newspaper articles. The findings suggest that media coverage does not affect the price jumps but has an increasing effect on crashes.

Although firm-level corporate governance mechanisms are important tools for constraining bad news hoarding and hence crash risk, regulatory oversight of managerial reporting behaviour can also be a powerful monitoring mechanism. Kubick and Lockhart (2016) test this proposition and find that firms located farther from the SEC headquarters experience greater crash risk. Managers who believe that enforcement of disclosure violations is less likely due to their office being farther away from the SEC will follow an asymmetric information release policy for negative and positive information, hence increasing the probability of crash risk. However, this may not be a concern for investors if religion plays a constraining role (Callen and Fang, 2016). What happens when firms farther from the SEC headquarters operate in counties with higher levels of religiosity? How would the result of Kubick and Lockhart (2016) change if religion were used as an independent variable? Finally, Sun *et al.* (2017, forthcoming) investigate the split share reform initiated by the Chinese Securities Regulatory Commission (CSRC) and find that the reform decreases crash risk, and this is more pronounced in firms with a higher proportion of shares held by controlling shareholders. The beneficial effect of the reform is further concentrated in firms with a high level of tunnelling prior to the reform.

Collectively, studies on the effect of corporate governance on crash risk via the effect on firms' financial reporting quality are intuitive and theoretically coherent. The findings conform to two streams of literature, including (i) the corporate governance attributes and external monitoring mechanisms that shape financial disclosures and reporting quality; and (ii) Jin and Myers' (2006) theory on bad news hoarding-induced crash risk and corresponding empirical evidence that firms with more opaque financial reporting are more prone to crash risk.

3.5. Informal institutional mechanisms and crash risk

The preceding section summarised the literature on the association between formal governance mechanisms and crash risk. In this section, we review the

impact of informal institutions on crash risk. Such informal institutions may be firm-specific norms and values, management ethos and codes of conduct in business, as well as more general norms and values existing in society at large. Informal governance mechanisms shape the behaviour and financial practices of individuals and firms (Callen and Fang, 2015b; Cao *et al.*, 2016), which can either curb or boost bad news withholding behaviour, and therefore crash risk. The role of informal institutions is of special significance in emerging economies, where formal institutions such as investor protection, corporate governance and accounting standards are weak and less developed.

3.5.1. Political connections and crash risk

Lee and Wang (2017) use data from China and document that the presence of politically connected directors accentuates crash risk in listed SOEs, courtesy of appointment of local government officials as directors. In contrast, appointment of central government-affiliated directors helps listed privately controlled firms to reduce crash risk. Luo *et al.* (2016) document that firms having connections with government officials experience less crash risk. Piotroski *et al.* (2015) conjecture that political events in China create incentives for listed companies to withhold bad news, because politicians and executives of listed companies incur large costs and strong penalties for releasing negative news around politically sensitive events. As expected, they find that both SOE- and non SOE-listed companies time bad news disclosure strategically, showing significantly lower (greater) likelihood of experiencing stock price crash risk before (after) two major political events: meeting of the National Congress and provincial-level political promotions. Li and Chan (2016) find that having a Communist Party of China (CPC) committee member serving as a director can lower a firm's crash risk. Interestingly, all the published studies on political connections and crash risk have been performed using data from China. However, this limits the generalisation of the findings to other countries where political connections are pervasive. A comprehensive examination of political connections' effect on crash risk would require a comparative study between countries where politicians influence business operations versus countries with very little political interference over business operations.

3.5.2. Religiosity, trust and crash risk

Another informal institution having implications for crash risk is religion. Callen and Fang (2015b) find that crash risk is lower for firms headquartered in counties in the USA with higher levels of religiosity, supporting the argument that religion as a social norm constrains managerial bad news hoarding incentives. Research on the impact of religion on crash risk considers broader religious beliefs as manifested at the state/county level. However, it would also be important to consider the individual religious beliefs of the executives (e.g.

CFOs) and auditors who are in charge of the financial reporting process. It is therefore imperative to investigate whether it is the religious beliefs of individuals or the broader social norm that plays the pivotal role in constraining the bad news hoarding tendency. Li *et al.* (2017) test the association between social trust and stock price crash risk in China and find that firms headquartered in high social trust regions tend to have smaller crash risks. Cao *et al.* (2016) also document a negative relationship between social trust and stock price crash risk.

From a conceptual perspective, both religion and social trust are embedded within the broader concept of social capital. These two positive attributes are in contrast to a 'culture of corruption', which adversely affects social capital. Therefore, it will be interesting to examine how regional public corruption undermines the functioning of reasonably well-established formal institutions to affect firm-specific crash risk.

Collectively, the research on the impact of informal institutions on crash risk shed light on how informal institutions interact with formal corporate governance mechanisms in affecting crash risk. Although research abounds on formal governance institutions, literature on the more implicit non-economic informal institutional factors has the potential to offer more interesting insights. Finally, extant studies on the role of informal institutions in affecting crash risk focus predominantly on single countries. Cross-country studies may provide better insights into the role of informal institutions and provide confidence about findings from single country studies.

