Auditors' Evidence Evaluation and Aggregation Using Beliefs and Probabilities

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***Abstract*—This paper examines auditors' performance when they make belief-based or probability-based risk assessments by focusing on two phases of the audit process: the assessment of audit evidence and the aggregation of evidence. Based on an experiment in which forty eight experienced auditors participated, we find that auditors make essentially the same risk assessments regardless of whether they use beliefs or probabilities. More specifically, there is no significant difference in the assessed strength of evidence between the belief function treatment and the probability treatment and auditors' aggregation of evidence is not in accordance with 'AND' logic in both treatments. However, the difference in the assessed direction of evidence between these two approaches is significant. These results raise issues which need to be addressed in practice and in future research.**

Keywords: Risk assessment, Belief functions, Probability, Audit risk.

I. Introduction

The purpose of this experiment is to examine whether the approach to risk assessment adopted by auditors affect their assessments. Two prominent approaches to risk assessment are considered: probability theory and the theory of belief functions. Little is known about how various investigators including auditors perform when they provide belief-based versus probability-based risk assessments. In this study, we examine the assessment and aggregation of audit evidence by forty eight practicing auditors.

We find that the auditors' assessments of strength of evidence do not differ significantly when measured by likelihood ratios based on beliefs which are transformed into probabilities using the Cobb and Shenoy [1][2][3] transformation method. However, in one setting the evidence was interpreted completely opposite contingent on whether the assessments were belief-based or probability-based. We also find that auditors do not aggregate their assessments according to the logical 'AND' rule implied by the judgment setting being audited. These findings indicate that the risk assessment approach may have critical effects that need to be considered in business and audit practice and in future audit research.

II. Literature Review and Hypothesis Development

The importance of risk assessment in auditing continues to be emphasized in literature [4] as is evidenced by the issuance of new 'risk assessment' auditing standards (SAS Nos. 104-111). These standards suggest that a financial statement audit is a recursive process in which auditors make risk assessments related to various management assertions based on evidence. Thus the audit team must plan, collect and evaluate audit evidence in response to assessed risks and aggregate the evidence to ultimately form an opinion regarding the fair presentation of financial statements.

Although auditing standards emphasize the importance of risk assessment and require auditors to consider the 'likelihood' that a material misstatement will occur (e.g., SAS No. 109 and No. 110), few guidelines are provided about how to define likelihood or how to measure and express risks. Audit standards suggest that risk components may be assessed quantitatively by using percentages or non-quantitatively by using a categorical scale (SAS No. 47) such as *maximum-moderate-low* or *high-medium-low*. However, in cases such as when conducting audit sampling, auditors may feel comfortable with using a percentage (e.g., a 'probability') in assessing sampling risk since sampling techniques are based on probability theory [5].

Given that the audit risk formula is illustrated by using a percentage scale in auditing standards, audit risk is often conceptualized as the *probability* of a material misstatement. Historically, during audit planning, auditors could assess two important risk components, *inherent risk* and *control risk*, at the maximum level (risk = 1.00) if strategically this seemed to be the most efficient approach (SAS No. 47). However, it is problematic to set inherent or control risk at maximum because a 1.00 probability assessment implies certainty [6][7]. During audit planning, the auditor has limited evidence and almost never would be certain as to either inherent or control risk.

A more reasonable interpretation of assuming maximum risk is that it is the *plausibility* of a material misstatement

that is being assessed. That is, the assessed risk is the sum of the belief that a material misstatement is present and an assessment of uncommitted belief [6]. Thus in auditing standards and practice, audit risk is sometimes considered to be probability and in other cases as plausibility.

One important problem encountered when using probability in risk assessment is that the level of ambiguity auditors have concerning the risk assessment is not made explicit. However, unless an auditor decreases the level of ambiguity to an acceptable level, an unqualified audit opinion cannot be provided (SAS No. 31).

