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Received: 2 February 2021 | Revised: 5 August 2023 | Accepted: 9 August 2023

DOI: 10.1111/jbfa.12745

JBFA

ARTICLE

The influence of uncertainty on financial reporting behavior: The case of P&C insurers

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Funding information
Katie School of Insurance and Risk Management

Abstract

We examine how uncertainty about a firm's future cash flows influences the quality of its accounting information. As uncertainty increases, information asymmetry between managers and stakeholders will almost certainly increase, amplifying the potential influence of uncertainty. We focus on a specific setting where severe levels of uncertainty can influence financial reporting, the property-casualty (P&C) insurance industry and use catastrophes as a shock to the level of uncertainty regarding P&C insurer's future cash flows. We use P&C firms' claim loss estimation errors as a proxy for accounting information quality. Results suggest that, in times of heightened uncertainty, managers respond by increasing accounting information quality. Moreover, managerial claim loss forecasts are more accurate for publicly traded P&C firms relative to privately—or mutually—owned P&C firms as catastrophe exposure increases. Additionally, claim loss estimates are incrementally more accurate in times of heightened uncertainty for public P&C firms with higher institutional ownership or analyst following. These results corroborate the conjecture that managers' decisions to provide more accurate forecasts in times of heightened uncertainty are attributable to an increased demand for better information by external stakeholders.

KEYWORDS
accounting quality, catastrophe, financial reporting, property and casualty insurance

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1 | INTRODUCTION

We examine how fundamental uncertainty about a firm's future cash flows influences accounting information quality. As uncertainty regarding a firm's operations and prospects increases, the information asymmetry between managers and stakeholders will likely increase. For example, consider the case of a property-casualty (P&C) insurer following a Category 5 hurricane. Because of a current-period event (the hurricane), the P&C insurer's stakeholders and managers will both face increased uncertainty regarding the firm's future cash flows. Neither stakeholders nor managers initially know how much cash the P&C firm will pay out to policyholders in future periods due to the damage caused by the hurricane in the current period. However, the managers' familiarity with the firm and its customers will mitigate managers' uncertainty relative to external stakeholders' uncertainty since the latter are not privy to the same detailed information. For example, managers have access to information such as how many of the firm's policyholders live in the hurricane's path, the average property value for those properties, etc. We explore how managers respond to information-asymmetry-increasing events that heighten uncertainty regarding firms' future cash flows.

We investigate one of the fundamental questions in the accounting literature: Under what circumstances do managers use accounting discretion to (1) disclose private information versus (2) extract rents from stakeholders?[1] The circumstance of interest in our case is a state of heightened uncertainty, which has the effect of increasing information asymmetries. On the one hand, information asymmetry is a necessary condition for earnings management (Dye, 1988; Trueman & Titman, 1988). A voluminous literature finds that managers tend to manipulate earnings under certain circumstances (e.g., Christie & Zimmerman, 1994; Givoly et al., 2010; Graham et al., 2005; Leuz et al., 2003; Ndofor et al., 2015; Richardson, 2000). They may exploit increased information asymmetry in these periods of proliferating uncertainty by manipulating earnings opportunistically, leading to lower quality accounting information. Alternatively, managers may attempt to offset this increased information asymmetry by making a more concerted effort to convey private information to satisfy stakeholders' need for more information (Beatty & Harris, 1999; Nichols et al., 2009), in which case net information asymmetry may remain constant or even decrease.

The P&C industry provides an ideal setting for observing the relation between uncertainty and accounting quality for three reasons.[2] First, catastrophic events provide a powerful shock to the uncertainty that affected P&C firms face regarding their future cash flows.[3] Second, P&C firms must report (1) claim loss reserves, an estimate of the insurer's liability in the year of a catastrophe as well as (2) the resulting actual claim losses paid for that year in subsequent years (the realization of actual claim payments). The difference between the claim loss reserve in the catastrophe period and the eventual actual claim losses for that period—the claim loss estimation error—provides a relatively clean proxy for accounting information quality in catastrophe-period earnings.

Third, heterogeneity in the ownership structure of the firms in our sample provides an opportunity to learn what motivates managers to change financial reporting in more uncertain times. In other words, it allows us to shed some light on the managerial intent behind any changes in financial reporting behavior. Our sample consists of data from public, private and mutually owned P&C firms. Managers of publicly traded firms must use financial statements and other public disclosures to resolve information asymmetry between management and investors. However, managers of privately and mutually owned P&C firms are more likely to use an "insider access" model (Ball & Shivakumar, 2005). Previous studies have found that private firms have lower levels of information asymmetry between managers and investors than public firms (Beatty & Harris, 1999). Therefore, any change in the claim loss reserve estimation errors for nonpublic firms should be relatively free of managerial intent to mitigate or exacerbate information asymmetries. This variation in ownership structure enables us to test whether any change in accounting information quality among

[1] For our purposes, the concept of managerial disclosure of private information refers to the way in which a manager may choose to exercise managerial discretion to convey information to stakeholders via the financial statements (as opposed to other channels such as managerial guidance to equity analysts).

[2] Beaver et al. (2000) also argue that, as the property and casualty industry is relatively homogeneous, it is possible to identify appropriate control variables for exogenous events.

[3] Christensen (2002) argues the P&C industry is the appropriate setting for investigating uncertainty because an event-based gauge of pre-disclosure uncertainty is available for P&C firms (Christensen, 2002; Christensen et al., 2005).

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public P&C firms during periods of heightened uncertainty is attributable to a managerial response to the information asymmetry between managers and stakeholders in those firms.

To observe the relation between an escalation in uncertainty and accounting information quality, we use P&C firms' exposure to catastrophes as a shock to the level of uncertainty regarding affected insurers' future cash flows (Christensen, 2002). We use P&C firms' claim loss estimation errors to capture accounting information quality (Petroni, 1992). We find that managers provide more accurate forecasts of claim losses (smaller claim loss estimation errors) in periods of heightened uncertainty than in other periods. This evidence suggests that executives use managerial discretion to more accurately convey private information in their financial reports during times of heightened uncertainty.

We hypothesize that the relation between heightened uncertainty regarding a firm's future cash flows and claim loss forecast accuracy may be attributable to a correspondingly heightened demand for information from stakeholders and information intermediaries (Ball & Shivakumar, 2005; Beatty & Harris, 1999). To test this hypothesis, we perform cross-sectional tests examining how the positive relation between elevated uncertainty and managerial claim loss forecast accuracy is affected by public ownership, institutional ownership and analyst following. We expect public ownership, higher levels of institutional ownership and higher analyst following to create more managerial incentives to provide better information in more uncertain times. We find that managerial claim loss forecasts are more accurate for publicly traded P&C firms relative to private and mutually owned P&C firms as exposure to a catastrophe increases. Managerial claim loss forecasts are also incrementally more accurate for P&C firms with higher institutional ownership and larger analyst following. These results are consistent with the conjecture that managers' efforts to provide more accurate forecasts in times of heightened uncertainty are attributable to an increased demand for better information by external stakeholders.

While collective evidence is consistent with the stakeholder demand explanation, we acknowledge that managerial ability may also play an influential role. Superior managers may be more able than their less capable peers to provide stakeholders with more accurate loss forecasts in times of heightened uncertainty.[4] To assess the plausibility of this conjecture, we conduct cross-sectional analyses to test whether the negative relation between catastrophe exposure and claim loss forecast error is stronger for firms with more able managers. We use three measures of managerial ability: CEO compensation, CEO experience and MA_Score. Our analysis provides evidence that financial reporting quality improves as catastrophe exposure increases for all managers, not just for those who are more able. However, we also find some evidence that outstanding managers are capable of reporting more accurate claim loss reserve estimates when the appropriate incentives exist. In summary, our results suggest that managers generally respond to heightened uncertainty by improving claim loss estimate accuracy regardless of managerial ability, but that more capable managers may do so with greater efficacy.