Section summary: This section has summarised five categories of existing research on the determinants of stock price crash risk. From a financial reporting perspective, extant research confirms that opaque financial reports stemming from accruals and REM increase crash risk, but conservative accounting and financial statement comparability attenuate such risk. Studies investigating the association between managerial incentives and crash risk find that CEO and CFO option compensation and CEO overconfidence increase crash risk. Studies relating corporate governance mechanisms, both formal and informal, with crash risk show that institutional investor stability, industry-specialist and long-tenured auditors, along with D&O liability insurance reduce crash risk, while weak internal controls, analyst following, analyst herding and excess perks consumption increase crash risk. Some of the informal governance mechanisms examined are religion, political connections and social trust. Taken together, extant research has provided important insights into the determinants of crash risk, although more can be done, as is evident from some of the research opportunities highlighted in this section.

Table 1 provides the descriptive values of the primary crash proxies retrieved from the descriptive statistics sections of the respective papers and shows the variation of those values across studies. Also presented are the coefficient values and the statistical significance of the main test variables retrieved from the regression analysis section of the respective papers. The papers are ordered

Table 1
Coefficient values and the statistical significance of the main test variables

		Descriptive values of the crash proxies									
		CRASH		NSKEW		DUVOL			Coefficient estimates and the statistical significance of the main IVs		
Authors	Predictor constructs	Mean	STD	Mean	STD	Mean	STD	Main IV	CRASH	NSKEW	DUVOL
Hutton *et al.* (2009)	Opacity	0.17	–					*OPAQUE*	0.855***	–	–
Kim *et al.* (2011b)	Tax avoidance	0.161	0.368	−0.079	0.739	–	–	*SHELTER BTD*	0.270*** 0.233***	0.253*** 0.07***	–
Francis *et al.* (2014)	Real earnings management	0.195	0.396	−0.072	0.792	−0.141	0.51	*REM [DISX]* *REM [PROD]*	0.089** 0.172***	–	–
Kim *et al.* (2014)	Corporate social responsibility	–	–	0.035	0.81	−0.002	0.37	*CSR_SCORE*	–	−0.064**	−0.027**
Cohen *et al.* (2014)	Earnings management in banks	Not reported	Not reported	–	–	–	–	*EARN_MGT* *EARN_MGT* CRISIS*	8.22* 22.70**	–	–
Kim and Zhang (2015)	Accounting conservatism	0.12	0.327	−0.20	0.71	–	–	*CSCORE*	−1.27**	−0.57***	–
DeFond *et al.* (2015)	Adoption of IFRS	–	–	−0.285	0.615	–	–	*Mandatory Adopters* POST*	–	−0.11***	–
Ertugrul *et al.* (Forthcoming)	Annual report readability	0.21	0.41	0.16	0.87	0.008	0.38	*log(File size)*	0.032**	0.026***	0.009**
Kim *et al.* (2011a)	CEO/CFO equity incentives	0.172	0.377	0.034	0.693	0.004	0.332	*CEO_OPTION* *CFO_OPTION*	−0.029 0.757***	−0.009 0.278***	−0.005 0.131***
He (2015)	CEO inside debt	–	–	–	–	–	–	*InsiDebt*	−0.1458**	–	–
Kim *et al.* (2016a)	CEO overconfidence	0.172	0.378	0.068	0.74	0.027	0.345	*OC_CJRS* *OC_SZ*	0.103* 0.162***	0.049*** 0.045**	0.022*** 0.023***
Andreou *et al.* (2017)	CEO age	0.192	0.394	0.094	0.728	–	–	*LN_AGE*	0.924***	0.025***	–
Callen and Fang (2015a)	Short interest	−0.43	1.68	−0.14	1.59	−0.17	0.66	*SIR*	0.64**	0.70***	0.31***

(continued)

Table 1 (continued)

		Descriptive values of the crash proxies									
		CRASH		NSKEW		DUVOL			Coefficient estimates and the statistical significance of the main IVs		
Authors	Predictor constructs	Mean	STD	Mean	STD	Mean	STD	Main IV	CRASH	NSKEW	DUVOL
Chang *et al.* (Forthcoming)	Stock liquidity	0.19	0.39	0.008	0.76	–	–	*LIQ*	0.216***	0.057***	–
Andreou *et al.* (2016)	Corporate governance systems	–	–	0.101	0.811	−0.00	0.364	*Nine PCF scores from 21 individual CG variables*	Too many variables to be tabled		
Chen *et al.* (2017a)	ICW	0.097	0.296	−.199	0.642	–	–	*IC_INDEX*	−0.926**	−0.228***	–
An and Zhang (2013)	Institutional ownership	−0.09	0.70	−0.17	0.94	−0.10	0.41	*IO*	0.054**	0.13***	0.06***
								IO_DED	−0.19***	−0.26***	−0.10***
								IO_TRA	0.39***	0.66***	0.30***
Callen and Fang (2013)	Institutional investors	−0.46	1.67	−0.07	1.24	−0.15	0.56	*StdI *100*	0.30***	0.23***	0.14***
								DED	−0.50***	−0.37***	−0.17***
								TRA	1.09***	1.14***	0.47***
Aman (2013)	Media Coverage	–	0.706	–	–	–	–	*MEDIA*	0.26***	–	–
Xu *et al.* (2013a,b)	Analyst coverage, forecast optimism and conflict of interest	0.09	0.29	−0.14	0.66	−0.1	0.48	*Analyst*	0.019***	0.008**	0.005**
								Analyst_OPT	0.024***	0.011**	0.007**
								Analyst_IB	0.02***	0.009***	0.007***
								Analyst_Affiliated	0.023***	0.009***	0.006***
Robin & Zhang (2015)	Auditor industry specialisation	0.19	0.39	−0.10	0.76	−0.05	0.35	*SPECIALIST*	−0.07***	−0.03***	−0.012***
Habib and Hasan (2016)	Auditor-provided tax services	–	–	−0.07	1.17	−0.37	0.91	*FEERATIO*	–	−0.017**	−0.014***
Kubick and Lockhart (2016)	Proximity to SEC	0.19	0.39	0.008	0.67	−0.011	0.32	*SEC Distance*	0.05**	0.03***	0.018***
Xu *et al.* (2016)	Analyst herding	0.105	0.306	−0.173	0.648	−0.128	0.465	*DHI*	0.905**	0.111***	0.063**
Xu *et al.* (2014)	Excess perks	–	–	−0.365	0.630	−0.273	0.457	*ExcessPerk*	–	0.247***	0.136***

