73-30,753

WARD, Bart Hopkins, 1945-
A DECISION THEORETIC APPROACH TO THE RESOLUTION OF MEASUREMENT ISSUES IN AUDITING.

Northwestern University, Ph.D., 1973
Accounting

University Microfilms, A XEROX Company, Ann Arbor, Michigan

NORTHWESTERN UNIVERSITY

A DECISION THEORETIC APPROACH TO THE RESOLUTION OF MEASUREMENT ISSUES IN AUDITING

A DISSERTATION
SUBMITTED TO THE GRADUATE SCHOOL
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
for the degree

DOCTOR OF PHILOSOPHY
Field of Accounting and Information Systems

By

BART HOPKINS WARD

Evanston, Illinois
June 1973

ACKNOWLEDGMENTS

First I wish to thank Professors Allan Drebin, Thomas Prince, Lawrence Revsine and David Baron for their guidance during the preparation of this dissertation. I also wish to acknowledge the encouragement of Professor James Godfrey and the intangible contributions of numerous but unnamed persons belonging to the community of scholars at Northwestern University.

Arthur Andersen and Company generously provided a grant which enabled me to devote full-time effort to this project. The professional accounting firms of Arthur Andersen and Company, Haskins and Sells, Price Waterhouse & Co., and Touche Ross and Co. allowed members of their respective auditing staffs to participate in this study. To each of those professional accountants who participated, I extend a sincere thank-you.

Finally, I thank my wife Mickey for her patience and support.

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CHAPTER I

INTRODUCTION

To some extent each audit engagement is unique. Several fundamental decisions however must be reached in virtually all audits. This work deals with the manner in which certain of these decision-making problems are structured and solved by the auditor. The decisions of particular interest here are concerned with the producton and evaluation of audit evidence and with the impact of such evidence on the opinion rendered by the auditor.

The auditor is frequently faced for example with the problem of selecting an appropriate audit procedure. It may be for instance that the auditor wishes to gather more information than is currently available about a client's receivables balance. In such a situation the auditor might consider for inclusion in the audit program either 1) an extensive review and testing of the client's billing system, or 2) reliance on a larger sampling and subsequent verification of year-end account balances.

Another problem encountered by the auditor in every engagement involves the evaluation of evidence. How much information is enough? How reliable are judgments based on the information already at hand?

Every engagement also requires the auditor to determine whether corrections should be recommended. Where correction is required, the impact of the error and correction must also be considered.

This work shows how the solutions to these three problems can be related within a single framework. This framework envisions the impact of audit decisions as being determined by subsequent events. Audit decisions are the result of the evaluation of audit evidence. Audit evidence, in turn, is produced by implementation of an audit program. The planning of an audit engagement should therefore anticipate the auditor's information needs based on the decisions which will be required and the consequences of alternative actions. This does not mean that the outcome of a decision must be anticipated but rather that the need to select from available alternatives must be recognized and plans formulated accordingly.

It is the failure to provide for this sort of flexibility which limits the usefulness of the conventional materiality doctrine as a guide for audit decision-making. The conventional materiality criterion does not fully distinguish between the impacts associated with various error amounts. Hence where uncertainty surrounds the auditor's knowledge of the proper account balance there is no way to adequately assess the risk associated with his current state of knowledge. By the same token, therefore, the expected value of additional information from any particular audit procedure cannot be determined. As a result, the effectiveness of alternative procedures cannot be compared. The appropriate decision, therefore, cannot be determined on this basis.

A recent draft of a statement by the Committee of Auditing Procedures of the American Institute of Certified Public Accountants highlights the critical nature of such deficiencies. The statement emphasizes the need for methods enabling the determination of the efficiency and especially the effectiveness of alternative audit procedures.[1] This dissertation explores a methodology which enables the auditor to address the decision-making process from just such a perspective. A new materiality concept is presented for use as a guide to audit decision-making. The methods developed are based on the relationship between the auditor's assessment of the severity of error in financial statements and decisions regarding the allocation of resources consumed in the search for evidence in support of an opinion regarding the fairness of such statements.

