Information Asymmetry around Operational Risk Announcements

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Abstract

Operational risk incidences are likely to increase the degree of information asymmetry between firms and investors. We analyze operational risk disclosures by U.S. financial firms during 1995-2009 and their impact on different measures of information asymmetry in the firms' equity markets. Effective spreads and the price impact of trades are shown to increase around the first announcements of such events and to revert after the announcement of their settlement. This is especially pronounced for internal fraud and business practices related events. Market makers respond to higher information risk around the first press cutting date by increasing the quoted depth to accommodate an increase in trading volumes.

The degree of information asymmetry around operational risk events may be influenced by the bank's risk management function and the bank's governance structure. We indeed find that information asymmetry increases more strongly after events' first announcements when firms have weaker governance structures—lower board independence ratios, lower equity incentives of executive directors, and lower levels of institutional ownership. In contrast, the firms' risk management function has little to no impact on information asymmetry. We interpret this as evidence that the risk management function is primarily driven by regulatory compliance needs. The results of this study contribute to our understanding of information asymmetry around operational risk announcements. They help to shed light on the role that regulation and corporate governance can play in order to establish effective disclosure practices and to promote a liquid and transparent securities market.

Keywords: Operational risk, information asymmetry, market liquidity, bid-ask spread, corporate governance, enterprise risk management.

JEL Classification Numbers: D82, G14, G30.

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1 Introduction

We study information asymmetry in the equity market around operational risk announcements in U.S. public financial firms. Better disclosure practices of financial information improve liquidity, provide a monitoring role over the behavior of senior management, and help maintain the trust of stakeholders—shareholders, supervisors, governments, and depositors. Diamond (1985) argued that releasing information makes shareholders better-off by maximizing their welfare. Recent U.S. regulatory initiatives that address disclosure include the Gramm-Leach-Bliley Act (GLBA) of 1999 that broadens the range of permissible banking activities and adds provisions regarding information-sharing, the Health Insurance Portability and Accountability Act (HIPAA) of 1996 that deals with security and privacy of data in the healthcare industry, the Basel II Capital Accord of 2001 that mandates regulatory capital for risks and their market disclosure, the Sarbanes-Oxley Act (SOX) of 2002 that mandates disclosures of internal control weaknesses in compliance with the SEC's disclosure laws,[1] and the Dodd-Frank Act of 2010 that calls for stricter reporting and disclosure requirements in the financial industry, along with a mortgage reform and consumer protection rules.

The Basel Committee on Banking Supervision (BCBS) mandates the measurement and management of operational risk, defined as the risk of loss resulting from inadequate or failed internal processes, people, systems, or from external events. Operational risk may arise from diverse causes, such as unauthorized transactions, business disruptions due to technology and software failures, flawed financial models and products, poor business practices, natural disasters, employment issues and discrimination, and execution and delivery failures. Along with credit, market, and liquidity risks, operational risk has been acknowledged as a major source of material failures in financial firms. Trading errors and excessive risk-taking that led to a $6.2 billion trading fiasco for JPMorgan Chase in 2012 ("London Whale"), Bernard Madoff's $50 billion Ponzi scheme in 2008, a $7.2 billion trading loss at Société Générale in 2008, and the colossal losses from the September 11, 2001 terrorist attacks, are some recent examples. Chernobai, Jorion, and Yu (2011) showed that operational risk events are manifestations of internal control weaknesses and can be traced to improper business practices, weak economy, poor governance, and excessive risk-taking of executives. Wang and Hsu (2013) also found that stronger governance helps reduce occurrence of operational risk in financial firms. Basel II Capital Accord's Pillar III calls for more stringent market discipline and transparency via public disclosures of operational risk:

> "The Committee aims to encourage market discipline by developing a set of disclosure requirements which will allow market participants to assess key pieces of information on the scope of application, capital, risk exposures, risk assessment processes, and hence the capital adequacy of the institution. In principle, banks' disclosures should be consistent with how senior management and the board of directors assess and manage the risks of the bank."
> (BCBS, 2006b, p. 226)

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[1]SOX's relevant sections are Section 302 (Corporate Responsibility for Financial Reports) and Section 404 (Management Assessment of Internal Controls).

To date, much of academic work on operational risk has been focused in the area of Pillar I of the Capital Accord that deals with the quantification of the regulatory risk capital. Recent studies of the equity market reaction to operational risk public announcements (Perry and de Fontnouvelle, 2005; Cummins, Lewis, and Wei, 2006; Gillet, Hübner, and Plunus, 2010) found that such news spur large drops in market prices, in particular for internal fraud events. Cummins, Lewis, and Wei (2006) showed that the cumulative abnormal returns are over 1% for banks and over 3% for insurers, and Gillet, Hübner, and Plunus (2010) found the cumulative abnormal returns to exceed 4%. Motivated by recent regulatory advancements and prior research on operational risk, our question is: if operational risk announcements are informative releases, then do such releases affect information asymmetry between informed and uninformed traders in the equity market, and how?

Information asymmetry arises from differential information between informed and non-informed traders. In classical information asymmetry models (e.g., Copeland and Galai, 1983; Glosten and Milgrom, 1985), informed traders (e.g., large shareholders, financial analysts, creditors, and managers at competing firms) possess superior price-relevant firm-specific information not available to non-informed traders, or can extract private information from public releases. They profit from trading on private information (not yet) available to uninformed traders (e.g., market makers and discretionary liquidity traders). Market makers bear losses incurred due to the informational disadvantage when they make public the prices at which they commit to sell or buy; however, they offset them by imposing a bid-ask spread—wide enough to recoup the losses but tight enough to maintain fair liquidity demand. Hence, bid-ask spreads widen when market makers perceive higher levels of information asymmetry. Market makers may also reduce the quoted depth, thus adversely affecting liquidity.

Information asymmetry has been studied predominantly in the context of corporate earnings announcements. Bessembinder and Kaufman (1997), Stoll (2000), Venkataraman (2001), Chung, Elder, and Kim (2010), Bhattacharya, Desai, and Venkataraman (2012), and Bhattacharya, Ecker, Olsson, and Schipper (2012) found increased levels of information asymmetry around such announcements.[2] Kim and Verrecchia (1994), Lee, Mucklow, and Ready (1993), Krinsky and Lee (1996), and Affleck-Graves, Callahan, and Chipalkatti (2002) showed that market makers act to increased information asymmetry around earnings releases by temporarily widening the bid-ask spread. By doing so, they attempt to protect themselves against informed investors who may be responsible for the high volumes and volatility in trading (Lee, Mucklow, and Ready, 1993; Easley and O'Hara, 1992; Harris and Raviv, 1993).

Earnings announcements are scheduled releases. For scheduled announcements, elevated trading prior to the release is primarily due to informed traders who trade to profit from information leakage, but may also be enhanced by uninformed traders who try to gamble on the upcoming news. In contrast, operational risk announcements are unscheduled and almost always constitute bad surprises to investors. When an event is unscheduled, any excess trading prior to the announcement is accounted for by informed

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[2]Recent studies of corporate earnings restatement announcements (Palmrose, Richardson, and Scholz, 2004; Anderson and Yohn, 2002) also found that information asymmetry is increased around such news releases.

traders. Literature on unscheduled announcements is sparse. Chae (2005) studied information asymmetry around the announcements of acquisition, target, and Moody's bond ratings changes, and Brooks, Patel, and Su (2003) investigated CEO deaths, plane crashes, and plant explosions. These studies found that information asymmetry increases in general, but their data consisted of announcements of many diverse causes without focusing on a single one. Our study differs from these by focusing on a single well-defined class of unscheduled announcements—operational risk events. In addition to studying information asymmetry around the first press cutting of such events, we also study it around the settlement announcements (that are more anticipated).

"*Banks' disclosures should be consistent with how senior management and the board of directors assess and manage the risks of the bank.*" (BCBS, 2006*b*, p. 226) The quality of information disclosed by the management is positively associated with the strength of corporate governance (Klein, 2002; Ajinkya, Bhojraj, and Sengupta, 2005; Karamanou and Vafeas, 2005). Kanagaretnam, Lobo, and Whalen (2007) found that firms with more active and independent boards and with higher insider holdings incur less information asymmetry around quarterly earnings releases. Prior research showed operational risk to be inversely related to the strength of corporate governance (Chernobai, Jorion, and Yu, 2011; Wang and Hsu, 2013). Establishments of operational risk committees and Chief Operational Risk Officer positions should reduce lower-tail risk and also promote better communication of risk to the senior management and key stakeholders. This study examines whether better governance and risk management initiatives improve disclosure quality and reduce information asymmetry around operational risk announcements.

Using a rich sample of 331 operational risk announcements from U.S. financial firms during 1995-2009 and examine their trades and quotes on NYSE, AMEX, and NASDAQ exchanges. We study separately the first press cutting and settlement announcements. We find that information asymmetry—measured by effective spread and price impact of trade (and their changes from the non-event period)—significantly increases around operational risk first announcements but decreases around the settlement announcements, particularly for internal fraud events and events related to flawed business practices. Furthermore, firms with stronger governance (higher board independence ratio, higher equity incentives of insiders, and higher institutional ownership) experience lower levels of information asymmetry around the first announcements, and around settlements better governed firms see a smaller reduction in information asymmetry, but that the effect of risk management initiatives is limited. We interpret this as evidence of the risk management function being primarily driven by the need for regulatory compliance.

To the best of our knowledge, this is the first study that investigates market microstructure around operational risk announcements in financial firms. Identifying the factors affecting information asymmetry around such events may help regulators develop policies that would ensure a transparent and liquid securities market, which would provide investors with greater confidence in their investments. This paper proceeds as follows. Sections 2 and 3 describe our operational risk data and our measures of information asymmetry. Section 4 develops testable research hypotheses. Section 5 describes our research design and variables. Section 6 presents our empirical findings. Section 7 discusses liquidity. Section 8 concludes.

2 Description of Operational Risk Announcements Data

Following Basel II, we categorize operational risk into seven main event types:

1. Internal Fraud: events intended to defraud, misappropriate property, or circumvent regulations or company policy that involve at least one internal party. Examples: unauthorized trading and theft.

2. External Fraud: events intended to defraud, misappropriate property, or circumvent the law performed by an external party. Examples: check kiting and breach of system security.

3. Employment Practices and Workplace Safety: events inconsistent with employment, health, or safety agreements. Examples: losses arising from employee relations, safety of the environment, and diversity and discrimination.

4. Clients, Products, and Business Practices: events due to failures to comply with a professional obligation to clients and improper design of a product. Examples: improper business and market practices, product flaws, and faulty advisory activities.

5. Damage to Physical Assets: events leading to a damage or loss of physical assets either from natural disasters or man-made disasters. Examples: fires, floods, hurricanes, vandalism, and terrorism.

6. Business Disruption and System Failures: events causing disruption of business or system failures. Examples: hardware failures, software bugs, and computer viruses.

7. Execution, Delivery, and Process Management: events due to failed transaction processing or process management occurring from relations with trade counterparties and vendors. Examples: losses from faulty transaction execution and maintenance, customer intake and documentation.

The source of our operational risk announcements data is the Algo Financial Institutions Risk Scenario Trends (Algo FIRST) database, marketed by IBM.[3] FIRST's primary purpose is to assist financial institutions to understand, identify, and manage their operational risk through a comprehensive collection (over 13,000 entries) of operational risk case studies. Nearly three quarters of the recorded events are from financial institutions and more than half are from the U.S. The information is collected from public sources, such as the media, the Securities and Exchange Commission's (SEC) press releases, and court orders. As such, all information is readily available to investors and provides an ideal basis for our research. Details on each announcement include firm name, dates, event type, loss amount, claimant name, geographical location, and a detailed narrative.[4]

For most operational risk events, announcements are made over a period of time, each announcement marking a distinct development of the event. Gillet, Hübner, and Plunus (2010) studied the market reaction around the three timings: (1) the first press cutting date marking the first mentioning of the event, (2) the recognition date when the company announces the event, and (3) the settlement date, on which the settlement occurs. But the first two timings often coincide. Hence, we use two timings

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[3]IBM acquired the FIRST database after its acquisition of Algorithmics, Inc. in October 2011.

[4]The database was previously used in Wang and Hsu (2013), Chernobai, Jorion, and Yu (2011), Gillet, Hübner, and Plunus (2010), Cummins, Lewis, and Wei (2006), Rosenberg and Schuermann (2006), and Perry and de Fontnouvelle (2005).

instead: the first is the first press cutting date and the second is the announcement of settlement. In the cases when the announcement of an upcoming settlement is made prior to the actual settlement date, we use the former date for the settlement date. Whenever the settlement announcement is the first announcement available on a particular event, we retain no date for the first announcement. As such, while for the majority of events in our sample we have both the first announcement and settlement dates, for some of the more recent ones only the first announcement information is available, and for another few we have only the settlements.

We focus on operational risk announcements in publicly traded U.S. financial firms. We further restrict our data to events with losses that are material in nature, in excess of $10 million.[5] Constrained by availability of the governance data, we narrow our sample period to 1995-2009. We then exclude events with unclear first press cutting date and settlement date, with unclear firm name, that are random in nature (those due to terrorism or natural disasters in the category Damage to Physical Assets), with unavailable TAQ data, or with missing market or governance data. We then check the dates for consistency with the LexisNexis and Factiva business news databases. We also excluded one event in firm with stock price under $1 and another event that had less than 5 trades per day. Our final sample contains 331 events. The sample selection procedure is summarized in Table 1.

Figure 1 illustrates the time series of operational risk events' announcements. The frequency increased over the sample period. A pronounced jump is evident around 2002, which coincides with the passage of the Sarbanes-Oxley Act. Another jump occurs around 2008 and is likely a consequence of the financial crisis. Figure 2 illustrates average cumulative abnormal equity returns (CARs) for the event window [-20,+10]. CARs are negative around first announcements and positive around settlement announcements, consistent with earlier empirical findings (Gillet, Hübner, and Plunus, 2010; Cummins, Lewis, and Wei, 2006; Perry and de Fontnouvelle, 2005). CARs are -1.64% over the event window [-3,+3] and -7.83% over the event window [-20,+10] around first announcements. For settlement announcements, these are 1.57% and 5.73%, respectively. These results are statistically significant at 1% level.

Table 2 provides additional description of our data. From Panel A, the majority of the announcements are of Clients, Products, and Business Practices (CPBP) type (57.7% of the first and 68.8% of the settlement announcements), followed by internal fraud (15.8% and 12.8%, respectively) and external fraud (13.3% and 7%, respectively). Only about 30% of the first and 53% of the settlement announcements are self-disclosed; the majority are disclosed by a third party, such as a regulatory authority (e.g., the SEC and the National Association of Securities Dealers (NASD)), shareholder, client, or court, and are not accompanied by a statement by the firms. This is particularly evident for the first announcements in the CPBP category, in which events are typically linked to failed business strategies that firms are reluctant

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[5]For many announcements, the information on the loss amount is absent from the initial announcement but is either estimated later or accumulates over time as a result of fines and payments to third parties. Also, sometimes the initial announcement contains an estimate of loss rather than the exact amount. In such cases, we treat the estimate as an actual loss amount. Our sample contains the events with loss amount known to be in excess of $10 million at the present time (as of 2014), regardless of the actual timing at which the loss amount became known.

to reveal to the public voluntarily; notably, for these events the pattern reverses around settlements. For internal fraud the distribution is fairly uniform, perhaps because firms believe that their disclosure is less detrimental to the firm's public status. The fact that the majority of the first announcements are involuntary in nature alleviates concerns over self-selection bias. Panel A also informs about events that disclose the loss amount. For over half of our events, the loss information is contained in the initial announcement, and for others it is missing (it is often released with a delay by weeks, months, or even years). In contrast, almost all (98%) press releases of settlements include the loss amount. Panel B of Table 2 reports the distribution of events by the two-digit Standard Industry Classification (SIC) code. Roughly one third of events (32.9%) occurred in banks, another third in securities and commodity brokers (33.2%), 23% in insurance, and less than 12% are in non-depository institutions and real estate firms.

3   Measures of Information Asymmetry

Bid-ask spread is commonly decomposed into three components, each reflecting particular costs to the market maker (Copeland and Galai, 1983; Ho and Stoll, 1981, 1983; Glosten and Milgrom, 1985; Glosten, 1987; Glosten and Harris, 1988; Grossman and Miller, 1988; Hasbrouck, 1988; Stoll, 1978, 1989). *Order processing costs* compensate market makers for the time they take to stay able to match buy and sell orders and perform the paperwork involved in the transaction. *Inventory holding costs* compensate market makers for holding less than fully diversified portfolios. *Adverse selection costs* compensate market makers for undertaking the risk of dealing with more informed traders who may possess superior information or who may be able to process information in a faster and cost-efficient manner; this risk is known as *information risk*. The adverse selection component is the one linked to information asymmetry and reflects how market makers act as uninformed traders and estimate their information risk associated with trading alongside informed traders.[6]

Our first measure of information asymmetry is *percentage effective spread* (Lee, 1993; Huang and Stoll, 1996). Quoted bid-ask spread does not necessarily capture trading costs for transactions occurring outside the posted quotes, because an order whose size exceeds the quoted quantity at the best prices may be completed at a price outside the bid-ask spread (Lee, 1993; Huang and Stoll, 1996; and Bhattacharya, Desai, and Venkataraman, 2012). Therefore, effective spread is a better measure of trading costs as it accounts for trades both inside and outside the quotes. Unlike quoted spread, effective spread is estimated using *ex post* trading costs of executed trades. In essence, effective spread calculates the deviation of the execution price from the true underlying value of the security and is computed as:

$$Percentage\ Effective\ Spread\ _{it} = 2 \times D_{it} \times \frac{Price\ _{it} - Midpoint\ _{it}}{Midpoint\ _{it}} \times 100, \qquad (1)$$

where $Price_{it}$ is the transaction price at time t for security i and $Midpoint_{it}$ is the midpoint of the quoted

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[6]Studies using quoted spreads as a measure of information asymmetry include Copeland and Galai (1983), Glosten and Milgrom (1985), Kim and Verrecchia (1994), Krinsky and Lee (1996), and Affleck-Graves, Callahan, and Chipalkatti (2002).

ask and bid prices immediately prior to the transaction. The variable D_{it} is 1 for market buy orders and -1 for sell orders. The multiplication by 2 accounts for the round trip cost of transactions. Following Bhattacharya, Ecker, Olsson, and Schipper (2012), Bhattacharya, Desai, and Venkataraman (2012), Chung, Elder, and Kim (2010), and Bessembinder and Kaufman (1997), for the midpoint we use the midpoint of the last quote immediately prior to the trade. Effective spread can be viewed as an estimate of the execution cost paid by traders and the gross revenue earned by liquidity providers, and captures both the non-informational costs (inventory costs, order processing costs, and possibly market maker rents) and informational (adverse selection) costs of liquidity provision. We use two versions of effective spread. The first one is in the level form as defined in Equation (1), and the second one is the *change in percentage effective spread* as in Bhattacharya, Desai, and Venkataraman (2012) and Affleck-Graves, Callahan, and Chipalkatti (2002), which is the difference between daily average percentage effective spread for each of the days in the event window and the average percentage effective spread during the non-event period. This difference should be positive during periods of heightened information asymmetry.

Our second measure of information asymmetry is *percentage price impact of trade* proposed by Huang and Stoll (1996). It estimates the adverse selection risk perceived by liquidity providers based on the price adjustments observed subsequent to a transaction. For anticipated good (bad) news, the market maker expects the informed traders to submit buy (sell) orders. However, non-informed traders are equally likely to submit buy and sell orders, creating order flow imbalance. For an undervalued security this imbalance will tend to be positive and for an overvalued security negative. Market makers react to such order flow imbalances by widening spreads and adjusting quotes upward following buy orders and downward following sell orders. Hence, these price adjustments capture market makers' assessment of the proportion and the extent of information asymmetry between informed and liquidity traders (Bhattacharya, Desai, and Venkataraman, 2012; Glosten and Milgrom, 1985). The percentage price impact is computed as:

$$Percentage\ Price\ Impact\ of\ Trade\ _{it} = 2 \times D_{it} \times \frac{Price\ _{i,t+\tau} - Midpoint\ _{it}}{Midpoint\ _{it}} \times 100, \qquad (2)$$

where $Price_{i,t+\tau}$ is the first transaction price τ minutes after time t and $Midpoint_{it}$ is the midpoint of the quoted ask and bid prices immediately prior to time t. Literature considers various time horizons to estimate an asset's post-trade economic value—from $\tau = 5$ minutes to $\tau = 30$ minutes. However, Werner (2004) reports that spread measures obtained in large samples are relatively insensitive to the choice of the post-trade benchmark. In our study, we use $\tau = 30$ minutes, which has been the choice in Bhattacharya, Desai, and Venkataraman (2012), Bhattacharya, Ecker, Olsson, and Schipper (2012), Venkataraman (2001), and Bessembinder and Kaufman (1997). In addition to the level form of this variable, as in Bhattacharya, Desai, and Venkataraman (2012), we also use the *change in percentage price impact of trade* which is the difference between percentage price impact of trade for each of the days in the event window and the average percentage price impact of trade during the non-event period.

