The Effects of Computer Assurance Specialist Competence and Auditor AIS Expertise on Auditor Planning Judgments

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ABSTRACT

In complex accounting information system (AIS) environments, the exchange of audit evidence between computer assurance specialists (CAS) and auditors plays a critical role in determining audit quality. We investigate the effects of CAS competence and auditor AIS expertise on auditor planning judgments in a complex AIS environment. Using a quasi-experimental design, we manipulate CAS competence as high or low between auditors and measure auditor AIS expertise. Consistent with hypotheses, both auditor AIS expertise and CAS competence significantly affected auditor risk assessments in a complex AIS setting. Interestingly, with respect to the planning of substantive procedures, auditors' reactions to CAS competence variation were moderated by their own level of AIS expertise. Under conditions of low CAS competence, auditors with higher AIS expertise expanded the scope of their audit testing beyond the scope set by auditors with lower AIS expertise. The effect of AIS expertise diminished when auditors received evidence from a highly competent CAS. Our results suggest that auditors' AIS expertise can play a significant role in complex AIS environments and in their ability to compensate for CAS competence deficiencies.

Keywords: *accounting information systems; audit planning; audit risk model; computer assurance specialist; source competence*

Data Availability: *Data are available upon request.*

1. Introduction

In this study, we investigate the effects of computer assurance specialist (CAS) competence and auditor accounting information system (AIS) expertise on auditor planning judgments in a complex AIS environment. Recent professional standards have stated that auditors need to change their audit strategies in reaction to the all-encompassing changes in information technology (IT) at their clients (AICPA [2001], [2002]). IT applications, such as enterprise resource planning (ERP) systems, are significantly changing the ways in which companies operate their businesses (e.g., business process reengineering) and auditors perform their duties (Helms [1999], POB [2000]). For example, the implementation and utilization of ERP systems at many major corporations can increase audit-related risks such as business interruption, database security, process interdependency, and overall control risk (Hunton, Wright, and Wright [2004]). As technological developments continue, auditors will need to expand their AIS knowledge and skills in order to perform effective and efficient audits (POB [2000], Kinney [2001], AICPA [2002]). Expertise in the AIS domain may make auditors more cognizant of AIS-specific risks and provide them with the sophisticated audit skills required in such settings (Lilly [1997], Hunton, Wright, and Wright [2004]).

Statement on Auditing Standards (SAS) No. 94 (AICPA [2001]) suggests that a CAS be assigned to assist in the audit of computer-intensive environments. CAS (also referred to as computer auditors, information systems audit specialists, and IT auditors) provide the auditor with control testing evidence relating to the client's AIS (Curtis and Viator [2000], AICPA [2001], Hunton, Wright, and Wright [2004]). Client implementations of increasingly complex IT applications and the recent requirement of auditor attestation to management's internal control assessment should substantially increase the role of CAS on audit engagements (PCAOB

[2004]). However, auditors typically perceive the skills of (and value added by) CAS to be suspect (Hunton, Wright, and Wright [2004], Bierstaker, Janvrin, and Lowe [2004]), and data gathered for this study indicate substantial variation in the competence of CAS in practice.

While CAS are becoming an increasing source of evidence for auditors (POB [2000], AICPA [2001]), little prior research has examined the CAS/auditor relationship. Further, while prior studies have generally investigated scenarios where the source of audit evidence maintained a similar expertise structure to the auditor's (e.g., a subordinate auditor (Bamber [1983])), auditors and CAS generally have different expertise structures (Curtis and Viator [2000], Hunton, Wright, and Wright [2004]). These differences could make judgments related to CAS evidence difficult for auditors. As CAS are typically within-firm specialists, audit guidance requires auditors to supervise and review CAS as they would any other engagement team member (AICPA [1978], AICPA [2001]). But while auditors are typically able to compensate for subordinate auditor competence deficiencies by employing additional procedures themselves, auditors with limited AIS expertise may not have the knowledge structure to compensate for CAS of low competence. We build on prior auditor expertise, AIS, and source competence literature by investigating the effects of auditor AIS expertise and CAS competence on auditor risk assessments. Further, we follow the effects of, and interactions between, auditor AIS expertise and CAS competence through the audit process to examine the nature, staffing, timing, and extent of the auditor's planned substantive procedures.

In our study, auditors were given a quasi-experimental case where the competence of the CAS was manipulated as high and low between auditors and auditor AIS expertise was measured via a post-experimental questionnaire. The case provided auditors with documentation related to a potentially risky change in AIS at a client and evidence from a CAS indicating system controls were reliable. After examining the evidence, the auditors were asked to assess inherent and control risks and to plan the nature, staffing, timing, and extent of substantive procedures for a transaction cycle. The quality of the auditors' risk assessments and the effectiveness of their substantive procedures were measured with the aid of audit experts.

Our results indicate that auditors with higher AIS expertise, relative to those with lower AIS expertise, assessed inherent and controls risks as higher and designed corresponding substantive tests that were greater in scope to mitigate those risks. For high AIS expertise auditors, both the quality of their risk assessments and the effectiveness of their scope of tests exceeded those of low AIS expertise auditors. Auditors were also sensitive to the reliability of CAS as an evidence source and assessed control risk higher when provided with control testing evidence from a CAS with low (versus high) competence. More importantly, when planning substantive procedures, auditors' AIS expertise levels moderated their reaction to CAS competence. Specifically, the difference between high AIS expertise auditors' and low AIS expertise auditors' scope of planned audit procedures was greater when CAS competence was low than when it was high. These results suggest that auditor AIS expertise can play a significant role in advanced AIS environments and in their ability to compensate for CAS competence deficiencies by increasing the scope of substantive tests.

The remainder of this paper is organized as follows. The next section discusses the background and related research and develops the hypotheses. Sections 3 and 4 present the method and results, respectively. Section 5 offers conclusions and implications.