Unlike probability assessments, auditors must explicitly express the level of ambiguity under the belief functions approach. While using either belief-based or probability-based risk assessments would contribute to making auditors' risk assessments quantitative, belief-based assessments have the additional advantage of making the level of ambiguity explicit. However, it is not clear whether these two approaches result in different audit risk judgments. Obtaining experimental evidence on differences between belief-based and probability-based assessments will both clarify this issue and allow audit quality to be improved.

In psychology, judgment elicitation approach effects often have been addressed as the issue of response mode effects. For example, some psychology research has investigated whether probability judgments elicited verbally are different from judgments elicited numerically and has found that people express their judgments verbally and numerically equally well and consistently [8][9]. However, other studies report significant response mode effects. For example, more extreme responses are observed in verbal judgments as compared to numerical judgments [10].

The effect of the elicitation approach on probability judgments has also been examined in auditing research. For example, Reimers et al. [11] compare control risk assessments made by using categorical expressions with those made using probabilities and find that the numerical assessments are significantly smaller than the categorical assessments. They also find that consensus is higher when categorical assessments are used. However, Stone and Dilla [12] report that in assessing inherent risk, auditors show higher consensus and consistency when their risk assessments are numerical rather than categorical.

In summary, prior studies in psychology, auditing and accounting do find response mode effects in various probability assessment contexts. A study of risk assessments which are belief-based versus probability-based contributes to the literature by providing evidence concerning possible important differences in risk assessment.

A. The effect of 'approach' on the assessment of audit evidence

One important feature of auditing is the assessment of evidence as auditing standards require auditors to obtain sufficient and appropriate audit evidence (e.g., SAS No. 106). However, it is not clear how auditors should assess and measure the sufficiency and appropriateness of obtained evidence. In determining whether sufficient and appropriate evidence has been obtained and in assessing audit risk, auditors need to assess the *direction of evidence*, that is, whether it is confirming, disconfirming, mixed or has no diagnostic value and the *strength of evidence*. A novel feature of this study is that we estimate the auditor's implicit assessment of direction/strength of evidence and examine the effects of risk assessment approach on the auditors' assessments.

Given that there is no prior study that examines the effect of risk assessment approach on auditors' assessments of evidence and it is unclear how such differences would affect the auditor's implicit assessment of the strength of evidence or of whether evidence tends to be confirming, disconfirming or mixed, our hypotheses are stated in a null form as follows:

HYPOTHESIS 1a. *The assessed strength of evidence using belief-based versus probability-based assessments is not expected to differ significantly*.

HYPOTHESIS 1b. *The assessed direction of evidence using belief-based versus probability-based assessments is not expected to differ significantly*.

B. The effects of 'approach' on evidence aggregation

A second important aspect of evidence evaluation in auditing is the *aggregation of audit evidence*. Under the audit risk model, auditors need to consider the effects of misstatements in the *aggregate* as well as at the financial statement account-level in light of a significance or *materiality* threshold (e.g., SAS No. 107). Although auditing standards provide little guideline regarding how to aggregate evidence across financial statement assertions, one logical approach to quantitatively aggregate the assessments is to use the logical 'AND' rule [6]. This logic provides an important benchmark to evaluate the auditors' judgments by comparing their actual aggregations with those derived using the 'AND' rule.

Prior studies report that auditors do not aggregate various assessments well. For example, Jiambalvo and Waller [13] find that auditors' actual assessments of the allowable risk of incorrect acceptance for planned substantive audit tests based on three risk components are significantly different from those calculated by using the audit risk model as specified in SAS No. 39. Similar results are reported by Daniel [14], who examines auditors' assessments of audit risk components and finds that auditors do not aggregate the audit risk components in a way that is consistent with the models in auditing standards.

