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# An Examination of Auditor Planning Judgements in a Complex Accounting Information System Environment\*

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## 1. Introduction

This study investigates the effects of computer assurance specialist (CAS) competence and auditor accounting information system (AIS) expertise on auditor planning judgements in a complex AIS environment. Recent professional standards state that auditors need to change their audit strategies in reaction to the all-encompassing changes in their clients' AIS (American Institute of Certified Public Accountants [AICPA] 2001, 2002). Information technology (IT) applications, such as enterprise resource planning (ERP) systems, are significantly changing the ways in which companies operate their businesses (e.g., business process re-engineering) and auditors perform their duties (Helms 1999; Public Oversight Board [POB] 2000). For example, the implementation and utilization of ERP systems at many major corporations can increase audit-related risks such as business interruption, data base security, process interdependency, and overall control risk (Hunton, Wright, and Wright 2004). As technological developments continue, auditors must expand their AIS knowledge and skills in order to perform effective and efficient audits (POB 2000; Kinney 2001; AICPA 2002). Prior research suggests that 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 et al. 2004). To our knowledge, our study is the first to examine whether auditors' AIS expertise levels affect their risk assessments and subsequent testing decisions in a complex AIS setting.

*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 information systems audit specialists and IT auditors) provide

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auditors with control-testing evidence relating to their clients' AIS, and auditors incorporate such evidence into their control risk assessments and subsequent testing (e.g., AICPA 2001). Client implementations of increasingly complex AIS, as well as the Public Company Accounting Oversight Board's (PCAOB's) requirement of auditor attestation to management's internal control assessment, have substantially increased the role of CAS as an evidence source on audit engagements (Messier, Eilifsen, and Austen 2004; PCAOB 2004). From 1990 to 2005, the number of CAS employed by each Big 4 firm is estimated to have grown from 100 to 5,000, and CAS testing can now represent over half of the financial statement audit work (O'Donnell, Arnold, and Sutton 2000; Bagranoff and Vondrzyk 2000). Their role is likely to further expand as inadequate system controls have recently been cited in Securities and Exchange Commission (SEC) filings as a chief source of material weaknesses (Solomon 2005). Still, auditors typically perceive the skills of (and value added by) CAS to be suspect (Bagranoff and Vondrzyk 2000; Hunton et al. 2004; Janvrin, Bierstaker, and Lowe 2004), and data gathered for our study indicate auditors perceive substantial variation in the competence of CAS in practice. Given these auditor perceptions, in conjunction with the expanded role of CAS, there is a call for research examining the CAS/auditor relationship and its consequences on the audit (Hunton et al. 2004).

Although auditors are typically sensitive to subordinate auditor competence deficiencies (i.e., unreliable evidence) and can compensate by employing additional procedures themselves, auditors' ability to effectively respond to CAS competence deficiencies may be moderated by their own AIS expertise level. As the AIS expertise of the auditor increases, the auditor's knowledge of system design and controls should be greater and thus provide the auditor with a clearer understanding of what system controls the CAS has (or has not) tested, as well as the ability to compensate for CAS competence deficiencies. We extend the literature by exploring the moderating effect of auditor AIS expertise on auditor control risk assessment and the nature, staffing, timing, extent, and effectiveness of the auditor's planned substantive testing.

In our study, we gave auditors a quasi-experimental case where we manipulated the competence of the CAS as high and low between auditors and measured auditor AIS expertise by means of a post-experimental questionnaire. The case provided auditors with documentation related to a potentially risky change in a client's AIS (i.e., an ERP implementation) and evidence received from a CAS indicating system controls were reliable. After examining the evidence, the auditors assessed control risk and planned the scope of substantive testing for a transaction cycle.

Our results indicate that auditor AIS expertise and CAS competence affected auditors' control risk assessments, because both those with high AIS expertise and those assigned low competence CAS tended to assess control risk as higher than their counterparts. While we find no evidence that auditors' AIS expertise moderated the effect of CAS competence on their control risk assessments, AIS expertise levels did moderate their ability to effectively incorporate CAS evidence into their planned substantive testing. Specifically, the difference between high AIS expertise auditors' and low AIS expertise auditors' scope and effectiveness of planned audit

procedures was greater when CAS competence was low than when it was high. We performed a mediation analysis to identify why low AIS expertise auditors have difficulty incorporating unreliable CAS evidence into their planning judgements, while high AIS expertise appears to overcome this problem. Results suggest that, relative to auditors with lower AIS expertise, those with higher expertise are more likely to identify and react to potential AIS-specific risks when the competency of the CAS is deficient.

The findings of our study have a number of important implications. For example, our findings provide some insight into internal control testing and effective audit testing in complex AIS environments. Further, our results suggest that auditors' AIS expertise can play a significant role in advanced AIS settings and in their ability to compensate for CAS competence deficiencies. Thus, it may be prudent for firms to consider the combined capabilities of these individuals when assigning them to engagements with complex AIS.

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

## 2. Background and hypothesis development

Two auditing standards address the impact of technology on the audit. *Statement on Auditing Standards No. 80* (AICPA 1996) suggests that, in complex AIS environments, auditors may need to perform more control testing to reduce audit risk to an appropriate level and rely less on substantive procedures. *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 determine the effect of IT on the audit, gain an understanding of controls, and design and perform tests of system controls. ERP systems are the dominant environment for auditors servicing public clients; by 1999, 70 percent of Fortune 1000 firms had either implemented or planned to implement ERP systems in the near future (Cerullo and Cerullo 2000). However, little is known about how auditors behave in ERP settings and how they interact with CAS assigned to test ERP system controls.

The profession has acknowledged that there are significant risks associated with ERP system implementations (POB 2000). Specifically, inherent risk is often heightened because issues such as inadequately trained personnel, improper data input, and interdependencies among business processes can arise (e.g., O'Leary 2000; Soh, Kien, and Tay-Yap 2000; Wah 2000; Hunton et al. 2004). Control risk can also increase as the focus shifts from segregation of duties to greater access to information, 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; Bulkeley 2006). Prior research suggests that auditors typically react to increased risks by increasing risk assessments and the scope of planned substantive procedures (AICPA 1983; Wright and Bedard 2000; Messier and Austen 2000). However, in complex AIS environments, the competence of

the CAS responsible for testing system controls and the auditor's level of AIS expertise may affect these judgements.

