How do auditors perceive and respond to client firms' technological peer pressure? Evidence from going-concern opinions

Abstract

We examine how the technological aspect of competition (or technological peer pressure) affects the likelihood that auditors issue going-concern opinions. We find that a client firm's technological peer pressure increases the likelihood that the firm receives a going-concern opinion. This finding is consistent with the notion that perceived auditor business risk increases with client technological peer pressure so that auditors are more likely to issue going-concern opinions to clients with such pressure. Further evidence shows that this positive effect is more pronounced for client firms with greater innovation originality, that are financially constrained, and for auditors facing higher litigation risk. We also find that technological peer pressure reduces the probability of both Type I and Type II misclassifications when auditors exert more effort. Additional analyses show that client firms' technological peer pressure positively affects the likelihood of using auditors specialized in auditing R&D. Taken together, our study implies that auditors exert more effort to increase audit quality in response to the higher auditor business risk induced by clients' technological peer pressure, instead of simply being conservative.

Keywords: Technological peer pressure; Going-concern opinions; Audit opinion accuracy

1. Introduction

The study examines the effect of a client firm's technological competition on the likelihood of receiving a going-concern opinion and on opinion accuracy. There is an extensive literature on the determinants of going-concern opinions, including financial ratios, market performance, corporate governance, legal environment, auditor characteristics and incentives, as well as managerial incentives (e.g., Carcello and Neal 2000; DeFond et al. 2002; Chen et al. 2013; DeFond and Zhang 2014). This study focuses on the competitive environment that a client confronts for the following two reasons. First, auditing standards require that auditors understand the competitive environment of a client firm when identifying risks of material misstatements and assessing the client's going-concern assumption (PCAOB AS 2110; AU-C Section 315).[1] Second, prior studies show that competition (such as product market competition) increases client business risk, and as a result, increases auditor business risk (Wang and Chui 2015). Auditors respond to higher business risk by increasing audit fees (Bell et al. 2001) and issuing more going-concern opinions (DeFond et al. 2016).

Both auditing standards and auditing literature suggest that a client's competition affects an auditor's risk assessment and decision-making regarding going-concern opinions. However, there is limited research directly examining how an auditor perceives and responds to the client's competitive environment, particularly from the dimension of technology, in the process of going-concern reporting. Such a question is important and worthy of investigation for two reasons. First, firms facing technological competition, or peer pressure, usually hold a large amount of intangible assets and R&D investments. Intangibles, especially those that are internally developed, pose

[1] Specifically, PCAOB AS 2110 states that auditors should understand relevant industry factors of the company, including the competitive environment and technological developments. Similarly, AU-C Section 315 states that auditors may consider the market and competition, such as price competition, as well as product technology as examples of industry conditions of a client entity.

greater challenges in valuation and assessment of future cash flows, relative to tangible assets. Auditors are granted access to private information on clients' technologies in the process of auditing (Krishnan and Wang 2014), therefore, auditors' perceptions of clients' technological competitive environments are relevant. Second, prior studies show that auditor conservatism has a real effect on corporate innovation (e.g., Chy and Hope 2018). Thus, understanding how auditors respond to clients' technological competition, i.e., exerting more effort or being more conservative, provides insights on clients' operations.

Competition is multi-dimensional. Cao et al. (2018) refer to technological competition as "the extent to which a firm invests in technology that will be used to develop or improve its products" (on p. 2). As they point out, technological competition is one fundamental dimension of the more broadly defined product market competition. In a knowledge-based economy, whether a business entity can survive in a technologically competitive environment is vital to its survival and success (Eisdorfer and Hsu 2011; Cao et al. 2018). An auditor might perceive the technological competition and peer pressure of its client as rivalry threats that lead to increased client/auditor business risks and increased likelihood of business failure, or as opportunities to advance technologies and strengthen competitive competencies that lead to increased likelihood of future profitability.

When facing intensive technological competition, a firm could develop its own cutting-edge technologies or choose to be a fast follower by acquiring technologies from inventors or imitating innovations of competitors (Yung 2016). Both involve greater client business risk that threatens its existence on a going-concern basis. First, an innovation program is risky and its outcome is uncertain. Failure in innovation hurts a firm's profit and future competitive advantage, and ultimately can lead to business failure (Eisdorfer and Hsu 2011). In addition, technology-related risks, such as cybersecurity and privacy threats, might adversely affect a firm's financial position and revenue growth (PwC 2018). Second, if a firm chooses to be a follower, there could be an adverse selection discount that hurts firm valuation and increases the difficulty of obtaining external financing (Yung 2016). Third, when imitating innovation of competitors, a firm might encounter lawsuits for technology infringement and end up with an unfavorable court decision and high litigation cost, making the firm subject to higher risk of bankruptcy (Eisdorfer and Hsu 2011).

A client's business risk, induced by intensified technological competition, can transfer into higher audit risk (e.g., O'Keefe et al. 1994; Johnstone 2000). In response to the higher auditor business risk, auditors might be "lowering the threshold for issuing a going concern opinion" (DeFond et al. 2016, p. 70) or increasing audit effort to improve audit quality (Bell et al. 2001; Venkataraman et al. 2008; Blankley et al. 2012). Thus, if auditors perceive rivalry threats and increased client/auditor business risks from clients' technological competition, they are more likely to issue going-concern opinions.

On the contrary, auditors might perceive clients' technological competition or peer pressure as an opportunity to use technologies to develop and improve products that decrease the likelihood of business failure. Prior studies show that technological competition generates knowledge spillovers, which could increase the marginal productivity of innovation outputs (Qiu and Wan 2015). It also reflects the extent to which a firm explores technology fields with heated inventive activity (Li et al. 2018). Firms tend to accumulate financial resources, e.g., increasing cash holding, to take advantage of the spillover effects of technological competition (Qiu and Wan 2015) or form strategic alliances to explore 'hot' technologies in the economy (Li et al. 2018), which might improve a firm's liquidity and reduce bankruptcy risk. Further, firms in a technologically competitive environment have incentives to avoid a going-concern opinion because of ensuing adverse consequences, including preventing them from innovating or acquiring outside technologies. Lastly, an auditor might not fully understand its client's technological competition because innovation-related information is non-salient and difficult to process (Hirshleifer et al. 2013), and may not coincide with economic value (Kogan et al. 2017). Thus, there might be a positive or indirect association between technological competition and the likelihood of going-concern opinions.

We examine these competing predictions using a panel of data during the period from 2000 to 2010. We use the measure of technological peer pressure (*TPP*) following Cao et al. (2018). *TPP* is a firm's technological peer pressure, constructed by comparing the aggregate R&D stock from its all peers to its own R&D stock. Modified from the variable in Bloom et al. (2013), *TPP* captures both technological rivalry threats and technology spillovers by relating a firm's own technological investments to the technological developments of the economy. We first find that a client's technological peer pressure positively affects the likelihood of receiving a going-concern opinion, consistent with the prediction that intensified technological competition, or peer pressure, increases perceived client and auditor business risks. Further, we show that the effect of technological peer pressure is economically significant. One standard deviation increase in our measure of technological peer pressure leads to an approximately 11.4% increase in the likelihood of going-concern opinions.

We perform three cross-sectional analyses. First, we find that the positive relation between technological peer pressure and the likelihood of going-concern opinions is caused by new and original technologies, measured as in Hirshleifer et al. (2018), because it is more difficult and challenging for auditors to understand and evaluate the information on original technologies. Second, the positive relation between technological peer pressure and the likelihood of going-concern opinions are more pronounced for clients with financial constraints (Hadlock and Pierce 2010), supporting the arguments that financially constrained firms are not able to finance their R&D projects continuously (Li 2011) or quickly absorb technology spillovers (Qiu and Wan 2015), which decreases profitability and increases the probability of business failure. Third, we find a stronger effect for auditors with higher litigation risk (Hennes et al. 2008; Kim and Skinner 2012; Chen et al. 2013).

We also examine the impact of technological peer pressure on the going-concern reporting accuracy. Technological peer pressure could lower the accuracy of going-concern issuance by increasing the uncertainty of the financial viability of clients, which makes it more challenging for auditors to evaluate a firm's going-concern assumption. In contrast, technological peer pressure may also motivate auditors to assess firms' going-concern assumption more accurately. Firms facing technological peer pressure demand high audit quality. Moreover, auditors might anticipate an increased probability of opinion errors and increased engagement risk from clients' technological competition. Thus, they are more likely to increase effort or use specialists' work (Griffith 2018) to more accurately evaluate a firm's going-concern assumption.

We find that although technological peer pressure increases the probability of Type I misclassification in general, auditors who exert more audit effort could reduce both Type I and Type II errors for clients with intensified technological peer pressure. In addition, we find that technological peer pressure positively affects the likelihood of using auditors specialized in auditing R&D. These results indicate that auditors respond to clients' technological peer pressure by exerting more effort and applying specialized knowledge to increase the reporting accuracy of going-concern opinions.

Our study contributes to the prior literature in two primary ways. First, we contribute to the research on the determinants of going-concern audit opinions by examining one factor unexplored by the prior studies, that is, technological competition faced by clients. Auditing standards state that auditors should understand the competition and technological developments when assessing risks of material misstatements and a client's going-concern assumption (PCAOB AS 2110; AU-C Section 315). However, there is no evidence for how a client's competitive environment affects auditors' going-concern reporting. Our study introduces a new angle of competition, technological peer pressure, into auditing research and directly examines the effect of clients' technological peer pressure on the likelihood of going-concern opinions, as well as opinion accuracy. Our study suggests that investors or other interested parties could use this firm-specific technology-based competition measure to infer client and auditor business risks.