2. *Background and Hypothesis Development*

2.1 ERP SYSTEMS AND AUDITOR AIS EXPERTISE

The significant effect of IT advancements on the audit profession is evident in the release of two auditing standards that address the impact of technology on the audit. SAS No. 80 (AICPA [1996]) suggests that, in complex AIS environments, auditors may not be able to reduce audit risk to an appropriate level via additional substantive procedures and may need to perform more control testing. SAS No. 94 (AICPA [2001]) indicates that, in computer-intensive settings such as ERP system environments, auditors should consider assigning one or more CAS to the engagement in order to appropriately determine the effect of IT on the audit, gain an understanding of controls, and design and perform tests of IT controls. While the clients of audit firms use a variety of systems to process accounting transactions, ERP systems are the dominant environment for auditors servicing public clients. In 1999, 70% of the Fortune 1000 firms had either implemented or planned to implement ERP systems in the near future (Cerullo and Cerullo [2000]). Thus, while the potential advantages of ERP systems (e.g., real time data, shortened cycle times, reduced complications with Sarbanes-Oxley Act compliance) have made them the system of choice among many corporations (Brown [1997], O'Leary [2000], Hunton, Wright, and Wright [2004], Winters [2004]), the profession has acknowledged that there are significant risks associated with their implementation (POB [2000]).

Specifically, inherent risks are often heightened in the periods immediately following ERP system implementations as issues such as inadequately trained personnel, improper data input, and interdependencies among business processes can lead to an increased potential for financial statement misstatements, misclassifications, and defalcations (e.g., O'Leary [2000], Soh, Kien, and Tay-Yap [2000], Wah [2000], Hunton, Wright, and Wright [2004]). Control risk also can increase as the focus shifts from segregation of duties to greater access to information.[1] Additionally, supervisory review is typically minimal and supplemental internal control applications are often not properly integrated with the ERP system (Turner [1999], Wright and Wright [2002]). The increased inherent and control risks associated with ERP systems are expected to be greatest in the periods immediately following implementation as, over time, companies are more likely to address these issues. Audit guidance prescribes (and prior research suggests) that auditors typically react to increased inherent and control risks by increasing risk assessments and the scope of planned substantive procedures in non-complex AIS environments (AICPA [1983], Wright and Bedard [2000], Messier and Austen [2000]). However, in complex AIS environments, the levels at which the auditor assesses risks and the resulting scope of substantive testing may be dependent on the auditor's level of AIS expertise.

Expertise has been defined as "the possession of a large body of knowledge and procedural skill" (Chi, Glaser, and Rees [1982, p. 8]). Consistent with this more general definition, we define AIS expertise as the auditor's knowledge and procedural skill in the domain of auditing AIS. The expertise literature in auditing suggests that experts tend to use more appropriate information acquisition and processing strategies, resulting in better decision making (Biggs, Messier, and Hansen [1987], Shelton [1999], Bonner and Lewis [1990]). Further, prior research indicates that domain-specific experience plays an important role in developing expertise, with

[1] Inherent risk is the risk that the financial statements are susceptible to a material misstatement, assuming there are no related controls. Control risk is the risk that the entity's internal control structure will not prevent or detect a material misstatement (AICPA [1983]). The audit risk model states that audit risk (i.e., the risk that the auditor fails to appropriately modify his or her opinion on financial statements that are materially misstated) can be expressed as the multiplicative combination of inherent risk, control risk, and detection risk (i.e., the risk that the auditor will not detect a material misstatement that exists in the financial statements). Thus, to compensate for increases in inherent and control risks, the auditor reduces detection risk by planning substantive procedures that are greater in scope (AICPA [1983]).

training in the given domain combining with this experience to increase expertise levels (e.g., Bonner [1990], Bonner and Lewis [1990], Bedard and Chi [1993]).

Monroe and Ng [2000] view the auditor risk assessment process as a belief revision task, with the prior year assessment serving as a starting point, or "anchor." This anchor is then revised, often insufficiently, given new evidence or information (e.g., current year implementation of an ERP module) to create a current year assessment. For auditors, reliance on prior year assessments as an anchor tends to increase as task difficulty increases (Joyce and Biddle [1981]). Given their knowledge base/abilities, auditors with low AIS expertise may be less able to fully consider the potential effects of risks associated with an ERP implementation (Bedard, Graham, and Jackson [2004]). Therefore, these auditors may be more likely to anchor on prior year assessments (Low [2004]). Auditors with high expertise, on the other hand, may be more aware of the possible risks associated with a current year ERP system implementation (Hunton, Wright, and Wright [2004]). This increased awareness of risks among high AIS expertise auditors could lead to higher assessed risk levels, as professional skepticism should be exercised to achieve reasonable assurance that material misstatements are detected (AICPA [1988]).

To mitigate their higher risk assessments (and consistent with the audit risk model), auditors with higher AIS expertise will likely increase the scope of planned audit procedures beyond that of low AIS expertise auditors in complex AIS environments (AICPA [1983]). Auditors with greater domain-specific expertise should have the knowledge to plan and competently perform expanded audit procedures to effectively mitigate domain-specific risks (Low [2004]). In contrast, given the difficulty of the task and their inferior ability to recognize the impact of an ERP implementation on their risk assessments, low AIS expertise auditors may be more prone to rely on prior year testing as an anchor. Even in scenarios where low AIS expertise auditors are aware of increased risks, they may not be confident in their ability to select tests which will appropriately decrease detection risk (Ajzen [1991]). Thus, they may perceive that expanding substantive tests will only decrease audit efficiency (e.g., increasing the budget of a particular substantive test that does not increase the audit's effectiveness in a complex AIS setting would lead to a decrease in audit efficiency).

The above discussion suggests that, in an AIS environment indicative of increased risks, auditors with greater AIS expertise will assess both inherent and control risks at higher levels than auditors with lower AIS expertise. In addition, auditors with high AIS expertise should also increase the scope of planned substantive audit procedures beyond that of low AIS expertise auditors. Thus, we test the following hypotheses:

H1a: High AIS expertise auditors will assess inherent risk as higher than low AIS expertise auditors in an AIS environment indicative of increased risks.

H1b: High AIS expertise auditors will assess control risk as higher than low AIS expertise auditors in an AIS environment indicative of increased risks.

H1c: High AIS expertise auditors will plan substantive audit procedures that are greater in scope than low AIS expertise auditors in an AIS environment indicative of increased risks.