The effective spread and price impact of trade have been used extensively in recent literature to

quantify information asymmetry: Bessembinder and Kaufman (1997), Stoll (2000), Venkataraman (2001), Chung, Elder, and Kim (2010), Bhattacharya, Desai, and Venkataraman (2012), and Bhattacharya, Ecker, Olsson, and Schipper (2012). Computations of Equations (1) and (2) require categorizing trades as seller- or buyer-initiated. Two algorithms have been proposed. In the first algorithm proposed by Lee and Ready (1991), trades completed at prices above (below) the midpoint price are classified as buy (sell); trades executed at the midpoint are assigned according to the "tick test" where trades at a higher (lower) price relative to the most recent trade are classified as buys (sells). In another algorithm proposed by Ellis, Michaely, and O'Hara (2000), trades executed at the ask (bid) quote are classified as customer buys (sells), and the tick test is used for all other trades. Finucane (2000) showed that although the two algorithms produce very similar results, Lee and Ready's (1991) algorithm slightly outperforms the second algorithm. In this paper, we estimated our models using both algorithms and the results were practically identical. In what follows, all results use Lee and Ready's (1991) algorithm.

4   Hypotheses Development

Higher quality disclosures reduce information asymmetry between market participants—informed and non-informed (liquidity) traders. Kim and Verrecchia (1994) argued that disclosures about firm's fundamentals, such as earnings announcements, stimulate informed judgments among traders. Informed traders are better able to perform a superior assessment of the information and to process public disclosures into private information, than market makers. In anticipation of such announcements, information asymmetry in the market rises as investors increase their search for private information that would allow them to profit once earnings are made public (Bhattacharya, Desai, and Venkataraman, 2012; Bhattacharya, Ecker, Olsson, and Schipper, 2012; Chung, Elder, and Kim, 2010; Stoll, 2000; Fu, Kraft, and Zhang, 2012; Brown, Hillegeist, and Lo, 2009).

Earnings announcements are scheduled. For unscheduled announcements, information asymmetry has been documented to increase as well. Chae (2005) studied abnormal trading volume around unscheduled announcements of acquisition, target, and Moody's bond ratings changes. Brooks, Patel, and Su (2003) studied adverse events such as a CEO death, plane crashes, and plant explosions. Both studies documented an increase in information asymmetry. Operational risk events are similar to these types of events. On the basis of previous empirical research, we hypothesize that operational risk first announcements increase information asymmetry in the equity markets. Furthermore, because such announcements are unanticipated by investors, we expect this increase in information asymmetry to be more pronounced immediately following the announcement.

In turn, operational risk settlement announcements are perceived by investors as positive news (Figure 2B; Gillet, Hübner, and Plunus, 2010) that have been long anticipated. Because news of an achieved resolution agreement brings the event to a closure, we anticipate information asymmetry to decrease around the press release. Furthermore, this decline should be more pronounced immediately following

the announcement. We formulate our first set of hypotheses as follows.

H1a: *Information asymmetry increases around operational risk first announcements, especially immediately after the announcement.*

H1b: *Information asymmetry decreases around operational risk settlement announcements, especially immediately after the announcement.*

We investigate whether the strength of corporate governance helps explain the changes in information asymmetry around operational risk announcements. The quality and quantity of information disclosed by the management is positively associated with the strength of corporate governance (Klein, 2002; Ajinkya, Bhojraj, and Sengupta, 2005; Karamanou and Vafeas, 2005). *"Banks' disclosures should be consistent with how senior management and the board of directors assess and manage the risks of the bank."* (BCBS, 2006b, p. 226) We consider the effects of external and internal governance.

The Basel II Capital Accord requires that senior management and the board of directors play a central role in operational risk management. Specifically, Pillar II mandates regular reporting of operational risk practices to senior management and the board of directors, and regular review of risk management systems and processes by internal and external auditors (BCBS, 2006b, pp. 149-151). Independent board directors balance the power of executive directors sitting on the board and monitor the performance and integrity of the senior management. They motivate the senior management to exert more effort to provide disclosure of higher quality and to improve internal controls thus reducing agency costs between owners and managers (Fama, 1980; Fama and Jensen, 1983; Walsh and Seward, 1990; Beasley, 1996; Beasley, Carcello, Hermanson, and Lapides, 2000; Klein, 2002; Farber, 2005). Therefore, we expect board independence to be negatively associated with information asymmetry around operational risk announcements—both first and settlements.

We examine the role of stock holdings by the firm's board directors. The agency theory theorizes a positive link between managerial ownership and disclosure quality. The extent of managerial ownership helps align the interests of management with those of shareholders (Jensen and Meckling, 1976). We therefore hypothesize that information asymmetry is lower around operational risk announcements for firms with higher levels of managerial stock ownership.[7] We look also at the monitoring role played by blockholders. Because of their wealth being closely linked to the performance and market valuation of the disclosing firm, larger shareholders have stronger incentives to exert monitoring over the integrity and efficiency of management. This alleviates agency conflicts and enhances disclosure quality (Shleifer and Vishny, 1986; Huddart, 1993; Admati, Pfleiderer, and Zechner, 1994; Maug, 1998; Noe, 2002). Therefore,

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[7]Recent empirical work frequently supports another, management entrenchment, theory that suggests a negative association between managerial ownership and disclosure quality. The theory postulates that concentrated managerial ownership could be counter-productive to the firm's long-term value, as management could effectively wield external monitoring. Strong equity incentive might cause management to focus too much on meeting certain stock price targets and maximizing their private benefits, while paying short attention to risk management controls or even reducing disclosure levels (Ruland, Tung, and George, 1990; Gelb, 2000; Eng and Mak, 2003; Nagar, Nanda, and Wysocki, 2003) and may lead to financial misreporting (Burns and Kedia, 2006; Efendi, Srivastava, and Swanson, 2007).

market makers are expected to shrink the adverse selection component of the bid-ask spread for firms with large stakes in stock held by institutional owners.[8]

We proxy for external governance by the strength of shareholder rights. Weaker shareholder rights mean that the firm's management is more isolated from the external market for corporate control. Researchers have found a negative link between the strength of shareholder rights and the incidence of financial misstatements (Baber, Kang, Liang, and Zhu, 2009), reporting of internal control weaknesses (Elbannan, 2009), and operational risk exposure by financial firms (Chernobai, Jorion, and Yu, 2011). The management in firms with weak governance would show more discretion to follow its own agenda and would have diminished incentives to align their interests with those of shareholders. We therefore expect firms with stronger shareholder rights to make greater attempts at providing more credible information to investors, leading to lower information asymmetry around operational risk announcements.[9]

H2: *Information asymmetry is lower around operational risk first and settlement announcements for firms with stronger internal and external governance.*

Strong risk management function in financial firms is necessary in order to correctly identify risks and to prevent excessive risk-taking (Ellul and Yerramilli, 2013; Kashyap, Rajan, and Stein, 2008; Stulz, 2008). By adopting an enterprise risk management (ERM) system, companies attain a more systematic, top-down, approach toward risk management, which includes risk assessment, quantification, financing, and managing, and which in turn improves firm's operational and strategic decisions, leads to more efficient capital allocation, and increases the value of the organization (Grace, Leverty, Phillips, and Shimpi, 2014). Beasley, Pagach, and Warr (2008) and Liebenberg and Hoyt (2003) found that establishing of a Chief Risk Officer (CRO) position signals the adoption of an ERM system and the equity market reacts positively to such news in corporate firms. Hoyt and Liebenberg (2011) and Grace, Leverty, Phillips, and Shimpi (2014) found that ERM adds value to publicly traded insurance firms by increasing the cost and revenue efficiency. Baxter, Bedard, Hoitash, and Yezegel (2013) document increased usefulness and reliability of accounting information for financial firms with higher quality ERM. Since disclosure is a characteristic of a town-down risk management, transparency and quality of information regarding risk and operational efficiency available to market participants should improve. Therefore, we conjecture the

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[8]A counter argument can be made but is not supported by our data. In the financial industry, the principal-agent relationship is not confined to the traditional relationship between managers and shareholders as found for industrial firms. Frequently, managers and large shareholders of financial firms experience more severe agency conflicts with minor shareholders, tax payers, and the society as a whole (Evans and Quigley, 1995; BCBS, 2006a). In the presence of deposit insurance, institutional investors may have incentives to undertake higher risks (Laeven and Levine, 2009; Ellul and Yerramilli, 2013). As a result, they may mitigate the disclosure incentives of managers in order to extract private benefits at the detriment of minor shareholders (Jensen and Meckling, 1976; John, Litov, and Leung, 2008; and Laeven and Levine, 2009), forcing the management to withhold information and dilute public disclosure. They start trading on private information prior to an announcement, thus driving up the trading volume. Market makers observe high trading volume and might suspect undisclosed information to be possessed by blockholders and anticipate higher information risk. As a result, to protect themselves against information risk, market makers may widen the bid-ask spread.

[9]Perry and de Fontnouvelle (2005) found a positive link between shareholder rights and the market reaction to operational risk announcements. They argued that an operational risk in a firm with strong governance constitutes an unanticipated surprise to investors, causing them to react strongly to such an announcement. Consequently, market makers might revise their previous assessment of information risk associated with trading the stocks of such firms.

presence of risk management initiatives to be negatively associated with information asymmetry.

While in corporate firms improvements in risk management are driven by learning from bad experience and past losses, financial firms may have other incentives. In financial services firms risk management practices are significantly more mature than in corporate firms (Beasley, Branson, and Hancock, 2012; Pagach and Warr, 2011). Ellul and Yerramilli (2013) document an across-the-board increase in risk management initiatives in bank holding companies after 1999, and argue that banks frequently appoint risk managers merely to satisfy regulatory compliance, without giving them real power. Minton, Taillard, and Williamson (2014) report that in 2001, 4-5% of all banks have a risk committee and CRO, and by 2007 13% of firms had a risk committee and 19% had the CRO position.[10]

Ellul and Yerramilli (2013) identify two channels through which risk management function may develop in financial firms. In the "business model channel" banks have an aggressive risk culture and choose to take higher risks coupled with weaker risk management functions. Financial firms are in the business of taking risks and they may optimally choose to undertake higher risks while at the same time tightening risk controls in addition to increasing hedging. In the "hedging channel" banks adopt a more aggressive stance on risk management when they experience financial distress. Beasley, Pagach, and Warr (2008) found no significant association between the equity market reaction and appointments of senior risk executives in financial firms. Minton, Taillard, and Williamson (2014) found that bank holding companies with a greater percentage of financial experts among independent directors engage in higher risk-taking activities because they have better understanding of more complex investments. Furthermore, they found that in stable times, the presence of external financial experts on the firm's board is associated with higher risk taking. Baxter, Bedard, Hoitash, and Yezegel (2013) too found no association of ERM quality with equity returns during the financial crisis (September 2008 through February 2009) in US financial services firms. In light of these considerations, we anticipate a dampened effect of risk management on information asymmetry.

We use several proxies for operational risk management: the presence of an Operational Risk Officer and his tenure; the existence of an operational risk committee and the number of years since its establishment; the presence of a Chief Risk Officer and his tenure; the existence of an enterprise-wide risk committee and the number of years since its establishment. Additionally, to capture the effectiveness of the board's risk oversight, we keep track if a firm's Chairman serves on the risk management committee. The above considerations motivate the following hypothesis.

H3: *Information asymmetry is lower around operational risk first and settlement announcements for firms with stronger risk management functions.*

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[10]For comparison, in our sample of firms with operational risk announcements, 55% of firms have an enterprise-wide risk committee and around 45% have a CRO position. These figures are substantial, given that they represent average proportions during the 1995-2009 period. However, our sample is biased toward larger firms and also risk management variable are significantly more prevalent in firms with above-median assets size. In past literature, firm size and business complexity have been shown to be positively associated with adoptions of an ERM system or appointments of a senior risk executive (Minton, Taillard, and Williamson, 2014; Gordon, Loeb, and Tseng, 2009; Hoyt and Liebenberg, 2011).

Operational risk events come from diverse causes, and while some types, such as internal fraud and flawed business practices, are truly idiosyncratic and thus, arguably, more controllable from within the firm, others, such as external fraud, are externally originated (Chernobai, Jorion, and Yu, 2011). One would expect the announcements of internally inflicted events to represent the most significant amount of novel information revealed to the public. Perry and de Fontnouvelle (2005) and Gillet, Hübner, and Plunus (2010) found that internal fraud announcements cause the highest decline in the market value of loss firms.[11] Gillet, Hübner, and Plunus (2010) also document a significant drop in equity values for events of type Clients, Products, and Business Practices. Cummins, Lewis, and Wei (2006) documented material leakage of information prior to operational risk announcements. Informed traders who possess superior knowledge about internal operations are likely to begin trading on such private information in the days leading to the announcement, thus increasing the information gap between informed and non-informed traders. We therefore hypothesize that information asymmetry is increased around operational risk first announcements especially for internal events. At the same time, because firms are more likely to implement controls in place to remediate such events and to make such actions publicly known, we anticipate no to little change in information asymmetry around the settlements. We thus hypothesize:

H4a: *Increase in information asymmetry around operational risk first announcements is higher for internal fraud events and events related to flawed business practices.*

H4b: *Information asymmetry around operational risk settlement announcements is lower for internal fraud events and events related to flawed business practices.*

The information content of an announcement may also shed light on how information asymmetry might change. The first characteristic is the disclosure source. We differentiate between events that are disclosed by the firm itself and events disclosed by a third party, such as a regulator, court, a customer, or a client firm. The benefits of self-disclosure of internal control deficiencies allow the management to "get in front of the issues" (Karr, 2005) and to signal to the market that the firm is free of more serious problems such as material weaknesses or a heightened likelihood of future earnings restatements (Martinek, 2005; Ashbaugh-Skaife, Collins, and Kinney, 2007). The positive message sent to the market serves as an assurance for the investors that the firm holds the quality of its financial information to a high standard. Therefore, one would anticipate a decrease in information asymmetry for self-disclosed events. In contrast, when an event is disclosed only by a third party, this raises red flags regarding potential serious problems with internal controls that the firm's management is trying to withhold. Third-party disclosure may deepen investors' concerns over the stability of the firm's future cash flows. Consequently, information asymmetry around third-party announcements should rise.[12]

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[11] Perry and de Fontnouvelle (2005) found that internal fraud events cause market value drop that roughly 2 times exceeds the loss percentage (i.e., the loss amount divided by the market capitalization). Gillet, Hübner, and Plunus (2010) found that for operational risk announcements, trading volume begins to rise starting around day 4 prior to the press cutting date and the abnormal volume reaches roughly 25% on day -2, almost 50% on day 0, and 68% on day +1.

[12] A counter-argument could be made, but is not supported by our data. Ashbaugh-Skaife, Collins, and Kinney (2007) studied voluntary disclosures of internal control deficiencies prior to SOX and found that the market shows no significance reaction to such announcements. Prior to SOX firms were likely selective in the information that they chose to disclose and

Our second characteristic of an announcement is the information about the material impact that is disclosed. We consider quantifiable impact—the dollar amount of the loss. Gillet, Hübner, and Plunus (2010) found the negative equity market reaction to operational risk announcements to be stronger when the loss amount is unknown. Hirschey, Palmrose, and Scholz (2005) showed that the magnitude of a negative impact can be explained by the degree to which firms attempt to hide the extent of losses. When a loss amount is unknown at the first announcement, investors believe that important information about operational risk is intentionally left undisclosed, and uncertainty regarding the financial consequences for the firm rises. This should translate to greater information asymmetry. We believe this to be of relevance only for the first announcements because nearly all settlements incur a financial charge to the institution (see Table 2, Panel A). The preceding discussion motivates our last hypothesis:

H5: *Information asymmetry is lower around operational risk announcements with greater information content—that are self-disclosed and that contain information on the loss impact. The second effect is relevant only for first announcements.*

5   Research Design

5.1   Variables

We use our two proxies for information asymmetry—effective spread and price impact of trade—in level form (*EFFECTIVE SPREAD* and *PRICE IMPACT*) along with their differences from the non-event period (Δ *EFFECTIVE SPREAD* and Δ *PRICE IMPACT*). The intra-day data on trades and quotes is from the Trade and Quote (TAQ) database. Following convention, we exclude quotes posted on regional exchanges. We use all NYSE, AMEX, and NASDAQ quotes posted between 9:30 AM and 4:00 PM EST for each trading day. As in Bessembinder (1999), we eliminate trades marked as exchange acquisitions or involving nonstandard settlement.[13] We treat potential outliers by removing extreme trades involving price changes between two consecutive trades of over 50%. We also drop all quotes with non-positive ask or bid price, quotes associated with trading halts or designated order imbalances, and quotes that are non-firm.[14] Following convention, our event window spans 7 trading days, starting 3 trading days prior and ending three trading days after each announcement. As in Bhattacharya, Desai, and Venkataraman (2012), our non-event period spans the two weeks (10 trading days) commencing four calendar weeks prior to the announcement date and is used as a benchmark in constructing the Δ-form variables.[15]

We use four variables related to corporate governance. We proxy for stronger boards using board independence (*BOARD INDEPENDENCE*), computed as the ratio of fully independent directors on the

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voluntarily disclosed only what they believed to have no long-term impact on the firm. Hence, self-disclosed operational risk announcements may actually deepen investors' concern that there is more in stock to what has been revealed.

[13]TAQ database Sale Condition codes A, D, D, N, O, R, and Z.

[14]TAQ database Quote Condition codes 4, 7, 9, 11, 13, 14, 15, 19, 20, 27, and 28.

[15]Earlier studies have considered a non-event period of two trading days starting four weeks prior to the announcement date. An advantage of using a wider window is strengthening the validity of our benchmark quotes and trades. We tried using a two-day period for the non-event period but the results were weaker than using 10 trading days.

board. We measure equity incentives of board directors by their ownership of company's shares (*INSIDER OWNERSHIP*), computed as the ratio of common shares owned by the insiders to all common shares outstanding. Because this variable is severely right-skewed, we winsorize it at 95%. We also proxy for the effects of ownership concentration by the fraction of common shares owned by outside blockholders (*BLOCK OWNERSHIP*) holding over 5% of firm's shares. Data on institutional ownership were collected from the Blockholders database for 1996-2001 and for the period 2001-2009 hand-collected from proxy statements. Gompers, Ishii, and Metrick (2003) governance index (*GINDEX*) is the number of anti-takeover charter provisions and laws, ranging from 0 to 24. Higher index values mean better insulation from the market for corporate control, and thus weaker shareholder rights. The data are from RiskMetrics.

The nine risk management variables were hand-collected from 10-K and proxy filings. Five are dummy variables—*OPRISK OFFICER*, *OPRISK COMMITTEE*, *CHIEF RISK OFFICER*, *RISK COMMITTEE*, and *CHAIR ON RC*. The other four are the number of years each risk management function has been in place—*OPRISK OFFICER YEARS*, *OPRISK COMMITTEE YEARS*, *CHIEF RISK OFFICER YEARS*, and *RISK COMMITTEE YEARS*. Table 7 provides further details on the risk positions and committees in our sample. Similarly to Ellul and Yerramilli (2013), we construct *RISK MANAGEMENT SCORE* by taking the first principal component of our nine risk management variables. Principal component analysis performs a singular value decomposition of the correlation matrix of the nine variables. We extracted the single factor that is the eigenvector in the decomposition with the highest eigenvalue. By constructing a risk management score in this way, the risk series that move more together are given more weight in the overall score, eliminating the need to subjectively judge on the relative importance of each risk factor. Higher values of the score suggest better ERM.[16]

We use several variables related to announcements characteristics. The first two are a dummy variable for self-disclosed events (*DISCLOSED BY FIRM*) and a dummy variable that flags whether the operational loss amount was revealed on the press cutting date (*LOSS ANNOUNCED*). We also distinguish between event types using Basel-defined event type classification described in Section 2. As explained earlier, we exclude all announcements related to Damage to Physical Assets due to their random nature. We include three dummy variables to capture the effects of internal fraud (*INTERNAL FRAUD*), events of type Clients, Products, and Business Practices (*CLIENTS, PRODUCTS, & BUSINESS PRACTICES*), and external fraud (*EXTERNAL FRAUD*), and hold all other events as a reference group.

Our models include several control variables. *NUMBER OF ANALYSTS* is the number of analysts following the firm in the latest earnings per share forecast, collected from Thomson Reuters' Institutional Brokers' Estimate System (I/B/E/S) database. For firms with lower analyst coverage, information is transmitted more slowly across the investing public (Hong, Lim, and Stein, 2000) and investors are less certain about the firm's future performance (Lang and Lundholm, 1996; Abarbanell, Lanen, and

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[16]Baxter, Bedard, Hoitash, and Yezegel (2013) use a different, analyst-based, measure of overall ERM quality. They use S&P ERM quality rating that is based on S&P analysts' evaluations (weak, adequate, strong, or excellent) of a financial firm's ERM, gathered from the 404 ERM disclosures in the S&P Ratings Direct database. The data covers selected firms among banks and insurance companies.

Verrecchia, 1995; Barron, Kim, Lim, and Stevens, 1998). Hence, market makers might anticipate higher information risk around operational risk announcements for firms with lower analyst coverage. In support of this view, Atiase and Bamber (1994) and Kanagaretnam, Lobo, and Whalen (2005) document higher abnormal bid-ask spread around corporate earnings announcements for firms that are less widely followed.

Drawing from past research on information asymmetry, we include firm size (*FIRM SIZE*) as a control, computed as the natural logarithm of a firm's total assets at the end of the previous quarter. Firms' total assets were extracted from Compustat. We also control for leverage (*LEVERAGE*). Empirical studies suggest that there may be an increase in volatility in the stock market prior to an earnings announcement because of speculative trades. As we discussed earlier, for operational risk announcements, any jump in volatility should suggest trades by informed investors trying to profit from private information. We thus include the variable *VOLATILITY* measured as the standard deviation of daily equity returns during the year ending one month prior to the announcement. We expect a positive coefficient because greater riskiness is translated into greater uncertainty regarding the future of the firm that may be known only to informed traders. While *VOLATILITY* captures idiosyncratic risk of the firm, we also include a measure of systematic risk, *BETA*, that is estimated as the beta factor estimated from single-factor CAPM model; we use 255 days of daily equity returns and the value-weighted market index. Market data are obtained from the University of Chicago's Center for Research in Security Prices (CRSP).

