Auditor reputation, client IPOs, and audit firm data breaches

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Abstract:

A foundational theory of auditing is the role that the auditor's reputation plays in both the conduct of audits and stakeholder perceptions of financial information. Prior research documents that auditor reputation is value enhancing in the IPO setting. However, the primary measure of reputation in these studies is audit firm size, which also proxies for resources, competencies, audit quality, and litigation risk. Therefore, it is difficult to identify whether auditor reputation has value independent of these attributes. We exploit cybersecurity breaches at Big 4 audit firms as exogenous shocks to the audit firm's reputation because breaches occur randomly (exogenously) across time and within firms, and are unrelated to the underlying audit quality. We find that a data breach of an audit firm in the 90 days prior to a client's IPO is associated with economically meaningful reduced demand for IPO shares as measured by offer price revisions. This effect is mitigated in IPOs backed by venture capitalists or high-quality underwriters. The effect is magnified by the severity and saliency of the breach. We also find that a breach is positively associated with subsequent bid-ask spreads and price volatility, suggesting that the market response to the breach persists until additional information is revealed about the IPO firm. Collectively, our evidence suggests that auditor reputation has value independent of auditor size and competency.

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1. Introduction

Audit firms develop reputations over time by accumulating competencies and resources. Because auditing is a credence good, third parties value these characteristics to the extent that the characteristics are observable, such as when the market assigns greater value to larger audit firms. Thus, an audit firm's reputation is highly correlated with its size, and studies therefore often proxy for auditor reputation using audit firm size (e.g., DeAngelo 1981; Balvers, McDonald, and Miller 1988; Beatty 1989). Studies also find that when lapses in audit quality are publicly observable, auditor reputation declines and the market responds accordingly (e.g., Weber, Willenborg, and Zhang 2008; Dee, Lulseged, and Zhang 2011; Skinner and Srinivasan 2012). Thus, the upshot for auditors is to grow their firms and ensure they follow auditing standards on each audit engagement. However, prior literature provides little insight about auditor reputation related to factors other than resources, competencies, and procedural due diligence. In other words, prior literature lacks clear insights of the value of auditor reputation independent of observable audit quality or firm size. Understanding the value of auditor reputation is important because audit firms must judiciously allocate their resources, including to efforts to maintain independence and to the development of competencies that allow them to deliver high quality audits. Documenting the value of auditor reputation can provide insights on the relative importance of reputation, help auditors direct their efforts, and inform market participants in their investment decisions. In this study, we investigate the market's assessment of an auditor's reputation independent of firm size or public disclosure of a lapse in audit quality.

In this study, we use the initial public offering (IPO) setting to determine the market's assessment of auditor reputation. We use IPOs for two primary reasons. First, companies going public have relatively less public information available (e.g., no public historical market

information), so the role and reputation of the auditor are particularly meaningful. To this end, prior literature finds that reputable auditors, as measured by audit firm size, influence client IPOs by improving the perceived quality of financial information resulting in lower information risk for investors (Balvers et al. 1988; Beatty 1989; Michaely and Shaw 1995). However, because audit firm size is a static measure (e.g., Beatty 1989), which is correlated with important audit firm characteristics including competence, quality, and litigation risk (DeFond and Zhang 2014, p. 278), it is difficult to attribute these findings to the auditor's reputation alone.[1] Second, there is no trading leading up to the IPO which allows for a clean assessment of the value of auditor reputation.

To investigate auditor reputation, we begin with a definition of reputation borrowed from the management literature. According to Lange, Lee, and Dai (2011, p. 154), "over time an organization can become well known, can accrue a generalized understanding in the minds of observers as to what it is known for, and can be judged favorably or unfavorably by its observers," and while "[r]eputation is rooted in the organization's historical behavior," reputation "can be abruptly changed if new information about the organization's past behavior comes to light or if the organization's latest behaviors or associations are jarring to observers." The first part of the definition is consistent with prior studies that use auditor size as a proxy for auditor reputation. The latter part of the definition is consistent with studies that investigate significant lapses in audit quality (e.g., Weber et al. 2008; Skinner and Srinivasan 2012). To answer our research question, we identify information about an auditor that might be "jarring" to potential IPO investors but that is uncorrelated with audit firm size or the auditor's conduct of the audit. Specifically, we use auditor cybersecurity breaches as a reputation-harming event that can potentially affect the market's demand for shares of an IPO firm. When potential investors learn that the IPO firm's

[1] Further, some literature on reputation is "based exclusively on rare events" (DeFond and Zhang 2014, 278) such as singular major audit failures (Weber et al. 2008; Skinner and Srinivasan 2012).

auditor has suffered a data breach, we anticipate that the auditor's reputation will be damaged, which will lead to perceptions of increased information risk. This will harm the information-quality role of the auditor. All things equal, investors choose investments with lower information risk, resulting in lower demand for the IPO shares.[2] Thus, we anticipate that an auditor data breach will influence IPO price formation.

However, there are also several reasons that IPO investors might not react to an audit firm data breach. A data breach at an audit firm does not reveal information about an IPO firm's expected future cash flows or its investment prospects. The data breach is also unrelated to audit quality and the degree to which the auditor has constrained managerial bias in the IPO firm's financial reporting. Furthermore, an IPO registration statement is filed under the 1933 Securities Act, which imposes a higher litigation risk for the auditors. As such, auditors would place higher emphasis on the quality of IPO firm audits. Lastly, because IPOs are a major event, investors perform their own due diligence on the valuation prospects of the firm. Therefore, investors may find an audit firm data breach to be irrelevant to the IPO firm's value and as a result, the breach may not affect demand for IPO shares.

We obtain a sample of 868 IPOs audited by Big 4 firms occurring during the period 2005 to 2018. We then collect data on cybersecurity incidents occurring at Big 4 audit firms from the Privacy Rights Clearinghouse (PRC) website. We match auditor data breaches revealed in the 90 days preceding the IPO to the IPO sample and test how the existence of such a breach affects IPO price formation. Our research design has a number of important characteristics. First, by limiting

[2] A data breach could also negatively impact demand for the IPO firm's stock because of the potential that the data breach revealed proprietary information about the IPO firm to certain parties that would take advantage of their inside information during the IPO. In our study, we explicitly rule out this direct cost possibility by investigating the nature of the lost data for each data breach to confirm that a breach did not contain information about the forthcoming IPO.

our sample to the set of firms generally considered to be "high-quality" auditors (Big 4 audit firms), we largely hold constant audit firm resources, competencies, and litigation risk, allowing us to draw inferences on auditor reputation independent of these characteristics. Second, cyber security breaches are unrelated to prior audit quality and vary both across time and within audit firms providing variation in the treatment. Third, the data breach is plausibly exogenous to the IPO. This fact mitigates concerns about correlated omitted variables because auditor data breaches occur randomly (or as determined by an unrelated perpetrator) across firms and time and are unrelated to any other auditor or client choices or economic factors. Therefore, our design facilitates identification of damage to the auditor's reputation and the subsequent consequences of auditor reputation on demand for IPO shares.

As indicated above, we expect that a data breach at an audit firm will be associated with reduced demand for IPO shares. The data breach will negatively affect the auditor's reputation, leading the market to perceive a higher information risk for the IPO, which will lead to lower demand for shares and a lower assessed value of the IPO firm. Consistent with our prediction, we find that a data breach at an IPO firm's auditor is associated with an offer price revision amounting to a 4.1 percent decrease, which equates to approximately $8.9 million in forgone capital raising for the mean IPO firm in our sample.[3] This result implies that damaged reputation of the auditor, as measured by cybersecurity breaches, has significant market consequences for audit clients.

While our main test finds that auditor data breaches negatively impact IPO offer price, we also investigate whether data breaches are associated with underpricing (i.e., first-day returns).

[3] We measure market demand for an IPO firm using offer price revisions. These revisions capture the difference between the initially proposed offer price and the final offer price. Revisions can decrease or increase the offer price. Our measure captures the change in offer price of treatment firms (i.e., those associated with an auditor breach) relative to the change in offer price of control firms (i.e., those not associated with an auditor data breach). We use the term "lower offer price revision" to refer to circumstances where the offer price adjustment results in a lower offer price for a treatment firm than for a control firm. This can occur when the treatment firm experiences a greater decrease in the offer price or a smaller increase in the offer price than experienced by control firms.

Prior literature suggests that IPO offer prices adjust more strongly to negative information than to positive information (e.g., Kutsuna, Smith, and Smith 2009). In our setting, underwriters would therefore impound the decreased market demand resulting from the auditor data breach into offer prices more fully. Thus, we would expect there to be no association between auditor data breaches and first-day underpricing. We find this to be the case. While data breaches are associated with lower offer price revisions, data breaches are not associated with IPO underpricing.

