



A measure of perceived auditor ERP systems expertise

ERP systems
expertise

Development, assessment, and uses

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Abstract

Purpose – The purpose of this study is to develop, assess, and provide uses for a measure of perceived enterprise resource planning (ERP) systems expertise for financial statement auditors. ERP systems are the dominant system used by the public company clients of audit firms. In such settings, the Theory of Planned Behavior suggests that auditor perceptions of their own ERP systems expertise should influence their perceived behavioral control and, in turn, explain auditor behavior.

Design/methodology/approach – A five-item measure of perceived ERP systems expertise is developed from a review of audit expertise studies and the Theory of Planned Behavior.

Findings – An assessment of the measure shows that it possesses a high level of reliability and construct validity (i.e. convergent and discriminant validity). Factor analysis results indicate that all five items satisfactorily load on one factor. The results also suggest that auditors' perceptions of ERP systems expertise are not simply a by-product of general audit experience (AUDEXP).

Practical implications – Discusses possible future uses of the measure, including whether the measure explains auditor control testing performance and the customization of the measure for IT audit specialists and internal auditors.

Originality/value – This study's measure should provide researchers with a tool to examine how auditor self-perceptions of ERP systems expertise can affect auditor behavior and the quality of contemporary audit services.

Keywords Auditing, Business planning, Behaviour

Paper type Research paper

Introduction

The purpose of this study is to develop, assess, and provide possible uses for a measure of perceived financial statement auditor (hereafter, auditor) enterprise resource planning (ERP) systems expertise. While the clients of audit firms use a variety of systems to process accounting transactions, ERP systems are the dominant system environment for auditors servicing public clients. In 1999, 70 percent of the Fortune 1000 firms had either implemented or planned to implement ERP systems in the near future (Cerullo and Cerullo, 2000). In complex audit environments such as ERP systems, auditors will need to expand their technological knowledge and skills in order to perform effective and efficient audits (POB, 2000; Kinney, 2001). Ajzen's (1991) Theory of Planned Behavior suggests that auditors who perceive they have higher levels of ERP systems expertise should perceive they have more behavioral control in



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ERP settings. Behavioral control refers to the perception of the ease or difficulty of performing the behavior of interest (e.g. auditing in an ERP environment). Prior research in psychology has shown that perceived behavioral control strongly influences individual behavior (Bandura, 1982, 1991).

Recent accounting research has shown that, in ERP system settings,

- (1) auditors are not apt to recognize heightened inherent and control risks; and
- (2) auditors with higher perceived ERP systems expertise are better able to use IT audit specialists and plan the scope of substantive procedures to mitigate ERP system related risks (Hunton *et al.*, 2004; Brazel and Agoglia, 2004).

Therefore, perceived auditor ERP systems expertise may be a significant determinant of auditor behavior and audit quality in ERP environments. Unlike variables of interest to researchers that are characteristic of audit engagements and can be manipulated in an experiment (e.g. integrity of management), perceived auditor ERP systems expertise is a trait associated with the individual auditor. As such, if researchers wish to examine the role of this variable in experimental or survey research, a reliable and valid measure of perceived auditor ERP systems expertise must be developed and assessed. While the investigation of this construct appears to be a fruitful area for future research, no measure of this variable exists in the literature. Prior research examining the construct of expertise and Ajzen's (1991) Theory of Planned Behavior were reviewed to create a multiple-item scale designed to measure auditors' perceptions of ERP systems expertise. The multiple-item scale was then assessed for reliability and construct validity with 73 practicing audit seniors.

Assessment results for the measure indicate that it does possess a high level of reliability and construct validity (i.e. convergent and discriminant validity). The Cronbach's α associated with the items was found to be satisfactory and there is evidence that the measure is stable over time. Factor analysis results indicate that all five items intended to measure auditor self-assessed ERP systems expertise loaded heavily on one factor and this factor was labeled "perceived auditor ERP systems expertise". In addition, the results suggest that this perception is not correlated with general audit experience (AUDEXP). Possible uses of the scale are then discussed, including the use of the measure in experimental and survey research, the advantages and disadvantages of pre- and post-experimental measurement of auditors, and how the scale can be customized for use with other auditors (i.e. internal, information systems) or specific IT settings.

