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Information Technology in an Audit Context: Have the Big 4 Lost Their Advantage?

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Abstract

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Disciplines

Accounting | Business Administration, Management, and Operations | Business Law, Public Responsibility, and Ethics | Finance and Financial Management | Management Information Systems

Comments

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Audit Information Technology Use and Perceived Importance: Have the Big 4 Lost Their Advantage?

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ABSTRACT

Audit firms use information technology (IT) to improve audit quality, effectiveness, and efficiency. While audit IT has evolved over the past decade, limited guidance is available to assist practitioners in determining how IT can be used. Our research objectives are fourfold. First, we examine to what extent auditors use and assess perceived importance of IT in their audits. Second, we look at different-size firms to determine whether IT adoption and implementation decisions differ by firm size. Third, we investigate changes in auditors' use and perceived importance of IT over the past decade. Fourth, we examine whether IT has impacted the communication modes used by auditors when reviewing workpapers and fraud brainstorming. Overall, Big 4 auditors were not significantly more likely to use IT than non-Big 4 auditors, suggesting that the dominance of the Big 4 firms' use of IT has lessened. In fact, there are a few applications where non-Big 4 auditors appear to have taken the lead. In addition, our findings indicate that auditors have increased the use of all the IT applications we examined ten years ago. However, we find evidence that auditors may prefer to use even more IT in their audits than they are currently using.

Key Words: Information technology, audit firm size, audit applications, diffusion innovation theory.

Data Availability: Data used in this study is available from the authors upon request.

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INTRODUCTION

> "We are concerned about emerging technologies and trying to understand how auditors plan to perform the audits of the future." Lewis Ferguson, PCAOB board member, September 8, 2015

As business processes have become more complex and as extensive innovations in information technology (IT)[1] have fundamentally altered the way businesses operate, auditors are using IT to assist them with the audit process, including workpaper review and fraud brainstorming (Kotb and Roberts 2011; Rosli, Yeow, and Siew 2012; Dowling and Leech 2014; Tysiac 2015).[2] Due to these technological changes and increased emphasis on IT internal controls, conventional audit practices and techniques have become outdated, creating a need for IT-driven audit techniques that can potentially improve audit quality, efficiency, and effectiveness (Pathak and Lind 2010; Curtis and Payne 2014; Lombardi, Bloch, and Vasarhelyi 2015). While IT has evolved over the past decade, limited guidance is available to assist practitioners in determining how IT can be used in their audits and the importance of IT use to practitioners. This has prompted a call by the academic accounting community for additional research into understanding how and to what extent IT is used in conducting audits (Curtis, Jenkins, Bedard, and Deis 2009; Mazza, Azzali, and Fornaciari 2014; D'Onza, Lamboglia, and Verona 2015). Further, diffusion innovation theory suggests that innovations, such as new IT, are adopted at different points in time by different groups, consisting of innovators, early adopters, early majority, late majority and laggards (or simply early and late adopters) (Agarwal, Ahuja, Carter, and Gans 1998; Rogers 2003). Thus, adoption of IT in an audit context may vary by firm size given differences in resource availability between large and small audit firms.[3]

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[1] *Information technology* refers to "the automated means of originating, processing, storing, and communicating information, and includes recording devices, communication systems, computer systems (including hardware and software components and data), and other electronic devices" (AICPA 2007; AU 319.02).
[2] Auditing through the computer was also mandated by the Sarbanes–Oxley Act of 2002 (SOX).
[3] Unless otherwise stated, the term "firms" refers to audit firms and not client firms throughout the paper.

Auditing standards do provide some guidance (e.g., AICPA 2001, 2002, 2006, 2010; PCAOB 2007) on how to incorporate IT in audits (Bauer and Estep 2015). For instance, AU-C 240 includes several references to IT as a means of evaluating fraud and AU-C 315 describes the importance of considering IT factors on internal control evaluation. This guidance, however, is broadly stated to allow the profession to adapt with the business environment and with IT advances (Curtis et al. 2009).

As noted above, the adoption and use of IT may not necessarily be uniform over different-sized audit firms. Larger audit firms have clients that are more likely to have complex IT, necessitating the need for these firms to make significant investments in their own IT to audit such clients in an efficient and effective manner. Smaller audit firms are less likely to have clients with complex IT and often do not have sufficient resources to adopt significant IT (Curtis and Payne 2008; Rosli et al. 2012). Firms that fail to adopt IT early may also fall behind in developing new, innovative client services (Drew 2015). This creates a potential economic barrier between different sized firms that has audit efficiency and effectiveness implications (Janvrin, Bierstaker, and Lowe 2008). Further, based on diffusion innovation theory (Agarwal et al. 1998; Rogers 2003), IT adoption over time often becomes a necessity as the implementation of early adopters is perceived by the market to provide economic benefit and competitive survival (Rogers 1995). Thus, the larger firms may resemble early adopters, and smaller firms may be the technology laggards.

Nevertheless, there are some indications that non-Big 4 firms are beginning to close the gap between their IT capabilities and those of the Big 4 firms, creating a more level playing field (Bills, Cunningham, and Myers 2016). Furthermore, Defond, Francis and Hallman (2016) report evidence that non-Big 4 firms have increased their market share of the public company audit market in the last decade; this likely necessitates greater investments in and use of a range of IT. It is unclear, however, which types of audit applications and uses of IT, including communication modes for workpaper review and group brainstorming, this might pertain to and whether this trend is pervasive.

Our study investigates changes in auditors' IT use and perceived importance over the last ten years, a decade of significant change in the audit environment. We collected data to compare to Janvrin et al.'s (2008) initial benchmark data collected in 2004 (see Appendix). This analysis should help academics and practitioners better understand the changing IT practices of firms. We also look at different-sized firms to determine whether IT adoption and implementation decisions are in line with diffusion innovation theory. More specifically, we examine a sample of Big 4, "second tier" or national[4], regional, and local firms to investigate if Big 4 firms continue to use IT more extensively and perceive IT as more important than other firms.

We examine IT use and perceived importance in the audit context, as well as how audit firm size is associated with IT use and perceived importance. We utilized a field-based instrument to collect data related to IT applications that are used as part of the audit process. We provide separate analysis and detail for two specific audit IT applications — workpaper review and group brainstorming. These two audit IT applications are considered evolving technology for communication processes within firms and have been the recent focus of research in the practitioner and academic literature.

The case instrument was completed by 111 auditors representing Big 4, national, regional, and local firms. Our findings indicate that, overall, auditors increased the use of all audit applications we examined as compared to ten years ago, suggesting a potential enhancement to audit quality. Analytical procedures, risk assessment, sampling, internal control evaluation, professional standards research software and electronic workpapers were amongst the most extensively used, whereas use of applications such as continuous transaction monitoring and database modeling was relatively low. On the other hand, use of fraud review, expert systems, and tests of online transactions have experienced the largest increases compared to ten years ago. We also found that risk assessment, tests of online transactions, fraud review, knowledge management systems, and expert systems are the applications

[4] Similar to Janvrin et al. (2008), this research uses the term 'national' although some firms in this category (e.g., RSM, Grant Thornton, and BDO) may have offices located outside the U.S.

that have increased the most in terms of perceived importance over the last decade, signaling the potential for expanded use of these applications across a variety of audit firms in the years to come.

Interestingly, Big 4 auditors were significantly more likely to use IT than non-Big 4 auditors for relatively few audit applications (e.g., internal control evaluation and dashboards), suggesting that the dominance of the Big 4 firms in their use of IT, an area of concern for standards setters in the past, has dwindled over the last ten years. In addition, we find that auditors' use of IT at national firms resembled that of the Big 4 firms, and unlike ten years ago for a few applications (e.g., sampling, and knowledge management systems), auditors from national firms had the highest use and highest perceived importance amongst the different firm size classifications. In contrast, Janvrin et al. (2008) found that auditors' IT use at the national firms was more comparable to that of the Big 4 firms for some applications (sampling, internal control evaluation, fraud review, electronic workpapers) and more comparable to the smaller firms for other applications (audit planning software, audit report writing,) in 2004.

On the other hand, our results indicate that local firms continue to lag on IT use and perceived importance for audit testing, audit completion/report writing, and client administrative /practice management applications. Auditors from local firms also rated a number of applications (e.g., sampling, data mining, fraud review, electronic workpapers, dashboards, and data analytics) as less important than the other firms, so auditors from these firms may not perceive that this places them at a competitive disadvantage, since their clients may not demand this type of IT. Nevertheless, our findings suggest that, for most audit firms other than local firms, IT use now appears to be a widespread component of the audit environment.