Because lower IPO price revisions in connection with auditor data breaches imply decreased demand for shares, we examine factors that should plausibly offset the negative impact of an impaired auditor reputation. Specifically, we investigate how venture capitalist backing and underwriter reputation affect the association between auditor data breaches and IPO pricing. Venture capitalists provide governance and constraints on earnings management to companies going public (Krishnan et al. 2011; Hochberg 2012), so venture capitalist involvement should reduce the impact from an impairment to the auditor's reputation. Likewise, a high-reputation underwriter provides a stronger signal about the information quality of the IPO firm (Lee and Masulis 2011), which should mitigate the influence of an auditor's damaged reputation. In cross-sectional tests, we find results consistent with these expectations. The effects of auditor data breaches are mitigated in venture-capital-backed IPOs and IPOs with higher-reputation underwriters.

Next, we investigate whether the nature of the audit firm's data breach is associated with IPO price revisions. We expect that more severe breaches will attract more attention and result in greater market consequences for audit firm clients. Using the number of records that were breached as a measure of the breach's severity, we find that breach severity amplifies the effect of the breach on the offer price revision. Next, we use media coverage of the breach as a measure of its salience.

We expect that data breaches identified by the media will attract more investor attention and have a greater effect on investor demand for IPO shares. Consistent with this expectation, our results indicate that breaches made public by the media have lower offer price revisions. These tests document that the severity and salience of the auditor data breach vary predictably with the expected reputational damage to the firm and exacerbate its effect on IPO offer prices.

We next investigate whether the effects of auditor data breaches extend beyond the effect on the initial offer price. Because the reputation of an auditor is important to the market's perceptions about the information quality of the IPO firm, a shock to the auditor's reputation should create uncertainty about the precision of the IPO firm's financial information and the firm's underlying value even after the initial pricing of the IPO. As such, we examine whether the information risk effects of the breach persists once the shares begin actively trading. We use two measures, including bid-ask spreads (Callahan, Lee, and Yohn 1997) and return volatility (Kothari, Li, and Short 2009) over the first 90 days of trading. We find that auditor data breaches are positively associated with both bid-ask spreads and return volatility consistent with investors continuing to price protect due to a negative signal about the auditor's reputation and its effect on perceptions of IPO firm value and information quality. However, the effect of the breach diminishes over time as more information is revealed such that we find that the effect no longer persists in the second quarter after the IPO.

Our results suggest that the market reacts to a data breach at the auditor, which serves as a reputation shock that is unrelated to its underlying audit quality. To further validate this point, we model the likelihood of a restatement of audited financial statements in the three years subsequent to an IPO. We find no evidence that auditor data breaches are associated with restatements of an IPO company's financial statements. These results are consistent with damage to the auditor's

reputation driving down demand for IPO shares due to perceptions of information risk rather than discounting due to a reduction in actual information quality.

Our study provides several contributions to the literature. First, we contribute to the literature on auditor reputation. Prior literature notes that auditors develop reputations over time by providing high quality audits, and reputable firms (typically identified based upon audit firm size or expertise) command fee premiums because of their reputations (Simunic 1980; Francis 1984; Francis, Reichelt, and Wang 2005). Prior studies also note that auditor reputation suffers when egregious auditor failures are made public (Weber et al. 2008; Skinner and Srinivasan 2012). Our study documents how time-varying reputational shocks to the auditor unrelated to audit performance have economic consequences to their clients, which provides insights about the value of auditor reputation.

Second, we contribute to the literature on IPO price formation by showing how auditor reputation can affect a significant economic transaction. Prior literature documents that the use of large auditors provides value to an IPO firm because the large auditors are associated with lower IPO underpricing (Beatty 1989; Michaely and Shaw 1995; Willenborg 1999). Our study expands on those studies by documenting how circumstances of the auditor unrelated to the IPO play an important role in IPO price formation. While IPO firms may not necessarily be able to avoid an association with an auditor that experiences a data breach, timing of the breach and IPO are important, and our study documents other factors that can offset the costs of sudden auditor-reputation-harming events.

Finally, we contribute to the growing literature on cybersecurity risks. Several studies document that data breaches have a significant negative effect at companies with a breach (e.g., Campbell, Gordon, Loeb, Zhou 2003; Rosati et al. 2017; Huang and Wang 2021), and auditors

price these breaches on client engagements (e.g., Yen, Lim, Wang, and Hsu 2018; Smith, Higgs, and Pinsker 2019; Li, No, and Boritz 2020). However, prior literature has not documented a capital market implication from breaches of the auditor's own data.

2. Prior Literature and Hypotheses

2.1. IPO Pricing

When a firm decides to raise public equity through an IPO, the firm releases information to potential investors through a registration statement filed with the SEC on Form S-1. The registration statement provides financial and management background about the company (e.g., Cohen and Dean 2005; Leone, Rock, and Willenborg 2007; Hanley and Hoberg 2010; Loughran and McDonald 2013; Hendricks, Howell, and Bingham 2019). The initial registration statement is filed about three to four months before the IPO, on average, and omits information about the number of shares included in the offering and the offer price. After filing Form S-1, management, with the help of an underwriter, chooses the number of shares that will be offered and determines an expected price range for the company's shares. At this point, management files an amended form, Form S-1/A, with the SEC disclosing the number of shares offered in the IPO and a price range for the offering. On average, IPO firms file Form S-1/A about a month before the IPO date. In the month leading up to the IPO, underwriters then attempt to determine the market's interest in the shares and set a final offer price based on the assessed market interest (Cornelli and Goldreich 2001, 2003).

Underwriters connect with potential investors to determine the level of demand for the IPO firm's shares. Much of this interaction occurs during "roadshows," which consist of management and underwriters visiting major cities and making presentations to create enthusiasm for the IPO shares. These presentations are targeted to analysts, institutional investors, fund managers, hedge

funds, and other large investors in the underwriter's network. During these interactions, underwriters attempt to determine the price that these investors are willing to pay and request non-contractual bids for share purchases. Through this process, the underwriter determines the demand for the firm's shares, enabling the underwriter and management to set a final offer price by the day before the IPO. If the demand for the shares is high, the price will be set relatively higher within, or even above, the initial price range. Conversely, if demand for the shares is low, the price will be adjusted lower within, or even below, the initial offer price range. The difference between the final offer price on the IPO date and the midpoint of the proposed price range included earlier in Form S-1/A is the price revision, which is the focus of our study.

On the date of the IPO, the firm's stock begins to trade on an exchange, and the stock price generally closes above the final IPO offer price. This underpricing phenomenon has been examined extensively in prior research. Benveniste and Spindt (1989) and Loughran and Ritter (2002) predict a partial-adjustment theory where underwriters impound only a portion of the positive information revealed during the IPO process into the final offer price in order to reward investors who helped the underwriters determine demand for the stock with greater underpricing. On the other hand, if investors' valuation is below underwriters' initial expectations, the offer price needs to fully reflect this negative information in order for investors to purchase IPO shares. This suggests an asymmetric investor response to the direction of news, with underwriters incorporating positive news only partially, but negative news fully, into the offer price. Based on these theories, prior research uses first-day returns and IPO offer price revision as measures of IPO investor

demand (e.g., Hanley 1993; Kandel et al. 1999; Blankespoor, Hendricks, and Miller 2017; Dambra, Schonberger, and Wasley 2020).

2.2. Auditors and IPOs

Firms undergoing an IPO have significant information asymmetry between the company and potential investors. While the registration statement addresses some of the existing information asymmetry, the absence of historical market data makes valuing an IPO firm more difficult than valuing actively traded firms with ample price and financial history. For this reason, the auditor is particularly important for IPO firms, as the Form S-1 is the first release of historical audited financial information. To this end, prior literature has investigated the role of the audit firm in the IPO process. Studies find that reputable auditors provide a perceived reduction in information risk regarding IPO firms (Beatty 1989; Michaely and Shaw 1995; Balvers et al. 1988; Willenborg 1999). For this reason, underwriters recommend, and managers appoint, reputable auditors leading up to an IPO (Menon and Williams 1991). However, because reputable auditors are more costly, IPO firms consider the tradeoff between higher audit costs and forgone capital from lower pricing of the IPO (Hogan 1997).

Generally, an audit firm develops a reputation for quality over time as the market observes the firm providing high-quality audits. Studies such as Balvers et al. (1988) and Beatty (1989) find that large audit firms are associated with lower underpricing which is attributed to the reputation of large firms. Subsequent studies have continued to use audit firm size as a proxy for audit quality, documenting that the market continues to value the reputation of large auditors in IPO transactions (e.g., Hogan 1997; Willenborg 1999).

In using the size and expertise of the audit firm as a proxy for auditor reputation, these prior studies argue that larger firms are more reputable because they have more to lose from an

audit failure. While these studies are informative about the relation between audit firm characteristics (size) and IPO pricing, these studies do not isolate auditor reputation from other factors correlated with audit firm size, namely litigation risk incentives, firm-level competencies and resources, and audit quality (DeFond and Zhang 2014). Furthermore, auditor reputation can vary over time and within audit firm strata (e.g., Big 4, next-tier, etc.) that are generally considered equal in quality.