Dusenbury et al. [15] compare various audit risk models such as the SAS model, a model adopted by an auditing firm and a belief functions-based model and find that the firm-

specific model is more *conservative* than the SAS model and that the belief functions-based model is more *conservative* than the firm-specific model. Monroe and Ng [16] compare auditors' intuitive assessments of audit risk and the traditional audit risk model as well as various alternative models including the belief functions model. They find that there are inconsistencies between the auditors' intuitive assessments and the traditional audit risk model, but there is no significant difference between the auditors' intuitive assessments and the belief functions model. Furthermore, Mock et al. [17] indicate by analyzing verbal protocol data that although most auditors exhibit reasoning consistent with a probability representation, the auditors have difficulty in revising beliefs consistent with Bayes' theorem in the evidence aggregation phase of the task.

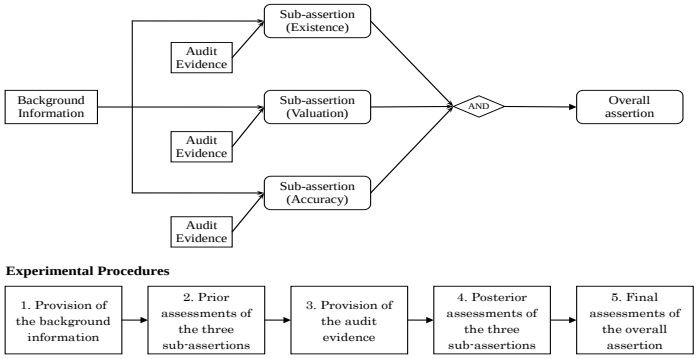

Figure 1. Evidential network for auditors' risk assessments and its aggregation and experimental procedures

Given that prior studies show evidence that auditors have difficulty in aggregating their risk assessments, it is important to examine whether risk assessment approach also affects the degree of consistency with 'AND' logic in aggregating evidence as well as whether the aggregation of evidence assessments based on belief functions and probability differs. However, it is unclear how the approach to risk assessment might affect either the level of aggregated evidence assessments or the degree of consistency with 'AND' logic. Thus, our hypotheses are stated in a null form as follows:

HYPOTHESIS 2a. *The aggregated levels of assessed risks obtained using belief-based versus probability-based assessments are not expected to differ significantly.*

HYPOTHESIS 2b. *The aggregated levels of assessed risks obtained using belief-based versus probability-based assessments are not expected to differ significantly from those obtained using 'AND' logic.*

III. RESEARCH METHOD

A. Research framework

In this study, the auditor's task is modeled as an evidential network. Evidential networks have been utilized in many decision making studies [18][19] and in auditing [6][20][21]. Figure 1 depicts the sequential reasoning involved in our experiment and shows key relationships among three financial statement sub-assertions, an overall assertion and provided audit evidence.

B. Description of the experiment

To examine the hypotheses, an experiment was conducted using 48 practicing auditors from Japanese Big 4 firms. The case materials used were developed by the researchers, pilot tested and revised according to suggestions provided by liaisons from one of the participating firms. Then liaisons from each audit firm distributed the case materials, collected completed ones and forwarded them to the researchers.

Among the 48 participants, seven are partners, six are senior managers, fourteen are managers, twelve are seniors and eight are junior auditors (Data on staff rank are missing for one participant). The participants were randomly assigned to each treatment. Their average audit experience is 9.6 years.

C. Task and manipulations

In the experiment, we manipulate the 'approach' (belief-based vs. probability-based assessments) to elicit auditors' assessments related to three sub-assertions and one overall assertion. The research instrument is organized as follows (see Figure 1). First, the purpose of the study and general instructions were provided to participants. Then training materials illustrated how auditors' risk assessments should be expressed using either beliefs or probabilities.

Following the instruction and training sections, background information on a hypothetical client was provided. The client was described as a manufacturer of tools for cutting materials and parts. Also, information regarding the audit engagement, the results of the prior years' audit, a materiality threshold, and the summarized financial statements was included.

Then the participants were asked to assume that they were working on the audit of the accounts receivable. They were provided with three sub-assertions (existence, valuation and accuracy) and were asked to make risk assessments related to these assertions based on the background information using either beliefs or probabilities.