### ***Computer assurance specialist competence***

An auditor typically includes a CAS on the engagement team to test the general and application controls of the system for computer-dominant audit clients (Vendrzyk and Bagranoff 2003). The auditor incorporates CAS testing evidence into a control risk assessment. Prior studies describe the auditor's control risk assessment as consisting of (a) client control strength, (b) auditor test strength, and (c) auditor test results (Libby, Artman, and Willingham 1985; Maletta and Kida 1993). Prior research suggests that auditors will likely perceive tests of controls (i.e., auditor test strength) performed by a CAS of lower competence to be weaker than those of a more competent CAS (Bamber 1983; Hirst 1994). Thus, a decrease in the perceived level of CAS competence should lead to higher auditor control risk assessments and more expansive substantive testing procedures (AICPA 1983; Arens, Elder, and Beasley 2003).<sup>1</sup>

There are some indications that auditors have substantial concerns about CAS competence in practice and question the value CAS add to the audit engagement (Bagranoff and Vendrzyk 2000; Janvrin et al. 2004). 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.<sup>2</sup> Also, increased demand for CAS due to the internal control attestation requirement of the PCAOB 2004 has resulted in CAS being stretched over more audit engagements, as well as audit firms losing highly competent CAS to corporations (Annesley 2005; Marks 2005).

Prior studies examining the effects of source competence on auditor judgements have typically investigated scenarios where evidence sources maintained a similar expertise structure to the auditor's (e.g., a subordinate auditor: Bamber 1983). As such, these studies have typically found uniform auditor reactions to variations in source competence. The auditor/CAS relationship is unique in that the two parties generally have different expertise structures (Curtis and Viator 2000; Hunton et al. 2004). For example, while CAS focus on system design and controls, auditors typically develop expertise in generally accepted accounting principles (GAAP) and generally accepted auditing standards (GAAS). These differences could make it more difficult for auditors to incorporate CAS evidence into their planning judgements.

### ***Effect of AIS complexity on judgements***

Complex AIS settings, such as ERP systems, raise the complexity level of auditor planning judgements (AICPA 1996). For example, *SAS No. 80* (AICPA 1996) discusses the complexity of determining the nature and timing of substantive tests, noting that the auditor should consider the use of computer-assisted audit techniques and that system-provided evidence may only be available for a given period of time. Auditors also report having difficulty factoring CAS results into their substantive planning decisions (Bagranoff and Vendrzyk 2000; Vendrzyk and Bagranoff

2003). The presence of CAS competence deficiencies, and the inability of auditors to rely on CAS system control testing, is likely to compound the task complexity associated with auditor testing decisions.

A practice commonly referred to in public accounting as SALY (same as last year) involves “anchoring” on prior year workpapers and has been demonstrated in the auditing literature (e.g., Joyce and Biddle 1981; Wright 1988; Brazel, Agolia, and Hatfield 2004). 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 to create a current year assessment. The extent of anchoring on prior year judgements tends to increase as task difficulty increases (Joyce and Biddle 1981). However, expertise in the AIS domain may reduce the aforementioned difficulties of assessing risks and planning tests in complex AIS settings, reduce auditor reliance on prior year judgements, and provide auditors with the knowledge base to adjust their audit plans to mitigate potential AIS-specific risks.

### *The moderating role of auditor AIS expertise*

We define auditor AIS expertise as the auditor’s knowledge and procedural skill in the domain of auditing AIS (Chi, Glaser, and Rees 1982). Expertise can be gained through domain-specific experience and training (e.g., Bonner 1990; Bonner and Lewis 1990; Bédard and Chi 1993). The expertise literature in auditing suggests that experts tend to use more appropriate information and processing strategies, resulting in better decision making (e.g., Biggs, Messier, and Hansen 1987; Bonner and Lewis 1990; Shelton 1999). Because auditors typically maintain different expertise structures from CAS (i.e., GAAP/GAAS versus system design and control expertise), gaining expertise in AIS (the domain of the CAS) diminishes differences relating to this expertise structure and should improve auditors’ perceptions of their ability to compensate for CAS deficiencies.

In complex AIS settings where CAS competence is low, the auditor must draw upon his or her own AIS expertise to identify system risks, adjust control risk upward, and supplement weak CAS tests by strategically expanding the scope of testing. Auditors with high AIS expertise should be more aware of the possible risks associated with a current year ERP implementation and the increased likelihood that the CAS may not have identified system control problems (Hunton et al. 2004). Thus, high AIS expertise auditors are more likely to discount CAS test results, assess control risk higher, and effectively expand the scope of substantive testing beyond the prior year (AICPA 1988). High AIS expertise auditors have the requisite knowledge and procedural skill to plan and competently perform additional relevant substantive procedures, as well as decide the appropriate staffing, timing, and budget for such procedures in a complex AIS environment (Ajzen 1991).

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 2005). Therefore, if given positive testing results from a CAS with low competence, these auditors may be more likely to anchor on prior year control risk assessments and testing decisions that do

not reflect current year AIS risks. For these auditors, a SALY approach might appear to be the most defensible strategy when auditing a client with complex AIS. Relative to those with high expertise, low AIS expertise auditors are less likely to be critical of positive CAS test results given their less complete understanding of CAS testing (Bagrahoff and Vendirzyk 2000). Thus, while prior research suggests that low AIS expertise auditors may be sensitive to competence deficiencies in CAS and discount the reliability of CAS evidence, these auditors are less likely to act on these perceptions because they are unaware of the appropriate procedures, staffing, etc., to compensate for low CAS competence (Bamber 1983; Ajzen 1991; Hirst 1994).