Prior literature notes that even high-quality auditors can damage their reputation when the market learns they have provided low-quality services. For example, Andersen's failure to identify material misstatements at Enron resulted in a loss of reputation for Andersen, ultimately leading to its demise (Barton 2005). Other audit firms have also been associated with significant frauds, resulting in damage to their reputations (Weber et al. 2008). Even public blunders while performing other types of assurance services such as counting the votes for the Oscars have been shown to be detrimental to high-reputation firms (Abbott and Buslepp 2022), though none of these studies has investigated how changes in the auditor's reputation affect IPO pricing.

Our focus on cybersecurity breaches at audit firms and demand for IPO shares is a unique approach to study the value of auditor reputation in capital markets. We hold constant audit firm size and competency and observe a direct shock to the auditor's reputation that is unrelated to any lapse in the quality of the auditor's provision of audit services. Rather, the occurrence of a data breach can cause a change in market perception of the reputation of a high-quality auditor independent of the recent quality of the firm's audit services. If a cybersecurity event damages the auditor's reputation, then the market will question the quality of the auditor's certification and price protect against increased risk. The increase in risk occurs because the market attributes greater information risk to the IPO, which is manifest through higher implied discount rates and a

higher cost of capital (Lambert, Leuz, and Verrecchia 2007). In the IPO setting, the consequence of a decrease in the auditor's reputation would be decreased demand for shares and corresponding downward price revisions by the underwriters prior to trading.[4]

2.3 Setting of Cybersecurity Breaches

The literature on cybersecurity has grown in recent years in accordance with the importance of digital processes and the occurrence of cybersecurity incidents. Extant research provides several inferences relevant to our study. First, studies generally indicate that the market reacts to data breaches occurring at public companies. Companies experiencing data breaches have negative returns, increased bid-ask spreads, and increased trading volume (Campbell, Gordon, Loeb, and Zhou 2003; Rosati et al. 2017; Lending, Minnick, and Schorno 2018). In fact, the market appears to price cybersecurity risk even without the occurrence of a breach, especially during periods of relatively higher risk (Florackis, Louca, Michaely, and Weber 2020). Though data breaches can also result in significant out-of-pocket costs as companies address the breach, market consequences account for the majority of the loss in shareholder wealth (Kamiya, Kang, Kim, Milidonis, and Stulz 2021).

Despite a number of studies investigating the effects of data breaches on markets, no prior study has investigated the implications of a breach of an audit firm's data. Auditors maintain confidential client data which could have a significant effect on clients if their data is exposed. Further, audit firms are considered experts in cybersecurity risks as evidenced by their significant role in consulting on cybersecurity. While investors and auditors appear to react to breaches of public companies, it is important to study the extent to which data breaches occurring to the auditor

[4] There are reasons harm to the auditor's reputation should affect investors' demand for an IPO firm's stock. Given finite resources an investor has to invest, allocating relatively fewer resources to an IPO firm whose auditor has recently received negative publicity is a rational decision.

affect capital markets. We focus on the impact of auditor data breaches on IPO clients specifically since auditor's certification of financial information is particularly salient in this setting.

2.4. Hypothesis Development

Based upon prior literature documenting significant costs to firms experiencing a data breach (e.g., Huang and Wang 2021; Kamiya et al. 2021), we anticipate that a data breach will negatively impact the reputation of an audit firm. Although a data breach is economically unrelated to a client firm's IPO, an impaired auditor reputation from a data breach would manifest in a client's IPO because investors would perceive an increase in information risk.

Early literature established that IPO firms benefit by associating with a high-reputation auditor (Balvers et al. 1988; Beatty 1989). The high-reputation auditors in these studies were the group consisting of the largest audit firms (now the Big 4) and have commonly been treated as a homogeneous group in subsequent research. However, when an audit firm receives negative publicity, the market tends to differentiate that auditor from other audit firms within the group (e.g., Barton 2005; Weber et al. 2008; Dee et al. 2011; Boone, Khurana, and Raman 2015). Thus, we expect that potential investors will increase their assessment of information risk when the IPO firm's auditor is subject to a data breach leading up to the IPO. Because investors' confidence in financial information is closely linked to the value they place on the auditor's opinion, any reputational harm to the auditor would affect investors' trust in the financial information associated with the IPO. If the data breach causes investors to perceive an increase in information risk (Lambert et al. 2007), then this will lead to an increase in the required premium to invest in the IPO firm. As a required premium increases, the acceptable offer price decreases. This reduction in demand will be manifest to underwriters as they conduct the roadshow with potential investors and promote the IPO. In response to lower-than-expected demand, underwriters will select a final

offer price that is lower than the price they would have selected in the absence of an auditor data breach.[5] As such, we state our first hypothesis in the alternative form as follows:

H1: An auditor data breach is associated with lower IPO offer price revisions.

Multiple parties participate in an IPO, and participants besides the audit firm can contribute to potential investors' perceptions of the IPO firm's value and information quality. As such, the negative signal from impaired auditor reputation through a cybersecurity breach can be mitigated. One such participant is venture capitalists, who provide governance and constraints on earnings management to companies going public (Krishnan et al. 2011; Hochberg 2012). These constraints reduce concerns about information risk, and because venture capitalists are sophisticated investors, their involvement sends a credible signal to the market about the value of the IPO firm. Given these benefits, participation from venture capitalists can mitigate the potential impact of a damaged auditor reputation resulting from a data breach.

Another key participant in the IPO process is the underwriter. Underwriters have varying degrees of experience and reputation, similar to audit firms. Underwriters more widely known in the market also reduce information uncertainty and information risk (Lee and Masulis 2011). Because an underwriter's reputation can signal value to the market about the IPO, we expect the underwriter's reputation can offset underpricing associated with a negative shock to the auditor's reputation.

Therefore, we expect that decreased demand for shares due to a data breach at the audit firm is mitigated in IPOs with venture capitalists or high reputation underwriters. We formally state this expectation in the following hypothesis:

[5] We view this as analogous to the finding in Beatty (1989) that high reputation auditors will lead to higher offer prices. Correspondingly, in our prediction, we anticipate that a negative shock to the auditor's reputation will lead to lower offer prices.

H2: Venture-capitalist backing and high reputation underwriters mitigate lower IPO offer price revisions associated with an auditor data breach.

3. Sample Selection and Descriptive Statistics

We collect data on IPOs from Thomson Reuters' Securities Data Company (SDC) database. Our sample consists of U.S. IPOs between 2005 and 2018. We restrict our sample to offerings made on the American, New York, and NASDAQ stock exchanges. Following prior research, we also exclude financial firms, unit offerings, rights offerings, and blank check companies. We limit our sample to IPOs with Big 4 auditors.[6] We then merge our IPO sample with Compustat, CRSP, and Audit Analytics to obtain the required financial and market data to construct our variables. We also collect company founding dates and underwriter reputation rankings from Jay Ritter's website and data used to construct our measures of offer price revisions from SEC EDGAR.[7] We exclude firms with missing financial or market information necessary for our empirical analysis. Our final sample includes 868 IPOs.

We obtain data on data breaches from the Privacy Rights Clearinghouse (PRC). The PRC compiles a list of publicly disclosed data breaches in U.S. firms since 2005. These data breaches are revealed to the public through several sources. First, the data breaches generally involve personal, confidential information (e.g., names, social security numbers, etc.), and laws in all 50 states require the company subject to the breach to notify affected parties. Second, affected companies also report data breaches to state attorney generals, many of whom report the data breaches on their websites. Third, several organizations track data breaches and list the data

[6] We limit our sample to Big 4 auditors because we are interested in time-varying changes in reputation within high quality auditors. Furthermore, there are only four instances of data breaches in non-Big 4 audit firms, and only three instances of IPO firms with non-Big 4 auditors that had a data breach in the 90-day window prior to the issue date in our sample. In untabulated analysis, we continue to find a negative impact on price revisions after including IPO firms with non-Big 4 auditors.

[7] We thank Jay Ritter for publicly providing the Field-Ritter dataset of company founding dates used in Field and Karpoff (2002) and Loughran and Ritter (2004).

breaches on their websites. These organizations often identify data breaches when individuals or state attorney generals are notified of the breaches. Finally, the media breaks the story for some breaches, but also provides coverage of data breaches once they have been identified from other sources.