In the belief functions treatment, the auditors were asked to express the belief assessments that a presented sub-assertion was true ($m(a)$), was false ($m(\sim a)$), and the uncommitted belief ($m(\{a, \sim a\})$) so that the sum of these three assessments equals to one. In the probability treatment, the auditors were asked to assess the probabilities that a sub-assertion was true ($p(a)$) and false ($p(\sim a)$) so that the sum of these two assessments equals to one.

After these assessments were made, audit evidence was provided for each sub-assertion, and the auditors were asked to update the assessments, that is to provide posteriors, based on the evidence. The provided audit evidence for the existence, valuation and accuracy assertions, respectively, was the results of 1) confirmations of the accounts receivable; 2) enquiries to the company's credit department concerning the estimate of the allowance for bad debts; and 3) the results of the statistical sampling of sales transactions.

Based upon pilot testing and consultations with liaisons, we expect the evidence for the existence and accuracy assertions to be moderate in strength and confirming. The evidence for the valuation assertion, the credit department enquiries, is expected to be mixed (partly confirming and partly disconfirming), but overall, slightly confirming. As discussed later, the auditors' actual assessments of the strength and direction of the evidence are generally consistent with these expectations.

The audit evidence was designed so that each item of evidence could be assessed independently. To reinforce this, the auditors were asked to take only the item for a particular sub-assertion into account and not to consider the evidence for other assertions. Independence among the evidence items allows us to model the evidential network with a 'tree structure' (see figure 1) rather than as a network which is a much more complex structure to model and evaluate.

Then the auditors made final assessments of the overall assertion regarding the fair presentation of the accounts receivable based on all the information provided in the case materials including the background information and the audit evidence provided for each sub-assertion. The final assessments require the auditors to aggregate the prior risk assessments and evidence assessments.

D. Variables

The main independent variable of this study is the approach used to express auditors' risk assessments of various assertions (belief-based vs. probability-based). As stated above, we are interested in whether the auditors' evidence assessments and aggregation of evidence are affected by the approach used to express their risk assessments.

Since the belief and probability assessments are measured on a different scale, it is not meaningful to compare these assessments directly. Thus, to compare the risk assessments and other attributes related to these assessments, we transform belief assessments into probability using the plausibility transformation method proposed by Cobb and Shenoy [1][2][3] and make comparisons based on the transformed beliefs and the corresponding probability assessments.

To measure the assessed strength and direction of evidence, we use the likelihood ratio, λ_E. The variable λ_E is defined as $(p'(a)/p'(\sim a)) / (p(a)/p(\sim a))$, and $p'(a)$ and $p'(\sim a)$ are posterior probability assessments that an assertion '*a*' is true and false, respectively, and $p(a)$ and $p(\sim a)$ are prior probability assessments that an assertion '*a*' is true and false, respectively. If λ_E is larger than one ($\lambda_E > 1$), this implies that, overall, the direction of evidence is perceived as confirming the assertion '*a*' and that the larger λ_E is, the stronger the perceived evidence is. On the other hand, if λ_E is smaller than one ($0 < \lambda_E < 1$), the direction of evidence is perceived as disconfirming the assertion '*a*' and the smaller λ_E is, the stronger the evidence is. Also, if λ_E equals to one, the evidence is perceived as having no strength or direction, that is, no diagnostic value.

In the experiment, auditors make belief or probability assessments of three sub-assertions and the overall assertion as described earlier. 'AND' logic implies that the overall assertion is true if and only if the three sub-assertions are true. Although there are alternative ways of aggregating these items, in this paper we use the logical AND rule as it is the prominent approach used in prior evidential reasoning studies [6][22]. According to probability theory and 'AND' logic, the probability that the overall assertion is true is calculated as follows.

$$p(a_O) = p(a_E)*p(a_V)*p(a_A)$$

where $p(a_O)$ is the probability that the overall assertion is true, $p(a_E)$ is the probability that the existence assertion is true, $p(a_V)$ is the probability that the valuation assertion is true and $p(a_A)$ is the probability that the accuracy assertion is true.