I.1 Objectives

There are several objectives of this study. Existing practices regarding the assessment of the severity of error in financial statement presentations will be reviewed in order to reveal untested assumptions upon which current practices regarding materiality measurement are based. The first aim of this work is to set out some potential effects of these assumptions on the use of such materiality measurements. Particular concern will focus on use of these measures as guides for audit decision-making. The second objective is to analyze current thinking about the relationship between the assessment by the auditor of the severity of the consequences of error and the planning and decision-making activities which surround the collection and evaluation of audit evidence.

Another objective of this work is to present the framework of an audit decision-making model. The model incorporates consideration of the uncertainty which can surround assessments concerning the materiality of error. These assessments are made in a concrete manner without relying on the untested assumptions which plague current measurement practices. The model gives explicit consideration to (1) the use of a measurement function in conjunction with assessment of the consequences of possible deviations or errors in an account balance and (2) the probability that each such deviation will occur. This decision model provides a means for operational comparison of the expected benefits which would arise from the implementation of competing evidence gathering procedures. The model also suggests a method for determining an optimal audit resource allocation plan. This is done by giving consideration to both the expected value of information which might be generated by whatever alternative procedures are being considered and to the cost which would be incurred by implementation of each such procedure.

The final aim of this work is to report the results and conclusions from an empirical study designed and carried out as part of the overall research effort. The objectives of this investigation were: (1) to determine whether the concept of audit responsibility is well enough defined within the profession to allow us to speak of measuring it in a uniform and operationally meaningful manner, (2) to demonstrate tests of the validity of certain assumptions which underlie current practice regarding such measurement, and (3) to explore the validity of certain assumptions made by both the proposed decision-making model and the associated measurement technique.

I.2 Scope and Method of Presentation

This study is specifically concerned with unraveling the resource allocation decisions which the auditor makes while gathering information about the proper nature of the account balance(s) under review. Emphasis is therefore concentrated on the relationship between the evaluation of audit evidence and its contribution to the formation of judgment about the fairness of a particular balance or set of balances. This study focuses on the manner in which decisions are made about how to go about gathering evidence, when to stop gathering evidence and what decision to make once all the evidence is in.

At times reference will be made to a class of audit decisions which deal with the choice among alternative generally accepted accounting methods or with disclosure practices concerning either inconsistent application of principles or incomparabilities due to changes in economic conditions not involving changes in principle. An excellent and detailed discussion of these issues is available elsewhere.[2] Such matters are outside the scope of this work. This work concentrates instead on the class of decisions which involve the consumption of the majority of the auditor's resources. These decisions are related to the risk involved in being uncertain about fact rather than principle. It must be noted, however, that this does not exclude from consideration the risk arising from the <u>difference in the effect</u> of applying an unfair or inconsistent principle and the effect of applying some fair or consistent alternative principle.

The overriding issue of concern in most of what follows is not <u>whether</u> but rather <u>how</u> can the effect of materiality in auditing, audit risk, or audit responsibility as it is referred to here, be quantified and put to useful purposes. As the next chapter of this work indicates measurement standards in this area are already being promulgated. That same chapter suggests why the rationale for such standards may be inappropriate for use in conjunction with audit decision-making activities especially where the conditions of uncertainty about fact exist. In addition Chapter II serves in part as a guide to the manner in which the auditor is held accountable for his responsibility concerning the opinion he renders on the fairness of a client's financial statement presentations. In this regard it should be noted that this work is premised on the assumption that there is a sharing of loss due to the consequences of a subsequently discovered error in financial statement presentations on which the auditor has rendered an opinion. Such loss may be shared by the auditor, the client and the public. Therefore, the auditor must at least as things currently stand, define as best he can that portion of any potential loss which he believes he should or will be accountable for in light of his legal and professional obligations and then act accordingly.

The third chapter in this study reviews current literature about the manner in which audit decision-making is carried out. Emphasis is placed on the relationship between the method used to assess the consequences of audit decisions and the rationale used as guides to making such decisions.