We control for stock performance using *PRICE* which is the trading price on the previous trading day for each day in the event window. We believe that market makers anticipate larger discrepancy in opinions between informed and liquidity traders for announcements that bring bigger surprises to the market, i.e., those accompanied by the greater drops in equity values. Easley and O'Hara (1992) showed that market makers widen the spreads in response to unusually high trading volumes. We thus include the logarithm of the trading volume (*VOLUME*) on the previous trading day for each event day as a control. The logarithm of the number of common shares outstanding (*NUMBER OF SHARES*) is used as an additional control variable in our model for liquidity determination.

Another control variable is *DECIMAL* that equals 1 for all events after January 29, 2001 and 0 otherwise. On this date, NYSE and AMEX moved from fractional pricing to decimal pricing, and NASDAQ mirrored the change on April 9, 2001. Bessembinder (2003) found that the reductions in tick size have led to a significant narrowing in spreads; in particular, trades executed outside the quotes saw the largest improvements in executions costs, thus making effective spread an event more efficient measure of information asymmetry than quoted spread.[17] We also include dummy variables to distinguish between banks (*BANKS*) and insurance firms (*INSURERS*) from other financial firms, to account for possible industry differences in information asymmetry. In one of our robustness checks, we also include year fixed effects. Variables' description and data sources are summarized in Appendix.

[17]Bhattacharya, Desai, and Venkataraman (2012) eliminated all earnings announcements in 2001 to avoid problems due to having announcement and non-announcement periods in different tick size regimes. None of the events in our sample had event window and non-event period belong to the two different tick size regimes.

5.2 Econometric Framework

Our data are organized as a balanced cross-sectional time-series panel. Each panel represents an individual event spanning seven trading days. Such research design was used in Lee, Mucklow, and Ready (1993), Libby, Mathieu, and Robb (2002), Verrecchia and Weber (2006), Werner (2004), Kanagaretnam, Lobo, and Whalen (2005, 2007), and Yohn (1998).[18] The dependent variable is a measure of information asymmetry—effective spread or price impact of trade—and the independent variables consist of firm-specific governance and risk management covariates, event-specific announcement characteristics, and control variables. For each firm-event i and trading day t of the event window, we estimate the following Ordinary Least Squares (OLS) regression model separately for the first and settlement announcements:

$$(\Delta) \ \textit{Information Asymmetry}_{it} = \alpha + \sum_{j=1}^{J} \gamma_j \textit{Governance}_{it,j} + \sum_{r=1}^{R} \psi_r \textit{Risk Management}_{it,r}$$

$$+ \sum_{k=1}^{K} \beta_k \textit{Announcement Charactistics}_{it,k} + \sum_{m=1}^{M} \theta_m \textit{Control Variables}_{it,m} + \varepsilon_{it}, \qquad (3)$$

where on the left hand side *Information Asymmetry* is *EFFECTIVE SPREAD* or *PRICE IMPACT* in level or change (Δ) form. On the right hand side, term α is the intercept, term *Governance* is the set of governance variables (*BOARD INDEPENDENCE, INSIDER OWNERSHIP, BLOCK OWNER-SHIP,* and *GINDEX*), term *Risk Management* is either the *RISK MANAGEMENT SCORE* or the set of individual risk management variables (described in Section 5.1), term *Announcement Characteristics* is the set of variables related to announcement characteristics (*DISCLOSED BY FIRM*, *LOSS AN-NOUNCED, INTERNAL FRAUD, EXTERNAL FRAUD*, and *CLIENTS, PRODUCTS, & BUSINESS PRACTICES*), term *Control Variables* is comprised of control variables (*NUMBER OF ANALYSTS FIRM SIZE, VOLATILITY, LEVERAGE, BETA,* (Δ)*PRICE,* (Δ)*VOLUME,* and dummy variables *DECIMAL, BANKS,* and *INSURERS*), and the term ε is the residual term. We account for potential heteroscedasticity by using heteroscedasticity-robust standard errors.

We estimate Equation (3) using announcement period [-3,+3][19] but later differentiate between pre- and post-announcement periods by estimating the models for [-3,-1] and [0,+3] separately (Lee, Mucklow, and Ready, 1993; Libby, Mathieu, and Robb, 2002; Werner, 2004; Yohn, 1998). In the pre-announcement periods, information asymmetry measures the speed with which traders process the private information that may have leaked prior to each operational risk announcement. In the post-announcement periods, they capture the efficiency with which traders process the private information that has been disclosed. Over the full announcement period, information asymmetry reflects the net effect of the two.

[18]Other papers such as Affleck-Graves, Callahan, and Chipalkatti (2002), Chae (2005), Eleswarapu, Thompson, and Venkataraman (2004), and Krinsky and Lee (1996) used a cross-sectional research design with one observation per event.

[19]In a robustness check omitted for brevity we tried [-1,+1] but obtained qualitatively similar results.

6 Empirical Results

6.1 Univariate Results

Figure 3 illustrates effective spread and price impact of trade in the window surrounding the first and settlement announcement dates. Left column presents these variables in their level form, and right column presents their changes from the non-event period. Information asymmetry in the level form is positive on the interval, as expected, with a notable spike at day 0 with only a slow downward trend after the announcement for first announcements; for settlements, the highest levels of information asymmetry are on day -3. These patterns are more pronounced for price impact of trade and for the abnormal changes in the two variables. This is consistent with the view that effective spread is a noisier measure of the adverse selection component of information asymmetry, than price impact of trade.

We also distinguish between three versions of post-trade benchmark τ in the computation of price impact of trade (see Equation (2))—$\tau = 30$, 15, and 5 minutes—depicted in Figures 3e and 3f. Around first announcements, the level of price impact is the highest immediately after a trade ($\tau = 5$ minutes), while for the change in price impact of trade the highest value is for $\tau = 30$ minutes. A 30 minute horizon includes revisions of quotes after a longer interval of time and is likely to better capture the market makers' full adjustment of their quotes in response to abnormal sell or buy order flow. The 30 minutes horizon has been a common choice in literature (e.g., Bhattacharya, Desai, and Venkataraman, 2012; Bhattacharya, Ecker, Olsson, and Schipper, 2012; Venkataraman, 2001; and Bessembinder and Kaufman, 1997).[20] All our subsequent empirical results will focus on the 30 minute interval.

Table 3 summarizes sample descriptive statistics of our explanatory variables. The average and median G-Index values are 9, the average ratio of independent board members is 72.3% around first announcements (and is 74.4% around settlements) which is similar to the median value, just under 5% of firm shares are held by insiders and roughly 7% by institutional stockholders on average. A typical firm in our sample has 17 to 18 analysts following. An average firm size is $228.7bln ($exp(12.34)$) suggesting that our sample is biased toward large firms perhaps because larger firms are more under the media radar. We do not see any notable skewness in our variables, and quantile-quantile plots revealed only a slight deviation from normality for most of our variables, thus mitigating concerns that our empirical findings may be driven by outliers in the data.

Table 4 reports on the average effective spread and price impact of trade for different types of events and two sub-periods, pre-announcement [-3,-1] and post-announcement [0,+3], in level form (Panel A) and in abnormal change form (Panel B), along with mean difference tests for different sub-samples according to our key explanatory variables' median values (Panel C). The results in Panel A reveal interesting patterns of information asymmetry around the announcements. As expected, information asymmetry (in level form) is statistically significant (at 1% level) in all instances. The level of information asymmetry tends to increase in the second sub-period around first announcements, while the opposite is observed

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[20]Huang and Stoll (1996) report that results are robust to the choice of horizon from 5 minutes to 30 minutes.

around the settlement announcements. These results are supported in Panel B that shows the changes in information asymmetry from the non-event period. We also note a striking difference in the levels of information asymmetry by event type. Across all cases, the level of information asymmetry is the highest around the first announcements of Clients, Products, and Business Practices events and second or third highest for internal fraud events. For the same events, there is a significant drop in price impact of trade from non-event period around the settlements for the former type of events, and no notable drop for the latter type perhaps because financial firms take serious measures to remediate their business practices after announcements of such failures and make their actions public, leaving little information that is available only to the informed traders. All in all, our results lend preliminary support to our hypotheses *H1a*, *H1b*, and *H4* that predicted an increase in information asymmetry around first announcements and a decrease around settlement announcements, especially for internally originated events.

Panel C of Table 4 provides preliminary insight into the associations between information asymmetry, governance and risk management, and event characteristics beyond event type, as per our hypotheses *H2*, *H3*, and *H5*. With regard to the strength of internal and external governance, the univariate results are mixed. For the level-form information asymmetry measures, the results for the first announcements consistent with our predictions are for *GINDEX*, *DISCLOSED BY FIRM*, and *LOSS ANNOUNCED*. For the information asymmetry measures in δ-form, the only expected result is for *BOARD INDEPENDENCE*. As for the settlement announcements, because information asymmetry drops around settlement announcements (as was seen in Panel B of Table 4 and Figure 3), we expect firms with high ratios of board independence and insider ownership, high risk management scores, and events with loss amount disclosed in the settlement announcement to be associated with *smaller* drops in information asymmetry; Table 4 Panel C supports the aforementioned expectations only for the level form information asymmetry measures. All in all, this table partially supports our hypotheses.

We also examined Pearson's pairwise correlations between our variables; full table with results is omitted for brevity. Insider ownership appears to be strongly negatively associated (-0.33) with board independence (perhaps because firms with low independence ratios compensate for the weak internal governance by equity incentives for the executives), with number of analysts (-0.28), and with firm size (-0.33). Firm size is also strongly positively correlated with the number of analysts following (0.36) because larger firms tend to be followed by a greater number of analysts. Firm size is positively correlated with the risk management score (0.49), which is expected based on our earlier discussion in Section 4. Apart from these, we do not see much problems with multicollinearity amongst our explanatory variables. Additionally, the Variance Inflation Factors (VIF) in our subsequent econometric models range from 1.03 to 3.48 per variable with an average VIF per model between 1.89 and 2.23 that are well within acceptable ranges (under 10), eliminating concerns over multicollinearity.

We must caution against overinterpreting the above results because they are univariate in nature and do not control for the impact of other important variables in our model. In what follows, we proceed to the multivariate analysis of information asymmetry around operational risk announcements.

6.2 Multivariate Results

The results of our models (Equation (2)) are presented in Table 5. For each measure of information asymmetry—effective spread and price impact of trade—we use two versions of the dependent variable, in its level and change form. As such, we have four models for the first announcements and four models for the settlement announcements. The reported results use event window $t = [-3, +3]$.

With regard to internal and external governance, our findings support hypothesis *H2*. For the first announcements, the coefficient of *BOARD INDEPENDENCE* is negative and significant at 1% level for all four model specifications. To better see the economic significance of the result, an increase in this variable from its first quartile to its third quartile (63.64% and 82.35%, respectively, from Table 3) results in a predicted decrease in effective spread by 0.40% (18.72%×0.0212) and a decrease in Δ -effective spread from non-event period by 0.43%. Similarly, *ceteris paribus*, an increase in *INSIDER OWNERSHIP* from its first to its third quartile results in a predicted decrease in price impact of trade by 0.41% and a decrease in Δ -price impact of trade by 0.17%. With regard to institutional ownership concentration, *BLOCK OWNERSHIP* enters our models with expected negative sign. All else equal, an increase in *BLOCK OWNERSHIP* from its first to its third quartile is predicted to increase price impact by 0.99%, a result statistically significant at the 1% level. *GINDEX* has a predicted positive coefficient (an exception is in $\Delta PRICE\ IMPACT$ equation where the coefficient is negative but insignificant), but which is significant only in the level regressions. For an increase in G-Index from its first to its third quartile, a *ceteris paribus* predicted increase in effective spread is 0.41% and in price impact of trade is 1.39%. These predicted effects are per single transaction and are economically significant when extrapolated over several trading days. Around the settlement announcements, the signs of the coefficients of these variables are reversed (with only two exceptions), as predicted by our hypothesis *H2*. This suggests that, overall, the reduction in information asymmetry is smaller for better governed firms.

With respect to risk management, we are unable to see that information asymmetry is lower around first announcements of operational risk events in firms with more established risk management systems. This is consistent with our discussion leading to hypothesis *H3* and suggests that risk management initiatives in financial firms are undertaken largely to meet regulatory requirements without carrying significant power, and their impact on the information disclosure quality is limited. The result is also consistent with Ellul and Yerramilli's (2013) "business model channel" for the development of risk management systems in financial firms. According to this channel, financial firms may optimally choose to undertake high risks while strengthening risk controls at the same time, a conjecture supported by past literature. As high business risks are associated with greater uncertainty in the equity markets, this should also widen information asymmetry between the informed and noninformed traders. For the settlement announcements, the coefficient of *RISK MANAGEMENT SCORE* is positive and significant (as we expected) for Model (8) (Δ price impact of trade equation) and is negative and mildly significant in the other three model specifications, suggesting that transparency is higher for firms with more established risk management practices around the settlements.

We find some evidence that, around first announcements, events due to internal fraud of flawed business practices are associated with greater levels and increases in information asymmetry. This results holds primarily in Models (3) and (4) (i.e., level and Δ-price impact of trade equations), supporting our hypothesis $H4a$. Our findings also indicate that around the settlement announcements information asymmetry drops for these events by a lesser extent than for other types of events, as we predicted in hypothesis $H4b$. This is especially pronounced for events related to business practices.

The variable *DISCLOSED BY FIRM* has the predicted negative, although insignificant, sign for the first announcements only in Models (3) and (4). Evidently, both firms and investors benefit from such announcements being informative. Around settlement announcements, the coefficient is predicted positive and significant in three out of four models. We do not find strong evidence that when the loss amount is contained in the initial announcement it reduces information asymmetry. However, as is evident from Models (5)-(7), in anticipation of a settlement announcement, there is a smaller reduction in information asymmetry around settlement announcements if the loss amount is disclosed than when it is not disclosed, as expected. In sum, our results lend support to our hypothesis $H5$.

As for our control variables, the findings are mixed. *FIRM SIZE*, *VOLATILITY*, *LEVERAGE*, *BETA*, and $(\Delta)PRICE$ enter most of our models with expected signs and statistically significant coefficients. We also find some evidence that around first announcements, information asymmetry is greater in insurance firms than in banks or other financial firms. We also find that decimalization has a surprisingly positive effect on information asymmetry. One possible explanation to this result is that post-decimalization period (2001-2009) in our sample overlaps with two periods of economic downturns—early 2000s and the credit crisis of 2008-2009. Since markets tend to exhibit greater volatility during economic recessions, it is likely that firms are more inclined to withhold private (negative) information from the public, thus widening the information gap between informed and non-informed traders. In a later section, we will perform a robustness check in which we exclude the problematic period post-August 2008. Interestingly, *NUMBER OF ANALYSTS* enters our regressions in Models (1)-(4) with an unexpected positive sign, which is statistically significant in three of the four models. Eleswarapu, Thompson, and Venkataraman (2004) note that companies may provide material information to analysts as a reward for obtaining favorable ratings and recommendations, who in return pass this information to large clients. Such selective disclosure leads to trading advantages of informed traders and can therefore contribute to the asymmetric information costs faced by non-informed traders.

We briefly comment on the goodness of fit. R^2 ranges from 14% to 30% in level regressions and from 4% to 8% in Δ-regressions. In market microstructure papers, it is not uncommon to see low R^2 values. For example, in Bhattacharya, Desai, and Venkataraman (2012) R^2 is only around one to two percent. Similarly, in Kanagaretnam, Lobo, and Whalen (2007), R^2 is under 5%. We also compare our models using AIC and BIC criteria.[21] The preferred model is the one with lower AIC and BIC values. The

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[21]Akaike Information Criterion (AIC) is computed as $AIC = 2k - 2ln(L)$ where k is the number of parameters estimated and L is the likelihood value. AIC rewards goodness of fit and applies penalty for overfitting. Bayesian Information Criterion

values of AIC and BIC coefficients generally drop when the dependent variables are taken in their change form, suggesting a better model. Also, although R^2 values are higher for level regressions, AIC and BIC values for the same models tend to be lower than for their counterparts in the Δ-regressions.

In Table 6, we estimate our econometric models from Table 5 separately for two sub-periods of the event window: the pre-announcement period [-3,-1] and the post-announcement period [0,+3]. As predicted in our hypotheses, the governance effects on information asymmetry have higher absolute values of the coefficients and are also more statistically significant in the post-announcement period, with the exception of G-Index. A similar pattern is evident with regard to announcement characteristics. All in all, our earlier results from Table 5 appear magnified for the post-announcement period for the first announcements, suggesting that not only does information asymmetry increase immediately following the announcement, but that this increase is also more strongly determined by the strength of governance and other variables. Likewise, for the settlement announcements, we observe from Panel B of Table 6 that the reduction in information asymmetry is moderated by stronger governance and higher information content of the press releases during the post-announcement period.

We note that our results in Tables 5 and 6 frequently varied depending on whether the dependent variable is taken in the level or difference form. When information asymmetry is taken in the level form, the coefficient may capture contemporaneous effects of the governance and other variables on the overall level of information asymmetry in the markets, and may not necessarily reflect their impact on information asymmetry around operational risk announcements. In this sense, when the dependent variable is in difference form (i.e., all even-numbered models in Table 5 and Models (3), (4), (7), and (8) in Table 6), we are better able to delineate the effects of our explanatory variables on the changes in information asymmetry around first and settlement announcements of operational risk events. In subsequent discussions we will focus on information asymmetry in its change form.

6.3   Risk Management and Information Asymmetry

In our previous models we used an aggregate risk management score variable for the effectiveness of the overall risk management system in a financial firm. In this section, we take a closer look at the individual components of operational risk management programs and enterprise-wide risk management system. To do so, we include in our models all of the nine risk management variables to examine the individual impact of each of them on the change in information asymmetry around operational risk announcements. We begin with describing in greater detail our risk management data.

Figure 4 illustrates the time series behavior of our firms' adoptions of various risk management initiatives. It was not until 1999 that the first firm in our sample established an Operational Risk Committee and not until 2003 that the first firm appointed an Operational Risk Officer. As is summarized in Table 7, less than 8% of our firms have an Operational Risk Officer position established at the time of an operational risk first announcement, and this proportion increased by only around 3% by the time

(BIC) is computed as $BIC = k\ ln(n) - 2ln(L)$ and accounts also for the sample size n.

of settlement. Less than a quarter of firms have an Operational Risk Committee in place around the first announcement, and this proportion increased by 10% by the time of settlement. With regards to firm-wide risk committees and CROs, such initiatives began sooner. On the one hand, nearly half of our firms have the CRO position or a risk committee. On the other hand, other firms were slow with implementing similar risk management practices, as the proportions of firms with the CRO position or a risk committee remained practically unchanged by the time of settlement. These descriptive statistics echo Ellul and Yerramilli (2013) that document that even though there was an across-the-board increase in risk management initiatives after 1999, bank holding companies with high tail risk prior to 1999 did not experience greater increases in such initiatives than the bank holding companies with low tail risk.

Table 8 presents our multivariate results. Models (1) and (5) are replica of Models (4) and (8) from Table 5, respectively. We add three new model specifications. In Models (2) and (6) we include variables related to operational risk management: *OPRISK OFFICER*, the interaction term *OPRISK OFFICER*OPRISK OFFICER YEARS*, *OPRISK COMMITTEE*, and *OPRISK COMMITTEE*OPRISK COMMITTEE YEARS*. In Models (3) and (7) we include variables related to enterprise-wide risk management: *CHIEF RISK OFFICER*, the interaction term *CHIEF RISK OFFICER*CHIEF RISK OFFICER YEARS*, *RISK COMMITTEE*, *RISK COMMITTEE*RISK COMMITTEE YEARS*, and *RISK COMMITTEE*CHAIR ON RISK COMMITTEE*.[22] Finally, in Models (4) and (8) we combine all risk management variables in one model.

Two results stand out. First, even after decomposing risk management score, we are unable to find strong evidence that better risk management helps reduce information asymmetry around operational risk first announcements. The results are more in line with our hypothesis around settlement announcements. Second, only the coefficients of senior risk officers (*OPRISK OFFICER* and *CHIEF RISK OFFICER*) enter our models consistently with expected signs—negative in the first announcement regressions and positive in the settlement regressions. There appears to be no consistent pattern for the interaction variables and risk committees-related variables. One possible explanation is that when firms hire a senior risk officer, they bring an expert with a great amount of technical expertise (Liebenberg and Hoyt, 2003; Thiessen, Hoyt, and Merkley, 2001) and a person who is frequently an outsider,[23] that results in a shift in the risk culture within the firm. Senior risk officers are held accountable for ERM of the firm, report directly to the CEO or CFO, and are responsible for communicating the firm's risk profile to external stakeholders. In contrast, risk-related committees typically constitute appointees from already existing board members, and so the risk management (and governance) leadership within the firm is effectively unchanged. Therefore, while senior risk officers oversee the risk identification and assessment process more effectively, establishments of risk committees seem little more than regulatory compliance.

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[22]We did not include an interaction term between operational risk committee and Chairman serving on the committee, because in none of the firms in our sample was the Chairman serving on the committee.

[23]Thiessen, Hoyt, and Merkley (2001) report, based on a 2001 survey, that one third of all CROs were hired from outside of the organization. According to the survey, CROs identify operational risk management as one of their key responsibilities.

6.4   Robustness Checks

In this section, we will test the robustness of our models using a series of robustness checks. Table 9 presents the results. Panel A summarizes the results for the first announcements and Panel B for the settlement announcements. In both panels the dependent variable is the abnormal change in price impact of trade. We use price impact of trade rather than effective spread because it is a less noisy measure of the adverse selection component of information asymmetry.