The PRC database also provides information on the magnitude (i.e., total number of records compromised) and information source (e.g., state attorney general or media) of the data breach. There were 21 unique data breaches of Big 4 audit firms during our sample period. The nature of the breaches varies. For example, on September 25, 2017, a news report revealed that Deloitte had been subject to a "sophisticated hack that compromised the confidential emails and plans of some of its blue-chip clients" (Hopkins 2017). The hacker used an administrator's account to access Deloitte's global email server and then viewed emails regarding several of the firm's clients. Breaches can also be less sophisticated such as when an individual auditor loses a laptop with sensitive information. For example, a laptop was stolen from a "locked trunk of [an] Ernst & Young employee's car in a parking lot," and the laptop contained "the names and credit-card numbers of about 243,000 Hotels.com customers" (Reilly 2006). We match each data breach to the IPO sample if the IPO firm has an auditor that had a data breach revealed within the 90-day window prior to the firm going public. Because an auditor can simultaneously be involved in multiple IPOs, our sample consists of 63 IPOs occurring in connection with an auditor that has suffered a recent data breach. Table 1 summarizes the IPO and data breach sample selection process.

Table 2 provides descriptive statistics for all IPOs in our sample. Of the 868 IPOs, 7.3 percent had an auditor with a data breach in the 90-day window prior to the issuance date (*Breach*). The mean (median) price revision (*Price_Revision*) is a 2.7 percent reduction (0 percent). The

majority of IPO firms are venture capital-backed (*VC*), listed on NASDAQ (*Nasdaq*), and operating at a loss (*ROA*). Approximately 8 (14) [19] percent of IPO firms had a restatement within one year (two years) [three years] after going public (*Restatements_1yr*, *Restatements_2yr*, *Restatements_3yr*). The media were the first to publicize 32 percent of the data breaches in our sample (*Media/Breach*). Lastly, the average breach had approximately 47 thousand records compromised (*Records* for observations with a breach).[8] The appendix includes detailed definitions of all variables included in our analyses.

4. Research Design and Empirical Results

4.1. Data breaches and IPO pricing

In this section, we examine our primary research question of whether auditor data breaches affect the demand for IPO shares. We predict that an auditor data breach will impair the auditor's reputation and cause a decrease in investor demand for shares of the IPO. As a result, we expect a negative effect on IPO pricing outcomes. We test this prediction by estimating the following regression:

$$IPO\_Price_i = \beta_0 + \beta_1 Breach_i + Controls_i + Fixed\,Effects_i + \varepsilon_i \quad (1)$$

The dependent variable, *IPO_Price*, is defined as one of two pricing variables: *Price_Revision* or *Underpricing*. *Price_Revision* is the percentage change from the midpoint of the initially proposed offer price range to the final offer price. *Underpricing* is the percentage change from the offer price to the closing price on the IPO date. Our variable of interest, *Breach*, is an indicator variable equal to one if the IPO's auditor had a data breach in the 90-day window prior to the issue date, or zero otherwise.

[8] In untabulated analysis, we test whether IPO firm characteristics for IPOs with auditor data breaches are significantly different from those without auditor data breaches. Of the 14 control variables included in our regression analysis, only *Biotech* and *ROA* are statistically different between the treatment and control groups. This suggests that the auditor data breach is plausibly exogenous to IPO firm characteristics.

We control for multiple IPO firm characteristics following prior research (e.g., Yung et al. 2008; Loughran and McDonald 2013; Butler et al. 2014; Willenborg et al. 2015; Barth et al. 2017). Specifically, we control for market value of equity (*Market_Val*), assets (*Assets*), revenue (*Revenue*), profitability (*ROA*), R&D intensity (*R&D*), venture capital-backing (*VC*), NASDAQ listing (*Nasdaq*), underwriter reputation (*Reputation*), firm age (*Age*), ownership retention (*Retained*), capital structure (*Leverage*), growth opportunities (*BTM*), biotech industry membership (*Biotech*), and IPO waves (*IPO_Vol*). All continuous variables are winsorized at the 1st and 99th percentiles to mitigate the influence of outliers. We also include year, industry, and auditor fixed effects and cluster standard errors by industry.

Table 3 reports results of estimating Equation 1. Column 1 reports the regression estimates when *Price_Revision* is the dependent variable. We find a negative and statistically significant coefficient on *Breach* (*t*-stat = -2.08). These results suggest that an auditor data breach reduces the offer price relative to the midpoint of the firm's initially proposed offer price range, consistent with reduced investor demand. The economic magnitude of the results are also meaningful. Specifically, a data breach is associated with a 4.1 percent decrease in the offer price, which equates to $8.9 million in value for the mean IPO firm in the sample.

Column 2 of Table 3 reports the results when *Underpricing* is the dependent variable. We do not find a statistically significant effect on *Breach* (*t*-stat = -0.39). Our failure to find an association is consistent with managers and underwriters observing decreased market demand during the price formation period due to the auditor data breach and impounding this information into offer prices. Due to these offer price revisions, the two groups of IPO firms experience similar first-day returns. Thus, the evidence in Table 3 is consistent with our prediction that data breaches negatively influence the pricing of IPOs due to an impairment of the auditor's reputation.

4.2. IPO pricing and governance

In the previous section, we find that auditor data breaches affect IPO price formation. We contend that the negative shock to auditor reputation causing the price revisions may be offset by alternative signals of IPO quality. Specifically, we argue that venture capitalists and highly reputable underwriters provide improved corporate governance and constraints on earnings management (e.g. Krishnan et al. 2011; Lee and Masulis 2011; Hochberg 2012) that would offset the negative effects of an impaired auditor reputation, and they provide a credible signal to the market about the quality of the IPO firm.

To test this prediction, we first estimate Equation 1 after partitioning the sample on whether the IPO firm is venture-capital backed.[9] We then partition the sample on whether the firm's underwriter is highly reputable. Specifically, we create a binary variable set equal to one for IPO firms with underwriters with a Carter-Manaster reputation score (Carter and Manaster 1990; Loughran and Ritter 2004) that is above the sample mean, or zero otherwise.[10] We expect that venture capital-backed IPOs and high underwriter reputation alleviate the negative relationship between data breaches and IPO pricing.

Table 4 reports the results of this analysis. Columns 1 and 2 provide the coefficient estimates for the venture capital-backed partitions. Column 1 (column 2) provides regression estimates for IPOs that are venture capital-backed (non-venture capital-backed). Our findings suggest that the association between auditor data breaches and IPO pricing is concentrated in firms that are not venture capital-backed (t-stat = -2.07 in column 2) and that this association is

[9] We drop *Underpricing* as a dependent variable in the remaining analyses since we fail to find an association with data breaches in our primary analysis.

[10] The Carter-Manaster reputation score for underwriters is derived by ranking underwriters' position on "tombstone" announcement for new shares with the most prestigious underwriters being listed.

statistically different from the association found in venture capital-backed IPOs (Chi-Square = 2.84).

Columns 3 and 4 of Table 4 provide the coefficient estimates for partitions on underwriter reputation. Column 3 (column 4) reports results for IPOs with an underwriter reputation score that is above (below) the sample mean. We find that the association is concentrated in IPO firms with low underwriter reputation scores (*t*-stat = -2.23 in column 3). Furthermore, the association between data breaches and IPO pricing for IPOs with low underwriter reputation is statistically different from those with high underwriter reputation (Chi-Square = 7.45). These results suggest that the heightened information risk caused by the auditor data breach is mitigated when other parties involved in the IPO can signal the IPO firm's value to the market and alleviate investor concerns about the reliability of information.

4.3. IPO pricing and breach characteristics

In this section, we perform cross-sectional tests based on varying breach characteristics to provide further evidence that our findings are attributable to the announcement of the data breach. Specifically, we examine variation in IPO pricing based on the magnitude of the breach and source that publicized the breach. These tests are important because they are better able to attribute the pricing impact we document to the data breach itself, rather than to some other possible confounding event.

The first characteristic we examine is the magnitude of the data breach. The PRC data includes information on the number of records stolen as a result of the breach. We predict the negative impact of the data breach on IPO pricing to be greater for breaches that are more severe. We create a variable, *Records*, which is equal to the natural log of the number of total records stolen and interact this variable with *Breach*. If the auditor data breach is causing our findings,

then we expect our results to be stronger when the breach compromises a greater number of records.

Column 1 of Table 5 reports the result of this analysis. We find a negative and statistically significant coefficient on the interaction term (*t*-stat = -2.16). These results suggest that the negative association between the auditor data breach and IPO pricing is greater when the breach is more severe.

The second characteristic we examine is the saliency of the data breach. The PRC data provides information on the party that first announced the breach to the public. For example, a majority of data breaches are announced through websites that spread awareness of data breaches (e.g., databreaches.net). The office of the attorney general of the related state announces some of the other breaches. News of data breaches announced by the media is nonetheless more likely to affect IPO pricing relative to these other information sources due to its extensive reach (Bushee et al. 2010). We create an indicator variable, *Media*, that is equal to one if the media made the announcement of the data breach, or zero otherwise.[11] We then interact *Media* with *Breach*. We expect the association between the data breach and IPO pricing to be stronger for breaches first announced by the media.

