



On accounting's twenty-first century challenge: evidence on the relation between intangible assets and audit fees

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Abstract

We inform the policy debate arising from the dramatic shift in US firms' balance sheets towards intangible assets that has created a challenge for market participants to estimate firm value. While accounting guidelines have failed to keep pace with this change, the auditors' perspective on this issue remains unknown. Our study reveals that auditors also find it relatively more challenging to audit firms with higher intangible assets. Specifically, we document a strong positive relation between audit fee and the proportion of intangible assets, after controlling for standard audit fee determinants. Further, we show that firms with higher proportion of intangible assets are associated with higher auditor effort and higher litigation risk for auditors, manifesting in higher audit fee. *Ex post* proxies of innovation success, such as patents, citation-weighted patents and *ex ante* R&D expense, indicate that firms with greater likelihood of innovation success are also charged higher audit fees. We find that high intangible asset firms in concentrated patent-generating industries (i.e. with lower expected patent litigation) are charged lower audit fees than similar firms in patent-competitive industries.

Keywords Intangible assets · Audit fees · Intangible valuation · Audit limitations · Accounting policy and guidelines

JEL classification M41 · M44 · M49

“A high or rising audit fee can indicate one of two things, experts say. Either the auditor is charging a risk premium, aiming to cover future legal costs to them of something gone awry, or they may just be doing more work on the audit, digging

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into areas where results are uncertain.” Nanette Burns (*Corporate audit fees up? Beware of trouble ahead – Reuters, October 9, 2011*)

1 Introduction

Over the last several decades US firms have witnessed a tectonic shift in their asset mix as tangible investments in property, plant, and equipment have decreased significantly with a concomitant increase in intangible or knowledge-based assets (Corrado et al. 2009; Corrado and Hulten 2010; Lev and Gu 2016). Figure 1 traces this phenomenon of rising intangible assets as a proportion of total assets since 1990. This phenomenon is also at the heart of what has been called “accounting’s twenty-first century challenge” by researchers as well as the popular press.¹ Financial Accounting Standards Board (FASB) has grappled with this issue (Upton 2001) but till date has failed to come up with definitive rules to effectively value intangible assets. It has been long recognized (see Lev and Zarowin 1999) that this lack of effectively valuing intangibles is diminishing the usefulness of financial information and ultimately leading to a weakened correlation between earnings and the corresponding stock prices at US firms.

The ongoing debate has two sides. On one hand, Lev and Gu (2016) argue that because of the dramatic increase in intangibles in corporate balance sheets and the increasing contribution of intangible assets to firm value, financial statements fail to give a clear picture of a firm’s financial position. They note that the book value and the reported earnings of a new firm are poor predictors of the market value primarily due to the growing proportion of intangible assets. On the other hand, Skinner (2008) argues that it is not the purpose of a financial statement to report the firm value, and that the matter of valuing intangible assets and firms, more generally, should be left to market participants—valuing firms is not an area that requires intervention from the FASB or any other regulatory authority, such as the PCAOB (Public Company Accounting Oversight Board).

In this study we seek to provide new insights into this ongoing debate through the prism of the auditors because the increasing prominence of intangible assets in US corporations has associated implications for the accounting profession and thereby its rule-setting bodies, such as FASB or PCAOB. External auditors play a crucial independent role in enhancing transparency and certifying the financial information available for capital market participants to accurately estimate asset values of corporations. For providing this service they charge audit fees as compensation. While a few studies (e.g. Blankley et al. 2012) use intangible assets as one of many control variables when explaining audit fee, we could not find a study that gives this question the central attention this issue deserves. We aim to fill this gap. When considering intangible assets, we consider multiple proxies. Specifically, we consider (a) intangible assets created as a result of direct recognition (e.g. goodwill), (b) inputs that go into making intangible assets (e.g., R&D and SG&A), and (c) outputs produced (e.g. patents). We also explore channels that may be responsible for the observed relationships, and discuss the results in the context of the central issue. Ultimately, our goal is to shed light on this accounting challenge. If external auditors charge higher fees for firms with greater proportion of intangible assets, then arguably, the audit fees charged is

¹ "Accounting’s twenty-first Century Challenge: How to Value Intangible Assets," by Vipal Monga, The Wall Street Journal (March 21, 2016).

a manifestation of the difficulty in validating the reported asset values (auditor effort) and certifying the authenticity of the financial reports (exposure to litigation risk).

By addressing the following questions we are able to provide some insights into this “accounting challenge of the twenty-first century.”² How do intangible assets affect audit fees? What are some of the factors (or pathways) that determine the relation between intangibles and audit fee? By addressing these questions directly, we hope to add a new dimension to the audit fee literature by explicitly incorporating intangible assets and thereby inform the current debate on the effect of the dramatic shift in the asset mix in US corporate balance sheets on the accounting profession. The answers to these questions can reveal the auditor’s perspective of auditing firms with more intangibles and provide some policy guidance to ameliorate this twenty-first century accounting challenge. A positive association between intangibles and audit-fees will reveal that auditors find it costly or more challenging to audit these firms, in spite of their expertise and ability to intimately examine the firm from the inside. Arguably, capital market participants, who neither have the expertise nor the opportunity afforded to the auditors to examine the firm as closely from the inside, are even more challenged by this phenomenon to accurately value firms having greater proportion of intangible assets.

We use data on fees charged by external auditors from Audit Analytics for US based Compustat firms and test if the proportion of intangible assets on a firm’s balance sheet affects the audit fee. We conduct our analysis using multiple proxies of intangible assets. While we present all our results for the customary balance sheet definition of intangible assets, all our findings are also robust to using income statement definitions of intangible assets used in the literature, e.g. R&D and advertising expenses (e.g. see Barth et al. 2001) and also to using balance sheet item Goodwill.

We find similar strong results when we use another proxy (not directly captured on a firm’s balance sheet) of verifiable intangible asset—the number of patents awarded to the firm by the United States Patent and Trademark Office (USPTO). We find that firms with higher proportions of intangible assets pay significantly higher audit fees, after controlling for the previously established determinants of audit fees. Specifically, we find that as the proportion of intangible assets increases from the 25th to the 75th percentile, the audit fee increases by an economically significant 7.3%.

Next, we investigate what factors might be causing auditors to charge higher audit fees for firms with higher intangible assets. First is the uncertainty channel. Cohen et al. (2013) argue that investments in intangibles (more specifically, research and development) are inherently difficult to value even for stock market participants.³ They contend that market participants are unable to distinguish between “good” and “bad” investments in R&D. Pástor and Veronesi (2009) argue that new technologies are inherently risky and the merits of those are revealed after long lags creating a time varying pattern in idiosyncratic risk. We

² See Lev and Gu (2016, p. 88) who argue that accounting relevance has been lost due to the shift from tangible to intangible assets and more disclosure and regulatory changes are needed to accurately capture intangibles in financial reports.

³ For a guide on steps involved in, methodologies adopted, and limitations encountered in valuation of intangible assets, see the report available at http://www.wipo.int/export/sites/www/sme/en/documents/valuationdocs/inn_ddk_00_5xax.pdf.

Additionally, many issues related to differing opinions on accounting of intangible assets are also present in the Jenkins Committee report (available from the AICPA website at <http://www.aicpa.org/InterestAreas/FRC/AccountingFinancialReporting/DownloadableDocuments/Jenkins%20Committee%20Report.pdf>).

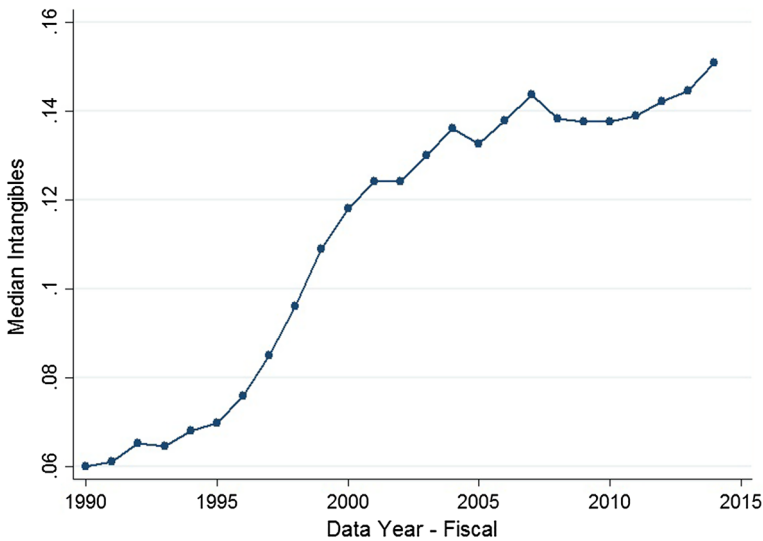


Fig. 1 Intangible assets. This figure presents the annual median intangible assets' proportion for a sample of US headquartered COMPUSTAT firms between 1990 and 2014. We exclude financial firms (SIC codes 6000-6999) and utilities (SIC codes 4900-4999). We also exclude firms with missing asset size. INTANGIBLES is defined as Compustat item INTAN/AT

contend that the uncertainties associated with investments in intangible assets also affect auditors.

While the auditors can see the expenses in R&D, they do not know if this is something that enhances value or destroys it (using the Pástor and Veronesi framework, will they lead to “good” or “bad” outcomes). Increasingly, firms also have to complete an Intellectual Property (IP) audit in which they have to assess value of a firm’s intellectual property and periodically test it for impairment.⁴ Errors in this assessment also lead to noisy estimates of intangible assets. Given this background, we contend that dealing with intangible assets creates uncertainty in valuation and assessment.⁵

The uncertainty associated with intangible assets also exposes auditors to greater (litigation) risk. To understand this *uncertainty* channel fully, we first investigate if firms with high intangible assets do in fact have higher business risk, which can increase the litigation risk for auditors. We use variability in cash flow, and in net income as measures of firm’s business risk. Our results show that after controlling for usual factors, firm’s business risk is increasing in the proportion of intangible assets. As intangible assets increase by one standard deviation, cash flow (net income) volatility increases by an economically significant 0.0048 (0.0148) units, representing a 4.6% (9.8%) increase over the average volatility.

⁴ Firms increasingly use audits to ascertain the value of tangible assets. We found a filing (DEF 14 A) from Altria Group (available at <https://www.sec.gov/Archives/edgar/data/764180/000119312516533005/d155747ddef14a.htm>) mentioning that “The Innovation Committee oversees the Company’s management of the risks associated with technology, research and product development, including intellectual property. The Audit Committee oversees the Company’s information technology security program.”

⁵ More recently, Peters and Taylor (2017) have updated the neoclassical q -theory of investment to suggest that a version of Tobin’s q that includes adjustments for intangible capital is superior to the standard q as a valuation metric.

We then proceed to examine if increase in the firm business risk is the only way intangible assets contribute to the audit fee. For this, we include business risk as an additional control variable in our audit fee tests and, not surprisingly, find that the audit fee is increasing in the proportion of intangible assets even after controlling for business risk. From this analysis, we conclude that while business risk contributes to the *uncertainty* channel, it is not the only risk auditors face in auditing firms with intangible assets.

The second channel is based on Simunic's (1980) argument that two important contributors to audit fee are auditor effort and litigation risk. He finds that audit fee is increasing in the auditor effort and also in the proportion of the litigation related risks the auditors take on in their client engagements. We next investigate each of these channels. Our analysis shows that a commonly used proxy of auditor effort (DAYS TO SIGN) (e.g., Ettredge et al. 2006; Jha and Chen 2015; Knechel and Payne 2001) increases with the proportion of intangible assets. Intangible assets, such as patents and copyrights can be encroached upon by others, sometimes even inadvertently, resulting in drawing the firm and the auditor into a lengthy litigation.⁶

We investigate if the auditor's litigation risk is also dependent on the proportion of intangible assets. By modeling litigation risk associated with auditing a firm we find that, after controlling for other factors known to affect this relation, litigation risk is higher for auditors with clients that have higher proportion of intangible assets. Litigation risk, thus, can be another reason for higher audit fees charged to firms with higher intangible assets. While it is known that litigation risk for an auditor also depends on a client's propensity to deceive investors and other stakeholders (e.g. Chen et al. 2012; Gul et al. 2003) our result shows that intangible assets contribute significantly to litigation risk.⁷ We also find that the audit fee is higher for firms that operate in '*patent-competitive*' industries in which many of their competitors file for many patents—thereby exposing firms to more patent related litigation, compared to those that operate in '*patent-concentrated*' industries where relatively fewer firms file for patents. This evidence further supports the plausibility of the litigation risk channel in knowledge-based firms.

Our study establishes that audit fee is significantly related to the proportion of intangible assets, after controlling for previously established determinants of audit fee. Further, no extant study has investigated the type and extent of intangible assets, including patents, citation-weighted patents, and R&D expenses, to directly identify the effect of intangible assets on audit fees and discuss the channels through which this relation can be understood. Some previous studies restricted to either banks or private firms have used intangible assets only as a proxy for audit complexity (e.g. Cameran and Perotti 2014; Fields et al. 2004; Hope et al. 2012).

In this study we investigate how intangible assets, claimed to be a leading cause for obfuscation of the quality of financial reports (Lev and Gu 2016), affect audit fees. Our analysis will provide evidence on how auditors view the trend of increasing intangible assets among US firms as making financial reporting easier or more difficult. We find

⁶ Thousands of patent related cases are filed every year, some by patent assertion entities (PAEs) and non-practicing entities (NPEs), involving an estimated \$7 billion in legal expenses and litigation settlement costs every year. See news report at <http://www.ipwatchdog.com/2016/01/05/npe-patent-litigation-increased-2015/id=64724/> and full data at <http://npedata.com/>.