First, we previously used cross-section time-series panel models. Because many of our explanatory variables remain constant over the event window, there may be insufficient time-series variation in our explanatory variables overall. To address this concern, in our first robustness check (RC1) we use cross-sectional average values of information asymmetry over the event window as our dependent variable. In particular, for each event announcement, we use only one observation. The dependent variable is the average measure of information asymmetry per transaction over the event window [-3,+3], and the two explanatory control variables that varied on a daily basis in our earlier specification (*PRICE* and *VOLUME*) are similarly defined. Such research design was adopted in Eleswarapu, Thompson, and Venkataraman (2004), Bhattacharya, Desai, and Venkataraman (2012), Krinsky and Lee (1996), Affleck-Graves, Callahan, and Chipalkatti (2002), and Chae (2005). For the first announcements (Panel A), the number of observations drops to 188 from 1,316 and for the settlements (Panel B) it drops to 288 from 2,014. The magnitudes of the coefficients are qualitatively unchanged, but the significance dropped for some variables. R^2 increased by about 11% in Panel A and 2% in Panel B.

Second, Bessembinder (2003) showed that firms on NYSE and NASDAQ exchanges experienced significant declines in tick size due to decimalization in 2001. In our original models we included a dummy variable *DECIMAL* to account for changes in information asymmetry due to decimalization but found an unexpected positive association. One plausible explanation is that the dummy variable overlaps with two economic recession periods in the U.S. since 2001: April 2001-November 2001 and January 2008-June 2009.[24] While the former one was short, the latter one was more prolonged and more severe. Prior research has shown that stock returns become more volatile during recessions reflecting greater uncertainty in the markets. As a result, information asymmetry may experience an overall increase in the post-2001 era, which may explain our earlier results. In this robustness check we exclude the problematic post-credit crisis period starting August 2008, following earlier studies. Model (RC2) in Table 9 reports the results for this robustness check. The results resemble closely our original findings but are strengthened as is seen from the increased magnitudes of most coefficients. *R*-squared also improved slightly.

Third, we examine separately fraud events (RC3), events of type Clients, Products, & Business Practices (RC4), and all other events (RC5). As is seen from Panel A in Table 9, institutional stockholders provide an incentive to financial firms to disclose higher quality information regarding Clients, Products, & Business Practices type events that are closely linked to firms' business practices, but not fraud or

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[24]Source: the National Bureau of Economic Research (NBER), `http://research.stlouisfed.org/fred2/series/USREC`.

other events. However, price impact of trade is most likely to decline when firms disclose fraud events. Then, around settlement announcements, firms with more independent boards and with boards with high insider ownership are the ones experiencing the lowest drops in adverse selection for internal fraud and business practices-related events, because such governance structures equip firms with better incentives to disclose high quality information to all market participants.

In the fourth robustness check (RC6), we include year fixed effects to account for any omitted macroeconomic variables that may change over the sample period. Most of the year dummy variables came out insignificant (coefficients are omitted for brevity). Other results remain robust for the most part and are economically unchanged.

Fifth, some of our results may be tainted by operational risk announcements that were made as part of scheduled earnings announcement, restatements, or reported in SEC filings. To address this concern, we carry out robustness check (RC7), in which we drop 21 such first announcements and 13 such settlement announcements and re-estimate our main model. The results are qualitatively the same.

In the sixth, final robustness check, we redefined our *RISK MANAGEMENT SCORE* variable. Instead of performing a principal component decomposition of the correlation matrix of the risk factors, we created an additive version of the risk management score by giving a score of one for the presence of each of the following operational risk and broader firm-wide risk management initiatives: existence of the Operational Risk Officer position (*OPRISK OFFICER*), existence of the Operational Risk Committee (*OPRISK COMMITTEE*), existence of Chief Risk Officer position (*CHIEF RISK OFFICER*), existence of a risk committee (*RISK COMMITTEE*), and the Chairman of the board serving on the risk committee (*RISK COMMITTEE*CHAIR ON RISK COMMITTEE*). The results are depicted in Model (RC8) in Table 9. The coefficients and their significance levels remain robust to this model specification.

7   Market Liquidity and Bid-Ask Spread

Information asymmetry around operational risk announcements may affect liquidity. Past studies have used two measures of stock market liquidity: quoted depth and trading volume. Gillet, Hübner, and Plunus (2010) documented that abnormal trading volume increases by 68% following operational risk announcements in U.S. financial firms. Chae (2005) compared liquidity for scheduled and unscheduled news announcements. He showed that informed traders begin trading the stock more actively prior to an announcement, while uninformed discretionary liquidity traders are unwilling to trade prior to the announcement because price sensitivity to order flow is high. In his empirical results, trading volume *decreases* by over 15% prior to scheduled earnings announcements but *increases* for unscheduled announcements. In our sample, abnormal change in trading volume is positive around first announcements (unscheduled) and is negative around settlement announcements (anticipated); see Table 3. To the contrary, Kim and Verrecchia (1994) argue that the increase in trading volume generated by informed traders more than offsets the decrease in trading volume by discretionary liquidity traders, and so the overall

increase in trading volume prior to an earnings announcement is solely driven by informed trading. In either case, we expect that the increase in trading volume prior to operational risk first and settlement announcements should be overwhelmingly attributed to informed traders.

In this section, we take a closer look at market liquidity surrounding operational risk announcements. Quoted depth is the quantity limit set by the market maker and is measured as the sum of number of shares available at bid and at ask. Past empirical studies have looked at how market makers use quoted depth as a strategic tool to hedge against information asymmetry and how the bid-ask spread and quoted depth interact. Dupont (2000) and Kavajecz (1998) showed that market makers may use spreads and depths as substitutes when faced with information asymmetry.[25] Earlier studies have maintained that bid-ask spread and depth are simultaneously determined (Kavajecz, 1998, 1999; Dupont, 2000; Libby, Mathieu, and Robb, 2002; Kanagaretnam, Lobo, and Whalen, 2005, 2007; Lee, Mucklow, and Ready, 1993). Specifically, around earnings announcements abnormal quoted depth decreases in information asymmetry; Lee, Mucklow, and Ready (1993) showed that wider spreads are accompanied by lower depths, but depths return to normal levels shortly (within half an hour) following the news release.

Following earlier studies (e.g., Lee, Mucklow, and Ready, 1993; Kavajecz, 1999; Dupont, 2000; Libby, Mathieu, and Robb, 2002; Hedge and Miller, 1989; and Kanagaretnam, Lobo, and Whalen, 2005, 2007), we model quoted depth simultaneously with our two measures of information asymmetry—effective spread and price impact of trade—in their change forms, using a system of equations. As such, we augment these earlier studies that use quoted bid-ask spread as a measure of information asymmetry. Simultaneous modeling allows to correct for correlations between the error terms. In each system of two equations, the first equation estimates Δ QUOTED DEPTH and the second equation estimates either Δ EFFECTIVE SPREAD or Δ PRICE IMPACT. Following prior empirical research, in the depth equation we include an appropriate measure of information asymmetry along with additional control variables—NUMBER OF SHARES and Δ VOLUME. In the information asymmetry equation, we include Δ QUOTED DEPTH along with other variables included in our models described in the previous sections, but omit Δ VOLUME. The simultaneous equations model is specified as follows:[26]

$$\Delta \text{ } QUOTED \text{ } DEPTH_{it} = \alpha + \xi \text{ } \Delta \text{ } Information \text{ } Asymmetry_{it} + \sum_{j=1}^{J} \gamma_j Governance_{it,j} \quad (4)$$

$$+ \sum_{r=1}^{R} \psi_r Risk \text{ } Management_{it,r} + \sum_{k=1}^{K} \beta_k Announcement \text{ } Charactistics_{it,k} + \sum_{m=1}^{M} \theta_m controls_{it,m} + \varepsilon_{it}$$

[25]Easley and O'Hara (1992) developed a theoretical model explaining the negative association between abnormal trading volume prior to an announcement and market depth immediately following an announcement. In their model, market makers exploit trading volume to uncover the existence of informed traders: if market makers note abnormal trading volume, they suspect higher informed trading and react by widening the bid-ask spread and reducing the quoted depth. In this study we do not find empirical support to this view: the association between abnormal levels of quoted depth and trading volume is positive and significant at the 1% level, when all other factors are accounted for.

[26]Studies that considered trading volume as an alternative measure of liquidity have also used a system of a equations to simultaneously model spread and volume. See for example, Affleck-Graves, Callahan, and Chipalkatti (2002), Glosten and Harris (1988), and Hedge and Miller (1989).

and

$$\Delta \text{ Information Asymmetry }_{it} = \alpha' + \xi' \Delta \text{ QUOTED DEPTH }_{it} + \sum_{j=1}^{J} \gamma'_j \text{Governance }_{it,j} \quad (5)$$

$$+ \sum_{r=1}^{R} \psi'_r \text{Risk Management}_{it,r} + \sum_{k=1}^{K} \beta'_k \text{Announcement Charactistics}_{it,k} + \sum_{m=1}^{M'} \theta'_m \text{controls}_{it,m} + \varepsilon_{it}.$$

The results are presented in Table 10. In the information asymmetry equations, the coefficients' signs are for the most part consistent with our earlier models that used price impact of trade. Consistent with earlier studies, we find that market makers use quoted depth and spread as substitutes to deal with information risk of facing informed traders. This is evident from the coefficients of appropriate measures of information asymmetry in the depth equations (all odd-numbered models) and the coefficients of quoted depth in the spread equations (all even-numbered models) being negative and statistically significant at levels 1-5% (with only one exception in Models (3) and (4)).

As expected, quoted depth increases in trading volume. The coefficient of Δ *VOLUME* is positive and significant at 1% level in all four depth equations. For banks and insurers, quoted depth is higher than for other financial firms, which may be explained by elevated trading volume during the event period. Interestingly, *NUMBER OF ANALYSTS* enters the depth models with an expected positive sign, although the coefficient is statistically insignificant. Analyst forecasts are more accurate for firms that have a great number of analysts following, resulting in narrower spreads (supported in our Models (6) and (8) in this table) and more generous depths set by the market makers.

8   Conclusion

Recent regulatory initiatives call for greater market transparency in the public disclosure of financial information. An example is the Basel Capital Accord that lays out a set of standards for financial institutions regarding the quantification, management, and disclosure of operational risk. Other initiatives that address disclosure include the Gramm-Leach-Bliley Act (GLBA) of 1999, the Health Insurance Portability and Accountability Act (HIPAA) of 1996, the Sarbanes-Oxley Act (SOX) of 2002, and the Dodd-Frank Act of 2010. Recent empirical research has shown that public announcements of operational risk events are value-relevant, as market values of firms experience statistically significant drops. This paper takes that stream of research one step further and explores the ways in which market makers react to changes in information asymmetry caused by unscheduled operational risk announcements, and then by their settlement announcements. In our analysis, effective bid-ask spread and price impact of trade serve as proxies for information asymmetry. Using 15 years of data from public U.S. financial firms, we find evidence of a substantial increase in information asymmetry around first press-cutting dates of operational risk events and a decrease in information asymmetry around their settlement announcements. Our empirical results are robust to various model specifications.

We examined the role of internal and external governance and risk management on information asymmetry. We found that stronger governance structure reduces information asymmetry around operational risk event announcements. Specifically, around the first announcements effective spread and price impact of trade are significantly negatively associated with board independence ratio, equity incentives, and institutional ownership, and are significantly positively associated with G-Index. Similarly, around the settlement announcements strong governance leads to smaller drops in information asymmetry. This result offers compelling evidence that stronger governance structure reduces information asymmetry between the informed and non-informed traders. We also examined the effects of the strength of the risk management function, proxied for by the existence of Chief Risk Officer, Chief Operational Risk Officer, operational risk committee, enterprise-wide risk committee, and the number of years each of these had been in place, and found that only the presence (or appointments) of senior risk officers have an impact on information asymmetry, while risk-related committees do not. We interpret this as evidence that the risk management function is largely driven by the regulatory compliance needs and has only a limited impact on the level of information asymmetry between firms and investors. Alternatively, this can be explained by the "business model channel," in which financial firms with an aggressive risk culture may optimally choose to undertake high risks while tightening their risk controls.

The increase in information asymmetry around first announcements is higher for internal fraud-related events or those linked to weak business practices. This result agrees with similar findings for earnings announcements in prior studies. This finding is particularly intriguing given that, unlike earnings announcements that are scheduled, first announcements of operational risk are unscheduled. Therefore, much of the abnormal trading should be attributed to informed traders while the noise trading by liquidity traders is minimal. For the same internal events, we found that the drop in information asymmetry around the settlement announcements is smaller than for other types of operational risk events. We believe this is because firms choose to provide the public with more accurate and value-relevant information regarding the remediation actions and new policies to resolve the issues, in order to avoid bad publicity and adverse reputational consequences, which in turn reduces adverse selection.

This is the first empirical study to examine information asymmetry around operational risk announcements. Our empirical findings also revealed that trading volume experiences a substantial increase around operational risk first announcements and that quoted depth is negatively associated with information asymmetry, showing an overall improvement in liquidity. This information might be useful for regulators in establishing more effective operational risk disclosure requirements for financial firms. Further theoretical and empirical research is necessary to investigate the determinants of liquidity and explain market makers' decisions to increase quoted depth and the underlying drivers of elevated abnormal trading volume around such announcements. Answering these questions would contribute to our understanding of the liquidity consequences of public disclosures of fraud and other operational risk events. Another avenue worth exploring is comparison of information asymmetry around operational risk announcements between non-financial corporations, banks, insurers, and other financial firms. A preliminary analysis

suggests that there are differences in the levels and determinants of information asymmetry even within the financial sub-industries. For example, information asymmetry around the first announcements of operational risk events is better explained by the strength of internal and external governance for insurers and non-banks, than for depository institutions, a result that may be attributable to greater disclosure requirements for banks and differences in the governance structures. We leave this important research question to future investigation.

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Appendix: Description of Variables

The following table summarizes the variables used in this study and their definitions. All dollar denominated variables are measured in 2009 UDFA. All continuous variables except GINDEX and FIRM SIZE are winsorized at 1% and 99%. The event window spans 7 trading days beginning 3 trading days prior to the announcement date and ending 3 trading days after. The non-event period spans 10 trading days (two weeks) commencing two calendar weeks prior to the announcement date.

Variable	Definition	Source
Information Asymmetry and Market Liquidity:		
EFFECTIVE SPREAD	Daily average effective spread per transaction. Effective spread (ES) for time t is computed as (Lee, 1993; Huang and Stoll, 1996): $$ES_t = 2 \times D_t \times \frac{Price_t - Midpoint_t}{Midpoint_t} \times 100$$, where $Price_t$ is the transaction price at time t and $Midpoint_t$ is the midpoint of the quoted ask and bid prices immediately prior to the transaction. The factor D_t equals 1 for market buy orders and -1 for market sell orders, and factor 2 accounts for the round trip cost of transaction. Measurement units: Percent.	TAQ
Δ EFFECTIVE SPREAD	Average effective spread on event day minus average effective spread in non-event period. Measurement units: Percent.	TAQ
PRICE IMPACT	Daily average price impact of trade per transaction. Price impact of trade (PIT) for time t is computed as (Huang and Stoll, 1996): $$PIT_t = 2 \times D_t \times \frac{Price_{t+\tau} - Midpoint_t}{Midpoint_t} \times 100$$, where $Price_{t+\tau}$ is the first transaction price at least τ minutes after the transaction at time t, with τ taking values 5, 15, or 30 minutes, and $Midpoint_t$ is the midpoint of the quoted ask and bid prices immediately prior to the transaction. The factor D_t equals 1 for market buy orders and -1 for market sell orders, and factor 2 accounts for the round trip cost of transaction. Measurement units: Percent.	TAQ
Δ PRICE IMPACT	Average price impact of trade on event day minus average price impact of trade in non-event period. Measurement units: Percent.	TAQ
QUOTED DEPTH	Natural logarithm of average quoted depth per transaction on the trading day. Measurement units: ln (number of shares).	TAQ
Δ QUOTED DEPTH	Natural logarithm of average quoted depth per transaction on the trading day during event window minus natural logarithm of average quoted depth per transaction in non-event period. Measurement units: ln (number of shares).	TAQ
Corporate Governance:		
BOARD INDEPENDENCE	Ratio of independent board directors on the board at the end of previous year. Measurement units: Percent.	RiskMetrics, Proxy filings
INSIDER OWNERSHIP	Proportion of shares held by all executive and non-executive directors at the end of previous year. Measurement units: Percent.	Proxy filings
BLOCK OWNERSHIP	Proportion of shares held by outside blockholders at the end of previous year. Measurement units: Percent.	Proxy filings
GINDEX	Gompers, Ishii, and Metrick's (2003) governance index (G-index) at the end of previous year. It is an additive index constructed by giving one point to each of the 22 firm-level antitakeover provisions and 6 state antitakeover laws, with a total of 24 unique provisions. Higher index values indicate weaker investor protection. Measurement units: Whole number between 0 and 24.	RiskMetrics
Announcement Characteristics:		
INTERNAL FRAUD	1 if the event is of internal fraud type; 0 otherwise.	Algo FIRST, LexisNexis, Factiva
EXTERNAL FRAUD	1 if the event is of external fraud type; 0 otherwise.	Algo FIRST, LexisNexis, Factiva
CLIENTS, PRODUCTS, & BUSINESS PRACTICES	1 if the event is of type Clients, Products, & Business Practices; 0 otherwise.	Algo FIRST, LexisNexis, Factiva
DISCLOSED BY FIRM	1 if the event is self-disclosed by the firm; 0 if the announcement is made by a third party, such as a client, court order, or the SEC. We considered an event self-disclosed if an announcement by a third party is accompanied by a statement by the firm on the same trading day. This variable is determined separately for first announcements and settlement announcements.	Algo FIRST, LexisNexis, Factiva
LOSS ANNOUNCED	1 if the announcement discloses loss amount; 0 otherwise. This variable is determined separately for first announcements and settlement announcements.	Algo FIRST, LexisNexis, Factiva

Risk Management Variables:

OPRISK OFFICER	1 if the firm has an Operational Risk Officer position; 0 otherwise.	Proxy, 10-K filings
OPRISK OFFICER YEARS	Number of years since establishment of the Operational Risk Officer position.	Proxy, 10-K filings
OPRISK COMMITTEE	1 if the firm has an operational risk committee; 0 otherwise.	Proxy, 10-K filings
OPRISK COMMITTEE YEARS	Number of years since establishment of the operational risk committee.	Proxy, 10-K filings
CHIEF RISK OFFICER	1 if the firm has a Chief/Senior Risk Officer position; 0 otherwise.	Proxy, 10-K filings
CHIEF RISK OFFICER YEARS	Number of years since establishment of the Chief/Senior Risk Officer position.	Proxy, 10-K filings
RISK COMMITTEE	1 if the firm has a risk committee; 0 otherwise.	Proxy, 10-K filings
RISK COMMITTEE YEARS	Number of years since establishment of the risk committee.	Proxy, 10-K filings
CHAIR ON RC	1 if the Board Chairman is sitting on the risk committee; 0 otherwise.	Proxy, 10-K filings
RISK MANAGEMENT SCORE	The first principal component of the nine risk management variables, obtained via a singular value decomposition of the correlation matrix of risk management categories. The single factor is the eigenvector with the highest eigenvalue.	Constructed by authors

Control Variables:

NUMBER OF ANALYSTS	Number of analyst forecasts included in the I/B/E/S consensus earnings per share forecast immediately prior to announcement.	I/B/E/S
FIRM SIZE	Natural logarithm of total assets reported at the end of the last quarter before the announcement. Measurement units: ln (USD million).	Compustat
VOLATILITY	Standard deviation of the daily stock returns including dividends during the calendar year ending one month prior to announcement. Measurement units: Percent.	CRSP
LEVERAGE	Leverage ratio computed by dividing total debt by total assets at the end of the last quarter before the announcement. Measurement units: Decimal.	Compustat
BETA	A measure of firm's systematic risk. Estimated as the beta factor from single-factor CAPM model. We use 255 days of daily equity returns and the value-weighted market index.	CRSP
PRICE	Average trading price on previous trading day. Measurement units: USD.	TAQ
Δ PRICE	(Average trading price on previous trading day divided by average trading price in non-event period) minus one. Measurement units: Percent.	TAQ
NUMBER OF SHARES	Natural logarithm of the number of common shares outstanding on the previous trading day prior to the announcement date. Measurement units: ln (thousand of shares).	CRSP
VOLUME	Natural logarithm of trading volume amount on the previous trading day. Measurement units: ln (number of shares).	TAQ
Δ VOLUME	Natural logarithm of trading volume on previous trading day minus natural logarithm of average daily trading volume in non-event period. Measurement units: ln (number of shares).	TAQ
DECIMAL	1 if the announcement is made after decimalization of tick size (January 29, 2001); 0 otherwise.	Algo FIRST, LexisNexis, Factiva
BANKS	1 if the two-digit U.S. Standard Industry Classification (SIC) code is 60 (depository institutions); 0 otherwise.	Proxy filings
INSURERS	1 if the two-digit U.S. Standard Industry Classification (SIC) code is 63 or 64 (insurance); 0 otherwise.	Proxy filings

Table 1: Sample Selection

This table describes our data screening procedure.

Data Screening Description	Number of Events
1. Announcements in U.S. public financial firms with loss >$10mln during 1980-2009*	729
– announcements during 1980-1994	−121
2. Announcements in U.S. public financial firms with loss >$10mln during 1995-2009	608
– announcements with unclear first press cutting date or company name	−88
– announcements of events of type Damage to Physical Assets	−85
– announcements with missing trades and quotes data, stock price <$1, <5 trades per day	−94
3. Final sample:	331
Events with both the first announcement and settlement announcement	178
Events with only the first announcement	32
Events with only the settlement announcement	121

*The data were extracted from the FIRST database at the end of 2009. Settlement dates for two events (as seen in Figure 1) were later updated and are shown to be in 2010 and 2013.