Our results also indicate that certain technology applications are beginning to influence the conduct of audits, but this is dependent on firm size as well as how long the application has been available. Collaboration (group) technology is now considered a viable communication mode for workpaper review and group brainstorming, particularly for larger firms that have the necessary

resources to invest (cf., Rosli et al. 2012). However, video conferencing is rarely used by any firms in this regard.

This study provides data on how auditors employed by firms of diverse sizes use audit IT, their perceptions of the importance of audit IT, and how this has changed over the past decade. These findings are important to standards setters, researchers, and practitioners. Our work provides standards setters with information on the extent to which auditors have adopted and are using audit IT, areas where IT could be but generally is not currently used, and differences in IT use and perceived importance across audit firms of different sizes. Further, through the lens of diffusion innovation theory, the study provides evidence to researchers and practitioners that audit IT use and perceived importance varies both by audit firm size and over time. Finally, this research is important because the type of IT auditors use could potentially impact their judgment, which ultimately influences audit quality and effectiveness (Bonner 1999). Of course, future research would be needed to substantiate this. Thus, our results should be of interest to both researchers and practitioners as they work to improve audit quality and effectiveness.

The remainder of the article is organized as follows. In the next section we review the impact of IT on the audit profession and discuss how firm size may be an important factor in this area. Next, we discuss the methodology and present the results of our study. Finally, we discuss the results and offer important implications for future research.

BACKGROUND AND LITERATURE REVIEW

The Impact of IT on the Audit Function

IT has had a major impact on the audit profession over the last several years (Kotb and Roberts 2011; Rosli, Yeow, and Siew 2012; Dowling and Leech 2014). First, firms are increasingly using audit support systems to integrate electronic workpapers, decision aids, and knowledge repositories (Dowling and Leech 2007; Lin and Fan 2011; Carson and Dowling 2012). These systems

operationalize audit firm methodology (Dowling and Leech 2014). Second, IT has had a significant effect on communication processes within firms such as group brainstorming and audit workpaper review (Chen, Trotman, and Zhou 2015). Third, IT-driven audit techniques and tools enable auditors to "drill down" into the underlying details of financial statements (Cao, Chychyla, and Stewart 2015; Dzuranin and Malaescu 2016). In this manner whole populations are often analyzed instead of samples (Titera 2013). Fourth, IT has enabled management and auditors to provide continuous auditing for specific transaction cycles (Byrnes, Ames, Vasarhelyi, and Warren 2012; Perols and Murthy 2012).[5] Fifth, IT impacts the behavior and attitudes of individuals working in firms, as well as firm structure and processes. For example, IT use can reduce the time auditors spend performing automated and/or clerical tasks allowing them more time to spend on riskier, more pressing areas that require greater judgment, potentially improving audit quality (Lombardi et al. 2015). [6]

Audit firms invest in and use IT with the expectation that it will lead to (1) substantial economic benefits (Curtis et al. 2009; Masli, Peters, Richardson, and Sanchez 2010) and (2) significantly improved audit quality, effectiveness, and efficiency (Curtis and Payne 2014; Westermann et al. 2015). To better understand what types of IT are being used by audit firms, we identify and measure current auditor IT use and perceived importance. Few studies have examined audit IT use and perceived importance, especially changes over a ten year period. Moreover, there have been significant changes in IT that limit the extent to which prior findings can be generalized to the current audit environment. We also measure perceived importance of the use of IT.[7] Auditors may not use some types of IT even if they perceive that IT is important (Janvrin et al. 2008). In this manner, auditors may see this measure

[5] While continuous auditing has had some influence on auditing over the last several years, it is not the focus of our study.
[6] However, in this process, IT may also diminish the development of critical thinking, problem-solving skills, and professional skepticism in auditors (Westermann, Bedard, and Earley 2015).
[7] *Audit IT use* refers to the extent auditors employ or use IT throughout the audit process. *Perceived importance of IT use* refers to the degree of importance that auditors attach to the use of IT during the audit process.

as reflecting their expectations of the future use of IT in their audits. Thus, the overarching research questions (RQs) that we examine in this study are:

RQ1a: What types of IT do auditors use most frequently today?
RQ1b: Has the frequency of use of audit IT changed over the past decade?

RQ2a: What types of IT do auditors perceive as being more important today?
RQ2b: Have perceptions of the importance of audit IT changed over the past decade?

Impact of Firm Size on IT Use and Perceived Importance

Firm size varies greatly within the audit profession, from small local one-office firms to large international Big 4 firms (Bills et al. 2016; Keune, Mayhew, and Schmidt 2016). The size of CPA firms may influence the adoption and use of IT on audits. Diffusion innovation theory suggests that innovations, such as new IT, are adopted at different points in time by different groups, approximating a normal distribution (Rogers 2003). These groups consist of innovators, early adopters, early majority, late majority and laggards (or simply early and late adopters) (Agarwal et al. 1998). Over time, adoption often becomes a necessity as the implementation of early adopters is perceived by the market to provide economic benefit and competitive survival (Rogers 1995).

The process of IT adoption is a function of certain characteristics of the adopter groups. Early adopters (as compared to late adopters) are deemed to (1) have more social pressure to obtain an edge on their peers in a competitive environment, (2) have a greater ability to absorb risk, and (3) have greater control over substantial financial resources and related organizational slack to use these resources (Agarwal et al. 1998; Reinking, Arnold, and Sutton 2015; Rogers 1995). We posit that the characteristics of early adopters are aligned with larger public accounting firms (e.g., Big 4 firms). That is, Big 4 firms are in an ultra-competitive environment with a significant market share. Given their size, these firms are in a better position, relative to non-Big 4 firms, to absorb the risk of adopting IT technology. Non-Big 4 firms have greater resources that may enable them to purchase and implement superior IT, and develop their own proprietary IT to a greater extent than do non-Big 4 firms (Riemenschneider, Harrison, and Mykytyn 2003). Furthermore, Big 4 firms' use of IT is likely

to be an indication of having clients with correspondingly greater IT complexity. This may be because of the differences between the size of the clients served by these firm types and their corresponding IT needs.[8] Thus, Big 4 firms are likely to perceive that audit IT applications are more important and vital to their business than do non-Big 4 firms. The early adoption of audit IT applications enables them to service their large clients with high complexity systems and enables them to maintain their technology advantage over non-Big 4 firms, as well as keeping up with their competitors. We also surmise that there may be some discrepancy between IT use and perceived importance between Big 4 and non-Big 4 audit firms that may (1) suggest that barriers to entry exist, and (2) identify areas where non-Big 4 firms may need assistance to be competitive.

Limited research has found that firm size may influence auditors' use of IT applications in their audits (Chang, Chen, Duh, and Li 2011; Buuren, Koch, Amerongen, and Wright. 2014). Of particular relevance to our study, Janvrin et al. (2008) provides an assessment of the extent to which auditors use IT applications and their perceived importance (see Appendix). They found that auditors employed by Big 4 firms are likely to use audit applications and rate their perceived importance higher than auditors from non-Big 4 firms for several applications including audit planning, electronic workpapers, internal control evaluations, and sampling. While Janvrin et al. (2008) provides some initial insights into auditors' IT use, the data were collected in 2004. Therefore, the study's results and corresponding implications may have limited applicability to the current evolving state of auditing.

On the one hand, the perceived gap in IT capabilities between Big 4 and non-Big 4 firms in the past has caught the attention of regulators who were concerned that non-Big 4 firms may not be able to compete with larger firms in terms of IT investment (ACAP 2008; Keune et al. 2016). Recent developments, however, suggest that non-Big 4 firms' IT capabilities may have caught up to the non-Big 4 firms, at least in terms of some audit applications. First, non-Big 4 firms have begun to form

[8] Data collected in this study suggest most integrated and public company audits were performed by auditors from Big 4 and National firms, with a few performed by auditors from regional firms.

associations, networks, and alliances as a means to compete with Big 4 firms in regard to technical accounting associates, national training, and IT resources (Bills et al. 2016).[9] These associations provide member audit firms with an opportunity to overcome many constraints by providing access to intellectual and other resources, including access to IT resources. Second, over the last several years, software (e.g., practice aids, CCH's Knowledge Coach®) has become widely available and more affordable to non-Big 4 firms. Such software is often designed to follow the flow of the typical audit process and contains practice aids that include explanations of, and access to, relevant professional standards. Further, as databases and web platforms have become nimbler, commoditized and cloud-based, non-Big 4 firms can access high tech products at a lower price (Neal 2015). Third, SOX has had the effect of providing growth opportunities to local, regional, and national firms including potentially investments in IT (Dennis 2005; Rozycki 2005). Furthermore, the Big 4 firms have shed some of their smaller and riskier clients, who have turned to non-Big 4 firms to be their auditors (Cheney 2004). The increase in audit clients for non-Big 4 firms should have the effect of narrowing size and resource differences between Big 4 and non-Big 4 firms.