Second, our study contributes to the research on the consequences of technological competition. There has been a fair amount of finance and management literature examining the impact of technological competition on corporate financing and strategies (e.g., Qiu and Wan 2015; Qiu et al. 2017; Li et al. 2018), however, there is scant research exploring technological competition in accounting and auditing literature.[2] Our research provides evidence on how technological competition affects auditors' decision-making process regarding going-concern opinions.

The remainder of the paper is organized as follows. Section 2 describes the related literature and develops hypotheses. Section 3 describes the sample selection and research variables. Section 4 discusses the empirical results. We conclude in Section 5.

[2] Two recent studies examine the relation between technological competition and corporate disclosure. Cao et al. (2018) find an overall negative association between technological peer pressure and product disclosure. Ettredge et al. (2018) find that technology spillover is associated with the choices of disclosure in annual reports. Cao et al. (2018) find an overall negative association between technological peer pressure and product disclosure.

2. Literature review and hypothesis development

Extant literature has documented many client characteristics that are associated with the issuance of going-concern opinions (e.g., Carson et al. 2013; DeFond and Zhang 2014). These characteristics range from financial statement items, such as debt defaults (e.g., Carcello et al. 1995; Raghunandan and Rama 1995; Carcello and Neal 2000; Behn et al. 2001; Geiger and Raghunandan 2001; Geiger et al. 2005; Lee et al. 2005; Bruynseels and Willekens 2012) to non-financial statement factors, for instance, market returns and stock return volatility (e.g., DeFond et al. 2002; Kausar and Lennox 2011), mitigating factors (Behn et al. 2001), corporate governance (Carcello and Neal 2000), institutional and legal environment (Geiger et al. 2006), etc. Recent studies provide evidence that managerial-level attributes also affect the likelihood of going-concern audit opinions, such as managerial ability (e.g., Krishnan and Wang 2015) and managerial incentives (e.g., Chen et al. 2013). One determinant missing from this line of research is the technologically competitive environment faced by clients and perceived by auditors.

The competitive environment of a firm significantly influences its strategies and future performance. In response to competition, firms lower prices or differentiate their products to gain market share. From the stock market perspective, competition increases stock return volatility of a firm because it increases the uncertainty of the firm's fundamental future cash flows (Irvine and Pontiff 2009). The product market competition also affects auditing. Wang and Chui (2015) examine the relation between product market competition and audit fees. They find that the increased client business risk, induced by product market competition, transfers to higher auditor business risk, leading to higher audit pricing.

In a knowledge-based economy, technology "underpins innovation in all forms" (PwC 2018, p. 5) and is the main driver of firm value in the long run. Firms could significantly reduce production costs by applying better production technologies, leading to lower prices. Further, firms could develop new products, or add new features to existing products, by applying innovative product technologies to differentiate themselves from competitors. Firms could also enter a new market or industry with innovative technologies.[3] Thus, succeeding in technological competition is critical to a firm's survival, growth and profitability (Cao et al. 2018).

Given the importance of a firm's competitive environment to its survival and profitability, the auditing standards require that auditors understand the competitive environment of a client firm (PCAOB AS 2110; AU-C Section 315). An auditor might perceive its client's technological competition or peer pressure as threats to the survival of its client, which leads to increased client and auditor business risks.

A firm has two options in response to the intensified technological competition and peer pressure. The first option is to develop a firm's own cutting-edge technologies. This option requires long-term commitment, countless experiments and sizable and risky investments in capital and labor, which requires significant financial resources. If a firm fails to develop new technologies or cannot transfer the R&D investment into profitability, the firm's financial status could significantly deteriorate.[4] To support its R&D, a firm might cut operating expenses, or forgo other profitable projects, which further decreases the imminent profitability. If the firm finances innovation by debt contracts, default risk could increase, resulting in potential business failure.

[3] For example, in a recent study on artificial intelligence (AI), "PwC projects that AI will add US$15.7 trillion to global GDP by 2030 as a result of efficiencies and higher customer values" (PwC 2018, p. 5).
[4] Gu (2016) shows that a R&D project is more likely to fail with more competition, therefore, R&D intensive firms are riskier in competitive industries.

Technology-related risks, such as cybersecurity or privacy threats, could also harm a business (PwC 2018).

The second option is to be a fast follower by acquiring technologies from inventors or imitating innovations of competitors (Yung 2016). Firms that choose to be a follower bear a "cost of delay." Yung (2016) shows that external financing reduces the incentive to be a follower and encourages innovation, therefore, firms that choose to be followers are considered to be less able firms with lower valuations, and have difficulties financing externally, which might deteriorate the firm's financial status. In addition, when imitating innovation of competitors, a firm might encounter lawsuits for infringement, and an unfavorable court decision and high litigation costs could lead to bankruptcy. Eisdorfer and Hsu (2011) provide evidence that technological competition increases the probability of bankruptcy. To summarize, intensified technological competition or peer pressure increases client business risk and could negatively impact a client firm's financial status, increasing the probability of future business failure.

Prior auditing literature suggests that higher client business risk is associated with higher auditor business risk (e.g., O'Keefe et al. 1994; Johnstone 2000). Auditors tend to charge higher audit fees (e.g., Morgan and Stocken 1998; Bell et al. 2001), resign from the audit engagements (e.g., Krishnan and Krishnan 1997; Shu 2000), or issue going-concern opinions for clients with higher business risk, to reduce potential litigation costs. For example, DeFond et al. (2016, p. 70) assert that "another strategy for mitigating risk is lowering the threshold for issuing a going concern opinion." They find that the engagement risk is lower for conservative clients, leading to less likelihood of going-concern opinions. Kaplan and Williams (2013) provide evidence that issuing going-concern reports for financially distressed clients protects auditors from lawsuits. In addition, auditors could also increase effort to improve audit quality when they assess higher business risk (Bell et al. 2001; Venkataraman et al. 2008; Blankley et al. 2012). Following this line of reasoning, if an auditor perceives its client's technological peer pressure as increasing client and auditor business risks, it is more likely to issue a going-concern audit opinion.

Alternatively, an auditor might perceive its client's technological competition or peer pressure as an opportunity to use technologies to develop and improve products, which leads to future profitability. Furthermore, firms are likely to accumulate financial resources or take strategies to obtain financing to prepare for the technological competition. For example, Qiu and Wan (2015) show a knowledge spillover effect of technological competition that could increase the marginal productivity of innovation inputs of peer firms. They show that firms increase cash holding in response to technological competition for the funding needed to acquire outside technologies or develop their own innovations. Li et al. (2018) find that firms which are chasing technologies with heated inventive activity (or technology conglomerates) are more likely to form strategic alliances which facilitate knowledge pooling and cross-fertilization.

Increasing cash holdings could improve a firm's liquidity and financial position, which increases the ability that a firm continues its operations on a going-concern basis. Forming strategic alliances helps to attract investors and obtain financing, which decreases bankruptcy risk (Demirkan and Zhou 2016). If an auditor perceives technological competition or peer pressure as an opportunity for technological development and its client is well-prepared financially, the auditor is less likely to issue a going-concern opinion. Furthermore, researchers present evidence on the negative consequences of going-concern opinions, such as negative market reaction (e.g., Menon and Williams 2010) and increased cost of equity and debt (e.g., Amin et al. 2014; Chen et al. 2016). These consequences might negatively affect a firm obtaining resources required to compete for technologies, therefore, managers have greater incentives to pressure auditors for clean opinions.

It is also likely that an auditor is unable to fully consider its client's technological competition because it is difficult to process non-salient technology-related information or predict the economic value of innovation output. The scientific value of innovation output may not coincide with the economic value. For example, a minor technology advancement may generate significant economic value as long as it restricts competition from rival firms (Kogan et al. 2017). Thus, audit opinions do not systematically reflect clients' technological competition or peer pressure. We state our first hypothesis in a null form as follows:

H1: Technological peer pressure is not associated with the likelihood that a firm receives a going-concern audit opinion.

Literature on the going-concern reporting accuracy shows that there are two types of misclassification of going-concern opinions.[5] Prior studies document high rates of both types of misclassification. For example, Carson et al. (2013) summarize that in the United States, the percentage of firms receiving a going-concern opinion, but do not file for bankruptcy, is around 80 to 90 percent (Type I) while around 40 to 50 percent of bankrupt firms did not receive a going-concern opinion (Type II).

Auditors incur costs of losing clients, that are associated with the Type I misclassification, and litigation costs or reputation loss, that are associated with the Type II misclassification. The trade-off of these two costs partially explains the high rates of reporting errors of going-concern opinions (Carson et al. 2013). In addition to the auditors' incentives, lack of expertise could also result in lower reporting accuracy of going-concern opinions (e.g., Arnold et al. 2001).[6]

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[5] Type I misclassification refers to a situation of issuing a going-concern opinion to a firm which is viable and Type II misclassification refers to a situation of not issuing a going-concern opinion to a firm which subsequently fails. Chy and Hope (2018) point out that Type I misclassification captures auditor conservatism and Type II misclassification captures auditor aggressiveness.

[6] Studies also show that there are technical and allocative inefficiencies of audit firm staffing (Chang et al. 2018), which might lead to lower audit quality.

Technological competition or peer pressure increases the likelihood of a client's business failure, leading to higher auditor business risk. If auditors behave more conservatively by lowering the threshold of issuing a going-concern opinion, we expect to observe an increase in Type I misclassification. In the meantime, technological competition increases the uncertainty of financial viability of clients, which makes it more challenging for auditors to evaluate a client firm's going-concern assumption. Therefore, it is possible that auditors make more errors in going-concern reporting.