In contrast to when CAS competence is low, the effect of auditor AIS expertise on auditors' planning judgements should diminish when CAS competence is high. When CAS competence is high, it is more appropriate for the auditor to rely on positive (i.e., system controls are reliable) CAS control testing results (Bamber 1983; Hirst 1994). Positive results from a highly competent CAS should mitigate auditor concerns about potential system risks and lead to current year control risk assessments that are similar to those of the prior year. Thus, auditors should feel less compelled to use their own AIS expertise to substantially increase the scope of testing when CAS competence is high. On the basis of the above discussion, we predict that auditor AIS expertise will moderate the effect of CAS competence on auditor planning judgements (see Figure 1). Specifically, given CAS evidence indicating system controls are reliable, we expect the positive influence of auditor AIS expertise on control risk assessments and the scope and effectiveness of substantive testing will be greater when CAS competence is low (versus high). We therefore test the following hypotheses:

*HYPOTHESIS 1. The difference between high and low AIS expertise auditors' control risk assessments will be greater when CAS competence is low than when it is high.*

*HYPOTHESIS 2a. The difference between high and low AIS expertise auditors' scope of planned substantive audit procedures will be greater when CAS competence is low than when it is high.*

*HYPOTHESIS 2b. The difference between the effectiveness of high and low AIS expertise auditors' planned substantive audit procedures will be greater when CAS competence is low than when it is high.*

### 3. Method

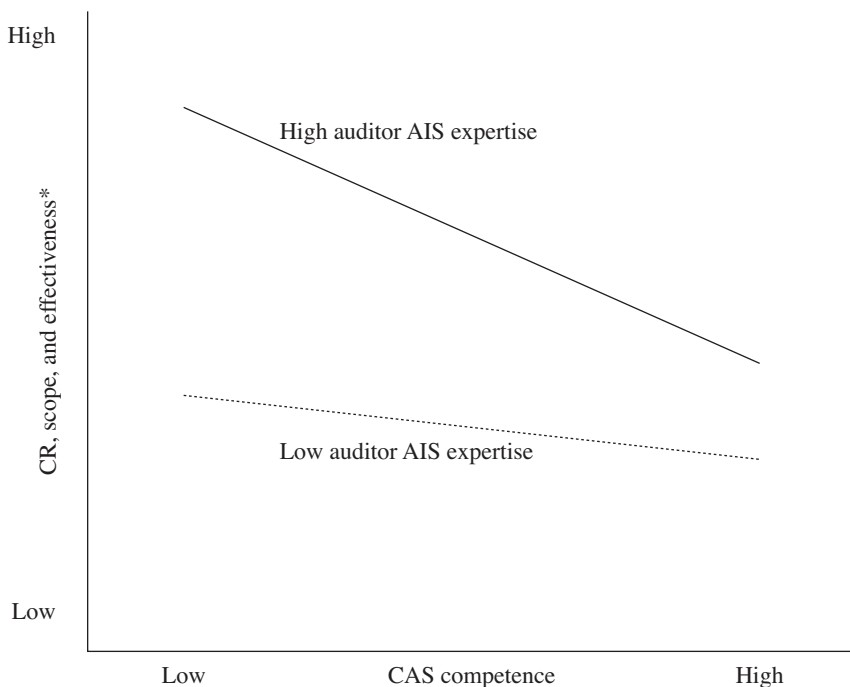
#### *Participants*

Seventy-four practicing auditors from four international and two national public accounting firms participated in this study. Participants were audit seniors with, on average, 3.7 years of experience.<sup>3</sup> Prior research and discussions with practitioners revealed that audit seniors would be familiar with evaluating the evidence provided by CAS and performing planning judgements (e.g., Houston 1999; Messier and Austen 2000).

**Experimental task and procedure**

We provided participants 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). Participants also received a current year workpaper documenting the client’s implementation of an ERP system module for the cycle and information that a CAS would be assigned to the engagement to test system controls. Potential implementation problems noted in the current year workpaper included the transferal of legacy-system data to the ERP system due to a mid-year conversion and the integration of a supplemental internal control package with the system (e.g., Glover, Prawitt, and Romney 1999; Turner 1999). Participants then assessed and documented inherent risk for the cycle. Next, participants received information about the CAS (the CAS competence manipulation) and CAS control tests, which concluded that “system-related controls ... appear reliable”. Participants then evaluated

**Figure 1** Graph depicting predicted computer assurance specialist (CAS) competence and auditor accounting information system (AIS) expertise interaction



**Notes:**

\* CR refers to control risk assessment. Scope refers to the nature, staffing, timing, and extent of participants’ substantive tests. Effectiveness refers to the effectiveness of participants’ substantive tests.

the strength of CAS testing; 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, an auditor AIS expertise measure, and demographic items.

### ***CAS competence manipulation***

We randomly assigned participants to one of two CAS competence conditions. On the basis of prior source competence literature and discussions with audit practitioners, we identified three factors that substantially influence auditor perceptions of CAS competence: amount of CAS experience, amount of training, and past job performance (Bamber 1983; Brown 1983; 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. We manipulated the three indicators concurrently, and in a manner similar to prior source competence manipulations and congruous with practitioner experience (e.g., Bamber 1983; Schneider 1984; Anderson et al. 1994; Wright and Wright 2002). In the high (low) CAS competence condition, we informed participants 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 very effective (less than effective) tests of controls from the CAS on a previous audit.<sup>4</sup> A post-experimental manipulation check indicated participants attended to and understood the intended manipulation.<sup>5</sup>

### ***Measurement of auditor AIS expertise***

Although the level of CAS competence is a trait associated with the audit engagement, auditor AIS expertise is a trait associated with the individual auditor. Because 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's 1990 measures of control and ratio knowledge). 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 the appendix).