Prior research has shown that auditors employed by Big 4 firms often rate the use and perceived importance of IT higher than those from non-Big 4 firms (Janvrin et al. 2008). This finding is consistent with early adopters as described by diffusion theory. However, diffusion theory also predicts that over time technology laggards will catch up to the early adopters. Recent research suggests that smaller firms have created alliances to make gains that may erode larger firms' technology advantage (Bills et al. 2016). Nevertheless, we predict that auditors from Big 4 firms will continue to use and rate audit

[9] Accounting firm associations are autonomous organizations in which all audit firm members are independent in legal name and structure. Member firms pay annual fees to belong to the association. Access to association resources enables smaller firms to perform high-quality, public company audits (as measured by lower instances of restatements, discretionary accruals and inspections deficiencies), and enables these firms to charge higher audit fees (Bills et al. 2016).

IT as more important given the greater resources they can leverage to maintain a technological advantage. Therefore, our first set of hypotheses are as follows:

H1a: Auditors employed by Big 4 firms will use more audit IT than auditors employed by non-Big 4 firms (i.e., national, regional and local).
H1b: The gap in audit IT use between auditors employed by Big 4 and non-Big 4 firms has closed over the past decade.
H1c: Auditors employed by Big 4 firms will rate the perceived importance of audit IT higher than auditors employed by non-Big 4 firms.
H1d: The gap in audit IT perceived importance between auditors employed by Big 4 and non-Big 4 firms has closed over the past decade.

Impact of IT on Communication Modes for Workpaper Review and Fraud Brainstorming

We also examine how IT may have impacted the communication modes used by two audit applications - workpaper review and group brainstorming.[10] These two applications enable auditors to choose from various communication modes, ranging from no IT (face-to-face) to more involved IT (e.g., video conferencing, collaboration technology). Both of these audit IT applications have received a great deal of attention in the literature (Trotman, Simnett, and Khalifa 2009; Brazel, Carpenter, and Jenkins 2010; Andiola 2014; Bamber, Payne, and Ramsey 2014).

Workpaper Review Communication Modes including IT

The use of IT may facilitate workpaper review. Several recent studies have examined the audit workpaper review process (Andiola 2014). At the outset, research focused on the transition from paper audit files to electronic audit files, by comparing face-to-face to electronic feedback modes.[11] Much of this research examined workpaper reviewers' perceptions of accountability, effort level, effectiveness, and overall review quality (Brazel, Agoglia, and Hatfield 2004; Agoglia, Hatfield, and Brazel 2009; Payne, Ramsay, and Bamber 2010; Bamber, Payne, and Ramsey 2014). The emphasis of this research

[10] Janvrin et al. (2008) examined the influence of IT on performing workpaper reviews, but not on group brainstorming.

[11] Electronic work papers allow supervisors the flexibility to perform electronic review without having to be physically present at a specific client location or time. The electronic review process generally involves the supervisor reviewing work papers online and interacting with the preparer electronically to communicate, discuss, and resolve review notes (Agoglia et al. 2009).

was examining how the *anticipation* of a particular workpaper review mode produced certain levels of personal accountability, leading to different levels of performance (Andiola 2014). The results from this research are mixed as contextual effects and task differences appear to play a role in how participants respond to certain review modes. More importantly, this research focused on the performance of face-to-face and electronic workpaper review communication modes rather than its frequency and use.

In the last several years, as audit group work arrangements have become more globally dispersed, other workpaper feedback modes are becoming more common in the auditing environment such as use of the telephone, video conferencing (Skype), and collaboration (group) technology. Although these modes have not been actively researched as to audit workpaper review, it is reasonable to expect that technology-based communication modes are used more by Big 4 firms than by non-Big 4 firms. Big 4 firms are likely to see these technology-based workpaper review modes as innovations to differentiate themselves from non-Big 4 firms and their competitors. Big 4 firms are also likely to have the financial resources to invest in these newer, more technology-based modes. This leads to the following hypothesis:

> **H2:** Auditors employed by Big 4 firms will use more technology-based communication modes to review audit workpapers than auditors employed by non-Big 4 firms.

Group Brainstorming Communication Modes including IT

IT may also impact communication modes used by auditors during group brainstorming. Statement on Audit Standards (SAS) 99 and International Auditing Standards (ISA) 240 make it mandatory for a brainstorming session to be performed in the planning phase on all audit engagements (Chen et al. 2015). These standards require auditors to brainstorm with team members but leave open the manner and mode in which brainstorming sessions are to be performed (Beasley and Jenkins 2003; Lynch, Murthy, and Engle 2009). It is unclear the extent to which different brainstorming

communication modes are used as well as the effectiveness of these modes to identify fraud risk factors associated with the client (Carpenter 2007).

Since the adoption of SAS 99, research has examined the usefulness of group brainstorming in audit contexts. Initial research (e.g., Carpenter 2007; Hoffman and Zimbelman 2009) provided evidence of the benefits of group brainstorming sessions as compared to individual judgments, as well as the effect of different quality group brainstorming on fraud risk assessments (Trotman, Simnett, and Khalifa 2009; Brazel, Carpenter, and Jenkins 2010). Other studies have progressed to comparing face-to-face brainstorming judgments versus electronic judgments (Lynch et al. 2010; Chen et al. 2015). More recent technological advances include video conferencing (e.g., Skype), collaboration (group technology), as well as other techniques. Given that research on more technology-based group brainstorming modes is scant, it is unclear whether these modes are more effective and/or efficient than a face-to-face mode. Regardless, Big 4 firms as early adopters are anticipated to adopt these technology-based group brainstorming modes more and to use them to a greater extent than non-Big 4 firms. Big 4 firms have the requisite resources and motivation to purchase these modes to maintain and/or keep a competitive edge over non-Big 4 firms and their competitors. This discussion leads to our third hypothesis:

H3: Auditors employed by Big 4 firms will use more technology-based audit brainstorming modes than non-Big 4 firms.

METHOD

Participants

Participants included 111 auditors from Big 4, national, regional, and local firms (see Table 1).[12] We contacted local offices of each Big 4 firm, two national firms, and several regional and local firms across the US. From these offices, we collected data from 85 auditors who completed the survey

[12] As noted in the Appendix, Janvrin et al. (2008) collected data from 181 auditors from Big 4, national, regional, and local firms.

instrument online. In addition, one researcher attended two continuing education conferences co-hosted by a state society of certified public accountants (CPA) and a large university to obtain responses from an additional 26 auditors. These respondents completed the survey instrument in hardcopy. Overall, our participants were from broad geographic areas in the US and represented several regions including the East, Southeast, Midwest, and West.

[INSERT TABLE 1 ABOUT HERE]

As shown in Table 1, participants averaged 9.9 years of external audit experience..[13] Most participants (74 percent) held CPA certificates. The majority of the participants (59 percent) were male. Participants worked for a variety of firms; 34 percent of participants were employed at Big 4 firms, 24 percent by national firms, 19 percent at regional firms, and 23 percent at local firms. Thirty-seven percent indicated that their highest educational level was a master's degree; 63% stated that they only had a bachelor's degree. Seventy-four percent of respondents were CPAs. Participants varied in self-identified IT expertise with 62 percent indicating intermediate IT expertise, 18 percent stating they were IT novices, and 20 percent indicating they were IT experts (Mackay and Lamb 1991).[14]

Instrument Development and Validation

Pilot Testing

We collected the study data in 2014 using the same instrument that was used to collect data in 2004 (Janvrin et al. 2008) (see Appendix). The most significant change to the original instrument involved adding new questions related to fraud brainstorming. To increase construct validity, we conducted two rounds of pilot testing. Four researchers with significant auditing and information systems knowledge examined the instrument. We then pilot tested the revised instrument with eight

[13] We grouped age into six categories (i.e., < 25, 25-30, 31-40, 41-50, 51-60, and over 60). The most common category was 25-30 years old. In the 2004 survey (Janvrin et al. 2008), we asked participants to indicate a specific age.