⁷ We cannot completely rule out endogeneity in this relationship, i.e. some characteristics that help in creation of intangible assets, like complexity, also increase litigation risk. We discuss this issue further in the section titled "Robustness and sample selection issues."

that while business risk is also high for firms that have higher intangible assets, this risk alone only partially explains the higher audit fee. Our analysis shows that firms with higher intangible assets also have higher litigation risk that manifests in higher audit fee. Further, we document that firms with higher intangible assets are also associated with significantly higher auditor effort.

We make several contributions to the literature. First, we shed light on the ongoing debate on whether intangibles have made financial statements less informative by showing that even auditors who are experts in understanding the financial situation of the firm have difficulty estimating the value of intangibles. Because we find that even auditors find it difficult to certify the financial statement of firms with more intangibles, our study underscores that the difficulty in assessing the value of intangible assets starts right at the reporting stage, well before market participants get a chance to interpret the financial information. Put differently, given the current financial reporting rules, investors' sophistication alone will not be sufficient to improve the transparency of financial reporting.

Second, we contribute to the audit fee literature. We know that a wide range of firm characteristics affect audit fees (Antle et al. 2006; Causholli et al. 2010; Mitra et al. 2019; Vafeas and Waegelein 2007). While others have found that firms with higher intangible assets are more risky, invest heavily in R&D, and have a higher cost of capital (e.g. see Cohen et al. 2013), no prior study has explicitly linked intangible assets to auditor compensation when also exploring the reasons behind such a relationship. Some prior attempts include a partial measure of intellectual pursuits as an afterthought, but we give this issue the comprehensive attention it deserves, by examining not only the input for intangible assets (R&D expense), but also the fruits of such investments manifested in the form of patents and intangible assets. We find that both are significantly related to audit fee. In investigating how these firm pursuits ultimately lead to higher audit fee (higher business risk, higher auditor effort, and higher litigation risk), we also document possible pathways that ultimately lead to the higher audit fee. Thus, our study provides a comprehensive analysis of this important relation between audit fee and intangible assets filling a gap in this literature.

Third, our findings have important policy implications. FASB reports have recognized (e.g. Upton 2001) the problems associated with reporting of intangible assets. Our collective evidence is a clarion call to FASB and PCAOB to update and adapt the current audit standards to incorporate intangible asset valuation guidelines to address this important challenge.

The rest of the paper progresses as follow: We develop our hypotheses in Sect. 2. Empirical methods and key variables are presented in Sect. 3. Section 4 presents the sample construction process and summary statistics. The results and robustness tests are presented in Sects. 5 and 6, respectively. Section 7 concludes.

2 Hypotheses development

2.1 Intangible assets and audit fee

The basis of sustained profitability for a firm is to allocate capital efficiently. To this end, innovations using intangible assets are the most important value driver of modern corporations and a key source of economic growth (Solow 1956). Increasingly, intangible assets (or knowledge assets) are driving the value of US firms. So, while the value of traditional

firms (e.g. Ford, Hilton Hotels) depends more on tangible assets, other relatively younger firms (e.g. Lyft, Airbnb) derive most of their value from intangible assets. Even at traditional firms, the future growth opportunities appear to be driven by investments in more intangible assets (e.g. self-driven car at an auto company, or a smart phone application to make the hotel room booking process more accessible, etc.).

The mix of tangible and intangible assets affects risk profile, financial policy, and also how a firm communicates with investors. Intangible capital is costly to obtain and produces future profits, albeit with risk (Peters and Taylor 2017). Compared to tangible assets, intangible assets (such as patents, brands, business processes, and other forms of intellectual property) are more difficult to value and collateralize. It is also more difficult to verify or liquidate investments in intangible assets Falato et al. (2013). Valuation of intangible assets is also more difficult to communicate to market participants. With increased investments in intangible assets, US firms are adopting different financial policies than they would otherwise pursue (Falato et al. 2013). Firms with high intangible assets hold more cash, less debt, fund more R&D through non-governmental sources, etc. All these choices also increase risk (Pástor and Veronesi 2009), and require a more nuanced communication strategy with financial market participants (Bhattacharya and Ritter 1983)

Auditors play a critical role in financial reporting. Auditors have to not only make sure that the firms are following financial guidelines, but also ensure that investors have valid information to make informed decision about capital allocation.⁸ While auditors are aware of their special role, accounting for intangible assets is prone to managerial discretion.⁹ Value of investments in intangible assets depends on the strength of the technology used, length of technological life cycle and other complex factors (Wyatt 2005). As such, valuing intangible assets is inherently noisy (Cohen et al. 2013). This is also supported by the fact that firms with more intangible assets also attract more analyst following (Barth et al. 2001), as the analysts believe this to be a valuable service to their paying clients.¹⁰ Based on the above discussion, we hypothesize that auditors will take into consideration the complexities associated with intangible assets resulting in extra effort and litigation risk when setting their audit fee. This leads us to our hypothesis:

Hypothesis 1 (H1) The audit fee is increasing in the proportion of intangible assets at a firm, *ceteris paribus*.

In contrast, the alternative is that intangibles are like any other assets that the firm has. All industries go through cyclical changes in asset values and firms that have higher

⁸ Speech by Steven Harris at PCAOB, entitled “The Importance of Auditing and Audit Regulation to the Capital Markets,” available at https://pcaobus.org/News/Speech/Pages/03202014_American.aspx.

⁹ A plausible argument in favor of higher audit fee for firms with higher intangible assets is made using the “real options” framework. Investments in intangible assets are inherently uncertain and can be viewed a series of real options with many states that depend on several systematic, idiosyncratic and investment-specific factors. The range of states of these options creates a complex state-dependent problem whose categorization is difficult for auditors. In the absence of well-defined guidelines on valuing these options, auditors face higher risks and have to spend extra effort in reducing the dimensionality of the valuation problem to fit the accounting reporting needs. This exercise contributes to the higher audit fee. See Mun (2002) and Copeland and Antikarov (2003) for a review of the use of real options framework in valuing assets.

¹⁰ There are a number of studies that indicate the difficulty in valuing intangibles. Gu and Wang (2005) find that analysts make greater errors when analyzing firms with more intangibles. Edmans (2011) shows that stock prices do not fully incorporate the value from all intangibles, e.g. employee satisfaction. Douglas et al. (2016) find that higher cash flow volatility is associated with higher yield spread suggesting that default risks are higher when cash flow is volatile. Lev (2004) notes that investors often overvalue intangible-intensive firms from less established industries and undervalue firms from established sectors.

intangible assets are no different. So while the intangibles may be explaining less, or more, the fundamental relation between financial variables and assets is stable, and as such, the auditors are essentially doing the same job valuing intangibles as they do when valuing any other asset. Intangibles do not pose any extra challenge and as such intangible assets will not significantly affect audit fee. If this alternative is true, then, after controlling for usual firm characteristics, intangibles should not significantly affect audit fee. The current audit fee model in the literature implicitly makes this assumption.

2.2 What drives the relation between intangible assets and audit fee?

Firms engage in a variety of activities. Many of these activities are straightforward and it is easy to predict how they will impact firm value (e.g., maintenance of capital expenditures). With some others, it is more difficult to decipher how they will ultimately impact firm value. Inherently, using intangibles to predict profits is risky because of underestimating costs of innovation, while over-estimating benefits of innovation (Holmstrom 1989). While successful innovations improve profits, not all innovations succeed. These asymmetric pay-offs can lead to uncertain revenues and cash flow and thereby, higher business risk. Bell et al. (2001) find that increased business risk is related to higher audit fee. So, it is entirely possible that investments in intangible assets result in higher *business risk*, which in turn drives the audit fee higher. To isolate this effect we have separately controlled for business risk to see if intangible assets have additional power in explaining audit fee beyond business risk.

Simunic (1980) considers auditor effort and litigation risk to be two important contributors to audit fee. So, a plausible channel that can be related to higher audit fees for firms with higher intangible assets is *auditor effort*. Auditors concede that valuing intangible assets, such as intellectual property, is inherently complex activity and prone to managerial manipulation, hence requiring more auditor time and effort. Although anecdotal, a recent Wall Street Journal article¹¹ quote buttresses this argument: “The PCAOB said in an April report that it found many deficiencies in the way auditors accounted for the value of intangible assets. The auditors didn’t always understand how management came up with estimates of value and didn’t test the assumptions executives and their advisers used to peg the worth of those audits, the report said.” Hence, we argue that one reason for higher audit fees for firms with higher proportion of intangible assets is greater auditor effort needed to audit such firms.

Hypothesis 2 (H2) The auditor effort is increasing in the proportion of intangible assets at a firm, *ceteris paribus*.

Another plausible channel that can be related to higher audit fees for firms with higher intangible assets is *litigation risk*. Anecdotal evidence¹² suggests that courts have to

¹¹ “Valuation Experts Will Be Held to a New Standard,” Wall Street Journal, November 21, 2016, Available at: <https://www.wsj.com/articles/valuation-experts-will-be-held-to-a-new-standard-1479740400>.

¹² “Supreme Court Hears Apple—Samsung Patent Case,” Wall Street Journal, October 12, 2016, Available at: <http://www.wsj.com/articles/apple-samsung-to-argue-patent-case-before-supreme-court-1476178202>; “Microsoft to Buy Nokia’s Devices Unit for \$7.2 Billion,” Bloomberg News, September 3, 2013 <https://www.bloomberg.com/news/articles/2013-09-03/microsoft-to-buy-nokia-s-devices-business-for-5-44-billion-euros>.

intervene in settling many cases involving encroachment of intellectual property right. Patents, copyrights, etc. are the fruits of investments in intangible assets. The increased incidence of patent related lawsuits raises another possible concern for auditors.¹³ Some firms come under risk of possible lawsuits from Non-Practising Entities and Patent Assertion Entities (so called “patent trolls”). Increasingly, firms are also doing IP audits¹⁴ of their portfolio, and also routinely considering impairment to their IP portfolio. Some firms even report the presence of an IP committee consisting of appointed directors who perform this function. An auditor is concerned by litigation risk (Simunic 1980) even if the firm is not at fault. The fines associated with lawsuit can be much more than the total fees charged by auditor.¹⁵ Between 1996 and 2008 the six largest auditing firms paid approximately \$5.16 billion to settle lawsuits (ACAP 2008). These facts point to another possible risk emanating from investment in intangible assets, *litigation risk*, which can drive the audit fee higher.

Hypothesis 3 (H3) The auditor exposure to litigation risk is increasing in the proportion of intangible assets at a firm, *ceteris paribus*.

3 Empirical models and measurement of key variables

3.1 Empirical models

To test if audit fee is significantly related to intangible assets, we use the following empirical model specification:

$$\begin{aligned}
 LN(DAYS\ TO\ SIGN) = & \beta_0 + \beta_1 INTANGIBLES + \beta_2 IC_WEAK + \beta_3 LNASSETS \\
 & + \beta_4 DEBT + \beta_5 ROA + \beta_6 CASH + \beta_7 BIG4 + \beta_8 LOSS \\
 & + \beta_9 FISCAL\ YEAR\ END + \beta_{10} PUBLIC\ EXCHANGE \\
 & + \beta_{11} UNQUALIFIED\ OPINION + \beta_{12} GOING\ CONCERN \\
 & + \beta_{13} INHERENT\ RISK + \beta_{14} LITIGATION + \beta_{15} AUDITOR\ CHANGE \\
 & + \beta_{16} SEGMENTS + \beta_{17} COUNTY\ PRESENCE + \beta_{18} LARGE\ SCALE \\
 & + \beta_{19} SPECIALIST + \beta_{20} AUDITOR\ COMPETITION + Industry\ Dummies \\
 & + Year\ Dummies + County\ Dummies + \epsilon
 \end{aligned} \tag{1}$$

The variable definitions are as follows:

¹³ Kline (2004) notes that patent litigation is a growth industry. They write the following:

“During the twelve-month period ending September 9, 2003, US patent owners filed 2788 patent infringement lawsuits, a 13% increase over the same period 5 years earlier. Similarly, in 2003 the United States issued 187,487 patents, a 22% increase over 1999. Patent litigation has become the sport of kings.”

¹⁴ By their own admission, “The newer class of intangible and intellectual property assets raise varied and less understood valuations challenges.” See the Report from the working group of PCAOB publications, available at https://pcaobus.org/News/Events/Documents/09092015_IAGMeeting/Publications_Slides.pdf.

¹⁵ For example, Dye (1993) notes that Max Rothenberg and Company performed audit for \$600 for a client, but was liable for \$232,278.30 for alleged deficiencies.