In addition to examining auditors' judgments, some recent research has evaluated the *quality* of these judgments (e.g., Low [2004], Brazel, Agoglia, and Hatfield [2004]). Research investigating auditor expertise has found that domain-specific expertise improves auditor performance. Among auditors with the same level of general audit experience, the nature of their experience and training has been shown to differentiate their domain-specific performances (Bonner [1990], Bonner and Lewis [1990], Low [2004]). Given the significant risks and complexities associated with ERP systems, AIS expertise should be an important factor in planning effective audits in such settings (Wright and Wright [2002]). For example, Hunton, Wright, and Wright [2004] found that auditors with greater AIS expertise were more likely to recognize a seeded control weakness in the study's experimental case. The findings of Low [2004] suggest that auditors with greater domain-specific expertise have a better understanding of the mix of audit tests and resources needed to address increased risks in a given domain. As a result, it is expected that auditor AIS expertise should positively affect the quality of their risk assessments and the effectiveness of their scope decisions. Risk assessments and effectiveness ratings from audit experts, given the underlying circumstances and risks for our study's hypothetical audit client, will serve as the basis for evaluating auditor risk assessment quality and the effectiveness of their substantive procedures (Tan [1995], Low [2004]). We therefore investigate the following hypotheses:

H2a: The quality of inherent risk assessments will be greater for high AIS expertise auditors than for low AIS expertise auditors.
H2b: The quality of control risk assessments will be greater for high AIS expertise auditors than for low AIS expertise auditors.
H2c: High AIS expertise auditors will plan more effective substantive audit procedures than low AIS expertise auditors.

2.2 COMPUTER ASSURANCE SPECIALIST COMPETENCE

Prior research has consistently found auditors to be sensitive to the perceived competence of their evidence sources. This literature has shown that auditors discount the inferential value/reliability of evidence received from sources of lower competence (e.g., Bamber [1983], Brown [1983], Anderson, Koonce, and Marchant [1994], Hirst [1994]). Given their tendency to be sensitive to source competence, auditors are likely to consider CAS competence when evaluating evidence obtained and audited by CAS (i.e., system control testing).

There are some indications that auditors have concerns about CAS competence in practice. For example, Hunton, Wright, and Wright [2004] note considerable intra-firm tension surrounding the engagement of CAS and that auditors were unlikely to engage CAS in ERP environments, reflecting perhaps a perceived lack of value added to the audit. Similarly, Bierstaker, Janvrin, and Lowe [2004] find that auditors consider CAS testing for clients with highly computerized systems as only moderately important. Participants in our study expressed in a post-experimental questionnaire that they have experienced a fairly large degree of variation in CAS competence on their engagements that, at times, limits their reliance on CAS evidence.[2]

An auditor may add a CAS to the engagement team and charge the CAS with testing the general (e.g., password) and application (e.g., data input) controls of the system for computer-dominant audit clients (Vendrzyk and Bagranoff [2003]). Prior research has described the auditor's control risk assessment as consisting of: (1) client control strength, (2) auditor test strength, and (3) auditor test results (Libby, Artman, and Willingham [1985], Maletta and Kida [1993]). SAS No. 47 (AICPA [1983]) advises auditors that, absent contradictory evidence, risk levels should be assessed at their maximum. Also, prior research suggests that auditors will likely perceive tests of internal controls (i.e., auditor test strength) performed by a CAS of higher competence to be stronger than those of a less competent CAS (Bamber [1983], Hirst [1994]). Thus, when provided with evidence from a CAS that specifies the system controls are reliable, an increase in the perceived level of CAS competence should lead to larger reductions of control risk by auditors (Arens, Elder, and Beasley [2003]).[3] Specifically, when CAS competence is higher, auditors may perceive CAS control test strength as stronger and, given CAS tests that support a reduction of control risk below maximum, decrease the level of control risk

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[2] Participants were asked, on a scale from 1 (Disagree) to 10 (Agree), whether they had experienced variation in CAS competence. The mean response was 7.23. They were also asked, on a scale from 1 (Small) to 10 (Large), the amount of CAS competence variation they had experienced in practice. Participants' mean response was 6.93. Mean responses to the two questions were not significantly different between our study's four conditions (all p's > .15).

[3] Client control strength (i.e., internal controls tested) and CAS test results (i.e., AIS controls appear reliable) were kept constant between auditors. Therefore, H3 and H4 are developed given that the positive results of CAS tests of controls support an assessment of control risk below the maximum level (i.e., below 100 percent).

accordingly. On the other hand, similar positive evidence obtained from CAS with low competence is likely to result in less reliance on that evidence and, in turn, control risk assessments that are higher or closer to the maximum level. Therefore, we examine the following hypothesis:

> *H3*: Auditors using positive evidence from a CAS of higher competence will assess control risk as lower than auditors using positive evidence from a CAS of lower competence.

2.3 THE MODERATING ROLE OF AUDITOR AIS EXPERTISE

While it is expected that auditors will be sensitive and react to variation in CAS competence when assessing control risk, auditors' reactions with respect to substantive testing decisions may not be as homogeneous. Considerable professional judgment is required when planning substantive tests (Arens, Elder, and Beasley [2003]), and task complexity may increase as auditors move from risk assessment to planning related substantive tests. Prior research and an evaluation of the auditing profession suggest that changes in risk assessments are often not reflected in the scope of audit testing (e.g., Hackenbrack and Kneckel [1997], Mock and Wright [1999], POB [2000]). Also, a recent front-page article in the Wall Street Journal notes several highly publicized cases where auditors' failed to react to increased client risks by expanding the scope of substantive tests (Weil [2004]).

CAS and auditors maintain different expertise structures (Curtis and Viator [2000], Hunton, Wright, and Wright [2004]) and auditors' AIS expertise levels may determine their ability to compensate for CAS competence deficiencies by increasing the scope of substantive tests. Indeed, the Public Oversight Board indicated that auditors will need to "expand their technological knowledge and skills," as they "cannot cede all technological matters" to CAS (POB [2000], p. 171). Under conditions of low CAS competence (and evidence indicating system controls are reliable), auditors possessing high AIS expertise may be more likely to expand substantive testing because they have the knowledge and procedural skill (i.e., behavioral control) to plan and perform additional substantive procedures to compensate for CAS competence deficiencies (Ajzen [1991]). Under the same conditions, auditors with low AIS expertise may be more apt to rely on CAS evidence and not appreciably change substantive procedures from those of the prior year. Compensating for CAS competence deficiencies through expanding the scope of testing represents a significantly more difficult task for them. The anchoring and adjustment literature suggests that these auditors will more likely rely on prior year planned substantive tests rather than increase their testing (e.g., Joyce and Biddle [1981]). In contrast, the effect of auditor AIS expertise on the scope of their substantive tests should diminish when CAS competence is high, as it is more appropriate to rely on the favorable CAS control testing evidence (Bamber [1993], Hirst [1994]). The above discussion suggests that CAS competence and auditor AIS expertise may interact to affect auditor planning judgments (see Figure 1). Thus, we investigate the following hypothesis:

[Insert Figure 1]

H4: The difference between high AIS expertise auditors' and low AIS expertise auditors' scope of planned substantive audit procedures will be greater when CAS competence is low than when it is high.