Our analysis builds on Christensen (2002), who finds that market reactions to earnings are greater in times of heightened uncertainty. More specifically, earnings response coefficients (ERCs) are higher for affected P&C insurers in periods of catastrophe. We use the same setting to ask a related but different set of questions. What happens to the level of accounting information quality in times of heightened uncertainty? What motivates any observed change in those levels during uncertain times?

We make two main contributions to the literature on managerial discretion and disclosure. First, we find that accounting information quality improves in times of heightened uncertainty. This result complements Christensen's (2002) evidence that stakeholders pay more attention to P&C firm earnings in times of greater uncertainty. Our results are related to studies on the relation between information asymmetries and earnings quality in the banking industry. These studies find that managers at publicly traded (privately owned) banks, which are subject to higher (lower) levels of information asymmetry, are more (less) likely to use accounting discretion to manage earnings in ways that

[4] We note that the stakeholder demand and managerial ability explanations are not mutually exclusive. The documented relation between catastrophe exposure and claim loss forecast accuracy may be due to a confluence of both factors. Our focus is to provide evidence that the observed increase in accounting information quality is at least partially due to an increase in the demand for better information.

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communicate private information to investors (Beatty & Harris, 1999; Nichols et al., 2009). We provide an incremental contribution to the literature by providing evidence that managers at public firms seem to make a concerted effort to *improve* accounting information quality when information asymmetry is likely to have increased.

Second, we provide evidence that this increase in quality is at least partially attributable to an increase in the demand for better information about future cash flows during highly uncertain times by stakeholders. This result also complements Christensen's (2002) evidence since stakeholders who are extra motivated to use accounting information in decision-making are more likely to demand higher quality information from managers.

Our results are pertinent to recent changes in accounting regulation for insurers, which provide evidence that stakeholders demand high-quality accounting information. For example, IFRS 17, effective January 1, 2023, requires insurers to provide more consistent and comparable financial statements relating to insurance contracts written in different countries. To help achieve this goal, the new rule requires insurance contracts to be measured at current value and companies to use fewer non-Generally accepted accounting principles (GAAP) measures. Similarly, in ASC 944, the Financial Accounting Standards Board (FASB) requires insurers to improve the effectiveness of disclosures for long-duration contracts. The rule requires entities to disclose information about significant inputs, assumptions, judgments, measurement methods and changes to those elements. We note that these regulations *mandate* insurers to provide higher quality financial reports. Our results suggest that insurers may also *voluntarily* disclose higher quality accounting information during periods of heightened uncertainty due to an increase in stakeholder demand.

2 | HYPOTHESIS DEVELOPMENT

Christensen (2002) tests whether earnings announcements are more informative to stakeholders in times of greater uncertainty. He notes two types of uncertainty that affect the informativeness of earnings: the uncertainty in the noise of the earnings signal and the uncertainty inherent in the level of a firm's future cash flows. Christensen (2002) tests for a relation between the uncertainty inherent in the level of a firm's future cash flows and the informativeness of earnings announcements. He uses the extent to which a P&C firm is financially exposed to a catastrophic event as a proxy for uncertainty and ERCs as a proxy for earnings informativeness. He finds that ERCs are greater in catastrophe periods for P&C firms with greater financial exposure to the catastrophe. This result suggests that earnings announcements are more informative to stakeholders in times of greater uncertainty. In other words, stakeholders are more likely to use a firm's earnings announcement to make investment decisions in periods of greater uncertainty about the firm's future cash flows than in less eventful periods.

Our analysis differs from Christensen's because, while he focuses on the effect of uncertainty on the *consumption* of accounting information, we focus on the effect of uncertainty on the *creation* of accounting information. The difference is important. For example, managers may provide stakeholders with lower quality accounting information in times of heightened uncertainty. They may do so out of necessity; perhaps the manager does not have good information in times of great uncertainty. Alternatively, managers may exploit uncertainty-induced increases in information asymmetry to bias earnings in ways that suit their own purposes (Christie & Zimmerman, 1994; Givoly et al., 2010; Graham et al., 2005; Leuz et al., 2003; Ndofor et al., 2015; Richardson, 2000;). Regardless of the quality of earnings in times of great uncertainty, stakeholders may pay more attention to earnings announcements when making investment decisions because of a perceived dearth of reliable information from other sources. In other words, stakeholders may pay more attention to earnings announcements in times of greater uncertainty (Christensen, 2002) even though earnings quality in those periods may be lower. We shed light on what happens to firms' earnings quality in the face of heightened uncertainty. Therefore, we speak to whether the increased role of earnings in investors' decision-making during these periods is also associated with increased earnings quality.

An increase in information asymmetry will likely lead to an increase in outsiders' demand for higher quality accounting information. Beatty and Harris (1999) and Ball and Shivakumar (2005) find that publicly traded firms produce higher quality accounting information than private firms. Ball and Shivakumar (2005) suggest that this difference is

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due to a higher demand for high-quality accounting information from public firms stemming from higher levels of information asymmetry between managers and stakeholders. Prior theoretical models show that managers have incentives to provide accurate information to satisfy stakeholder demand. For example, Stocken (2000) shows that, in repeated games, communication between managers and stakeholders may improve because managers can benefit from building a reputation for providing accurate disclosures. Beyer and Dye (2012) find that managers can build a reputation for being forthcoming. Given sufficiently strong reputational incentives, they will disclose even the most negative earnings expectations. We may observe these effects in our setting: catastrophes are likely to increase information asymmetry between managers and stakeholders, while stakeholders may increase their demand for high-quality accounting information to mitigate the increase in information asymmetry. Managers who wish to establish or maintain a reputation for high-quality disclosure may respond to stakeholder demand.

Alternatively, managers have greater access to information about a firm's operations and prospects than stakeholders. They may attempt to capitalize on this information asymmetry to enrich themselves at the expense of shareholders (Jensen & Meckling, 1976). Many studies have found that managers opportunistically manipulate earnings under the right circumstances. For example, Graham et al. (2005) find that managers are sometimes motivated to manage earnings out of career concerns and to protect their image. Badertscher (2011) finds that managers of overvalued firms are more likely to manage earnings. A sizeable literature finds evidence of earnings manipulation among firms close to falling short of earnings expectations (e.g., Burgstahler & Dichev, 1997; Burgstahler & Chuk, 2015, 2017; Degeorge et al., 1999). Other earnings management studies find that managers manipulate earnings in settings where information asymmetry is relatively high (e.g., Friedlan, 1994; Ndofor et al., 2015; Teoh et al., 1998; Richardson, 2000). Information asymmetry is a necessary condition for earnings management (Dye, 1988; Trueman & Titman, 1988). Thus, during times of heightened uncertainty induced by catastrophes, managers may exploit increases in information asymmetry to manipulate earnings opportunistically, leading to a decline in accounting information quality.

Richardson (2000) argues that earnings management can only occur when shareholders have insufficient incentives, resources or access to relevant information to monitor manager's actions (see also Schipper, 1989). During a catastrophe, investors have strong incentives to monitor managers' actions as they increase their reliance on accounting information, which could constrain earnings management. Moreover, as the claim loss estimation error provides a strong proxy for both earnings management and earnings quality, investors also have access to relevant information to monitor P&C insurer managers' actions. Since managers have incentives to build their reputation, they are more likely to increase earnings quality than manage earnings during a catastrophe.[5] Therefore, in our first test, we hypothesize that managers will respond to an increase in uncertainty (exposure to catastrophe) by increasing accounting information quality.

H1: Claim loss reserve estimation error decreases (accounting information quality increases) as exposure to catastrophes increases for P&C firms.