[14] It is important to note that the demographics of participants in the current study are similar to the demographics reflected in the 2004 data (Janvrin et al. 2008) with regards to the distribution of responses across firm size, IT expertise, and audit experience (see Appendix).

auditors from four firms (Big 4, national, regional, and local firms) who had an average of 4.5 years of experience.[15] Based on pilot testing, we revised the wording of some audit applications, verified that participants were able to consistently define each IT, and confirmed that participants correctly interpreted the wording of the frequency and extent of the IT specialist question.

Categories of Audit IT

We designed our instrument to elicit responses regarding a wide variety of audit IT. We propose that audit IT encompasses IT used as part of audit applications, workpaper review and group brainstorming. Given that workpaper review and group brainstorming may involve multiple modes of communication, we asked for the frequency of use of each communication mode. Thus results for these audit IT are presented separately.

Audit applications. We used the term *audit applications* to describe tasks related to the audit program. We reviewed prior literature and held discussions with practitioners and researchers to identify 22 audit applications. These applications include for example, analytical procedures (Messier, Simon, and Smith 2013), internal control evaluations (Asare, Fitzgerald, Graham, Joe, Negangard, and Wolfe 2013), and sampling (Durney, Elder, and Glover 2013). They also included recent applications such as those developed to assist with audit tasks; for example, fraud review (Trompeter, Carpenter, Desai, Jones, and Riley 2013), interactive data visualizations (Dilla, Janvrin, and Raschke 2010), and administrative/practice management tasks such as knowledge management (Lin and Fan 2011). We grouped the audit applications according to audit task functions (client acceptance and audit planning, audit testing, audit completion and report writing, and administrative/practice management).

[15] Pilot testing provided us feedback on two specific instrument design issues. First, we considered developing a specific audit scenario in which we could ask respondents to indicate their extent of IT use regarding that scenario. Interestingly, discussions with pilot study participants questioned the value of this approach since their responses would be to a fictitious scenario that some would not be familiar with. Second, we considered asking participants to select one specific audit and indicate if they used each audit application and productivity tool in that *selected* audit. However, since the use of IT is widespread across organizations in the US, we elected to ask participants to indicate if they used each audit application and productivity tool in a *typical* audit.

For each audit application, respondents indicated (1) the *extent of use* on a typical audit using a seven-point scale where 1 = none and 7 = extensive, and (2) the *perceived importance* for a typical audit using a seven-point scale where 1 = not important and 7 = very important.[16] Several prior information systems studies use *extent of use* to represent the IT use theoretical construct (Straub, Limayem, and Karahanna 1995; Venkatesh, Morris, Davis, and Davis 2003). Data on perceived importance were collected from auditors to measure differences in perceived importance between various applications and tools (see Sprinkle and Tubbs 1998).

Workpaper review communication modes including IT. We examined the extent of use of six modes of communication when reviewing workpapers: electronic (reviewer evaluates electronic workpapers and emails feedback to preparer), face-to-face, telephone (feedback provided via phone conversation and voice mail messages), video conferencing (e.g., Skype), collaboration (group) technology, and other (Agoglia et al. 2009; Andiola 2014). Participants were asked to estimate how frequently (0% to 100%) they use each of the communication modes when conducting a typical audit workpaper review (e.g., between staff and senior, or senior and manager, etc.).

Group brainstorming. We identified the following group brainstorming communication modes: email, face-to-face, video conferencing (e.g., Skype), collaboration (group) technology, and other (Beasley and Jenkins 2003; Lynch et al. 2009). Participants were asked to estimate how frequently (0-100%) they use each of these group brainstorming modes for planning and risk assessment (including fraud assessment).

Firm Size

[16] In order to be consistent with prior research (e.g., Fischer 1996; Curtis and Payne 2008; Omoteso, Patel, and Scott 2010; Kotb and Roberts 2011; Stoel, Havelka, and Merhout 2012; Ahmi and Kent 2013; Bachlechner, Thalmann, and Manhart 2014; Curtis and Payne 2014; Mazza et al 2014), we measured the impact of IT at the individual level. Measuring IT at the firm level is very difficult and in many cases not possible as firms often do not allow non-firm personnel access to their audit manuals and key personnel. An advantage of our approach is that we can assess the IT auditors actually use, instead of inferring this from firm policy data.

To collect firm size information, each respondent indicated whether he or she was currently employed by a Big 4, national, regional, or local firm. Prior research generally compares data from Big 4 firms to non-Big 4 firms (e.g., Bills et al. 2016). While it is commonly known that Big 4 firms have made significant investments in IT (early adopters), less descriptive research exists that documents use of IT procedures by non-Big 4 firms (Chang et al. 2011; Rosli et al. 2012). In addition, very little research has addressed the extent to which 'second tier' or national firms use computer-related audit procedures despite the fact that these firms have many SEC clients (Dey and Robin 2011). Thus, we chose to compare IT use and perceived importance between (1) Big 4 and non-Big 4 firms, (2) Big 4 and national firms, (3) national and smaller firms (regional and local), (4) larger firms (Big 4 and national) and smaller firms (regional and local), (5) regional firms and local firms, and (6) local firms and all other firms.

RESULTS

Use and Perceived Importance of Audit IT Applications (RQ1 & RQ2)

RQ1 examines how frequently auditors use IT (RQ1a) and whether this frequency has changed over the past decade (RQ1b). RQ2 explores the types of IT that auditors perceive to be important (RQ2a) and whether the perceived importance has changed over the past decade (RQ2b). As shown in Table 2, there is a wide dispersion in audit application use. Descriptive statistics indicate that respondents rated (in descending order) electronic workpapers, internal control documentation, sampling, risk assessment, professional standards research software, internal control evaluation, fraud review, and analytical procedures as having the highest extent of use (means ranged from 6.45 - 5.38 on a seven-point scale). Other applications (in descending order), including client acceptance, audit planning software, audit report writing, and data analytics, were rated as next highest in use (5.04 - 4.71). The extent of use of applications (in descending order) such as continuous transaction monitoring, and database modeling had the lowest ratings (2.91 - 2.59). It is important to note that, with the exception of audit report writing, use of *all* of the applications increased as compared to the

2004 data, with fraud review, expert systems, and tests of online transactions having the largest increases.

[INSERT TABLE 2 ABOUT HERE]

Table 2 also demonstrates wide dispersion in perceived importance. The highest perceived levels of importance were similar to the ratings for extent of use and consisted of (in descending order) electronic workpapers, internal control documentation, risk assessment, fraud review, sampling, professional standards research software, internal control evaluation, and analytical procedures (6.27 - 5.63). The applications that have increased the most in terms of perceived importance over the last ten years include risk assessment, tests of online transactions, fraud review, knowledge management systems, and expert systems, potentially signaling growth in their use in the future.

The Association of Firm Size with Audit Application Use and Perceived Importance (H1)

We ran two sets of ANCOVA tests.[17] First, we present ANCOVA tests with firm size as the independent variable and participant experience serving as a covariate for the data collected in 2014.[18] For audit applications that were found to vary by firm size, we subsequently conducted Scheffe post hoc comparisons to test H1a and H1c. Second, we ran ANCOVA tests with firm size, year of data collection, and firm size by year interaction with participant experience as a covariate combining the 2014 and 2004 data into one data set. For audit applications with significant firm size by year interactions, we also conducted Scheffe post hoc comparisons to test H1b and H1d. For ease of exposition, we chose to include significance levels in the corresponding tables rather than the text.

H1 posits that auditors employed by Big 4 firms will use more audit IT (H1a) and perceive its importance to be higher than auditors employed by non-Big 4 firms (H1c). Further H1b posits that the

[17] We ran the ANCOVA tests using weighted least squares regression to account for differences in firm size sample cells.
[18] Results are qualitatively similar when the seven auditors with less than one year of experience are removed from the sample.

gap between audit IT use by auditors employed by Big 4 and non-Big 4 firms has closed over the past decade. As shown in Table 3, ANCOVA results suggest that firm size is associated with auditors' use for several audit applications. Post-hoc comparisons to determine specific differences across firms indicate that Big 4 auditors were significantly more likely to use IT than non-Big 4 auditors for just one client acceptance/audit planning application (analytical review), none of the audit testing applications, none of the audit completion applications, and two of the administrative/practice management applications (dashboards/interactive data visualizations and electronic workpapers). Thus, in general, H1a is not supported. Furthermore, non-Big 4 auditors were significantly more likely to use analytical review tools than Big 4 auditors. Thus, the dominance of the Big 4 firms in their use of IT has dwindled over the last ten years, consistent with diffusion theory (early adopters). This supports H1b.