3. Method

3.1 PARTICIPANTS

Seventy-four practicing auditors from four international and two national public accounting firms participated in this study. Participants were audit seniors with, on average, 3.70 years of experience.[4] Prior research and discussions with practitioners revealed that audit seniors would be familiar with evaluating the evidence provided by CAS and performing planning judgments (e.g., Houston [1999], Messier and Austen [2000]).

3.2 RESEARCH INSTRUMENT

Participants were provided with a case that contained background information for a hypothetical client, relevant authoritative audit guidance, and prior year workpapers. These workpapers included prior year inherent and control risk assessments and substantive testing for the sales and accounts receivable cycle (hereafter, cycle). They were then provided with a current year workpaper documenting the client's implementation of an ERP system module for the cycle and informed a CAS would be assigned to the engagement to test system controls. The current year workpaper noted the following potential implementation problems: the transferal of legacy-system data to the ERP system due to a mid-year conversion, the integration of a supplemental internal control package with the system, the decision to move data input for the cycle from the accounting department to transaction sources (e.g., shipping department), the use of only the ERP system module (vs. dual ERP and legacy systems) to capture cycle transactions immediately after implementation, and the lack of internal/external audit involvement in the implementation process (e.g., Glover, Prawitt, and Romney [1999], Turner [1999]). Participants then assessed and documented inherent risk for the cycle. Next, participants were provided with information about the CAS (the CAS competence manipulation) and identical CAS control tests which concluded that "system-related controls … appear reliable." Participants then evaluated

[4] There were no significant differences in general audit experience, or any other demographic variables (e.g., experience with: assessing risks, planning substantive procedures, and the client's industry), between our study's four groups (all p's > .30). Also, there were no significant differences (p = .95) between groups in time spent on the case (overall sample mean = 33.43 minutes).

the reliability of the CAS's evidence, assessed and documented control risk, and planned the nature, staffing, timing, and extent of substantive procedures for the cycle. Lastly, participants completed a post-experimental questionnaire that included a manipulation check and an auditor AIS expertise measure. Experimental materials were pilot tested with practicing auditors to ensure their clarity and realism.

3.3 CAS COMPETENCE MANIPULATION

Participants were randomly assigned to one of two CAS competence conditions. Based on prior source competence literature and discussions with audit practitioners, three factors that substantially influence auditor perceptions of CAS competence were identified: amount of CAS experience, amount of training, and past job performance (Bamber [1983], Brown [1983], Margheim [1986], Schneider [1984], Rebele, Heintz, and Briden [1988], Anderson, Koonce, and Marchant [1994]). As suggested by Kadous and Magro [2001], the manipulation of CAS competence in this study made use of all three important facets of the construct. The three indicators were manipulated concurrently, and in a manner similar to prior source competence manipulations and congruous with practitioner experience (e.g., Bamber [1983], Schneider [1984] Anderson, Koonce, and Marchant [1994], Wright and Wright [2002]).

In the high *(low)* CAS competence condition, participants were informed that: (a) the CAS had four years *(eight months)* of experience, (b) the CAS had *(had not yet)* received training in the specific AIS implemented by the client, and (c) a colleague had received strong *(weak)* tests of controls from the CAS on a previous audit. To evaluate the realism (i.e., external validity) of the low and high CAS competence manipulations, participants were asked to respond to the following two post-experimental statements: (1) "CAS similar to the CAS described in the case study exist at my firm" on a scale from 1 ("disagree") to 10 ("agree") and (2) "the likelihood that a CAS similar to the CAS described in this case study could be assigned to an audit engagement is" on a scale from 1 ("very low") to 10 ("very high"). Non-tabulated mean responses for the low and high conditions for question (1) were 7.85 and 7.26, respectively, and for question (2) 6.90 and 6.62, respectively. Both differences between low and high CAS competence groups were insignificant (p's > .35). The relatively high, and insignificantly different, mean responses to these questions suggest the manipulation of CAS competence was similarly realistic in both its high and low conditions. A post-experimental manipulation check indicated participants attended to and understood the intended manipulation.[5]

3.4 MEASUREMENT OF AUDITOR AIS EXPERTISE

While the level of CAS competence is a trait associated with the audit engagement, auditor AIS expertise is a trait associated with the individual auditor. Since one cannot readily manipulate factors such as forms of intelligence (Peecher and Solomon [2001]), and an observable measure of AIS expertise would be infeasible to obtain (Abdolmohammadi and Shanteau [1992]), we use a self-reported measure as a surrogate for actual participant expertise (similar to Bonner and Lewis [1990]). Given that no measure of AIS expertise existed in the literature, a five-item questionnaire was developed through a review of the expertise and self-efficacy literatures to measure auditor AIS expertise (see Appendix).

Prior audit research establishes a link between domain-specific experience/training and expertise (e.g., Bonner [1990], Bonner and Lewis [1990], Bedard and Chi [1993]). Thus, we

[5] After completing the case, participants were asked to assess the competence of the CAS on a ten-point scale (where 1 = "very low" and 10 = "very high"). For the low and high competence conditions, the mean responses were significantly different and in the expected direction (3.76 and 7.94, respectively, p < .001). In addition, participant perceptions of the importance of each of the three factors used to manipulate CAS competence (e.g., CAS experience) were relatively high and not significantly different between conditions (p's > .20).

include in our measure four experience and training-related items (e.g., experience auditing AIS, AIS training). The remaining item directly measures auditor perceptions of their AIS expertise as suggested by Ajzen [1991]. These measures are significantly positively correlated (p's < .05) with two objective measures of exposure to AIS obtained from our study's participants: "experience with client ERP implementations" and whether participants had "a system-related major or minor in college."

Through the five-item measure (collected post-experimentally), participants evaluated their AIS expertise on eight-point scales, with higher scores indicative of greater AIS expertise. A pilot study utilizing 45 audit seniors confirmed the reliability and construct validity of the measure.[6] Additionally, general audit experience of participants in both the pilot study and this study is not significantly correlated with the five AIS expertise items. Thus, auditor AIS expertise appears to be a distinct domain of auditor expertise and not simply a by-product of general audit experience.