LN (AUDIT FEE)=the natural logarithm of the audit fee charged by the external auditor;

IC_WEAK=an indicator variable that takes a value of one if the firm is identified as having weak internal controls;

LNASSETS=the natural logarithm of the total value of the firm's assets;

DEBT=the ratio of total debt to total assets;

ROA=the ratio of earnings before interest, taxes, depreciation, and amortization (EBITDA) to total assets;

BIG4=an indicator variable equal to one if the auditor is one of Big 4 and zero otherwise;

LOSS=an indicator variable that is equal to one if EBITDA is negative;

FISCAL YEAR END=an indicator variable that is equal to one if the fiscal year-end is in December;

DAYS TO SIGN=the natural logarithm of the lag between the signature date of the audit opinion and the date of the fiscal year-end, as used by Knechel and Payne 2001; Ettredge, Li, and Sun 2006; Jha and Chen 2015; etc.;

PUBLIC EXCHANGE=an indicator variable that is equal to one if firm is listed on a major US public exchange;

UNQUALIFIED OPINION=an indicator variable that is equal to one if the opinion of the auditor is unqualified;

GOING CONCERN=an indicator variable that is equal to one if the auditor issued an audit report with an explanatory paragraph on the status as a going concern;

INHERENT RISK=the sum of total receivable and inventory divided by total assets;

LITIGATION=an indicator variable that is equal to one if the firm belongs to a litigation-prone industry and zero otherwise;

AUDITOR CHANGE=an indicator variable that is equal to one if the auditor changed in the fiscal year and zero otherwise;

SEGMENTS=the number of geographic segments;

COUNTY PRESENCE=the natural logarithm of all the audit fees an auditor collected from firms in the county, constructed as in Fung et al. (2012);

LARGE SCALE=the percentile rank of the city-industry number of audit clients for each audit firm (variable values range from 0.01 to 0.99);

SPECIALIST=an indicator variable that is equal to one when the auditor is an industry leader;

AUDITOR COMPETITION=the auditor's competition in the county;

We have firm-year observations, where the subscript *it* is suppressed for ease of exposition. The dependent variable is the natural logarithm of the audit fees charged by the firm's auditor. Detailed list of variables and their definitions, including sources, are described in "Appendix 1". The key variable of interest is *INTANGIBLES*. The firm-level control variables are based on Jha and Chen (2015) and Hay et al. (2006). In general, auditors charge higher fees to large, complex, and risky firms. Most of the control variables capture the size and complexity of the firm. We add industry indicator variables, based on two-digit Standard Industrial Classification (SIC) codes, as well as year indicator variables to control for the effect of changes in the financial reporting regulations following Fung et al. (2012). We also include county dummies to capture the location of the firm's headquarters because recent research shows that regional cultural factors can also affect audit fees. To control for the possibility that the error terms might be correlated by firm and across time, we cluster the standard errors by firm and

year. When we want to see the effect of additional controls on audit fee, we include those variables to the specification in Eq. (1).

We use similar regression models when investigating the effect of intangible assets on business risk as presented in Eq. (2):

$$\begin{aligned}
 \text{BUSINESS RISK} = & \beta_0 + \beta_1 \text{INTANGIBLES} + \beta_2 \text{IC_WEAK} + \beta_3 \text{LNASSETS} \\
 & + \beta_4 \text{DEBT} + \beta_5 \text{ROA} + \beta_6 \text{CASH} + \beta_7 \text{LOSS} + \beta_8 \text{MTOB} + \beta_9 \text{ALTMAN Z} \\
 & + \text{Industry Dummies} + \text{Year Dummies} + \epsilon
 \end{aligned}
 \tag{2}$$

The variables that are included in Eq. (2) but not already defined in Eq. 1 are:

MTOB = the ratio of market value to (book) value of common equity;

ALTMAN Z = the Altman-Z index, calculated as in Altman (1968);

We use two proxies for *BUSINESS RISK*, namely *VOLATILITY_CASHFLOW*, the volatility in firm's cash flow (normalized by assets) and *VOLATILITY_NI*, the volatility in firm's net income (normalized by assets), both measures are calculated using preceding five years of data.

When investigating auditor effort, we use an empirical model similar to the one shown in Eq. (1), except that the dependent variable is *DAYS TO SIGN*, which is defined as the lag between signature date and audit opinion date of the auditor. The model is specified as follows:

$$\begin{aligned}
 \text{LN(DAYS TO SIGN)} = & \beta_0 + \beta_1 \text{INTANGIBLES} + \beta_2 \text{IC_WEAK} + \beta_3 \text{LNASSETS} \\
 & + \beta_4 \text{DEBT} + \beta_5 \text{ROA} + \beta_6 \text{CASH} + \beta_7 \text{BIG4} + \beta_8 \text{LOSS} \\
 & + \beta_9 \text{FISCAL YEAR END} + \beta_{10} \text{PUBLIC EXCHANGE} \\
 & + \beta_{11} \text{UNQUALIFIED OPINION} + \beta_{12} \text{GOING CONCERN} \\
 & + \beta_{13} \text{INHERENT RISK} + \beta_{14} \text{LITIGATION} + \beta_{15} \text{AUDITOR CHANGE} \\
 & + \beta_{16} \text{SEGMENTS} + \beta_{17} \text{COUNTY PRESENCE} + \beta_{18} \text{LARGE SCALE} \\
 & + \beta_{19} \text{SPECIALIST} + \beta_{20} \text{AUDITOR COMPETITION} + \text{Industry Dummies} \\
 & + \text{Year Dummies} + \text{County Dummies} + \epsilon
 \end{aligned}
 \tag{3}$$

We model firm level litigation risk using a logit regression as follows:

$$\begin{aligned}
 \text{LAWSUIT} = & \beta_0 + \beta_1 \text{INTANGIBLES} + \beta_2 \text{IC_WEAK} + \beta_3 \text{LNASSETS} + \beta_4 \text{DEBT} \\
 & + \beta_5 \text{ROA} + \beta_6 \text{CASH} + \beta_7 \text{BIG4} + \beta_8 \text{LOSS} \\
 & + \beta_9 \text{FISCAL YEAR END} + \beta_{10} \text{PUBLIC EXCHANGE} + \beta_{11} \text{UNQUALIFIED OPINION} \\
 & + \beta_{12} \text{GOING CONCERN} + \beta_{13} \text{INHERENT RISK} \\
 & + \text{Industry Dummies} + \text{Year Dummies} + \epsilon
 \end{aligned}
 \tag{4}$$

All of the above variables are defined in detail in "Appendix 1".

3.2 Measuring intangible assets

To ensure the validity of our findings we use several proxies to capture intangible assets. The most direct one (*INTANGIBLES*) is the Compustat available balance sheet item INTAN, scaled by assets (see Makrominas 2017). This captures the recognized intangible

assets, other than goodwill, that the firm has purchased and includes copyrights, patents etc. We use this as our main proxy for intangible assets. Following Barth et al. (2001), we also separately use Goodwill, R&D and advertising expenses (scaled by assets) as additional measures of intangible assets. The results are strong whether considering each of these proxies individually or collectively. For the sake of completeness, we consider another broad proxy of intangibles (*INTANGIBLES2*). We construct this measure by subtracting Property Plant and Equipment (PP&E), cash and net working capital from the firm's total assets as reported on the balance sheet, and then scaling the remainder by total assets.

Patents are increasingly becoming an important part of firm value and intangible assets. In our analysis, we also include the number of patents awarded (*NUMPATENTS*) to a firm by the USPTO and the number of forward citation weighted patents (*NUMPATENTS-Citation weighted*) as a measure of intangible results (see Kogan et al. 2017). Our results continue to hold for each of these proxies of intangible assets.

The proxies for intangible assets range from a precise but likely incomplete measures, such as, *INTANGIBLES*, R&D, Goodwill, to a less precise but all-encompassing measure, *INTANGIBLES2*. We also consider an “output” measure, number of patents, which captures the efficiency and fruits of investments in innovation and R&D. While the proxies individually capture different dimensions of intangible assets, they all lead us to the same conclusion that firms with higher intangible assets are charged a higher audit fee.

4 Sample construction and summary statistics

We retrieve data for US firms from the Compustat database for the period 2002 to 2014. Auditor information is extracted from Audit Analytics. We exclude firms that operate in the financial and regulated industries, as identified by the SIC codes (between 6000-6999 and 4900-4999, respectively). For a firm to be included in the sample, it also should have a non-zero asset size and non-missing information about its auditor. We use the central index key (CIK) variable to match sample firm information between Compustat and Audit Analytics. Following Roychowdhury (2006) missing values of R&D are set to zero as long as SG&A expenses are available. Based on these selection criteria we get 57,575 firm-year observations. We match by year, auditor and the CIK to get audit fee data from the Audit Analytics database. This reduces our sample size to 36,953 firm-year observations. When we use our full list of control variables, our sample is further reduced to 31,245 firm-year observations, consisting of 5163 firms in 53 different two-digit SIC industries. “Appendix 2” presents our sample formation process based on our selection criteria. We winsorize each continuous variable at the 1st and the 99th percentile, by year, to eliminate the influence of outliers.

Panel A of Table 1 shows descriptive statistics for our focus variables. The means and medians of most variables are in line with other studies (e.g., Jha and Chen 2015). The average firm has 17.5% of its total assets as intangibles and is charged an audit fee of approximately \$1.68 million. Figure 1 shows the median fraction of total assets held as intangible assets by US firms. The median firm held 6% of its assets as intangible assets in 1990 and this proportion increased to 15% in 2014. We partition our sample into two groups based on above or below median proportion of intangible assets for the year. The median audit fee charged to each of these two groups is shown in Fig. 2. This captures the annual variation in audit fee (arguably, capturing the effect of Sarbanes–Oxley Act of 2004,

and other annual features), but clearly shows that the audit fee for firms with higher intangible assets is higher in each year of our sample period.

Panel B of Table 1 presents the correlation matrix. The correlation between audit fee and intangibles is 0.15 and statistically significant. As expected from findings in prior studies, audit fee is positively correlated with firm size, profitability, and debt.

5 Results

5.1 Audit fees and intangible assets

In this section, we examine the relation between audit fee and intangible assets. Results of this analysis are reported in Table 2. Specification 1 shows the estimates of the complete model (Eq. 1). We find that the coefficient for *INTANGIBLES* is positive and statistically significant with a p value of 0.000. This supports our central hypothesis (H1) that firms with higher fraction of intangible assets are charged a higher audit fee. The coefficient of 0.2538 for *INTANGIBLES* suggests that as the fraction of intangible assets changes from the 25th to the 75th percentile, the audit fee charged increases by an economically significant 7.3%, calculated as $(\text{EXP}(0.2538 * (0.286 - 0.008)) - 1)$. Specification 2 presents the regression estimates without the county dummies. The increase in coefficient on *INTANGIBLES* when we drop the county dummies suggests that a part of the audit fee is related to county specific factors.

Specification 3 presents the coefficient estimates without most of the firm and auditor control variables, except the proxies for intangible assets, size and internal control weakness. The *INTANGIBLES* coefficient increases in magnitude and remains highly significant, indicating a strong relation between audit fee and intangible assets even in the absence of other controls. The adjusted R -squared values for all the model specifications are very high and improve further as expected when we include more control variables. Overall, these results lend strong support for our hypothesis H1, which states that higher intangible assets should lead to higher audit fees.

Panel B of Table 2 presents the coefficients of *INTANGIBLES* when we estimate the same regression as presented in specification 1 in Panel A, using data for each year separately. We find that coefficient of *INTANGIBLES* is positive and significant in each year. We also note that the magnitude of this coefficient has not diminished in value since 2002, suggesting that any changes to financial reporting in the last decade, including the Sarbanes–Oxley Act of 2004, has not reduced the sensitivity of the relation between audit fee and intangibles.¹⁶

Our results presented above are based on the *INTAN* variable in the Compustat database. US GAAP allows recognition of purchased intangible assets, as captured by the balance sheet item Goodwill (e.g., Barth et al. 2001) and allows for expensing some other investments in intangibles, such as R&D and advertising expenses. To consider these specific proxies, we test our central hypothesis (Hypothesis 1) with other alternative measures of intangible assets. We consider Goodwill, R&D, and advertising expenses (normalized

¹⁶ The results are similar when we introduce a time trend variable and its interaction with the *INTANGIBLES* variable in the regression specification. For brevity, we do not report these results.

Table 1 Summary statistics & correlations

	N	Mean	SD	Median	25th percentile	75th percentile					
<i>Panel A: summary statistics</i>											
AUDIT FEE	31,245	1,682,188.100	3,486,308.400	775,308.000	332,400.000	1,665,000.000					
INTANGIBLES	31,245	0.175	0.195	0.103	0.008	0.286					
IC_WEAK	31,245	0.098	0.297	0.000	0.000	0.000					
LNASSETS	31,245	5.952	1.960	5.953	4.617	7.289					
DEBT	31,245	0.517	0.337	0.474	0.287	0.658					
ROA	31,245	0.031	0.277	0.101	0.021	0.157					
CASH	31,245	0.238	0.250	0.142	0.042	0.361					
BIG4	31,245	0.850	0.357	1.000	1.000	1.000					
LOSS	31,245	0.223	0.416	0.000	0.000	0.000					
FISCAL YEAR END	31,245	0.655	0.476	1.000	0.000	1.000					
DAYS TO SIGN	31,245	64.337	21.970	62.000	54.000	74.000					
PUBLIC EXCHANGE	31,245	0.847	0.360	1.000	1.000	1.000					
UNQUALIFIED OPINION	31,245	0.588	0.492	1.000	0.000	1.000					
GOING CON- CERN	31,245	0.043	0.202	0.000	0.000	0.000					
INHERENT RISK	31,245	0.253	0.185	0.225	0.104	0.362					
LITIGATION	31,245	0.428	0.495	0.000	0.000	1.000					
AUDITOR CHANGE	31,245	0.068	0.252	0.000	0.000	0.000					
SEGMENTS	31,245	2.381	0.860	1.732	1.732	3.000					
COUNTY PRES- ENCE	31,245	15.867	1.849	16.129	14.557	17.337					
LARGE SCALE	31,245	0.311	0.388	0.010	0.010	0.640					
SPECIALIST	31,245	0.617	0.486	1.000	0.000	1.000					
AUDITOR COMPETI- TION	31,245	0.399	0.202	0.321	0.271	0.430					
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
<i>Panel B: correlations</i>											
[1] AUDIT FEE	1.00										
[2] INATNGIBLES	0.15	1.00									
[3] IC_WEAK	0.03	0.01	1.00								
[4] LNASSETS	0.52	0.25	-0.07	1.00							
[5] DEBT	0.11	0.06	0.05	0.08	1.00						
[6] ROA	0.13	0.15	-0.06	0.48	-0.15	1.00					
[7] CASH	-0.14	-0.34	0.00	-0.39	-0.29	-0.46	1.00				
[8] BIG4	0.14	0.05	-0.09	0.37	-0.01	0.12	-0.01	1.00			
[9] LOSS	-0.17	-0.20	0.07	-0.49	-0.01	-0.71	0.52	-0.11	1.00		
[10] FISCAL YEAR END	0.04	0.01	0.02	0.00	0.05	-0.12	0.09	0.04	0.10	1.00	
[11] DAYS TO SIGN	-0.07	0.01	0.31	-0.25	0.12	-0.16	0.01	-0.16	0.15	0.04	1.00