Column 2 of Table 5 reports the results of this analysis. We find a negative and statistically significant coefficient on the interaction term (*t*-stat = -1.98), which suggests that the saliency of the data breach news magnifies the negative impact on pricing outcomes. Overall, we interpret the findings in Table 5 as additional evidence that the auditor data breach affects IPO pricing outcomes and that these findings vary predictably with breach characteristics.

[11] The correlation between *Records* and *Media* is insignificant (coefficient = 0.115), suggesting that the cross-sectional variation we observe is not within the same set of firms.

5. Additional Analysis

5.1. Post-IPO consequences of data breaches

Our findings are consistent with auditor data breaches reducing IPO pricing because a decline in auditor reputation influences investors' perceptions of the quality of information provided in connection with the IPO. To further demonstrate that information risk is the mechanism through which auditor data breaches affect investor perceptions of IPO firm value, we also investigate whether investors exhibit behavior consistent with information risk subsequent to the IPO date. When a cybersecurity breach harms an audit firm's reputation, the information risk effects are likely to continue to affect perceptions of the IPO until additional information is revealed and gradually subsumes the effects of uncertainty about the IPO. In this section, we examine capital market consequences of the breach in the quarter immediately after the IPO. Specifically, we use bid-ask spreads (*Spread*) and return volatility (*Volatility*) over 90 days of trading to measure post-IPO uncertainty. *Spread* is the average bid-ask spread in the 90-day window starting five days after the IPO, where the bid-ask spread is the difference between the ask and bid scaled by price. *Volatility* is the standard deviation of returns in the 90-day window starting five days after the IPO. We follow Loughran and McDonald (2013) in excluding the first four days after the offering to avoid abnormal trading such as flipping activity by institutional investors with IPO allocations. If investors' uncertainty does not subside at the IPO date, then we expect to find a positive relationship between auditor data breaches and post-IPO capital market measures of uncertainty.

Table 6 reports the results of this analysis. Column 1 provides results when examining *Spread* as the dependent variable. We find a positive and statistically significant coefficient on *Breach* (*t*-stat = 2.62). Column 2 provides results when examining *Volatility*. Similar to column 1, we find a positive effect on *Breach* (*t*-stat = 2.71). These results suggest that the uncertainty caused

by the auditor data breach persists for at least one quarter after the IPO date.[12] These findings also support our main hypothesis that auditor data breaches impact investor demand and thus IPO pricing because of ex ante uncertainty about the IPO firm.

5.2. Are data breaches associated with lower audit quality?

In our primary analysis, we show that the negative shock in auditor reputation resulting from the data breach reduces IPO prices, even though the data breach does not involve information about the IPO firm. This suggests that investors might perceive the data breach to be associated with the information quality of the IPO firm itself, despite the breach's irrelevance. In this section, we test our underlying assumption that the auditor data breach is not associated with the audit quality provided to the IPO firm. Specifically, we examine the likelihood of a restatement of audited financial statements in the years immediately after the IPO. We create an indicator variable, *Restatement_1yr*, that is equal to one if the IPO firm had a restatement announcement in the one-year period after the IPO. We also measure restatements over two-year and three-year periods after the IPO date (*Restatement_2yr* and *Restatement_3yr*). If the data breach affects IPO pricing due to a decline in auditor reputation and not due to a change in audit quality, then we expect to find no association between auditor data breaches and future restatements.

Table 7 reports the results of this analysis. Columns 1, 2, and 3 provide regression estimates when *Restatement* is measured over a one-, two-, and three-year period after the IPO. We fail to find a significant association between *Breach* and *Restatement* in any of the three columns (*t*-stat = -0.59 in column 1, 0.33 in column 2, and 0.49 in column 3). These findings suggest that the

[12] We also estimate the analysis using spreads and volatility in the subsequent 90-day window, i.e. days 95 to 184 relative to the IPO date. Untabulated results show that *Breach* is statistically insignificant when examining both *Spread* (t-stat = 0.31) and *Volatility* (t-stat = 0.92) as the dependent variable. These findings suggest that the uncertainty caused by the data breach is short-lived and subsides after one quarter of trading, potentially as more information is revealed about the firm.

auditor data breach is not associated with the IPO firm's audit quality and is consistent with our main interpretations that the decline in IPO pricing is driven by an auditor reputation effect.

5.3 Consideration of Endogeneity

The data breaches in this study occur to each Big 4 auditor at different points in time, reducing concerns that the results are driven by some other market or client phenomenon. Another important consideration is that data breaches occur in a random way. Neither the auditor nor the IPO firm choose to be subject to a breach (the treatment). This fact mitigates the potential that a correlated omitted variable exists because characteristics of the client, market sentiment, and economic conditions are independent of the data breach. Because data breaches are uncorrelated with other factors that could affect IPO price formation, concerns about endogeneity are much lower in our setting than in other studies where reputation-influencing events do not occur randomly, such as in audit failures.

6. Conclusion

In this study we investigate the value of auditor reputation. Prior literature documents that the market attributes value to large, prestigious auditors because auditing is a credence good, and market participants can generally observe only external firm characteristics. Thus, studies use auditor size as a proxy for auditor reputation (e.g., DeAngelo 1981; Balvers et al. 1988; Beaty 1989). However, the use of auditor size as a proxy for auditor reputation does not distinguish between the value of reputation itself and the value assigned to resources, competencies, and litigation-related incentives that characterize large audit firms. Some studies have also identified market responses when auditors are associated with significant, negative events such as client fraud or are subject to regulatory intervention because of lapses in audit quality (e.g., Weber et al. 2008; Dee et al. 2011; Skinner and Srinivasan 2012), but prior literature leaves unanswered

questions about the value of auditor reputation independent of observable audit quality or firm size. Our study uses auditor data breaches as a unique setting where auditor reputation is affected by an event that is exogenous to economic conditions, client and auditor characteristics, and audit quality.

We find that a cybersecurity breach at a company's auditor in the 90 days prior to its IPO is negatively associated with offer price revisions. This finding suggests that auditor reputation has value independent of client and audit firm characteristics and in addition to perceptions about the quality provided to audit clients. In subsequent tests, we document that other participants in the IPO process can offest decreases in auditor reputation. Specifically, we find that the association between auditor data breaches and IPO price formation is minimized in venture-capital-backed IPOs and in IPOs with high-reputation underwriters, which suggests that market participants assess auditor reputation in connection with the reputations of other relevant parties.

We also conduct analyses to validate our findings and to document a channel through which the reputational effects occur. Our results indicate that data breaches with greater effects and more publicity have greater influence on IPO price formation, as would be expected for a market reaction to information about auditor reputation. Furthermore, we find that the market reacts to auditor data breaches because of an increase in perceived information risk, and this perception continues until additional information released subsequent to the IPO eventually subsumes the information risk. Finally, we note that our findings are unrelated to audit quality, further suggesting that the market assigns value for information risk without any evidence that audit quality is impaired.

This study contributes several new insights. First, the results provide evidence about the value of auditor reputation, independent of auditor size or audit quality. Second, the study

contributes to the literature on IPO price formation by documenting how an exogenous shock to the auditor's reputation affects IPO offer price revisions. Finally, we contribute to the growing literature on cybersecurity by examining a market consequence to data breaches occurring to audit firms. These findings are relevant to IPO firms, auditors, and the academic literature.

References

Abbott, L. J., & Buslepp, W. L. 2022. An investigation of the market's pricing of auditor competence: Evidence from PwC's Oscars blunder. *Accounting, Organizations and Society*. 98, 101310.

Aggarwal, R. K., Krigman, L., & Womack, K. L. 2002. Strategic IPO underpricing, information momentum, and lockup expiration selling. *Journal of Financial Economics*. 66 (1), 105-137.

Balvers, R. J., McDonald, B., & Miller, R. E. 1988. Underpricing of new issues and the choice of auditor as a signal of investment banker reputation. *The Accounting Review*. 63 (4), 605-622.

Barnett, Michael L., Jermier, J. M., & Lafferty, B. A. 2006. Corporate reputation: The definitional landscape. *Corporate Reputation Review*. 9 (1), 26-38.

Barth, M. E., Landsman, W. R., & Taylor, D. J. 2017. The JOBS Act and information uncertainty in IPO firms. *The Accounting Review.* 92 (6), 25-47.

Barton, J. 2005. Who cares about auditor reputation? *Contemporary Accounting Research*. 22 (3), 549-586.

Beatty, R. P. 1989. Auditor reputation and the pricing of initial public offerings. *The Accounting Review.* 64 (4), 693-709.

Benveniste, L. M., & Spindt, P. A. 1989. How investment bankers determine the offer price and allocation of new issues. *Journal of Financial Economics*. 24 (2), 343-361.

Blankespoor, E., Hendricks, B. E., & Miller, G. S. 2017. Perceptions and price: Evidence from CEO presentations at IPO roadshows. *Journal of Accounting Research*. 55 (2), 275-327.