[INSERT TABLE 3 ABOUT HERE]

As shown in Table 4, Big 4 auditors were significantly more likely to rate the perceived importance of only one client acceptance/audit planning application (client acceptance), none of the audit testing applications, none of the audit completion applications, and only one administrative/practice management application (dashboards/interactive data visualizations) higher than non-Big 4 auditors. Therefore, H1c is not supported.

[INSERT TABLE 4 ABOUT HERE]

We also found that, with the exception of risk assessment, the use of audit IT applications by national firms was not significantly different from that of Big 4 firms. In fact, for a few applications (audit planning software, sampling, knowledge management systems, and expert systems), auditors from national firms appear to have the highest use and highest perceived importance amongst the different firm size classifications. This is contrasted with the 2004 data in which the national firms were more comparable to the Big 4 firms for certain applications and more comparable to the smaller firms for other applications (Janvrin et al. 2008).

While national firms, and to a lesser extent regional firms, have caught up to the Big 4 firms on numerous IT applications, providing some support for H1d, local firms have continued to lag on IT use and perceived importance for audit testing, audit completion/report writing, and administrative /practice management applications. In fact, for several applications (e.g., risk assessment, client acceptance, sampling, electronic workpapers, expert systems, dashboards and data analytics), auditors from local firms had significantly lower use and perceived importance than the other firm classifications. We note that it is not necessarily a lack of resources that may be driving these results as auditors from local firms do not perceive these IT applications to be as important to their businesses and clients. However, these results are also consistent with diffusion theory, in that we would expect local firms to be laggards given their resource constraints. Overall, these mixed findings provide partial support for H1d.

Workpaper Review Communication Modes including IT (H2)

The results reveal that the most common mode of communication for workpaper review is face-to-face (53.32%), followed by e-mail (41.44%), collaboration (group) technology (40.45%), and then the use of the telephone (20.36%) (see Table 5). It is important to note that video conferencing (e.g., Skype) is rarely being used (1.83%). When comparing communication modes to the 2004 data, it is clear that face-to-face communication has dropped somewhat (60.87% to 53.32%), email use (27.69% to 41.44%) and telephone use (9.97% to 20.36%) has increased, and collaboration (group) technology has now become a viable communication mode.

[INSERT TABLE 5 ABOUT HERE]

Overall, we find that auditors employed by Big 4 firms use more technology-based communication modes to review audit workpapers than those employed by non-Big 4 firms, as purported in H2. Results reveal that firm size is associated with telephone and collaboration communication modes with the smaller firms using these modes significantly less than the larger firms.

Big 4 auditors' most common mode of communication for workpaper review is as follows: email (59.19%), collaboration (group) technology (52.12%), face-to-face (46.22%), and telephone (23.89%). This distribution for email, face-to-face, and telephone is very similar to the 2004 data. Auditors from national firms currently have similar results to Big 4 auditors, with slightly more emphasis on face-to-face communication and slightly less communication via email. As compared to the 2004 data, auditors from national firms are now using email and the telephone more in their workpaper review communications. Auditors from regional firms have somewhat similar rankings of communication mode use as auditors from national firms, but are less likely to use each of the communication modes available. Over the ten-year period, auditors from regional firms have changed some of their communication mode use from face-to-face to collaboration (group) technology, to email and the telephone. Finally, auditors from local firms primarily use face-to-face (67.80) and email (25.40%) communication modes, with little change from 2004.

Group Brainstorming (H3)

As shown in Table 6, various group brainstorming modes were used by the respondents. The most common group brainstorming mode reported was face-to-face (87.29%) followed by email (40.50%), collaboration (group) technology (35.10%), and video conferencing (6.32%). These results are similar to the results for communication mode for workpaper review in terms of having a strong emphasis on face-to-face communication, a similar rank order of modes, and very little emphasis on video conferencing (e.g., Skype, Google hangout).[19]

[INSERT TABLE 6 ABOUT HERE]

H3 posits that auditors employed by Big 4 firms will use more technology-based audit brainstorming modes than those employed by non-Big 4 firms. In examining the association of group brainstorming with firm size, we find that Big 4 auditors used face-to-face (85.84%) the most. Email

[19] We were not able to compare the current group brainstorming data with the 2004 data as it was not collected previously.

(61.81%) and collaboration (group) technology (46.32%) are also being used to a large extent. It appears that Big 4 firms emphasize face-to-face communication more for brainstorming as opposed to workpaper review where email was a popular choice. Video conferencing is also used to a limited extent (14.22%). The responses of auditors from national firms are similar to those of the Big 4 auditors, with the exception of using email much less than the Big 4 auditors. The results for auditors from regional firms are also very similar to the Big 4 firm results, except for their decreased use of collaboration (group) technology and email. Finally, auditors from local firms almost exclusively use face-to-face group brainstorming with few efforts to use technology in this regard. These findings are somewhat consistent with the diffusion theory prediction (and H3) that the Big 4 firms would be early adopters of technology in group brainstorming, with other firms (laggards) catching up over time at differential rates.

CONCLUSIONS, IMPLICATIONS, AND FUTURE RESEARCH

Although IT has significantly changed the audit environment over the last several years, few studies have examined and documented audit IT use longitudinally. This is somewhat surprising given the influence of IT on the manner in which audits are performed and the potential for significant improvements to audit quality, effectiveness, and efficiency (Bedard, Deis, Curtis, Jenkins 2008; Curtis et al. 2009; Curtis and Payne 2014; Lombardi et al. 2015; Westermann et al. 2015). To provide important insights into the changes in IT over the last ten years, our descriptive study examines audit IT use and perceived importance in the current audit environment and compares our results to data collected in 2004 (see Janvrin et al. 2008). Furthermore, we analyze this data across a diverse group of audit firms including Big 4, national, regional, and local firms.

Overall, auditors increased the use of all of the applications we examined as compared to ten years ago, suggesting potential improvements to audit effectiveness and efficiency. Analytical procedures, risk assessment, sampling, internal control evaluation, internal control documentation, professional standards research software and electronic workpapers were amongst the most extensively

used, whereas use of applications such as continuous transaction monitoring and database modeling were relatively low. Future research could examine if use of these applications continues to grow over time, as many of them were rated as relatively important, perhaps leading to additional gains in audit effectiveness and efficiency. Fraud review, expert systems, and tests of online transactions had the largest increases of any application, suggesting potential improvements to audit quality in high risks areas. Further, risk assessment, test of online transactions, fraud review, knowledge management systems, and expert systems are the applications that have increased the most in terms of perceived importance over the last decade.

Auditors from Big 4 firms were significantly more likely to use IT than non-Big 4 auditors for relatively few audit applications (e.g., internal control evaluation and dashboards), suggesting that the dominance of the Big 4 firms in their use of IT has dwindled over the last ten years, consistent with the early majority phase of diffusion innovation theory. Although this has been an area of concern for standards setters in the past, our results suggest it may be less so in the current audit environment. In addition, the use of audit IT applications of national firms resembled those of the Big 4 firms, and for a few applications (e.g., sampling, and knowledge management systems), national firms had the highest use and highest perceived importance amongst the different firm size classifications, in contrast with the 2004 data in which the national firms were more comparable to the Big 4 firms for certain applications and more comparable to the smaller firms for other applications. On the other hand, local firms continue to lag on IT use and perceived importance for audit testing, audit completion/report writing, and administrative /practice management applications. There were several applications (e.g., sampling, data mining, fraud review, electronic workpapers, dashboards, and data analytics) where local firms had significantly lower use than the other firm classifications, consistent with diffusion theory laggards. However, local firms also tended to rate these applications as less important, so it is unclear whether or not this places them at a competitive disadvantage when compared to larger firms, since their clients may currently not demand these types of applications. On the other hand, it appears

that for all but the smallest of audit firms, IT use is now prevalent in the audit environment across a wide variety of applications. Future research is needed to investigate to what extent local firms may now be at a competitive disadvantage compared to larger firms.