On the contrary, auditors might improve reporting accuracy of going-concern opinions for clients facing fierce technological competition. First, clients facing fierce technological competition demand high audit quality and going-concern reporting accuracy. Prior studies show that conservative auditors could impede corporate innovation (Chy and Hope 2018), which is undesirable for clients that would like to succeed in a technological competition. Thus, auditors could not attract such clients if they simply behave conservatively by issuing more going-concern opinions. Second, clients' technological competition might indicate an increase in client/auditor business risk (or engagement risk). Studies on auditor judgement show that when the perceived engagement risk increases, auditors are more likely to include relational cues from specialists' work which improve their judgments and decisions (Griffith 2018). Third, clients facing technological competition usually invest more in R&D. When firms have high levels of R&D investments, it is difficult for auditors to evaluate R&D activities reliably and accurately (Godfrey and Hamilton 2005). Therefore, auditors might anticipate the increased probability of reporting errors, of going-concern opinions, at the planning stage.

To reduce the opinion errors, auditors could include specialized knowledge or expertise, allocate more resources in the audit engagements, expand audit scope, and increase sampling and testing to more accurately evaluate clients' going-concern assumptions. For example, Godfrey and Hamilton (2005) find a positive relation between R&D intensity and auditor's specialization in auditing R&D activities. In other words, auditors exert more effort to increase reporting accuracy of going-concern opinions. If this is the case, we could observe a decrease in both Type I and Type II misclassification rates if auditors exert more effort when auditing clients with intensified technological competition. Our second hypothesis is stated in the null form as follows:

H2: Technological peer pressure is not associated with the accuracy of auditors' going-concern opinions.

3. Data and research variables

Measuring technological peer pressure

We measure firm technological peer pressure (*TPP*) by following the procedure in Cao et al. (2018). *TPP* is modified from the technology spillover measure proposed by Bloom et al. (2013), but better captures the technological threats from peer firms. To calculate the measure, we first follow Bloom et al. (2013) and calculate the technological similarity between firms in their patent distributions across the 438 three-digit technology classes defined by the US Patent and Trademark Office (USPTO). We first assign to each firm a technology distribution vector V_i based on its patent distribution across 438 three-digit technology classes. $V_i = \{s_1, s_2, \ldots, s_{438}\}$, where s_1 is the proportion of patents held by firm *i* in technology class 1 during the past five years (i.e., *t-4* to *t*), and etc. We then construct:

$$M_{ij} = \frac{V_i{}' V_j}{\sqrt{V_i}\sqrt{V_j}} \tag{1a}$$

Where M_{ij} is the Jaffe (1986) cosine similarity between firm *i*'s V_i and firm *j*'s V_j. Intuitively, a higher value of this technological proximity measure indicates a greater technology overlap between firm *i* and firm *j*, which in turn suggests that firm *i* and *j*'s technological innovations face greater technology competition from each other. We then follow Cao et al. (2018) and compute *TPP* by averaging all the M_{ij} that firm *i* has over *j* by firm *j*'s R&D stock G,[7] sum up the products, scaled by firm *i*'s own R&D stock, and use the log transformation to calculate the overall technological peer pressure firm *i* faces from other firms in the economy:

$$TPP_{it} = log(1 + \sum_{j} M_{ij} G_{jt} / G_{it}) \qquad (1b)$$

The numerator $M_{ij}G_{jt}$ is the pool of rivals' R&D stock that represents the threats from rivals' technology advances to firm *i*. The denominator G_{it} is firm *i*'s own R&D stock and it represents the firm's technological preparedness (Cao et al. 2018). *TPP* hence represents the threats of rivals' technology advances relative to the firm's own preparedness. Using this measure, Cao et al. (2018) provide evidence that technology peer pressure incurs proprietary costs and could affect firm product disclosures.

Measuring innovation originality and technology obsolescence

Following Hirshleifer et al. (2018), we measure innovation originality (*Originality*) by the breadth of knowledge used to innovate. This is motivated by a popular view of innovation as recombinant search (e.g., Weitzman 1998; Singh and Fleming 2010). Under this view, innovation comes from combining technological components in novel manners or reconfiguring existing combinations. We proxy a firm's *Originality* by the average range of knowledge built upon by its recently granted patents, i.e., the average number of unique technological classes of patents cited by its recently granted patents. Intuitively, a patent that draws knowledge from a wide range of technology areas is more original because it tends to deviate from current technology trajectories

[7] As in Hall et al. (2005) and Bloom et al. (2013), R&D stocks are calculated using a perpetual inventory method with a 15 percent depreciation rate. That is, $G_t = R_t + (1-\rho)\, G_{t-1}$, where R_t is the R&D expenditure in year *t* and $\rho = 0.15$.

to a greater extent (e.g., Balsmeier et al. 2017). *Originality* may also reflect the capability of a firm's managers and scientists to combine different technologies in an original way.

We first compute a patent's originality score as the number of unique technological classes (i.e., 438 technology classes by the USPTO) assigned to the patents cited by the focal patent. We then proxy a firm's innovation originality in each year with the average originality score of all patents granted to the firm over the previous five years. The choice of a five-year window (i.e., *t-4* to *t*) for patent-based proxies is due to the five-year technology cycle (e.g., Matolcsy and Wyatt 2008; Pandit et al. 2011). The formula is expressed as followed:

$$Originality_{i,t} = \frac{1}{\#j} \sum_{p=0}^{4} C_{i,j,t-p} \quad (2a)$$

Where $C_{i,j,t}$ is the number of unique technology classes of all other patents cited by patent *j* granted to firm *i* in year *t*, and *#j* stands for the total number of the patents granted to firm *i* from year *t-4* to year *t* (inclusive).

Following Qiu et al. (2017), we measure a firm's technology obsolescence (*Obsolescence*) using the growth rate of patent classes of the firm. First, for each patent class *i* of 438 classes that are classified by the USPTO, we calculate its average annual growth rate in the number of patents over the previous ten years:[8]

$$\bar{g}_{i,t} = \frac{1}{10} \sum_{p=1}^{10} g_{i,t-p} \quad (2b)$$

$$g_{i,t} = \frac{Patent\ number_{i,t} - Patent\ number_{i,t-1}}{Patent\ number_{i,t-1}} \quad (2c)$$

[8] We require observations of at least three years for the calculation of average patent growth in the past.

A high growth rate indicates a rising class of technology. Next, we calculate the weight of class *i*'s patents in a firm *j*'s patent portfolio at time *t* using patents applied and eventually granted during the period *t-3* to *t-1*,

$$w_{j,i,t} = \frac{Patent\ number_{j,i,t}}{Total\ patent\ number_{j,t}} \quad (2d)$$

Where $Patent\ number_{j,i,t}$ is the number of class *i*'s patents granted to firm *j* during the period *t-3* to *t-1*; $Total\ patent\ number_{j,t}$ is the total number of patents granted to firm *j* during the period *t-3* to *t-1*.

We then create a firm-level measure of technology obsolescence that captures the growth trend of a firm's patent portfolio using the weighted average of the patent's growth for the firm's patent portfolio:

$$Technology\ trend_{j,t} = \sum_i w_{j,i,t}\bar{g}_{i,t} \quad (2e)$$

A lower value of $Technology\ trend_{j,t}$ suggests that firm *j* has more patents in classes that have a low growth rate and, hence, implies that firms experiencing a low technology trend are likely to be those that possess obsolete technologies and are incapable of generating new technologies through innovation to replace aging ones. We therefore use the negated $Technology\ trend_{j,t}$ as our obsolescence measure:

$$Obsolescence\ = -Technology\ trend_{j,t} \quad (2f)$$

Measuring product market competition

Technological competition is related to, but different from, product market competition. We control for the effect of product market competition in our analyses. Following Bloom et al. (2013), we measure product market competition in a similar fashion as technological competition. The product market competition measure takes into account the product market closeness captured by the overlaps between a firm and its rivals' sales across four-digit SIC industries. We first assign each firm with a product market distribution vector P_i based on its sales distribution across four-digit SIC codes (product market segments). $P_i = \{p_1, p_2, \ldots, p_n\}$, where p_i is the average sales share of firm *i* in the product market segment 1 during the past five years. We then construct

$$N_{ij} = \frac{P_i{}' P_j}{\sqrt{P_i}\sqrt{P_j}} \tag{3a}$$

Where N_{ij} is the cosine similarity between P_i and P_j; Intuitively, a higher value of the product market proximity measure indicates a greater overlap of firm *i*'s sales distribution across industries with firm *j*, which in turn suggests that firm *i*'s and *j*'s products face greater market competition or competition from each other.