Boone, J. P., Khurana, I. K., and Raman, K. K. 2015. Did the 2007 PCAOB disciplinary order against Deloitte impose actual costs on the firm or improve its audit quality? *The Accounting Review*. 90 (2), 405-441.

Bushee, B. J., Core, J. E., Guay, W., & Hamm, S. J. 2010. The role of the business press as an information intermediary. *Journal of Accounting Research*. 48 (1), 1-19.

Butler, A. W., Keefe, M. O. C., & Kieschnick, R. 2014. Robust determinants of IPO underpricing and their implications for IPO research. *Journal of Corporate Finance*. 27, 367-383.

Callahan, C. M., Lee, C., & Yohn. T. Y. 1997. Accounting information and bid-ask spreads. *Accounting Horizons*. 11 (4), 50-60.

Campbell, K., Gordon, L. A., Loeb, M. P., & Zhou, L. 2003. The economic cost of publicly announced information security breaches: empirical evidence from the stock market. *Journal of Computer Security*. 11 (3), 431-448.

Carter, R., & Manaster, S. 1990. Initial public offerings and underwriter reputation. *The Journal of Finance.* 45 (4), 1045-1067.

Cohen, B. D., & Dean, T. J. 2005. Information asymmetry and investor valuation of IPOs: Top management team legitimacy as a capital market signal. *Strategic Management Journal*. 26 (7), 683-690.

Cornelli, F., & Goldreich, D. 2001. Bookbuilding and strategic allocation. *The Journal of Finance*. 56 (6), 2337-2369.

Cornelli, F., & Goldreich, D. 2003. Bookbuilding: How informative is the order book? *The Journal of Finance*. 58 (4), 1415-1443.

Dambra, M., Schonberger, B., & Wasley, C. 2020. Creating visibility: Voluntary disclosure by private firms pursuing an initial public offering. *Working Paper*.

DeAngelo, L. E. 1981. Auditor size and audit quality. *Journal of Accounting and Economics*. 3, 183-199.

Dee, C. C., Lulseged, A., and Zhang, T. 2011. Client stock market reaction to PCAOB sanctions against a Big 4 auditor. *Contemporary Accounting Research.* 28 (1), 263-291.

Deloitte, LLP. 2021. For the tenth consecutive year, Deloitte retains its no. 1 position in security consulting services by market share. July 7, 2021. https://www2.deloitte.com/global/en/pages/about-deloitte/press-releases/for-the-tenth-consecutive-year-deloitte-retains-its-no-1-position-in-security-consulting-services-by-market-share.html. Accessed July 13, 2022.

DeFond, M., & Zhang, J. 2014. A review of archival auditing research. *Journal of Accounting and Economics*. 58 (2-3), 275-326.

Field, L. C., & Karpoff, J. M. 2002. Takeover defenses of IPO firms. *The Journal of Finance*. 57 (5), 1857-1889.

Florackis, C., Louca, C., Michaely, R., & Weber, M. 2020. *Cybersecurity risk* (No. w28196). National Bureau of Economic Research. *Working Paper*.

Francis, J. R. 1984. The effect of audit firm size on audit prices: A study of the Australian market. *Journal of Accounting and Economics*. 6 (2), 133-151.

Francis, J. R., Reichelt, K., & Wang, D. 2005. The pricing of national and city-specific reputations for industry expertise in the US audit market. *The Accounting Review*. 80 (1), 113-136.

Gordon, L. A., Loeb, M. P., & Zhou, L. (2016). Investing in cybersecurity: Insights from the Gordon-Loeb model. *Journal of Information Security*. 7 (02), 49.

Haislip, J., Kolev, K., Pinsker, R., & Steffen, T. 2019. The economic cost of cybersecurity breaches: A broad-based analysis. *Working Paper*.

Hanley, K. W. 1993. The underpricing of initial public offerings and the partial adjustment phenomenon. *Journal of Financial Economics*. 34 (2), 231-250.

Hanley, K. W., & Hoberg, G. 2010. The information content of IPO prospectuses. *The Review of Financial Studies*. 23 (7), 2821-2864.

Hendricks, B., Howell, T., & Bingham, C. (2019). How much do top management teams matter in founder-led firms?. *Strategic Management Journal*. 40 (6), 959-986.

Hochberg, Y. V. (2012). Venture capital and corporate governance in the newly public firm. *Review of Finance*. 16 (2), 429-480.

Hogan, C. E. 1997. Costs and benefits of audit quality in the IPO market: A self-selection analysis. *The Accounting Review*. 72 (1), 67-86.

Hopkins, N. 2017. Deloitte hit by cyber-attack revealing clients' secret emails. *The Guardian*, September 25, 2017. https://www.theguardian.com/business/2017/sep/25/deloitte-hit-by-cyber-attack-revealing-clients-secret-emails. Accessed June 29, 2022.

Huang, H. H., & Wang, C.2021). Do banks price firms' data breaches? *The Accounting Review*. 96 (3), 261-286.

Kamiya, S., Kang, J. K., Kim, J., Milidonis, A., & Stulz, R. M. 2021. Risk management, firm reputation, and the impact of successful cyberattacks on target firms. *Journal of Financial Economics*. 139 (3), 719-749.

Kandel, S., Sarig, O., & Wohl, A. 1999. The demand for stocks: An analysis of IPO auctions. *The Review of Financial Studies*. 12 (2), 227-247.

Kothari, S. P., Li, X., and Short, J. E. (2009). The effect of disclosures by management, analysts, and business press on cost of capital, return volatility, and analyst forecasts: A study using content analysis. *The Accounting Review.* 84 (5), 1639-1670.

Kutsuna, K., Smith, J. K., & Smith, R. L. 2009. Public information, IPO price formation, and long-run returns: Japanese evidence. *The Journal of Finance*. 64 (1), 505-546.

Krishnan, C. N. V., Ivanov, V. I., Masulis, R. W., & Singh, A. K. 2011. Venture capital reputation, post-IPO performance, and corporate governance. *Journal of Financial and Quantitative Analysis*. 46 (5), 1295-1333.

Lambert, R., Leuz, C., & Verrecchia, R. E. (2007). Accounting information, disclosure, and the cost of capital. *Journal of Accounting Research*. 45 (2), 385-420.

Lange, D., Lee, P.M. and Y. Dai 2011. Organizational Reputation: A Review. *Journal of Management.* 37 (1): 153-184.

Lee, G., & Masulis, R. W. 2011. Do more reputable financial institutions reduce earnings management by IPO issuers? *Journal of Corporate Finance*. 17 (4), 982-1000.

Lending, C., Minnick, K., & Schorno, P. J. 2018. Corporate governance, social responsibility, and data breaches. *Financial Review.* 53 (2), 413-455.

Leone, A. J., Rock, S., & Willenborg, M. 2007. Disclosure of intended use of proceeds and underpricing in initial public offerings. *Journal of Accounting Research*. 45 (1), 111-153.

Li, H., No, W. G., & Boritz, J. E. 2020. Are external auditors concerned about cyber incidents? Evidence from audit fees. *Auditing: A Journal of Practice & Theory*. 39 (1), 151-171.

Loughran, T., & McDonald, B. 2013. IPO first-day returns, offer price revisions, volatility, and form S-1 language. *Journal of Financial Economics*. 109 (2), 307-326.

Loughran, T., & Ritter, J. R. 2002. Why don't issuers get upset about leaving money on the table in IPOs?. *The Review of Financial Studies*. 15 (2), 413-444.

Loughran, T., & Ritter, J. 2004. Why has IPO underpricing changed over time? *Financial Management*. 33 (3), 5-37.

Makridis, C., & Dean, B. 2018. Measuring the economic effects of data breaches on firm outcomes: Challenges and opportunities. *Journal of Economic and Social Measurement.* 43 (1-2), 59-83.

Menon, K., & Williams, D. D. 1991. Auditor credibility and initial public offerings. *The Accounting Review*. 66 (2), 313-332.

Michaely, R., & Shaw, W. H. 1995. Does the choice of auditor convey quality in an initial public offering? *Financial Management*. 24 (4), 15-30.

O'Connell, M. 2017. TV ratings: Oscars drop to 32.9M viewers, telecast takes a bigger hit with younger set. *The Hollywood Reporter*, February 27, 2017. https://www.hollywoodreporter.com/tv/tv-news/tv-ratings-oscars-drop-again-early-numbers-980854/. Accessed June 29, 2022.

Reilly, D. 2006. Hotels.com credit card data lost in stolen laptop computer. *The Wall Street Journal* June 2, 2006. https://www.wsj.com/articles/SB114921264072869450. Accessed 9/14/2022.