In terms of workpaper review, the most common mode of communication is still face-to-face (although this has decreased over the last decade), followed by e-mail, collaboration (group) technology, telephone, and the rare use of video conferencing. The Big 4 firms continue to favor email (consistent with the 2004 data), and national firms have gravitated toward the use of email and the telephone more over time. Regional firms have somewhat similar rankings of communication use as national firms, but are less likely to use each of the communication modes available, and local firms primarily use face-to-face communication. This may also be a potential area of concern for standards setters, since prior research has suggested that face to face communication leads to the strongest feelings of accountability and the most thorough extent of workpaper documentation (Agoglia et al. 2009).

The most common group brainstorming modes was similar to that of the communication mode for workpaper review with a strong emphasis on face-to-face communication, a similar rank order of modes, and very little emphasis on video conferencing. There were also some distinctions amongst the different sized audit firms for fraud brainstorming. Big 4 firms used face-to-face communication the most often, with email and collaboration (group) technology also being used to a large extent. It appears that Big 4 firms emphasize face-to-face communication more for brainstorming as compared to workpaper review where email was a popular choice. Future research could examine if this is because brainstorming is viewed as a high risk area, or email does not facilitate brainstorming as well as face-to-face interactions, or both. The national firm results are similar to those of the Big 4 firms with the exception of using email much less than the Big 4 firms; the regional firm results were also very similar to the Big 4 firm results except for their decreased use of collaboration (group) technology. Local firms

almost exclusively use face-to-face group brainstorming, perhaps because they have fewer geographically dispersed work arrangements compared to larger firms.

Our results should be interpreted in light of several limitations. First, due to data availability limitations, we use auditor IT use and perceived importance to proxy for audit firm IT adoption. Obtaining audit firm level IT investment information would improve the extent to which our results can be generalized to practice, but this data may be difficult to obtain. Second, we did not measure perceived importance of IT for workpaper review and group brainstorming, since we were more concerned with how IT was impacted the communication modes used for these two audit processes. Third, we cannot ascertain that our sample is representative of auditors employed by Big 4, national, regional and local firms. To the extent that respondents who completed our survey differ from the overall population, our findings may not be generalizable. However, we were able to obtain responses from auditors across a wide variety of geographic regions in the U.S., including the East, Southeast, Midwest, and West. Fourth, to obtain data from a wide variety of firms, we collected data at the individual level, consistent with prior research (Bierstaker and Wright 2004; Janvrin et al. 2008). Future research using firm level data is needed to confirm our findings, however, collecting individual data allows us to assess the IT auditors actually use, instead of inferring this from a small sample of firm policy data. Fifth, our respondents did not identify whether audit application and productivity tool use was mandatory or voluntary, but they did indicate some latitude in terms of which applications they chose to use. Additional research could investigate whether our findings would differ in purely voluntary versus mandatory use settings. Finally, we did not capture participants' prior work experience at other audit firms. This variable could be utilized as a control variable in future research and could offer additional insights.

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TABLE 1
Participant Demographics n = 111

	Mean	Std. Dev.
Years as an external auditor[a]	9.9	9.6
	Frequencies	**Percent**
Age		
< 25	20	17.9%
25 - 30	38	33.9%
31 - 40	26	23.2%
41 - 50	13	11.6%
51 - 60	11	9.8%
> 60	4	3.6%
Highest education level		
Bachelor degree	70	62.5%
Master degree	41	36.1%
Coursework beyond master degree	1	0.9%
Certification[a, b]		
Certified internal auditor	3	
Certified public accountant	82	
Certified information systems auditor	10	
Certified management accountant	1	
Certified fraud executive	2	
Certified financial planner	0	
Other certification	27	
Gender[a]	M = 66	59.5%
	F = 45	40.5%
Firm size[a]		
Big 4	37	33.6%
National	27	24.5%
Regional	21	19.1%
Local	25	22.7%
IT expertise[a]		
Novice	20	18.2%
Intermediate	68	61.8%
Expert	22	20.0%

[a] One or more participants did not answer question.
[b] Participants could list more than one certification

TABLE 2
Use and Perceived Importance of Information Technology Audit Applications – 2014 and 2004
Means (Std. Deviations)

Audit Application	2014 (n=111) Extent of Use (Std. Dev.)	2004 (n=181) Extent of Use[a] (Std. Dev.)		2014 Level of Importance (Std. Dev.)	2004 Level of Importance[b] (Std. Dev.)	
Panel A: Client Acceptance and Audit Planning						
Analytical procedures / financial ratio tools	5.38 (1.54)	5.06 (1.63)	*[c]	5.63 (1.40)	5.50 (1.36)	
Internet search tools	N/A	4.60 (1.84)		N/A	4.75 (1.87)	
Audit planning software	4.90 (2.02)	4.20 (2.33)	**	5.12 (1.86)	4.99 (2.01)	
Risk assessment	5.92 (1.54)	4.09 (2.33)	**	6.16 (1.33)	4.73 (2.28)	**
Client acceptance	5.04 (1.89)	3.58 (2.41)	**	5.38 (1.62)	4.45 (2.22)	**
Panel B: Audit Testing						
Sampling	6.00 (1.42)	4.53 (2.07)	**	5.98 (1.40)	4.91 (2.05)	**
Internal control evaluation	5.45 (1.90)	3.90 (2.36)	**	5.73 (1.75)	4.77 (2.30)	**
Internal control documentation	6.05 (1.25)	N/A		6.17 (1.22)	N/A	
Data mining	3.55 (2.07)	2.60 (1.93)	**	4.14 (1.93)	3.82 (2.16)	
Continuous transaction monitoring	2.91 (1.99)	1.90 (1.56)	**	3.75 (1.94)	2.92 (1.97)	**
Test of online transactions	3.92 (1.98)	1.87 (1.63)	**	4.44 (1.93)	2.61 (2.16)	**
Database modeling	2.59 (1.71)	1.85 (1.51)	**	3.23 (1.74)	2.62 (1.75)	**
Digital analysis	N/A	1.67 (1.37)		N/A	2.31 (1.70)	
Panel C: Audit Completion and Report Writing						
Audit report writing	4.71 (2.03)	4.55 (2.28)		5.17 (1.86)	5.05 (2.00)	
Fraud review	5.43 (1.78)	2.83 (2.02)	**	6.05 (1.47)	4.18 (2.29)	**

TABLE 2 (continued)
Use and Perceived Importance of Information Technology Audit Applications – 2014 and 2004
Means (Std. Deviations)

Audit Application	2014 (n=111) Extent of Use (Std. Dev.)	2004 (n=181) Extent of Use[a] (Std. Dev.)		2014 Level of Importance (Std. Dev.)	2004 Level of Importance[b] (Std. Dev.)	
Panel D: Administrative/Practice Management						
Electronic workpapers	6.45 (1.55)	5.39 (2.11)	**[c]	6.27 (1.53)	5.79 (1.74)	*
Graphs	N/A	2.69 (1.59)		N/A	2.92 (1.73)	
Knowledge management systems	4.01 (2.01)	2.45 (2.01)	**	4.53 (1.87)	2.97 (2.34)	**
Expert systems	3.48 (2.02)	1.64 (1.43)	**	3.95 (1.93)	2.19 (1.90)	**
Professional standards research software	5.72 (1.36)	N/A		5.97 (1.24)	N/A	
Dashboards / interactive data visualizations	3.51 (1.93)	N/A		3.42 (2.09)	N/A	
Data analytics	4.71 (1.88)	N/A		4.99 (1.76)	N/A	

[a] Participants were asked to rate "the extent of use for each audit application on a typical audit" using a seven-point scale with 1 = *none* and 7 = *extensive*.

[b] Participants were asked to rate "the importance of each audit application for a typical audit" using a seven-point scale with 1= *not important* and 7 = *very important*.

[c] ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level for one-tailed t-test examining whether 2014 mean is higher than the 2004 mean.