Figure 1: Time Series Plot of Operational Risk Announcements

This figure illustrates the time series of the number of operational risk announcements in our sample.

First Announcements and Settlement Announcements by Year
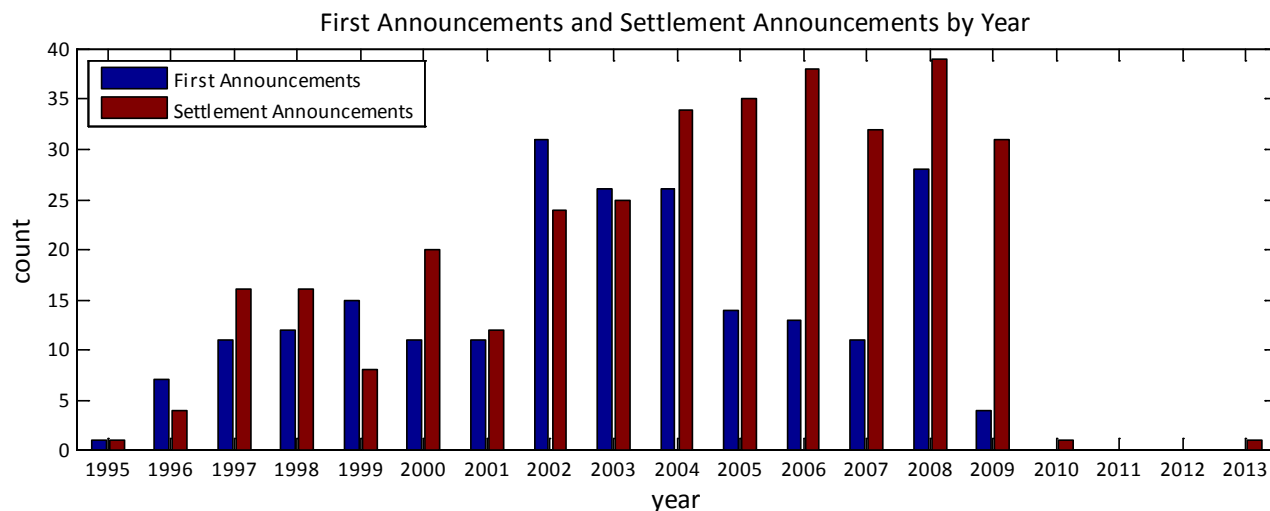
Figure 2: Abnormal Equity Returns around Operational Risk Announcements

This figure illustrates average cumulative abnormal returns for our sample data. A market model with equal-weighted market index was first used to estimate equity returns over 255 trading days ending 60 days prior to the announcement. Then, abnormal returns were computed as the difference between daily equity returns during the event period surrounding an announcement and the predicted returns based on the market model, and averaged across all events.

Panel A: First announcements

Cumulative abnormal returns (%) around first announcements

Panel B: Settlement announcements
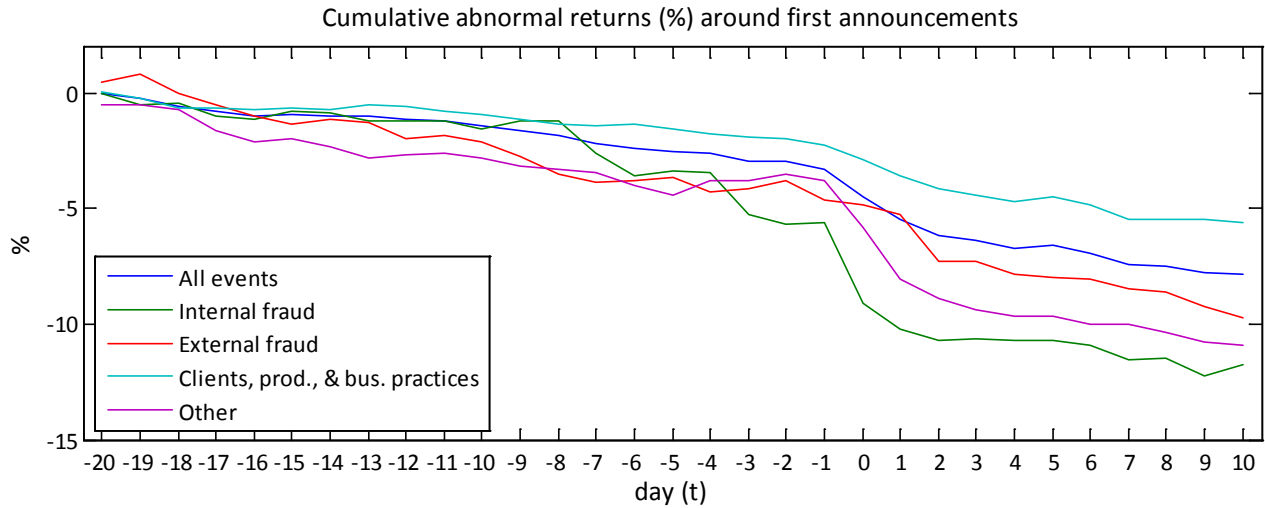
Cumulative abnormal returns (%) around settlement announcements
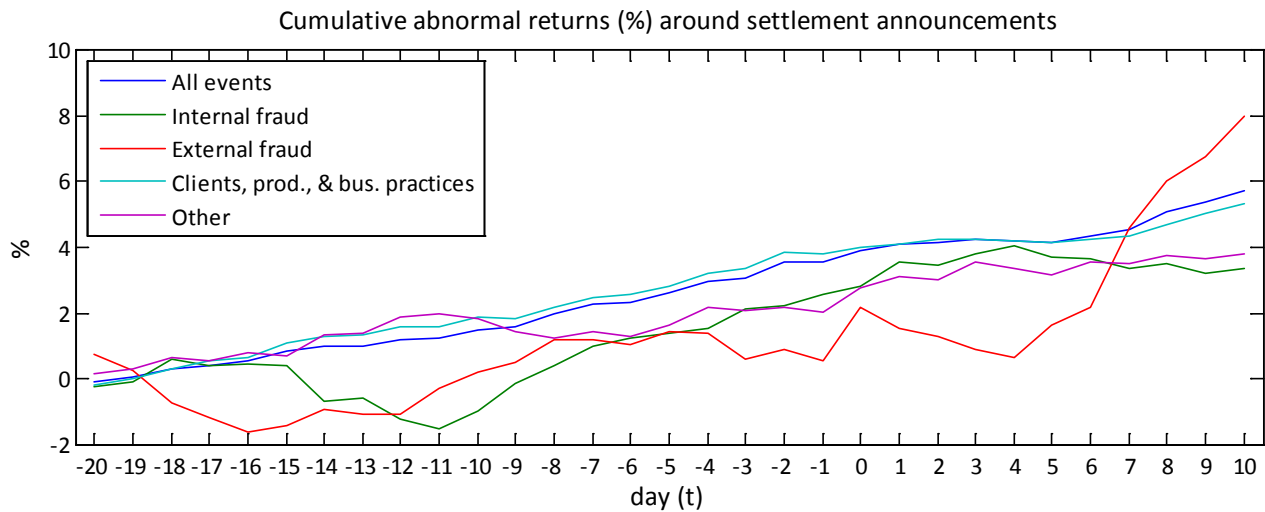
Table 2: Announcements Characteristics

This table summarizes the characteristics of operational risk event announcements.

Panel A: Distribution of announcements by disclosure source and loss amount

Event Type	Disclosure Source		Loss Amount		Total	
	Self-Disclosed	Third Party	Disclosed	Not Disclosed		
First Announcements:						
Internal Fraud	16	15	25	6	31	(15.8%)
External Fraud	12	14	21	5	26	(13.3%)
Employment Practices and Workplace Safety	0	11	4	7	11	(5.6%)
Clients, Products, and Business Practices	25	88	50	63	113	(57.7%)
Business Disruption and System Failures	2	2	2	2	4	(2.0%)
Execution, Delivery, & Process Management	4	7	7	4	11	(5.6%)
All First Announcements	59	137	109	87	196	(100%)
	(30.1%)	(69.9%)	(55.6%)	(44.4%)	(100%)	
Settlement Announcements:						
Internal Fraud	19	19	36	2	38	(12.8%)
External Fraud	8	13	20	1	21	(7.0%)
Employment Practices and Workplace Safety	10	3	13	0	13	(4.4%)
Clients, Products, and Business Practices	106	99	202	3	205	(68.8%)
Business Disruption and System Failures	2	1	3	0	3	(1.0%)
Execution, Delivery, & Process Management	12	6	18	0	18	(6.0%)
All Settlement Announcements	157	141	292	6	298	(100%)
	(52.7%)	(47.3%)	(98.0%)	(2.0%)	(100%)	

Panel B: Distribution of announcements by SIC industry code

Event Type	60xx Depository Institutions	61xx Non-Depository Institutions	62xx Security & Commodity Brokers	63xx, 64xx Insurance	65xx Real Estate	Total	
Internal Fraud	17	3	20	7	0	47	(14.2%)
External Fraud	21	4	5	2	0	32	(9.7%)
Employment Practices and Workplace Safety	1	4	9	1	0	15	(4.5%)
Clients, Products, and Business Practices	58	24	68	61	0	211	(63.7%)
Business Disruption and System Failures	2	0	1	1	0	4	(1.2%)
Execution, Delivery, and Process Management	10	1	7	3	1	22	(6.7%)
All Announcements	109	36	110	75	1	331	(100%)
	(32.9%)	(10.9%)	(33.2%)	(22.7%)	(0.3%)	(100%)	

Figure 3: Illustration of Information Asymmetry

This figure illustrates the time series of daily average measures of information asymmetry around the event window $t = [-3, +3]$ for our sample data, in their level form (left) and in abnormal change form (right).

a) Effective spread (%)

b) Change in effective spread (%)

c) Price impact of trade (%), 30 min

d) Change in price impact of trade (%), 30 min

e) Price impact of trade (%), 30, 15, 5 min

f) Change in price impact of trade (%), 30, 15, 5 min
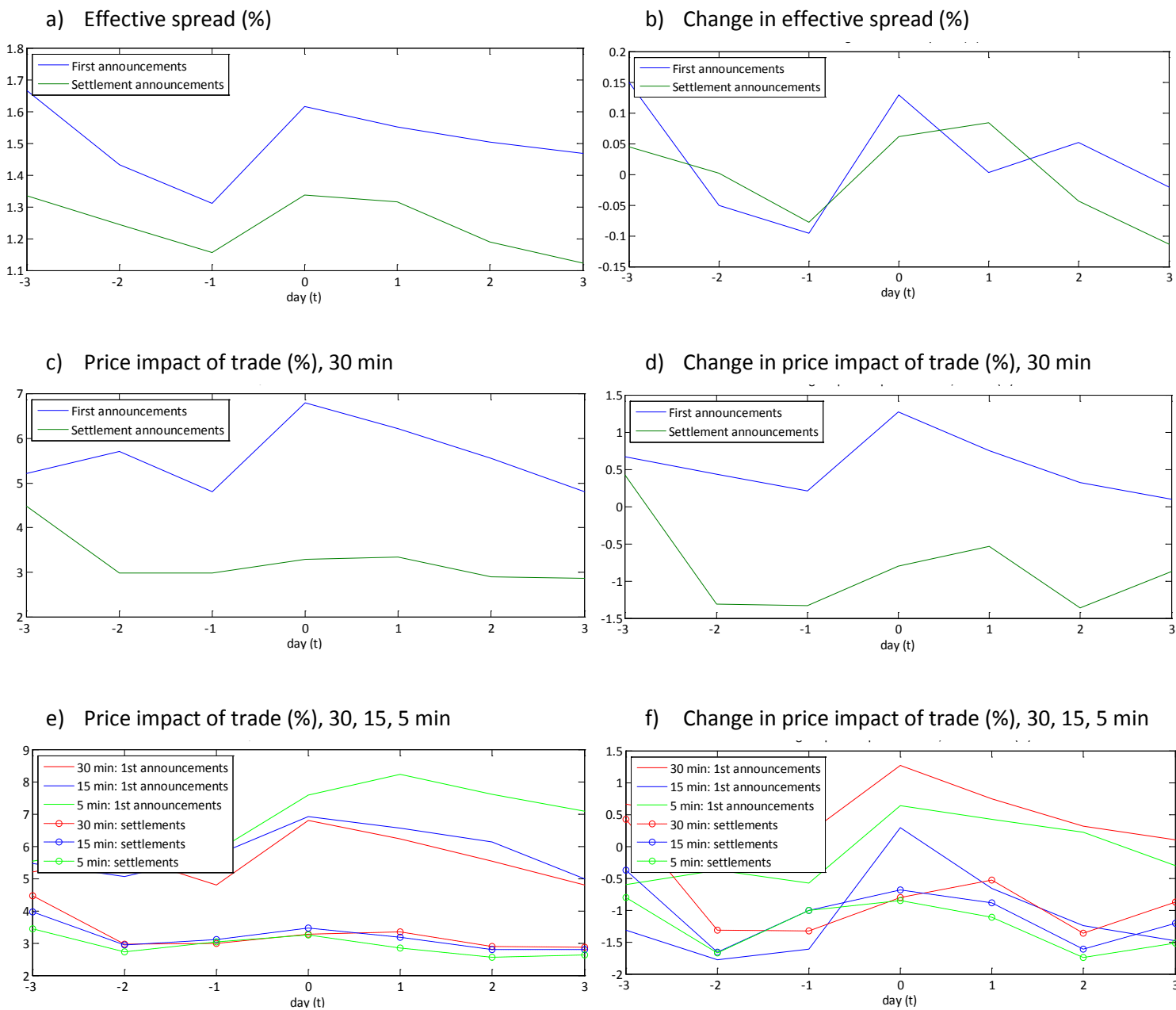
Table 3: Sample Descriptive Statistics

This table provides descriptive statistics for the characteristics of the firms in our data sample around the announcements for the event window $t = [-3, +3]$.

Variable	Announce-ment	Num. Obs.	Mean	St. Dev.	5th perc.	25th Perc.	50th Perc.	75th Perc.	95th Perc.
Governance & Risk Management:									
BOARD INDEPENDENCE	First ann.	1,477	72.341	13.538	50.000	63.636	75.000	82.353	90.910
	Settlement	2,114	74.433	13.642	50.000	65.385	77.778	83.333	90.909
INSIDER OWNERSHIP	First ann.	1,477	4.420	8.225	0.541	1.077	1.659	3.574	18.701
	Settlement	2,114	4.525	9.556	0.623	0.989	1.524	3.091	18.845
BLOCK OWNERSHIP	First ann.	1,477	7.097	10.039	0.000	0.000	5.348	10.562	27.918
	Settlement	2,114	7.678	9.998	0.000	0.000	5.569	11.472	26.962
GINDEX	First ann.	1,435	9.180	2.584	5.000	8.000	9.000	11.000	13.000
	Settlement	2,058	8.983	2.485	5.000	7.000	8.000	11.000	13.000
RISK MANAGEMENT SCORE	First ann.	1,526	0.006	2.059	-1.558	-1.558	-0.737	1.149	4.345
	Settlement	2,184	0.003	2.093	-1.902	-1.902	-0.847	1.646	3.550
Control Variables:									
NUMBER OF ANALYSTS	First ann.	1,463	17.746	6.869	6.000	14.000	17.000	22.000	31.000
	Settlement	2,142	16.533	6.634	3.000	13.000	17.000	20.000	27.000
FIRM SIZE	First ann.	1,484	12.336	1.743	8.641	11.474	12.852	13.635	14.306
	Settlement	2,156	12.351	1.968	7.697	11.516	13.054	13.728	14.417
VOLATILITY	First ann.	1,484	2.226	1.048	0.981	1.514	2.080	2.673	3.748
	Settlement	2,135	2.557	1.833	0.914	1.333	2.013	2.952	6.757
LEVERAGE	First ann.	1,484	0.361	0.249	0.025	0.183	0.284	0.575	0.822
	Settlement	2,156	0.326	0.240	0.020	0.138	0.266	0.558	0.783
BETA	First ann.	1,484	1.306	0.427	0.715	0.971	1.322	1.604	2.090
	Settlement	2,135	1.288	0.455	0.670	0.954	1.237	1.612	2.054
PRICE	First ann.	1,372	59.185	39.348	3.674	38.231	54.143	75.586	128.382
	Settlement	2,084	55.013	33.065	4.220	31.203	51.558	74.436	114.579
Δ PRICE	First ann.	1,372	-0.148	10.668	-16.313	-4.170	-0.105	4.050	16.015
	Settlement	2,084	0.217	10.579	-15.896	-3.737	0.456	4.818	15.759
VOLUME	First ann.	1,372	14.430	1.873	10.982	13.550	14.607	15.608	17.044
	Settlement	2,084	14.558	1.822	11.093	13.586	14.789	15.666	17.417
Δ VOLUME	First ann.	1,372	0.041	0.654	-0.901	-0.320	-0.014	0.346	1.195
	Settlement	2,084	-0.041	0.515	-0.870	-0.357	-0.052	0.273	0.829
QUOTED DEPTH	First ann.	1,372	3.513	0.961	2.124	2.895	3.393	3.982	5.209
	Settlement	2,084	3.465	1.133	1.951	2.764	3.331	3.961	5.313
Δ QUOTED DEPTH	First ann.	1,372	-0.008	0.389	-0.590	-0.253	-0.037	0.203	0.679
	Settlement	2,084	-0.049	0.351	-0.656	-0.264	-0.053	0.158	0.555

Table 4: Descriptive Statistics: Information Asymmetry around Operational Risk Announcements

This table reports daily average abnormal effective spread and price impact of trade, along with abnormal changes in these variables, around operational risk announcements. Superscripts ***, **, and * denote statistically significant difference of the average values from zero at the 1%, 5%, and 10% levels, respectively.

Panel A: Information asymmetry by event period and event type

Event Type	Exp. Sign	Effective Spread				Exp. Sign	Price Impact of Trade (30 min)			
		$t = [-3,-1]$		$t = [0,+3]$			$t = [-3,-1]$		$t = [0,+3]$	
		Mean	(t-stat)	Mean	(t-stat)		Mean	(t-stat)	Mean	(t-stat)
First announcements:										
Internal Fraud	+	0.8283	(4.98)***	1.4833	(5.72)***	+	2.5403	(5.51)***	4.1108	(5.90)***
External Fraud	+	0.5924	(4.92)***	0.6679	(6.03)***	+	2.0524	(6.99)***	2.1521	(7.78)***
Clients, Products, & Business Practices	+	1.8380	(9.52)***	1.7841	(11.24)***	+	7.1696	(7.65)***	7.8625	(7.76)***
Other Events	+	1.5185	(3.49)***	1.3952	(4.03)***	+	3.2754	(3.20)***	2.8593	(4.95)***
All Events	+	1.4707	(11.27)***	1.5369	(13.74)***	+	5.2420	(9.19)***	5.8479	(9.65)***
Settlement announcements:										
Internal Fraud	+	1.3673	(5.04)***	1.3464	(6.15)***	+	4.3405	(6.03)***	3.5141	(9.84)***
External Fraud	+	0.6698	(2.45)***	0.4577	(4.87)***	+	1.7980	(4.45)***	1.7049	(9.64)***
Clients, Products, & Business Practices	+	1.3110	(11.00)***	1.3308	(12.46)***	+	3.5844	(12.89)***	3.3122	(15.00)***
Other Events	+	1.0685	(5.00)***	1.0754	(5.12)***	+	2.9500	(6.35)***	2.2294	(7.52)***
All Events	+	1.2453	(13.20)***	1.2420	(15.03)***	+	3.4825	(15.75)***	3.1007	(19.01)***

Panel B: Change in information asymmetry by event period and event type

Event Type	Exp. Sign	Change in Effective Spread				Exp. Sign	Change in Price Impact of Trade (30 min)			
		$t = [-3,-1]$		$t = [0,+3]$			$t = [-3,-1]$		$t = [0,+3]$	
		Mean	(t-stat)	Mean	(t-stat)		Mean	(t-stat)	Mean	(t-stat)
First announcements:										
Internal Fraud	+	-0.1163	(-1.13)	0.5281	(2.12)***	+	0.1260	(0.41)	1.6970	(2.73)***
External Fraud	+	0.0843	(0.95)	0.1598	(1.99)***	+	0.4366	(2.07)***	0.5363	(2.65)***
Clients, Products, & Business Practices	+	0.1148	(0.80)	0.0047	(0.04)	+	0.9081	(1.55)*	0.8502	(1.53)*
Other Events	+	-0.4303	(-1.57)	-0.4999	(-1.99)**	+	-1.1993	(-1.61)	-1.6155	(-2.75)***
All Events	+	0.0019	(0.02)	0.0412	(0.48)	+	0.4423	(1.24)	0.6154	(1.78)**
Settlement announcements:										
Internal Fraud	—	0.0877	(0.43)	0.0439	(0.28)	—	-2.7021	(-2.18)***	-3.9323	(-3.27)***
External Fraud	—	-0.0004	(-0.00)	-0.1489	(-1.57)*	—	-0.0589	(-0.16)	-0.1520	(-0.69)
Clients, Products, & Business Practices	—	-0.0014	(-0.02)	0.0329	(0.46)	—	-0.1682	(-0.48)	-0.0562	(-0.24)
Other Events	—	-0.1789	(-0.94)	-0.1744	(-1.00)	—	-2.3886	(-1.71)**	-2.9722	(-2.50)***
All Events	—	-0.0102	(-0.15)	-0.0023	(-0.04)	—	-0.7369	(-2.22)***	-0.8913	(-3.38)***