Table 1 (continued)

	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
[12] <i>PUBLIC EXCHANGE</i>	0.12	0.02	-0.07	0.27	-0.26	0.23	0.02	0.15	-0.19	-0.00	-0.20
[13] <i>UNQUALIFIED OPINION</i>	-0.05	-0.04	-0.05	-0.04	-0.13	0.06	0.08	-0.05	-0.01	-0.03	-0.06
[14] <i>GOING CONCERN</i>	-0.06	-0.05	0.07	-0.27	0.29	-0.44	0.06	-0.11	0.28	0.05	0.17
[15] <i>INHERENT RISK</i>	0.01	-0.16	0.01	-0.05	0.08	0.22	-0.41	-0.10	-0.21	-0.18	0.02
[16] <i>LITIGATION</i>	-0.07	-0.04	0.02	-0.19	-0.10	-0.23	0.40	-0.01	0.25	-0.07	0.01
[17] <i>AUDITOR CHANGE</i>	-0.07	-0.02	0.07	-0.12	0.03	-0.07	0.00	-0.17	0.06	0.04	0.07
[18] <i>SEGMENTS</i>	0.33	0.18	-0.02	0.40	0.08	0.22	-0.32	0.10	-0.27	-0.01	-0.08
[19] <i>COUNTY PRESENCE</i>	0.25	0.08	0.01	0.35	-0.02	0.07	0.09	0.48	-0.04	0.07	-0.04
[20] <i>LARGE SCALE</i>	0.01	-0.05	0.01	-0.03	-0.11	-0.13	0.31	0.17	0.18	0.09	-0.03
[21] <i>SPECIALIST</i>	0.04	0.02	0.00	0.09	0.08	0.10	-0.24	-0.13	-0.14	-0.06	0.01
[22] <i>AUDITOR COMPETITION</i>	-0.00	-0.04	-0.02	0.04	0.04	0.08	-0.14	0.01	-0.11	-0.04	-0.03

	[12]	[13]	[14]	[15]	[16]	[17]	[18]	[19]	[20]	[21]	[22]
[12] <i>PUBLIC EXCHANGE</i>	1.00										
[13] <i>UNQUALIFIED OPINION</i>	0.08	1.00									
[14] <i>GOING CONCERN</i>	-0.25	-0.23	1.00								
[15] <i>INHERENT RISK</i>	-0.01	-0.01	-0.04	1.00							
[16] <i>LITIGATION</i>	0.01	0.02	0.04	-0.21	1.00						
[17] <i>AUDITOR CHANGE</i>	-0.07	-0.01	0.05	0.01	-0.01	1.00					
[18] <i>SEGMENTS</i>	0.11	-0.06	-0.09	0.13	-0.26	-0.05	1.00				
[19] <i>COUNTY PRESENCE</i>	0.14	-0.02	-0.09	-0.15	0.05	-0.14	0.08	1.00			
[20] <i>LARGE SCALE</i>	0.05	-0.01	-0.01	-0.24	0.22	-0.04	-0.14	0.49	1.00		
[21] <i>SPECIALIST</i>	-0.02	0.02	-0.00	0.16	-0.20	0.02	0.13	-0.42	-0.42	1.00	
[22] <i>AUDITOR COMPETITION</i>	0.01	0.03	-0.02	0.10	-0.11	-0.00	0.07	-0.47	-0.32	0.33	1.00

This table presents the summary statistics for the variables in our sample. Sample selection is described in “Appendix 2”. We winsorize all continuous variables at the 1st and the 99th percentile levels, each year. Panel A shows univariate statistics for the sample. Number of observations, mean, median, standard deviation, and values for the 25th and the 75th percentile of the sample are reported for each variable. Panel B shows the correlation matrix. Pairwise Pearson correlations are reported. The values in the **bold** are significant at five-percent level. Variables are as defined in “Appendix 1”

by assets) following the literature in this field (e.g. Barth et al. 2001). We include these three proxies individually and in combination.

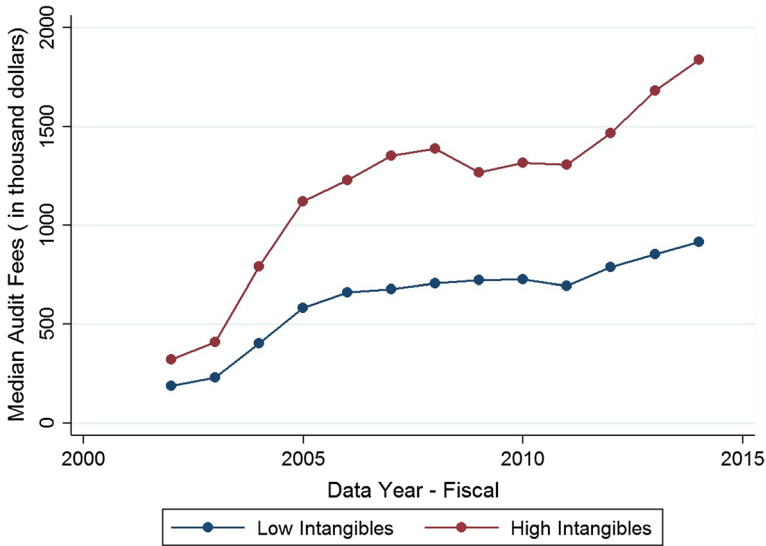


Fig. 2 Average Audit Fee for firms with high and low intangible assets. This figure presents the annual median audit fee for two groups of firms based on our sample. Sample selection is described in “Appendix 2”. The groups are based on whether the firm has above or below the median proportion of intangibles for the year. The measure of intangibles used is, *INTANGIBLES*, the recognized intangibles in the balance sheet. The blue (maroon) line shows the median audit fee for the low (high) intangibles group (Color figure online)

We also construct a broader measure of intangible assets as a catchall for all assets that are not captured by tangible assets (PP&E), cash or net working capital. We subtract these three tangible items from total assets reported by the firm and normalize the remainder by total assets (*INTANGIBLES2*). We then estimate the same regression as presented in Eq. 1, replacing our *INTANGIBLES* proxy with these other proxies. In all cases, we find strong results supporting our hypothesis. The findings using these alternative measures of intangible assets are presented in Table 3.

Table 3 reports the results when we use other plausible proxies for intangible assets. Specification 1 replicates specification 1 of Table 2, by replacing *INTANGIBLES* with Goodwill. Specifications 2 and 3 show the results using R&D and Advertising expenses respectively as proxy for intangible assets. In each of these cases, we find a strong positive relation between audit fee and intangible assets. Specification 4 presents the results using intangibles, goodwill, R&D, and advertising expenses in combination. When all the proxies are included, we find that the statistical significance of the goodwill variable drops, while the other variables remain significant. This is likely due to the high correlation (0.91) between *GOODWILL/ASSETS* and *INTANGIBLES* variables.¹⁷ Model 5 shows the results of the *INTANGIBLES2* variable. In each case, the intangible asset proxy is positive and statistically significant. A change from 25th to 75th percentile in Goodwill (R&D) changes audit fee by 2.9% (2.2%), while a similar change in advertising expense changes audit fee

¹⁷ Correlation coefficient between *INTANGIBLES* and *INTANGIBLES2* is 0.90. Correlation coefficient between *INTANGIBLES* and *ADV EXP/ASSETS* (*R&D/ASSETS*) is -0.03 (-0.06).

Table 2 Audit fee and intangible assets

	(1)	(2)	(3)
	$DV = LN(AUDIT\ FEE)$		
<i>Panel A: Regression result using entire sample</i>			
INTANGIBLES	0.2538*** (0.000)	0.2650*** (0.000)	0.3393*** (0.000)
<i>IC_WEAK</i>	0.2576*** (0.000)	0.2682*** (0.000)	0.3748*** (0.000)
<i>LNASSETS</i>	0.4705*** (0.000)	0.4766*** (0.000)	0.4675*** (0.000)
<i>DEBT</i>	0.2180*** (0.000)	0.2243*** (0.000)	
<i>ROA</i>	-0.2885*** (0.000)	-0.2905*** (0.000)	
<i>CASH</i>	0.2010*** (0.001)	0.3203*** (0.000)	
<i>BIG4</i>	-0.0104 (0.705)	0.0368 (0.119)	
<i>LOSS</i>	0.0200 (0.174)	0.0371** (0.019)	
<i>FISCAL YEAR END</i>	0.1056*** (0.009)	0.1034*** (0.010)	
<i>DAYS TO SIGN</i>	0.0032*** (0.000)	0.0035*** (0.000)	
<i>PUBLIC EXCHANGE</i>	0.1305*** (0.000)	0.1276*** (0.000)	
<i>UNQUALIFIED OPINION</i>	-0.0671*** (0.000)	-0.0797*** (0.000)	
<i>GOING CONCERN</i>	0.0211 (0.459)	0.0263 (0.386)	
<i>INHERENT RISK</i>	0.6834*** (0.000)	0.7244*** (0.000)	
<i>LITIGATION</i>	0.0611** (0.016)	0.0823*** (0.001)	
<i>AUDITOR CHANGE</i>	-0.1388*** (0.000)	-0.1453*** (0.000)	
<i>SEGMENTS</i>	0.1102*** (0.000)	0.1023*** (0.000)	
<i>COUNTY PRESENCE</i>	0.1287*** (0.000)	0.1117*** (0.000)	
<i>LARGE SCALE</i>	-0.1213*** (0.000)	-0.1081*** (0.000)	
<i>SPECIALIST</i>	0.1233*** (0.000)	0.1303*** (0.000)	
<i>AUDITOR COMPETITION</i>	-0.0635* (0.072)	0.0708** (0.040)	

Table 2 (continued)

	(1)	(2)	(3)
	$DV = LN(AUDIT FEE)$		
Industry dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
County dummies	Yes	No	No
Observations	31,245	31,245	31,245
R-squared	0.846	0.826	0.748
Year	Coeff.		<i>p</i> Value
<i>Panel B: Regression result using data corresponding to 1 year at a time</i>			
2002	0.1752**		(0.042)
2003	0.2507***		(0.002)
2004	0.2527***		(0.003)
2005	0.2231**		(0.012)
2006	0.3715***		(0.000)
2007	0.4437***		(0.000)
2008	0.3210***		(0.000)
2009	0.2826***		(0.000)
2010	0.3257***		(0.000)
2011	0.2496***		(0.005)
2012	0.2226***		(0.007)
2013	0.2507**		(0.014)
2014	0.3569***		(0.000)

Panel A of this table presents results from regressions for the (natural logarithm of) audit fees on intangible assets and controls for the entire sample. Panel B presents coefficient estimates for the variable *INTANGIBLES*, obtained by running a regression similar to specification 1 of Panel A in all aspects, except using data corresponding to 1 year at a time. Year represents the fiscal year for which data is used, while the coefficient and *p*-value correspond to that of the variable *INTANGIBLES*. Sample selection is as described in “Appendix 2”. All the variables are as defined in “Appendix 1”. Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. The values in the **bold** are significant at five-percent level

by 3.6%. A similar change in the *INTANGIBLES2* variable changes audit fee by 6.6%. Our results show strong support for our central hypothesis, irrespective of the proxy used. The results are economically significant and consistent for balance sheet based as well as income statement based proxies of intangible assets.¹⁸

Our results reveal that, even after controlling for other firm characteristics, auditors demand a premium for auditing intangible assets. We interpret this finding as manifestation of how auditors view the trend towards increasing proportion of intangibles in corporate balance sheet as a “clarion call” to the accounting standard-setting body, FASB, to update reporting rules and provide technical guidance on the methodologies to be used to value intangible assets.

Valuing intangible assets is expected to be challenging for auditors. Auditors are typically not trained in *intangible* asset valuation techniques that have come into existence over

¹⁸ Results for patent based proxies are shown in Panel A of Table 8.