TABLE 3
Means and ANCOVA Results Examining the Association of Firm Size and Year with Audit Application Use – 2014 and 2004

	Audit Application Use[a]				Firm Size		Year	Firm Size by Year Interaction	
	Big 4	National	Regional	Local	ANCOVA1[b]	Scheffe[c]	ANCOVA2[d]	ANCOVA2[e]	Scheffe[f]
Panel A: Client Acceptance and Audit Planning									
Analytical procedures/ financial ratio tools	4.97 *4.76[g]*	5.26 *4.97*	6.18 *4.54*	5.36 *5.55*	2.56*	*A *D	6.13**	3.51*`	*H
Audit planning software	4.76 *4.96*	5.63 *3.97*	4.91 *3.38*	4.24 *3.97*	2.35*	*C *F	8.77**	3.00*	
Risk assessment	5.51 *4.70*	6.48 *4.26*	6.62 *3.50*	5.40 *3.88*	4.09**	*B *E **F	56.56**	3.71*	*H
Client acceptance	4.59 *3.89*	5.44 *3.63*	5.68 *2.77*	4.60 *3.68*	2.36* [h]	*E *F	32.43**	3.03*	
Panel B: Audit Testing									
Sampling	6.16 *5.06*	6.63 *5.42*	6.29 *3.54*	4.80 *4.17*	6.14**	*C *D **E **F	42.61**	3.74*	*K
Internal control evaluation	6.24 *4.94*	5.63 *4.35*	4.71 *2.73*	4.64 *3.42*			30.64**		
Internal control documentation	6.30	6.15	6.14	5.44			N/A		

TABLE 3 (continued)
Means and ANCOVA Results Examining the Association of Firm Size and Year with Audit Application Use – 2014 and 2004

	Audit Application Use[a]				Firm Size		Year	Firm Size by Year Interaction	
	Big 4	National	Regional	Local	ANCOVA1[b]	Scheffe[c]	ANCOVA2[d]	ANCOVA2[e]	Scheffe[f]
Panel B: Audit Testing (continued)									
Data mining	3.59 *2.04*[g]	4.00 *2.16*	4.19 *1.50*	2.56 *1.53*	2.74*	*E **F	17.35**		
Continuous transaction monitoring	3.30 *2.13*	2.81 *2.03*	3.00 *1.35*	2.32 *1.72*			23.98**		
Test of online transactions	4.14 *2.70*	4.00 *1.84*	3.81 *1.42*	3.60 *1.31*			92.62**		
Database modeling	2.68 *2.04*	3.04 *2.16*	2.52 *1.50*	2.12 *1.53*			16.11**		
Panel C: Audit Completion and Report Writing									
Audit report writing	4.38 *3.55*	4.52 *4.84*	5.14 *4.65*	5.08 *5.37*					
Fraud review	5.43 *3.43*	5.85 *3.43*	5.90 *1.92*	4.52 *2.38*	2.66*	**E **F	127.48**	3.30*	*H
Panel D: Administrative/Practice Management									
Electronic workpapers	6.73 *6.77*	6.93 *6.23*	7.00 *4.12*	5.04 *4.39*	7.42**	*A *C **D **E **F	25.38**	8.20**	**H *J **K
Knowledge management systems	3.84 *3.91*	5.04 *2.39*	3.95 *1.31*	3.08 *1.80*	3.59**	*C *F	50.18**	8.89**	**G **H
Expert systems	3.84 *2.27*	4.00 *1.93*	3.48 *1.19*	2.36 *1.20*	2.87*[h]	*F	74.94**		

TABLE 3 (continued)
Means and ANCOVA Results Examining the Association of Firm Size and Year with Audit Application Use – 2014 and 2004

	Audit Application Use[a]				Firm Size		Year	Firm Size by Year Interaction	
	Big 4	National	Regional	Local	ANCOVA1[b]	Scheffe[c]	ANCOVA2[d]	ANCOVA2[e]	Scheffe[f]
Panel D: Administrative/Practice Management (continued)									
Professional standards research software	5.43	6.04	5.86	5.64			N/A		
Dashboards / interactive data visualizations	4.43	3.59	3.38	2.16	5.61**[h]	**A *D *E **F	N/A		
Data analytics	5.14	4.44	5.67	3.60	4.02**	**E **F	N/A		

[a] Participants were asked to rate "the extent of use for each audit application on a typical audit" using a seven-point scale with 1 = *none* and 7 = *extensive*.

[b] ANCOVA1 results for use rating differ based on firm size where F value is reported for firm size (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level. F-values are not reported when firm size (variable of interest) is not significant. We included experience as a covariate in these ANCOVAs.

[c] Scheffe results for use rating differ based on (A) differences between Big 4 and non-Big 4 firms, (B) differences between Big 4 and national firms, (C) differences between national and smaller (regional and local) firms, (D) differences between the larger firms (Big 4 and national) and smaller (regional and local), (E) regional and local firms, and (F) local vs. all other firms where ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[d] ANCOVA2 results for use rating differ based on year where F value is reported for year (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[e] ANCOVA2 results for use rating differ based on firm size by year interaction where F value is reported for firm size by year interaction (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[c] Scheffe results for use rating differ based on (G) differences between Big 4 and national firms in 2014 compared to 2004, (H) differences between Big 4 and regional firms in 2014 compared to 2004, (I) differences between Big 4 and local firms in 2014 compared to 2004, (J) differences between national and local firms in 2014 compared to 2004, and (K) differences between regional and local firms in 2014 compared to 2004 where ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[g] Italicized numbers represent 2004 data.

[h] Experience covariate, in addition to firm size, is significant at the p =< 0.05 level.

TABLE 4
Means and ANCOVA Results Examining the Association of Firm Size and Year with Audit Application Perceived Importance – 2014 and 2004

	Perceived Importance[a]				Firm Size		Year	Firm Size by Year Interaction	
	Big 4	National	Regional	Local	ANCOVA1[b]	Scheffe[c]	ANCOVA2[d]	ANCOVA2[e]	Scheffe[f]
Panel A: Client Acceptance and Audit Planning									
Analytical procedures/ financial ratio tools	5.41 *5.22*[g]	5.44 *5.47*	6.14 *5.42*	5.68 *5.82*					
Audit planning software	5.22 *5.36*	5.70 *4.72*	4.82 *4.42*	4.52 *5.03*					
Risk assessment	6.03 *5.54*	6.67 *4.93*	6.57 *3.69*	5.42 *4.51*	3.86*	**E **F	39.13**	4.54**	**H **K
Client acceptance	5.51 *5.27*	5.96 *4.30*	5.68 *3.46*	4.20 *4.35*	6.61**[h]	*A **C **D **E **F	16.50**	5.12**	*H
Panel B: Audit Testing									
Sampling	6.14 *5.57*	6.67 *5.77*	6.05 *3.73*	4.88 *4.52*	5.39**	*C *D *E **F	23.38**	3.65*	*K
Internal control evaluation	6.30 *5.76*	5.96 *4.94*	5.38 *3.88*	4.88 *4.35*			12.50**		
Internal control documentation	6.43	6.15	6.43	5.56	2.37*	*E *F	N/A		

TABLE 4 (continued)
Means and ANCOVA Results Examining the Association of Firm Size and Year with Audit Application Perceived Importance – 2014 and 2004

	Perceived Importance[a]				Firm Size		Year	Firm Size by Year Interaction	
	Big 4	National	Regional	Local	ANCOVA1[b]	Scheffe[c]	ANCOVA2[d]	ANCOVA2[e]	Scheffe
Panel B: Audit Testing (continued)									
Data mining	4.43	4.26	4.43	3.24			17.35**		
	2.59	*2.96*	*2.13*	*2.58*					
Continuous transaction monitoring	4.27	3.67	3.73	2.96			10.52**		
	3.14	*3.04*	*2.35*	*2.85*					
Test of online transactions	4.57	4.59	4.71	3.71			50.01**		
	3.89	*2.90*	*2.07*	*1.84*					
Database modeling	3.57	3.41	2.90	2.80			7.29**		
	2.59	*2.96*	*2.13*	*2.58*					
Panel C: Audit Completion and Report Writing									
Audit report writing	5.19	5.26	5.27	5.00					
	4.44	*5.31*	*5.46*	*5.41*					
Fraud review	6.08	6.15	6.57	5.38			57.07**		
	4.78	*4.47*	*3.42*	*3.92*					
Panel D: Administrative/Practice Management									
Electronic workpapers	6.35	6.81	6.90	5.00	6.83**	*C *D **E	7.25**	6.23**	**H
	6.62	*6.17*	*4.96*	*5.22*		**F			**K
Knowledge management systems	4.11	5.59	4.33	4.00	3.96**	**B	35.02**	6.90**	G**H*I*
	4.35	*2.94*	*2.31*	*2.26*		*C			
Expert systems	4.24	4.44	3.81	2.92	2.17*	*F	48.46**		
	3.00	*2.40*	*1.70*	*1.73*					

TABLE 4 (continued)
Means and ANCOVA Results Examining the Association of Firm Size and Year with Audit Application Perceived Importance – 2014 and 2004

	Perceived Importance[a]				Firm Size		Year	Firm Size by Year Interaction	
	Big 4	National	Regional	Local	ANCOVA1[b]	Scheffe[c]	ANCOVA2[d]	ANCOVA2[e]	Scheffe[f]
Panel D: Administrative/Practice Management (continued)									
Professional standards research software	5.68	6.26	6.33	5.76			N/A		
Dashboards / interactive data visualizations	4.59	3.59	3.10	1.88	3.32**	**A *C **D *E **F	N/A		
Data analytics	5.54	4.70	5.52	3.96	3.41**	**E **F	N/A		

[a] Participants were asked to rate "the importance of each audit application for a typical audit" using a seven-point scale with 1 = *not important* and 7 = *very important*.