(continued)

Table 1 (continued)

		Descriptive values of the crash proxies									
		CRASH		NSKEW		DUVOL			Coefficient estimates and the statistical significance of the main IVs		
Authors	Predictor constructs	Mean	STD	Mean	STD	Mean	STD	Main IV	CRASH	NSKEW	DUVOL
Callen and Fang (2015b)	Religion	−0.66	1.70	−0.21	0.59	−0.23	1.15	*REL*	−0.13**	−0.077**	−0.13**
Piotroski *et al.* (2015)	Political incentives	–	–	−0.650	0.674	–	–	*Political* *Post-Political*	–	−0.253*** 0.049*	–
Lee & Wang (2017)	Political connections	–	–	−0.173	0.676	−0.06	0.242	*PCD*IDENTITY*	–	0.407***	0.165***
Li and Chan (2016)	Communist Party Control	–	–	–	–	–	–	*PARTY_DIR*	–	−0.061**	–
Yuan *et al.* (2016)	D&O liability insurance	–	–	−0.215	0.793	−0.251	0.733	*D&O*	–	−0.137***	−0.113***
Zhang *et al.* (2016)	Corporate philanthropy	–	–	–0.24	0.82	−0.17	0.69	*Donations*	–	−0.0024**	−0.0026***
Cao *et al.* (2016)	Social trust	–	–	−0.198	0.646	−0.134	0.459	*TRUST*	–	−0.017***	−0.015***
Li *et al.* (2017)	Trust	–	–	−0.205	0.684	−0.165	0.48	*TRUST1*	–	−0.057***	−0.036***
								TRUST2	–	−0.046***	−0.029***
								TRUST3	–	−0.149***	−0.15***
Bhargava *et al.* (2017)	State antitakeover laws	−0.531	1.73	−0.18	1.46	−0.07	0.63	$AfterBC_T$	−0.092**	−0.061***	−0.044***
Sun *et al.* (2017)	Split share reform	–	–	−0.15	0.68	−0.20	0.70	$isReformed_t$	–	−0.226***	−0.199**

This table presents the coefficient values and the statistical significance of the main test variables retrieved from the descriptive statistics and regression analysis section of the respective papers. *CRASH*, *NSKEW* and *DUVOL* are the three primary crash proxies used in the studies. The Main IV column list the main independent variables used in the surveyed studies. *, ** and *** denotes statistical significance at the 10, 5 and 1 percent level, respectively.

In the following, we define those variables which have been used as the main variable of interests in the surveyed studies.

- Annual report readability [*log(File size)*]: the natural logarithm of the file size in megabytes of the SEC EDGAR 'complete submission text file' for the 10-K filing.
- Inside debt (*InsiDebt*): a dummy variable, which takes value of 1 if CEO relative leverage exceeds 1 and 0 otherwise (See Appendix 2 of the paper for the detailed calculation of CEO leverage).
- CEO overconfidence (*OC_CJRS*): dummy variable coded 1 if the CEO holds options at least twice during the sample period that are more than 100 percent in the money, and zero otherwise.
- CEO overconfidence (*OC_SZ*): it takes the value of one if the firm meets the requirements of at least three of the following five criteria and zero otherwise: (i) excess investment is in the top quartile within industry-years; (ii) net acquisitions from the statement of cash flows are in the top quartile within industry-years; (iii) the debt-to equity ratio is in the top quartile within industry-years; (iv) either convertible debt or preferred stock is greater than zero; and (v) the dividend yield is zero.
- Short interest (*SIR*): the number of shares sold short divided by total shares outstanding from the last month of fiscal year t, with a range from 0 to 1. Compustat Supplemental Short Interest File provides the available data to calculate short interest.
- Stock liquidity (*LIQ*): -100 times relative effective spread, which is the ratio of the difference between the trade price and the mid-point of the bid-ask quote over the trade price.
- Institutional ownership stability (*INSTOWN_Stable*): average standard deviation of institutional shareholding proportions across all investors in a firm over a 5-year period including sample year and the 4 years preceding it (i.e. 20 quarters).
- Dedicated institutional investor *(DED)* is the percentage of shares outstanding held by dedicated institutions at the end of the year.
- Transient institutional investor *(TRA)* is the percentage of shares outstanding held by transient institutions at the end of the year.
- Media coverage (*MEDIA*): information from Nikkei Telecom 21 on the number of citations over 1 year in four commercial newspapers, The Nikkei, the Nikkei Business Daily, the Nikkei Finance Journal and the Nikkei Marketing Journal.
- Tax fee ratio (*FEERATIO*): tax fees received by audit firms as a proportion of audit fees.
- Proximity to the SEC (*SEC distance*): the distance between the firm's headquarters and the closest SEC regional or national office. SEC national office in Washington DC and regional offices in New York City, Miami, Chicago, Denver and Los Angeles.
- Analyst herding intensity (*DHI*). The proportion of total forecasts for a given firm within a fiscal year that falls inside a 95 percent confidence interval is considered a measure of the degree of herding
- Excess perks (*ExcessPerk*): actual perk consumption minus expected perk consumption whereby the latter is derived by regressing perks consumption (scaled by revenue) on natural log of total compensation for all firm employees, firm size and the natural log of total income per capita of the region in which the firm is located.
- Religion (*REL*): religiosity data from the Association of Religion Data Archives (ARDA). Once every decade, the Glenmary Research Center collects data from surveys on religious affiliation in the United States (1971, 1980, 1990 and 2000). Based on the survey results, the centre reports county-level data on the number of churches and the number of total adherents by religious affiliation.