An AIS expertise score was calculated for each participant in this study as the mean of their responses to the five items. Participants scoring below and above the median expertise score of 3.000 were post-experimentally dichotomized as being of low and high AIS expertise, respectively. Three participants had mean scores of 3.000 and were removed from the original sample of seventy-four auditors for analyses performed in Section 4. Means for the low and high AIS expertise groups were 1.771 and 4.894, respectively. Based on scale labels for the five items, responses of 2 and 5 indicate that participants "mostly disagreed" and "mildly agreed,"

[6] Factor analysis of the pilot study data provided a Cronbach's alpha = 0.9106, well above the generally accepted threshold of 0.70, and all five items satisfactorily loaded on one factor (all factor loadings in excess of .70) (Nunnally [1978]). General audit experience (in months and years) and level within firm (e.g., fourth year) for the pilot study participants loaded on a separate factor. The Cronbach's alpha (0.9548) and factor loadings for this study were consistent with the pilot study.

respectively, that their AIS expertise exceeded their peers. This difference between the high and low AIS expertise groups indicates that participants in the two groups maintained significantly different perceptions of their own AIS expertise levels ($p < .001$). After randomly assigning participants to the two CAS competence conditions and post-experimentally dichotomizing participants into AIS expertise groups, the study consisted of four cells.

3.5 DEPENDENT VARIABLES

Consistent with prior research, inherent and control risk assessments for the sales and accounts receivable cycle were measured via separate scales (e.g., Anderson and Maletta [1994], Dusenbury, Reimers, and Wheeler [2000], Messier and Austen [2000]). Similar to Messier and Austen [2000], scales used in this study ranged from 0 to 100 percent, with percentages labeled in increments of 10. Also, 0, 50, and 100 percent were labeled "low risk," "moderate risk," and "high risk," respectively. Participants responded to the scale by inputting any whole number between 0 and 100 on a line below the scale.

After completing their risk assessments, participants were asked to prepare two separate audit programs for the substantive testing of sales and accounts receivable. As described by SAS No. 47 (AICPA [1983]) and Bedard, Mock, and Wright [1999]), the audit program allowed participants to design the nature, staffing, timing, and extent of substantive testing related to the two accounts. While, in practice, auditors modify all four of these items in reaction to their risk assessments, few prior studies have examined all four planning judgments simultaneously (Bedard, Mock, and Wright [1999]). The "nature" of participants' scope decisions was measured as the total number of procedures planned, similar to Low [2004] and Bedard, Graham, and Jackson [2004]. "Staffing" was determined by the total number of procedures assigned to a more senior-level auditor than staff assistant as suggested by O'Keefe, Simunic, and Stein [1994] and

Low [2004]. Consistent with SAS No. 47 (AICPA [1983]), the "timing" of participants' scope decisions was computed as the total number of testing hours budgeted at fiscal year-end (versus interim), and the "extent" of their decisions refers to the total number of budgeted audit hours (Mock and Wright [1999]). With respect to the four variables used to measure "scope," more planned procedures, more procedures assigned to senior-level auditors, more testing hours allocated to fiscal year-end, and/or more budgeted hours indicate audit procedures that are greater in scope (e.g., AICPA [1983], Mock and Wright [1993]).

Consistent with practice, participants had prior year workpapers available when providing both their risk assessments and substantive testing decisions. Prior year workpapers were constructed with the assistance of two audit senior managers and a partner from an international accounting firm. Inherent and control risks for the sales and accounts receivable cycle were assessed at low-to- moderate levels in the prior year (35% and 40%, respectively). Prior year audit testing for the two accounts indicated a combined 12 audit procedures that were all performed by staff assistants. Participants were allowed to delete prior year procedures and add current year procedures beyond those provided by the prior year's audit programs. In addition, 15 of the 93 total hours budgeted in the prior year were allocated to year-end/final testing (vs. interim).

The quality of participants' risk assessments and the effectiveness of their planned substantive procedures were determined with the assistance of audit experts. The experts were seven audit managers and a partner with, on average, 9.62 years of audit experience and were chosen due to their extensive task-specific experience (i.e., reviewing workpapers involving clients with complex AIS). Half of the experts received all the same case materials as those given to participants in the high CAS competence condition, while the other half received the materials given to the low CAS competence participants.[7] On the same scales as those used by participants, the experts provided their own inherent and control risk assessments. The experts' mean risk assessments served as the criteria for measuring the quality of participants' risk assessments. The experts' mean inherent risk assessment was 54.38, while the means of their control risk assessments were 65.00 and 62.50, respectively, for the low and high CAS competence conditions.[8] The quality of participants' inherent and control risk assessments were measured as the absolute value of the difference between their risk assessments and the mean assessments of the experts. Consistent with Tan [1995], lower absolute deviations are indicative of greater judgment quality (i.e., closer to the expert criterion).

After completing the case (and similar to Low [2004]), six of the experts (three in each CAS competence condition) individually evaluated the effectiveness of the planned substantive procedures (i.e., sales and accounts receivable audit programs) for each participant assigned to their condition.[9] Experts were blind to participant identity/background. They provided their effectiveness evaluations of participants' audit programs on a 10-point scale (1 = "very low"; 10 = "very high"). Participant effectiveness was computed as the mean score of the three experts assigned to the participant's CAS competence condition.

4. Results

For dependent variables for which relationships with both independent variables are hypothesized (control risk and scope measures), results are analyzed within a 2X2 ANOVA

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[7] To reduce the complexity of the experts' task and their time required, we randomly assigned them to cases with either low or high CAS competence conditions, similar to Low [2004]. Given that CAS competence is confounded with expert group, we propose no hypotheses regarding the effect of CAS competence on measures provided by the experts.

[8] We utilize the mean inherent risk assessment for all eight experts as a quality criterion since inherent risk is assessed prior to the CAS competence manipulation.