Development of measure

Within complex system environments, auditors will find it necessary to increase their systems expertise in order to provide them with the sophisticated audit skills required in such settings (Lilly, 1997; POB, 2000). As noted above, ERP systems appear to be the system used by the majority of large clients serviced by audit firms. ERP systems are defined as "information systems packages that integrate information and information-based processes within and across functional areas in an organization" (Kumar and Hillegersberg, 2000, p. 22). While the positive benefits associated with ERP system adoption (e.g. compliance with the Sarbanes-Oxley Act of 2002) have led to their widespread implementation (Winters, 2004), the profession has acknowledged that there are potential audit related risks associated with these complex systems

(POB, 2000). For example, 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). Given the complexity, pervasiveness, and potential risks associated with these systems, expertise in ERP systems may explain auditor behavior in these settings (Wright and Wright, 2002; Guess *et al.*, 2000).

Chi *et al.* (1982, p. 8) define expertise as “the possession of a large body of knowledge and procedural skill”. Prior research has shown that increased levels of expertise in specific domains can improve the domain specific performances of auditors (Bonner, 1990; Bonner and Lewis, 1990; Hunton *et al.*, 2004). Expertise studies in auditing have “mainly used the contrastive cross-sectional approach, where groups of experts and novices are compared on various dimensions” (Bedard and Chi, 1993, p. 23). While these studies are useful in identifying the differences between more and less experienced auditors, they offer little explanation for the causes of these differences (Bedard and Chi, 1993) and do not examine why variation exists in the performances of auditors with the same level of general AUDEXP (Bonner and Lewis, 1990).

Unlike other variables of interest to audit researchers that can be experimentally manipulated (e.g. the complexity of a client’s system), ERP systems expertise is a trait associated with the individual auditor. Since one cannot readily manipulate factors such as forms of intelligence, a reliable and valid measure of ERP systems expertise must be developed (Peecher and Solomon, 2001). Bonner and Lewis (1990, p. 2) suggest that researchers should “pay more attention to the criteria used to designate subjects as experts, either directly by the use of objective performance measures or indirectly by the use of well-specified measures of knowledge and ability”. Similar to other domains of auditor expertise, an objective performance measure of ERP systems expertise would often be impractical for researchers to obtain (Abdolmohammadi and Shanteau, 1992). What researchers can obtain from auditor participants in their studies are auditors’ self-assessments of ERP systems expertise. Indeed, in their seminal study of auditor expertise, Bonner and Lewis (1990) measured auditors’ self-reported expertise levels and found these measures explained auditor performance. The Theory of Planned Behavior (Ajzen, 1991) suggests that higher levels of perceived ERP systems expertise should enhance the perceived ease of performing audit activities in an ERP setting. Such behavioral control should influence individuals’ thought patterns, choice of activities, preparation for activities, and effort expended (Bandura, 1982, 1991). Thus, a measurement of perceived auditor ERP systems expertise may be useful to researchers attempting to explain auditor behavior in ERP system environments.

Given that no measure of perceived auditor ERP systems expertise exists in the literature, prior research examining auditor expertise and Ajzen’s (1991) Theory of Planned Behavior were reviewed to create a multiple-item scale designed to measure the construct. Prior research has focused on the role that domain-specific experience plays in expertise (Bonner, 1990; Bonner and Lewis, 1990; Ashton, 1991; Mauldin and Ruchala, 1999). Domain-specific experience is presumably the basis for obtaining the knowledge needed to become an expert (Abdolmohammadi and Shanteau, 1992). As such, included in the multiple-item scale were measures of auditors’ perceptions of their experience levels with auditing ERP systems, their time spent auditing ERP systems, and how early in their careers they began auditing ERP systems. Training in a given domain is expected to combine with experience to increase domain-specific expertise

levels (Bonner and Lewis, 1990; Bedard and Chi, 1993). Therefore, the level of perceived ERP systems training of auditors, both formal and informal, was measured[1]. Measurements of perceived experience and training as surrogates for perceived expertise/behavioral control are consistent with the Theory of Planned Behavior as it predicts behavioral control and, in turn, behavior, to be dependent on past experiences, resources, and anticipated impediments and obstacles (Ajzen, 1991). Lastly, Ajzen (1991) states that when behavioral control perceptions are expected to affect behavior, one must directly measure the construct that determines the level of behavioral control. Thus, in addition, auditors' perceptions of their ERP systems expertise were directly measured[2].