To conduct firm level analysis, we follow Bloom et al. (2013) and weight all N_{ij} that firm *i* has over *j* by firm *j*'s sales, sum up the products, and use the log transformation of this sum to calculate product market threat to firm *i*

$$SaleComp_i = log(\sum_j N_{ij} Sale_j) \tag{3b}$$

Sample description

The sample period covers from 2000 to 2010.[9] We begin by including all U.S. public firm-year observations in Audit Analytics with audit metrics such as going-concern opinions available,

[9] Our sample period begins at 2000 because the auditing data in Audit Analytics start to be available in 2000. Our sample period ends at 2010 due to the availability of the technological competition measure. The calculation of technological competition measure requires patent information during the previous five application years (see Appendix for variable definition). Our patent database covers all patents granted during 1976 and 2012 (inclusive) and on average, it takes two years for the USPTO to approve the application of a patent and grant it to its innovator. Because of the two-year lag between patent application and grant, the granted patent database we use is subject to truncation bias since it is very likely missing those patents filed for applications before 2012, but granted after 2012. See Hall et al. (2001) for more details about truncation bias of the patent database. To mitigate this truncation bias, we leave out two years and only use patent information with applications before the end of 2010.

and in Compustat with financial accounting data available for the sample period. Our initial sample has 48,436 firm year observations. We exclude ADRs, closed-end funds, REITs, firms with negative sales, financial and utility firms (i.e., SIC: 4000-4999 and 6000-6999) and firms without the necessary data to calculate technological competition variables and control variables in the main regression models. Our selection procedure results in a total number of 16,296 firm-year observations over the sample period. Following prior research, we restrict our sample to financially distressed firms with first-time going-concern opinions during the sample period (e.g., Li 2009; DeFond et al. 2002; Chen et al. 2013). We exclude 232 firm-year observations, which do not receive going-concern opinions for the first time, and 9,198 firm-year observations which are not financially distressed. This procedure leads to 16,064 firm-year observations in the full sample, and 6,866 firm-year observations that are financially distressed. Table 1 delineates the sample selection in detail. For continuous variables, we either take the logarithm or winsorize the data annually at the 1% and 99% percentiles.

<insert Table 1 around here>

Table 2 Panel A1 shows the sample distribution over years. We have the most observations (i.e., 15.15%) in 2001; since then there is a steady decline of observations every year. In 2010, we have the least observations (i.e., 4.62%). Panel A2 provides information on industry distribution by SIC codes for the sample (we list the largest 10 industries by 2-digit SIC code). We observe that the test sample is concentrated in some sectors. Biotech and pharmaceutical industries have the most sample observations (i.e., 26.33%), followed by electrical and electronics (i.e., 17.42%) and business services (i.e., 15.61%). Approximately 11.10% of the sample are not in any of the 10 largest industries.

Prior literature (e.g., Lim and Tan 2008; Reichelt and Wang 2010) restricts their going-concern opinion analyses to financially distressed firms. In addition, Lennox and Pittman (2010) indicate negative book equity as companies suffer financial distress. We conduct our analyses in both the full sample and the financially distressed sample. We define that a firm is financially distressed if it reports negative operating cash flow or negative book equity. Table 2 Panel B shows the descriptive statistics of the distressed sample and the full sample. The mean of the issuance of going-concern audit opinions (*GCOpinion*) is 0.076 for the distressed sample and 0.042 for the full sample, respectively. On average, the degree of technological peer pressure is 7.154 for the distressed sample versus 6.762 for the full sample, and the degree of sales competition is 10.328 for the distressed sample versus 9.917 for the full sample. Panel C compares firms with clean opinions and firms with first-time going-concern opinions. It shows that firms with going-concern opinions experience greater technological peer pressure than clean firms and the difference is significant, evidenced by the *p value* being less than 1%.

Table 2 Panel D presents the correlations among variables in the main regression. We observe that there is significantly positive correlation between going-concern audit opinions (*GCOpinion*) and technological peer pressure (*TPP*), evidenced by the coefficient of 0.087. Notably, going-concern audit opinion is also significantly correlated with sales competition (*SaleComp*). We also observe that technological peer pressure is positively correlated with loss incidence (*Loss*), earnings volatility (*EarnVol*), the absolute value of total accruals (*ACCR*), and negatively correlated with return on assets (*ROA*), leverage (*LEV*), and operating cash flows (*OCF*).

<insert Table 2 around here>

4. Empirical results

Our empirical investigation in this section helps answer the following question: How does an auditor perceive its client's technological peer pressure when issuing a going-concern opinion? We turn to multivariate analysis to examine the relationship between our technological peer pressure variable and the probability of the firm receiving a going-concern audit report. Following DeFond et al. (2002) and Li (2009), we use a pooled logistic regression to estimate the audit-opinion model specified as follows:

$$\Pr(GCOpinion = 1\ or\ 0)_{i,t} = \beta_0 + \beta_1 TPP_{i,t} + Control\ Variables_{i,t} + Year_t + Industry_i + \varepsilon_{i,t} \quad (4)$$

Where the dependent variable, *GCOpinion*, a dummy of going-concern audit opinion is either 1 or 0. The main variable of interest is the technological peer pressure (*TPP*), since we are interested in the effect of the technology aspect of peer pressure or competition, but we control for the effect of the sales aspect of the product market competition.

Following prior studies, we control for other factors that are likely to affect the issuance of going-concern opinions. Prior studies document that financially distressed firms are more likely to receive going-concern opinions. We control for Altman Z score (*AltmanZ*) and expect a negative coefficient on *AltmanZ.* A firm reporting a loss (*Loss*) is more likely to have a going-concern problem so we expect a positive coefficient on *Loss.* On the contrary, a firm reporting large cash flow (*OCF*) and high profitability (*ROA*) is less likely to have going-concern problems so we expect negative coefficients on *OCF* and *ROA*. We expect a negative association between going-concern opinions and firm size (*Size*), given that auditors perceive larger companies have more resources and greater ability to avoid bankruptcy (e.g., Mutchler et al. 1997; Li 2009). We control for measures of firm risk, including leverage (*LEV*) and earnings volatility (*EarnVol*), and we expect a positive relation between firm risk and going-concern opinions. We also control for accounting accruals (*ACCR*), since prior literature has shown the significant relation between accounting accruals and going-concern opinion (e.g., Francis and Krishnan 1999).

We further expect positive associations between going-concern opinions and large audit firms (*BigN*), audit specialization (*R&DSpec*), and audit report lag (*AuditLag*). Big auditors suffer greater reputation loss and litigation risk from failed audits (e.g., Khurana and Raman 2004; Li 2009) and thus are more likely to issue going-concern opinions. Godfrey and Hamilton (2005) present strong evidence that R&D intensity is positively associated with firms' choices of auditors who specialize in auditing R&D contracts. Reichelt and Wang (2010) find that when the auditor is both a national and a city-specific industry specialist, its clients are more likely to be issued a going-concern opinion. Moreover, prior research finds that going-concern companies are associated with longer reporting lags (e.g., McKeown et al. 1991; Mutchler et al. 1997; Li 2009).

If auditors believe that there is substantial doubt about the ability of the client to continue as a going-concern for a reasonable period of time, auditors should consider management's plans for dealing with the adverse effects of the conditions and events (PCAOB AS 2415). Such considerations include plans to borrow money or restructure debt and plans to increase ownership equity. Therefore, auditors are less likely to issue going-concern opinions when clients have the ability to raise additional debt financing and equity capital. We expect a negative association between new issuance for capital (*NewCapital*) and the propensity of going-concern audit opinions. Equation (4) also controls for year and industry fixed effects.

The results of estimating equation (4) are reported in Table 3. The model is significant at *p value* < 0.001, with pseudo R^2 of 40.2% for the distressed sample and pseudo R^2 of 42.3% for the full sample. All control variables are significant at *p value* < 0.10 except for earnings volatility (*EarnVol*), Big-N auditors (*BigN*) and auditor tenure (*Tenure*). The results in Table 3 show that a client firm confronting intensified technological peer pressure is more likely to receive a going-concern audit opinion, evidenced by a significantly positive parameter estimate (β_1 = 0.112 with *p value* < 1%) for the distressed sample and (β_1 = 0.091 with *p value* < 5%) for the full sample, respectively. The marginal effect of technological peer pressure is estimated as 0.075 (0.066) for the distressed (full) sample, which means that one standard deviation in *TPP* leads to 11.36% (12.55%) increase in the likelihood of going-concern opinions.

Lennox (1999) shows that operating cash flows (*CFO*) and leverage (*LEV*) have non-linear effects on financial viability. Failure to take account of these non-linearities may cause heteroscedasticity problems. In Equation (4), we also include polynomial variables (LEV^2, CFO^2, ROA^2, and ROA^3). The results, untabulated for simplicity, are qualitatively similar for control variables, whilst the coefficients on *TPP* remain significantly positive. In addition, we run subsampling tests 1) after we exclude non-Big N client firms; 2) on the sample from 2004 to 2010, given the audit market changes after 2003; 3) by adding an additional control of internal control weaknesses,[10] and we find that the main results from these additional tests still hold. Overall, our findings support the notion that auditors are more likely to issue going-concern reports when the client firm's technological peer pressure is fierce, *ceteris paribus*.

<insert Table 3 around here>

A type of information that is especially hard to evaluate is the originality of innovation. An original technology is competitive. At the same time, the originality involves many dimensions of uncertainty that requires extensive knowledge and expertise for auditors to evaluate. We further test whether the above observed relation between technological competition and the propensity of

[10] Internal control weakness is an indicator variable that takes a value of 1 if the firm discloses at least one material weakness in internal control over financial reporting in the given fiscal year, and 0 otherwise. Internal control disclosures under SOX Section 404 became available for the fiscal years ending on November 15, 2004 and beyond.

receiving a going-concern audit opinion varies when the client firm has original innovation activities. In Equation (4), we add the interaction of technological competition and originality (i.e., *TPP* × *Originality*), both used as dummy variables; 1 above the sample median by year and industry and 0 otherwise, to ease interpretation from multivariate regression.