[b] ANCOVA1 results for perceived importance rating differ based on firm size where F value is reported for firm size (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level. F-values are not reported when firm size (variable of interest) is not significant. We included experience as a covariate in these ANCOVAs.

[c] Scheffe results for perceived importance rating differ based on (A) differences between Big 4 and non-Big 4 firms, (B) differences between Big 4 and national firms, (C) differences between national and smaller (regional and local) firms, (D) differences between the larger firms (Big 4 and national) and smaller (regional and local), (E) regional and local firms, and (F) local vs. all other firms where ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[d] ANCOVA2 results for use rating differ based on year where F value is reported for year (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[e] ANCOVA2 results for perceived importance rating differ based on firm size by year interaction where F value is reported for firm size by year interaction (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[f] Scheffe results for perceived importance rating differ based on (G) differences between Big 4 and national firms in 2014 compared to 2004, (H) differences between Big 4 and regional firms in 2014 compared to 2004, (I) differences between Big 4 and local firms in 2014 compared to 2004, (J) differences between national and local firms in 2014 compared to 2004, and (K) differences between regional and local firms in 2014 compared to 2004 where ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[g] Italicized numbers represent 2004 data.

[h] Experience covariate, in addition to firm size, is significant at the p =< 0.05 level.

TABLE 5
Frequency of Workpaper Review Mode Use and Its Association to Firm Size – 2014 and 2004 Means and ANCOVA Results

Panel A: 2014 Data

Workpaper Review Mode[a]	Overall	Big 4	National	Regional	Local	ANCOVA[b]	Scheffe [c]
Face-to-face	53.32 (36.59)[d]	46.22 (36.14)	57.78 (33.61)	42.50 (36.26	67.80 (37.94)		
Email[d]	41.44 (39.10)	59.19 (39.10)	42.04 (37.64)	28.10 (36.66)	25.40 (33.82)		
Collaboration(group) technology	40.45 (44.33)	52.12 (45.38)	55.00 (44.47)	37.25 (43.45)	10.63 (27.04)	3.38*	*C **D**F
Telephone	20.36 (27.68)	23.89 (31.56)	29.12 (23.92)	19.75 (29.31)	5.21 (17.16)	3.06*	*C**D *F
Video conferencing[e]	1.83 (10.38)	3.97 (17.40)	1.75 (4.80)	0	0.42 (2.04)		

Panel B: 2004 Data

Workpaper Review Mode[a]	Overall	Big 4	National	Regional	Local	ANCOVA[b]	Scheffe [c]
Face-to-face	60.87 (34.67)[d]	49.87 (35.23)	59.80 (54.66)	65.38 (24.43)	70.75 (7.50)	2.70*	*A
Email	27.69 (34.23)	55.78 (45.54)	24.70 (38.42)	12.88 (11.83)	12.46 (3.20)	17.46**	**A **B
Telephone	9.97 (16.99)	19.00 (19.77)	7.32 (26.35)	3.65 (7.38)	6.09 (0.26)	5.85**	**A *B

[a] Respondents were asked to estimate how frequently (0 to 100 %) each mode was used when conducting a typical audit workpaper review (e.g., between staff and senior, or senior and manager).

[b] ANCOVA results for use rating differ based on firm size where F value is reported for firm size (variable of interest) and ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level. The covariate is participant experience. Note, F values were not reported in Janvrin et al. (2008).

[c] Scheffe results for use differ based on (A) differences between Big 4 and non-Big 4 firms, (B) differences between Big 4 and national firms, and (C) differences between national and smaller (regional and local) firms and (D) differences between the largest firms (Big 4 and national) and smaller (regional and local), (E) regional and local firms, and (F) local vs all other firms where ** indicates p ≤. 0.01 and * indicates p ≤. 0.05 level.

[d] Standard deviations

[e] Video conference includes Skye and Google's Hangout.

TABLE 6
Frequency of Group Brainstorming Use and its Association with Firm Size
Means and ANCOVA Results

Brainstorming Mode[a]	Overall	Big 4	National	Regional	Local	ANCOVA[b]	Scheffe [c]
Face-to-face	87.29 (22.21)[d]	85.84 (22.41)	85.19 (26.76)	95.25 (8.96)	84.80 (23.96)		
Email	40.50 (39.94)	61.81 (38.60)	37.69 (38.76)	33.70 (41.37)	15.80 (22.58)	2.28**	**A*B **D**F
Collaboration (group) technology	35.10 (42.79)	46.32 (44.71)	49.58 (43.93)	28.75 (41.32)	7.29 (21.92)	3.33*	**C **D**F
Video Conferencing[e]	6.32 (17.31)	14.22 (27.51)	4.09 (9.47)	3.86 (6.48)	0		

[a] Respondents were asked to estimate how frequently (0 to 100 %) each mode was used for brainstorming for planning and risk assessment (including fraud assessment).

[b] ANCOVA results for use/perceived importance rating differ based on firm size where F value is reported for firm size (variable of interest) and ** indicates $p \leq .0.01$ and * indicates $p \leq .0.05$ level. The covariate is participant experience.

[c] Scheffe results for use differ based on (A) differences between Big 4 and non-Big 4 firms, (B) differences between Big 4 and national firms, and (C) differences between national and smaller (regional and local) firms and (D) differences between the largest firms (Big 4 and national) and smaller (regional and local), (E) regional and local firms, and (F) local vs all other firms where ** indicates $p \leq .0.01$ and * indicates $p \leq .0.05$ level.

[d] Standard deviation.

[e] Video conferencing includes Skype and Google's Hangout.

APPENDIX
2004 Data

Participants

Participants included 181 auditors from Big 4, national, regional, and local firms (see Table A of the Appendix). One researcher attended the AICPA National Advanced Accounting and Auditing Technical Symposium to obtain responses from 109 auditors. Local offices of each Big 4 firm and one national firm were contacted. From these offices, data was collected from 72 auditors. All responses were collected after SOX.

Instrument Development and Validation

Two rounds of pilot testing were conducted. Four researchers with significant audit and systems knowledge examined the instrument. The revised instrument was then pilot tested with eight auditors from four firms (Big 4, national, regional and local) who had an average of 4.5 years of experience. Based on the pilot testing, the wording of some audit applications were revised. Further, we verified that participants were able to consistently define each IT.

Case Instrument

Audit applications. Audit applications were categorized by audit task functions (e.g., client acceptance and audit planning, audit testing, audit completion and report writing, and administrative/practice management). For each audit application respondents indicated (1) the extent of use on a typical audit, and (2) the perceived importance for a typical audit. Data on perceived importance were collected from auditors to measure differences in perceived importance between various applications and tools. Frequency of use (i.e., how frequently was an IT specialist used during audit engagements over the past year) and extent of use examine use of audit IT specialists.

Workpaper review methodology. Three communication modes for workpaper reviews were assessed: e-mail, face-to-face meetings, and telephone.

TABLE A
2004 Data
Participant Demographics n = 181

	Frequencies	Mean or Percent (Std. Dev.)
Years as an external auditor[a]		12.7 (9.4)
Age		36.5 (10.0)
Highest education level		
Bachelor degree	149	82.8%
Master degree	29	16.1%
Coursework beyond master degree	2	1.1%
Certification[a, b]		
Certified internal auditor	1	
Certified public accountant	156	
Certified information systems auditor	0	
Certified management accountant	1	
Certified fraud executive	8	
Certified financial planner	0	
Other certification	1	
Gender	M = 127	71.0%
	F = 52	29.0%
Firm size[a]		
Big 4	55	31.1%
National	31	17.5%
Regional	26	14.7%
Local	65	36.7%
IT expertise[a]		
Novice	30	16.7%
Intermediate	137	70.5%
Expert	23	12.8%

[a] One or more participants did not answer question.
[b] Participants could list more than one.