Auditors were asked to evaluate their perceived ERP systems expertise relative to other in-charge auditors or audit seniors (peers). This reference point is appropriate given that future research may use the measure to investigate the effects of this perception on the behavior of auditors with the same general level of experience within audit firms. It is also most applicable to seniors because their skills or expertise are rated against their fellow seniors during the promotion and compensation process. Thus, seniors are generally informed with regard to their expertise levels in relation to those of their peers. While this reference point may vary between auditors (i.e. auditors have different peer groups), the provision of the reference point allows auditors a relatively constant frame of reference when responding to the items[3]. Researchers investigating auditor ERP systems expertise with respect to other types of auditors (e.g. internal auditors, audit managers) can customize the questions to their participants.

The five questions and the eight-point Likert scale that were used to measure perceived auditor ERP systems expertise are provided in the Appendix. Other forms of systems (e.g. internal control applications) can be substituted for "ERP systems" by researchers using the measure in other settings. Lastly, the Likert scale for the measure contains no mid-point, thus inducing respondents to rate their expertise either above or below their peers. The intent of not providing a mid-point (i.e. not allowing participants to rate their expertise as equal to their peers) was to promote variation between auditors' responses to the questions.

Assessment of measure

The multiple-item scale developed in this study was assessed for reliability and construct validity with 73 practicing audit seniors (participants) from four international and two national public accounting firms. The offices of the firms that participated in the study were located throughout the US. Participants had an average of 3.68 years of AUDEXP. As discussed above, five items were used to measure perceived auditor ERP systems expertise. Participants recorded their responses to these items on eight-point scales. Internal consistency and factor analysis results indicate that the five-item measure does possess significantly high levels of both reliability and construct validity, respectively. Cronbach's α was calculated to assess the internal consistency of the measure. Results from the sample provide an α level of 0.9542 (non-tabulated), well above the generally accepted threshold of 0.70 recommended by Nunnally (1978). In addition, randomly splitting the sample into two groups of 36 and 37 participants provides acceptable α levels of 0.9634 and 0.9472 (non-tabulated), respectively. The test-retest method of assessing the reliability or

stability of the measure over time was infeasible due to restrictions on accessing the study's participants twice. In such cases, Mason and Levy (2001) suggest comparing the results of this study's sample to that of a prior sample of auditor participants in order to measure the stability of the instrument over time. Obtaining similar assessment results between two samples separated by time supports the assertion that the measure is stable (Mason and Levy, 2001). A pre-test of the measure, consisting of 45 practicing auditors, occurred approximately one year before this study. The pre-test's Cronbach's α was similar to the α level of this study and factor analysis results from the pre-test were consistent with those presented below[4]. Overall, it appears that the measure is reliable.

The assessment of construct validity (i.e. convergent and discriminant validity) for the five-item measure of perceived auditor ERP systems expertise was performed via exploratory factor analysis. Participants' general AUDEXP, coded in years (range = 1.00-10.92 years), was also included in the analysis to determine whether or not the ERP systems expertise items and general AUDEXP appear to measure separate factors (i.e. discriminant validity). Exploratory factor analysis via the principle components analysis method was performed on the sample data.

First, a correlation matrix was produced for all six items (i.e. five ERP systems expertise items and one general AUDEXP measure). Table I contains the Spearman correlation matrix. Table I reports that all five items intended to measure perceived auditor ERP systems expertise were significantly positively correlated (all p 's < 0.001). In addition, none of the five expertise items were significantly correlated with the general AUDEXP item (all p 's > 0.40). The lack of correlation between the ERP systems expertise items and the measure of general AUDEXP suggests that auditors' perceptions of ERP systems expertise are not simply a by-product of general AUDEXP.