- Political incentives (*Political and Post-Political*): an indicator variable equal to one if the firm-year relates to a specific political event (i.e. National Congress or Provincial-Level Political Promotion), zero otherwise. An indicator variable equal to one in the year immediately following the political event, zero otherwise.
- Political connection *(PCD*IDENTITY)*: number of politically connected directors on the board divided by the total number of directors. A board member as a politically connected director if he or she formerly (currently) served (serves) in one of the following posts: (1) government official, (2) member of the Chinese People's Congress (CPC), (3) member of the Chinese People's Political Consultative Conference (CPPCC) or (4) military official.
- Communist party control (*PARTY_DIR*): a dummy variable coded 1 if any members of the CPC committee are also directors, supervisors or senior executives; otherwise, it is zero.
- Director and Officer liability insurance (*D&O*): a dummy variable which equals 1 if a firm purchases D&O insurance in year t, and 0 otherwise.
- Corporate philanthropy (*Donations*): the natural logarithm of donation expenditures. Donation/Market value ratio and Donate = a dummy variable equals 1 when the amount of donation expenditures is positive and 0 otherwise.
- Social trust (*TRUST*): a provincial-level index, from a survey conducted by the Chinese Enterprise Survey System in 2000 that measures the trustworthiness of enterprises in China, where a higher index value suggests a more trustworthy business enterprise community in the province.
- Trust (*TRUST*): three measures are used. TRUST1 is the same as TRUST variable above. TRUST2 is Citizen trustworthiness at the provincial level, which is the millilitres of blood donated on a purely voluntary basis in 2000 in a province divided by the population in the province. TRUST3 is Citizen trustworthiness at the city level, which is from the Annual Report on Urban Competitiveness in 2001–2010.
- *AfterBC* is a dummy variable equal to one in the years after firm i's state of incorporation has passed BC laws, and zero otherwise.
- $isReformed_t$ denotes the split share structure reform, which equals 1 if the firm has completed the reform by year t and zero otherwise.

according to the five categories developed for surveying the papers. In each category, the papers are presented chronologically, the earliest published papers listed first. This table also reports the main variable of interest and its sign, magnitude and significance level as retrieved from the multivariate analyses of the published papers. Table 2 summarises the research questions, sample(s) used and key findings for the surveyed papers on the determinants of crash risk. We also report whether the selected studies justify their choice of a particular sample period and explain the economic significance of the reported coefficients on the main variable of interest (Dyckman and Zeff, 2014).

4. Consequences of crash risk

Although research initiatives designed to understand the causes of crash risk are plentiful, our review revealed only two published studies on crash consequences. We find this surprising. Following the incidence of crash, which has serious implications for shareholders' wealth, one would expect firms to take initiatives to reduce the likelihood of future crash risk. For example, if earnings manipulation is responsible for a crash, will there be more effective oversight of the financial reporting process by the audit committees during the post-crash period? If CEO and CFO equity incentives are responsible for crash risk, would the compensation committee consider redesigning compensation schemes? Answers to these questions are not simple. Although equity incentives have been identified as a determinant of crash risk (Kim *et al.*, 2011a), it is difficult for researchers to control for all other determinants, some of which may well be beyond CEO control, such as political turmoil. An unintended consequence of reducing equity incentives due to a crash could lead managers to forgo risky but positive NPV projects (Table 3).

Of the two published papers, An *et al.* (2015) investigate the impact of crash risk on a firm's speed of leverage adjustment and show that firms with a higher crash risk exposure slowly adjust their financial leverages towards targets. They also show that the negative relationship between crash risk and speed of leverage adjustment is less pronounced for firms in countries with more transparent financial reporting environments. Hackenbrack *et al.* (2014) document a two percent increase in clients' audit fees ahead of a price crash occurring.