Some firms possess obsolete technologies and are unable to develop new technologies through innovation to replace old ones. It is easier for auditors to evaluate a firm's aging technologies. To study whether the association between technological competition and going-concern audit opinions is related to technological obsolescence and firm's inability to innovate, in Equation (4), we add the interaction of obsolescence and technological competition (i.e., *TPP* × *Obsolescence*). Both are used as dummy variables; 1 above the sample median by year and industry and 0 otherwise, to ease interpretation from multivariate regression. Table 4 reports the results with the interaction of *TPP* × *Originality* in Column (1) and *TPP* × *Obsolescence* in Column (2).

Table 4 shows that the coefficient on *TPP* × *Originality* is significantly positive (0.074 with *p value* < 5%), indicating that when the client firm has original technologies, the auditor is more likely to issue a going-concern opinion. Our findings suggest that auditors may have difficulties in understanding the client's technological condition, especially when the technologies are new and original; Hirshleifer et al. (2018) indicate that innovative originality is stronger for firms with higher valuation uncertainty, lower investor attention, and greater sensitivity of future profitability to innovative originality.[11]

We further find that the coefficients on both *Obsolescence* and *TPP* × *Obsolescence* are negative (-0.032 and -0.035, respectively). Opposite to new and original technologies, old-aged

[11] Hirshleifer et al. (2018) further point out that the originality measure is constructed based upon patent information instead of product information. Therefore, these patents may not generate cash flows for the firm quickly; the road from patent being granted to the patent-protected products generating cash flows could take years and is subject to technical and market uncertainty.

technologies are not significantly related to the propensity of receiving a going-concern audit opinion. Taken together, the findings in Table 4 suggest that the above documented positive relationship between client's technological peer pressure and the propensity of receiving a going-concern audit opinion is not likely caused by obsolete technologies, and instead is caused by new and original technologies.

<insert Table 4 around here>

When technological peer pressure intensifies, firms demand a large amount of financial resources either to engage in innovation activities or to acquire from outside. Thus, a firm's cash holding and its accessibility to external financing is critical for it to survive the competition. Financially constrained firms are not able to finance their R&D projects continuously and are more likely to suspend their R&D projects, which suggests a higher probability of business failure. Li (2011) finds a positive relation between R&D intensity and stock returns only among financially constrained firms, which implies that the firm risk induced by R&D investment is driven by financial constraints. In addition, financially constrained firms are not able to quickly absorb technology spillovers, which decreases the R&D productivity (Qiu and Wan 2015) and potential profitability. Thus, financial constraints could worsen the negative effect of technological peer pressure on a firm's profitability, prospects and survival, which leads to higher odds of receiving going-concern audit opinions.

Following Hadlock and Pierce (2010), we use firm size and age to measure financial constraints. They confirm that firm size and age are negatively related to financial constraints. They also suggest that firm size and age are highly reliable predictors of financial constraints. An advantage of using firm size and age to proxy for financial constraints is that they are less likely to be endogenous relative to alternative measures, such as the KZ index.[12] Those measures are based on major firm policy variables, such as cash holdings, payout, leverage, and investment. Hadlock and Pierce (2010) show that financial constraint proxies based on firm policies (e.g., dividend and liquidity) result in unreliable loadings. They also establish that the only other variables that consistently predict constraints, after controlling for size and age, are leverage and cash flows.

We measure firm total assets (*TA*) as the natural logarithm of inflation adjusted book value of assets in 2006 dollars (2006 is the midyear of our sample period). Firm age (*Age*) is defined as the number of years between the observation year and the first year that the firm appears on Compustat. Hadlock and Pierce (2010) also note that introducing a non-linear term for size improves the explanatory power of proxies for financial constraints. Therefore, we add firm size squared (*TAsq*), in addition to firm size and age, as an alternative set of financial constraint proxies in our analyses. We estimate the Hadlock and Pierce Index (*HPindex*), which is calculated as $-0.737 \times TA_{t-1} + 0.043 \times TAsq_{t-1} - 0.04 \times Age_{t-1}$. *HPindex* is used to measure financial constraints; a higher index indicates greater financial constraints.

Next, we test whether the above documented relationship between technological peer pressure and the propensity of receiving a going-concern audit opinion becomes stronger or weaker when the client firm experiences financial constraints. In Equation (4), we add the interaction of technological peer pressure and HP Index (i.e., *TPP* × *HPindex*), where both are dummy variables in the regression; 1 above the sample median by year and industry and 0 otherwise, to ease interpretation. We also use the level of cash holding (*Cash*), the cash ratio following Qiu and Wan

[12] For interested readers, please refer to Farre-Mensa and Ljungqvist (2016) for a variety of financial constraint measures.

(2015), as another measure of financial constraint or the abundance of financial resources. *Cash* is used as reverse rank dummy, to ease interpretation from multivariate regression. Table 5 reports the results with the interaction of *TPP* × *Cash* in Column (1) and *TPP* × *HPindex* in Column (2).

Table 5 presents the cross-sectional analysis for financial constraints. In Column (1) the coefficient on *TPP* × *Cash (reverse rank)* is the most significant (0.080 with *p value* < 1%), indicating that the positive relation between technological peer pressure and going-concern opinions are stronger for the firms with financial constraints. In Column (2), we find that the coefficient on *TPP* × *HPindex* is the most significant (0.062 with *p value* < 1%). In conclusion, the results suggest that the above documented positive relationship between client's technological peer pressure and the propensity of receiving a going-concern audit opinion is more pronounced when the client firm experiences financial constraints or lacks financial resources.

<insert Table 5 around here>

An auditor incurs substantial litigation-related costs if it does not issue a going-concern opinion for a client that fails later on (e.g., Kaplan and Williams 2013). Auditors are more likely to issue going-concern opinions to avoid such cost if they perceive a higher litigation risk. Prior studies document a positive relation between litigation risk and the probability of issuing a going-concern opinion. Krishnan and Krishnan (1996) model the two stages of auditors' decision-making process and find that auditors' litigation risk positively affects auditors' opinion formulation process. Geiger et al. (2006) find that the Private Securities Litigation Reform Act, enacted in 1995, reduces the litigation threat against auditors and, therefore, decreases the likelihood of going-concern reports.

Studies also find that auditors are more likely to issue going-concern opinions during circumstances such as the global financial crisis, a period when clients have higher bankruptcy risk (e.g., Geiger et al. 2014), and in the post-SOX era, a period yielding a more stringent legal environment to auditors (e.g., Geiger et al. 2005; Fargher and Jiang 2008). Using a simultaneous equation estimation, Kaplan and Williams (2013) find that auditors' litigation risk *ex ante* is positively associated with going-concern opinions and going-concern reporting is negatively associated with auditor litigation and the likelihood of large financial settlements. Their results imply that auditors are able to protect themselves from potential litigation risk by issuing going-concern opinions. Following this line of research, we examine whether an auditor is more conservative in going-concern reporting, for its clients confronting intensified technological peer pressure, if it perceives a higher litigation risk.

We use a litigation score estimated from the litigation risk model developed by Kim and Skinner (2012). We further test whether the relation between technological competition and going-concern audit opinions is different for auditor with higher litigation risk. In Equation (4), we add the interaction of technological peer pressure and the litigation score (i.e., *TPP* × *Litigation*), both used as dummy variables; 1 above the sample median by year and industry and 0 otherwise, to ease interpretation from multivariate regression.

Hennes et al. (2008) propose a straightforward procedure for classifying restatements as either errors or irregularities and find that most of the restatements classified as irregularities are followed by fraud-related class action lawsuits. We include the interaction of a dummy of technological peer pressure and a dummy variable of fraudulent reporting, following Hennes et al. 2008, (i.e., *TPP* × *Fraud*). Table 6 reports the results with the interaction of *TPP* × *Litigation* in Column (1) and *TPP* × *Fraud* in Column (2). It shows that, in Table 6 Column (1), the coefficient on *TPP* × *Litigation* is significantly positive (0.085 with *p value* < 5%), indicating that when auditors expect higher litigation risk, they are more likely to issue going-concern opinions. In

Column (2), we find that the coefficients on both *Fraud* and *TPP* × *Fraud* are significantly positive (0.061 with *p value* < 5% and 0.124 with *p value* < 1%, respectively). In conclusion, the results suggest that the positive relation between client technological peer pressure and the propensity of receiving a going-concern audit opinion is more pronounced when the client firm experiences higher litigation risk and/or misreporting risk.

<insert Table 6 around here>

Audit opinion accuracy regression

To test the hypothesis H2, we examine the effects of technological peer pressure on the accuracy of auditors' going-concern opinions by analyzing Type-I and Type-II errors.[13] We estimate the following logistic model:

$$Type\ I\ Error_{i,t+1}\ or\ Type\ II\ Error_{i,t-1,2,3} = \beta_0 + \beta_1 TPP + Control\ Variables_{i,t} + Year_t + \varepsilon_{i,t} \quad (5)$$

The first dependent variable is Type I Error (*TypeI*), which equals 1 if an auditor issues a going-concern opinion to a client who does not subsequently file for bankruptcy in the next fiscal year (i.e., *t+1*), 0 otherwise. For the Type-I error test, the sample includes firms that receive first-time going-concern opinions, as rendering an initial going-concern opinion to a client is a particularly difficult decision for the auditor (Li 2009).[14] We have 522 firm observations that received first-time going-concern opinions. Another dependent variable is Type II Error *(TypeII)*, set to 1 if the bankrupt company did not receive a going-concern opinion in any of the prior three

[13] Using bankruptcy outcome as an *ex post* measure of whether a company should be given a going concern opinion is not always a perfect measure of accuracy. For instance, Type-II error can occur when a client firm voluntarily liquidates (Geiger and Rama 2006).