Next, factors (components) were extracted for all six items via principal components analysis. Utilizing Kaiser's (1960) eigenvalue-one criterion,

Item ^a	Spearman correlation matrix					
	ERPTRAIN	ERPEXP	ERPTIME	ERPBEGAN	ERPEXPERT	AUDEXP
ERPTRAIN	<i>1.00</i>	<i>0.864</i>	<i>0.747</i>	<i>0.728</i>	<i>0.829</i>	-0.097
ERPEXP		<i>1.00</i>	<i>0.704</i>	<i>0.679</i>	<i>0.874</i>	-0.021
ERPTIME			<i>1.00</i>	<i>0.800</i>	<i>0.791</i>	-0.039
ERPBEGAN				<i>1.00</i>	<i>0.755</i>	-0.023
ERPEXPERT					<i>1.00</i>	-0.024
AUDEXP						<i>1.00</i>

Notes: Italics = Significant correlations at the $p < 0.001$ level (two-tailed test); ^a The five items related to auditing complex and pervasive accounting information systems (e.g. ERP systems) and asked participants to respond on eight-point scales (1 = "strongly disagree"; 8 = "strongly agree"). All five items began with the same prompt ("Relative to other in-charge auditors at my firm"), before diverging. The divergent wording related to each of the individual items was: "I have received *more* combined informal and formal *training* during my career" (ERPTRAIN) "I have *more experience*" (ERPEXP) "a *larger* portion of my *time* is assigned" (ERPTIME) "I *began* at an earlier point in my career" (ERPBEGAN) "I have a *higher* level of *expertise*" (ERPEXPERT). Participants were also asked to provide their AUDEXP in months which was then coded into years (AUDEXP)

Table I. Spearman correlation matrix for perceived auditor ERP systems expertise items and AUDEXP

non-tabulated results show that two factors were extracted from the data (i.e. the results show two components have eigenvalues exceeding one). Table II presents the principal components factor matrix, which indicates how each of the six items loaded on the two factors. Inspection of Table II reveals that factor (component) one loadings for all five items intended to measure perceived auditor ERP systems expertise were satisfactorily greater than the commonly used threshold of 0.50 (Nunnally, 1978). Table II also depicts that the measure of general AUDEXP had satisfactory loadings greater than 0.50 on factor two. Consistent with the correlation matrix, this finding indicates that auditors' perceptions of ERP systems expertise may not be a factor of career longevity, but rather more likely affected by the specific client experiences, training, etc. of auditors[5].

Participants' mean expertise scores were measured as their mean response to the five items listed in the Appendix. Table III contains descriptive statistics and the frequency distribution for the mean expertise scores of the participants. The mean and median scores of the sample were 3.315 and 3.000, respectively. In addition, the sample's mean expertise scores appear to be fairly well distributed.

To determine the propensity of the measure to dichotomize sample participants into sub-samples perceiving either low or high ERP systems expertise, participants scoring below and above the median expertise score of 3.000 were classified as perceiving low and high expertise, respectively. Owing to the subjectiveness of the construct, the median score of the sample was used, as it is impossible to declare with certainty the exact point at which an auditor does or does not perceive high ERP systems expertise (Baron and Kenny, 1986). Means for the low and high expertise groups were 1.800 and 4.947, respectively. Based on scale labels for the five items, responses of 2 and 5 indicate that participants "mostly disagreed" and "mildly agreed", respectively, that their expertise exceeded their peers. A one-tailed independent-samples *t*-test (not tabulated) indicated a significant difference between the two groups ($p < 0.001$)[6]. These differences between the low and high expertise groups

Item ^b	Component matrix ^a	
	Component 1	Component 2
ERPTRAIN	0.930	0.011
ERPEXP	0.919	0.013
ERPTIME	0.916	-0.008
ERPBEGAN	0.885	0.010
ERPEXPERT	0.955	-0.025
AUDEXP	0.001	1.000

Notes: Extraction method: principal component analysis; ^a Two components extracted; and ^b The five items related to auditing complex and pervasive accounting information systems (e.g. ERP systems) and asked participants to respond on eight-point scales (1 = "strongly disagree"; 8 = "strongly agree"). All five items began with the same prompt ("Relative to other in-charge auditors at my firm"), before diverging. The divergent wording related to each of the individual items was: "I have received *more* combined informal and formal *training* during my career" (ERPTRAIN) "I have *more experience*" (ERPEXP) "a *larger* portion of my *time* is assigned" (ERPTIME) "I *began* at an earlier point in my career" (ERPBEGAN) "I have a *higher* level of *expertise*" (ERPEXPERT). Participants were also asked to provide their AUDEXP in months which was then coded into years (AUDEXP)

Table II.

