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Fuzzy Set Approach to Client Acceptance Decisions

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Introduction

In the 1990's accountants are being held to high levels of performance and responsibility by society. Both the numbers and the magnitude of legal judgments against public accounting firms are of great concern to accounting professionals. As professional accountants consider their practices and their vulnerability to client imposed risk, perhaps it is time to revisit the topic of "client acceptance." Research has shown that client characteristics are associated with litigation risk (Pratt 1994), audit scope (Walo 1995), and audit fees ((FEII 1994).

The purpose of this paper is to demonstrate the use of fuzzy sets in measuring and combining risk factors to assist in client acceptance decisions. The paper illustrates how fuzzy sets can be used to capture the beliefs of one or several partners assessing the factors involved in client acceptance, and then to build a fuzzy model that summarizes these assessments to determine whether a client should be accepted. The fuzzy models can be used as alternatives to or in combination with traditional decision-making approaches.

Discussion of Client Acceptance Issues

The American Institute of Certified Public Accountants (AICPA) *Audit and - Accounting Manual* provides an example of the factors that should be examined when prospective audit engagements are considered for acceptance. The factors of interest that typically appear in these questionnaires can be categorized into topics such as: services and reports, industry practices and conditions, organization and personnel, nature of operations, accounting issues, and management integrity. This research builds upon the AICPA's work by utilizing it to develop an intuitive model of how the client acceptance decision is made in practice, identifying the difficulties of this decision approach, and demonstrating how a fuzzy set approach could assist the decision maker.

A model that indicates the intuitive thinking and the judgments that must be made before a client is accepted can be specified as follows:

$$P(UCA) = f(S, IP, OP, O, A, MI)$$

where $P(UCA)$ is the probability of the prospective client's engagement partner making an unwise client acceptance decision. This decision is a function of the prospective client's engagement partner's reflections on six different factors: S, IP, OP, O, A, and MI. S reflects the likelihood of providing the needed services and reports that are being requested, IP reflects the conditions that exist as industry practices in the prospective

client's industry, OP indicates the assessment of the organization and personnel of the prospective client and whether a person is in a position to manipulate the auditor relationship, O indicates the nature of operations and perhaps the client's resilience to adverse or difficult times, A reflects the assessment of the accounting system that is present and its appropriateness, MI indicates whether the prospective client's management is motivated and inclined to allow errors and/or irregularities to exist in the financial statements. The manual provides relevant questions for each factor.

Identification of Problems

The problem with the utilization of a questionnaire is that the prospective engagement partner is frequently constrained to respond in a yes/no fashion. Questionnaire usage promotes making variables into binary (yes or no, 0 or 1) variables. However, the differences that exist in the real world are largely ignored under this approach. For instance, when an engagement partner is considering the management integrity of a prospective client, that person might consider the question "Has the prospective client been evasive, guarded, or glib when responding to inquiries?" Responding to this question in a yes or no response would fail to portray the different levels of communication that could be present.

Also, little guidance is available to assist a decision-maker when weighting the different factors. The previously described intuitive model identified factors such as: services and reports, industry practices, organization and personnel, nature of operations, accounting issues, and management integrity. How should these different factors be weighted when arriving at a final decision about client acceptance? Neither academic research nor the AICPA provides direction in aggregating the information collected from questionnaires regarding the different variables.

A Fuzzy Number Based Decision Aid

A model of client acceptance decision posited in the paper postulates the risk of unwise client acceptance decision as a function of six factors:

$$P(\text{UCA}) = A_s, \text{IP}, \text{OP}, \text{O}, \text{A}, \text{IvU}$$

We can use @ set to capture knowledge of the auditor(s) regarding each question and then we can combine these @ sets to arrive at the ultimate conclusion. These concepts can be *operationalized* by using @ numbers. The notion of @ numbers is contained in the theory of @ sets.

A fuzzy number represents a range of possible values instead of the single (precise or discrete) value a crisp number represents. Each possible value in the @ number range has a possibility level (also called a confidence level or a presumption level) or belief attached to it. A @ number needs three values or points (maximum, minimum, or possible) for a complete definition. However, a fuzzy number can include more than three points to completely represent knowledge (Kaufmann and Gupta, 1991).