[9] Six of the eight experts were able to provide us with effectiveness evaluations of the participants' planned substantive procedures (an effort- and time-intensive task).

framework. For other dependent variables (inherent risk, inherent and control risk quality, and scope effectiveness), independent-samples t tests were utilized, as the only independent variable of interest is auditor AIS expertise. Due to the directional nature of the hypotheses, all tests are one-tailed.[10]

4.1 AUDITOR AIS EXPERTISE

Hypothesis Set 1 predicts that, in an AIS environment indicative of increased risks, auditors with high AIS expertise will assess inherent and control risks higher and will plan substantive audit procedures that are greater in scope than auditors with low AIS expertise. Table 1 presents the results of Hypothesis Set 1 testing. Mean inherent risk assessments for the low

[Insert Table 1]

and high AIS expertise groups were 40.43 and 52.64, respectively. These means are in the hypothesized direction and indicate a significant AIS expertise effect ($t = 3.524$, $p < .001$), providing support for H1a. Means of the control risk assessments for the low and high groups were also significant and in the expected direction (means = 46.80 and 59.72, respectively; $F = 11.451$, $p < .001$), supporting H1b. Further, in documenting their risk assessments, auditors with higher AIS expertise supplied a greater number of evidence items to support their assessments than lower expertise auditors (non-tabulated means = 8.75 and 6.80 items, respectively; $t = 2.828$, two-tailed $p = .006$). Auditors with higher AIS expertise also documented more of the potential system implementation risks provided in the case study than lower expertise auditors (non-tabulated means = 1.28 and .57 items, respectively; $t = 2.959$, two-tailed $p = .004$). These

[10] Additionally, linear regressions using auditor AIS expertise as a continuous variable (i.e., auditors' mean AIS expertise scores) were conducted and were consistent with the results reported in the text.

results are consistent with the notion that high AIS expertise auditors are more aware of the risks associated with ERP system implementation.

Table 1 also presents results relating to the four scope measures: Nature, Staffing, Timing, and Extent. For the Nature measure, auditors with high AIS expertise planned significantly more procedures than auditors with low AIS expertise (12.83 and 11.89, respectively; F = 5.350, p = .012), providing support for H1c. Similarly, with respect to Staffing, auditors with higher AIS expertise also assigned more senior-level auditors to perform the procedures (3.28 and 2.29, respectively; F = 4.437, p = .020). Although not significantly different, means for the high and low AIS expertise groups on the Timing (43.03 and 34.31, respectively; F = 1.257, p = .133) and Extent (105.03 and 101.06, respectively; F = .558, p = .229) of planned audit procedures were also in the expected direction. Thus it appears that, relative to those with low expertise, high AIS expertise auditors expanded the scope of testing, primarily through the mechanisms of procedures planned and the staffing of those procedures.

Hypothesis Set 2 indicates that auditors with high AIS expertise will provide higher quality inherent and control risk assessments and more effective substantive procedures than auditors with low AIS expertise. The results of Hypothesis Set 2 testing are presented in Table 2. Mean

[Insert Table 2]

absolute deviations from the experts' mean inherent risk assessment for the low and high AIS expertise groups were 16.98 and 13.37, respectively. As expected, mean deviations were significantly lower for the high expertise group (t = -1.758, p = .041). Mean absolute control risk assessment deviations for the two groups were in the expected direction (low and high AIS expertise group means = 20.04 and 15.65, respectively) and significant at p = .067 (t = -1.520), providing support for H2b. Mean expert effectiveness ratings for the planned substantive tests of the low and high AIS expertise groups were 5.16 and 5.66, respectively. These means were in the hypothesized direction and significant (t = 2.096, p = .020), supporting H2c. Interestingly, if we substitute *general* audit experience for auditor AIS expertise as the independent variable, the contrasts tested in Hypothesis Sets 1 and 2 are no longer significant (all p's > .25). Thus, for this task, our measure of AIS expertise appears to be a better predictor of audit effectiveness than generic audit experience.[11]

4.2 CAS COMPETENCE AND CONTROL RISK ASSESSMENTS

Hypothesis 3 suggests that auditors obtaining positive evidence from a CAS with high competence will assess control risk at a lower level than auditors using similar evidence from a CAS with low competence. Auditors who receive evidence (indicating system controls are operating effectively) from a more competent CAS should perceive the evidence as more reliable than auditors receiving the same evidence from a less competent CAS. That appeared to be the case here, with participants in the high CAS competence condition evaluating the reliability of CAS evidence as higher, on average, than those in the low competence condition (non-tabulated means = 7.12 and 3.70, respectively, on a scale where 1 = "not reliable" and 10 = "very reliable"; t = 7.669, two-tailed p < .001). In turn, this ability to place greater reliance on the favorable system control evidence led auditors in the high CAS competence condition to assess control risk as lower, on average, than their counterparts (means = 47.59 and 58.65, respectively; F = 8.844, p = .002), providing support for H3 (see Table 3).

[Insert Table 3]

[11] To address the impact of confounding CAS competence with expert group, Low [2004] suggests performing independent-samples t tests within each CAS competence condition/expert group. Such tests produce results consistent with those presented in the text for Hypothesis Set 2.

4.3 THE INTERACTIVE EFFECT OF AUDITOR AIS EXPERTISE AND CAS COMPETENCE

Hypothesis 4 specifies the form of the interactive effect of auditor AIS expertise and CAS competence on the scope of planned substantive audit procedures. Specifically, the form of the interaction specified by H4 stipulates that the difference between high and low AIS expertise auditors' scope of planned substantive procedures will be greater when CAS competence is low than when it is high (see Figure 1).[12] This hypothesis was tested for all four scope measures using the following planned contrast:

(Cell 2 Mean – Cell 4 Mean) > (Cell 1 Mean – Cell 3 Mean)

where:

Cell 1 = high AIS expertise/high CAS competence group
Cell 2 = high AIS expertise/low CAS competence group
Cell 3 = low AIS expertise/high CAS competence group
Cell 4 = low AIS expertise/low CAS competence group.

Results relating to H4 are presented in Table 4. With respect to the Nature measure, the value

[Insert Table 4]

of the contrast is 1.52, significant at $p = .043$, and in the hypothesized direction (i.e., positive). Similarly, for Staffing, the value of the contrast is 1.56 and significant at $p = .062$. While in the appropriate direction, the contrast value for Timing (13.90) is not significant ($p = .213$). The value of the contrast for Extent (25.29), on the other hand, is significant ($p = .017$) and in the expected direction. Thus, there is support for the interactive effect posited in H4 for the Nature,

[12] While we hypothesize an interactive effect on scope decisions (since the complexity of the task is more likely to require auditors to utilize their AIS expertise when integrating CAS evidence/competence into their scope decisions), we do not have a similar expectation for the less complex task of assessing control risk. Results support this notion as the AIS expertise/CAS competence interaction is insignificant for control risk ($F = .108$, $p = .743$).