Component matrix for perceived auditor ERP systems expertise items and AUDEXP

Mean expertise score ^a	Frequency	Percent	Cumulative percent
1.0	5	6.85	6.85
1.2	2	2.74	9.59
1.4	4	5.48	15.07
1.6	3	4.11	19.18
1.8	4	5.48	24.66
2.0	10	13.70	38.36
2.2	2	2.74	41.10
2.4	2	2.74	43.84
2.6	3	4.11	47.95
2.8	1	1.37	49.32
3.0	3	4.11	53.42
3.2	3	4.11	57.53
3.4	3	4.11	61.64
3.6	1	1.37	63.01
3.8	5	6.85	69.86
4.0	1	1.37	71.23
4.2	1	1.37	72.60
4.4	1	1.37	73.97
4.8	1	1.37	75.34
5.0	2	2.74	78.08
5.2	1	1.37	79.45
5.4	1	1.37	80.82
5.6	2	2.74	83.56
5.8	2	2.74	86.30
6.0	1	1.37	87.67
6.2	3	4.11	91.78
6.4	2	2.74	94.52
6.6	1	1.37	95.89
6.8	1	1.37	97.26
7.0	1	1.37	98.63
7.2	1	1.37	100.00
Total	73	100.00	
Mean		3.315	
Median		3.000	
Std. Deviation		1.815	

Notes: ^a Participants' mean perceived ERP systems expertise scores were measured as their average response to the five, eight-point scales listed in the Appendix

Table III.
Frequency distribution
and descriptive statistics
for mean perceived
auditor ERP systems
expertise measure

indicate that the measure divided participants into two groups possessing significantly different perceptions of their own ERP systems expertise.

Lastly, a study by Brazel and Agoglia (2004) provides some evidence supporting the concurrent validity of the measure. Concurrent validity is the extent to which a measure can predict performance measured at the same time. They find that the measure provides two groups of auditors (i.e. auditors perceiving low and high ERP systems expertise), which differ in their assessments of risk and planning of substantive tests in an ERP setting. Additionally, with the aid of experienced auditors, it was determined that auditors perceiving high ERP systems expertise provided higher quality risk assessments and planned more effective substantive tests. Therefore, there is limited support that the measure behaves as expected.

Uses of measure

This section discusses possible uses for, and other issues concerning, the perceived auditor ERP systems expertise measure. The measure can be used to capture perceived auditor ERP systems expertise as part of an experimental study interested in determining its effects upon auditor performance, audit quality, auditor perceptions, etc. As noted above, Brazel and Agoglia (2004) find that the measure provides two groups of auditors (i.e. auditors perceiving low and high ERP systems expertise) which differ in their judgments and performance. Results from their study also suggest that the measure is superior to general AUDEXP when explaining auditor behavior in an ERP system setting. Other uses of this measure include studies of the effects of perceived auditor ERP systems expertise on their identification of control weaknesses as part of the recently approved standard requiring auditors to review and attest to the effectiveness of corporate internal controls (PCAOB, 2004). Winters (2004) notes that many public corporations have adopted ERP systems to assist them in their compliance with the Sarbanes-Oxley Act of 2002 and its related standards.

Given the apparent lack of correlation between ERP systems expertise and general AUDEXP, studies examining the performance differences between auditors with high ERP systems expertise and auditors with extensive general AUDEXP might contribute to our understanding of what experience/expertise factors best explain performance and in a variety of audit settings. For example, it may be preferable to assign a less experienced auditor with an ERP systems background to an ERP systems audit environment than a more senior auditor who may lack this domain of expertise. Survey research might measure a multitude of antecedent variables such as personal client experiences, specific firm trainings, and the ERP systems expertise of superiors (in conjunction with this study's measure) to determine their impact on the construct. Such research might provide insight into how firms can develop ERP systems expertise (or perceptions of behavioral control in ERP environments) in the initial years of auditors' careers.