Fuzzy numbers can help auditors in the measurement and combination of various questions that ultimately contribute to the client acceptance decision. The questions in *AICPA Audit and Accounting Manual* are @ in the sense that they cannot be quantified precisely. There are a number of questions associated with each factor and @ numbers can be used to measure these questions.

For example, consider the earlier question "Has the prospective client been evasive, guarded, or glib when responding to inquiries?" This question need not be answered as "yes" or "no." It is possible to capture the uncertain knowledge using three values: on a 0 to I scale. For example, the engagement partner believes that the client is honest at least 80% of the time but no more than 90% of the time, and the private investigator hired by the firm indicates that client is honest about 85% of the time. If the engagement partner is most comfortable (belief of one) with 85% estimate of client honesty, then using these three values, we can create a triangular belief graph. These calculations are done by FuziCalc* (Version 1.51) for Windows by FuziWare, Inc., which is a fuzzy number based spreadsheet. In the example given, 0.8500 can be called the "centroid," that is, the center of the graph, the value at which the belief graph would balance on the edge of a knife. This value is the best guess as to the most likely outcome, however, it is necessary to look at the associated belief graph to understand all other possible values and associated beliefs [FuziCalc't for Windows, User's Guide, 1995].

If two auditors disagree about the estimate of client honesty (that is, most comfortable value) then two comfortable values may emerge, say 80% and 90%. Incorporating these values will give a flat topped graph that represents a @ number that has a high confidence for the values between 0.8 and 0.9 and the centroid of the graph is 0.8572. Note that to completely understand a fuzzy number it is necessary to look at the centroid as well as the associated distribution of beliefs. If the auditor knows with certainty that the client is honest then a value of 1.00, a crisp number can be used. Various possibilities can be explored and presented in the graphical format.

In a similar fashion, each question for management integrity can be measured as a fuzzy number. The aggregation of these @ numbers is more complex. The model of client acceptance decision postulated earlier stipulates that the probability of unwise client acceptance decision is a function of six factors: services, industry practices, organization and personnel, operations, accounting, and management integrity. Therefore, an effort must be made to aggregate questions for each factor and then combine these six factors to determine the probability of an unwise client acceptance decision. There are no statistical formulas to do this.

However, @ numbers can be mathematically manipulated by using fuzzy spreadsheets or fuzzy calculators.

However, judgment needs to be exercised in the evaluation of each factor. For example, in evaluating services we are faced with questions such as - what services and reports are requested? These questions have descriptive answers. Here instead of each question being a fuzzy set, S can be evaluated as a @ set by mapping all the questions for S factor. For

example, for questions included in the S factor, the engagement partner can evaluate whether the CPA firm is capable of providing services and reports requested, is the risk acceptable, does the firm have an understanding of regulatory requirements, can the firm complete the work in given time, and does the firm have expertise and additional staff to provide company other services. These answers can be framed as a @ set. Similar evaluations can be done for each of the six factors.

The problem of combining the factors to assess the probability of unwise client acceptance decision is even more complex. It is also not clear whether these six factors should be added, multiplied, or evaluated separately. The aggregation of factors is clearly a matter of professional judgment. The fuzzy number approach can be used to add the factors or weigh those factors according to the judgment of the auditor. The advantage of fuzzy numbers is that they can be easily used to quickly build reasonably complex fuzzy models for aggregating factors. The ultimate result will be in the

form of a fuzzy number that characterizes the belief of the auditor concerning the probability of making an unwise client acceptance decision.

Conclusions and Limitations

This paper examines the use of fuzzy sets in assessing client acceptance decisions. Neither the academic nor professional literature provides clear guidance on measurement and aggregation of information about client acceptance. Fuzzy set can provide a remedy to this problem. Fuzzy sets and fuzzy

numbers can be used to measure the responses of engagement partners as they consider questions from questionnaires. It is possible to combine the beliefs of two or more partners. These fuzzy sets and fuzzy numbers then can be mathematically manipulated. This manipulation can help one to calculate the beliefs concerning six different factors in terms of fuzzy sets or fuzzy numbers. These six factors then can be combined either using fuzzy to calculate the ultimate risk of being associated with a prospective client.

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Note: All calculations and graphs are available from the first author.