Staffing, and Extent mechanisms of increasing scope. These results point to the critical role auditor AIS expertise plays when CAS competence on the engagement is deficient.[13]

5. Conclusions and Implications

In complex AIS environments, both auditor AIS expertise and their evaluations of CAS evidence play a critical role in determining audit quality (POB [2000]). The role of auditor AIS expertise in their judgment processes has not received substantial research attention, and complex AIS settings may require auditors to draw on this expertise when using CAS evidence. This study extends the literature by demonstrating that auditor AIS expertise and CAS competence affect not only auditors' risk assessments, but also the nature, staffing, and extent of their planned substantive procedures. More importantly, auditors' AIS expertise levels appear to influence their ability to compensate for potential CAS competence deficiencies.

The results of this study indicate that, in an AIS environment indicative of increased risks, auditors with higher AIS expertise assessed inherent and control risk as higher than auditors with lower AIS expertise. Higher AIS expertise auditors also planned substantive tests that were greater in scope. Specifically, they chose to increase their scope by planning significantly more procedures and assigning more senior-level auditors to perform those procedures than their counterparts. For high AIS expertise auditors, both the quality of their risk assessments and the effectiveness of their scope of tests exceeded those of low AIS expertise auditors. Auditors were also sensitive to the competence of CAS as an evidence source. When auditors received evidence supporting a control risk reduction from a highly competent CAS, they relied more on that

[13] Although not hypothesized, we expect (and find) a similar interactive effect as that described in H4 for the experts' effectiveness ratings of participants' scope decisions (value of contrast = .61, p = .082). This suggests that high AIS expertise auditors' superior knowledgebase allows them to plan more effective substantive tests, particularly when there are CAS competence deficiencies. This finding is limited by the confounding of CAS competence and expert group for the effectiveness measure as discussed in footnote 7.

evidence and, in turn, provided lower control risk assessments than auditors assigned to the low CAS competence condition.

With respect to the planning of substantive tests, auditors' AIS expertise levels moderated their reaction to CAS competence variation. Interestingly, this is in contrast to prior studies where auditors' reactions were more homogeneous in relation to variation in the competence of their evidence sources (e.g., Bamber [1983], Hirst [1994]). When CAS competence was low, auditors with higher AIS expertise planned a greater number of substantive tests, assigned more procedures to a senior-level auditor, and provided higher budgets than auditors with lower AIS expertise. Under conditions of high CAS competence, scope decision differences between high and low AIS expertise auditors were smaller. Thus, while auditor AIS expertise plays an important role in complex AIS environments, it is most critical when there are CAS competence deficiencies. This may represent a significant obstacle to firms, given practitioner concerns regarding CAS competence variability, as well as the perceived variability in their own AIS expertise.

The findings of this study have implications for practice and future research. Since the likelihood of under-auditing may increase in cases where both the CAS and auditor are of lesser ability, firms should consider the combined capabilities of these individuals when assigning them to audit engagements with advanced AIS. This analysis of engagement team expertise has taken on increased importance as the Public Company Accounting Oversight Board has recently approved a standard that requires auditors to review and attest to the effectiveness of corporate internal controls (PCAOB [2004]). Additionally, this study provides some insight into why auditors are sometimes reluctant to rely on CAS evidence during the course of their engagements. Given that auditor AIS expertise may play a significant role in determining audit quality in complex AIS environments, firms might also want to stress AIS training and experience during the initial years of auditors' careers. In this way, as staff auditors transition to the role of senior, they may be better equipped with the AIS expertise required in today's audit environment. The results also validate the importance of AIS courses in accounting curricula.

Future research should consider the impact of auditor domain-specific expertise when investigating their use of evidence, since this expertise may play a role in how the auditor responds to and incorporates this evidence into their decision making. Studies could also explore ways in which to improve the CAS/auditor relationship (e.g., through combined trainings and on-going dialogues). In addition, the impact of advanced AIS on audit quality should be further examined. The findings of our study point to a possible reduction in audit quality in the years surrounding a complex AIS implementation. Researchers could investigate the relationship between the complexity level of corporations' AIS and an observable measure of audit quality (e.g., restatements, earnings management). Also, given the recently increased auditor responsibilities with respect to internal control assessment (PCAOB [2004]), future research should examine whether it is more effective to either allocate additional internal control testing to CAS or provide auditors with additional training in evaluating IT risks. Another possible fruitful area of research might be the identification of other factors which influence auditor use of CAS (e.g., justification requirements, firm policies, budgetary pressure). Such research will advance our understanding of the role CAS, advanced AIS, and auditor AIS expertise play in determining the quality of contemporary audit services.

TABLE 1
Testing of Hypothesis Set 1

Dependent Variable[a]		Low AIS Expertise Group [*n* = 35]	High AIS Expertise Group [*n* = 36]	Test Statistic[b]	p-value
<u>Risk Assessments</u>					
Inherent Risk Assessment	Mean	40.43	52.64	3.524	<.001
	(SD)	13.90	15.28		
Control Risk Assessment	Mean	46.80	59.72	11.451	<.001
	(SD)	17.42	19.42		
<u>Scope Measures</u>					
Nature	Mean	11.89	12.83	5.350	0.012
	(SD)	1.83	1.77		
Staffing	Mean	2.29	3.28	4.437	0.020
	(SD)	1.78	2.40		
Timing	Mean	34.31	43.03	1.257	0.133
	(SD)	35.51	32.35		
Extent	Mean	101.06	105.03	0.558	0.229
	(SD)	22.81	25.03		

a *Inherent and Control Risk Assessments* were measured on scales ranging from 0 ("low risk") to 100 ("high risk") percent. *Nature* refers to the total number of procedures planned. *Staffing* was computed as the total number of procedures assigned to a more senior level auditor than staff assistant. *Timing* was measured as the total number of testing hours budgeted at fiscal year-end (versus interim). *Extent* refers to the total number of budgeted audit hours.
b For *Inherent Risk Assessment*, the test statistic is the t statistic from the independent-samples t test. For all other variables, the test statistic is the F statistic for the main effect of Auditor AIS Expertise from the overall 2X2 ANOVA.