To test Hypotheis 2a and Hypotheis 2b, we calculate assessments of an overall assertion based on the assessments of the sub-assertions using 'AND' logic and compare the calculated assessments with the actual auditors' assessments.

IV. RESULTS

Table I shows the means and standard deviations of the raw risk assessments in the belief functions framework (that is, $m(\sim a)$ and $Pl(\sim a)$), the transoformed belief assessments, and the probability assessments (that is, $p(\sim a)$) for the three sub-assertions and the overall assertion. To compare the transformed belief assessments and the probability assessments, we conduct *t*-tests to examine the approach effect and find no significant approach effect on the risk assessments for all assertions before and after audit evidence is provided.

To test Hypotheses 1a and 1b, we examine whether assessed strength and direction of evidence (λ_E) provided for each sub-assertion is different between the belief functions approach and the probability approach. Table II shows the assessed strength and direction of evidence provided for each sub-assertion. We exclude from the sample the three cases that the posterior assessments (that is, $p'(\sim a)$) include a zero value.

Table I
RISK ASSESSMENTS (N = 48)

	Before evidence is provided				After evidence is provided			
	Belief Functions		Transformed Belief	Probability	Belief Functions		Transformed Belief	Probability
	m(~*a*)	Pl(~*a*)	Pl(~*a*)/(Pl(*a*)+ Pl(~*a*))	p(~*a*)	m(~*a*)	Pl(~*a*)	Pl(~*a*)/(Pl(*a*)+ Pl(~*a*))	p(~*a*)
Existence assertion	.184	.804	.497	.450	.128	.364	.286	.288
Valuation assertion	.200	.856	.524	.478	.312	.748	.529	.467
Accuracy assertion	.176	.788	.488	.454	.172	.420	.329	.347
Overall assertion	–	–		–	.168	.428	.326	.347

Table II
ASSESSED STRENGTH OF EVIDENCE (λ_E)

	Mean	Number [%] of subjects that perceived evidence as disconfirming ($0 < \lambda_E < 1$)	Number [%] of subjects that perceived evidence as having no value ($\lambda_E = 1$)	Number [%] of subjects that perceived evidence as confirming ($\lambda_E > 1$)	Chi-square test results (*p*-value)
Existence sub-assertion					
Belief Functions	3.42	1 [4.0%]	2 [8.0%]	22 [88.0%]	.447
Probability	2.92	3 [14.3%]	2 [9.5%]	16 [76.2%]	
Valuation sub-assertion					
Belief Functions	1.27	8 [32.0%]	7 [28.0%]	10 [40.0%]	.737
Probability	1.50	7 [30.4%]	9 [39.1%]	7 [30.4%]	
Accuracy sub-assertion					
Belief Functions	3.18	4 [16.0%]	1 [4.0%]	20 [80.0%]	.080
Probability	3.95	7 [31.8%]	4 [18.2%]	11[50.0%]	

Table III
COMPARISON BETWEEN THE ASSESSMENTS CALCULATED USING 'AND' LOGIC AND THE ACTUAL ASSESSMENTS OF THE OVERALL ASSERTION (THE TRANSFORMED BELIEFS AND THE ORIGINAL PROBABILITIES)

	Assessments based on 'AND' logic aggregation		Actual Assessments		
	Assessment that the overall assertion is true	Assessment that the overall assertion is false	Assessment that the overall assertion is true	Assessment that the overall assertion is false	Paired samples *t*-test results (*p*-value)
Belief Functions	.261	.739	.674	.326	.000
Probability	.273	.727	.653	.347	.000

The evidence provided for the existence and accuracy sub-assertions are assessed stronger than the evidence for the valuation sub-assertion, but all evidence is perceived as confirming the sub-assertions. These results are generally consistent with our expectations based on pilot testing and consultations with liaisons.

To examine whether the mean assessment of strength of evidence between the approaches are significantly different, we conduct *t*-tests. The results show that there is no significant difference in the mean assessment for all sub-assertions, which supports Hypothesis 1a.