[14] If a firm's bankruptcy is in year *t+2* or *t+3* after being issued a going-concern opinion at year *t*, rather than the auditor having made a mistake, this may represent an even earlier warning to the market (Carcello and Palmrose 1994). We redefine *Type I Error* for firms not going bankrupt within 3 years after being issued a going-concern opinion and find similar test results.

years (i.e., *t-1* to *t-3*), 0 otherwise. For the Type-II error test, the sample includes only bankrupt companies. We have 202 firms that declare bankruptcy.

In Equation (5), following Mutchler et al. (1997), DeFond et al. (2002), and Li (2009), we control for financial distress factors, which include Altman Z-score (*AltmanZ*), cash from operating activities (*OCF*), financial leverage (*LEV*), profitability (*ROA*), new issuance for capital (*NewCapital*), and operating loss (*Loss*). Following Geiger and Rama (2006), we add client size (*Size*) and earnings volatility (*EarnVol*). Following Geiger and Raghunandan (2002) and Li (2009), we add the controls for auditor tenure (*Tenure*), big-N auditor (*BigN*) and audit report lag (*AuditLag*).

The results of estimating Equation (5) are reported in Table 7. The coefficient on technological peer pressure (*TPP*) is positive (β_1 = 0.076, *p value* < 5% in the Type-I error test, and β_1 = 0.041, *p value* > 10% in Type-II error test, respectively). The results show that technological peer pressure increases the likelihood of Type I error in general, implying greater auditor conservatism in going-concern reporting. The results on Big N auditors are mixed. Specifically, we find less Type I reporting errors for Big N auditors but insignificant results for Type II error. The results are consistent with studies, such as Mutchler et al. (1997) and Geiger et al. (2005), which also examine prior audit reports issued to bankrupt companies and conclude there is no significant big-N effect on the Type-II error rates.

The control variables, *Size*, *NewCapital*, and *OCF* have the predicted coefficient signs. Firm size (*Size*) has a negative effect on audit report error. Nogler (1995) finds that smaller companies are more likely to resolve their going-concern uncertainties, but larger companies receiving going-concern modifications are more likely to subsequently file for bankruptcy. Like client firm size, the magnitude of operating cash flows (*OCF*) and the new issuance for capitals

(*NewCapital*) have a significant negative effect on auditor's opinion error. For the control of auditor tenure, our results show that auditor tenure (*Tenure*) is positively associated with auditor's Type-I error while negatively associated with auditor's Type-II error.

<insert Table 7 around here>

Although Table 7 shows that technological peer pressure increases the likelihood of Type I misclassification in general, due to greater auditor conservatism, it is possible that not all the auditors respond to clients' technological competition in the same way. Clients facing fierce technological peer pressure demand higher audit quality, i.e., going-concern reporting accuracy, and auditor conservatism might be undesirable by these firms. For example, Chy and Hope (2018) show that auditor conservatism leads to a reduction of investments in R&D and innovations. In addition, auditors might have anticipated the increased cost associated with going-concern reporting errors for clients with greater technological competition. Thus, auditors might exert more effort, e.g., allocating more resources, expanding audit scope, increasing sampling and testing, to increase reporting accuracy.

Table 8 shows that how audit effort affects the relation between technological competition and reporting accuracy of going-concern opinions. Prior studies show that abnormal audit fees reflect audit effort (e.g., Blankley et al. 2012; Doogar et al. 2015). We follow these studies and measure audit effort as the residual value estimated from an audit fee model. Specifically, *ABFEE* is an indicator variable, 1 if the abnormal audit fee estimated following Blankley et al. (2012) is positive, and 0 otherwise. Consistent with Table 7, *TPP* positively affects the likelihood of Type I misclassification, implying more conservative audit reporting. The coefficient on the interaction between *TPP* and *ABFEE* is negative and significant in both *Type I* and *Type II* regressions (-0.056 and -0.046, respectively, *p value* < 5%). More importantly, F-tests show that the coefficient on

TPP + *TPP* × *ABFEE* is negative and significant, suggesting that auditors who exert more effort improve audit quality for clients facing fierce technological peer pressure by reducing both Type I and Type II misclassifications.

<insert Table 8 around here>

Technological competition and auditor specialization

One reason for high error rates of going-concern opinions, especially Type II misclassification, is that auditors fail to include specialized knowledge and expertise (Arnold et al. 2001; Carson et al. 2013). Firms facing fierce technological peer pressure and competition may hold large amounts of intangible assets and R&D capitals. Godfrey and Hamilton (2005) predict and find a positive association between R&D intensity and specialist auditor choice in auditing R&D-intensive clients. Prior studies on auditor judgement show that when the engagement risk is higher, auditors are motivated to elaborate on specialists' work (Griffith 2018). When clients face intensified technological peer pressure, auditors' perceived business risk (and engagement risk) is higher and auditors are more concerned with reporting accuracy of going-concern opinions. Thus, they are more likely to apply specialized knowledge of experts.

Table 9 reports the effect of a client's technological peer pressure on its auditor's R&D specialization. Following Godfrey and Hamilton (2005), we measure an auditor's R&D specialization as the percentage of all audit clients' R&D expense applicable to clients of the auditor of a firm. The results show a positive and significant association between a client's technological peer pressure and its auditor's R&D specialization (coefficient is 0.005 and 0.006, for the distressed sample and the full sample, respectively), indicating that clients facing intensified technological peer pressure are more likely to use auditors specialized in auditing R&D – the impact of technological peer pressure on demand for specialized auditor services.

<insert Table 9 around here>

5. Conclusions

The auditing standards require auditors to understand the competitive environment when they assess a client firm's going-concern problem, however, the effect of a client firm's competition on auditors' going-concern reporting is not explored in prior literature. In this study, we focus on the technological aspect of competition, technological peer pressure, as technologies become the main driver of a firm's economic value in the long term and are critical to a firm's viability.

We find that a client's technological peer pressure positively affects the likelihood of receiving a going-concern opinion, consistent with the notion that the perceived auditor business risk increases with intensified technological peer pressure so that auditors are more likely to issue going-concern opinions for such clients. Further evidence shows that this positive effect is more pronounced for client firms with original technologies, firms who are financially constrained, and for auditors facing higher litigation risk. We also find that technological peer pressure decreases both Type I and Type II reporting errors for auditors exerting more effort, suggesting that auditors exert more effort to increase audit quality in response to clients' technological peer pressure, instead of simply being conservative. Our study provides direct evidence on how auditors perceive and respond to the higher business risk from clients' technological peer pressure. Since auditors have access to clients' private information and have a real impact on clients' operations, their perceptions and responses to client firms' competitive environment are relevant and insightful.

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Appendix: Variable definitions

GCOpinion	=	An indicator variable equal to 1 for firms receiving a first-time going-concern audit opinion, 0 otherwise.
TypeI	=	An indicator variable equal to 1 for firms receiving going-concern opinion and not going bankrupt in the following year, 0 otherwise.
TypeII	=	An indicator variable equal to 1 for firms not receiving going-concern opinion and going bankrupt in any prior three years, 0 otherwise.
R&DSpec	=	Auditor specialization, as the percentage of all audit clients' R&D expense applicable to clients of the auditor of a firm, following Godfrey and Hamilton (2005).
TPP	=	The measure of technological peer pressure following Cao et al. (2018). See Section 3 for the detail of calculating the measure.
SaleComp	=	The measure of competitive threats from product market rivals following Bloom et al. (2013). See Section 3 for the detail of calculating the measure.
AltmanZ	=	Altman's (1983) default score.
Loss	=	An indicator variable equal to 1 if the firm's income before extraordinary items or operating cash flow is negative; 0 otherwise.
Size	=	The natural logarithm of market value of equity (csho × prcc_f).
ROA	=	Return on assets, defined as income before extraordinary items (ib) scaled by total assets (at).
ROAL	=	Lagged ROA
ACCR	=	Absolute value of total accruals (ib – oancf + xidoc) scaled by total assets.
LEV	=	Financial leverage, calculated as total debt (dltt + dlc) scaled by total assets.
OCF	=	Operating cash flow (oancf – xidoc) scaled by total assets.
EarnVol	=	The standard deviation of ROA in previous five years.
BigN	=	An indicator variable equal to 1 if the firm's auditor is among big N auditors, where N = 5 before the end of year 2002 and N = 4 after 2002.
Tenure	=	The duration of the auditor-client relationship in years after reconciling Compustat and AuditAnalytics databases. We use it as the logged value.
NewCapital	=	An indicator variable equal to 1 when the client firm issued equity (sstk) or long-term debt (dltt) during the year that is greater than 5% of total assets, 0 otherwise.
AuditLag	=	The logged value of the number of calendar days from fiscal year-end to the date of the auditor's report (i.e., auditor's signature date).
R&D	=	The logged value of R&D intensity (R&D scaled by sales).
OPCYCLE	=	Length of operating cycle in days, measured as days to sell inventory plus average collection period; days to sell is the average

		of the most current two years of total inventories divided by the sum of cost of goods sold divided by 360; average collection period is average of the most recent two years of total receivables divided by the sum of net sales divided by 360.
CAPINT	=	Capital intensity, measured as gross property plant and equipment scaled by sales.
Originality	=	A measure of innovation originality by the breadth of knowledge used to innovate, following Hirshleifer et al. (2018).
Obsolescence	=	A measure of technical obsolescence or negative technology trend following Qiu et al. (2017).
Cash	=	Cash ratio, measured as cash-to-assets and marketable securities divided by total book assets. We also use the logarithm of cash-to-assets ratio in our robustness checks, following Qiu and Wan (2015).
HPindex	=	Following Hadlock and Pierce (2010), we use firm size and age to measure financial constraints.
Litigation	=	Litigation score estimated using the litigation risk model developed by Kim and Skinner (2012).
Fraud	=	An indicator variable equal to 1 if the firm was required to restate their accounting numbers due to irregularity in previous two years; 0 otherwise. We classify using the restatement data developed by Hennes et al. (2008) to identify firms with financial reporting fraud.
ABFEE	=	An indicator variable equal to 1 if the abnormal audit fee estimated following Blankley et al. (2012) is positive, and 0 otherwise.