We also searched for working papers on the consequences of a price crash, although we had not included working papers in our survey. This departure was necessitated by a paucity of research on the consequences of a crash. Wu (2013) documents a positive association between current-period crash risk and CEO turnover in the subsequent year, an effect which is more pronounced for forced turnover. Further research also needs to document labour market penalties for directors of crash firms. Srinivasan (2005) finds that in the 3 years after restatement, director turnover is 48 percent for firms that restate earnings downward. As earnings restatement signals a lack of monitoring of the

Table 2
Determinants of stock price crash risk

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Panel A: Financial reporting quality, bad news hoarding and crash risk (Section 3.1.)					
Hutton *et al.* (2009)	Financial reporting opacity	1991-2005 sample period with a final sample of 40,882 firm-years	Sample periods begin in 1991 as three annual lags of cash-flow data is needed for estimating accruals, which is available only from 1987	Firms with opaque financial statements are more prone to stock price crashes. However, this relation more is pronounced before the passage of the Sarbanes-Oxley Act	Financial reporting opacity accounts for 15.8% of the variation in crash risk
Kim *et al.* (2011b)	Tax avoidance	1995–2008 sample period with 87,162 firm-year observations	To ensure the consistent measurement of tax avoidance variables, following the enactment of FAS 109, the authors start sample period in 1995	Various forms of tax avoidance increase crash risk	Logistic regression revels that the marginal effect of the tax avoidance measure varies from 3.1–3.6%. Economic significance for tax avoidance variable for two other crash risk measures is not reported
Francis *et al.* (2014)	Real earnings management (REM)	1989-2009 sample period with 44,731 firm-year observations	No justification is provided	Firms that deviate in real operations from industry norms are positively associated with future crash risk	One-standard deviation change around the mean of 3 years' absolute value of deviation in real operations increases crash likelihood by 0.94%
Kim *et al.* (2014)	CSR disclosures	1995–2009 sample period and 12,978 firm-year observations	Availability of CSR data from 1994 from KLD database and use of one year lagged value allow the	Firms with better CSR scores are less prone to crash risk. The role of CSR in reducing stock price crash risk is particularly important when internal monitoring by the boards or external	On average, an increase of one-standard deviation increase in *CSR_SCORE* is associated with a decrease of 0.052 in

(continued)

Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
			authors to begin the sample period from 1995	monitoring by institutional investors is weak	*NSKEW*. *DUVOL*, too, is economically significant
Cohen *et al.* (2014)	Financial institutions and crash	A total of 4,112 firm-year observations between 1997 and 2009	No justification is provided	Banks with more aggressive earnings management practices prior to the onset of the crisis period in 2007 exhibit significantly crash risk once the financial crisis begins	The impact of earnings management during the crisis is economically large at 8.88%
Kim and Zhang (2015)	Conditional conservatism	1962–2007 sample period with 114,548 firm-year observations	No justification is provided	Conditional conservatism reduces the likelihood of a firm experiencing future price crashes. Furthermore, changes in the degree of conditional conservatism are also negatively associated with changes in future crash risk	A one-standard deviation increase in the Basu (1997) coefficient reduces crash probability by 46.4%
DeFond *et al.* (2015)	IFRS adoption	Sample period 2003 to 2006 with 42,196 firm-year observations	Justification provided for the choice of the sample period	IFRS adoption decreases crash risk among nonfinancial firms, which is more pronounced among firms in poor information environments and in countries where IFRS adoption led to more credible changes to local GAAP. In contrast, IFRS adoption has no effect on crash risk for financial firms, but decreases crash risk among firms less affected by IFRS's fair value provisions	The decrease in crash risk associated with mandatory IFRS adoption among nonfinancial firms, is economically significant, ranging from 20 to 44%
Kim *et al.* (2016b)	Financial statement comparability	A total of 17,057 firm-year observations for the 1996–2013 sample period	No justification is provided	Crash risk decreases with an increase in comparability. This effect is more pronounced for firms with weaker external monitoring, operating in a lower quality information	Implied volatility measure is 9.52–11.90 percent higher for firms in the bottom decile of comparability

(continued)

Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
				environment and operating in less competitive industries	index than for firms in the top decile
Zhu (2016)	Accruals	A total of 108,184 firm-year observations between 1965 and 2013	No justification is provided	A strong positive association between total accruals and price crashes is found which is consistent with the hidden bad news explanation. With respect to the components of accruals, Zhu (2016) finds that less (more) reliable accrual components are significantly positively (not significantly) associated with price crashes	The probability of observing crash over the next year increases from 12.88% for the lowest decile of the current year's accruals to 17.27% for the highest decile
Ertrugrul *et al.* (Forthcoming)	Annual report readability and tone ambiguity	A total of 32,207 firm-year observations and 1995–2013 sample period	No justification is provided	Firms with larger reports and a higher proportion of uncertain and weak expressions experience greater crash risk supporting the argument that readability of a firm's financial disclosures are related to managerial information hoarding	A one-standard deviation increase in readability score would lead to an 18.2% increase in the average value of *NSKEW*
Panel B: Managerial incentives and managerial characteristics and crash risk (Section 3.2.)					
Kim *et al.* (2011a)	CEO versus CFO's equity incentives	1993–2009 sample period with 29,638 firm-year observations	No justification is provided	CFO's equity incentives are positively related to the firm's future crash risk. This association is more pronounced for CFOs and in firms operating in non-competitive industries and those with a high level of financial leverage	No

(continued)

Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
He (2015)	CEO inside debt	A total of 5,685 firm-year observations from 2006 to 2011	Starting from December 15, 2006, the SEC required public firms to disclose detailed information about the computation and value of executive pension benefits and deferred compensation	CEO inside debt holdings reduce firm-specific stock price crash risk	A one-standard deviation increase in InsiDebt decreases the incidence of a stock price crash by 3.1% points, which accounts for 15.38% of the sample mean of Crash
Kim *et al.* (2016a)	CEO overconfidence	1993–2010 sample period with 23,925 firm-year observations	No justification is provided	Overconfident CEOs are associated with higher stock price crash risk, an association which is pronounced if the CEO is more dominant among the top management team	Firms with overconfident CEOs are associated with 1.2% to 3.6% more crash risk compared to firms without overconfident CEOs
Andreou *et al.* (2017)	CEO age	Sample period 1995 to 2013. Final sample 18,649 firm-year observations.	No justification is provided	Firms with younger CEOs are more likely to experience price crashes. Updating market with negative news in the form of breaks in strings of consecutive earnings increases crash risk. This adverse impact of CEO age effect is strongest in the presence of managerial discretion	One standardised unit decrease of CEO age increases the probability of a stock price crash by approximately 7.60%
Panel C: Capital market transactions and crash risk (Section 3.3.)					
Chen *et al.* (2001)	Skewness in the daily returns to individual stocks	1962–1998 sample period with 51,426 firm-year observations.	Sample period begins in 1962 as trading volume data is available from this period	Stock price crash is most pronounced for firms with an increase in trading volume relative to trend over the prior 6 months and stock with positive returns over the prior 36 months	A one-standard deviation shock to *DTURNOVER* translates into a movement of 0.06 in the *NSKEW* variable

(continued)

Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Callen and Fang (2015a)	Short interest	40,660 firm-year observations for the years 1981 to 2011	Short interest information is available from 1981	One-year ahead stock price crash risk is positively associated with short interest. This positive association is more pronounced for firms with weak governance monitoring mechanisms, excessive risk-taking behaviour, and high information asymmetry	A change in the short interest from the 25th to 75th percentile explains on average 12.25% of the sample mean across alternative measures of crash risk
Chang *et al.* (Forthcoming)	Stock liquidity	Sample period 1993 to 2010. Final sample of 58,533 firm-year observations	Yes	A positive and significant association is found between a firm's stock liquidity and its future stock price crash risk. The liquidity effect is stronger for the firms with a higher proportion of short-horizon investors, greater information asymmetry, and higher levels of short-sale constraints	A one-standard deviation rise in stock liquidity is associated with 2.71% increase in the probability of a crash risk
Panel D: Corporate governance and crash risk (Section 3.4.)					
Callen and Fang (2013)	Institutional investor stability	1981–2008 sample period with 61,705 firm-year observations	No justification is provided	Institutional investor stability is negatively associated with one-year ahead stock price crash risk. Moreover, this relationship varies depending on whether institutional owners are public pension funds or bank trusts, investment companies and independent investment advisors	One year ahead crash risk increase by 5.3% with a shift from the 25th to the 75th percentile of the distribution of standard deviation of institutional shareholding

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Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
An and Zhang (2013)	Institutional investors	From 1987 through 2010 sample period with 79,932 firm-year observations	Sample period begins from 1987 as the historical SIC data is missing in Compustat before 1987	Monitoring by dedicated institutional investors mitigates managerial bad news hoarding, which reduces crash risk and stock price synchronicity	A one-standard deviation increase of dedicated institutional ownership will lead to an 17% decrease in crash risk at the mean, while a similar increase of transient institutional investors will increase crash risk by 46% at the mean
Aman (2013)	Media Coverage	A sample of Japanese companies from April 2003 to March 2006	No justification is provided	Intensive media reports on a firm provoke extremely large reactions in the market to corporate news	One-standard deviation increase in *lnMEDIA* generates a 0.082 standard deviation crash risk
Xu *et al.* (2014)	Excess perks	A sample of Chinese SOEs from 2003 to 2010	There were a sufficient number of firms voluntarily disclosing their perk expenses from 2003 and beyond, and it was also the first year with available institutional ownership data	Motivated by the intention to enjoy excess perks, executives in state-owned enterprises withhold bad news for extended periods, leading to higher future stock price crash risk	No
Robin and Zhang (2015)	Industry-specialist auditors	1990–2009 sample period with 58,365 firm-year observations	No justification is provided	Information intermediary and corporate governance roles of auditor industry specialisation reduce crash risk. Moreover, industry-specialist auditors moderate the effects of opacity, accounting conservatism, and tax avoidance on crash risk	No

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Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Chen *et al.* (2017a)	Internal control quality	A sample of Chinese listed firms from 2007 to 2012	The internal control index covers Chinese listed firms from 2007 to 2012	Internal control is negatively associated with price crash, and this negative relation is more pronounced in firms with weak governance (i.e. non-Big 4 auditors, located in provinces with low market development, and less conservative accounting) and with poor ability to mitigate impacts of extreme negative events (i.e. non-state-owned enterprises)	It is estimated that when internal control quality increases from the first to the third quartile, the crash risk proxy *NSKEW* decreases by 0.034, which is 19.73% of the median value of *NSKEW*
Habib and Hasan (2016)	Non audit tax services (NATS)	2002–2012 sample period with 21,950 firm-year observations	Sample period begins from 2002 as Congress ratified SOX in this year	NATS attenuate crash risk by constraining both tax expenses management and tax avoidance. Further, NATS reduce crash risk for firms following innovative business strategies. Empirical findings, therefore, support knowledge spillover benefits	No
Xu *et al.* (2016)	Analyst herding	A total of 4,821 firm–year observations for the period 2004 to 2012	Choice of the sample period is explained	Firms with disproportionately more analysts herding, have higher future stock price crash risk, and this is more pronounced for firms with higher information asymmetry. Analyst herding behaviour, however, is not related to positive stock price jumps, suggesting that analysts do not hold back good news for a firm	No