TABLE 2
Testing of Hypothesis Set Two

Dependent Variable[a]		Low AIS Expertise Group [n = 35]	High AIS Expertise Group [n = 36]	t Statistic	p-value
Inherent Risk Assessment Quality	Mean (SD)	16.98 9.83	13.37 7.27	-1.758	.041
Control Risk Assessment Quality	Mean (SD)	20.04 13.06	15.65 11.18	-1.520	.067
Effectiveness of Planned Substantive Procedures	Mean (SD)	5.16 .96	5.66 1.02	2.096	.020

a *Inherent (Control) Risk Assessment Quality* was calculated as the absolute deviation of participants' assessments from the experts' mean inherent (control) risk assessment. *Effectiveness of Planned Substantive Procedures* was measured as participants' mean effectiveness rating provided by the experts assigned to their CAS competence condition. Experts individually assessed effectiveness on a scale ranging from 1 ("very low") to 10 ("very high").

TABLE 3
Testing of Hypothesis 3

Dependent Variable[a]		Low CAS Competence Group [*n* = 37]	High CAS Competence Group [*n* = 34]	F Statistic[b]	p-value
Control Risk Assessment	Mean	58.65	47.59	8.844	0.002
	(SD)	17.90	19.68		

a *Control Risk Assessment* was measured on scale ranging from 0 ("low risk") to 100 ("high risk") percent.
b The F statistic is for the main effect of CAS competence from the overall 2X2 ANOVA.

TABLE 4
Testing of Hypothesis 4

Panel A - Descriptive Statistics

Dependent Variable[a]		High AIS/High CAS (Cell 1) [*n* = 19]	High AIS/Low CAS (Cell 2) [*n* = 17]	Low AIS/High CAS (Cell 3) [*n* = 15]	Low AIS/Low CAS (Cell 4) [*n* = 20]
Nature	Mean	12.21	13.53	12.00	11.80
	(SD)	1.27	2.00	2.07	1.67
Staffing	Mean	2.53	4.12	2.27	2.30
	(SD)	2.39	2.18	2.09	1.56
Timing	Mean	36.37	50.47	34.20	34.40
	(SD)	28.02	35.99	47.74	24.02
Extent	Mean	95.68	115.47	104.20	98.70
	(SD)	18.00	28.04	28.32	18.08

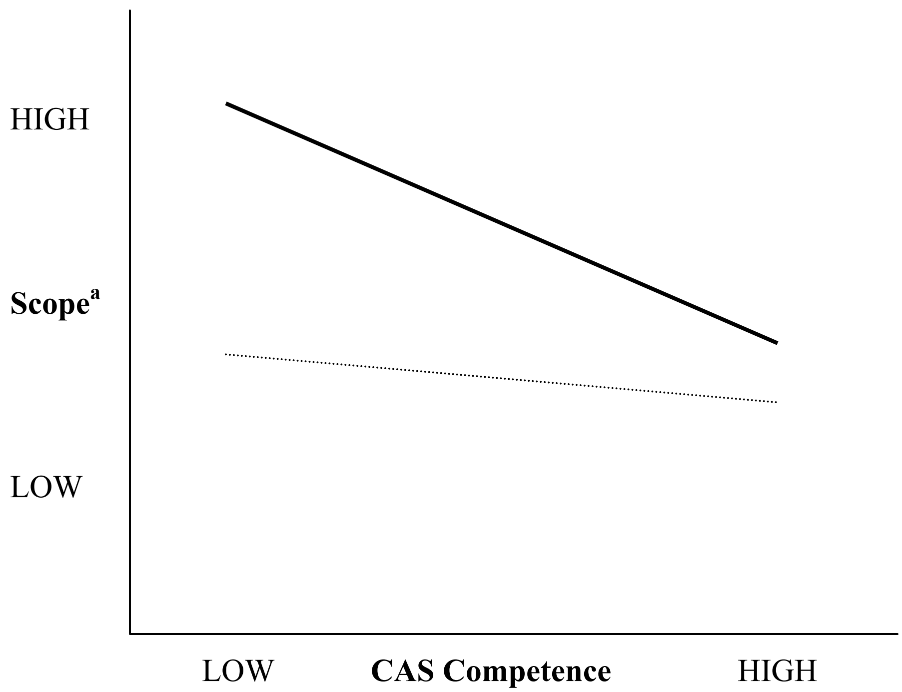
Panel B - Planned Contrasts

Dependent Variable[a]	Contrast Tested[b]	Value of Contrast	t Statistic	p-value
Nature	(13.53 - 11.80) - (12.21 - 12.00)	1.52	1.757	0.043
Staffing	(4.12 - 2.30) - (2.53 - 2.27)	1.56	1.565	0.062
Timing	(50.47 – 34.40) - (36.37 – 34.20)	13.90	0.805	0.213
Extent	(115.47 – 98.70) - (95.68 – 104.20)	25.29	2.192	0.017

a *Procedures* refers to the total number of procedures planned. *Labor* was computed as the total number of procedures assigned to a more senior level auditor than staff assistant. *Timing* was measured as the total number of testing hours budgeted at fiscal year-end (versus interim). *Extent* refers to the total number of budgeted audit hours.
b Planned contrast tested = (Cell 2 Mean – Cell 4 Mean) > (Cell 1 Mean – Cell 3 Mean).

FIGURE 1

Graph Depicting Predicted Computer Assurance Specialist (CAS) Competence and Auditor Accounting Information System (AIS) Expertise Interaction



Note: ——— indicates high auditor AIS expertise.
········· indicates low auditor AIS expertise.

[a] Scope of substantive tests (i.e., nature, staffing, timing, and extent).

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APPENDIX

Auditor Accounting Information System (AIS) Expertise Measure

The following questions were used to measure participants' AIS expertise levels:

1. Relative to other in-charge auditors at my firm, I have *more experience* auditing complex and pervasive accounting information systems (e.g., ERP systems).

2. Relative to other in-charge auditors at my firm, a *larger* portion of my *time* is assigned to auditing complex and pervasive accounting information systems (e.g., ERP systems).

3. Relative to other in-charge auditors at my firm, I *began* auditing complex and pervasive accounting information systems (e.g., ERP systems) at an *earlier* point in my career.

4. Relative to other in-charge auditors at my firm, I have received *more* combined informal and formal *training* in relation to complex and pervasive accounting information systems (e.g., ERP systems) during my career.

5. Relative to other in-charge auditors at my firm, I have a *higher* level of complex and pervasive accounting information systems (e.g., ERP systems) *expertise*.

Participants responded to each of the above questions via the following eight-point Likert scale:

1	2	3	4	5	6	7	8
Strongly Disagree	Mostly Disagree	Somewhat Disagree	Mildly Disagree	Mildly Agree	Somewhat Agree	Mostly Agree	Strongly Agree