However, focusing on the proportion of subjects that perceived evidence as confirming, disconfirming and having no diagnostic value, we find that there is a marginally significant difference in the proportions between the belief-based assessments and the probability-based assessments for the accuracy assertion (chi-square test, p = .080). More specifically, in the probability treatment, relatively more participants assessed the a priori confirming evidence to be either disconfirming ($0 < \lambda_E < 1$) or to have essentially no diagnostic value ($\lambda_E = 1$) for the sub-assertion. Such a difference is important because it shows that auditors using belief functions were able to assess the direction of the evidence more accurately than auditors using probability. This suggests that in some cases auditors' assessments of whether mixed evidence is overall confirming or disconfirming can be influenced by the approach used to make such assessments. This result provides evidence that rejects the null hypothesis (Hypothesis 1b).

Concerning Hypotheses 2a and 2b, Table III shows the means of the auditors' assessments that the overall assertion that the accounts receivables are fairly stated is true (false) assuming 'AND' logic aggregation and the actual direct assessments that the overall assertion is true (false) based on the transformed beliefs for the belief functions treatment and the original probability assessments for the probability treatment. *T*-test results for the assessments show that there is no significant difference in any assessment between the belief functions treatment and the probability treatment. These results indicate that the level of aggregated assessments is not affected by the approach to risk assessment, which are consistent with the null hypothesis (Hypothesis 2a). Although consistent with the results of prior hypothesis tests, this is somewhat surprising as the assessment of the overall assertion involves all three aspects of audit judgment investigated: assessment of risk, assessment of evidence and aggregation of evidence.

Also, to compare the actual assessments and the logical assessments, we conduct paired-samples *t*-tests. The results

indicate that for both treatments, the logical assessments and the actual assessments are significantly different (p = .000). That is, auditors assess the belief/probability that the overall assertion is true significantly higher than the aggregated belief/probability calculated based on 'AND' logic. This suggests that auditors' aggregation of evidence is not consistent with 'AND' logic irrespective of the risk assessment approach and clearly rejects the null hypothesis (Hypothesis 2b).

V. Conclusion

The general research question being explored in this study is whether auditors provide different risk assessments when they are based on belief or probability assessments. By focusing on the evidence evaluation and evidence aggregation phases, we find no significant difference in the assessed strength of evidence and the aggregation of evidence between the probability and belief functions treatments. Overall, these results indicate that auditors make essentially the same assessments whether they use beliefs or probabilities.

However, another finding indicates that there is a significant approach difference that should be considered (see also Fukukawa and Mock [23]). That is, the proportion of auditors who perceive the evidence as confirming, disconfirming and having no diagnostic value is significantly different between the probability and belief functions treatments for the accuracy sub-assertion. This result implies that auditors' assessments of evidence may be influenced by the approach, depending on the nature of the evidence. Examining the interaction between the approach and the nature of evidence is an important issue for future research.

We also find that auditors' aggregation of evidence is not in accordance with 'AND' logic both in the belief functions treatment and the probability treatment. This result may imply that the items of audit evidence provided were not independent but correlated, that is, the evidential reasoning is a network structure rather than a tree structure. Another possibility is that auditors are using an alternative logic such as a weighting scheme as discussed in Gao and Srivastava [22], which also warrants future research.

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References

[1] B. R. Cobb, and P. P. Shenoy. *A comparison of Bayesian and belief function reasoning*, Information Systems Frontiers, Vol. 5, pp. 345-358. December, 2003.

[2] B. R. Cobb, and P. P. Shenoy. *On transformations of belief function models to probability models*, Working Paper No. 293, University of Kansas, School of Business. 2004.

[3] B. R. Cobb, and P. P. Shenoy. *On the plausibility transformation method for translating belief function models to probability models*, International Journal of Approximate Reasoning, Vol. 41, No. 3, pp. 314 - 330. 2006.

[4] T. B. Bell, M. E. Peecher, and I. Solomon. *The 21st Century Public Company Audit*, KPMG international, 2005.