Table 3 Audit fee and alternate proxies for intangibles

	(1)	(2)	(3)	(4)	(5)
	<i>DV = LN (AUDIT FEE)</i>				
GOODWILL/ASSETS	0.2716*** (0.000)			0.0253 (0.788)	
R&D/ASSETS		0.1954*** (0.006)		0.2820*** (0.001)	
ADV EXP/ASSETS			1.1118*** (0.000)	1.1149*** (0.000)	
INTANGIBLES				0.2210*** (0.003)	
INTANGIBLES2					0.2081*** (0.000)
IC_WEAK	0.2579*** (0.000)	0.2594*** (0.000)	0.2565*** (0.000)	0.2584*** (0.000)	0.2532*** (0.000)
LNASSETS	0.4701*** (0.000)	0.4728*** (0.000)	0.4766*** (0.000)	0.4773*** (0.000)	0.4733*** (0.000)
DEBT	0.2179*** (0.000)	0.2004*** (0.000)	0.2203*** (0.000)	0.2279*** (0.000)	0.2120*** (0.000)
ROA	-0.2910*** (0.000)	-0.2328*** (0.000)	-0.2668*** (0.000)	-0.1953*** (0.000)	-0.3020*** (0.000)
CASH	0.1642*** (0.004)	0.0440 (0.354)	0.0918* (0.062)	0.2198*** (0.001)	0.2075*** (0.001)
BIG4	-0.0109 (0.697)	-0.0095 (0.731)	-0.0203 (0.461)	-0.0200 (0.477)	-0.0050 (0.853)
LOSS	0.0201 (0.179)	0.0240 (0.106)	0.0478*** (0.001)	0.0556*** (0.000)	0.0190 (0.182)
FISCAL YEAR END	0.1051*** (0.009)	0.1058*** (0.008)	0.1052*** (0.009)	0.1067*** (0.008)	0.1088*** (0.007)
DAYS TO SIGN	0.0033*** (0.000)	0.0033*** (0.000)	0.0033*** (0.000)	0.0033*** (0.000)	0.0033*** (0.000)
PUBLIC EXCHANGE	0.1272*** (0.000)	0.1182*** (0.000)	0.1304*** (0.000)	0.1341*** (0.000)	0.1263*** (0.000)
UNQUALIFIED OPINION	-0.0667*** (0.000)	-0.0715*** (0.000)	-0.0716*** (0.000)	-0.0669*** (0.000)	-0.0654*** (0.000)
GOING CONCERN	0.0203 (0.490)	0.0114 (0.692)	0.0002 (0.994)	0.0013 (0.966)	0.0241 (0.388)
INHERENT RISK	0.6488*** (0.000)	0.5440*** (0.000)	0.5058*** (0.000)	0.6555*** (0.000)	0.7157*** (0.000)
LITIGATION	0.0670*** (0.009)	0.0536** (0.023)	0.0817*** (0.001)	0.0481** (0.049)	0.0180 (0.446)
AUDITOR CHANGE	-0.1334*** (0.000)	-0.1372*** (0.000)	-0.1395*** (0.000)	-0.1349*** (0.000)	-0.1395*** (0.000)
SEGMENTS	0.1112*** (0.000)	0.1118*** (0.000)	0.1072*** (0.000)	0.1064*** (0.000)	0.1088*** (0.000)
COUNTY PRESENCE	0.1289***	0.1270***	0.1285***	0.1280***	0.1251***

Table 3 (continued)

	(1)	(2)	(3)	(4)	(5)
	$DV = LN(AUDIT\ FEE)$				
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
<i>LARGE SCALE</i>	-0.1214***	-0.1223***	-0.1208***	-0.1210***	-0.1255***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
<i>SPECIALIST</i>	0.1239***	0.1253***	0.1262***	0.1258***	0.1161***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
<i>AUDITOR COMPETITION</i>	-0.0614*	-0.0598*	-0.0628*	-0.0530	-0.0504
	(0.074)	(0.096)	(0.072)	(0.177)	(0.177)
Industry dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
County dummies	Yes	Yes	Yes	Yes	Yes
Observations	30,874	30,854	29,225	28,766	30,699
R-squared	0.846	0.846	0.847	0.849	0.848

This table presents results from regressions for the (natural logarithm of) audit fees on proxies of intangible assets, other than INTANGIBLES. Goodwill, Research and Development (R&D), Advertising expenses, and INTANGIBLES2, scaled by assets are the other proxies used for intangible assets. Sample selection is as described in “Appendix 2”. All the variables are defined in “Appendix 1”. Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

the last decade or so, such as the real options methodology. These techniques are not familiar to auditors and they are more in the realm of finance specialists. Hence, as this trend towards intangible assets continues, there is a clear need for some technical guidance from FASB and PCAOB to accurately and easily account for and value intangible assets across various industries.

Under the current standards, auditors seem to face a challenging task of valuing intangible assets without much technical training, or guidance from FASB or PCAOB. Therefore, in spite of the greater effort the auditors put in, the outcome is less than desirable. Further, because of the difficulty faced by auditors, who have intimate access to firm’s accounting data, they are unable to provide the expected validation of the reported (intangible) asset values and certify the authenticity of the financial reports. This in turn makes valuing corporate assets difficult for market participants (such as financial intermediaries, analysts, and investors) who, unlike auditors, typically do not have intimate inside access to financial information. This makes the link between firm fundamentals and stock prices weaker.

Left unaddressed, this accounting challenge will only exacerbate with time as the U.S. corporations continue the trend of moving towards greater proportion of intangible assets in their balance sheets. The trend in Fig. 1 and the coefficients from Panel B of Table 2 support this concern.

We next try to understand the factors that drive this relationship between audit fee and intangible assets. In the rest of the tables, we show results only for our main intangibles proxy. Results when using goodwill, R&D, or Advertising expenses continue to be statistically significant in support of our main results, but are omitted for the sake of parsimony.

5.2 Intangible assets and business risk

Between 1980 and 2005, while the total US expenditure in R&D has been reasonably stable at 2–3% of Gross Domestic Product, US firms are increasingly contributing more to R&D than the federal government. In 2001 alone, the private R&D expenditure was more than three-times that of the government expenditure.¹⁹ Considering this heavy private sector investment in R&D being funded by corporations, stock market now plays a big role in allocating capital to intangible assets. Pástor and Veronesi (2009) argue that investments in innovation increase stock return volatility. So, the increased R&D expenditures have also increased business risk for US firms, because these investments are associated with uncertainty. Cohen et al. (2013) argue that while some R&D investments are “good” in that they lead to improvements in productivity, technological innovations and enhanced profitability, others are “bad.”

While Cohen et al. look at R&D investments and Pástor and Veronesi examine stock market returns, we focus on the effect on audit fee. Considering that investors rely on auditors to generate and certify the quality of financial reports, the auditors' role is crucial in aiding efficient capital allocation. However, the findings in previous research that intangible assets make firms risky have implications for our study via the concern that the higher audit fee charged to firms reflect higher business risk associated with innovation. However, that is only a partial explanation of higher audit fees associated with intangible assets as we document a significant relation between intangible assets and audit fees even after controlling for business risk. In other words, higher business risk is only one of the channels contributing to the higher audit fee charged for firms with higher intangible assets.

To empirically explore the additional channels influencing this relation, we first investigate if intangible assets significantly increase business risk for firms, as captured by volatility in cash flow, and net income. Specifically, we examine if intangible assets contribute significantly to business risk. Results of this analysis are presented in Table 4.

In Table 4, specifications 1 and 2, we present regression results for volatility in cash flow and net income (as a fraction of assets) on firm characteristics, respectively. In each case, we calculate volatility using data for the preceding 5 years. After controlling for previously established determinants of business risk, we find that the proportion of intangible assets is a significant factor contributing to increased business risk. This is similar to the results in Cohen et al. (2013).

Next, we investigate if intangible assets are significantly related to the audit fee once we control for the business risk. To test this, we re-estimate the regression in Table 2 by adding the predicted business risk from the regression in Table 4. The results are presented in Table 5. We find that the coefficient for business risk is positive and significant, indicating that higher business risk contributes to higher audit fee. Notably, our main result that higher intangible assets lead to higher audit fee continues to hold. The relative magnitudes of the coefficient for INTANGIBLES in Tables 2 and 5 are also comparable. Intangible assets, thus, still continue to be significantly related to audit fee even when we control for business risk.

¹⁹ See the 2005 report entitled “R&D and Productivity Growth,” prepared by the Congressional Budget Office, available at <https://www.cbo.gov/sites/default/files/cbofiles/ftpdocs/64xx/doc6482/06-17-r-d.pdf>. Also see Chang and Su (2010) and Hwang et al. (2010) to understand impact of R&D expenditure on firm productivity.

Overall, we find that business risk is higher for firms with more intangible assets. We also find that higher business risk does contribute to a higher audit fee. While heightened business risk contributes to higher audit fee, our results suggest that intangible assets have significant incremental explanatory power even after controlling for business risk and other previously established determinants of audit fees. This further suggests that the challenge auditors face when auditing firms with higher intangible assets cannot be explained by the increased business risk in intangibles alone. Therefore, Lev and Gu (2016) suggest that the response should not be limited to addressing business risk alone.

5.3 Intangible assets and auditor effort

In this section we investigate the relation between intangible assets and auditor effort, which is a factor documented in Simunic (1980) to affect audit fee. The best proxy for measuring auditor effort is the hours an auditor took to audit a firm and prepare the required reports. Unfortunately, U.S. auditors do not report this data. In the absence of this information, we follow Ettredge et al. (2006) and Knechel and Payne (2001), and use the delay in filing the audit report, the *DAYS TO SIGN* variable as a proxy for auditor effort. Knechel et al. argue that the hours spent in auditing must be high when the audit firm is unable to file the report on time—so this is an indirect measure of abnormal effort and should be correlated with the hours spent. Simunic argues that when auditors exert greater effort in an audit engagement, they charge a higher fee to compensate for the time spent on the engagement. In examining this relation, we control for size and other firm characteristics and investigate if the proportion of intangible assets is significantly related to the audit fee. The auditor effort channel, discussed earlier, suggests a positive relation between auditor effort and intangible assets. Table 6 presents the results of this analysis.

Specification 1 in Table 6 shows a positive and highly significant relation between intangible assets and auditor effort. The statistically significant result is also evident in specifications 2 and 3 when we use a smaller set of control variables. Auditors clearly exert higher effort when auditing firms with higher intangible assets, after controlling previously established determinants of auditor effort. As the intangible assets increase from 25th to the 75th percentile, the proxy for auditor effort, *DAYS TO SIGN*, increases by a statistically significant 1.87%. Supporting our hypothesis (H2), this finding suggests that auditor effort is a significant factor behind higher audit fee and the higher effort might be driven by greater complexity associated with auditing intangible assets. This might also be symptomatic of complexity or absence of rules and guidelines regarding classification of intangible assets. Lev and Gu (2016) argue that there is scope for improvement by streamlining reporting standards surrounding intangible assets.

5.4 Intangible assets and litigation risk

In this section we investigate the association between intangible assets and litigation risk, which is another factor documented in Simunic (1980) to affect audit fee. Anecdotal evidence suggests that firms with intangible assets face litigation risks from “patent trolls” (see footnote 7). Lanjouw and Schankerman (1997) also find that legal disputes over intellectual property have become more common and costly to defend, with firms spending billions of dollars every year. While a host of factors [e.g., Jha and Chen 2015; Krishnan and Krishnan 1997; Shu 2000] are known to contribute to higher litigation risk for the auditor, prior research is silent on whether the auditors also face increased litigation risk when

Table 4 Business risk and intangibles

	(1) <i>DV = VOLATILITY_CASHFLOW</i>	(2) <i>DV = VOLATILITY_NI</i>
<i>INTANGIBLES</i>	0.02583*** (0.009)	0.08849*** (0.000)
<i>IC_WEAK</i>	0.00572 (0.255)	0.02518** (0.025)
<i>LNASSETS</i>	-0.01893*** (0.000)	-0.02835*** (0.000)
<i>DEBT</i>	0.08025*** (0.000)	0.13872*** (0.000)
<i>ROA</i>	-0.27540*** (0.000)	-0.36573*** (0.000)
<i>CASH</i>	0.15575*** (0.000)	0.22316*** (0.000)
<i>LOSS</i>	-0.03057*** (0.000)	0.00047 (0.966)
<i>MTOB</i>	0.00092 (0.141)	0.00233** (0.025)
<i>ALTMAN Z</i>	0.00089 (0.220)	-0.00265 (0.122)
Year dummies	Yes	Yes
Industry dummies	Yes	Yes
Observations	28,640	28,674
R-squared	0.450	0.376

This table presents results from regressions for risk measures on firm characteristics, including intangible assets. Dependent variable in specifications 1 and 2 is the standard deviation of firm's revenues (cash flow), scaled by assets, using last 5 years of data. Sample selection is as described in "Appendix 2". All the variables are defined in "Appendix 1". Standard errors are clustered by firm. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

auditing firms with higher intangible assets. We explore this link using data on shareholder litigations against auditors, controlling for firm and auditor characteristics known to affect this relationship. The results are presented in Table 7.

Specification 1 shows the results of the regression with controls for size and internal controls at the firm. The coefficient for *INTANGIBLES* is positive and statistically significant.²⁰ While this positive coefficient is line with our hypothesis of higher litigation risk because of activities related to intangible assets at the firm, we acknowledge that it is possible that we may have omitted variables in this specification. To further rule this out,

²⁰ This test is based on Audit Analytics data on lawsuits that are available only till 2011.