A sequential decision model for use in determining an optimal allocation plan for the collection and evaluation of audit evidence is presented by the fourth chapter. The model is concerned with a methodology for developing an optimal mix of audit procedures. Given the available procedures the method determines first which procedures are likely to produce evidence which will strengthen the auditor's opinion and secondly whether the collection of such evidence would be worthwhile in light of the cost of obtaining it. The model allows, for example, the comparison of an audit plan calling for retention of specific transaction records followed by extensive verification by either manual or computerized methods with an alternative plan which concentrates on a detailed review of programming documentation and control, or a plan calling for use of test decks or controlled program copies without the need for special file retention procedures. In more commonly recognized terms this is the dilemma of auditing "around," "with" or "through" the computer.[3]

Chapter V reports the results of an empirical investigation conducted by interviewing a sample of professional accountants in the Chicago area. Whatever conclusions are made about the findings of this study apply solely to this group of auditors. Replications of this type of investigation among other segments of the profession would be most welcome. The chapter includes results from attempts by those sampled to work with the measurement function concept and an analysis of the consensus regarding the relative importance of many factors which help contribute substance to the concept of audit responsibility and a report on how the responses obtained might affect the validity of current measurement practice as applied in auditing.

The final chapter of this work is devoted to a brief set of summary remarks and a discussion of how the uses of the measurement function concept and decision theoretic model might take root and then develop within the profession.

I.3 Research Methodology

A combination of research techniques was employed in order to carry out the research necessary to meet the objectives of this study. This combination of research techniques produce an interdisciplinary research methodology.

The research methodology encompassed the following combination of techniques:

1. A review of current literature dealing with materiality, audit responsibility, and contemporary audit decision-making strategies.
2. An analysis of this literature was accomplished from a measurement theory perspective premised by the assumption that audit resource allocation decisions take place under conditions of uncertainty.

3. The concepts of Bayesian decision theory were utilized to develop a model for optimal audit allocation. The model makes use of both statistical decision theory and the concepts of information economics. The model demonstrates how a cardinal loss measurement function can be put to use in order to evaluate the expected value of sample information from any particular audit technique or process and how to determine which procedure from the set of all available audit procedures would be the optimal choice in light of the auditor's current knowledge about the degree of uncertainty surrounding the proper total for any particular balance, the cost of the procedure and the expected value of information to be generated by that procedure.
4. A survey instrument making use of three specific modes of questioning was constructed, pretested, revised, and administered. The first mode involved use of the psychological Q-sort technique for ranking factors which have some bearing on audit responsibility. The Q-sort

techniques allows the determination of a reliable consensus about a complex dimension from a few or relatively small number of judges despite allowance for a personal sense of uncertainty on the part of each sorter. The second mode of questioning involved the elicitation of the respondent's perception of the functional relationship between the amount of a subsequently discovered error and the loss which the auditor would incur as a result. The third mode of questioning relied upon a discussion of selected questions. These questions were designed to test the validity of the structure of the model developed in Chapter IV. The questions dealt with the consideration given offsetting errors and the criteria used in judging the severity of an error.

5. A statistical analysis of hypotheses about the data collected by survey was undertaken. Because of the limited number of respondents and the ordinal nature of the data collected during the survey, the statiscal method chosen were those

that have been specifically developed for use with nonparametric, ordinal data. A discussion and tests of the reliability and validity of the results of the analysis are also included.

CHAPTER II

MATERIALITY AND AUDIT RESPONSIBILITY

This chapter discusses current definitions, usages and measurements of materiality. The primary purpose of this chapter is to demonstrate how the measurement assumptions which may be implicitly associated with use of the more popular materiality standards could lead to improper or inadequate inferences when applied under conditions of uncertainty as guides in the audit decision-making process.

There are several connotations which can be associated with the term materiality and there are some very closely related terms such as fairness and relevance whose connotations often seem to overlap. The appropriate meaning of any of these terms must be drawn from the context of the situation in which it is being used. Some of these different usages are examined here in order to set them apart and in order to indicate that particular connotation of materiality in auditing with which this work is most concerned. In order to distinguish this particular concept of materiality in auditing, it will be referred to as audit responsibility.