Table 1: Sample selection procedures

The total number of U.S. public firm-year observations in AuditAnalytics with going-concern data available and in Compustat with financial accounting data available for the sample period 2000-2010 (inclusive)	48,436
Less: firm-year observations without patent data available to calculate technological peer pressure measure	(27,740)
Less: financial and utility company observations (SIC: 6000-6999 and 4000-4999)	(1,012)
Less: firm-year observations with missing data in control variables	(3,388)
The total number of firm-year observations with going-concern opinions	16,296
Less: firm-year observations where the going-concern issuance is not the first time over the sample period	(232)
The total number of firm-year observations in the full sample	16,064
Less: firm-year observations with positive book equity and positive operation cash flow	(9,198)
The total number of firm-year observations in the financially distressed sample	6,866

Table 2: Descriptive statistics

Panel A1: Sample distribution across years

Year	# of firm-years	Percent
2000	658	9.58%
2001	1,040	15.15%
2002	902	13.14%
2003	763	11.11%
2004	655	9.54%
2005	572	8.33%
2006	533	7.76%
2007	460	6.70%
2008	492	7.17%
2009	474	6.90%
2010	317	4.62%
Total	6,866	100%

Panel A2: Sample distribution across in the top 10 industries with more samples

Two-digit SIC	Industries	# of firm-years	Percent
28	Biotech and Pharmaceuticals	1,808	26.33%
36	Electrical and Electronics	1,196	17.42%
73	Business Services	1,072	15.61%
38	Medical and Scientific Instruments	936	13.63%
35	Computers and Machinery	654	9.53%
87	Engineering & Management Services	142	2.07%
48	Communications	120	1.75%
37	Transportation Equipment	77	1.12%
33	Primary Metal Products	51	0.74%
34	Fabricated Metal Products	48	0.70%
Others	Others	762	11.10%
Total		6,866	100%

Table 2 <continued>

Panel B: Summary Statistics

B1: Distressed sample

Variable	N	Mean	Std Dev	Q1	Median	Q3
GCOpinion	6,866	0.076	0.258	0.000	0.000	0.000
TPP	6,866	7.154	1.508	6.280	7.212	8.042
SaleComp	6,866	10.328	1.745	9.589	10.702	11.537
AltmanZ	6,866	5.073	2.021	4.345	4.964	6.589
Loss	6,866	0.918	0.252	1.000	1.000	1.000
Size	6,866	5.228	1.627	4.151	5.203	6.195
ROA	6,866	-0.306	0.370	-0.422	-0.183	-0.051
ROAL	6,866	-0.295	0.383	-0.409	-0.172	-0.040
ACCR	6,866	0.095	0.094	0.030	0.065	0.124
LEV	6,866	0.433	0.314	0.190	0.359	0.599
OCF	6,866	-0.138	0.262	-0.235	-0.051	0.030
EarnVol	6,866	0.435	0.736	0.096	0.185	0.412
BigN	6,866	0.880	0.322	1.000	1.000	1.000
R&DSpec	6,866	0.122	0.070	0.007	0.136	0.188
Cash	6,866	0.243	0.214	0.076	0.180	0.350
Tenure	6,866	2.350	0.663	1.946	2.303	2.773
Litigation	6,866	0.067	0.080	0.008	0.023	0.069
Fraud	4,810	0.018	0.132	0.000	0.000	0.000

B2: Full sample

Variable	N	Mean	Std Dev	Q1	Median	Q3
GCOpinion	16,064	0.042	0.140	0.000	0.000	0.000
TPP	16,064	6.762	1.895	5.606	6.794	7.839
SaleComp	16,064	9.917	1.972	8.973	10.339	11.442
Size	16,064	6.236	2.024	4.828	6.102	7.511
AltmanZ	16,064	5.026	5.499	4.500	5.017	6.414
Loss	16,064	0.435	0.488	0.000	0.000	1.000
ROA	16,064	-0.036	0.241	-0.112	0.023	0.080
CROAL	16,064	-0.027	0.248	-0.102	0.031	0.086
ACCR	16,064	0.028	0.293	-0.053	0.003	0.059
LEV	16,064	0.435	0.272	0.218	0.401	0.594
OCF	16,064	-0.011	0.241	-0.051	0.065	0.122
Tenure	16,064	2.061	1.116	1.386	2.079	2.773
EarnVol	16,064	0.075	0.138	0.044	0.068	0.082
BigN	16,064	0.876	0.292	1.000	1.000	1.000
R&DSpec	16,064	0.123	0.075	0.008	0.135	0.187
Cash	16,064	0.185	0.181	0.050	0.123	0.261
Litigation	16,064	0.053	0.077	0.005	0.016	0.056
Fraud	9,022	0.023	0.128	0.000	0.000	0.000

Table 2 <continued>

Panel C: Summary statistics by audit opinion

	Clean Firms (N = 6,344)		Going-concern firms (N = 522)		P values of the difference	
Variable	Mean	Median	Mean	Median	Mean	Median
TPP	7.012	7.144	8.880	8.352	<0.001	<0.001
SaleComp	10.019	10.289	10.887	10.583	<0.001	0.004
AltmanZ	5.019	4.585	5.729	4.982	<0.001	<0.001
Loss	0.916	1.000	0.942	1.000	<0.001	1.000
Size	5.308	5.029	4.256	3.552	<0.001	<0.001
ROA	-0.288	-0.152	-0.525	-0.455	<0.001	<0.001
ROAL	-0.289	-0.168	-0.368	-0.196	<0.001	<0.001
ACCR	0.091	0.064	0.144	0.121	<0.001	<0.001
LEV	0.431	0.369	0.457	0.584	<0.001	<0.001
OCF	-0.125	-0.045	-0.296	-0.403	<0.001	<0.001
EarnVol	0.433	0.179	0.459	0.252	<0.001	<0.001
BigN	0.88	1.000	0.880	1.000	<0.001	1.000
Tenure	2.316	1.946	2.763	1.792	<0.001	<0.001
Cash	0.245	0.182	0.219	0.176	<0.001	<0.001
Fraud	0.017	0.000	0.030	0.000	<0.001	1.000
Litigation	0.065	0.049	0.078	0.074	<0.001	<0.001

Table 2 <continued>

Panel D: Pearson correlation of key variables based on distressed sample (N = 6,866)

	GCOpinion	*TPP*	*SaleComp*	*AltmanZ*	*Loss*	*Size*	*ROA*	*ROAL*	*ACCR*	*LEV*	*OCF*	*EarnVol*	*BigN*
TPP	**0.087**												
SaleComp	**0.021**	**0.055**											
AltmanZ	**-0.071**	**0.025**	**0.063**										
Loss	**0.193**	**0.201**	**0.093**	**-0.024**									
Size	**-0.217**	**-0.178**	**-0.154**	**-0.036**	**-0.073**								
ROA	**-0.300**	**-0.194**	**-0.176**	**-0.048**	**-0.266**	**0.393**							
ROAL	**-0.216**	**-0.118**	**-0.109**	**-0.016**	**-0.152**	**-0.216**	**0.603**						
ACCR	**0.216**	**0.112**	**-0.024**	**0.092**	-0.007	**-0.150**	**-0.154**	**-0.106**					
LEV	**0.158**	**-0.186**	**-0.124**	**-0.337**	0.013	**0.221**	**-0.031**	**0.155**	**-0.146**				
OCF	**-0.375**	**-0.200**	**-0.197**	**-0.013**	**-0.089**	**0.528**	**0.638**	**0.413**	**-0.176**	**-0.086**			
EarnVol	**0.113**	**0.156**	**0.075**	**0.109**	**0.065**	**-0.197**	**-0.333**	**-0.112**	**0.090**	**-0.054**	**-0.263**		
BigN	**-0.067**	**-0.199**	**0.046**	**0.047**	**0.024**	**0.243**	**0.019**	**0.127**	**-0.050**	0.011	**0.036**	**-0.016**	
Tenure	**-0.060**	**-0.291**	**0.017**	**0.073**	**-0.031**	**0.250**	**0.147**	**0.132**	**-0.077**	**0.087**	**0.097**	**-0.182**	**0.268**

This table presents descriptive statistics of variables. Panel A reports the sample distribution across years (Panel A1) and industries (Panel A2). Panel B reports summary statistics of variables for the distressed sample (Panel B1) and the full sample (Panel B2). Panel C compares firm characteristics between firms that receive going-concern opinions and firms that do not. There are 6,344 firm-years in the clean opinion subsample and 522 firm-years in the first-time going-concern opinion subsample. For the variable *Fraud*, there are 4,468 firm-years in the clean opinion subsample and 342 firm-years in the first-time going-concern opinion subsample. Panel D shows the Pearson correlations of key variables based on the distressed sample. The correlation coefficients in **bold** are significant at the 5% level. All variables (except the dummy or logged variables) are winsorized at the 1% and 99% percentiles each year. Refer to the Appendix for variable definitions.