Despite our prediction, it is also possible that managers do not change the quality of accounting information in times of increased uncertainty. Higher levels of accounting information quality can be costly to both managers and stakeholders. Stakeholders will suffer when managers are so focused on reporting quality that they become distracted from effectively managing day-to-day operations. Disclosures of exceptionally high quality may impose unwanted costs on managers and stakeholders because they may reveal proprietary information and weaken the firm's competitive advantages (Verrecchia, 1983). While there are numerous benefits to high-quality accounting information (Dechow

[5] It is important to note that we are not asserting that managers do not have and respond to incentives to provide accurate estimates in less uncertain times. Rather, we observe that managerial time and energy are constrained resources. Managers face a trade-off between spending time on improving financial reporting quality and spending time on improving firm operations. From the shareholders' perspective, the optimal allocation of managerial time and energy is that which maximizes shareholder benefits. Our conjecture is that the mix of managerial activities which will yield maximized shareholder benefits may be different in high uncertain times than in "normal" times (i.e., investors may prefer that managers make more of an effort to report higher quality accounting information during high uncertainty periods, even if it means they must spend less time on other managerial tasks).

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et al., 2010), these costs create an upper bound on the optimal level of accounting information quality. More specifically, the optimal level of reporting quality will be the point at which the marginal cost of producing an extra unit of quality is equal to its marginal benefit. This equilibrium shifts as the costs and benefits of higher quality reporting change during periods of heightened uncertainty.

Our second hypothesis relates to the multiperiod effect of catastrophes on financial reporting quality. In the case of P&C firms, uncertainty—and, therefore, information asymmetry—is likely to persist following a catastrophe as insurance adjusters begin reviewing claims and firms start processing payments. Thus, we expect a continued, but muted, elevation in stakeholder demand for higher quality accounting information in the period(s) following the catastrophe. This multiperiod effect has been observed in other shocks, including the addition of board risk committees (Ames et al., 2017). If an increase in accounting information quality for P&C firms during periods of catastrophe is attributable to an increase in the demand for better information due to increased uncertainty, then we should expect the level of accounting information quality to remain elevated but gradually revert to its mean in later periods as uncertainty is resolved.

H2: Improved claim loss reserve estimation errors in periods of catastrophes for exposed P&C firms persist but diminish over time.

Our remaining hypotheses relate to the potential factors that may influence the relation between exposure to heightened uncertainty and accounting information quality. The first hypothesis articulates our expectation that managers increase accounting information quality in more uncertain times in response to an increase in the demand for good information. The demand for high-quality information is due to the agency conflict, which has its roots in the information asymmetry between managers and shareholders (Jensen & Meckling, 1976; Healy & Palepu, 2001). Private and mutually owned firms do not experience information asymmetry and agency problems as acutely as publicly traded firms (Ball & Shivakumar, 2005; Beatty & Harris, 1999). Ball and Shivakumar (2005) attribute this difference in information asymmetry to differing levels of demand for earnings quality in public firms relative to private firms.

More specifically, Ball and Shivakumar (2005) argue that stakeholders in public companies demand higher quality financial statements in order to effectively monitor managers. This is because public companies have a large number of actual and potential stakeholders whose identities continually change as they trade the company's stock. Since it is extremely costly to communicate privately with stakeholders under these circumstances, managers must mitigate information asymmetry through high-quality public financial reporting. Conversely, private companies have fewer stakeholders, lower stakeholder turnover, are more likely to be closely held and have stakeholders that are more likely to have an active role in management. Thus, private companies are more likely to communicate privately with their stakeholders, who consequently have a lower demand for high-quality public information. In other words, in the absence of higher quality financial reporting from managers of public firms, information asymmetry between the managers and stakeholders at those firms is higher than it is for private firms. Ball and Shivakumar (2005) refer to the private, "as-needed" manner in which nonpublic firms are more likely to resolve information asymmetry as the "insider access" model.

We conjecture that the same elements of the "insider access" model that lead to different levels of information asymmetry in public and private firms, *ceteris paribus*, will lead to different responses to information asymmetry by public and private firms when uncertainty increases. Effective communication between managers and stakeholders mitigates information asymmetry. Managers of nonpublic firms can use "insider access" to communicate with stakeholders, but public firms must use formal communication channels such as the financial statements (Ball & Shivakumar, 2005). It follows that managers of nonpublic firms may not experience the same increase in demand for higher quality financial accounting information in times of heightened uncertainty as managers of publicly traded firms. If our test result is consistent with H1, and if this result is attributable to an increase in the demand for better information, then managers of public firms should respond by reporting incrementally better quality accounting information than managers of nonpublic firms. Thus, we form the following hypothesis:

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H3: The effect of exposure to catastrophes on claim loss reserve estimation errors is greater for public P&C firms than for nonpublic P&C firms.

If improved accounting information quality in times of higher uncertainty is attributable to an increased demand for higher quality information, managers at firms with higher levels of institutional stakeholder ownership are likely to face more pressure to deliver high-quality information than their peers at firms with lower levels of institutional ownership. Dye's (1988) theoretical model shows that firms are more likely to disclose private information if investors are more sophisticated. Other empirical studies find that institutional ownership is positively related to the quality and quantity of disclosure (Bushee & Noe, 2000; Healy et al., 1999; Velury & Jenkins, 2006). Accordingly, we conjecture that institutional owners can more effectively demand a higher level of accounting information quality from managers in times of heightened uncertainty.

H4: Claim loss reserve estimation error decreases (accounting information quality increases) incrementally as exposure to catastrophes increases for P&C firms with a higher proportion of institutional stakeholders.

Equity shareholders are not the only stakeholders with reasons to demand higher quality accounting information in times of heightened uncertainty. While prior research finds that firms bias financial reporting to meet or beat analysts' targets (Burgstahler & Dichev, 1997; Burgstahler & Chuk, 2015, 2017; Dhaliwal et al., 2004; Graham et al., 2005; Jensen, 2005), security analysts also play an important role in mitigating the information-asymmetry-induced agency problem (Healy & Palepu, 2001). Extant research finds that analysts have an incentive to build their reputations by issuing accurate earnings forecasts (Hong & Kubik, 2003; Jackson, 2005; Mikhail et al., 1999; Stickel, 1992). Analysts therefore have an incentive to demand higher quality accounting information from managers to use as inputs in their forecasting models in times of heightened uncertainty. Thus, we predict that an increase in the demand from analysts for better information in uncertain times will lead to higher accounting information quality.

H5: Claim loss reserve estimation error decreases (accounting information quality increases) incrementally as exposure to catastrophes increases for P&C firms with a larger analyst following.

3 | RESEARCH DESIGN

3.1 | Main effect analysis: Tests of H1, H2 and H3

To test the effect of catastrophe-induced uncertainty on claim loss reserve estimation errors among P&C insurers, we use ordinary least squares regression. We follow prior research (e.g., Geiger & North, 2006; Ames et al., 2017) to design our reserve estimation error model:

$$REE_{(t,t+1\ or\ t+2)} = \alpha + \beta_1 Exposure_t + \beta_2 Size_t + \beta_3 Growth_t + \beta_4 ROAA_t + \beta_5 Reinsurance_t + \beta_6 LagLoss_t + \beta_7 LargeLoss_t + \sum Year + \varepsilon_t, \quad (1)$$

$$REE_t = \alpha + \beta_1 Exposure_t + \beta_2 Public_t + \beta_3 Exposure_t \times Public_t + \beta_4 Size_t + \beta_5 Growth_t + \beta_6 ROAA_t + \beta_7 Reinsurance_t + \beta_8 LagLoss_t + \beta_9 LargeLoss_t + \sum Year + \varepsilon_t, \quad (2)$$

where *REE* is the absolute value of the claim loss reserve estimation error divided by total direct premiums written during the year. *Exposure* represents the percentage of a firm's total assets exposed to catastrophe losses during the year, as defined in Section 3.3. Year t is the year of the catastrophe, and year t+1 (t+2) indicates the first (second)

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year following the catastrophe.[6] We include the year indicators, *Year*, to control for time-specific trends and cluster standard errors by the insurer. We define all other variables in the Appendix.