Prior audit research establishes a link between domain-specific experience/training and expertise (e.g., Bonner 1990; Bonner and Lewis 1990; Bédard and Chi 1993). Thus, we include in our measure four experience and training-related items (e.g., experience auditing AIS, AIS training). The remaining item directly measures auditors' perceptions of their own AIS expertise, as suggested by Ajzen 1991. Through the five-item measure, participants evaluated their own AIS expertise on eight-point scales, with higher scores indicating greater AIS expertise.<sup>6</sup> Additionally, the general audit experience of participants in this study is not significantly correlated with the five AIS expertise items (all Pearson correlations  $< 0.05$  and  $p$ 's  $> 0.60$ , non-tabulated). Thus, auditor AIS expertise appears to be a distinct domain of auditor expertise and not simply a by-product of general audit experience.

We calculated an AIS expertise score for each participant in the study as the mean of his or her 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. After randomly assigning participants to the two CAS competence conditions and post-experimentally dichotomizing participants into AIS expertise groups, the study consisted of 71 participants in four cells.<sup>7</sup>

### *Dependent variables*

Consistent with prior research (e.g., Messier and Austen 2000), participants provided their inherent and control risk assessments for the sales and accounts receivable cycle on scales ranging from 0 to 100 percent (where 0 = “low risk”, 50 = “moderate risk”, and 100 = “high risk”) by inputting any whole number between 0 and 100 on a line below the scale. Participants also provided supporting documentation for their risk assessments. They then prepared 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 can modify any of these in reaction to their risk assessments, few prior studies have examined all four planning judgements simultaneously (Bedard et al. 1999). We measured the “nature” and “staffing” of participants’ scope decisions as the total number of procedures planned and the number of procedures assigned to a more senior-level auditor than staff assistant, respectively (e.g., Bedard et al. 2005; O’Keefe, Simunic, and Stein 1994). The “timing” and “extent” of participants’ scope decisions were computed as the total number of testing hours budgeted at fiscal year-end (versus interim) and the total number of budgeted audit hours, respectively (AICPA 1983; Mock and Wright 1999).

We constructed prior-year workpapers 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 percent and 40 percent, respectively). Prior-year audit testing for the two accounts indicated a total of 12 audit procedures that were all performed by staff assistants. For their current-year audit programs, participants could 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 (versus interim).

We also examine the effectiveness of participants’ planned substantive procedures with the aid of six audit experts. The experts were five audit managers and a partner with an average of about 10 years of audit experience who were chosen because of their extensive task-specific experience (i.e., reviewing workpapers involving clients with complex AIS). Half of the experts received 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. After completing the case themselves (and similar to Low 2004), the six

experts individually evaluated the effectiveness of the planned substantive procedures for each participant assigned to his or her condition. They provided the effectiveness ratings of participants' audit programs on a 10-point scale (1 = "very low"; 10 = "very high"). We computed participant effectiveness as the mean score of the three experts assigned to the participant's CAS competence condition. In an effort to help minimize expert-specific effects, we standardized individual expert effectiveness ratings (i.e., converted to *z*-scores: Ferguson and Takane 1989).

#### 4. Results

##### *The moderating effect of auditor AIS expertise*

Results are analyzed within a  $2 \times 2$  ANCOVA (analysis of covariance) framework (auditor AIS expertise by CAS competence condition).<sup>8</sup> Hypotheses 1, 2a, and 2b specify the form of the interactive effect of CAS competence and auditor AIS expertise on control risk assessments, scope decisions, and the effectiveness of scope decisions. Figure 1 illustrates this moderating effect.

##### *Auditor control risk assessments*

Table 1 and Figure 2 present results relating to Hypothesis 1. ANCOVA results in Table 1 indicate an insignificant CAS competence/auditor AIS expertise interaction for control risk ( $p = 0.916$ ). Given this result, we examine the direct effects of our explanatory variables on auditor control risk assessments. Consistent with prior source competence research (e.g., Bamber 1983; Hirst 1994), participants in the low CAS competence condition evaluated CAS test strength as weaker than those in the high competence condition (non-tabulated means = 4.00 and 7.88, respectively, where 1 = "very weak" and 10 = "very strong";  $p < 0.001$ ). This in turn resulted in a main effect for CAS competence, with auditors in the low competence condition assessing control risk higher (non-tabulated mean = 58.65) than those in the high condition (non-tabulated mean = 47.59,  $p = 0.003$ ). Similarly, we find a main effect for AIS expertise, with high AIS expertise auditors assessing risk higher in response to the risky ERP implementation (non-tabulated mean = 59.72) than those with low expertise (non-tabulated mean = 46.80,  $p < 0.001$ ). Figure 2 depicts these main effects. Interestingly, general audit experience did not have a significant effect on auditors' control risk assessments ( $p = 0.153$ ). While Hypothesis 1 is not supported, these results demonstrate that both CAS competence and auditor AIS expertise affect risk assessments in contemporary audit environments.

##### *Auditor scope decisions and scope decision effectiveness*

Hypothesis 2a (2b) specifies that the difference between high and low AIS expertise auditors' scope decisions (effectiveness) will be greater when CAS competence is low than when it is high. ANCOVA results in Table 1, though insignificant for the timing variable ( $p = 0.224$ ), indicate a significant CAS competence/auditor AIS expertise interaction for the nature, staffing, extent, and effectiveness of auditors' substantive procedures ( $p$ 's  $< 0.060$ ).<sup>9</sup> Figure 2 graphically illustrates these interactive effects. These results suggest that high AIS expertise auditors' superior

TABLE 1  
Auditor control risk assessments and the scope and effectiveness of planned substantive procedures (Hypotheses 1, 2a, and 2b)

ANCOVA for dependent variable	Independent/control variable	df	Mean square	F-value	p-value
Results of separate ANCOVAs for control risk, scope, and effectiveness measures					
Hypothesis 1					
<i>Control risk</i>	<i>Audit experience</i>	1	635.81	2.086	0.153
	<i>CAS competence</i>	1	2,804.63	9.202	0.003
	<i>AIS expertise</i>	1	3,631.76	11.915	<0.001
	<i>CAS competence</i> × <i>AIS expertise</i>	1	3.41	0.011	0.916
	Error	66	304.80		
Hypothesis 2a					
<i>Nature</i>	<i>Audit experience</i>	1	1.73	0.556	0.458
	<i>CAS competence</i>	1	5.33	1.717	0.195
	<i>AIS expertise</i>	1	16.17	5.211	0.026
	<i>CAS competence</i> × <i>AIS expertise</i>	1	8.64	2.784	0.050
	Error	66	3.10		
<i>Staffing</i>					
	<i>Audit experience</i>	1	6.26	1.478	0.228
	<i>CAS competence</i>	1	12.00	2.834	0.097
	<i>AIS expertise</i>	1	19.54	4.620	0.018
	<i>CAS competence</i> × <i>AIS expertise</i>	1	13.02	3.076	0.042
	Error	66	4.23		

(The table is continued on the next page.)