Rosati, P., Cummins, M., Deeney, P., Gogolin, F., Van der Werff, L., & Lynn, T. 2017. The effect of data breach announcements beyond the stock price: Empirical evidence on market activity. *International Review of Financial Analysis*. *49*, 146-154.

Rosati, P., Gogolin, F., & Lynn, T. 2019. Audit firm assessments of cyber-security risk: evidence from audit fees and SEC comment letters. *The International Journal of Accounting*. 54 (03), 1950013.Sheneman 2018

Simunic, D. A. 1980. The pricing of audit services: Theory and evidence. *Journal of Accounting Research*. 18 (1), 161-190.

Skinner, D. J., and Srinivasan, S. 2012. Audit quality and auditor reputation: Evidence from Japan. *The Accounting Review*, 87 (5), 1737-1765.

Smith, T. J., Higgs, J. L., & Pinsker, R. E. 2019. Do auditors price breach risk in their audit fees? *Journal of Information Systems*. 33 (2), 177-204.

Uberti, D. 2022. Fearing more cyberattacks, Congress requires key businesses to report digital breaches. *The Wall Street Journal* March 17, 2022. https://www.wsj.com/articles/fears-of-cybersecurity-attacks-may-increase-disclosure-requirements-for-businesses-11647444384?mod=ig_cybersecurityreport. Accessed 5/26/2022.

Weber, J., Willenborg, M., & Yang, Y. S. 2018. IPO Price Formation and Analyst Coverage. *Working paper*.

Weber, J., Willenborg, M., & Zhang, J. 2008. Does auditor reputation matter? The case of KPMG Germany and ComROAD AG. *Journal of Accounting Research*. 46 (4), 941-972.

Willenborg, M. 1999. Empirical analysis of the economic demand for auditing in the initial public offerings market. *Journal of Accounting Research*. 37 (1), 225-238.

Willenborg, M., Wu, B., & Yang, Y. S. 2015. Issuer operating performance and IPO price formation. *Journal of Accounting Research*. 53 (5), 1109-1149.

Yen, J. C., Lim, J. H., Wang, T., & Hsu, C. 2018. The impact of audit firms' characteristics on audit fees following information security breaches. *Journal of Accounting and Public Policy*. 37 (6), 489-507.

Yung, C., Çolak, G., & Wang, W. 2008. Cycles in the IPO market. *Journal of Financial Economics*. 89 (1), 192-208.

Appendix – Variable Definitions

Variable	Definition
Age	Log of the number of years from the firm's founding date to IPO
Assets	Log of total assets in the year prior to the IPO
Biotech	Indicator variable equal to one if the firm is in SIC code 2830, 2833, 2834, 2835, 2836, 8731, or zero otherwise
Breach	Indicator variable equal to one if the IPO firm's auditor had a data breach in the 90-day window prior to the issue date, or zero otherwise
BTM	Book value of equity in the year prior to the IPO divided by market value of equity
IPO_Vol	Log of the number of IPOs within the same industry in the one year window prior to the issue date
Leverage	Total liabilities divided by total assets in the year prior to the IPO
Market_Val	Log of market value of equity
Media	Indicator variable equal to one if the breach was announced by the media, or zero otherwise
Nasdaq	Indicator variable equal to one if the firm is listed on Nasdaq, or zero otherwise
Price_Revision	Offer price minus the midpoint of the proposed offer price range, divided by the midpoint of the proposed offer price range
Records	Log of one plus total records compromised as a result of the breach in 1000s
Reputation	Average Carter-Manaster reputation ranking of the firm's lead underwriters
Restatement_1yr	Indicator variable equal to one if the IPO firm had a restatement in the one-year period after the IPO
Restatement_2yr	Indicator variable equal to one if the IPO firm had a restatement in the two-year period after the IPO
Restatement_3yr	Indicator variable equal to one if the IPO firm had a restatement in the three-year period after the IPO
Retained	Post-IPO shares retained by pre-IPO shareholders, divided by total shares outstanding
Revenue	Log of total revenue in the year prior to the IPO
ROA	Earnings before extraordinary items divided by total assets in the year prior to the IPO
R&D	Research and development expense divided by total assets in the year prior to the IPO
Spread	Average bid-ask spread in the 90-day window starting five days after the issue date
Underpricing	Closing price on the IPO date minus the offer price, divided by the offer price
VC	Indicator variable equal to one if the firm is venture capital-backed, or zero otherwise
Volatility	Standard deviation of returns in the 90-day window starting five days after the issue date

Table 1 – Sample Selection

IPO Sample Selection	Observations
All U.S. IPOs from January 1, 2005 to December 31, 2018	2769
Exclude: IPOs in non-major stock exchanges	(547)
Exclude: Financial firms, unit issues, blank check companies, rights issues	(769)
Exclude: IPOs with missing historical financial and market information	(413)
Exclude: IPOs with a non-Big 4 auditor	(172)
Final IPO Sample	**868**

Table 1 describes how the IPO sample is constructed.

Table 2 – Descriptive Statistics

Variable	Mean	SD	P25	Median	P75
Age	2.534	0.931	1.946	2.398	2.944
Assets	4.980	1.706	3.762	4.670	6.210
Biotech	0.254	0.436	0.000	0.000	1.000
Breach	0.073	0.259	0.000	0.000	0.000
BTM	0.160	0.375	0.010	0.083	0.204
IPO_Vol	2.367	1.154	1.609	2.639	3.258
Leverage	0.349	0.445	0.004	0.224	0.521
Market_Val	13.030	0.927	12.402	12.912	13.587
Media	0.023	0.150	0.000	0.000	0.000
Nasdaq	0.636	0.481	0.000	1.000	1.000
Price_Revision	-0.027	0.210	-0.158	0.000	0.100
Records	0.386	1.962	0.000	0.000	0.000
Reputation	7.524	1.570	7.000	8.000	8.667
Restatement_1yr	0.083	0.276	0.000	0.000	0.000
Restatement_2yr	0.142	0.349	0.000	0.000	0.000
Restatement_3yr	0.192	0.394	0.000	0.000	0.000
Retained	0.723	0.148	0.680	0.752	0.815
Revenue	4.218	2.408	3.004	4.467	5.880
ROA	-0.276	0.619	-0.396	-0.041	0.037
R&D	0.257	0.431	0.000	0.119	0.333
Spread	0.006	0.007	0.002	0.004	0.007
Underpricing	0.181	0.334	0.000	0.101	0.275
VC	0.562	0.496	0.000	1.000	1.000
Volatility	0.035	0.015	0.024	0.033	0.043

Table 2 provides descriptive statistics for all variables used in our analysis. The sample contains 868 firm-year observations. All variable definitions are in the Appendix.

Table 3 – Data breaches and IPO pricing

	(1) *Price_Revision*	(2) *Underpricing*
Breach	-0.041**	0.018
	(-2.08)	(0.39)
Market_Val	0.133***	0.055*
	(8.27)	(1.89)
Assets	-0.062***	-0.031
	(-6.32)	(-1.67)
Revenue	0.011***	0.009
	(3.10)	(1.27)
ROA	-0.022	-0.022
	(-0.74)	(-0.70)
R&D	-0.102**	-0.079*
	(-2.53)	(-1.75)
VC	0.035**	0.140***
	(2.36)	(2.71)
Nasdaq	-0.010	0.038
	(-0.66)	(1.47)
Reputation	-0.007*	0.002
	(-1.93)	(0.34)
Age	-0.016**	-0.021
	(-2.64)	(-1.35)
Retained	-0.077	0.156*
	(-1.68)	(1.88)
Leverage	-0.046**	0.023
	(-2.57)	(0.44)
BTM	0.063***	0.183**
	(3.68)	(2.24)
Biotech	-0.024	-0.049
	(-1.08)	(-1.47)
IPO_Vol	0.027**	0.002
	(2.15)	(0.13)
Observations	868	868
R-squared	0.356	0.154
Industry FEs	Yes	Yes
Year FEs	Yes	Yes
Auditor FEs	Yes	Yes
Industry Clustering	Yes	Yes

Table 3 reports the results from estimating Equation (1). *Price_Revision* is the percentage change from the midpoint of the initial proposed offer price range to the offer price. *Underpricing* is the percentage change from the offer price to the closing price on the first trading day. Our variable of interest, *Breach*, is an indicator variable equal to one if the IPO firm's auditor had a data breach in the 90-day window prior to the issue date, or zero otherwise. All other variables are defined in the Appendix. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 4 – IPO Pricing and Governance