3.2 | Dependent variables

We use the absolute value of the claim loss reserve estimation error (*REE*) developed by Petroni (1992), which represents our proxy for accounting information quality, as our dependent variable. We calculate *REE* by taking the difference between realized claim losses and loss adjustment expenses reported in year *t*+5 and the initially reported claim loss and loss adjustment expenses reserve reported in year *t*. Managers may have incentives to understate forecasted reserves to increase reported earnings or overstate forecasted reserves to opportunistically build reserves for future earnings manipulation (i.e., create a cookie jar) during heightened uncertainty. Thus, we use the absolute value of this variable to test the accuracy of reserve estimation errors and, therefore, accounting information quality during periods of uncertainty. Higher values for *REE* indicate larger reserve estimation errors in either direction. Lower values for *REE* indicate more accurate disclosures by management.

3.3 | Explanatory variables

We use *Exposure* as our primary explanatory variable. Following Christensen (2002), *Exposure* represents the percentage of a firm's total assets exposed to catastrophe losses during the year. Using data from the SNL Financial database,[7] which contains financial information for property and casualty insurers, we calculate *Exposure* as follows:

$$Exposure_{i,\,t} = \frac{\sum_{j=1}^{n}\left[Geog\%_{i,j} \times \frac{Net\ Premium_{i,j}}{Total\ Premium_{j}} \times Total\ Loss_{j}\right]}{Net\ Assets_{i}}, \tag{3}$$

where *Exposure* is firm *i*'s exposure to claim losses from catastrophes during year *t*, $Geog\%_{i,j}$ is the percentage of net premiums written by firm *i* in states affected by catastrophe *j*, $Net\ Premium_{i,j}$ is the net premiums written by firm *i* in the lines of business affected by catastrophe *j*, $Total\ Premium_{j}$ is the total net premiums written by all P&C insurers in lines of business affected by catastrophe *j*, $Total\ Loss_{j}$ is the total estimated claim losses for catastrophe *j*,[8] and $Net\ Assets_{i}$ is firm *i*'s net total assets.

Exposure is a continuous measure, and it incorporates four important inputs: (1) the amount of insurance premiums a firm writes in geographic areas affected by a catastrophe, (2) its market share in lines of business affected by the catastrophe, (3) the magnitude of the catastrophe and (4) the size of the insurer. Managers may take advantage of heightened uncertainty to extract rents from stakeholders. In that case, we expect greater exposure to a catastrophe could result in greater opportunity to manage earnings and, therefore, a larger claim loss reserve estimation error. Alternatively, if managers disclose more private information during periods of catastrophe, we expect greater exposure to lead to greater reporting accuracy and, therefore, lower claim loss reserve estimation errors. Consistent with H1, we predict a negative relation between *REE* and *Exposure* in Equation (1). To test H2, we estimate the relation between *Exposure* at year *t* and the dependent variable, *REE*, measured in years *t*+1 and *t*+2. Consistent with H2, we predict that the negative relation between *Exposure* and *REE* weakens over time.

[6] For year *t*+1 and *t*+2 tests, the control variables are measured at year *t*. Our results remain qualitatively unchanged if control variables are measured at *t*+1 or *t*+2 under the respective tests.

[7] SNL Financial is now trading as S&P Global Market Intelligence.

[8] The total estimated loss for the catastrophe is reported by the ISO's Property Claim Services unit. Catastrophe losses include commercial total loss, personal total loss, auto loss and workers comp total loss from catastrophes in the United States, Puerto Rico and the U.S. Virgin Islands.

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We use Equation (2) to test H3. *Public* is an indicator variable equal to one if the P&C insurer has a stock ticker in the SNL Financial database, indicating a publicly traded firm. The level of information asymmetry is higher in publicly traded insurers than in their nonpublicly traded counterparts. Thus, if managers of publicly traded insurers seek to mitigate information asymmetry in times of heightened uncertainty, then the absolute value of firm claim loss estimation errors[9] in the period of the catastrophe will be lower for publicly traded P&C firms than for other ownership structures. Consistent with H3, we expect public insurers with greater exposure to report incrementally lower claim loss reserve estimation errors. Therefore, we predict a negative coefficient on the interaction of *Exposure* and *Public*.

3.4 | Control variables

Following Ames et al. (2017), we control for size, growth, profitability, reinsurance, prior year losses and large losses. For our first control variable, we use the natural log of net assets (*Size*) to control for size. In accordance with the political cost hypothesis, larger insurers may have less incentive to manage earnings to avoid attracting regulatory attention (Watts & Zimmerman, 1978) In other words, they may be less likely to engage in income-increasing earnings management or income-decreasing big bath behavior. The political cost hypothesis should therefore lead to a lower absolute value of the reserve error. In addition, larger insurers might employ more skillful managers who make more accurate estimates, which results in lower reserve errors. Moreover, Demerjian et al. (2020) find that firm size is negatively associated with the absolute value of earnings management. Thus, we predict a negative association between *REE* and *Size*.

Next, we control for growth (*Growth*) and profitability (*ROAA*). We use annual percentage growth in net premium written to compute *Growth*. High-growth firms are likely to require greater claims and loss-adjustment expenses, suggesting a positive association between *REE* and *Growth*. Conversely, *Growth* may also be another measure for uncertainty. Demerjian et al. (2020) find that sales growth is negatively associated with the absolute value of earnings management. As a result of the conflicting arguments and results, we do not make a directional prediction on the association between *REE* and *Growth*. Insurers that report better performance are likely to have higher accruals (Kothari et al., 2005). Thus, we use return on average assets (*ROAA*) as our proxy for performance and predict a positive association between *REE* and *ROAA*.

We use the reinsurance premiums ceded, scaled by direct premiums written, plus reinsurance premiums assumed (*Reinsurance*) to proxy for reinsurance. Insurers use reinsurance to hide under-reserving (Grace & Leverty, 2010; Harrington & Danzon, 1994). However, Grace and Leverty (2010) find mixed results between various definitions of reserve errors and reinsurance. Thus, we do not make any predictions about the sign of the relation between *REE* and *Reinsurance*.

We also control for lagged claim loss and loss adjustment expenses estimate (*LagLoss*), which is scaled by net total assets. Prior research includes the prior year's accounting estimates in earnings management models to reflect the reversal of accruals over time (Ashbaugh et al., 2003). We expect *LagLoss* to be negatively associated with *REE* because prior period accruals make it harder to increase claim loss estimates in the future. Finally, *LargeLoss* is an indicator variable representing insurers that report a net loss in the lowest earnings decile among all loss firms in a given year. This variable controls for factors that deter managers from meeting or beating earnings benchmarks (Ashbaugh et al., 2003; Frankel et al., 2002;). We expect insurers with large losses to have fewer incentives to manipulate earnings upward. However, these firms may also have an incentive to manage earnings downward as part of a "bath." Thus, we remain agnostic on our prediction related to *REE* and *LargeLoss*.

[9] We employ the absolute value rather than signed claim loss errors as our measure of the estimation error. Signed results capture two effects simultaneously—firms moving towards accurate reporting from over-reserving and firms moving towards accurate reporting from under-reserving. These two effects may compete with each other in a combined, signed test. Nevertheless, in an untabulated analysis, we employ signed tests and find qualitatively similar inferences.

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TABLE 1 Sample selection.