The assessment above provides evidence that the measure can either dichotomize a sample of auditors into groups perceiving either low or high ERP systems expertise or provide substantial variation in mean participant responses (Table III). Thus, this measure could be used in either ANOVA or as a continuous variable (i.e. mean participant response score) in ANCOVA and regression analyses of participant data. Given that perceived ERP systems expertise is a measured (versus manipulated) variable, researchers should take great care in measuring other possible explanatory variables in order to evaluate possible causal relationships between the measure and a particular outcome variable. For example, when investigating the effects of this perception on auditor risk assessments, researchers should measure participants' experience with assessing risks. If such experience is insignificant between groups, then the researcher can possibly rule out that variable as one that drives any expertise results. In cases where such a variable is significant between groups, the researcher can then include the measure in ANCOVA or as a control variable in regressions to determine whether perceived ERP systems expertise provides additional explanatory power.

One of the benefits of the measure is that perceived auditor ERP systems expertise can be measured in very little time. While Choo and Curtis' (2000) review of the expertise literature suggests using far more thorough measures of auditor expertise

(e.g. analysis of participant performance on an ERP system related task), the measure provided in this study may be an economical way of capturing perceived ERP systems expertise/behavioral control from auditors who have expended considerable mental effort in an experimental case study or survey. The provision of an exhaustive measure of ERP systems expertise after an experimental case study might cause auditors to drop out of the study or complete such a measure with less than their full attention. Therefore, a more time consuming measure might result in lost or inaccurate data. Audit professionals are a valuable resource for academic researchers and great care should be taken to ensure their use in studies is both effective and efficient.

The above discussion suggests that the measurement of perceived auditor ERP systems expertise could occur in a post-experimental questionnaire. This is advisable for two reasons. First, it is often difficult to obtain double access to audit professionals. Therefore, measuring auditor expertise and then later randomly assigning participants to experimental conditions can often be impractical. Second, measuring ERP system perceptions at the beginning of an experimental case study may sensitize participants to the research questions under investigation (e.g. the effects of perceived auditor ERP systems expertise on their performance in a given task). Researchers measuring ERP systems perceptions as an independent variable after dependent variables have been obtained should be certain that the experimental instrument does not substantially affect participants' expertise scores. In cases where participants are expected to gain ERP expertise through the completion of experimental materials, it is advisable to pre-measure auditors' expertise levels to enhance any causal interpretations. For studies that simply induce participants to use their ERP systems expertise in responding to experimental manipulations and other case study information, the measure can be used post-experimentally similar to the measurement of other demographic variables (e.g. general AUDEXP, industry expertise).

As indicated in the assessment section, this measure can be customized by future researchers to measure how other types of auditors perceive their ERP systems expertise/behavioral control in ERP system settings. Prior research has indicated concerns among auditors regarding deficiencies in IT audit specialist expertise (Hunton *et al.*, 2004; Brazel and Agoglia, 2004). Tailoring the measurement questions to factors influencing IT auditor perceived expertise and relating this perception to their control testing should provide insight into how these specialists can be used by auditors to meet new control testing standards (PCAOB, 2004). The findings of Brown (1983) and Margheim (1986) indicate that auditors are sensitive to the expertise of internal audit and rely more on the work of highly competent internal auditors. To investigate the positive effects of internal auditor ERP systems expertise, the measure's questions could be modified and used in studies examining how their expertise positively impacts the reliability of system related controls and corporate financial statements. The measurement items presented in the Appendix measure senior-level auditor perceived ERP systems expertise. With little customization, the measure could be used by researchers interested in examining the effects of audit staff, manager, or partner expertise perceptions on their performance in a variety of other system contexts (e.g. internal control applications). Lastly, when customizing the measure to other types of auditors or systems, researchers should pre-test the measure to determine the reliability and validity of the modified measure.

Conclusions and limitations

The purpose of this study was to develop, assess, and provide uses for a measure of perceived auditor ERP systems expertise. A review of the auditor expertise literature and Ajzen's (1991) Theory of Planned Behavior provided a five-item measure. An assessment of the measure shows that it possesses a high level of reliability, construct validity, and the results of Brazel and Agoglia (2004) support the concurrent validity of the measure. Interestingly, the results suggest that auditor perceptions of ERP systems expertise are not significantly related to general AUDEXP. Therefore, it may not be prudent to assume that auditor perceptions of ERP systems expertise (or perceptions of behavioral control in ERP settings) automatically increase in conjunction with the longevity of their audit careers. The measure also has the propensity to:

- (1) dichotomize auditors into distinct groups perceiving either low or high ERP systems expertise for experimental research; and
- (2) provide significant variation in participant responses for use in survey studies.