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Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Yuan *et al.* (2016)	D&O liability insurance	Sample period 2002 to 2012. A total of 914 firm-year observations	The D&O insurance appeared from 2002	D&O insurance is negatively associated with crash risk. The association is more pronounced in firms with lower board independence, non-Big 4 auditors, lower institutional shareholdings, and weaker investor protection. D&O insurance purchase is associated with less financial restatements and more disclosure of corporate social responsibility reports	No
Kubick and Lockhart (2016)	SEC oversight	A total of 18,081 firm-year observations from 1996 to 2012	YES. '...sample begins in 1996 [to] obtain historical zip codes from firm 10-K filings...'	Firms further away from SEC office are more likely to experience crash. This effect is more pronounced for firms with larger 10-K file sizes. This is consistent with managerial influence over annual report disclosures with an intent to obfuscate bad news when there is greater distance between managers and the SEC	A change from 1st to the 3rd quartile of the distance from SEC variable increases crash risk by 0.75%
Bhargava *et al.* (2017)	State antitakeover laws	Sample period 1980–1995. Final sample 56,018 firm-year observations	No justification is provided	Takeover protection reduces crash risk by mitigating bad news hoarding activities. This relation is more pronounced in the presence of information asymmetry and product market competition	Firms incorporated in states that have adopted the antitakeover law are associated with a 0.061 (0.044) decrease in *NSKEW* (DUVOL) respectively, and this is economically significant when compared against the mean value

(continued)

Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Sun *et al.* (2017)	Split share reform	A total of 11,661 firm-year observations for the period 2002 to 2013	Choice of the sample period not explained	Split share reform attenuates crash risk, and this effect is more pronounced in firms with a higher proportion of shares held by controlling shareholders and firms with a high level of tunnelling prior to the reform	After the reform, crash risk measured by *NSKEW* and *DUVOL* declines by 0.226 and 0.199, compared with the crash risk of these firms before the reform: an economically significant decline
Panel E: Informal institutions and crash risk (Section 3.5.)					
Piotroski *et al.* (2015)	Political incentives	A sample of listed Chinese firms over the period 1993 to 2011	No justification is provided	Listed firms experience a reduction in negative stock return skewness before two visible political events including meetings of the National Congress of the Chinese Communist Party and high-level, provincial-level political Promotions	No
Callen and Fang (2015b)	Religion	Sample observations 80,404 from 1971 to 2000	Although not explicitly stated, the data source, i.e. Glenmary Research Center collects data from surveys on religious affiliation once in a decade	Firms headquartered in counties with higher levels of religiosity exhibit lower levels of future stock price crash risk consistent with the view that religion, as a set of social norms, helps to curb bad-news-hoarding activities by managers. This negative association is more pronounced for riskier firms and for firms with weaker governance mechanisms	A shift from the 25th to the 75th percentiles of the distribution of religiosity reduces crash risk by 6.34% (*NSKEW*), 4.85% (*DUVOL*), and 3.78% (*CRASH*)

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Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Cao *et al.* (2016)	Social trust	Sample period 2001 to 2012. Final sample 16,144 firm-year observations	Justification for starting in 2001 is clearly explained. The provincial index of social trust in the Chinese Enterprise Survey System was constructed in 2000	Social trust and stock price crash risk are negatively correlated. However, this relation is dampened for firms with greater analyst coverage or high institutional ownership. Results suggest that social trust and other formal institutional monitoring mechanisms are partial substitutes	No
Li *et al.* (2016)	Trust	Sample period 2001 to 2015. Final sample 20,272	No justification is provided	Firms headquartered in regions of high social trust experience smaller crash risks. This is more pronounced for SOEs, for firms with weak monitoring, and for firms with higher risk-taking incentives. Moreover, firms in regions of high social trust are associated with higher accounting conservatism and fewer financial restatements	A one-standard deviation increase in *TRUST1* is associated with a 1.94% decrease of the standard deviation in future crash risk as measured by *NSKEW*
Lee and Wang (2017)	Political connections	A total of 4,680 firm-year observations during 2003 to 2012	Sample period begins in 2003 because the CSRC required Chinese listed firms to report the identity of the ultimate controller in the annual report from 2003	Politically connected directors accentuate crash risk in listed SOEs courtesy of appointment of local government officials as directors. In contrast, appointment of central government-affiliated directors, helps listed privately controlled firms to reduce crash risk. The presence of good quality institutions does not help to attenuate the adverse effect of political connections on crash risk	No

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Table 2 (continued)