Total number of observations in the SNL Financial database from year 2004 to 2013	30,848
Exclude P&C insurers' subgroups that do not report actual or forecasted claim information	(14,236)
Exclude observations with insufficient data to calculate the dependent variable (*REE*)—the loss reserve estimation error	(5,435)
Exclude observations with insufficient data to calculate the independent measure (*Exposure*)—the degree of exposure to catastrophe	(3,351)
Exclude observations with insufficient data to calculate the control variables (primarily due to missing *Reinsurance*, *Growth* and *ROAA*)	(1,740)
Total observations in the main sample	6,086

3.5 | Cross-sectional analysis: Tests of H4 and H5

To evaluate the incremental effect of stakeholder demand on managers' decision to provide more accurate accounting information during uncertain times, we estimate the following regression models:

$$\begin{aligned} REE_t = {} & \alpha + \beta_1 Exposure_t + \beta_2 Inst\_holdings_t + \beta_3 Exposure_t \times Inst\_holdings_t + \beta_4 Size_t \\ & + \beta_5 Growth_t + \beta_6 ROAA_t + \beta_7 Reinsurance_t + \beta_8 LagLoss_t + \beta_9 LargeLoss_t \\ & + \sum Year + \varepsilon_t, \end{aligned} \tag{4}$$

$$\begin{aligned} REE_t = {} & \alpha + \beta_1 Exposure_t + \beta_2 Analysts_t + \beta_3 Exposure_t \times Analysts_t + \beta_4 Size_t + \beta_5 Growth_t \\ & + \beta_6 ROAA_t + \beta_7 Reinsurance_t + \beta_8 LagLoss_t + \beta_9 LargeLoss_t + \sum Year + \varepsilon_t. \end{aligned} \tag{5}$$

We estimate Equation (4) to test our fourth hypothesis using a subsample of only public firms. The cross-sectional variable of interest in Equation (4) is the percentage of equity held by institutional stakeholders (*Inst_holdings*). We expect institutional stakeholders to increase the demand for accurate reporting during a catastrophe. Thus, we predict a negative β_3 coefficient, indicating that the negative association between *Exposure* and *REE* is stronger for insurers with higher institutional ownership. Using the same subsample of public firms, we test H5 by estimating the model in Equation (5), which uses the average number of analysts following the company (*Analysts*) as a proxy for external demand for quality information. We expect that a greater number of analysts will increase the demand for accurate reporting in catastrophe periods. We, therefore, predict that the negative association between exposure to catastrophe (*Exposure*) and claim loss estimation errors (*REE*) will be stronger for insurers that have higher analyst following (*Analyst*). A negative β_3 coefficient in Equation (5) would corroborate the hypothesis. We discuss the control variables in the preceding section.

4 | RESULTS

Table 1 describes our sample. We begin our sample with the SNL Financial database, which contains financial information for property and casualty insurers. We have access to the data beginning in 2004. However, to calculate the claim loss reserve error (*REE*), we require five additional years of data to compare originally reported claims losses with actual paid amounts 5 years later, consistent with the measure used by Petroni (1992). As a result, we use firm years from 2004 to 2013 for a total of 30,848 observations. We eliminated 14,236 observations without actual or forecasted claim information; many of the excluded observations are subgroups of P&C insurers that do not report actual or forecasted claim information. We removed 5435 observations with insufficient data to calculate *REE*. In addition,

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we excluded 3351 observations with insufficient data to calculate the measure of catastrophe exposure (*Exposure*) and 1740 observations with insufficient data to calculate the control variables. The remaining 6086 observations constitute our main sample, and it includes insurers with both commercial and noncommercial lines of business.[10] For cross-sectional tests related to analysts and institutional investors, we further reduce the sample because we require nonmissing institutional ownership data from Thomson Financial and nonmissing analyst data from Institutional Brokers' Estimate System (IBES). We obtain the catastrophe data from Insurance Services Office, Inc.'s (ISO's) Property Claim Services database, which contains information such as the names of catastrophes, the states that were affected by each catastrophe and estimates of catastrophe losses.

Panel A of Table 2 presents the descriptive statistics for our sample. All variables appear to be reasonably distributed, including net assets, our proxy for size, which we measure in the natural log to achieve a more normal distribution. Note the variation in key variables. *REE*, our measure of the absolute value of the difference between initially estimated claims losses and the updated value 5 years later, spans from 0.005 at the 10th percentile (very little error) to 0.297 at the 90th percentile (relatively significant error). Due to extreme values, we winsorize our data at the 1- and 99-percent levels.[11] As for our measure of catastrophe exposure, *Exposure*, the amount of exposure varies from 0.003 at the 10th percentile (very little exposure) to 0.232 at the 90th percentile level (relatively high exposure). *Growth* and *ROAA*, both measures of performance and likely future performance, span from negative values (−12.650; −1.230) at the 10th percentile to outstanding growth and returns at the 90th percentile (21.660; 6.630). Institutional holdings range from 0.469 at the 10th percentile level to 0.908 at the 90th percentile level. The number of analysts following the firms in our samples varies from 1.5 at the 10th percentile level to 23.833 at the 90th percentile level.

In Panel B of Table 2, we present the pairwise correlations between the primary variables in our hypothesis testing models. The correlation between *REE* and *Exposure* is significantly negative at the 10-percent level. This association provides preliminary evidence consistent with our first hypothesis, that reporting error decreases as catastrophe exposure increases. The correlation between *REE* and *Size* is also positively significant, indicating that larger firms report larger errors, perhaps due to larger levels of losses to estimate. This correlation is contrary to expectations. Conversely, the association between *Size* and *Exposure* is negatively significant. This evidence may indicate that, for larger firms, any single catastrophe is likely to represent a smaller share of the total coverage provided.

Table 3 contains the test results for our first hypothesis. Consistent with H1, we observe a significant and negative association between exposure to catastrophe and claim loss estimation errors in year *t*. Column 1 of Table 3 indicates that the coefficient on *Exposure* is −4.35 ($t = -2.73$). This result suggests that, as exposure to catastrophes increases, firms report claim losses more accurately, *ceteris paribus*.[12,13] As predicted, the coefficient on *Size* is significantly negative at the 0.10 level ($t = -1.66$), indicating that larger firms tend to be more accurate in their claim loss estimates. The coefficient on *LargeLoss* is significantly positive at the 0.10 level ($t = 1.93$). This evidence suggests that large losses are not associated with improved reporting accuracy of claim loss estimation errors. The opposite may be true, perhaps due to incentives to "take a bath."

[10] Commercial lines consist of policies written for commercial properties and commercial autos. Noncommercial lines of business consist of personal auto policies and policies purchased by homeowners and farm owners. Untabulated analyses indicate that using subsamples of commercial or noncommercial lines yield qualitatively similar inferences.

[11] Our results are robust to winsorization at the 1-/99-percent, 2-/98-percent and 3-/97-percent levels.

[12] Since our dependent variable is the absolute value of the claim loss reserve (unsigned), we check to make sure that this result is not simply documenting that P&C insurers are less likely to enlarge their "cookie jar" in years of catastrophe. In an untabulated analysis, we find that managers who overestimate (underestimate) the claim loss reserve in the year preceding catastrophe reverse course and are more likely to underestimate (overestimate) in the year of catastrophe. This result, coupled with the findings in Table 3, suggest that managers provide more accurate claim loss reserve estimates in times of uncertainty, and that they do so by "undoing" whatever under- or over-reserving was occurring before the catastrophe.

[13] To further test our conjecture that managers' financial reporting behavior is influenced by the degree of catastrophe-induced uncertainty, we partition the sample into high- and low-exposure subsamples, where the high- (low-) exposure subsample contains observations that have a catastrophe exposure level that is above (below) the sample median value. In an untabulated analysis, we find that the effect of catastrophic exposure on claim loss estimation error is mainly attributable to the high-exposure group. The coefficient on *Exposure* (−4.318) is statistically significant ($t = -2.48$) for the high-exposure group, whereas the same coefficient (0.002) from the low-exposure group is statistically insignificant ($t = 0.00$).

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TABLE 2 Descriptive statistics.