Table 5 Audit fee and intangibles in presence of risk

	(1)	(2)
	DV = LN (AUDIT FEE)	
<i>INTANGIBLES</i>	0.2565*** (0.000)	0.2495*** (0.000)
<i>VOLATILITY_CASHFLOW</i>	0.1711*** (0.000)	
<i>VOLATILITY_NI</i>		0.1628*** (0.000)
<i>IC_WEAK</i>	0.2497*** (0.000)	0.2473*** (0.000)
<i>LNASSETS</i>	0.4758*** (0.000)	0.4775*** (0.000)
<i>DEBT</i>	0.2088*** (0.000)	0.1981*** (0.000)
<i>ROA</i>	-0.2333*** (0.000)	-0.2150*** (0.000)
<i>CASH</i>	0.1795*** (0.007)	0.1781*** (0.006)
<i>BIG4</i>	-0.0144 (0.617)	-0.0139 (0.631)
<i>LOSS</i>	0.0346** (0.034)	0.0302* (0.066)
<i>FISCAL YEAR END</i>	0.1033** (0.011)	0.1028** (0.012)
<i>DAYS TO SIGN</i>	0.0033*** (0.000)	0.0033*** (0.000)
<i>PUBLIC EXCHANGE</i>	0.1346*** (0.000)	0.1344*** (0.000)
<i>UNQUALIFIED OPINION</i>	-0.0645*** (0.000)	-0.0620*** (0.000)
<i>GOING CONCERN</i>	0.0259 (0.337)	0.0196 (0.466)
<i>INHERENT RISK</i>	0.6847*** (0.000)	0.6916*** (0.000)
<i>LITIGATION</i>	0.0539** (0.040)	0.0523** (0.043)
<i>AUDITOR CHANGE</i>	-0.1492*** (0.000)	-0.1524*** (0.000)
<i>SEGMENTS</i>	0.1094*** (0.000)	0.1093*** (0.000)
<i>COUNTY PRESENCE</i>	0.1267*** (0.000)	0.1270*** (0.000)
<i>LARGE SCALE</i>	-0.1220*** (0.000)	-0.1219*** (0.000)
<i>SPECIALIST</i>	0.1217*** (0.000)	0.1219*** (0.000)
<i>AUDITOR COMPETITION</i>	-0.0641* (0.000)	-0.0661* (0.000)

Table 5 (continued)

	(1)	(2)
	DV = LN (AUDIT FEE)	
	(0.072)	(0.064)
Industry dummies	Yes	Yes
Year dummies	Yes	Yes
County dummies	Yes	Yes
Observations	30,609	30,647
R-squared	0.849	0.850

This table presents results from regressions for the (natural logarithm of) audit fees on firm characteristics including intangible assets and business risk. Sample selection is as described in "Appendix 2". All the variables are defined in "Appendix 1". Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

we expand our control variables to include firm characteristics (e.g. cash holdings, debt, risk), auditor's opinion of the firm and also use fixed effects to control for other time invariant industry characteristics and year specific events. In presence of this strict set of controls, we continue to find a strong positive relation between intangible assets and litigation risk (in fact, the coefficient even increases in magnitude). Based on this coefficient, increase in INTANGIBLES from the 25th to 75th percentile is associated with an economically significant 12.8% higher litigation risk. These robust results indicate that the expected losses from litigation are plausibly another reason, besides auditor effort, for the higher audit fee. Supporting our hypothesis H3, these results indicate that besides business risk, litigation risk is also significantly higher for auditors who audit firms with intangible assets. Both these risks seem to contribute to higher audit fees. We must note that it is hard to point to point to specific causes for higher litigation risk. As suggested by Lev and Gu (2016), lack of clarity surrounding auditors' treatment of intangible assets may be a reason contributing to the higher litigation risk. It is also possible that activities that lead to higher intangible assets (e.g. complexity, opacity) might also be correlated with opportunistic rent seeking behavior by managers, which also lead to the same outcome of a positive relation between intangible assets and litigation risk. Either way, in equilibrium, higher intangible assets appear to increase the probability of litigation, even after controlling for a robust set of controls.²¹

Overall, our results show that the higher litigation risk and auditor effort contribute to increasing the audit fee of firms with higher intangible assets, and that business risk alone cannot explain this increase. While a full analysis of what specific characteristics of intangible assets drive the higher effort or litigation risk is beyond the scope of our paper, we note that Lev and Gu (2016) and others have also called for a complete overhaul of the reporting standards.

Our paper informs that debate by providing an additional piece of evidence documenting the higher audit fee, after rigorously controlling for firm specific factors, audit related

²¹ Also see our detailed footnote 24 in the Robustness Checks section. We describe our results from attempt to simultaneously determine the effect of intangible assets on the three main dependent variables in our study, namely, audit fee, auditor effort and litigation risk. All results continue to strongly support our hypotheses.

Table 6 Auditor effort and intangibles

	(1)	(2)	(3)
	<i>DV = DAYS TO SIGN</i>		
<i>INTANGIBLES</i>	4.3299*** (0.000)	4.7599*** (0.000)	8.0104*** (0.000)
<i>IC_WEAK</i>	16.4202*** (0.000)	16.5937*** (0.000)	21.5709*** (0.000)
<i>LNASSETS</i>	- 3.4963*** (0.000)	- 3.5445*** (0.000)	- 2.8169*** (0.000)
<i>DEBT</i>	3.9615*** (0.000)	4.4012*** (0.000)	
<i>ROA</i>	1.2708 (0.287)	1.5815 (0.162)	
<i>CASH</i>	- 6.8235*** (0.000)	- 6.0646*** (0.000)	
<i>BIG4</i>	- 0.4692 (0.650)	- 0.3520 (0.744)	
<i>LOSS</i>	2.5952*** (0.000)	2.4213*** (0.000)	
<i>FISCAL YEAR END</i>	0.9870 (0.325)	1.1438 (0.236)	
<i>PUBLIC EXCHANGE</i>	- 5.1623*** (0.000)	- 5.4088*** (0.000)	
<i>UNQUALIFIED OPINION</i>	- 2.6597*** (0.000)	- 2.5930*** (0.000)	
<i>GOING CONCERN</i>	4.4885*** (0.000)	4.2516*** (0.001)	
<i>INHERENT RISK</i>	0.9873 (0.455)	0.8959 (0.472)	
<i>LITIGATION</i>	- 0.2887 (0.614)	- 0.0923 (0.858)	
<i>AUDITOR CHANGE</i>	3.6918*** (0.000)	3.8107*** (0.000)	
<i>SEGMENTS</i>	0.4899** (0.025)	0.5414** (0.039)	
<i>COUNTY PRESENCE</i>	0.9155*** (0.002)	0.7640*** (0.001)	
<i>LARGE SCALE</i>	- 0.5238 (0.444)	- 0.7982 (0.145)	
<i>SPECIALIST</i>	1.1212*** (0.007)	1.0535*** (0.005)	
<i>AUDITOR COMPETITION</i>	- 0.2180 (0.860)	- 0.0189 (0.981)	
Year dummies	Yes	Yes	No
Industry dummies	Yes	Yes	No
County dummies	Yes	No	No

Table 6 (continued)

	(1)	(2)	(3)
	DV = DAYS TO SIGN		
Observations	31,247	31,247	31,247
R-squared	0.294	0.264	0.156

This table presents results from regressions for the Days to sign on proxy of intangible assets, and other firm and auditor characteristics as independent variables. Sample selection is as described in “Appendix 2”. All the variables are defined in “Appendix 1”. Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

variables, etc. Our results underline the challenge that the participants in the audit market are unable to fully account for the complexity around intangible assets and hence auditors demand a premium for auditing firms with higher intangible assets. This premium is economically significant. Given that auditors are experts in their field and investors rely on independent auditors to certify the quality of reports, if auditors having direct access to the detailed records on intangible assets find it difficult to translate the nebulous intangible assets into the formatted accounting statements, much more must be lost in translation by investors who are a layer removed. This clearly represents an opening where clear rules and regulations about reporting different kinds of intangible assets, akin to reporting requirements of tangible assets, needs to be developed by FASB.

While we understand the complexity of this suggestion, we surely think that FASB could do more to codify reporting of intangible assets (at the least, viewing a firm's portfolio of intangible assets as a portfolio of “real options”, and developing guidelines similar to assigning value to option grants for the purpose of executive compensation). In the next section, we turn our attention to a more measurable form of intangible assets, i.e. patents.

5.5 Patents and audit fee

One of the key drivers of intangible assets is the technological and process innovations that a firm undertakes. These innovations in turn drive a firm's economic growth (see Schumpeter 1934). Patents are a measurable proxy of innovation. Even though valuing intangible assets is fraught with uncertainties and risks, they can be viewed as a measure of innovative use of a firm's assets (Amram 2005). We use data on patents awarded to US firms obtained from the USPTO made available by Kogan et al. (2017). These are unbiased outcomes of measurable successful innovation by the firm awarded by a government agency at the end of a rigorous verification process. We use the number of patents awarded to a firm as an *ex-post* proxy of a firm's level of innovation success and interpret them as an outcome of investments in intangible assets, including but not limited to R&D.

To examine whether success in innovation, as captured by the patents awarded to the firm, is related to audit fees, we re-estimate model 1 of Table 2 after substituting intangible assets with the one-year lagged number of patents awarded to the firm by the USPTO. These results are presented in Panel A of Table 8. The number of observations drops in these regressions because not all sample firms have information on patent awards. In specification 1 we use the number of patents variable and find strong, positive relation between patents filed and audit fee. Firms that have more patents are charged a higher audit fee,

Table 7 Lawsuit and intangibles

	(1)	(2)
	DV = LAWSUIT	
<i>INTANGIBLES</i>	0.3614** (0.039)	0.4344** (0.023)
<i>IC_WEAK</i>	1.4074*** (0.000)	1.4350*** (0.000)
<i>LNASSETS</i>	0.2706*** (0.000)	0.4869*** (0.000)
<i>DEBT</i>		0.0700 (0.628)
<i>ROA</i>		0.0881 (0.779)
<i>CASH</i>		0.8479*** (0.008)
<i>BIG4</i>		-0.2637 (0.152)
<i>LOSS</i>		0.7724*** (0.000)
<i>FISCAL YEAR END</i>		-0.0686 (0.425)
<i>PUBLIC EXCHANGE</i>		0.1314 (0.214)
<i>UNQUALIFIED OPINION</i>		-0.2564 (0.146)
<i>GOING CONCERN</i>		0.5583*** (0.005)
<i>INHERENT RISK</i>		0.3447 (0.321)
Year dummies	No	Yes
Industry dummies	No	Yes
Observations	31,245	31,019
Pseudo R-squared	0.052	0.117

This table presents results from logit regressions using the dummy variable Lawsuit, which takes a value of 1 if the auditor of a firm faces a lawsuit in a given year, and zero otherwise. The regression models the probability of the auditor being sued using firm and auditor characteristics as controls. Sample selection is as described in “Appendix 2”. All the variables are defined in “Appendix 1”. Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

supporting the notion that patents are difficult to value and therefore, auditors charge a premium. This finding is consistent with past research that has linked R&D investments to higher patent filings and awards (e.g. see Bloom et al. 2013; Hall et al. 2005) and with our finding in Table 3 showing that R&D is positively related to audit fees.

Table 8 Patents and audit fee

	(1)	(2)
	<i>DV = LN (AUDIT FEE)</i>	
<i>Panel A: Using patents as a measure of intangible assets</i>		
<i>NUMPATENTS</i>	0.0005*** (0.000)	
<i>NUMPATENTS- Citation weighted</i>		0.0002*** (0.000)
<i>IC_WEAK</i>	0.3015*** (0.000)	0.3011*** (0.000)
<i>LNASSETS</i>	0.4674*** (0.000)	0.4694*** (0.000)
<i>DEBT</i>	0.2266*** (0.000)	0.2264*** (0.000)
<i>ROA</i>	-0.3610*** (0.000)	-0.3628*** (0.000)
<i>CASH</i>	-0.1506** (0.030)	-0.1486** (0.034)
<i>BIG4</i>	-0.0362 (0.387)	-0.0379 (0.365)
<i>LOSS</i>	-0.0072 (0.761)	-0.0056 (0.814)
<i>FISCAL YEAR END</i>	0.1173* (0.055)	0.1177* (0.054)
<i>DAYS TO SIGN</i>	0.0029*** (0.001)	0.0029*** (0.001)
<i>PUBLIC EXCHANGE</i>	0.0852** (0.028)	0.0844** (0.030)
<i>UNQUALIFIED OPINION</i>	-0.0595*** (0.000)	-0.0593*** (0.000)
<i>GOING CONCERN</i>	0.0794** (0.029)	0.0807** (0.027)
<i>INHERENT RISK</i>	0.7419*** (0.000)	0.7470*** (0.000)
<i>LITIGATION</i>	-0.0449 (0.221)	-0.0445 (0.228)
<i>AUDITOR CHANGE</i>	-0.1376*** (0.000)	-0.1374*** (0.000)
<i>SEGMENTS</i>	0.1066*** (0.000)	0.1082*** (0.000)
<i>COUNTY PRESENCE</i>	0.1259*** (0.000)	0.1262*** (0.000)
<i>LARGE SCALE</i>	-0.1395*** (0.000)	-0.1395*** (0.000)
<i>SPECIALIST</i>	0.1219*** (0.000)	0.1223*** (0.000)

Table 8 (continued)

	(1)	(2)
	DV = LN (AUDIT FEE)	
<i>AUDITOR COMPETITION</i>	0.0679	0.0679
	(0.428)	(0.425)
Industry dummies	Yes	Yes
Year dummies	Yes	Yes
County dummies	Yes	Yes
Observations	7725	7725
R-squared	0.886	0.886
		(1)
		DV = LN(AUDIT FEE)
<i>Panel B: The marginal effect of industry concentration on relation between intangible assets and audit fee</i>		
<i>INTANGIBLES</i>		0.4732***
		(0.000)
<i>High-Patent-HHI*INTANGIBLES</i>		-0.1487**
		(0.021)
<i>Patents-HHI2</i>		0.0393**
		(0.020)
<i>IC_WEAK</i>		0.2733***
		(0.000)
<i>LNASSETS</i>		0.4752***
		(0.000)
<i>DEBT</i>		0.2016***
		(0.000)
<i>ROA</i>		-0.3124***
		(0.000)
<i>CASH</i>		0.1569**
		(0.033)
<i>BIG4</i>		-0.0252
		(0.376)
<i>LOSS</i>		0.0148
		(0.359)
<i>FISCAL YEAR END</i>		0.1245**
		(0.011)
<i>DAYS TO SIGN</i>		0.0031***
		(0.000)
<i>PUBLIC EXCHANGE</i>		0.1214***
		(0.000)
<i>UNQUALIFIED OPINION</i>		-0.0659***
		(0.000)
<i>GOING CONCERN</i>		0.0290
		(0.402)
<i>INHERENT RISK</i>		0.6663***
		(0.000)
<i>LITIGATION</i>		0.0674**

Table 8 (continued)

	(1) DV = LN(AUDIT FEE)
	(0.011)
<i>AUDITOR CHANGE</i>	-0.1336***
	(0.000)
<i>SEGMENTS</i>	0.1116***
	(0.000)
<i>COUNTY PRESENCE</i>	0.1265***
	(0.000)
<i>LARGE SCALE</i>	-0.1291***
	(0.000)
<i>SPECIALIST</i>	0.1343***
	(0.000)
<i>AUDITOR COMPETITION</i>	-0.0667
	(0.144)
Year fixed effect	Yes
Time fixed effect	Yes
County fixed effect	Yes
Observations	22,603
R-squared	0.843

This table presents results from regressions for the (natural logarithm of) audit fees on intangible assets and controls. Sample selection is as described in “Appendix 2”. All the variables are as defined in “Appendix 1”. Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. p -values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

In specification 2 of Table 8 (Panel A), we use citation-weighted patent count as another measure of patents. This variable is constructed by using the patents awarded to a firm, weighted by the number of citations received by those patents from others. Literature in this area suggests that weighting the patents by citation counts gives more weight to the patents that are scientifically important than to ones that are not (Kogan et al. 2017). This rules out frivolous patents and gives more weightage to economically significant ones.²² These alternate measures show the same strong result indicating firms with higher intangible assets, as measured by citation weighted patent count, are charged a higher audit fee. This is another new link related to audit fees that we document in this study. These results further strengthen our hypothesis that intangible assets are positively related to audit fee.