Authors	Research question	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
Li and Chan (2016)	Communist Party Control	A sample of Chinese SOEs from 2003 to 2012	No justification is provided	Having a CPC committee member serves as a director can lower a firm's crash risk	No
Zhang *et al.* (2016)	Donations: China	Sample period 2002 to 2013. Final sample 14,631 firm-year observations.	Yes: CSMAR began to disclose firms' donation expenditures in 2002	A negative association between corporate donations and price crash is found. However, this negative effect is dampened for SOEs, compared with non-SOEs, and in the post-split share reform period	In the baseline model, a one-standard deviation increase in *Donations* is associated with 6.21% and 9.33% decreases in *NSKEW* and *DUVOL*, respectively, relative to the mean values.
Panel F: Expected crash risk and financial reporting quality					
Kim and Zhang (2014)	Financial reporting opacity	Sample period 1996 to 2007. Final sample 14,734 firm-year observations	No justification is provided	Earnings management, earnings restatements and poor internal control quality are significantly and positively associated with the steepness of the implied volatility smirk implying that financial reporting opacity increases expected crash risk	A one-standard deviation change in *OPAQUE* is related to a 3.7% change in the level of the implied volatility smirk: an economically significant impact
Kim *et al.* (2016b)	Financial statement comparability	Sample period 1996 to 2013. Final sample 17,057 firm-year observations	No justification is provided	More comparable financial statements reduce expected crash risk as is evident from a significantly negative association between financial statement comparability and the implied volatility smirk	The volatility smirk is 9.52–11.90% higher for firms in the bottom decile of comparability than for firms in the top decile

This table presents research questions, sample(s) used, and key findings for the surveyed papers on the determinants of crash risk. Panel A to Panel E summarises the studies which are grouped into (i) financial reporting and corporate disclosures; (ii) managerial incentives and managerial characteristics; (iii) capital market transactions; (iv) corporate governance mechanisms, with a particular emphasis on formal governance mechanisms; and (v) informal institutional mechanisms. We also report whether the selected studies justified their choice of a particular sample period, and explained the economic significance of the reported coefficients on the main variable of interest.

Table 3
Consequences of crash risk (Section 4)

Authors	Consequence	Sample	Sample period justification	Findings	Economic significance of the coefficient of interest
An *et al.* (2015)	Speed of leverage adjustment	Sample period 1989 to 2013. Final sample 120,764 firm-year observations from 41 countries	No justification is provided	Crash-prone firms adjust their financial leverages more slowly towards their targets suggesting that larger transaction costs inhibit firms from adjusting their capital structures often. The negative association between crash and leverage adjustments is less pronounced in countries with a more transparent information environment	If a firm's *NSKEW* increases by one-standard deviation, then there will be a 1.22% decrease in the speed of leverage adjustments
Hackenbrack *et al.* (2014)	Year-to-year change in the negotiated audit fee	Sample period 2000 to 2011. Final sample 27,708 firm-year observations	Yes	Companies experiencing a price crash have their auditor charging a 2 to 3 percentage point more audit fees	Auditors charge a 2 to 3 percentage point more audit fees to clients experiencing crash risk

This table presents research questions, sample(s) used, and key findings for the surveyed papers on the consequences of crash risk. We also report whether the selected studies justified their choice of a particular sample period, and explained the economic significance of the reported coefficients on the main variable of interest.

financial reporting process, which could cause crash risk, future research needs to show that labour market penalties exist for directors of crash firms.

Another interesting avenue for future research on crash risk consequences would be to examine post-crash investment behaviour, including CEO risk taking, in crash firms. If overinvestment leads to crash risk, it might then be assumed that firms would adjust their investment policies towards the optimum level following a crash. As research has found that overconfident CEOs are more prone to overinvestment compared to their counterparts (Lin *et al*., 2005; Malmendier and Tate, 2005; Huang *et al*., 2011), replacing overconfident CEOs in the post-crash period may be an effective remedy. But Goel and Thakor (2008) show that in a tournament setting, overconfident managers are more likely to become executives because they perceive less risk and therefore take more chances. This may suggest retention of overconfident CEOs by firms experiencing crash risk.

Taken together, we believe that there is immense potential for future research in the area of crash risk consequences. We have outlined some of the areas where research attention can be directed and proposed hypotheses that may be empirically tested.

5. Conclusion

In this paper, we reviewed the empirical literature on the determinants and consequences of stock price crash risk. Managerial incentives for hoarding bad news have been the primary focus of the burgeoning literature on crash risk. However, incentives alone would not be sufficient to withhold bad news. Managers would have to devise mechanisms for concealing negative information. Earnings manipulation, tax avoidance and voluntary disclosures have been identified as some of the mechanisms used by managers. Finally, reporting conservatism, external auditing and corporate governance mechanisms can curb managerial opportunistic use of mechanisms for concealing negative information.

In terms of country coverage on the determinants of crash risk research, we note with no surprise that the United States dominates the empirical research, followed by China. Although there are a couple of international studies, we were surprised to find no published study on either crash risk determinants or the consequences of crash from other parts of the world. Of course, inferences may be similar for countries with institutional environments similar to the United States, such as the UK, Australia and Canada, and this may restrain researchers from pursuing research on crash risk in other similar institutional settings. Yet it is well known that, despite the institutional similarities, similar research questions or some variants thereof have been pursued across these countries. Therefore, we call for more research in an international context to better understand the effect of country-specific idiosyncratic features on the determinants and consequences of crash risk.

However, the exclusive focus on the managerial bad news hoarding perspective has undermined the tension that should be a key ingredient of a survey paper. We expect that literature on crash risk in the future will generate rich insights once the competing theories are incorporated into the research design.

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