Possible future uses of the measure include examining its effects on the performance of ERP system related audit tasks and customizing the measure to determine the systems expertise levels of other types of auditors. Such research will advance our understanding of the role perceived auditor ERP systems expertise plays in influencing auditor behavior and determining the quality of contemporary audit services.

There are several limitations to this study and the measure it has developed. First, the measure captures auditors' perceptions or self-assessments of ERP systems expertise, not their actual experience, training, etc. with respect to ERP systems. The measure thus lacks objectivity or does not measure actual behavioral control in an ERP system setting, although Ajzen (1991, p. 183) suggests "while the importance of actual behavioral control is self-evident ... of greater psychological interest ... is the perception of behavioral control and its impact on ... actions". In addition, any objective measure available to academic researchers (e.g. hours auditing ERP systems) will still be self-reported by auditor research participants and thus subject to bias. Still, future research using this study's measure should obtain more objective measures (or determinants) of auditors' ERP systems expertise to:

- (1) evaluate if auditor perceptions of expertise mirror actual expertise; and
- (2) determine whether more objective or perceived expertise measures better explain auditor behavior.

Second, the Theory of Planned Behavior (Ajzen, 1991) indicates that intentions can combine with perceived behavioral control to affect behavior. The construct of auditor intent with respect to ERP systems was excluded from this study in an attempt to achieve a parsimonious measure. Given that auditors are part of a profession and thus abide by a code of conduct, intentions toward auditing may be a perception that lacks the variation present in perceived behavioral control, which is affected by personal training/experience. Notwithstanding, future research could evaluate whether the measure can be improved (i.e. better explain auditor behavior) by adding questions to capture the construct of intent.

Third, more research is needed to evaluate the predictive and concurrent validity (i.e. criterion validity) of the measure and its stability over time. Fourth, the measure relates to a specific form of system: ERP systems. While this form of system may be

the dominant type encountered by auditors of public companies (Cerullo and Cerullo, 2000), there are a variety of systems in use and this measure may not properly measure auditor perceptions of expertise with respect to other IT. Lastly, the audit expertise literature has clearly shown that experience and training combine to create expertise in auditors. Still, other dimensions of ERP systems expertise not included in the measure (e.g. ERP implementation knowledge) may be relevant to determining perceived auditor ERP systems expertise. Future research investigating auditor interactions with ERP systems may uncover such additional sources of expertise.

Notes

1. Discussions with audit practitioners indicated that ERP systems training was often received from firm provided formal training sessions and/or informal (on the job) training. In order to fully measure perceived auditor ERP systems training, both sources of training were combined in one item.
2. Prior audit expertise research has focused on the combined role of experience and training in the development of expertise. As research into auditor interactions with ERP systems (or other complex systems) progresses, other complementary sources of ERP systems expertise may be identified and potentially added to this study's measure.
3. By not providing a reference point, albeit a reference point which is perceived by the auditor and may vary between auditors, the researcher maintains no control over how auditors interpret the question. For example, one auditor may assess his or her ERP systems training in relation to his or her peers, while another may assess his or her training in relation to a competent IT audit specialist. Such confusion would certainly reduce the explanatory value of the measure.
4. Non-tabulated internal consistency and factor analysis results for the pre-test sample 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 0.70) (Nunnally, 1978). General AUDEXP (in years) and level within their firm (e.g. fourth year) for the pre-test participants loaded on a separate factor.
5. Orthogonal (varimax) and oblique (direct oblimin) rotations of the factors (non-tabulated) do not qualitatively change the results.
6. Three participants had mean scores of 3.000 and were removed from the original sample of 73 auditors for the independent-samples *t*-test performed.

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Appendix. Perceived auditor (ERP) systems expertise measure

The following questions measure perceived auditor ERP systems expertise.

- (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 (strongly disagree), 2 (mostly disagree), 3 (somewhat disagree), 4 (mildly disagree), 5 (mildly agree), 6 (somewhat agree), 7 (mostly agree), 8 (strongly agree).