Much has been written concerning the doctrine of materiality and its measurement. Less attention however has been paid to the particular responsibility which the auditor accepts (at least implicitly) by attesting to the fairness (or lack of fairness) of information presented by a client's financial statements. This chapter attempts to demonstrate that currently suggested measurements and standards of materiality are not satisfactory operational definitions of methods of arriving at assessments which can adequately guide the auditor in a majority of his audit planning and decision-making activities.[1]

II.1 Materiality in Accounting

In distinguishing between other concepts of materiality and audit responsibility, it will be helpful to begin with a set of definitions for the term materiality. Although the term is often used in a broader sense almost to the point of encompassing audit responsibility as defined below, it seems appropriate to utilize a narrower set of definitions here in order to avoid ambiguity and in order to emphasize the important distinctions between the fundamental nature of judgments concerning materiality, per se, and judgments concerning the fairness of financial statement presentations.

II.1.1 Concepts of Materiality

The bookkeeping materiality decision will be defined as one which involves consideration of a conscious acceptance of a range of possible errors in order to expedite bookkeeping and/or reporting procedure. This type of materiality involves the procedural routine which management adopts in the recording of specific economic events and deals with the trade-off between convenience and precision.

Management may, for example, expense capital assets whose acquisition price falls below some arbitrary but established amount. The management of a firm may also decide to aggregate for presentation purposes several distinguishable items such as property, plant, and equipment or it may report these items separately. The management of an enterprise may also decide whether or not to round off for financial reporting purposes all numbers below a certain power level threshold.

For the most part, bookkeeping materiality is concerned with decisions regarding convenience and not the conveyance of meaning. Actions taken by invoking this concept of materiality may be arbitrary in light of established principles and theories. Such actions are excused, however, because they result in negligible effect on the meaning conveyed to users of financial reports affected by this type of materiality decision.

Issues which involve the selection of a proper (generally accepted) method of accounting for and/or reporting the meaning of the economic events of the firm turn on the materiality of presentation and disclosure. Such decisions involve the means, treatment, or structure to be utilized in conveying relevant information to the users of financial statements. In fact, this meaning of the term materiality is often connoted instead by usage of the term relevancy.[2] Relevance as discussed below and as used here will be more closely associated with the selection of a most appropriate method from among all generally accepted methods which might be adopted for purposes of recording financial information.

For the most part, matters involving the materiality of presentation and disclosure are the result of unique economic events. Typical of economic occurrences which are often deemed relevant to the judgments of financial statement users are: the terms of a sale and lease back arrangement, extraordinary gains or losses, acquisition of subsidiaries, transactions with corporate officers or employees, etc.

Decisions regarding materiality of presentation or disclosure are judgments about the propriety of the means adopted to report financial information. In cases where such information is deemed to have been improperly treated, a material error or misstatement is the result. Henceforth, unless otherwise noted, this is the connotation which should be associated in this study with the term materiality.

II.1.2 Operational Tests and Measures of Materiality

Several rule-of-thumb and some arbitrary measures of materiality have been formally advanced only to meet with varying degrees of acceptance in practice. There are several tests which have as a central theme some fixed standard focusing on ratio tests of earnings reported by the firm under review. Certain other methods have as a central theme ratio tests based on statement items other than earnings. In addition there is a class of miscellaneous measurements whose tests rest on empirical or behavioral phenomena.

II.1.2.1 Ratio Testing

The most frequently suggested operational measures of materiality are ratios directly related to income, either income of the current period or an income trend exhibited over the more recent periods of the firm's operation.

The usual operational method applied in order to test the materiality of an item in question requires the determination for the item in question of the percentage of income before tax and extraordinary gains and losses which the item represents. The test of materiality is the comparison of percentage of income before tax and extraordinary items with a recognized standard percentage which is the line of demarcation between immaterial and material items. The recognized standard apparently ranges between five and fifteen percent. Several studies have served to lend credence to this range as the accepted standard range of materiality. A survey of professionals indicated the following:

> By a strong majority respondents have indicated that the most important relative is the amount of the loss to current income.[3]

This same study indicated that the average line of demarcation between material and immaterial items based on this one standard was about ten percent.