Panel C: Mean comparison of information asymmetry by sub-samples of explanatory variables

Event Type	Exp. Sign	Information Asymmetry				Change in Information Asymmetry			
		Effective Spread		Price Impact		Δ Effective Spread		Δ Price Impact	
		Mean	(*t*-stat)	Mean	(*t*-stat)	Mean	(*t*-stat)	Mean	(*t*-stat)

First Announcements:

BOARD INDEPENDENCE
Above Median		2.0610	(12.84)***	7.9819	(9.09)***	-0.1729	(-1.43)	0.3382	(0.76)
Below Median		1.1162	(12.34)***	3.4262	(12.78)***	0.2396	(3.58)***	0.5909	(2.12)**
Difference	—	0.9447	(5.23)***	4.5556	(5.12)***	-0.4125	(-3.04)***	-0.2528	(-0.49)

INSIDER OWNERSHIP
Above Median		2.2236	(14.44)***	8.1634	(9.95)***	0.0643	(0.57)	1.0987	(2.45)**
Below Median		0.8264	(12.21)***	3.1364	(13.57)***	-0.0140	(-0.24)	0.0072	(0.03)
Difference	—	1.3972	(8.39)***	5.0270	(5.98)***	0.0783	(0.62)	1.0916	(2.18)**

BLOCK OWNERSHIP
Above Median		1.4792	(13.18)***	6.5389	(9.05)***	-0.0643	(-0.74)	0.7638	(1.99)**
Below Median		1.5496	(12.04)***	4.6741	(10.50)***	0.1142	(1.23)	0.3230	(1.00)
Difference	—	-0.0704	(-0.41)	1.8649	(2.19)**	-0.1785	(-1.41)	0.4407	(0.88)

GINDEX
Above Median		2.1463	(12.5)***	8.6779	(8.87)***	0.0560	(0.45)	0.5500	(1.07)
Below Median		0.9520	(11.53)***	3.5672	(11.90)***	0.0854	(1.14)	0.5931	(2.01)**
Difference	+	1.1943	(6.61)***	5.1107	(5.39)***	-0.0294	(-0.21)	-0.0431	(-0.08)

RISK MANAGEMENT SCORE
Above Median		1.7665	(12.88)***	7.1492	(9.29)***	0.1128	(1.09)	0.8310	(2.06)**
Below Median		1.2557	(12.53)***	4.0588	(11.30)***	-0.0624	(-0.85)	0.2573	(0.87)
Difference	—	0.5108	(3.02)***	3.0903	(3.66)***	0.1751	(1.39)	0.5736	(1.15)

DISCLOSED BY FIRM
Yes		1.3206	(9.59)***	3.7770	(10.06)***	0.3022	(3.03)***	1.1901	(3.95)***
No		1.5894	(15.00)***	6.3683	(10.93)***	-0.0954	(-1.20)	0.2618	(0.79)
Difference	—	-0.2688	(-1.45)	-2.5913	(-2.81)***	0.3975	(2.89)***	0.9283	(1.70)*

LOSS AMOUNT
Announced		1.4772	(13.68)***	4.1372	(10.08)***	0.1371	(1.58)	0.8381	(3.23)***
Not Announced		1.5478	(11.44)***	7.4063	(9.27)***	-0.1170	(-1.28)	0.1693	(0.37)
Difference	—	-0.0706	(-0.41)	-3.2691	(-3.85)***	0.2540	(2.00)**	0.6689	(1.33)

Settlement Announcements:

BOARD INDEPENDENCE
Above Median		1.3771	(13.72)***	3.3126	(17.3)***	-0.1078	(-1.54)	-1.0303	(-3.09)***
Below Median		1.1263	(14.77)***	3.2460	(17.35)***	0.0846	(1.56)	-0.5776	(-2.25)**
Difference	+	0.2509	(2.01)**	0.0666	(0.25)	-0.1925	(-2.19)**	-0.4528	(-1.09)

INSIDER OWNERSHIP
Above Median		1.6262	(15.51)***	3.9721	(18.08)***	-0.0278	(-0.38)	-1.2681	(-3.40)***
Below Median		0.8574	(13.29)***	2.5638	(17.42)***	0.0119	(0.24)	-0.3102	(-1.75)*
Difference	+	0.7688	(6.20)***	1.4083	(5.30)***	-0.0396	(-0.45)	-0.9580	(-2.30)**

BLOCK OWNERSHIP
Above Median		1.2874	(14.09)***	3.3985	(17.12)***	-0.0917	(-1.40)	-1.5942	(-4.53)***
Below Median		1.2066	(14.15)***	3.1559	(17.61)***	0.0765	(1.31)	0.0144	(0.07)
Difference	+	0.0808	(0.65)	0.2426	(0.91)	-0.1682	(-1.91)*	-1.6086	(-3.87)***

GINDEX
Above Median		1.4016	(14.32)***	3.3172	(17.75)***	-0.0819	(-1.24)	-1.1927	(-3.60)***
Below Median		0.9627	(8.41)***	3.0200	(9.94)***	-0.0271	(-0.30)	-0.4480	(-1.32)
Difference	—	0.4390	(2.79)***	0.2972	(0.88)	-0.0547	(-0.49)	-0.7447	(-1.45)

RISK MANAGEMENT SCORE
Above Median		1.3473	(14.01)***	3.6904	(17.91)***	-0.0773	(-1.11)	-1.1984	(-3.44)***
Below Median		1.1407	(14.47)***	2.8435	(16.96)***	0.0651	(1.22)	-0.4560	(-2.01)**
Difference	+	0.2065	(1.66)*	0.8468	(3.19)***	-0.1425	(-1.63)	-0.7424	(-1.79)*

DISCLOSED BY FIRM
Yes		1.2958	(14.23)***	3.3659	(16.93)***	0.1001	(1.56)	-1.1668	(-3.42)***
No		1.1850	(14.20)***	3.1514	(18.20)***	-0.1237	(-2.11)**	-0.4439	(-2.04)**
Difference	+	0.1108	(0.89)	0.2145	(0.81)	0.2237	(2.56)**	-0.7229	(-1.74)*

LOSS AMOUNT
Announced		1.2584	(19.87)***	3.2859	(24.25)***	0.0081	(0.18)	-0.8199	(-3.88)***
Not Announced		0.5162	(3.93)***	2.2244	(6.28)***	-0.6764	(-2.48)**	-1.0775	(-1.98)**
Difference	+	0.7421	(1.68)*	1.0616	(1.12)	0.6845	(2.20)**	0.2576	(0.17)

Table 5: Multivariate Results: Determinants of Information Asymmetry

This table presents the results of our OLS model. The dependent variable is a daily measure of information asymmetry during $t = [-3,+3]$. t-statistics based on heteroscedasticity-robust standard errors are reported in parentheses. Superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Exp. Sign	First Announcements				Exp. Sign	Settlement Announcements			
		Effective Spread		Price Impact (30 min)			Effective Spread		Price Impact (30 min)	
		(1) Level	(2) Change (Δ)	(3) Level	(4) Change (Δ)		(5) Level	(6) Change (Δ)	(7) Level	(8) Change (Δ)
Governance and Risk Management:										
BOARD INDEPENDENCE	−	-0.0212	-0.0229	-0.0092	-0.0294	+	0.0026	0.0048	-0.0237	0.0079
		(-2.96)***	(-3.57)***	(-0.27)	(-1.15)		(0.47)	(1.04)	(-1.83)*	(0.51)
INSIDER OWNERSHIP	−	-0.0480	-0.0232	-0.1652	-0.0661	+	0.0482	0.0327	0.0975	0.0752
		(-4.14)***	(-2.66)***	(-3.61)***	(-1.88)*		(2.71)***	(2.67)***	(2.47)**	(2.00)**
BLOCK OWNERSHIP	−	-0.0105	-0.0237	-0.0938	-0.0363	+	0.0085	0.0151	0.0213	0.0838
		(-1.13)	(-3.01)***	(-2.49)**	(-1.58)		(1.17)	(2.93)***	(1.43)	(2.88)***
GINDEX	+	0.1362	0.0410	0.4625	-0.0792	−	-0.0490	-0.0053	-0.0707	0.2528
		(3.85)***	(1.60)	(3.14)***	(-0.69)		(-1.86)*	(-0.24)	(-1.24)	(2.79)***
RISK MANAGEMENT SCORE	−	0.0359	0.0577	0.4109	0.3000	+	-0.0923	-0.0373	-0.1445	0.3956
		(0.93)	(1.44)	(1.45)	(1.72)*		(-2.30)**	(-1.08)	(-1.65)*	(3.19)***
Announcement Characteristics:										
INTERNAL FRAUD	+	-0.5053	0.3351	0.9637	1.8281	+	0.3111	0.3687	0.8146	-0.5769
		(-1.70)*	(1.43)	(1.07)	(2.57)***		(1.44)	(1.82)*	(1.72)*	(-0.46)
EXTERNAL FRAUD	+	-0.7477	0.2911	-2.5348	-0.0502	−	-0.2993	0.1327	-0.9377	1.6934
		(-2.70)***	(1.42)	(-2.21)**	(-0.08)		(-1.28)	(0.72)	(-2.23)**	(1.96)**
CLIENTS, PRODUCTS, & BUS. PRACTICES	+	-0.1719	0.2027	2.5910	1.3605	+	0.2564	0.2766	0.5279	2.7015
		(-0.61)	(0.89)	(2.74)***	(1.82)*		(1.46)	(1.83)*	(1.54)	(2.95)***
DISCLOSED BY FIRM	−	0.2913	0.0757	-0.6579	-0.4756	+	0.2665	0.2225	0.6760	-0.8801
		(1.44)	(0.48)	(-1.02)	(-1.03)		(2.18)**	(2.38)**	(2.46)**	(-2.02)**
LOSS ANNOUNCED	−	0.1578	0.3295	-3.0073	1.2339	+	0.9102	0.7858	2.0749	-0.4558
		(0.91)	(2.20)**	(-2.99)***	(2.06)**		(5.47)***	(2.66)***	(4.06)***	(-0.61)
Control Variables:										
NUMBER OF ANALYSTS		0.0714	0.0106	0.6051	0.1393		0.1070	-0.0035	0.1921	-0.0895
		(5.08)***	(0.92)	(4.41)***	(1.94)*		(8.59)***	(-0.38)	(6.36)***	(-2.02)**
FIRM SIZE		0.4091	-0.1540	-1.3330	-1.5782		0.4537	0.0921	0.5034	0.5356
		(4.35)***	(-3.18)***	(-1.86)*	(-4.32)***		(7.35)***	(2.40)**	(3.19)***	(2.24)**
VOLATILITY		0.3797	-0.0729	1.0666	-0.3659		-0.0336	-0.0492	-0.2813	-0.2236
		(3.57)***	(-0.97)	(2.54)**	(-1.37)		(-0.75)	(-1.61)	(-2.61)***	(-1.60)
LEVERAGE		0.8562	0.0398	0.8577	-0.7955		0.5099	-0.9622	1.6110	-5.0631
		(1.67)*	(0.10)	(0.35)	(-0.40)		(1.11)	(-2.78)***	(1.59)	(-3.71)***
BETA		-0.3571	0.1463	6.4675	3.3125		-0.0765	0.1129	1.4999	0.0318
		(-1.18)	(0.58)	(3.56)***	(3.14)***		(-0.40)	(0.82)	(2.85)***	(0.05)
(Δ) PRICE		-0.0184	-0.0226	-0.0427	-0.0078		-0.0188	-0.0108	-0.0294	-0.0363
		(-6.74)***	(-2.37)**	(-3.68)***	(-0.16)		(-7.45)***	(-2.19)**	(-5.42)***	(-1.29)
(Δ) VOLUME		-0.8837	0.0507	-2.0200	1.8413		-0.7789	0.3301	-0.8284	0.3573
		(-9.13)***	(0.28)	(-3.66)***	(2.59)***		(-11.22)***	(3.44)***	(-5.62)***	(0.62)
DECIMAL		1.6659	0.4650	8.5909	2.5379		1.6818	-0.0783	3.7375	-2.8351
		(5.92)***	(2.18)**	(6.10)***	(3.23)***		(9.51)***	(-0.77)	(10.16)***	(-4.41)***
BANKS		-0.2017	0.5011	-1.3663	0.5328		-0.6695	0.1414	-0.1574	1.9993
		(-1.35)	(3.54)***	(-1.54)	(0.76)		(-3.93)***	(1.04)	(-0.36)	(3.21)***
INSURERS		0.5915	1.1629	-0.9986	1.5359		-0.9211	-0.2146	-0.0890	1.1482
		(1.51)	(4.06)***	(-0.72)	(1.38)		(-4.05)***	(-1.24)	(-0.15)	(2.03)**
Constant		7.7821	2.0790	24.6393	13.7076		4.1159	-2.4087	1.9414	-7.2450
		(7.67)***	(2.81)***	(4.07)***	(3.83)***		(5.00)***	(-4.14)***	(1.03)	(-2.35)**
Number of observations		1,316	1,316	1,316	1,316		2,014	2,014	2,014	2,014
F-stat. all variables		12.04	3.43	5.48	3.34		16.89	3.29	12.59	2.99
[Prob > F]		[0.000]***	[0.000]***	[0.000]***	[0.000]***		[0.000]***	[0.000]***	[0.000]***	[0.000]***
F-stat. governance & risk management		5.91	3.98	4.50	3.65		4.41	4.36	7.11	4.05
[Prob > F]		[0.000]***	[0.001]***	[0.001]***	[0.003]***		[0.001]***	[0.001]***	[0.000]***	[0.001]***
F-stat. announcement characteristics		2.39	2.09	5.01	3.13		9.29	3.55	8.46	3.55
[Prob > F]		[0.036]**	[0.064]*	[0.000]***	[0.008]***		[0.000]***	[0.003]***	[0.000]***	[0.003]***
R^2		0.3045	0.0779	0.1536	0.0821		0.2841	0.0393	0.1429	0.0505
AIC		6,360.21	5,959.40	10,854.48	9,573.49		9,343.60	8,527.50	12,769.94	14,766.67
BIC		6,469.04	6,068.23	10,963.31	9,682.32		9,461.36	8,645.27	12,887.70	14,884.44

Table 6: Multivariate Results: Information Asymmetry During Pre- and Post-Announcement Periods

The dependent variable is a daily measure of information asymmetry during pre-announcement period $t = [-3,-1]$ and during post-announcement period $t = [0,+3]$. t-statistics based on heteroscedasticity-robust standard errors are reported in parentheses. Superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: First announcements

Variable	Exp. Sign	Effective Spread				Exp. Sign	Price Impact of Trade (30 min)			
		Level		Change (Δ)			Level		Change (Δ)	
		(1) $t=[-3,-1]$	(2) $t=[0,+3]$	(3) $t=[-3,-1]$	(4) $t=[0,+3]$		(5) $t=[-3,-1]$	(6) $t=[0,+3]$	(7) $t=[-3,-1]$	(8) $t=[0,+3]$
Governance and Risk Management:										
BOARD INDEPENDENCE	−	-0.0123	-0.0282	-0.0110	-0.0316	−	0.0178	-0.0316	0.0059	-0.0532
		(-1.24)	(-3.03)***	(-1.20)	(-3.83)***		(0.44)	(-0.63)	(0.16)	(-1.58)
INSIDER OWNERSHIP	−	-0.0180	-0.0698	-0.0018	-0.0397	−	-0.0534	-0.2520	0.0066	-0.1197
		(-1.29)	(-4.47)***	(-0.17)	(-3.28)***		(-0.89)	(-3.81)***	(0.12)	(-2.66)***
BLOCK OWNERSHIP	−	-0.0006	-0.0180	-0.0134	-0.0305	−	-0.0202	-0.1496	0.0134	-0.0705
		(-0.05)	(-1.43)	(-1.21)	(-2.91)***		(-0.49)	(-2.56)**	(0.46)	(-2.07)**
GINDEX	+	0.1533	0.1256	0.0512	0.0323	+	0.1733	0.6832	-0.3479	0.1103
		(2.83)***	(2.72)***	(1.46)	(0.91)		(0.77)	(3.57)***	(-1.92)*	(0.78)
RISK MANAGEMENT SCORE	−	0.0686	0.0199	0.0362	0.0674	−	0.1664	0.6147	0.0507	0.4640
		(1.12)	(0.39)	(0.62)	(1.21)		(0.47)	(1.44)	(0.21)	(1.86)*
Announcement Characteristics:										
INTERNAL FRAUD	+	-0.6098	-0.3851	0.1721	0.4793	+	0.6565	1.2487	1.7713	1.9019
		(-1.43)	(-0.94)	(0.57)	(1.43)		(0.50)	(1.00)	(1.72)*	(1.98)**
EXTERNAL FRAUD	+	-0.4761	-0.8917	0.3146	0.3076	+	-1.6511	-3.1618	0.3483	-0.2519
		(-1.14)	(-2.38)**	(1.08)	(1.05)		(-1.07)	(-1.92)*	(0.37)	(-0.26)
CLIENTS, PRODUCTS, & BUS. PRACTICES	+	0.1227	-0.3468	0.4224	0.0683	+	2.3727	2.7727	1.5041	1.3209
		(0.28)	(-0.93)	(1.21)	(0.22)		(1.77)*	(2.18)**	(1.33)	(1.34)
DISCLOSED BY FIRM	−	0.3896	0.2046	0.3654	-0.1354	−	0.3989	-1.4522	0.5659	-1.2739
		(1.45)	(0.73)	(1.95)*	(-0.60)		(0.45)	(-1.63)	(0.91)	(-2.00)**
LOSS ANNOUNCED	−	-0.1896	0.4244	-0.0533	0.6463	−	-4.6756	-1.7677	-0.4184	2.5406
		(-0.74)	(1.81)*	(-0.24)	(3.27)***		(-3.55)***	(-1.22)	(-0.53)	(2.94)***
Control Variables:										
NUMBER OF ANALYSTS		0.0566	0.0818	-0.0032	0.0194		0.4066	0.7557	0.0536	0.2012
		(2.63)***	(4.36)***	(-0.18)	(1.27)		(2.15)**	(3.88)***	(0.49)	(2.16)**
FIRM SIZE		0.5902	0.2896	-0.0219	-0.2380		-0.5066	-1.9357	-1.1491	-1.8599
		(4.61)***	(2.31)**	(-0.35)	(-3.51)***		(-0.56)	(-1.86)*	(-2.38)**	(-3.56)***
VOLATILITY		0.5613	0.2610	0.0617	-0.1755		1.2803	0.9340	-0.2925	-0.4197
		(3.57)***	(1.87)*	(0.52)	(-1.84)*		(2.59)***	(1.51)	(-0.70)	(-1.18)
LEVERAGE		-0.5239	1.8058	-1.1535	0.8122		-5.5222	5.5646	-5.0087	2.1931
		(-0.74)	(2.62)***	(-2.16)**	(1.44)		(-1.23)	(2.32)**	(-1.36)	(1.16)
BETA		-0.9088	0.0526	-0.2291	0.4613		4.5868	7.9190	2.6322	3.8500
		(-1.80)*	(0.14)	(-0.57)	(1.43)		(1.76)*	(3.13)***	(1.66)*	(2.71)***
(Δ) PRICE		-0.0135	-0.0212	-0.0097	-0.0265		-0.0416	-0.0427	0.0740	-0.0414
		(-3.64)***	(-5.52)***	(-0.62)	(-2.24)**		(-2.39)**	(-2.70)***	(0.74)	(-0.80)
(Δ) VOLUME		-0.9946	-0.8320	-0.1577	0.1154		-1.9289	-2.1631	1.7521	1.8847
		(-6.88)***	(-6.68)***	(-0.57)	(0.51)		(-4.05)***	(-2.42)**	(1.41)	(2.21)**
DECIMAL		1.5173	1.8292	-0.0285	0.8343		5.9819	10.6789	1.3011	3.4480
		(3.78)***	(4.69)***	(-0.09)	(3.12)***		(3.84)***	(4.89)***	(1.14)	(3.21)***
BANKS		-0.5169	0.0365	0.1922	0.7344		-2.3320	-0.6171	-0.5874	1.3603
		(-2.21)**	(0.19)	(0.91)	(3.83)***		(-1.71)*	(-0.54)	(-0.52)	(1.59)
INSURERS		-0.8700	1.6553	-0.0054	2.0238		-5.1150	2.1360	-1.6980	3.8652
		(-1.90)*	(2.98)***	(-0.02)	(4.99)***		(-2.28)**	(1.30)	(-0.89)	(3.24)***
Constant		7.2799	8.2854	0.8740	2.7581		23.8169	25.9675	13.8492	12.9904
		(4.76)***	(6.37)***	(0.85)	(2.86)***		(3.21)***	(2.80)***	(2.50)**	(2.95)***
Number of observations		564	752	564	752		564	752	564	752
F-stat. all variables		5.49	6.80	1.54	3.16		3.32	2.95	1.47	3.41
[Prob > *F*]		[0.000]***	[0.000]***	[0.066]*	[0.000]***		[0.000]***	[0.000]***	[0.086]*	[0.000]***
F-stat. governance & risk management		2.02	5.04	1.03	4.71		0.43	4.88	1.18	3.67
[Prob > *F*]		[0.074]*	[0.000]***	[0.400]	[0.000]***		[0.829]	[0.000]***	[0.319]	[0.003]***
F-stat. announcement characteristics		2.38	1.85	1.44	3.36		3.16	2.88	0.89	3.49
[Prob > *F*]		[0.037]**	[0.101]	[0.210]	[0.005]***		[0.008]***	[0.014]**	[0.488]	[0.004]***
R^2		0.3423	0.3048	0.0415	0.1450		0.1765	0.1590	0.0872	0.1141
AIC		2,724.63	3,645.45	2,558.99	3,404.97		4,516.69	6,332.57	4,049.67	5,528.27
BIC		2,815.66	3,742.52	2,650.03	3,502.05		4,607.73	6,429.65	4,140.71	5,625.35