Panel A: Univariate statistics								
Variable	***N***	**Mean**	**Stdev**	**10%**	**25%**	**50%**	**75%**	**90%**
REE	6086	0.709	5.079	0.005	0.015	0.040	0.099	0.297
Exposure	6086	0.093	0.107	0.003	0.023	0.062	0.124	0.232
Public	6086	0.428	0.495	0.000	0.000	0.000	1.000	1.000
Size	6086	12.714	1.805	10.603	11.436	12.549	13.876	15.123
Growth	6086	15.123	39.308	−12.650	−3.030	2.740	9.310	21.660
ROAA	6086	2.713	3.736	−1.230	1.020	2.890	4.710	6.630
Reinsurance	6086	0.440	0.283	0.069	0.179	0.441	0.678	0.841
LagLoss	6086	0.163	0.141	0.039	0.074	0.129	0.212	0.308
LargeLoss	6086	0.013	0.114	0.000	0.000	0.000	0.000	0.000
Analyst	1672	12.834	8.734	1.500	3.317	14.455	21.909	23.833
Inst_holdings	1673	0.727	0.193	0.469	0.639	0.756	0.868	0.908

Panel B: Pearson correlations									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1	*REE*									
2	*Exposure*	−0.048*								
3	*Size*	0.143*	−0.107*							
4	*Growth*	−0.025	−0.011	−0.014						
5	*ROAA*	−0.031	0.153*	0.120*	−0.124*					
6	*Reinsurance*	−0.223*	−0.029	−0.273*	−0.081*	−0.073*				
7	*LagLoss*	0.049*	0.237*	−0.138*	−0.136*	0.117*	−0.287*			
8	*LargeLoss*	0.048*	−0.018	−0.069*	−0.007	−0.292*	−0.039*	0.158*		

(Continues)

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TABLE 2 (Continued)

Panel B: Pearson correlations										
		1	2	3	4	5	6	7	8	9
9	*Analyst*	0.009	−0.158*	0.168*	−0.039	0.140*	0.202*	−0.002	0.049*	
10	*Inst_holdings*	−0.002	−0.013	0.011	−0.046*	0.145*	0.089*	−0.040	−0.033	0.487*

Note: Panel A of Table 2 presents the univariate statistics of the variables, and Panel B presents the Pearson correlations between the variables. *REE* is the absolute value of an insurer's claim loss reserve estimation error; *Exposure* is the measure of an insurer's exposure to catastrophes; *Public* is an indicator variable equal to 1 if the insurer is a publicly traded company and 0 otherwise; *Size* is a firm's net total assets; *Growth* is the annual percentage of growth in net premium written; *ROAA* is return on average assets; *Reinsurance* is the reinsurance ratio; *LagLoss* is claim loss estimation at year $t-1$ and *LargeLoss* is an indicator variable equal to 1 if the firm has a large loss. *Analyst* is the average number of analysts following the insurer and *Inst_holdings* is the percentage of shares outstanding held by institutional stakeholders. More detailed variable definitions are presented in the Appendix.* indicates statistical significance at the 10% level. .

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TABLE 3 The effect of catastrophe exposure on claim loss reserve error.

	REE_t	REE_{t+1}	REE_{t+2}
	(1)	(2)	(3)
Intercept	2.295**	0.181	0.027
	(2.34)	(1.12)	(0.19)
Exposure	**−4.347*** **	**−0.399***	**−0.299**
	(−2.73)	**(−1.86)**	**(−1.25)**
Size	−0.086*	0.010	0.018*
	(−1.66)	(0.97)	(1.86)
Growth	−0.002	0.0002	0.0001
	(−1.07)	(0.46)	(0.32)
ROAA	−0.026	−0.009*	−0.007*
	(−1.43)	(−1.85)	(−1.91)
Reinsurance	−0.319	−0.147*	−0.113*
	(−0.62)	(−1.88)	(−1.74)
LagLoss	0.664	0.098	0.050
	(0.46)	(0.41)	(0.27)
LargeLoss	2.624*	0.119	0.035
	(1.93)	(0.66)	(0.31)
Year fixed effects	YES	YES	YES
R-squared	0.01	0.01	0.01
N	6086	5,278	4,544

Note: This table presents results of the effect of an insurer's catastrophe exposure on the claim loss reserve error at year *t*, *t*+1 and *t*+2, where year *t* is the year of catastrophe. *REE* is the absolute value of an insurer's claim loss reserve estimation error; *Exposure* is the measure of an insurer's exposure to catastrophes. All other variables are defined in the Appendix.***, ** and * indicate statistical significance at the 1%, 5% and 10% two-tailed level, respectively.

While we expect catastrophe exposure to influence claim loss estimation errors in the current year, we also test whether the effect extends beyond year *t*. The purpose behind this analysis is to test our second hypothesis: the effect of catastrophe exposure on reporting quality diminishes over time. To the extent that the association between *Exposure* and *REE* is attributable to the demand for better information quality resulting from a catastrophe, we should observe the association fading in year *t*+1. Consistent with this interpretation, in column 2 of Table 3, we observe that the association between *Exposure* and *REE* remains negative, although it is now significant only at the 0.10 level ($t = -1.86$). The coefficients on both *ROAA* and *Reinsurance* are statistically significant ($t = -1.85$ and -1.88, respectively). The negative associations suggest that both performance and a firm's proclivity to acquire reinsurance are associated with improved claim loss estimation accuracy.

In column 3 of Table 3, we present the results for year *t*+2. To the extent that the association between *Exposure* and *REE* is attributable to a discrete event, we would expect the association to be strongest in year *t*. Consistent with our expectation, we observe that the association between *Exposure* and *REE* is no longer statistically significant at conventional levels in year *t*+2 ($t = -1.25$). As in column 2, *ROAA* and *Reinsurance* are significantly negative at the 0.10 level ($t = -1.91$ and -1.74, respectively).[14]

[14] In an untabulated analysis, we estimate the model in Table 3 for year *t*−1. Similar to the results of year *t*+2, we find that the association between *REE* and *Exposure* is statistically insignificant.

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TABLE 4 The effect of catastrophe exposure and ownership type on claim loss reserve error.

	REE_t
Intercept	2.512**
	(2.42)
Exposure	−3.047*
	(−1.89)
Public	1.134***
	(3.70)
Exposure*×*Public	**−2.912***
	(−1.88)
Size	−0.129**
	(−2.24)
Growth	−0.003
	(−1.27)
ROAA	−0.048**
	(−2.53)
Reinsurance	−0.670
	(−1.23)
LagLoss	0.980
	(0.69)
LargeLoss	2.271*
	(1.72)
Year fixed effects	YES
R-squared	0.02
N	6,086

Note: This table presents the results of the incremental effect of ownership type (i.e., public firms) on the relation between an insurer's catastrophe exposure and the claim loss reserve error. *Public* is an indicator variable equal to 1 if the insurer is a publicly traded company and 0 otherwise; *REE* is the absolute value of an insurer's claim loss reserve estimation error, and *Exposure* is the measure of an insurer's exposure to catastrophes. All other variables are defined in the Appendix.***, ** and * indicate statistical significance at the 1%, 5% and 10% two-tailed level, respectively.

The variable *Size* is significantly negative at time *t*, is not significant at time *t*+1 and is significantly positive at *t*+2. We conjecture that the changes in *t*+1 and *t*+2 may reflect a "fading" over time and a reversing of accruals by *t*+2. While *Reinsurance* and *ROAA* are not statistically significant at time *t*, the effect size is, in fact, larger than at time *t*+1 and *t*+2. We attribute the lack of significance at time *t* to an increase in variation in reporting. By contrast, *LargeLoss*, an indicator variable equal to 1 if an insurer generates a large net loss during the year, has a larger effect size and is positive and statistically significant at time *t*. We observe a similar level of significance in Tables 4–6. We interpret this result as evidence of firms reporting more aggressively in years of otherwise negative news.

We report in Table 4 the test results for our third hypothesis that the demand for better information quality during periods of uncertainty will be stronger among publicly owned firms. To this end, we replicate the model from Table 3 with the addition of an indicator variable for public ownership (*Public*) and an interaction between our variable of interest (*Exposure)* and *Public*. The coefficient for *Public* is significantly positive at the 0.01 level ($t = 3.70$). This result suggests that, overall, public ownership is associated with greater error in the claim loss reserve estimate relative to other ownership types. This evidence is consistent with an interpretation that public ownership incentivizes

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TABLE 5 The effect of catastrophe exposure on claim loss reserve error by ownership type.