TABLE 1 (Continued)

Results of separate ANCOVAs for control risk, scope, and effectiveness measures

ANCOVA for dependent variable	Independent/control variable	df	Mean square	F-value	p-value
<i>Timing</i>	<i>Audit experience</i>	1	275.88	0.235	0.629
	<i>CAS competence</i>	1	871.16	0.743	0.392
	<i>AIS expertise</i>	1	1,420.40	1.211	0.275
	<i>CAS competence × AIS expertise</i>	1	686.59	0.585	0.224
	Error	66	1,173.24		
<i>Extent</i>	<i>Audit experience</i>	1	116.80	0.216	0.644
	<i>CAS competence</i>	1	910.53	1.680	0.793
	<i>AIS expertise</i>	1	79.70	0.164	0.199
	<i>CAS competence × AIS expertise</i>	1	2,913.30	5.381	0.012
	Error	66	541.43		
Hypothesis 2b <i>Effectiveness</i>	<i>Audit experience</i>	1	0.01	0.008	0.929
	<i>CAS competence</i>	1	0.02	0.051	0.822
	<i>AIS expertise</i>	1	3.24	7.068	0.010
	<i>CAS competence × AIS expertise</i>	1	1.21	2.630	0.055
	Error	66	0.46		

(The table is continued on the next page.)

TABLE 1 (Continued)

**Notes:**

*Control risk* was assessed by participants on a scale 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. *Effectiveness* was determined by experts and computed as the experts’ mean effectiveness ratings of participants’ audit programs on 10-point scales (1 = “very low”; 10 = “very high”). Effectiveness ratings were standardized (converted to z-scores). *Audit experience* was measured as participants’ number of months of audit experience. *CAS competence* was coded 1 for high CAS competence and 0 for low CAS competence. *AIS expertise* was coded 1 for high AIS expertise and 0 for low AIS expertise. For all dependent variables, cell sizes are as follows: high CAS competence/high AIS expertise,  $n = 19$ ; high CAS competence/low AIS expertise,  $n = 15$ ; low CAS competence/high AIS expertise,  $n = 17$ ; low CAS competence/low AIS expertise,  $n = 20$ .

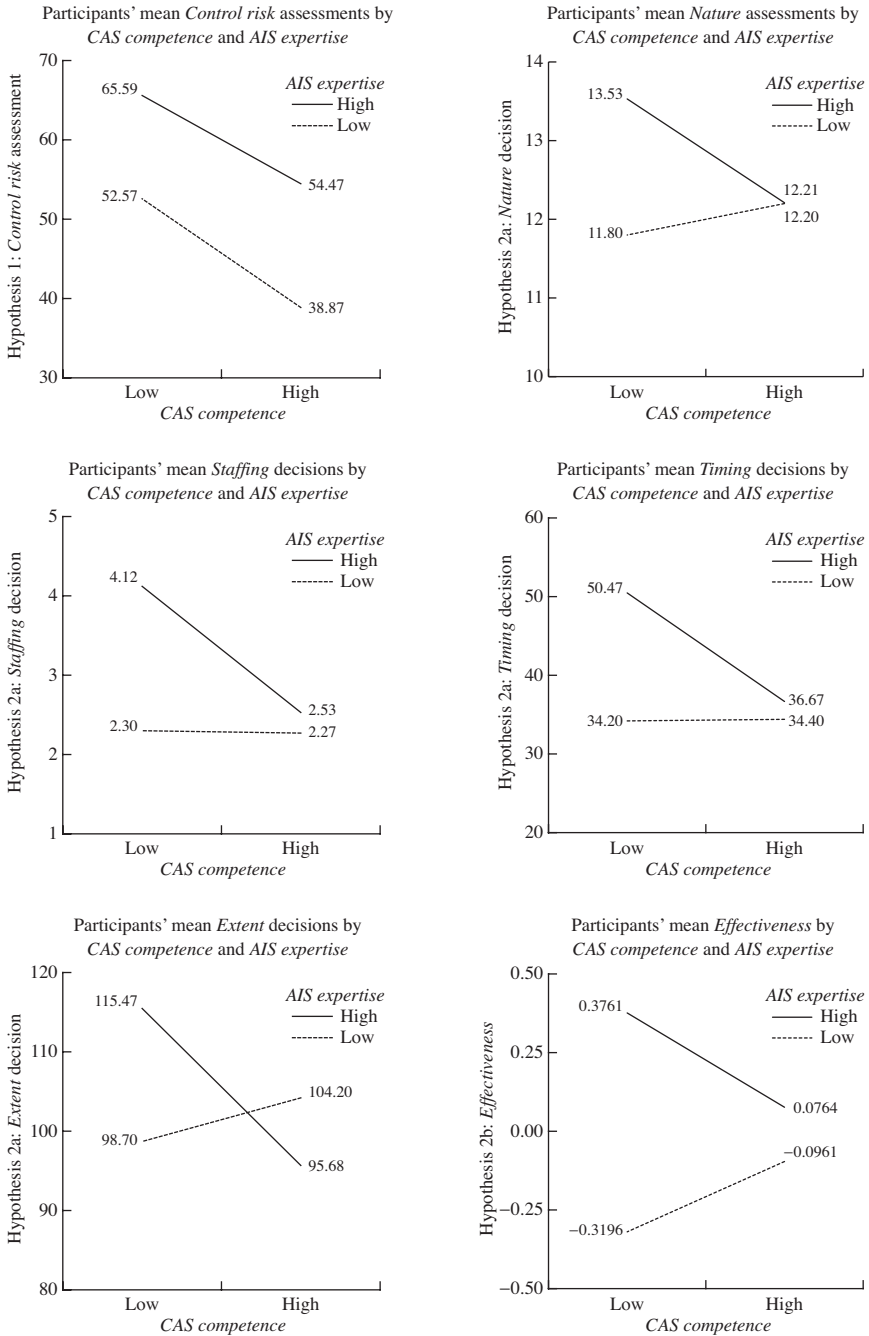
knowledge base allows them to effectively expand the scope of substantive tests, particularly when there are CAS competence deficiencies.<sup>10</sup>