One of the factors explaining the higher audit fee is litigation risk. We find support for this in Sect. 5.5 showing that firms with higher litigation risk are charged a higher audit fee. Interestingly, Ziedonis (2004) has studied the market for the highly innovative semiconductor industry from a transaction cost economics perspective and concludes that when the market is competitive in terms of generating intellectual property, it is optimal for firms

²² We also get similar strong and statistically significant result when using the economic value of patents variable from Kogan et al. (2017), in place of the *NUMPATENTS* variable.

to protect their own intellectual property more aggressively, i.e. file for more patents. A firm that faces higher competition in the race for patents in a R&D competitive industry is more likely to be in breach of other patents or “step on someone’s toes” unintentionally and hence is also more prone to patent-related litigation from competitors. Ziedonis argues that the strategy of building a portfolio of patents in a R&D competitive market is similar to an attempt to create a de facto “exchange of hostage” (Williamson 1983) situation. Survey evidence of Cohen et al. (2013) also finds that many a times, firms patent ideas to preempt rivals from related inventions.

With this background, we craft a moderating test using a patent-based measure of industry concentration. We conjecture that if patent-related litigation risk is higher in industries where there are many firms filing for patents aggressively, the auditor should face a higher litigation risk in industries that are more competitive in generating patents (more likelihood of “stepping on someone’s toes”), compared to those that are more concentrated in terms of patent filings. We use the patent information to create a Herfindahl–Hirschmann Index (HHI) of patents concentration, similar to Hall et al. (2005). We then create a dummy variable, *High-Patent-HHI*, that takes a value of 1 if the calculated industry concentration based on patents for the year is above the median value of HHI of patents, and zero otherwise.

We investigate whether audit fees differ based on whether the firm is operating in a competitive innovation environment or a concentrated one. For this test, we regress audit fees on the firm and auditor controls in Table 8 (Panel B), and include an interaction term, *High-Patent-HHI X INTANGIBLES*, to investigate the marginal effect of industry concentration on the relation between intangible assets and audit fee. We find that firms with high intangible asset but in more concentrated patent-generating industries, i.e. those that have a lower expected risk of patent related litigation, are charged a lower audit fee relative to similar firms in patent-competitive industries. The coefficient on the interaction term is negative and significant with a *p*-value of 0.021. This serves as a moderating test and clearly shows that audit fee is lower for firms in industries that are expected to see lower patent-related litigation.²³

6 Robustness and sample selection issues

At the outset, we address the issue of causality and endogeneity. In this study, we are examining the relation between audit fees (which is exogenous) and intangible assets. As far as causality is concerned, clearly, there is no economic rationale to suggest that high audit fee can *cause* firms to have higher intangible assets. Put differently, audit fee is charged by an external auditor so it cannot cause the firm to increase intangible assets. Hence, it is indisputable that the causality runs from intangible assets to audit fee and not vice versa. We also note that we control for all firm variables and auditor related characteristics known to affect audit fee, as well as unobservable industry, time and location factors. Our results are strong and robust after controlling for all these factors.

²³ We also conduct an additional test by explicitly controlling for our business risk proxies to confirm our findings in Tables 6 through 8. Our results are robust to this additional test. These results are available upon request.

Table 9 Robustness check—propensity score matched sample comparison

	(1)	(2)
	Mean	Median
<i>Difference in Ln(AUDIT FEE)</i>	0.1767*** (0.000)	0.236*** (0.000)

This table presents results for difference in the (natural logarithm of) audit fees between firms with above median value of INTANGIBLES and a propensity score matched sample with one-to-one nearest-neighbor matching with replacement (Heckman et al. 1997) when using all covariates, as used in Table 2, as controls for creating the propensity score. Specification 1 (2) shows the mean (median) difference between the treated and propensity score matched sample. *p*-values reported in parentheses represent values from using a t-test (Ranksum test). ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

We address sample selection issues using a two-pronged strategy. First, we divide the sample of firms into quartiles of total assets, each year. We then consider if the relation between audit fee and intangible assets is different between firms in the different quartiles of assets. We continue to find strong and positive statistical relation between intangible assets and audit fee in all asset quartiles.²⁴ Second, we consider a propensity score matched sample where firm characteristics are similar, but the level of intangible assets is not. For this test, using a probit regression, we estimate the probability of belonging to a level of above-median intangible assets using all the covariates used to describe audit fee in our main regression model (as shown in Table 2). Then, using predicted probabilities—propensity scores—we match firms using one-to-one nearest-neighbor matching with replacement (Heckman et al. 1997). We match firms with known propensity scores in the treatment (above-median intangible assets) group to one with a similar propensity score firm in the control (below-median intangible assets) group. We then test to see if the audit fees charged to these firms are different. Table 9 shows the results for this test. We find that the audit fee charged to the average (median) firms in the treatment group is $e^{0.1767}$, i.e. 19.32% (26.64%) higher than the fee charged to a similar firm in the control group. The difference in audit fee between the two groups is highly significant with a *p*-value of 0.000.²⁵

We also rule out any concern about any disproportionate firm observations from years when audit fee has been higher on average by considering a compressed sample of only one observation per firm. We create a sub-sample that has only one observation for each firm in

²⁴ We estimate a regression similar to the one shown in specification 1 of Table 2, explaining audit fee using control variables and INTANGIBLES. The coefficient on INTANGIBLES variable in the first, second, third and fourth quartiles of assets are 0.2564, 0.1184, 0.2095, 0.3682, respectively. In each case, the coefficients are statistically significant. These results are omitted for brevity, but available upon request.

²⁵ In the absence of identification of an exogenous shock, we examine the equilibrium outcome in a simultaneous equations system encompassing audit fee and intangible assets. To further alleviate this concern, we estimate the effect of intangible assets on the three main dependent variables in our study, namely, audit fee, auditor effort, and litigation risk, simultaneously. In this exercise, we model the three relations while allowing the variables to be endogenously and simultaneously determined, with correlated error structures between models. Our simultaneous equation modelling results also confirms that intangible assets continue to be positively related to all three variables of interest, further supporting our hypotheses that intangible assets contribute to higher audit fee, increased auditor effort and increased litigation risk, simultaneously.

Table 10 Robustness check—
compressed sample of one
variable per firm

	(1) DV = LN(AUDIT FEE)
<i>INTANGIBLES</i>	0.3406*** (0.000)
<i>IC_WEAK</i>	0.3731*** (0.000)
<i>LNASSETS</i>	0.5126*** (0.000)
<i>DEBT</i>	0.1315*** (0.000)
<i>ROA</i>	-0.4418*** (0.000)
<i>CASH</i>	0.3418*** (0.000)
<i>BIG4</i>	-0.2392*** (0.000)
<i>LOSS</i>	-0.0312 (0.296)
<i>FISCAL YEAR END</i>	0.1129*** (0.000)
<i>DAYS TO SIGN</i>	0.0067*** (0.000)
<i>PUBLIC EXCHANGE</i>	0.1954*** (0.000)
<i>UNQUALIFIED OPINION</i>	0.0105 (0.574)
<i>GOING CONCERN</i>	-0.0756* (0.077)
<i>INHERENT RISK</i>	0.6230*** (0.000)
<i>LITIGATION</i>	0.0773** (0.010)
<i>AUDITOR CHANGE</i>	-0.3234*** (0.000)
<i>SEGMENTS</i>	0.0943*** (0.000)
<i>COUNTY PRESENCE</i>	0.1889*** (0.000)
<i>LARGE SCALE</i>	-0.1977*** (0.000)
<i>SPECIALIST</i>	0.1333*** (0.000)
<i>AUDITOR COMPETITION</i>	-0.0769 (0.555)
Industry dummies	Yes
Year dummies	N/A
County dummies	Yes

Table 10 (continued)

	(1)
	$DV = LN(AUDIT\ FEE)$
Observations	5123
R-squared	0.843

This table presents results from regressions for the (natural logarithm of) audit fees on intangible assets and controls, using a compressed sample of one observation per firm. Sample is created by taking one median observation per firm, irrespective of the number of years of data we have for the firm. All the variables are as defined in "Appendix 1". Standard errors are clustered by firm and year. Industry (as defined by SIC 2-digit industry classification), year, and country dummies are used as indicated. *p*-values are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively

our larger sample, capturing the median observation for the firm from all the years for which data on the firm is available. We then run a regression where we use this compressed sample of one observation per firm and re-estimate the relation between audit fee and intangible assets. These results are presented in Table 10. We find that audit fee is significantly related to the proportion of intangible assets in this sample as well. This further cements our claim that this is not a time period specific effect or driven by just a few firms in the sample that are disproportionately represented. Hence, the response to this challenge has to match the scale of the problem and address an economy wide problem with an appropriate response.

7 Conclusions

The last several decades have witnessed a significant increase in the proportion of intangible assets on the balance sheets of US firms and this trend continues. Although the impact of such a dramatic change in the asset mix on financial policies and capital structure has been adequately acknowledged in the literature, the auditor's revealed perspective on this so-called "twenty-first century accounting challenge" has not been comprehensively examined. While Lev and Gu (2016) have documented that current accounting guidelines have not been able to keep pace with these changes, we are the first to document that auditors charge a premium for auditing firms with higher intangible assets and explore the reasons explaining this premium.

We also document that the proportion of a firm's intangible assets is positively related to audit fees, after controlling for previously established audit fee determinants. Further, we find that high intangible assets require more auditor effort and expose them to greater litigation risk resulting in higher audit fees. Besides R&D expenses, we show that *ex post* proxies of innovation success (fruits of R&D), such as number of patents and citation-weighted patents also influence audit fees. Finally, we find that firms in concentrated patent-generating industries (i.e. those that have a lower expected risk of patent-related litigation) with higher proportion of intangible assets are charged lower audit fees compared to similar firms in patent-competitive industries.

Overall, our study contributes to the literature by establishing that auditors find it more challenging to audit firms with higher intangible assets. We infer that this is symptomatic of a problem at the origin of financial information production process that can only get exacerbated as US firms increase reliance on intangible assets in the future. This challenge

needs to be addressed urgently with better audit and reporting guidelines by FASB and PCAOB regarding intangible assets.

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Appendix 1

See Table 11.