Panel A: The effect of catastrophe exposure on loss reserve error among public firms	
	REE_t
Intercept	7.311***
	(3.15)
Exposure	**−9.042*** **
	(−2.86)
Size	−0.320***
	(−2.58)
Growth	−0.006**
	(−2.06)
ROAA	−0.006
	(−0.20)
Reinsurance	−2.082**
	(−2.10)
LagLoss	−1.643
	(−1.05)
LargeLoss	7.611*
	(1.95)
Year fixed effects	YES
R-squared	0.04
N	2,604
Panel B: The effect of catastrophe exposure on loss reserve error among mutual and private firms	
	REE_t
Intercept	0.005***
	(0.01)
Exposure	**−0.334**
	(−0.25)
Size	−0.004
	(−0.10)
Growth	0.002
	(0.71)
ROAA	−0.036
	(−1.47)
Reinsurance	0.239
	(0.43)
LagLoss	2.607
	(1.30)
LargeLoss	0.169
	(0.26)

(Continues)

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TABLE 5 (Continued)

Panel B: The effect of catastrophe exposure on loss reserve error among mutual and private firms	
	REE_t
Year fixed effects	YES
R-squared	0.02
N	3,482
Assessment of Difference in Coefficients	
Test *Exposure* (panel A) = *Exposure* (panel B).	
Chi-squared	6.46**
p-value	0.011

Note: Panel A presents the test results related to H3 using a subsample that contains only publicly traded firms. Panel B presents the test results related to H3 using a subsample that contains only private and mutually owned firms. A test of difference in the coefficients of *Exposure* between the subsamples is reported in Panel B. *REE* is the absolute value of an insurer's claim loss reserve estimation error; *Exposure* is the measure of an insurer's exposure to catastrophes. All other variables are defined in the Appendix.***, ** and * indicate statistical significance at the 1%, 5% and 10% two-tailed level, respectively.

opportunistic reporting (Degeorge et al., 1999), even during a catastrophe. However, as predicted, we observe a significantly negative relation with the interaction of *Exposure* and *Public* ($t = -1.88$). This result provides some evidence consistent with our conjecture that, as P&C firms are exposed to catastrophes, public firms report incrementally higher quality accounting information than nonpublic firms.[15]

We also perform subsample tests related to H3 and present the results in Table 5. In Panel A, we test the relation between catastrophe exposure and claim loss reserve errors using a sample containing only public firms. In Panel B, we investigate the relation using a sample containing only private and mutual P&C firms. The results in Panel A indicate that exposure to catastrophe is negatively associated with claim loss estimation errors based on the variable of interest, *Exposure* ($t = -2.86$). In contrast, we find that the relation between catastrophe exposure and claim loss estimation errors is not statistically distinguishable from zero in the sample of private and mutual P&C firms ($t = -0.25$). Taken together, the results suggest that private and mutual P&C firms do not face information asymmetry and agency problems as acutely as their publicly owned peers during times of high uncertainty, evidence consistent with the preceding main effect results using the full sample. Since we find that the main effect is primarily attributable to public firms, we restrict our sample to publicly owned firms for our remaining tests.

Table 6 presents our test results for H4, which predicts that institutional ownership is likely to be inversely related to the absolute value of claim loss reserve errors among publicly owned firms as uncertainty increases. We employ a subset of our primary sample for which institutional ownership data are available. The resulting subsample contains 1673 observations. Consistent with our hypothesis, we observe a significant negative association with our variable of interest, *Exposure*×*Inst_holdings*, with a coefficient of −1.51 ($t = -2.35$). This evidence suggests that, even among firms whose equity is publicly traded, incentives to report claims losses accurately are incrementally stronger for firms with more sophisticated investors. These results are consistent with our conjecture that the increase in accounting information quality in times of heightened uncertainty is attributable to an increase in stakeholders' demand for better information.

Table 7 depicts our results for H5, which predicts that claim loss reserve errors are likely to be inversely related to the number of analysts following an insurer as the insurer's exposure to catastrophes increases. The test sample contains public firms that have available analyst data from the IBES dataset. We conjecture that analysts are likely to

[15] In untabulated results, we find the sum of the coefficients on *Public* and *Exposure*×*Public* to be statistically insignificant. A statistically significant sum would suggest that catastrophe lowers *REE* of public firms to the point that it is lower than nonpublic firms, an assertion we do not make. Our claim strictly refers to managers' *relative* change in reporting accuracy in response to the catastrophe exposure.

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TABLE 6 The effect of catastrophe exposure and institutional ownership on claim loss reserve error.

	REE_t
Intercept	0.053
	(0.43)
Exposure	0.571
	(1.29)
Inst_holdings	0.124
	(1.25)
Exposure×Inst_holdings	**−1.506****
	(−2.35)
Size	0.016
	(1.51)
Growth	−0.0004***
	(−2.75)
ROAA	0.001
	(0.15)
Reinsurance	−0.318***
	(−5.38)
LagLoss	−0.145
	(−0.85)
LargeLoss	0.631**
	(2.42)
Year fixed effects	YES
R-squared	0.12
N	1,673

Note: This table presents the results of the incremental effect of institutional stakeholders on the relation between an insurer's catastrophe exposure and the claim loss reserve error. The test sample contains only publicly traded insurers. *Inst_holdings* is the percentage of shares outstanding held by institutional stakeholders; *REE* is the absolute value of an insurer's claim loss reserve estimation error and *Exposure* is the measure of an insurer's exposure to catastrophes. All other variables are defined in the Appendix.***, ** and * indicate statistical significance at the 1%, 5% and 10% two-tailed level, respectively.

provide some additional oversight from a capital market perspective and contribute to a perceived or actual incentive to maximize reporting accuracy, particularly in the year of a catastrophe. Consistent with expectations, we find a negative incremental association between analyst following and the absolute value of claim loss reserve errors among public firms as exposure increases. The coefficient on *Exposure×Analyst* is statistically significant at the 0.01 level ($t = -4.07$). This result provides additional evidence consistent with our conjecture that demand for high-quality reporting is highest among insurers closely tied to sophisticated capital market participants.

4.1 | Additional analysis: The effect of managerial ability

Although we hypothesize that the observed improvement in earnings quality during catastrophes is due to stakeholders' demand for more accurate information, we acknowledge that any change in earnings quality could also be partially attributable to differences in managers' ability to produce more accurate accounting information during periods of

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TABLE 7 The Effect of Catastrophe Exposure and Analyst Following on Claim Loss Reserve Error.

	REE_t
Intercept	0.245
	(1.55)
Exposure	−0.354*
	(−1.70)
Analyst	0.006**
	(2.10)
Exposure*×*Analyst	**−0.049*** **
	(−4.07)
Size	0.009
	(0.63)
Growth	−0.0004**
	(−2.26)
ROAA	−0.003
	(−0.77)
Reinsurance	−0.370***
	(−5.64)
LagLoss	−0.111
	(−0.61)
LargeLoss	0.609**
	(2.10)
Year fixed effects	YES
R-squared	0.12
N	1,672

Note: This table presents the results of the incremental effect of financial analysts on the relation between an insurer's catastrophe exposure and the claim loss reserve error. The test sample contains only publicly traded insurers. *Analyst* is the average number of analysts following the insurer; *REE* is the absolute value of an insurer's claim loss reserve estimation error, and *Exposure* is the measure of an insurer's exposure to catastrophes. All other variables are defined in the Appendix.***, ** and * indicate statistical significance at the 1%, 5% and 10% two-tailed level, respectively.

catastrophic losses. We perform cross-sectional analyses to assess the plausibility of this alternative explanation. Consistent with prior studies (e.g., Gallemore and Labro, 2015), we use abnormal compensation (*Comp*) as our first measure of managerial ability. We define abnormal compensation as the difference between a CEO's total compensation (in the natural log) and the average CEO compensation in the sample for a given year. We use managerial experience as a second measure of managerial ability. We use the length of CEO tenure in years to measure managerial experience. We report the additional analysis results in Table 8. Consistent with results in Table 3, the association between exposure and the claim loss reserve estimation error remains negative across the three model specifications. This result provides evidence that reporting quality increases as exposure to a catastrophe increases for all managers, including managers with the least experience and lowest compensation. In column 1 of Table 8, we examine the main effects of both abnormal compensation and experience. Neither is statistically significant ($t = 1.65$, $t = -0.61$). However, in column 2, the interaction of abnormal compensation and *Exposure* is significantly negative ($t = -1.98$). This evidence

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TABLE 8 Additional analysis: The effect of catastrophe exposure and managerial ability on claim loss reserve error.