Overall, these results point to the critical role auditor AIS expertise plays when CAS competence on the engagement is deficient. Thus, one might expect firms to typically assign auditors with greater AIS expertise to complex AIS clients like the hypothetical client in our study. However, this does not appear to be the case. Participant mean responses (non-tabulated) to a post-experimental question regarding the likelihood that they could be assigned to a similar client in the future were not significantly different between high and low AIS expertise auditors ( $p > 0.200$ ). Thus, while firms may have quality controls to match other domains of auditor expertise with client characteristics (for example, industry expertise), firms may not currently appreciate the positive effects auditor AIS expertise may have on audit quality.

***Mediation analysis: mechanism behind the moderating effect of auditor AIS expertise***

The results supporting Hypothesis 2a lead us to consider the mechanism behind the interactive effect of auditor AIS expertise and CAS competence on auditor scope decisions (i.e., why low expertise auditors encounter difficulties when incorporating less reliable CAS evidence and high expertise auditors appear to overcome these difficulties). Because it appears that auditors’ control risk assessments are not the mechanism behind the observed scope interactions, we focus on another measure to help explain these results.<sup>11</sup> The mechanism we consider is the auditor’s ability to identify ERP-related risks (measured as the number of ERP system-related risks the auditor documents during risk assessment). Clearly, the potential

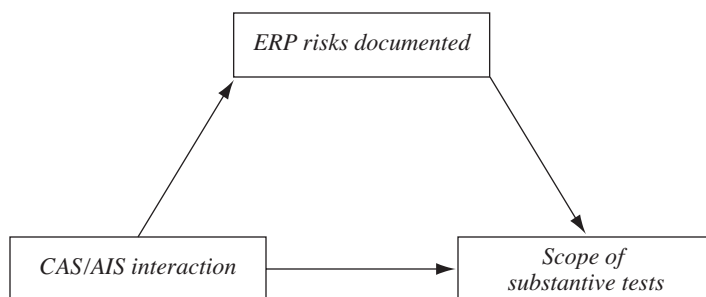
**Figure 2** Graphical presentations for Hypotheses 1, 2a, and 2b



for unidentified system-related risks increases when CAS competence is low, and auditor AIS expertise may moderate the ability to identify and document more ERP system risks. Greater documentation of ERP risks might then lead to more expansive substantive tests. Consistent with Hypothesis 2a development, we find greater differences in the number of ERP risks documented by high and low AIS expertise auditors when CAS competence is low (nontabulated means = 4.82 and 2.15, respectively,  $p < 0.001$ ) than when it is high (nontabulated means = 3.37 and 2.27, respectively,  $p = 0.415$ ). Following Baron and Kenney 1986, we conduct a mediation analysis to investigate whether auditors' ability to recognize and document ERP risks mediates the CAS competence/auditor AIS expertise interactive effect on their scope of substantive procedures (see Figure 3). With respect to scope measures, we focus on the number of planned procedures because this decision by the auditor typically drives our other scope measures (e.g., the extent/budget of audit testing).<sup>12</sup>

Statistical evidence of ERP risk documentation mediating the relationship between the observed CAS competence/AIS expertise interaction and the nature of testing first requires that the interaction significantly affects the nature of substantive tests. Our tests of Hypothesis 2a indicate this relationship exists. Second, the interaction must affect the mediating variable. Table 2 reports results of an ANCOVA, including the explanatory variables used to test Hypothesis 2a, where there is a significant interactive effect on the number of ERP risks documented ( $p = 0.080$ ). Third, the number of ERP issues documented must also be significantly correlated with the nature of testing. Non-tabulated results provide a significant and positive Pearson correlation of 0.354 ( $p < 0.010$ ). Lastly, when the number of ERP issues documented is included in the model used to test Hypothesis 2a, (a) that term must be significant, and (b) the interaction term must either be insignificant

**Figure 3** Scope of substantive tests with auditor's documentation of ERP risks as mediator



**Notes:**

*CAS/AIS interaction* represents the effect of the CAS competence/auditor AIS expertise interaction. *Scope of substantive tests* refers, in this case, to the total number of procedures planned (i.e., *Nature*). *ERP risks documented* refers to the number of ERP system-related risks a participant documented during risk assessment.

TABLE 2  
Results of separate ANCOVAs for mediation analysis

ANCOVA for dependent variable	Independent/control variable	df	Mean square	F-value	p-value
<i>ERP risks documented</i>	<i>Audit experience</i>	1	4.40	1.038	0.312
	<i>CAS competence</i>	1	7.55	1.781	0.187
	<i>AIS expertise</i>	1	61.47	14,490	<0.001
	<i>CAS competence × AIS expertise</i>	1	8.58	2.022	0.080
	Error	66	4.24		
<i>Nature</i>	<i>ERP risks documented</i>	1	10.02	3.342	0.036
	<i>Audit experience</i>	1	0.83	0.276	0.601
	<i>CAS competence</i>	1	3.12	1.039	0.312
	<i>AIS expertise</i>	1	5.29	1.763	0.189
	<i>CAS competence × AIS expertise</i>	1	5.52	1.843	0.090
Error		65	3.00		

**Notes:**

*ERP risks documented* refers to the number of ERP system-related risks a participant documented during risk assessment. *Nature* refers to the total number of procedures planned. All other variables are as defined in Table 1.