A recent empirical study utilizing discriminate analysis supports this test of the relationship of an item to reported income as the most powerful test for materiality at least in regard to matters of changes in the consistency of reporting practices and in relationship to a multitude of other standards (sixteen) which might be utilized as tests for the determination of whether an item is material.[4] The study, however, yields apparently inconclusive results regarding the appropriate value or value range for the standard percentage.[5]

Frederick Neumann also conducted an investigation of the standard of materiality utilized in the test for reported consistency exceptions. This work reinforces the notion that the standard for differentiating between immaterial and material items (in particular items which are the result of changes in accounting methods) is the range of five to fifteen percent income. In particular the results indicate that the most widely adopted view may be nearer the conservative end (five percent) of this range.[6] A difference in median quartile bounds was found to exist when statistics drawn from items whose effect was to reduce income were compared with the statistics from items that increased income. Though no tests of significance were performed the data shows that for 77 cases where income decreased and 125 cases in which income increased as a result of the change in accounting methods from one period to the next, the median and quartile statistics for the percentage effect on income were lower for those which decreased income than for those which increased income. These particular results are shown in Table 2-1.

Finally, the following passage from this article is of great interest:

> What can account for this seemingly low limit to materiality? If a basis other than the effect on the year's net income is being used to measure it, then surely it would be disclosed. It would appear, rather, that it is the scale, and not the measure which is at issue. Qualification for seemingly immaterial amounts appears all the more curious if one can attribute to both the independent auditor and his client a reluctance to have reports qualified.[7]

By the same token an article dealing with examination of reporting practices in light of Opinion No. 9 of the Accounting Principles Board shows that with respect to the classification of extraordinary items at least a substantial share (slightly less than 18 percent of the reported extraordinary items) represented less than 5 percent of net income before extraordinary items.[8] (Opinion No. 9 requires

TABLE 2-1

ANALYSIS OF PERCENTAGE EFFECT ON INCOME OF ITEMS REPORTED AS HAVING MATERIAL EFFECT ON FINANCIAL STATEMENTS

For category changes which are known to have:	1st Quartile	Median	3rd Quartile
Increased net income (125)	3.5%	7.8%	14.2%
Decreased net income (77)	2.7%	5.4%	13.3%
Decreased, had no effect, or increased net income (214)	-3.7%	+2.2%	8.8%
Increased or decreased net income ignoring direction or effect (214)	2.7%	5.8%	13.3%

Source: Frederick L. Neumann, "The Incidence and Nature of Consistency Exceptions," The Accounting Review, XLIV (July, 1969), 552.

that an item be material as a necessary condition for being extraordinary).[9] The tax effects will substantially alter the significance of this result: however, a few examples are given in the article of items that are less than 2 percent of income before tax but which are presented as extraordinary nonetheless. Perhaps these two studies are indications that research involving the structure of materiality decisions should give greater attention to procedures for incorporation of situational conditions rather than the promulgation of standards.

Another perspective of materiality based on an income effective measurement standard is provided by considering the percentage effect which an item has on the average income for the last several periods' operation. The length of a base period for determining average income is, of course, arbitrary, but generally a five-year period has been adopted. The advantage cited for this method over relying on a single year's income as a standard is the ability to provide comparability in materiality measurement in terms of long-run earning power from one period to the next in spite of some volatility in earnings.

One other income related method for judging whether an amount is material requires an analysis of the growth trend in income which a firm has exhibited during its recent history. No standard range has become apparent for use with this measurement nor is there evidence of the adoption in practice of a standard range, although one hypothetical example is presented in the literature.[10] The primary reason given to support its significance follows:

> According to the 1957 Statement of the American Accounting Association, "an item should be regarded as material if there is reason to believe that knowledge of it would influence the decisions of an informed investor." Many security analysts would probably consider items that affect net results by as little as 5% to be significant, and hence, material. The compound annual growth rate of earnings of a great many corporations is around 5%; hence, an influence on net earnings as great as the annual change due to growth factors must generally be deemed significant.[11]

Other measurements based on the construction of ratios have also been suggested. The most common of these involve utilizing bases developed from total assets, gross revenue and working capital.[12] These suggestions are, however, judging from the relative literature in the two areas and the findings reported above, of little consequence when considered beside the concern over income effects.

This result is also supported by primary evidence coincidental to this research.