	(1)	(2)	(3)
Intercept	0.481***	0.473***	0.479***
	(2.99)	(2.95)	(2.86)
Exposure	−0.703***	−0.718***	−0.692**
	(−2.66)	(−2.65)	(−2.55)
Comp	0.028	0.046***	0.028
	(1.65)	(3.02)	(1.63)
Experience	−0.011	−0.012	−0.011
	(−0.61)	(−0.66)	(−0.48)
Exposure*×*Comp		**−0.244****	
		(−1.98)	
Exposure*×*Experience			**−0.006**
			(−0.05)
Size	0.001	0.001	0.001
	(0.02)	(0.07)	(0.03)
Growth	-0.001***	−0.001***	−0.001***
	(−3.03)	(−3.02)	(−3.05)
ROAA	−0.008	−0.008	−0.008
	(−1.40)	(−1.43)	(−1.40)
Reinsurance	−0.438***	−0.436***	−0.439***
	(−5.69)	(−5.71)	(−5.69)
LagLoss	0.107	0.129	0.108
	(0.34)	(0.40)	(0.34)
LargeLoss	0.487	0.472	0.488
	(1.01)	(0.98)	(1.01)
Year fixed effects	YES	YES	YES
R-squared	0.15	0.15	0.15
N	1,365	1,365	1,365

Note: This table presents the results of the effect of executive compensation and experience on the relation between an insurer's catastrophe exposure and the claim loss reserve error. The test sample contains only publicly traded insurers. *REE* is the absolute value of an insurer's claim loss reserve estimation error; *Exposure* is the measure of an insurer's exposure to catastrophes. *Comp* is abnormal executive compensation, calculated as the difference between a firm's CEO total compensation (in natural log) and the average CEO compensation in the sample in a given year; *Experience* represents executive tenure, measured by the number of years of being CEO of the firm. All other variables are defined in the Appendix.***, ** and * indicate statistical significance at the 1%, 5% and 10% two-tailed level, respectively.

suggests that outstanding managers are capable of reporting more accurate claim loss reserve estimates when the appropriate incentives exist.[16]

[16] This result provides inductive evidence that improved financial reporting during periods of uncertainty is a result of effort or skill on the part of managers rather than a fatigue-induced "defaulting" to accurate reporting.

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Conversely, our proxy for managerial experience is not a significant predictor of improved financial reporting in any of our model specifications. Specifically, the interaction between *Exposure* and *Experience* in column 3 indicates the effect is negligible ($t = -0.05$). Moreover, in an untabulated analysis, we use the managerial score (MA_Score) developed in Demerjian et al. (2012) as our final measure of managerial ability. We find MA_Score to be negatively associated with loss claim reserve error (i.e., better managers reporting more accurately). However, the interaction between MA_Score and *Exposure* is not statistically significant ($t = 0.36$),[17] suggesting that managerial ability does not have an incremental effect. Taken together, we interpret the evidence to be mixed. While it has not been our intent to explore how managerial ability affects accounting information quality in times of heightened uncertainty, the results suggest future research in this area may be warranted. We contribute to the literature by providing evidence that the increase in accounting information quality observed in our tests is at least partially due to an increase in the demand for better information.

5 | CONCLUSION

We provide important evidence about the influence of uncertainty on managers' financial reporting decisions. Our setting of P&C insurers in the periods following major catastrophes provides a unique opportunity to examine this association. We argue that a catastrophe introduces additional uncertainty about insurers' future cash flows to the extent that they are exposed to potential losses associated with the catastrophe. This heightened uncertainty is likely to be especially prevalent among external users of financial reports. We employ firms' claim loss estimation errors as our proxy for the quality of accounting information. Our results suggest that the accuracy of reported claim loss reserves improves in times of higher uncertainty.

We propose that the improved forecast accuracy is attributable to a perception among firm managers that investors and other stakeholders desire higher quality financial reporting to help them grapple with the added uncertainty inherent in times of catastrophe. Our cross-sectional tests provide evidence consistent with this conjecture. We find that public ownership—where there is a higher level of information asymmetry between managers and shareholders—is significantly associated with improved reporting accuracy as exposure to potential catastrophe losses increases. We do not find this type of relation in our sample of nonpublic firms—where information asymmetry and the external demand for high-quality financial information are likely lower. In subsequent tests, we predict and find that greater institutional ownership and analyst following are associated with lower (higher) levels of claim loss reserve errors (reporting accuracy) as exposure to catastrophes increases.

We acknowledge that our study is subject to limitations. For example, the sample of firms we use in our cross-sectional analyses may suffer from endogeneity since firms with analyst following are more likely to have institutional shareholders. Moreover, analysts and institutional shareholders may choose to follow and invest in firms with more accurate financial reports. In addition, we require the ability to observe several successive years of data to calculate *REE*, which may result in survivorship bias. Finally, the unique characteristics of the property and casualty insurance industry may limit the generalizability of our results. While we cannot rule out the possibility that our results may be attributable to some alternative explanation, the outcomes of our tests all consistently suggest that managers improve financial reporting quality in times of elevated uncertainty and that this relation is more pronounced for firms with higher levels of information asymmetry and for firms with stakeholders who are likely to demand better information in more uncertain times.

[17] The Demerjian et al. (2012) measure of managerial ability (MA_Score) is limited to public firms only. After requiring nonmissing input variables needed to estimate the scores, the resulting sample has 208 observations.

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ACKNOWLEDGMENTS

We are thankful to the Katie School of Insurance and Risk Management at Illinois State University for financial support. In addition, we are grateful to Bryan Graden, Aaron Nelson and the participants of the BYU Accounting Research Symposium for helpful comments.

DATA AVAILABILITY STATEMENT

Data are available from sources mentioned in the article.

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How to cite this article: Ames, D., Lao, B., Sankara, J., & Wood, J. (2023). The influence of uncertainty on financial reporting behavior: The case of P&C insurers. *Journal of Business Finance & Accounting*, 1–24. https://doi.org/10.1111/jbfa.12745

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APPENDIX A: VARIABLE DEFINITIONS

Variable	Description
REE	*REE* is our calculation of a firm's claim loss reserve estimation error for all lines of business in year *t*. Using a process similar to Petroni (1992), we deduct claim loss and loss adjustment expenses 5 years after the incident year from the claim loss and loss adjustment expenses estimated in the incident year. We use the absolute value of this measure, and this difference is scaled by the total direct premium written. Lower values indicate more accurate reporting and better financial disclosure, whereas higher values indicate worse accounting information quality
Exposure	A firm-year measure of an insurer's exposure to catastrophes following the method in Christensen (2002)
Public	Indicator variable taking the value of 1 if the insurer is a publicly traded company and 0 otherwise. A publicly traded insurer is classified as any company listed in the SNL database with an ultimate parent exchange of NYSE or NASDAQ (Ames et al., 2017)
Size	Natural log of net total assets
Growth	Annual percentage of growth in net premium written
ROAA	Return on average assets at year *t* as reported in the SNL database
Reinsurance	Reinsurance ratio, calculated as reinsurance premiums ceded/(direct premiums written + reinsurance premiums assumed)
LagLoss	Lagged claim loss estimation, calculated as claim loss estimation/net total assets, at year $t-1$
LargeLoss	Indicator variable is equal to 1 if the net loss, scaled by net total assets, in a given year is in the lowest earnings decile among all loss firms
Analyst	Average number of analysts following the insurer
Inst_holdings	Percentage of equity held by institutional stakeholders
Comp	Abnormal executive compensation is calculated as the difference between a firm's CEO total compensation (in natural log) and the average CEO compensation in the sample in a given year
Experience	Executive tenure: the number of years being CEO of the firm

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