(full mediation) or its significance must decline (partial mediation). ANCOVA results in Table 2 show that the mediator (number of ERP issues documented) has a significant effect on the nature of testing ( $p = 0.036$ ). Further, the  $p$ -value for the interaction term increases from  $p = 0.050$  (Table 1) to  $p = 0.090$  when the mediator is included in the model, indicating a decline in significance for the interaction term. These results point to the identification and documentation of ERP risks partially mediating the interactive effect of CAS competence and AIS expertise on the scope of substantive procedures, helping to explain the mechanism behind the result observed for Hypothesis 2a. Specifically, relative to those with lower expertise, auditors with higher AIS expertise appear to use their knowledge base to identify more ERP-specific issues and, in turn, add more substantive procedures to mitigate these issues, particularly when incorporating evidence from a less competent CAS.

## 5. Conclusions, limitations, and implications

In complex AIS environments, both auditors' AIS expertise and their evaluations of CAS evidence play a critical role in determining audit quality (POB 2000). Although complex AIS (such as ERP systems) and CAS have become common fixtures on audit engagements, little prior research has examined how they affect auditor judgements. In our study, we contribute to the literature by exploring the moderating effect of auditor AIS expertise on control risk assessment and the nature, staffing, timing, extent, and effectiveness of planned substantive testing. In addition, we examine a mechanism behind this moderating effect.

The results of this study indicate that auditors were sensitive to the competence of CAS and assessed control risk higher when provided with positive control testing evidence from a CAS with low (versus high) competence. We also find that, in an AIS setting indicative of increased risk, auditors with higher AIS expertise assessed control risk as higher than those with lower expertise. Although auditors' AIS expertise did not moderate the effect of CAS competence on their control risk assessments, expertise levels did moderate their reaction to CAS competence variation with respect to the planning of substantive tests. This finding 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).<sup>13</sup> When CAS competence was low, auditors with higher AIS expertise effectively 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 (who tended to anchor more on prior year scope decisions). Under conditions of high CAS competence, differences in scope decisions and testing effectiveness between high and low AIS expertise auditors were smaller. A mediation analysis suggests that the ability of high AIS expertise auditors to identify potential ERP risks helps drive the observed moderating effect of AIS expertise on auditors' scope decisions. Interestingly, in our complex AIS setting, general audit experience did not have a significant effect on auditor judgements. Thus, our findings suggest that AIS expertise plays an important role in complex AIS environments and appears to be most critical when there are CAS competence deficiencies.

It is interesting to note the difference in results observed for the risk assessment and substantive testing tasks (i.e., the CAS competence/AIS expertise interaction was significant for Hypothesis 2a, but not for Hypothesis 1). One possible explanation is that task complexity plays a role, because planning substantive tests is typically a more difficult and involved task than risk assessment (Arens et al. 2003). Indeed, the auditing literature suggests that changes in risk assessments are often not reflected in the scope of audit testing (e.g., Hackenbrack and Knechel 1997; Mock and Wright 1999; POB 2000), and complex AIS settings further raise the difficulty of the auditor's task of planning substantive tests (AICPA 1996; Bagranoff and Vendirzyk 2000; Vendirzyk and Bagranoff 2003). Moreover, when CAS competence is low, the auditor must draw on his or her own AIS expertise to supplement weak CAS tests by expanding the scope of testing, a significantly more difficult task for low AIS expertise auditors. Specifically, although low AIS expertise auditors appear sensitive to CAS competence deficiencies and in turn recognize and assess risk (i.e., the less complex task) as higher, these auditors are less likely to have the knowledge base to plan appropriate substantive tests (i.e., the more complex task) to compensate for low CAS competence and, instead, may rely on a simple approach such as SALY for their scope decisions (Bamber 1983; Ajzen 1991; Hirst 1994).

As with all research, our study's limitations should be considered when evaluating its findings. In particular, although audit seniors are familiar with making the kinds of planning judgements we asked of them, we did not provide these relatively inexperienced participants with the opportunity to consult with engagement management as they could in practice (constraints on participant access made consultation infeasible). Thus, while our results point to the potential for underauditing when a CAS of low competence is paired with an audit senior of low AIS expertise, we cannot speak to the potential for corrective measures by means of substantial audit manager or partner oversight. Future research could examine the effectiveness of engagement management oversight and input as a quality control, especially in cases where CAS competence and auditor AIS expertise are lacking. Lastly, we investigate the effects of auditor AIS expertise and CAS competence in a single setting where an ERP system was implemented and CAS evidence for the sales and accounts receivable cycle was positive (i.e., client system controls appear reliable). Future studies could examine the effects of CAS/auditor interactions using other settings and tasks.

The findings of this study have implications for practice and future research. For example, our results provide insight into the processes of testing internal controls and tailoring effective audit programs to ensure sufficient and competent audit documentation in contemporary audit settings. Given the potential for deleterious effects in complex AIS settings, PCAOB audit firm inspectors should consider evaluating whether firm policies (e.g., training, scheduling) are in place to ensure the sufficiency of both the competence of the CAS and the AIS expertise of auditors assigned to the engagement. Additionally, the findings of our study point to a possible reduction in audit quality in the years surrounding a complex AIS implementation. Future research could investigate the relationship between the complexity

level of corporations' AIS and measures of audit quality (e.g., restatements, earnings management). Also, given recently increased auditor responsibilities with respect to internal control assessment (PCAOB 2004), future research could consider the implications for audit efficiency and effectiveness of either allocating additional internal control testing to CAS or providing auditors with greater training in evaluating IT risks. Studies could also explore ways in which to improve the CAS/auditor relationship (e.g., through combined trainings and ongoing dialogues). Such research will advance our understanding of the role complex AIS, CAS, and auditor AIS expertise play in determining the quality of contemporary audit services.