[5] D. M. Guy, D. R. Carmichael, and O. R. Whittington. *Audit Sampling: An Introduction*, John Wiley & Sons Inc. 2001.

[6] R. P. Srivastava, and G. Shafer. *Belief-function formulas for audit risk*, The Accounting Review, Vol. 67, pp. 249-283. April 1992.

[7] K. Harrison, R. P. Srivastava, and R. D. Plumlee. *Auditors' evaluations of uncertain audit evidence: belief functions versus probabilities*. In Belief Functions in Business Decisions, edited by R. P. Srivastava and T. Mock, New York, NY: Physica-Verlag Heidelberg, pp. 161-183. 2002.

[8] T. S. Wallsten. *The costs and benefits of vague information*. In Insights in Decision Making, edited by R. M. Hogarth, The University of Chicago Press, pp. 28-43. 1990.

[9] T. S. Wallsten. *Measuring vague uncertainties and understanding their use in decision making*. In Acting under Uncertainty: Multidisciplinary Conceptions, edited by G. M. von Furstenberg, Kluwer Academic Publishers, pp. 377-398. 1990.

[10] T. S. Wallsten, D. V. Budescu, and R. Zwick. *Comparing the calibration and coherence of numerical and verbal probability judgments*, Management Science, Vol. 39, No. 2, pp. 176-190. 1993.

[11] J. Reimers, S. Wheeler and R. Dusenbury. *The effect of response mode on auditors' control risk assessments*, Auditing: A Journal of Practice & Theory, Vol. 12, Fall, pp. 62-78. 1993.

[12] D. N. Stone, and W. N. Dilla. *When numbers are better than words: The joint effects of response representation and experience on inherent risk judgments*, Auditing: A Journal of Practice & Theory, Vol. 13, Supplement, pp. 1-23. 1994.

[13] J. Jiambalvo, and W. Waller. *Decomposition and assessments of audit risk*, Auditing: A Journal of Practice & Theory, Vol. 3, No. 2, pp. 80-88. 1984.

[14] S. J. Daniel. *Some empirical evidence about the assessment of audit risk in practice*, Auditing: A Journal of Practice & Theory, Vol. 7, No. 2, pp. 174 – 181. 1988.

[15] R. Dusenbury, J. Reimers, and S. Wheeler. *An empirical study of belief-based revision and probability-based specifications of audit risk*, Auditing: A Journal of Practice & Theory, Vol. 15, No. 2, pp. 12 – 28. 1996.

[16] G. Monroe, and J. Ng. *The descriptive ability of models of audit risk*. In Belief Functions in Business Decisions, edited by R. P. Srivastava and T. Mock, New York, NY: Physica-Verlag Heidelberg, pp. 161-183. 2002.

[17] T. J. Mock, A. M. Wright, M. T. Washington and G. Krishnamoorthy. *Auditors' uncertainty representation and evidence aggregation*, Behavioral Research in Accounting, Vol. 9, Supplement, pp. 123-147. 1997.

[18] J. Pearl. *Probabilistic Reasoning in Intelligent Systems*. Morgan Kaufman Publishers. 1988.

[19] D. Von Winterfeldt, and W. Edwards. *Decision Analysis and Behavioral Research*. Cambridge University Press, Cambridge. 1986.

[20] R. P. Srivastava, and T. J. Mock. *Introduction to belief functions*. In Belief Functions in Business Decisions, edited by R. P. Srivastava, and T. J. Mock, 1-16. New York, NY: Physica-Verlag Heidelberg, pp. 1-16. 2002.

[21] L. Sun, R. Srivastava, and T. Mock. *An information systems security risk assessment model under Dempster-Shafer theory of belief functions*. Journal of Management Information Systems, Vol. 22, pp. 109-142. 2006.

[22] L. Gao, and R. P. Srivastava. *The anatomy of management fraud schemes: Analyses and implications*. Working Paper. 2007.

[23] H. Fukukawa, and T. J. Mock. *Audit risk assessments using belief versus probability*. Auditing: A Journal of Practice & Theory. 2010 [forthcoming].