Table 11 Variable definitions

Variable (alphabetical)	Definition and source
<i>ADV EXP/ASSETS</i>	It is the ratio of advertising expense to total assets (XRD/AT). Source: Compustat
<i>ALTMAN Z</i>	$Z\text{-score} = 3.3 * (NI/AT) + 1 * (SALE/AT) + 1.4 * (RE/AT) + 1.2 * (WCAP/AT) + ((0.6 * (PRCC_C * CSHO))/LT)$, see Altman (1968). Source: COMPUSTAT
<i>AUDIT FEE</i>	The total audit fee of the primary external auditor. Source: Audit Analytics
<i>AUDITOR CHANGE</i>	This indicator variable equals 1 if the auditor had changed in the fiscal year, and 0 otherwise. Source: Compustat
<i>AUDITOR COMPETITION</i>	This variable measures the auditor's competition in the county. It is calculated as in Newton et al. (2013). Source: Compustat and Audit Analytics
<i>BIG4</i>	This indicator variable equals 1 if the primary auditor is one of the following: PricewaterhouseCoopers, Ernst & Young, Deloitte & Touche, or KPMG, and 0 otherwise. Source: Compustat and Audit Analytics
<i>COUNTY PRESENCE</i>	This variable measures the presence of the auditor in the county and is constructed as in Fung et al. (2012). It is the natural logarithm of the sum of the audit fees that the auditor collected from the firms in the county. Source: Compustat and Audit Analytics
<i>DAYS TO SIGN</i>	It is the lag between the signature date of the audit opinion and the date of the fiscal year-end (SIG_DATE_OF_OP_S FISCAL_YEAR_END_OP). Source: Audit Analytics
<i>DEBT</i>	It is the ratio of total liabilities to total assets (LT/AT). Source: Compustat
<i>FISCAL YEAR END</i>	It is equal to 1 if the fiscal year ends in December, and 0 otherwise. Source: Audit Analytics
<i>GOING CONCERN</i>	It equals 1 if the auditor issues a going concern modified report, and 0 otherwise. Source: Audit Analytics
<i>GOODWILL/ASSETS</i>	It is the ratio of goodwill to total assets (GDWL/AT). Source: Compustat
<i>HIGH-HHI</i>	It is equal to one if a firm is in a higher than median HHI (based on number of patents filed) industry for the year. HHI for this purpose is calculated by squaring the fraction of patents filed by a firm in a year and summing this over all firms in the industry (based on 2 digit SIC). Source: Number of patents are available at https://iu.app.box.com/patents ; see Kogan et al. (2017)
<i>IC_WEAK</i>	1 if internal control is weak, 0 otherwise. Internal control measures are constructed as in Cheng et al. (2013)
<i>INHERENT RISK</i>	It is the sum of receivables and inventory and scaled by assets ((RECT + INVT)/AT). Source: Compustat
<i>INTANGIBLES</i>	The intangibles assets in the firm normalized by total assets (INTAN/AT). Source: Compustat

Table 11 (continued)

Variable (alphabetical)	Definition and source
<i>INTANGIBLES2</i>	It is calculated by subtracting Property, Plant and Equipment, (PPENT), Current Assets (ACT) from Total Assets (AT) and normalizing the remainder by total assets: $((AT-PPENT-ACT)/AT)$. Source: Compustat
<i>LARGE SCALE</i>	This variable measures the scale of the auditor as in Fung et al. (2012). Source: Compustat and Audit Analytics
<i>LAWSUIT</i>	An indicator variable that is equal to 1 if there is a lawsuit against the firm in that year. We code LAWSUIT as 1 if, in any given year, the firm is classified in the following categories: Accounting and Auditing Enforcement Release (category 54), Accounting Malpractice (category 2), Financial Reporting (category 48), and 0 otherwise. Source: Audit Analytics
<i>LITIGATION</i>	This indicator variable equals 1 if the SIC code of the firm is one of the following: 833–2836, 3570–3577, 3600–3674, 5200–5961, 7370–7374, or 8731–8734. Source: Compustat
<i>LNASSETS</i>	It is the natural logarithm of total assets ($\ln(AT)$). Source: Compustat
<i>LOSS</i>	It is equal to 1 if the ROA is negative, and 0 otherwise. Source: Compustat
<i>MTOB</i>	This variable measures the market-to-book $((PRCC_C*CSHO)/CEQ)$ value of equity. Source: Compustat
<i>NUMPATENTS</i>	Number of patents awarded to the firm by the US Patent Office. <i>NUMPATENTS-Citation weighted</i> is the weighted average version of this variable where each patent is weighted by how many other patents cite the current one in the future, see Kogan et al. (2017). Source: https://lu.app.box.com/patents
<i>PUBLIC EXCHANGE</i>	It equals 1 if the firm is a public company trading in a major exchange (Compustat data item STKO=0), and 0 otherwise. Source: Compustat
<i>R&D/ASSETS</i>	It is the ratio of research and development expense to total assets (XRD/AT). Source: Compustat
<i>ROA</i>	It is the ratio of net income to total assets ($EBITDA/AT$). Source: Compustat
<i>SEGMENTS</i>	The number of business segment. Source: Compustat
<i>SPECIALIST</i>	This variable measures whether the auditor is a specialist and is constructed as in Fung et al. (2012). Source: Compustat and Audit Analytics
<i>UNQUALIFIED OPINION</i>	It equals 1 if the auditor issues an unqualified opinion without any additional language (Compustat data item AUOP = 1), and 0 otherwise. Source: Compustat
<i>VOLATILITY_CASHFLOW</i>	This variable measures the volatility of the cash flows to the total assets ($OANCF/AT$) using 5 years, including current year. If the lag values for all four years are unavailable, we construct the volatility measure using the current year and the last 3 years. Source: COMPUSTAT
<i>VOLATILITY_NI</i>	This variable measures the volatility of net income to assets (NI/AT) using 5 years, including current year. If the lag values for all four years are unavailable, we construct the volatility measure using the current year and the last 3 years. Source: COMPUSTAT

Appendix 2

This appendix lists all criteria used in selection the main sample used in the paper. Count provides the number of observation and changes in them, as a particular criterion is used in data selection. SIC is the historic Standard Industry Classification code and LOC is the head-quarter location of the firm. All other variables are as defined in "Appendix 1." See Table 12.

Table 12 Data selection

COMPUSTAT firms (2002–2014) & LOC == "USA"	80,463
Less financial firms (SIC >= 6000 & SIC <= 6999)	(15,197)
Less utilities firms (sich >= 4000 & sich <= 4999)	(7691)
Less firms with missing <i>LN (AUDIT FEE)</i>	(20,622)
Less firms with missing <i>INATNGIBLES</i>	(647)
Less firms with missing <i>INHERENT RISK</i>	(464)
Less firms with missing <i>IC_WEAK</i>	(1141)
Less firms with missing <i>DEBT</i>	(124)
Less firms with missing <i>ROA</i>	(67)
Less firms with missing <i>CASH</i>	(2)
Less firms with missing <i>FISCAL YEAR END</i>	(158)
Less firms with missing <i>PUBLIC EXCHNG</i>	(17)
Less firms with missing <i>UNQUALIFIED OPINION</i>	(1)
Less firms with missing <i>LITIGATION</i>	(363)
Less firms with missing <i>SEGMENTS</i>	(2580)
Less firms with missing <i>COUNTY PRESENCE</i>	(144)
	31,245.00

References

- ACAP (2008) Final report of the advisory committee on the auditing profession to the US Department of the Treasury. Advisory Committee on the Auditing Profession, Washington, DC
- Altman EI (1968) Financial ratios, discriminant analysis and the prediction of corporate bankruptcy. *J Finance* 23:589–609
- Amram M (2005) The challenge of valuing patents and early-state technologies. *J Appl Corp Finance* 17:68–81
- Antle R, Gordon E, Narayanamoorthy G, Zhou L (2006) The joint determination of audit fees, non-audit fees, and abnormal accruals. *Rev Quant Finance Account* 27:235–266
- Barth ME, Kasznik R, McNichols MF (2001) Analyst coverage and intangible assets. *J Account Res* 39:1–34
- Bell TB, Landsman WR, Shackelford DA (2001) Auditors' perceived business risk and audit fees: analysis and evidence. *J Account Res* 39:35–43
- Bhattacharya S, Ritter JR (1983) Innovation and communication: signalling with partial disclosure. *Rev Econ Stud* 50:331–346
- Blankley AI, Hurtt DN, MacGregor JE (2012) Abnormal audit fees and restatements. *Audit J Pract Theory* 31:79–96. <https://doi.org/10.2308/ajpt-10210>
- Bloom N, Schankerman M, Van Reenen J (2013) Identifying technology spillovers and product market rivalry. *Econometrica* 81:1347–1393
- Cameran M, Perotti P (2014) Audit fees and IAS/IFRS adoption: evidence from the banking industry. *Int J Audit* 18:155–169
- Causholli M, De Martinis M, Hay D, Knechel WR (2010) Audit markets, fees and production: towards an integrated view of empirical audit research. *J Account Lit* 29:167–215
- Chang H-L, Su C-W (2010) Is R&D always beneficial? *Rev Pac Basin Financ Mark Policies* 13:157–174
- Chen C, Martin X, Wang X (2012) Insider trading, litigation concerns, and auditor going-concern opinions. *Acc Rev* 88:365–393
- Cheng M, Dhaliwal D, Zhang Y (2013) Does investment efficiency improve after the disclosure of material weaknesses in internal control over financial reporting? *J Acc Econ* 56:1–18
- Cohen L, Diether K, Malloy C (2013) Misvaluing innovation. *Rev Financ Stud* 26:635–666
- Copeland T, Antikarov V (2003) *Real options: a practitioners guide*. Cengage Learning, New York
- Corrado CA, Hulten CR (2010) How do you measure a "technological revolution"? *Am Econ Rev* 100:99–104
- Corrado C, Hulten C, Sichel D (2009) Intangible capital and US economic growth. *Rev Income Wealth* 55:661–685

- Douglas AV, Huang AG, Vetzal KR (2016) Cash flow volatility and corporate bond yield spreads. *Rev Quant Finance Account* 46:417–458
- Dye RA (1993) Auditing standards, legal liability, and auditor wealth. *J Political Econ* 101:887–914
- Edmans A (2011) Does the stock market fully value intangibles? Employee satisfaction and equity prices. *J Financ Econ* 101:621–640
- Ettredge ML, Li C, Sun L (2006) The impact of SOX section 404 internal control quality assessment on audit delay in the SOX era. *Audit J Pract Theory* 25:1–23
- Falato A, Kadyrzhanova D, Sim J (2013) Rising intangible capital, shrinking debt capacity, and the US corporate savings glut. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2350863. Accessed 1 June 2017
- Fields LP, Fraser DR, Wilkins MS (2004) An investigation of the pricing of audit services for financial institutions. *J Account Public Policy* 23:53–77
- Fung SYK, Gul FA, Krishnan J (2012) City-level auditor industry specialization, economies of scale, and audit pricing. *Account Rev* 87:1281–1307. <https://doi.org/10.2308/Accr-10275>
- Gu F, Wang W (2005) Intangible assets, information complexity, and analysts' earnings forecasts. *J Bus Finance Account* 32:1673–1702
- Gul FA, Chen CJP, Tsui JSL (2003) Discretionary accounting accruals, managers' incentives, and audit fees. *Contemp Account Res* 20:441–464
- Hall BH, Jaffe A, Trajtenberg M (2005) Market value and patent citations. *RAND J Econ* 36:16–38
- Hay DC, Knechel WR, Wong N (2006) Audit fees: a meta-analysis of the effect of supply and demand attributes. *Contemp Account Res* 23:141–191
- Heckman JJ, Ichimura H, Todd PE (1997) Matching as an econometric evaluation estimator: evidence from evaluating a job training programme. *Rev Econ Stud* 64:605–654
- Holmstrom B (1989) Agency costs and innovation. *J Econ Behav Organ* 12:305–327
- Hope O-K, Langli JC, Thomas WB (2012) Agency conflicts and auditing in private firms. *Account Organ Soc* 37:500–517
- Hwang Y-S, Min H-G, Han S-H (2010) The influence of financial development on R&D activity: cross-country evidence. *Rev Pac Basin Financ Mark Policies* 13:381–401
- Jha A, Chen Y (2015) Audit fees and social capital. *Account Rev* 90:611–639. <https://doi.org/10.2308/accr-50878>
- Kline DJ (2004) Patent litigation: the sport of kings. *MIT Technology Review*. <https://www.technologyreview.com/s/402686/patent-litigation-the-sport-of-kings/>
- Knechel WR, Payne JL (2001) Additional evidence on audit report lag. *Audit J Pract Theory* 20:137–146
- Kogan L, Papanikolaou D, Seru A, Stoffman N (2017) Technological innovation, resource allocation, and growth. *Q J Econ* 132:665–712
- Krishnan J, Krishnan J (1997) Litigation risk and auditor resignations. *Account Rev* 72:539–560
- Lanjouw JO, Schankerman M (1997) Stylized facts of patent litigation: value, scope and ownership. National Bureau of Economic Research. <https://www.nber.org/papers/w6297>. Accessed 10 Apr 2017
- Lev B (2004) Sharpening the intangibles edge. *Harvard Bus Rev* 6:109–116
- Lev B, Gu F (2016) The end of accounting and the path forward for investors and managers. Wiley, Hoboken
- Lev B, Zarowin P (1999) The boundaries of financial reporting and how to extend them. *J Account Res* 37:353–385
- Makrominas M (2017) Recognized intangibles and the present value of growth options. *Rev Quant Finance Account* 48:311–329
- Mitra S, Jaggi B, Al-Hayale T (2019) Managerial overconfidence, ability, firm-governance and audit fees. *Rev Quant Finance Account* 52:841–870
- Mun J (2002) Real options analysis: tools and techniques for valuing strategic investments and decisions, vol 137. Wiley, New York
- Newton NJ, Wang D, Wilkins MS (2013) Does a lack of choice lead to lower quality? Evidence from auditor competition and client restatements. *Audit A J Practice Theory* 32:31–67
- Pástor L, Veronesi P (2009) Technological revolutions and stock prices. *Am Econ Rev* 99:1451–1483
- Peters RH, Taylor LA (2017) Intangible capital and the investment-q relation. *J Financ Econ* 123:251–272
- Roychowdhury S (2006) Earnings management through real activities manipulation. *J Account Econ* 42:335–370
- Schumpeter JA (1934) The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle, vol 55. Transaction Publishers, Piscataway
- Shu SZ (2000) Auditor resignations: clientele effects and legal liability. *J Account Econ* 29:173–205

- Simunic DA (1980) The pricing of audit services: theory and evidence. *J Account Res* 18:161–190
- Skinner DJ (2008) Accounting for intangibles—a critical review of policy recommendations. *Account Bus Res* 38:191–204
- Solow RM (1956) A contribution to the theory of economic growth. *Q J Econ* 70:65–94
- Upton W (2001) Special report: business and financial reporting, challenges from the new economy (No. 219-A). Financial Accounting Standards Board (FASB), Connecticut
- Vafeas N, Waagelein JF (2007) The association between audit committees, compensation incentives, and corporate audit fees. *Rev Quant Finance Account* 28:241–255
- Williamson OE (1983) Credible commitments: using hostages to support exchange. *Am Econ Rev* 73:519–540
- Wyatt A (2005) Accounting recognition of intangible assets: theory and evidence on economic determinants. *Account Rev* 80:967–1003
- Ziedonis RH (2004) Don't fence me in: fragmented markets for technology and the patent acquisition strategies of firms. *Manag Sci* 50:804–820

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