Panel B: Settlement announcements

Variable	Exp. Sign	Effective Spread				Exp. Sign	Price Impact of Trade (30 min)			
		Level		Change (Δ)			Level		Change (Δ)	
		(1) $t=[-3,-1]$	(2) $t=[0,+3]$	(3) $t=[-3,-1]$	(4) $t=[0,+3]$		(5) $t=[-3,-1]$	(6) $t=[0,+3]$	(7) $t=[-3,-1]$	(8) $t=[0,+3]$
Governance and Risk Management:										
BOARD INDEPENDENCE	+	0.0013	0.0037	0.0039	0.0053	+	-0.0118	-0.0326	0.0119	0.0032
		(0.15)	(0.49)	(0.55)	(0.89)		(-0.58)	(-1.95)*	(0.48)	(0.16)
INSIDER OWNERSHIP	+	0.0370	0.0567	0.0224	0.0403	+	0.1108	0.0876	0.0728	0.0755
		(1.44)	(2.32)**	(1.28)	(2.40)**		(1.78)*	(1.71)*	(1.26)	(1.50)
BLOCK OWNERSHIP	+	0.0056	0.0109	0.0168	0.0136	+	0.0269	0.0175	0.0898	0.0764
		(0.51)	(1.10)	(2.22)**	(1.92)*		(1.03)	(1.03)	(2.05)**	(1.98)**
GINDEX	−	-0.0660	-0.0364	-0.0175	0.0039	−	-0.1605	-0.0029	0.1569	0.3228
		(-1.56)	(-1.08)	(-0.49)	(0.14)		(-1.66)*	(-0.04)	(1.18)	(2.62)***
RISK MANAGEMENT SCORE	+	-0.0988	-0.0884	-0.0241	-0.0470	+	-0.0581	-0.2092	0.5169	0.3043
		(-1.46)	(-1.80)*	(-0.41)	(-1.13)		(-0.36)	(-2.26)**	(2.52)**	(1.97)**
Announcement Characteristics:										
INTERNAL FRAUD	+	0.3634	0.2718	0.4073	0.3402	+	0.9155	0.7402	-0.2811	-0.8123
		(1.11)	(0.93)	(1.27)	(1.29)		(1.04)	(1.45)	(-0.15)	(-0.48)
EXTERNAL FRAUD	−	-0.1800	-0.3799	0.2969	0.0020	−	-1.3798	-0.5904	1.2133	1.9464
		(-0.44)	(-1.38)	(0.94)	(0.01)		(-1.81)*	(-1.25)	(0.90)	(1.72)*
CLIENTS, PRODUCTS, & BUS. PRACTICES	+	0.2821	0.2375	0.2749	0.2786	+	0.3434	0.6678	2.0959	3.1311
		(1.09)	(0.99)	(1.22)	(1.36)		(0.57)	(1.68)*	(1.46)	(2.62)***
DISCLOSED BY FIRM	+	0.2626	0.2726	0.2507	0.1980	+	0.5631	0.7685	-1.1007	-0.7576
		(1.34)	(1.74)*	(1.68)*	(1.65)*		(1.20)	(2.33)**	(-1.54)	(-1.38)
LOSS ANNOUNCED	+	0.8007	0.9941	0.6335	0.9011	+	1.9373	2.1798	-0.8045	-0.1702
		(2.95)***	(4.73)***	(1.55)	(2.14)**		(1.98)**	(4.08)***	(-0.74)	(-0.16)
Control Variables:										
NUMBER OF ANALYSTS		0.1063	0.1074	-0.0042	-0.0029		0.2254	0.1672	-0.0868	-0.0909
		(5.56)***	(6.51)***	(-0.30)	(-0.24)		(4.47)***	(4.53)***	(-1.21)	(-1.62)
FIRM SIZE		0.4195	0.4783	0.0919	0.0917		0.3067	0.6502	0.3806	0.6451
		(4.33)***	(5.94)***	(1.57)	(1.80)*		(1.10)	(3.65)***	(1.07)	(2.01)**
VOLATILITY		-0.0223	-0.0439	-0.0445	-0.0519		-0.4062	-0.1895	-0.3196	-0.1487
		(-0.32)	(-0.75)	(-0.93)	(-1.30)		(-2.35)**	(-1.38)	(-1.47)	(-0.81)
LEVERAGE		0.4542	0.5498	-1.1371	-0.8260		1.5670	1.6275	-5.4502	-4.6825
		(0.59)	(0.96)	(-2.00)**	(-1.91)*		(0.84)	(1.51)	(-2.43)**	(-2.78)***
BETA		-0.2198	0.0277	-0.0923	0.2698		1.7631	1.2997	-0.1185	0.2127
		(-0.78)	(0.11)	(-0.45)	(1.44)		(2.11)**	(1.91)*	(-0.12)	(0.27)
(Δ) PRICE		-0.0175	-0.0198	-0.0107	-0.0108		-0.0237	-0.0336	-0.0040	-0.0529
		(-4.45)***	(-5.97)***	(-1.34)	(-1.72)*		(-2.55)**	(-5.21)***	(-0.09)	(-1.50)
(Δ) VOLUME		-0.7165	-0.8214	0.2912	0.3716		-0.7208	-0.9068	-0.2616	0.7091
		(-6.20)***	(-9.52)***	(1.58)	(3.44)***		(-3.19)***	(-4.72)***	(-0.25)	(1.08)
DECIMAL		1.6638	1.6915	-0.1091	-0.0564		3.8586	3.6454	-2.9426	-2.7555
		(6.08)***	(7.23)***	(-0.71)	(-0.41)		(6.51)***	(7.81)***	(-2.95)***	(-3.27)***
BANKS		-0.8064	-0.5656	0.0790	0.1860		-0.3703	0.0039	2.0614	1.9717
		(-3.01)***	(-2.54)**	(0.38)	(1.03)		(-0.53)	(0.01)	(2.11)**	(2.43)**
INSURERS		-1.1227	-0.7653	-0.3643	-0.1046		-0.5359	0.2518	0.7057	1.4888
		(-2.88)***	(-2.80)***	(-1.18)	(-0.53)		(-0.50)	(0.41)	(0.71)	(2.26)**
Constant		4.2492	3.9648	-1.7017	-2.9286		2.3731	1.5794	-3.1891	-10.1394
		(3.34)***	(3.64)***	(-1.99)**	(-3.67)***		(0.78)	(0.66)	(-0.68)	(-2.47)**
Number of observations		864	1,150	864	1,150		864	1,150	864	1,150
F-stat. all variables		7.00	10.36	1.41	2.30		5.66	7.29	1.25	2.20
[Prob > *F*]		[0.000]***	[0.000]***	[0.111]	[0.001]***		[0.000]***	[0.000]***	[0.203]	[0.002]***
F-stat. governance & risk management		1.71	2.90	1.95	2.99		2.74	6.38	2.11	2.37
[Prob > *F*]		[0.129]	[0.013]**	[0.083]*	[0.011]**		[0.018]**	[0.000]***	[0.062]*	[0.038]**
F-stat. announcement characteristics		2.98	6.74	1.44	2.50		3.09	5.99	0.96	3.10
[Prob > *F*]		[0.011]**	[0.000]***	[0.206]	[0.029]**		[0.009]***	[0.000]***	[0.440]	[0.009]***
R^2		0.2489	0.3137	0.0323	0.0505		0.1241	0.1723	0.0435	0.0640
AIC		4,063.22	5,315.28	3,727.96	4,832.68		5,667.84	7,094.78	6,450.64	8,339.80
BIC		4,163.21	5,421.28	3,827.95	4,938.68		5,767.84	7,200.78	6,550.63	8,445.79

Figure 4: Risk Management in Firms with Operational Risk Announcements during 1995-2013

This figure illustrates the time series behavior of risk management traits of the firms in our sample.

Panel A: First announcements
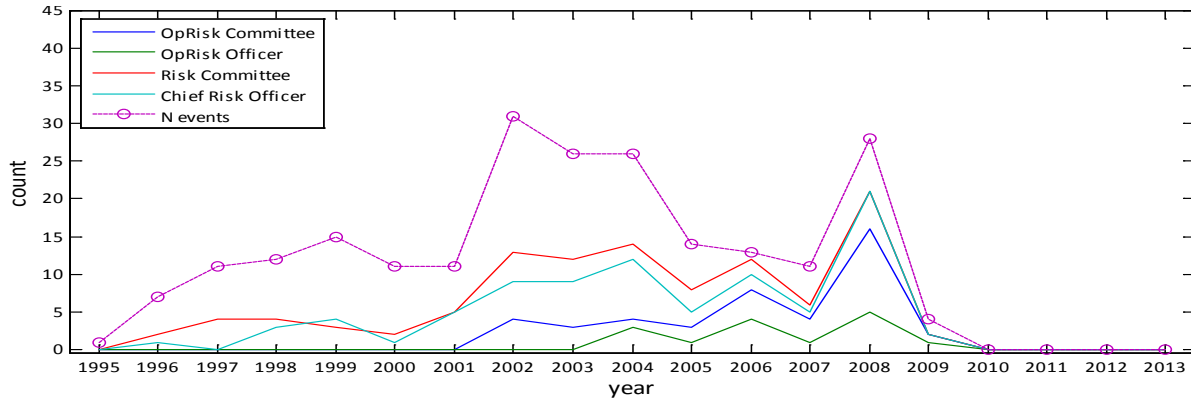
Panel B: Settlement announcements
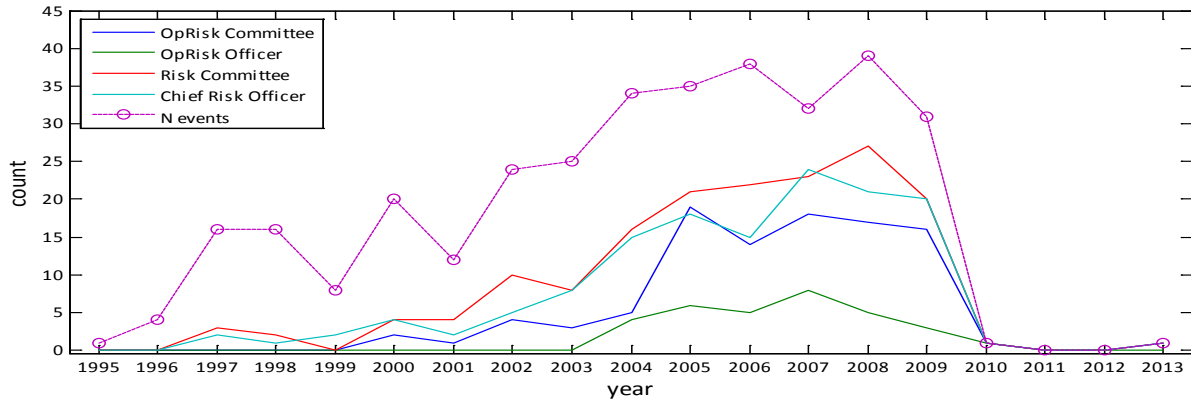
Table 7: Descriptive Statistics of Risk Management Variables

This table describes sample statistics of the risk management variables in our sample data, for events in firms with non-zero values of these variables.

Variable Name	Examples of Titles from Our Data	Sample Descriptive Statistics				
			Mean (years)	Min (years)	Max (years)	Count	Prop.
OPRISK OFFICER	Chief Operational Risk Officer, Operational Risk Manager, Head of Operational Risk	First ann.				15	7.61%
		Settlement				32	10.74%
OPRISK OFFICER YEARS		First ann.	2.00	0.5	5		
		Settlement	1.97	0.5	6		
OPRISK COMMITTEE	Compliance and Operational Risk Committee, Operational Risk Committee, Operational Risk Management Group, Enterprise Operational Risk Management, Operational Risk Council, Operational Risk Oversight Committee	First ann.				44	22.33%
		Settlement				101	33.89%
OPRISK COMMITTEE YEARS		First ann.	2.83	0.5	8		
		Settlement	2.82	0.5	9		
CHIEF RISK OFFICER	Chief/Senior Risk Officer, Enterprise Risk Officer, Chief Risk Management Officer, Chief Risk Policy Officer, Senior Vice President for Risk Management	First ann.				87	44.16%
		Settlement				139	46.64%
CHIEF RISK OFFICER YEARS		First ann.	3.52	0.5	12		
		Settlement	4.46	0.5	14		
RISK COMMITTEE	Global Risk Committee, Risk Management Committee, Risk Policy Committee, Risk Oversight Committee, Firmwide Risk Committee, Enterprise Risk Committee	First ann.				108	54.82%
		Settlement				162	54.36%
RISK COMMITTEE YEARS		First ann.	4.96	0.5	15		
		Settlement	5.81	0.5	16		
CHAIR ON RC		First ann.				18	9.14%
		Settlement				14	4.70%

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Table 8: Multivariate Results: Information Asymmetry and Risk Management

This table focuses on the impact of individual risk management variables on information asymmetry around operational risk announcements. The dependent variable is the change in price impact of trade from non-event period during the event window $t = [-3,+3]$. Models (1) and (5) in this table are Models (4) and (8) from Table 5, respectively. t-statistics based on heteroscedasticity-robust standard errors are reported in parentheses. Superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Exp. Sign	First Announcements Change (Δ) in Price Impact of Trade (30 min)				Exp. Sign	Settlement Announcements Change (Δ) in Price Impact of Trade (30 min)			
		(1)	(2)	(3)	(4)		(5)	(6)	(7)	(8)
Governance:										
BOARD INDEPENDENCE	—	-0.0294	-0.0341	-0.0216	-0.0284	+	0.0349	0.0188	0.0130	0.0230
		(-1.15)	(-1.28)	(-0.84)	(-1.03)		(2.40)**	(1.12)	(0.84)	(1.34)
INSIDER OWNERSHIP	—	-0.0661	-0.0698	-0.0592	-0.0540	+	0.0995	0.0803	0.0841	0.0939
		(-1.88)*	(-1.99)**	(-1.60)	(-1.47)		(2.77)***	(2.17)**	(2.41)**	(2.74)***
BLOCK OWNERSHIP	—	-0.0363	-0.0456	-0.0265	-0.0364	+	0.0686	0.0854	0.1044	0.1095
		(-1.58)	(-1.94)*	(-0.91)	(-1.19)		(2.33)**	(2.92)***	(3.53)***	(3.63)***
GINDEX	+	-0.0792	-0.1050	-0.0595	-0.0370	—	0.1118	0.2002	0.1360	0.1573
		(-0.69)	(-0.96)	(-0.45)	(-0.28)		(1.26)	(2.38)**	(1.43)	(1.63)
Risk Management:										
RISK MANAGEMENT SCORE	—	0.3000				+	0.2021			
		(1.72)*					(1.77)*			
OPRISK OFFICER	—		-1.5903		-1.5542	+		2.2611		2.5937
			(-0.80)		(-0.80)			(1.98)**		(2.30)**
OPRISK OFFICER*OPRISK OFFICER YEARS	—		0.3011		0.1849	+		0.4100		0.1324
			(0.52)		(0.33)			(1.50)		(0.43)
ORISK COMMITTEE	—		1.6595		1.9155	+		1.1215		1.0367
			(1.65)*		(1.67)*			(1.52)		(1.00)
ORISK COMM*OPRISK COMM YEARS	—		0.1190		0.0717	+		-0.3843		-0.3406
			(0.53)		(0.30)			(-3.03)***		(-2.48)**
CHIEF RISK OFFICER	—			-0.0599	-0.2478	+			1.7979	1.2748
				(-0.08)	(-0.35)				(2.65)***	(2.14)**
CHIEF RISK OFFICIER*CRO YEARS	—			0.1179	0.0611	+			0.1867	0.1671
				(1.16)	(0.55)				(2.31)**	(1.76)*
RISK COMMITTEE	—			-0.2943	-0.5321	+			-1.4893	-2.1225
				(-0.35)	(-0.55)				(-2.66)***	(-2.59)***
RISK COMMITTEE*RISK COMM YEARS	—			0.0712	0.0841	+			-0.1005	-0.0651
				(0.78)	(0.86)				(-1.93)*	(-1.16)
RISK COMMITTEE*CHAIR ON RC	—			2.4836	2.8087	+			1.6817	1.7572
				(1.93)*	(2.10)**				(2.01)**	(2.09)**
Announcement Characteristics:										
INTERNAL FRAUD	+	1.8281	1.7626	1.6667	1.5717	+	-0.2614	0.1181	-1.1645	-0.4854
		(2.57)***	(2.52)**	(2.29)**	(2.20)**		(-0.20)	(0.09)	(-0.90)	(-0.35)
EXTERNAL FRAUD	+	-0.0502	-0.2195	-0.2938	-0.6329	—	2.1111	2.3190	0.9773	1.4399
		(-0.08)	(-0.33)	(-0.44)	(-0.90)		(2.43)**	(2.56)**	(1.11)	(1.57)
CLIENTS, PRODUCTS, & BUS. PRACTICES	+	1.3605	1.1635	1.4294	1.2090	+	2.8729	3.2269	2.3383	2.8890
		(1.82)*	(1.49)	(1.93)*	(1.54)		(3.32)***	(3.25)***	(2.47)**	(2.80)***
DISCLOSED BY FIRM	—	-0.4756	-0.4513	-0.7152	-0.7350	+	-0.6569	-0.9283	-1.0348	-1.0725
		(-1.03)	(-0.99)	(-1.49)	(-1.54)		(-1.62)	(-2.12)**	(-2.32)**	(-2.40)**
LOSS ANNOUNCED	—	1.2339	1.2283	1.0983	1.0494	+	-0.4417	-0.0455	-0.6534	-0.4559
		(2.06)**	(1.98)**	(1.73)*	(1.61)		(-0.56)	(-0.06)	(-0.82)	(-0.54)
Control Variables		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Number of observations		1,316	1,316	1,316	1,316		2,014	2,014	2,014	2,014
F-stat. all variables		3.34	3.03	3.18	2.93		2.70	3.20	2.95	3.20
[Prob > *F*]		[0.000]***	[0.000]***	[0.000]***	[0.000]***		[0.000]***	[0.000]***	[0.000]***	[0.000]***
F-stat. risk management			1.16	1.58	1.46			5.40	4.48	3.66
[Prob > *F*]			[0.325]	[0.163]	[0.158]		[0.000]***	[0.000]***	[0.001]***	[0.000]***
R²		0.0821	0.0830	0.0860	0.0889		0.0780	0.0548	0.0623	0.0678
AIC		9,573.49	9,578.19	9,575.90	9,579.77		14,707.46	14,763.69	17,749.46	14,745.73
BIC		9,682.32	9,702.56	9,705.46	9,730.06		14,825.23	14,898.28	14,889.66	14,908.36

Table 9: Robustness Checks for Determinants of Information Asymmetry

This table presents the results of robustness checks. The dependent variable is the change in price impact of trade from non-event period during $t = [-3,+3]$. Model 0 in Panel A is Model (4) for first announcements and in Panel B is Model (8) for the settlement announcements from Table 5, respectively. In RC1 the dependent variable is the average change in effective spread per transaction during the event period, and the data is in cross-section form. In RC2 we exclude the post-credit crisis period. Additionally, we run separate models for fraud (RC3), Clients, Products, and Business Practices events (RC4), and all other events (RC5). In RC6 we include year fixed effects. In RC7 we eliminate events disclosed during scheduled earnings announcements or restatement announcements. In RC8, we redefine our risk management score as an additive index obtained by the sum of six risk management variables: OPRISK OFFICER, OPRISK COMMITTEE, CHAIR ON OPRISK COMMITTEE, CHIEF RISK OFFICER, RISK COMMITTEE, and CHAIR ON RISK COMMITTEE. t-statistics based on heteroscedasticity-robust standard errors are reported in parentheses. Superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Change in price impact of trade around first announcements