### 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 by means of 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

### Endnotes

1. We hold client control strength (i.e., internal controls tested) and CAS test results (i.e., AIS controls appear reliable) constant between participants in this study. Therefore, this study's hypotheses 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). The failure to discount positive results in light of source competence deficiencies can lead to underauditing (Hirst 1994). In today's environment of audit failures, factors or scenarios that may lead to underauditing are of particular importance (e.g., Weil 2004).

2. We asked participants, on a scale from 1 (disagree) to 10 (agree), whether they had experienced variation in CAS competence. The mean response was 7.23. Participants also indicated, 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  $> 0.150$ ). These responses support the notion that CAS with lower competence are assigned to engagements with auditors of all AIS expertise levels.
3. There were no significant differences in general audit experience, or any other demographic variables (e.g., experience with assessing risks, planning substantive procedures, being assigned to similar audit clients, and the client's industry), between our study's four groups (all  $p$ 's  $> 0.300$ ). Also, there were no significant differences ( $p > 0.950$ ) between groups in time spent on the case (overall sample mean = 33.43 minutes).
4. To evaluate the realism (i.e., external validity) of the low and high CAS competence manipulations, participants responded to the following two post-experimental items: (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"). Mean responses for the low and high conditions for item (1) were 7.84 and 7.36, respectively, and for item (2) were 7.08 and 6.67, respectively. The relatively high, and insignificantly different ( $p$ 's  $> 0.400$ ), mean responses to these questions suggest the manipulation of CAS competence was similarly realistic in both the low and high conditions.
5. After completing the case, participants assessed the competence of the CAS on a 10-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,  $p < 0.001$ ).
6. A pilot study using 45 audit seniors confirmed the reliability and construct validity of the measure. Factor analysis of the pilot study data provided a Cronbach's alpha = 0.911, well above the generally accepted threshold of 0.700, and all five items satisfactorily loaded on one factor (all factor loadings in excess of 0.700) (Nunnally 1978). General audit experience (in years) and level within firm (e.g., fourth year) for the pilot study participants loaded on a separate factor. The Cronbach's alpha (0.955) and factor loadings (all  $> 0.700$ ) for this study were consistent with the pilot study.
7. Three participants had mean scores of 3.000 and were removed from the original sample of 74 auditors to avoid the problem of subjective classification. Including these participants in either the high or low expertise group does not affect the conclusions drawn, nor does treating AIS expertise as a continuous variable. Also, consistent with the notion that our self-assessed measure serves as a reasonable proxy for auditor AIS expertise, high AIS expertise auditors assessed both inherent and control risk higher ( $p$ 's  $< 0.010$ ) and provided higher quality risk assessments (i.e., lower absolute deviations from the mean risk assessments of expert auditors;  $p$ 's  $< 0.070$ ) than those with low expertise. Furthermore, in documenting their risk assessments, high AIS expertise auditors also supplied a greater number of evidence items to support their assessments ( $p$ 's  $< 0.010$ ).

8. We control for participants' general audit experience by including it as a covariate in our analyses, to isolate the explanatory power of participants' AIS expertise beyond general experience. Due to the directional nature of expectations, all tests of hypotheses are one-tailed.
9. The use of some, but not all, factors to expand scope is consistent with results found in prior studies of scope decisions (Bedard and Wright 1994), and discussions with practicing auditors suggest that they often view these items as substitutes (e.g., assigning a more senior staff member to a procedure instead of increasing the budget). Additionally, because we measure scope by means of multiple measures (e.g., nature, staffing), we conducted a multivariate analysis of variance (MANOVA) prior to performing all univariate tests in order to control the experimentwise Type I error rate (Gardner 2001). MANOVA results indicate a significant CAS competence/AIS expertise interactive effect ( $p < 0.050$ ), thus providing support that significant univariate test results reported in the text are not the result of an inflated experimentwise Type I error rate (Gardner 2001). Lastly, we also examine an indirect measure of effectiveness: the number of critical procedures participants included as part of their planned substantive testing (where critical procedures are determined by our experts to be procedures important to include in planned testing). Consistent with results of our direct measure of effectiveness, the ANCOVA interaction term for critical procedures indicates that CAS competence and AIS expertise interact to positively affect this measure ( $p = 0.006$ ).
10. Recall that our hypotheses rely, implicitly, on low AIS expertise auditors anchoring more on prior year risk assessments and scope decisions (and insufficiently adjusting them to reflect current year risks) than high AIS auditors. Non-tabulated analysis of auditors' absolute deviations from prior year judgements provides a relatively consistent finding. In a complex and risky AIS setting, auditors with lower AIS expertise appear to anchor more on prior year judgements than those with higher expertise. Specifically, the absolute deviations from prior year risk assessments and staffing and extent of testing decisions were significantly smaller for auditors with lower AIS expertise (all  $p$ 's  $< 0.070$ ).
11. Although auditors' control risk assessments might seem a reasonable candidate for this mechanism, the lack of support for Hypothesis 1 indicates that these assessments are not mediating the interactive effect of CAS competence and AIS expertise on scope measures described in Hypothesis 2a (that is, CAS competence and auditor AIS expertise do not significantly interact to affect auditors' control risk assessments, which is a requirement to demonstrate mediation; see Baron and Kenney 1986).
12. Non-tabulated mediation analyses for the timing and extent of substantive tests are qualitatively similar to those presented for a number of planned procedures (i.e., nature).
13. Prior studies have manipulated the competence of evidence sources such as client management, internal auditors, and subordinate auditors and have found homogenous auditor reactions to source competence variation (e.g., Bamber 1983; Anderson et. al 1994). Plausible explanations for the uniform auditor reactions are (a) the similarity in expertise structures (i.e., accounting and auditing) between the evidence sources and auditors and (b) auditors drawing on relatively equal levels of expertise in accounting and auditing to appropriately compensate when source competence was low. In our

study, it appears the low CAS competence condition required participants to draw significantly on a nontraditional expertise structure (i.e., AIS expertise) that varies substantially between auditors.

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