Table 3: Technological competition and going-concern audit opinion

	Dependent variable = *GCOpinion*		
	Predicted sign	Distressed sample	Full sample
TPP	+	0.112***	0.091**
		(2.69)	(2.11)
SaleComp	+	0.016*	0.023*
		(1.71)	(1.92)
AltmanZ	-	-0.027**	-0.021**
		(-2.24)	(-2.34)
Loss	+	0.344***	0.214***
		(5.16)	(3.94)
Size	-	-0.796***	-0.789***
		(-8.46)	(-8.30)
ROA	-	-0.647***	-0.612***
		(-3.06)	(-2.81)
ROAL	-	-0.231**	-0.216**
		(2.35)	(2.08)
ACCR	+	2.209***	2.259***
		(4.12)	(4.28)
LEV	+	1.384***	1.547***
		(8.28)	(9.55)
OCF	-	-2.426***	-2.363***
		(-10.16)	(-10.01)
EarnVol	+	0.038	0.010
		(1.08)	(0.65)
BigN	+	0.102	0.140
		(1.22)	(1.42)
Tenure	-	-0.023	-0.001
		(-0.55)	(-0.02)
NewCapital	-	-0.092**	-0.070*
		(-2.03)	(-1.81)
AuditLag	+	0.081*	0.049**
		(1.70)	(2.45)
R&DSpec	+	0.067**	0.069***
		(2.30)	(4.01)
Industry & Year FE		Yes	Yes
N		6,866	16,064
Pseudo R^2		0.402	0.423

This table presents logistic regression results examining the association between firm-level technological competition and the prosperity of receiving a going-concern audit opinion. The dependent variable is a dummy of going-concern audit opinion. The explanatory variable of interest is technological competition. Estimates on industry & year indicators are not reported for brevity. Significance is based on two-way clustered standard errors to account for time-series (2-digit SIC industry group) and cross-sectional (year) dependence. Refer to the Appendix for variable definitions.

Table 4: Technological competition and going-concern audit opinion – Technological originality or obsolescence

	Dependent variable = *GCOpinion*	
	Model (1)	Model (2)
TPP	0.066**	0.064**
	(2.18)	(2.15)
Originality	0.034	
	(1.55)	
TPP × *Originality*	0.074**	
	(2.52)	
Obsolescence		-0.032
		(-1.56)
TPP × *Obsolescence*		-0.035*
		(-1.87)
Controls	Included	Included
Industry & Year FE	Yes	Yes
N	6,866	6,866
Pseudo R^2	0.403	0.403

This table presents logistic regression results examining the association between firm-level technological competition and the prosperity of receiving a going-concern audit opinion when the client firm has original technology or obsolete technology. The dependent variable is a dummy of going-concern audit opinion. The explanatory variable of interest is technological competition. Estimates on industry & year indicators are not reported for brevity. Significance is based on two-way clustered standard errors to account for time-series (2-digit SIC industry group) and cross-sectional (year) dependence. Refer to the Appendix for variable definitions.

Table 5: Technological competition and going-concern audit opinion – Financial constraints

	Dependent variable = *GCOpinion*	
	Model (1)	Model (2)
TPP	0.062**	0.061**
	(2.10)	(2.08)
Cash (reverse rank)	0.034*	
	(1.83)	
TPP × *Cash (reverse rank)*	0.080***	
	(3.12)	
HPindex		0.036**
		(1.98)
TPP × *HPindex*		0.062***
		(2.67)
Controls	Included	Included
Industry & Year FE	Yes	Yes
N	6,866	6,866
Pseudo R^2	0.403	0.402

This table presents logistic regression results examining the association between firm-level technological competition and the prosperity of receiving a going-concern audit opinion when the client firm has financial constraints. The dependent variable is a dummy of going-concern audit opinion. The explanatory variable of interest is technological competition. Estimates on industry & year indicators are not reported for brevity. Significance is based on two-way clustered standard errors to account for time-series (2-digit SIC industry group) and cross-sectional (year) dependence. Refer to the Appendix for variable definitions.

Table 6: Technological competition and going-concern audit opinion – Litigation risk

	Dependent variable = *GCOpinion*	
	Model (1)	Model (2)
TPP	0.062**	0.063**
	(2.10)	(2.11)
Litigation	0.025	
	(0.95)	
TPP × *Litigation*	0.085**	
	(2.56)	
Fraud		0.061**
		(2.13)
TPP × *Fraud*		0.124***
		(3.16)
Controls	Included	Included
Industry & Year FE	Yes	Yes
N	6,866	4,810
Pseudo R^2	0.403	0.403

This table presents logistic regression results examining the association between firm-level technological competition and the prosperity of receiving a going-concern audit opinion when the auditor faces more audit risk (i.e., misreporting or litigation risk). The dependent variable is a dummy of going-concern audit opinion. The explanatory variable of interest is technological competition. Estimates on industry & year indicators are not reported for brevity. Significance is based on two-way clustered standard errors to account for time-series (2-digit SIC industry group) and cross-sectional (year) dependence. Refer to the Appendix for variable definitions.

Table 7: Technological competition and going-concern opinion accuracy

	Dependent variable = *TypeI*	Dependent variable = *TypeII*
TPP	0.076**	0.041
	(2.29)	(1.53)
SaleComp	0.023	0.020
	(1.51)	(1.44)
AltmanZ	-0.057*	-0.016
	(-1.66)	(-1.56)
Loss	-0.310**	-0.201
	(-2.04)	(-1.36)
Size	-0.283*	-0.288***
	(-1.68)	(-3.81)
ROA	0.533**	0.403*
	(2.12)	(1.68)
NewCapital	-0.200	-0.130*
	(-1.55)	(-1.80)
LEV	-0.736***	-0.303**
	(-2.79)	(-2.41)
OCF	-0.961*	-0.126
	(-1.78)	(-1.50)
EarnVol	0.055	0.399
	(0.36)	(1.41)
BigN	-0.981**	0.152
	(-2.00)	(0.31)
AuditLag	0.037	0.016
	(1.12)	(0.55)
Tenure	0.050*	-0.073*
	(1.67)	(-1.70)
Year FE	Yes	Yes
N	6,664	202
Pseudo R^2	0.272	0.190

This table presents the regression examining the association between firm-level technological competition and the opinion accuracy. *TypeI* equals 1 if an auditor issues a going-concern opinion to a client that does not subsequently file for bankruptcy in the next fiscal year, 0 otherwise. *TypeII* equals 1 if an auditor fails to issue a going-concern opinion to a client that subsequently declares bankruptcy, 0 otherwise. The sample of Type II misclassification is restricted to firms that go bankrupt. The explanatory variable of interest is technological competition. Coefficient *p value* is two-tailed and based on Wald Chi-squares robust to heteroscedasticity and time-series correlation following the methodology in Rogers (1993). Estimates on year indicators are not reported for brevity. Refer to Appendix for variable definitions.

Table 8: Technological competition and going-concern opinion accuracy – Audit effort

	Dependent variable = *TypeI*	Dependent variable = *TypeII*
TPP	0.048*	0.032
	(1.93)	(1.27)
ABFEE	-0.009	-0.011
	(-0.55)	(-0.58)
TPP × *ABFEE*	-0.056***	-0.046**
	(-2.65)	(-2.39)
Controls	Included	Included
Industry & Year FE	Yes	Yes
N	6,664	202
Pseudo R^2	0.272	0.191
Coefficient of (*TPP* + *TPP* × *ABFEE*)	-0.008***	-0.014**
F Statistics	8.85	4.38

This table reports the results on how audit effort affects the relation between technological competition and going-concern reporting accuracy. The dependent variable is a dummy variable that indicates type I error of reporting a going-concern opinion (column 1) or a dummy variable that indicates type II error of reporting a going-concern opinion (column 2). Abnormal audit fees (*ABFEE*) is used to proxy for audit effort. Logistic regression estimated method is applied to the models in both Panel A and B. Significance is based on two-way clustered standard errors to account for time-series (within the same 2-digit SIC industry group) and cross-sectional (within the same year) dependence. Refer to the Appendix for variable definitions.

Table 9: Technological competition and auditor R&D specialization

	Dependent variable = *R&DSpec*	
	Distressed sample	Full sample
TPP	0.005**	0.006**
	(2.30)	(2.55)
SaleComp	-0.002*	-0.001
	(-1.81)	(-1.30)
R&D	0.009***	0.007***
	(2.98)	(3.43)
OPCYCLE	0.001	0.001
	(0.53)	(0.66)
CAPINT	0.003**	0.002*
	(2.02)	(1.96)
Loss	0.005	0.004
	(1.21)	(1.02)
Size	0.015***	0.021***
	(6.64)	(8.50)
ROA	0.177	0.154
	(1.18)	(0.94)
LEV	0.044**	0.100***
	(2.14)	(3.39)
EarnVol	0.033	0.019
	(0.56)	(0.35)
NewCapital	0.002	0.003
	(0.56)	(0.81)
Tenure	0.004***	0.010***
	(3.51)	(3.94)
Industry/Year FE	Yes	Yes
N	6,866	16,064
Adj. R^2	0.114	0.131

This table reports the results on the relationship between technological competition and auditor R&D specialization. All continuous variables are winsorized at 1% and 99%. Estimates on industry & year indicators are not reported for brevity. Significance is based on two-way clustered standard errors to account for time-series (2-digit SIC industry group) and cross-sectional (year) dependence. Refer to the Appendix for variable definitions.