Variable	Exp. Sign	Model 0 Table 5: Model (4)	RC1 Cross-Section	RC2 Pre-Crisis	RC3 Events: Fraud	RC4 Events: CPBP	RC5 Events: Other	RC6 Incl. Year Fixed Eff.	RC7 Excl. Earn. Ann.	RC8 RM Score
Governance & Risk Mangmt:										
BOARD INDEPENDENCE	—	-0.0294	-0.0279	-0.0299	-0.0157	-0.0161	0.0307	-0.0167	-0.0208	-0.0319
		(-1.15)	(-0.68)	(-1.13)	(-0.71)	(-0.36)	(0.22)	(-0.61)	(-0.75)	(-1.25)
INSIDER OWNERSHIP	—	-0.0661	-0.0579	-0.0648	-0.1264	-0.0387	0.1892	-0.0770	-0.0652	-0.0690
		(-1.88)*	(-1.03)	(-1.83)*	(-1.16)	(-0.81)	(0.76)	(-2.10)**	(-1.81)*	(-1.90)*
BLOCK OWNERSHIP	—	-0.0363	-0.0359	-0.0341	0.0066	-0.0834	-0.0210	-0.0284	-0.0405	-0.0349
		(-1.58)	(-1.07)	(-1.49)	(0.31)	(-1.99)**	(-0.13)	(-1.25)	(-1.67)*	(-1.52)
GINDEX	+	-0.0792	-0.0693	-0.0795	-0.1353	-0.1503	0.1788	0.0142	-0.0299	-0.0838
		(-0.69)	(-0.37)	(-0.66)	(-0.91)	(-0.85)	(1.09)	(0.10)	(-0.25)	(-0.73)
RISK MANAGEMENT SCORE	—	0.3000	0.2979	0.3131	0.0420	0.5945	-0.3394	0.5498	0.4215	0.5116
		(1.72)*	(0.91)	(1.60)	(0.29)	(2.50)**	(-0.57)	(2.55)**	(2.16)**	(1.61)
Announcement Characteristics:										
INTERNAL FRAUD	+	1.8281	1.8641	1.8876				2.0833	1.9186	1.7969
		(2.57)***	(1.59)	(2.60)***				(2.74)***	(2.28)**	(2.52)**
EXTERNAL FRAUD	+	-0.0502	-0.0243	-0.1889				0.3290	-1.2408	-0.0290
		(-0.08)	(-0.02)	(-0.28)				(0.58)	(-1.39)	(-0.04)
CLIENTS, PROD., & BUS. PRAC.	+	1.3605	1.4094	1.3334				1.5488	0.8933	1.3865
		(1.82)*	(1.12)	(1.69)*				(1.95)*	(1.08)	(1.87)*
DISCLOSED BY FIRM	—	-0.4756	-0.5370	-0.5479	-0.8856	-0.4281	1.9499	-0.4277	0.1599	-0.6100
		(-1.03)	(-0.68)	(-1.09)	(-2.13)**	(-0.58)	(0.85)	(-0.88)	(0.32)	(-1.25)
LOSS ANNOUNCED	—	1.2339	1.2502	1.3345	1.2647	2.0435	1.2058	0.6956	1.4739	1.2193
		(2.06)**	(1.15)	(2.15)**	(1.69)*	(2.43)**	(1.11)	(1.10)	(2.31)**	(2.01)**
Control Variables:										
NUMBER OF ANALYSTS		0.1393	0.1364	0.1308	-0.0740	0.2772	-0.0977	0.0967	0.1826	0.1233
		(1.94)*	(1.02)	(1.87)*	(-1.35)	(2.71)***	(-0.31)	(1.31)	(2.38)**	(1.82)*
FIRM SIZE		-1.5782	-1.5623	-1.5613	-0.1800	-2.4363	0.3794	-1.3672	-1.8424	-1.5343
		(-4.32)***	(-2.10)**	(-4.39)***	(-0.62)	(-4.74)***	(0.35)	(-4.64)***	(-4.38)***	(-4.28)***
VOLATILITY		-0.3659	-0.3892	-0.3462	0.0538	0.4431	-1.0798	1.5563	-0.1873	-0.3276
		(-1.37)	(-0.90)	(-0.84)	(0.17)	(0.75)	(-0.75)	(1.61)	(-0.72)	(-1.19)
LEVERAGE		-0.7955	-0.6017	-0.9776	2.9241	0.5513	-6.1424	-0.9416	-0.1200	-1.0719
		(-0.40)	(-0.26)	(-0.48)	(1.47)	(0.17)	(-1.41)	(-0.46)	(-0.07)	(-0.54)
BETA		3.3125	3.1489	3.4281	-1.6574	2.0706	7.0813	1.3647	3.5712	3.3367
		(3.14)***	(1.55)	(3.02)***	(-1.64)	(1.50)	(1.01)	(1.11)	(3.32)***	(3.21)***
(Δ) PRICE		-0.0078	0.0101	-0.0094	-0.0276	0.0019	-0.0911	-0.0213	-0.0050	-0.0076
		(-0.16)	(0.26)	(-0.16)	(-1.43)	(0.02)	(-0.65)	(-0.43)	(-0.1)	(-0.16)
(Δ) VOLUME		1.8413	2.4429	1.9667	1.8397	2.8188	-1.9428	1.6666	1.8735	1.8303
		(2.59)***	(2.55)**	(2.60)***	(4.18)***	(2.52)**	(-1.42)	(2.33)**	(2.43)**	(2.57)***
DECIMAL		2.5379	2.4654	2.5494	-0.2760	5.5665	-2.0096	30.4391	2.6060	2.4589
		(3.23)***	(1.65)	(3.17)***	(-0.46)	(3.84)***	(-0.39)	(22.12)***	(3.2)***	(3.05)***
BANKS		0.5328	0.5373	0.7189	0.6342	1.2694	2.2277	0.6667	1.0953	0.4277
		(0.76)	(0.47)	(0.89)	(1.23)	(1.15)	(2.52)**	(0.74)	(1.53)	(0.62)
INSURERS		1.5359	1.4025	1.5849	5.0655	1.1109	2.9351	0.5194	2.0571	1.5462
		(1.38)	(1.03)	(1.37)	(3.62)***	(0.59)	(0.43)	(0.44)	(1.98)**	(1.39)
Constant		13.7076	13.5552	13.4720	6.8448	19.4936	-14.6852	-28.2306	14.0954	13.1202
		(3.83)***	(2.31)**	(3.70)***	(1.75)*	(4.03)***	(-1.10)	(-4.15)***	(3.72)***	(3.82)***
Number of observations		1,316	188	1,260	364	777	175	1,316	1,190	1,316
F-stat. all variables		3.34	1.49	3.28	3.70	3.39	10.15	82.04	3.56	3.32
[Prob > *F*]		[0.000]***	[0.092]*	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***	[0.000]***
F-stat. govern. & risk mangmt		3.65	1.22	3.52	1.05	3.91	2.04	4.93	3.83	3.66
[Prob > *F*]		[0.003]***	[0.300]	[0.004]***	[0.391]	[0.002]***	[0.076]**	[0.000]***	[0.002]***	[0.003]***
F-stat. announcement charact.		3.13	1.38	3.28	2.73	3.05	0.69	2.35	4.02	3.11
[Prob > *F*]		[0.008]***	[0.236]	[0.006]***	[0.067]*	[0.048]**	[0.501]	[0.039]**	[0.001]***	[0.009]***
R^2		0.0821	0.1931	0.0828	0.2531	0.1083	0.2150	0.1417	0.0925	0.0827
AIC		9,573.49	1,211.21	9,220.57	2,061.73	5,942.22	1,134.48	9,511.25	8,688.68	9,572.62
BIC		9,682.32	1,279.17	9,328.48	2,131.87	6,026.01	1,191.45	9,687.45	8,795.40	9,681.45

Panel B: Change in price impact of trade around settlement announcements

Variable	Exp. Sign	Model 0 Table 5: Model (8)	RC1 Cross-Section	RC2 Pre-Crisis	RC3 Events: Fraud	RC4 Events: CPBP	RC5 Events: Other	RC6 Incl. Year Fixed Eff.	RC7 Excl. Earn. Ann.	RC8 RM Score
Governance & Risk Mangmt:										
BOARD INDEPENDENCE	+	0.0079	0.0072	0.0077	0.2085	0.0228	-0.3189	-0.0112	-0.0024	0.0051
		(0.51)	(0.20)	(0.47)	(2.99)***	(1.48)	(-3.43)***	(-0.55)	(-0.15)	(0.32)
INSIDER OWNERSHIP	+	0.0752	0.0751	0.0857	0.1633	0.0961	-2.2194	0.0881	0.0753	0.0731
		(2.00)**	(0.74)	(2.12)**	(2.05)**	(2.86)***	(-3.71)***	(2.40)**	(1.99)**	(1.94)*
BLOCK OWNERSHIP	+	0.0838	0.0831	0.0927	0.0918	0.0435	0.0124	0.0771	0.0895	0.0832
		(2.88)***	(1.26)	(2.97)***	(1.61)	(1.86)*	(0.08)	(2.59)***	(2.92)***	(2.87)***
GINDEX	—	0.2528	0.2516	0.2589	1.4757	-0.1001	2.0428	0.2334	0.3085	0.2329
		(2.79)***	(1.16)	(2.79)***	(3.98)***	(-1.61)	(3.94)***	(2.72)***	(3.01)***	(2.63)***
RISK MANAGEMENT SCORE	+	0.3956	0.3958	0.3313	0.5518	0.3230	1.9533	0.2576	0.4430	0.5798
		(3.19)***	(1.41)	(2.32)**	(2.04)**	(2.46)**	(2.73)***	(2.21)**	(3.21)***	(3.14)***
Announcement Characteristics:										
INTERNAL FRAUD	+	-0.5769	-0.5918	-0.8365				-0.6683	-0.3583	-0.5189
		(-0.46)	(-0.18)	(-0.60)				(-0.53)	(-0.27)	(-0.41)
EXTERNAL FRAUD	—	1.6934	1.6854	2.2196				0.5613	1.6814	1.7975
		(1.96)**	(0.75)	(2.40)**				(0.61)	(1.88)*	(2.06)**
CLIENTS, PROD., & BUS. PRAC.	+	2.7015	2.6876	2.6802				2.6653	3.0022	2.8056
		(2.95)***	(1.15)	(2.64)***				(2.82)***	(3.11)***	(3.02)***
DISCLOSED BY FIRM	+	-0.8801	-0.8865	-0.8858	-5.2057	0.6166	-3.0098	-0.7033	-1.0020	-0.8594
		(-2.02)**	(-0.97)	(-1.80)*	(-4.55)***	(1.43)	(-2.15)**	(-1.94)*	(-2.10)**	(-1.98)**
LOSS ANNOUNCED	+	-0.4558	-0.4681	-0.5327	-9.9240	1.3557	—	-1.2371	-0.6077	-0.4251
		(-0.61)	(-0.27)	(-0.56)	(-4.22)***	(1.45)	—	(-1.56)	(-0.78)	(-0.58)
Control Variables:										
NUMBER OF ANALYSTS		-0.0895	-0.0898	-0.1142	0.1185	-0.0728	-1.0889	-0.0695	-0.0722	-0.0864
		(-2.02)**	(-0.88)	(-2.21)**	(0.75)	(-1.59)	(-4.24)***	(-1.60)	(-1.65)*	(-1.94)*
FIRM SIZE		0.5356	0.5392	0.5841	3.4865	0.1157	-1.3046	0.4715	0.5586	0.5455
		(2.24)**	(0.96)	(2.37)**	(2.95)***	(0.77)	(-0.94)	(2.15)**	(2.24)**	(2.28)**
VOLATILITY		-0.2236	-0.2168	-0.6855	2.4498	-0.3557	-3.8670	-0.5735	-0.3010	-0.1685
		(-1.60)	(-0.65)	(-1.80)*	(4.35)***	(-2.96)***	(-2.96)***	(-2.31)**	(-2.08)**	(-1.22)
LEVERAGE		-5.0631	-5.0260	-4.9276	12.7854	-2.5421	-40.5904	-6.0236	-5.0516	-5.0531
		(-3.71)***	(-1.62)	(-3.39)***	(3.22)***	(-1.98)**	(-4.30)***	(-4.23)***	(-3.63)***	(-3.70)***
BETA		0.0318	0.0218	-0.5694	-16.6076	0.4141	-0.1587	0.4249	0.1311	0.0022
		(0.05)	(0.02)	(-0.69)	(-4.42)***	(0.59)	(-0.02)	(0.59)	(0.21)	(0.00)
(Δ) PRICE		-0.0363	-0.0300	-0.0381	-0.0610	0.0369	-0.3600	-0.0290	-0.0371	-0.0368
		(-1.29)	(-0.54)	(-0.81)	(-1.31)	(1.09)	(-2.65)***	(-1.04)	(-1.25)	(-1.31)
(Δ) VOLUME		0.3573	0.5426	0.2600	3.7139	0.6061	-8.7102	0.4957	0.3481	0.3660
		(0.62)	(0.29)	(0.38)	(2.82)***	(1.13)	(-3.67)***	(0.87)	(0.59)	(0.64)
DECIMAL		-2.8351	-2.8375	-3.2308	-10.2268	-1.2308	-5.6823	1.5308	-2.8822	-2.8518
		(-4.41)***	(-1.90)*	(-4.02)***	(-4.17)***	(-2.38)**	(-2.89)***	(1.41)	(-4.28)***	(-4.45)***
BANKS		1.9993	1.9827	1.8842	-1.7467	2.0699	-0.0915	1.8822	2.2613	1.8482
		(3.21)***	(1.36)	(2.58)***	(-0.81)	(3.48)***	(-0.03)	(2.97)***	(3.43)***	(3.03)***
INSURERS		1.1482	1.1519	0.8531	9.9168	0.6421	-8.7115	0.9637	1.4387	1.1848
		(2.03)**	(0.99)	(1.32)	(2.93)***	(1.17)	(-1.79)*	(1.54)	(2.41)**	(2.10)**
Constant		-7.2450	-7.1872	-5.5652	-48.5027	-2.1456	73.8827	-5.6262	-7.7493	-8.0583
		(-2.35)**	(-1.07)	(-1.43)	(-2.94)***	(-0.98)	(3.24)***	(-1.79)*	(-2.45)**	(-2.67)***
Number of observations		2,014	288	1,734	378	1,405	231	2,014	1,937	2,014
F-stat. all variables		2.99	0.92	2.78	2.63	2.85	2.30	2.45	2.75	2.99
[Prob > *F*]		[0.000]***	[0.567]	[0.000]***	[0.001]***	[0.000]***	[0.004]***	[0.000]***	[0.000]***	[0.000]***
F-stat. govern. & risk mangmt		4.05	0.70	3.95	4.39	3.71	4.63	4.18	4.00	4.05
[Prob > *F*]		[0.001]***	[0.623]	[0.002]***	[0.001]***	[0.002]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***
F-stat. announcement charact.		3.55	0.68	3.37	12.68	1.88	4.60	3.97	3.38	3.69
[Prob > *F*]		[0.003]***	[0.636]	[0.005]***	[0.000]***	[0.153]	[0.033]**	[0.001]***	[0.005]***	[0.003]***
R^2		0.0505	0.0725	0.0534	0.3754	0.0457	0.4054	0.1002	0.0533	0.0510
AIC		14,766.67	2,033.87	12,967.00	2,809.00	9,687.89	1,793.10	14,684.56	14,261.40	14,765.58
BIC		14,884.44	2,110.79	13,081.62	2,879.83	9,782.35	1,851.62	14,875.23	14,378.35	14,883.35

Note: For RC5, LOSS ANNOUNCED took the value of 1 for all events and was therefore dropped from the estimation due to lack of variability in the variable.

Table 10: Simultaneous Determination of Liquidity and Information Asymmetry

This table presents the results of the simultaneous equations model for the determinants of liquidity and information asymmetry around first announcements and settlement announcements of operational risk events. For each of the four specifications, the dependent variable is the change in daily quoted depth in the first equation, and change in a daily measure of information asymmetry from the non-event period during the event window $t = [-3,+3]$. The two measures of information asymmetry are effective spread (ΔES) and price impact of trade (30 min) (ΔPIT). t-statistics based on heteroscedasticity-robust standard errors are reported in parentheses. Superscripts ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Variable	Exp. Sign	First Announcements ΔINFORMATION ASYMMETRY=ΔES (1) ΔDEPTH	(2) ΔES	ΔINFORMATION ASYMMETRY=ΔPIT (3) ΔDEPTH	(4) ΔPIT	Exp. Sign	Settlement Announcements ΔINFORMATION ASYMMETRY=ΔES (5) ΔDEPTH	(6) ΔES	ΔINFORMATION ASYMMETRY=ΔPIT (7) ΔDEPTH	(8) ΔPIT
Δ INFORMATION ASYMMETRY	—	-0.0091 (-2.07)**		0.0012 (1.08)		—	-0.0180 (-4.74)***		-0.0022 (-2.71)***	
Δ QUOTED DEPTH	—		-0.4144 (-2.40)**		0.9937 (1.45)	—		-0.6464 (-4.92)***		-1.8718 (-3.03)***
Governance and Risk Management:										
BOARD INDEPENDENCE		0.0012 (1.22)	-0.0226 (-3.65)***	0.0015 (1.47)	-0.0354 (-1.44)		0.0003 (0.44)	0.0055 (1.22)	0.0003 (0.36)	0.0091 (0.43)
INSIDER OWNERSHIP		-0.0006 (-0.29)	-0.0246 (-1.82)*	-0.0003 (-0.15)	-0.0935 (-1.74)*		-0.0027 (-2.47)**	0.0299 (4.66)***	-0.0031 (-2.85)***	0.0682 (2.26)**
BLOCK OWNERSHIP		-0.0021 (-1.64)	-0.0246 (-3.03)***	-0.0019 (-1.45)	-0.0350 (-1.09)		-0.0030 (-3.11)***	0.0136 (2.42)**	-0.0030 (-3.19)***	0.0786 (2.99)***
GINDEX		-0.0001 (-0.01)	0.0397 (1.35)	-0.0004 (-0.07)	-0.1028 (-0.88)		0.0103 (2.82)***	0.0001 (0)	0.0110 (3.01)***	0.2720 (2.68)***
RISK MANAGEMENT SCORE		-0.0240 (-3.26)***	0.0486 (1.10)	-0.0246 (-3.34)***	0.3174 (1.81)*		0.0068 (1.21)	-0.0301 (-0.95)	0.0083 (1.47)	0.4203 (2.83)***
Announcement Characteristics:										
DISCLOSED BY FIRM		0.1536 (6.09)***	0.1465 (0.93)	0.1527 (6.05)***	-0.3819 (-0.61)		-0.0374 (-2.33)**	0.2120 (2.26)**	-0.0433 (-2.71)***	-0.9277 (-2.11)**
LOSS ANNOUNCED		-0.0587 (-2.58)***	0.3031 (2.13)**	-0.0636 (-2.80)***	1.3290 (2.35)**		-0.0113 (-0.21)	0.7715 (2.41)**	-0.0261 (-0.48)	-0.4906 (-0.33)
INTERNAL FRAUD		-0.0134 (-0.33)	0.3261 (1.28)	-0.0193 (-0.47)	1.8768 (1.85)*		0.0647 (1.97)**	0.4174 (2.17)**	0.0570 (1.74)*	-0.4403 (-0.49)
EXTERNAL FRAUD		0.0082 (0.19)	0.2905 (1.06)	0.0058 (0.13)	-0.1335 (-0.12)		0.0638 (1.64)	0.1866 (0.81)	0.0651 (1.67)*	1.8343 (1.71)*
CLIENTS, PRODUCTS, & BUS. PRACTICES		0.0377 (1.14)	0.2133 (1.04)	0.0338 (1.03)	1.2768 (1.56)		-0.0116 (-0.46)	0.2624 (1.76)*	-0.0102 (-0.4)	2.6835 (3.84)***
Control Variables:										
NUMBER OF ANALYSTS		0.0032 (1.28)	0.0124 (0.84)	0.0030 (1.19)	0.1434 (2.43)**		0.0002 (0.09)	-0.0020 (-0.19)	0.0000 (0.01)	-0.0848 (-1.77)*
FIRM SIZE		-0.0059 (-0.45)	-0.1551 (-2.36)**	-0.0019 (-0.14)	-1.6287 (-6.23)***		-0.0215 (-2.33)**	0.0879 (2.09)**	-0.0225 (-2.43)**	0.5248 (2.66)***
VOLATILITY		-0.0302 (-1.98)**	-0.0817 (-0.87)	-0.0287 (-1.89)*	-0.3107 (-0.83)		0.0224 (3.47)***	-0.0409 (-1.09)	0.0227 (3.52)***	-0.1866 (-1.06)
LEVERAGE		0.0033 (0.04)	0.0090 (0.02)	0.0039 (0.05)	-1.4677 (-0.72)		0.0610 (1.09)	-0.9546 (-3.03)***	0.0672 (1.2)	-5.0669 (-3.43)***
BETA		0.3047 (6.53)***	0.2942 (1.00)	0.2980 (6.36)***	3.6158 (3.09)***		-0.0387 (-1.39)	0.0942 (0.58)	-0.0404 (-1.45)	-0.0361 (-0.05)
Δ PRICE			-0.0246 (-3.82)***		-0.0263 (-1.03)			-0.0148 (-3.35)***		-0.0451 (-2.17)**
NUMBER OF SHARES		0.0137 (0.84)		0.0124 (0.77)			0.0431 (3.55)***		0.0439 (3.61)***	
Δ VOLUME		0.0699 (4.21)***		0.0684 (4.09)***			0.0859 (5.74)***		0.0831 (5.57)***	
DECIMAL		0.1204 (3.74)***	0.5261 (2.71)***	0.1133 (3.51)***	2.6697 (3.46)***		-0.0130 (-0.51)	-0.0539 (-0.37)	-0.0185 (-0.73)	-2.7979 (-4.12)***
BANKS		0.1037 (2.99)***	0.5412 (2.50)**	0.0981 (2.83)***	0.4580 (0.53)		-0.0149 (-0.64)	0.1602 (1.17)	-0.0134 (-0.57)	1.9981 (3.11)***
INSURERS		0.2317 (4.91)***	1.2701 (4.39)***	0.2176 (4.64)***	1.8156 (1.58)		0.0506 (1.64)*	-0.1852 (-1.06)	0.0571 (1.85)*	1.2063 (1.47)
Constant		-0.7872 (-4.51)***	1.8009 (2.10)**	-0.8128 (-4.64)***	14.6481 (4.29)***		-0.4389 (-3.04)***	-2.5221 (-3.78)***	-0.4175 (-2.89)***	-7.4887 (-2.39)**
Number of observations		1,316	1,316	1,316	1,316		2,014	2,014	2,014	2,014
χ^2-statistic		168.37	116.09	166.14	99.08		179.14	90.22	165.06	114.95
[Prob > χ^2]		[0.000]***	[0.000]***	[0.000]***	[0.000]***		[0.000]***	[0.000]***	[0.000]***	[0.000]***
R^2		0.1111	0.0786	0.1105	0.0683		0.0733	0.0339	0.0726	0.0507