	(1)	(2)	(3)	(4)
VC Backed?	Yes	No		
Underwriter Reputation?			High	Low
	Price Revision	*Price Revision*	*Price Revision*	*Price Revision*
Breach	-0.015	-0.087**	0.002	-0.099**
	(-0.43)	(-2.07)	(0.06)	(-2.23)
Market_Val	0.155***	0.115***	0.102***	0.182***
	(9.62)	(7.43)	(7.43)	(9.27)
Assets	-0.048***	-0.060***	-0.050***	-0.075***
	(-3.19)	(-4.46)	(-4.06)	(-4.63)
Revenue	0.001	0.012	0.005	0.016*
	(0.10)	(1.27)	(0.64)	(1.76)
ROA	-0.035	0.023	-0.012	-0.023
	(-1.25)	(0.41)	(-0.36)	(-0.67)
R&D	-0.080**	-0.077	-0.078	-0.112**
	(-2.12)	(-0.93)	(-1.61)	(-2.40)
VC			0.050**	0.025
			(2.02)	(0.89)
Nasdaq	-0.039*	0.012	-0.008	-0.014
	(-1.65)	(0.56)	(-0.45)	(-0.45)
Reputation	-0.011**	-0.005	-0.006	-0.011
	(-1.98)	(-0.72)	(-0.30)	(-1.48)
Age	0.033	-0.019*	-0.008	-0.026
	(1.59)	(-1.94)	(-0.82)	(-1.50)
Retained	0.008	-0.113*	-0.083	-0.082
	(0.10)	(-1.87)	(-1.41)	(-0.90)
Leverage	-0.060**	-0.026	-0.061**	-0.025
	(-2.50)	(-0.96)	(-2.41)	(-0.93)
BTM	0.089*	0.061**	0.066***	0.035
	(1.95)	(2.50)	(2.77)	(0.72)
Biotech	-0.048	-0.003	-0.024	-0.026
	(-1.39)	(-0.06)	(-0.62)	(-0.58)
IPO_Vol	0.009	0.011	0.028*	0.026
	(0.46)	(0.64)	(1.89)	(1.13)
Chi-Square	2.84*		7.45***	
p-value	0.092		0.006	
Observations	487	381	531	337
R-squared	0.474	0.287	0.312	0.465
Industry FEs	Yes	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes	Yes
Auditor FEs	Yes	Yes	Yes	Yes
Industry Clustering	Yes	Yes	Yes	Yes

Table 4 reports results of the effect of data breaches on price revisions after partitioning the sample based on venture capital-backing and underwriter reputation. *Price_Revision* is the percentage change from the midpoint of the initial proposed offer price range to the offer price. Our variable of interest, *Breach*, is an indicator variable equal to one if the IPO firm's auditor had a data breach in the 90-day window prior to the issue date, or zero otherwise. All other variables are defined in the Appendix. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 5 – IPO Pricing and Breach Characteristics

	(1) *Price_Revision*	(2) *Price_Revision*
Breach	0.000	-0.018
	(0.01)	(-0.76)
*Breach*Records*	-0.009**	
	(-2.16)	
*Breach*Media*		-0.070*
		(-1.98)
Market_Val	0.133***	0.132***
	(8.24)	(8.18)
Assets	-0.062***	-0.062***
	(-6.40)	(-6.37)
Revenue	0.011***	0.012***
	(3.14)	(3.21)
ROA	-0.023	-0.021
	(-0.78)	(-0.71)
R&D	-0.104**	-0.099**
	(-2.60)	(-2.52)
VC	0.034**	0.035**
	(2.33)	(2.31)
Nasdaq	-0.010	-0.010
	(-0.64)	(-0.61)
Reputation	-0.007*	-0.007*
	(-1.94)	(-1.95)
Age	-0.016**	-0.016**
	(-2.64)	(-2.66)
Retained	-0.073	-0.078
	(-1.64)	(-1.65)
Leverage	-0.046**	-0.047**
	(-2.60)	(-2.59)
BTM	0.065***	0.063***
	(3.74)	(3.58)
Biotech	-0.025	-0.025
	(-1.17)	(-1.16)
IPO_Vol	0.028**	0.026**
	(2.22)	(2.11)
Observations	868	868
R-squared	0.359	0.358
Industry Fes	Yes	Yes
Year Fes	Yes	Yes
Auditor Fes	Yes	Yes
Industry Clustering	Yes	Yes

Table 5 replicates results in Equation (1) after interacting *Breach* with *Records* (column 1) and *Media* (column 2). *Price_Revision* is the percentage change from the midpoint of the initial proposed offer price range to the offer price. *Breach* is an indicator variable equal to one if the IPO firm's auditor had a data breach in the 90-day window prior to the issue date, or zero otherwise. *Records* is the log of number of records compromised as a result of the breach. *Media* is an indicator variable equal to one if the breach was announced by the media, or zero otherwise. Our variables of interest are the interaction terms *Breach*Records* (column 1) and *Breach*Media* (column 2). All other variables are defined in the Appendix. ∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% level, respectively.

Table 6 – Post-IPO Consequences of Data Breaches

	(1) *Spread*	(2) *Volatility*
Breach	0.001**	0.005***
	(2.62)	(2.71)
Market_Val	-0.002***	-0.000
	(-3.54)	(-0.38)
Assets	-0.000	-0.002***
	(-0.54)	(-3.25)
Revenue	-0.000*	-0.000
	(-2.01)	(-0.57)
ROA	-0.001**	0.002
	(-2.24)	(0.55)
R&D	-0.000	0.002
	(-0.67)	(0.70)
VC	-0.003***	0.004**
	(-2.97)	(2.48)
Nasdaq	0.001***	0.001
	(4.75)	(1.60)
Reputation	-0.000*	-0.000
	(-1.82)	(-0.14)
Age	-0.000	-0.001*
	(-0.09)	(-1.76)
Retained	0.002**	0.005
	(2.03)	(1.60)
Leverage	0.001	0.000
	(1.53)	(0.24)
BTM	-0.000*	-0.001
	(-1.79)	(-1.22)
Biotech	0.002***	0.007***
	(3.48)	(4.23)
IPO_Vol	0.000	0.000
	(1.19)	(0.71)
Observations	868	868
R-squared	0.450	0.407
Industry Fes	Yes	Yes
Year Fes	Yes	Yes
Auditor Fes	Yes	Yes
Industry Clustering	Yes	Yes

Table 6 reports results of the effect of data breaches on post-IPO capital market consequences. Column 1 (column 2) reports results when the dependent variable is *Spread* (*Volatility*). *Spread* is the average bid-ask spread in the 90-day window starting five days after the issue date. *Volatility* is the standard deviation of returns in the 90-day window starting five days after the issue date. Our variable of interest, *Breach*, is an indicator variable equal to one if the IPO firm's auditor had a data breach in the 90-day window prior to the

issue date, or zero otherwise. All other variables are defined in the Appendix. ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively.

Table 7 – Data Breaches and Restatements

	(1)	(2)	(3)
	Restatement_1yr	*Restatement_2yr*	*Restatement_3yr*
Breach	-0.025	0.021	0.028
	(-0.59)	(0.33)	(0.49)
Market_Val	-0.003	-0.038	-0.051
	(-0.17)	(-1.23)	(-1.45)
Assets	0.011	0.028	0.028
	(0.71)	(1.24)	(0.97)
Revenue	0.006	0.006	0.025
	(0.54)	(0.38)	(1.50)
ROA	-0.047**	-0.043	-0.152**
	(-2.41)	(-1.26)	(-2.42)
R&D	-0.039	-0.018	-0.171**
	(-1.08)	(-0.36)	(-2.16)
VC	0.003	0.024	0.065
	(0.12)	(0.68)	(1.53)
Nasdaq	-0.010	0.006	0.015
	(-0.54)	(0.28)	(0.63)
Reputation	-0.012*	-0.011	-0.018*
	(-1.84)	(-1.42)	(-1.84)
Age	-0.004	0.008	0.014
	(-0.34)	(0.57)	(0.70)
Retained	-0.016	0.045	0.048
	(-0.30)	(0.55)	(0.50)
Leverage	-0.016	-0.009	-0.056*
	(-0.75)	(-0.38)	(-1.75)
BTM	-0.017	-0.020	-0.074
	(-0.59)	(-0.42)	(-1.36)
Biotech	-0.058**	-0.079	-0.001
	(-2.32)	(-1.41)	(-0.01)
IPO_Vol	0.014	0.023	0.036
	(0.63)	(0.76)	(1.13)
Observations	868	868	868
R-squared	0.045	0.058	0.084
Industry FEs	Yes	Yes	Yes
Year FEs	Yes	Yes	Yes
Auditor FEs	Yes	Yes	Yes
Industry Clustering	Yes	Yes	Yes

Table 7 reports results of the effect of data breaches on restatements. Column 1, 2, and 3 report results for restatements in a one-, two-, and three-year window after the IPO (*Restatements_1yr*, *Restatements_2yr*, *Restatements_3yr*). Our variable of interest, *Breach*, is an indicator variable equal to one if the IPO firm's auditor had a data breach in the 90-day window prior to the issue date, or zero otherwise. All other variables are defined in the Appendix. ∗∗∗, ∗∗, and ∗ denote significance at the 1%, 5%, and 10% level, respectively.