II.1.2.1.1 Critique of Ratio Testing

The largest flaw in the use of ratio tests for judging materiality is the use of a fixed zone of percentages as a standard. Justification for utilizing the relationship between the magnitude of an item and income in the operational process of adjudging whether the item is material is <u>not</u> lacking. The problem lies in constructing a standard or scale for operationally measuring materiality in terms of the income criterion. The argument presented here is basically that income, and hence fixed ratio scales based on income, is not an absolute. The impact of income and therefore any amount normalized with respect to income is not constant from one situation to the next. To illustrate the point, consider two firms with the following characteristics:

	Firm	
	<u>A</u>	<u>B</u>
Total Assets	a_1	b_1
Retained Earning	a_2	b_2
Income	a_3	b_3
Sales	a_4	b_4

percentage throughout the review of a firm's financial presentations implies a symmetry with respect to income increasing and income decreasing items. It is not clear that such an implication is valid.

II.1.2.1.2 A Measurement Perspective

Having viewed its symptoms, the problem itself can now be defined. The problem stems from constructing an absolute standard based on a zero point that is fixed with respect to an income derivative despite the fact that income is a relative with respect to the economic conditions and events of the firm. It is not appropriate therefore to associate a standard but arbitrary scale value (or set of values such as 5 percent and 15 percent of income) with either an absolute lack of materiality or the absolute existence of a material amount.

In order to achieve an absolute standard, an absolute zero must exist for measurement purposes. If this were the case with respect to materiality, then it would follow that the materiality cut-off would be exactly the same in all situations and for over- and understatements alike. In other words, the <u>greatest</u> lower bound on materiality would and assume that for $i \neq 3$, $a_i = b_i$, so that only the income figures are different. Furthermore, take $b_3 < a_3$ such that $5\% \, a_3 > 15\% \, b_3$. Clearly, if the ratio standard is applied, an amount x, where $15\% \, b_3 < x < 5\%$ of the amount a_3, must be material with respect to Firm B and immaterial with respect to Firm A. A multitude of specific examples could be produced in which most observers would disagree with such a conclusion.

Another set of criticisms of the ratio testing measurement process arises because this process distinguishes neither profit from loss nor an item which will have an income reducing effect from an item with an income increasing effect. There may be a conservative bias among those who are concerned with materiality. If so, it would seem that an item could be material if when corrected the effect were to reduce income but immaterial or at least substantially less material if the correction's effect on income was positive. On the other hand, should the item with positive effect on income be just enough to change a reported loss to reported profit, it might well be more material than an item with the same magnitude but with a negative income effect. The application of a single scale and standard in all cases be represented by the identical ratio of dollar amount of income. All the empirical studies mentioned above and the currently espoused view that the standard for judging materiality in any particular situation lies within a broad zone of 5 to 15 percent of income indicate that the absolute zero measure of materiality has not been established in conjunction with the percentage effect on income scale.

As an absolute value of percentage effect on income, zero is of course the least lower bound in all cases. (This assumption will be proper so long as the exclusive criterion for judging materiality is the usual ratio measure.) This does not mean that the absolute zero for scaling purposes can be taken to be zero percentage effect on income since amounts greater than zero may be immaterial as well. The conclusion drawn is that there is no absolute zero in an operational sense associated with any of the materiality measurement methods discussed above. Therefore, the conclusion, even as a general rule, that an item whose income effect is less than say 5 percent of income is to be deemed immaterial seems completely arbitrary. This conclusion is supported by example in the financial press.[13] This same criticism can also be applied to standards based on income trends or other income derivatives as well.

Only a single point or standard, the materiality cut-off point in any given situation, and the relationship of such a point to cut-off points in other situations has been under review. For the most part, no effort has yet been made to deal with the relative materiality of an item. The thrust of the discussion has been to treat materiality with respect to an item as a qualitative dichotomous matter -- either the item in question is material or it is not. This sort of measurement, the determination of whether it belongs to one class or another, is an example of nominal scaling. There is a very coarse (dichotomous) ordinal scaling involved as well perhaps since the errors in the immaterial class are recognized as being less severe than those in the material category and this sort of rank ordering is the basic operation of ordinal scaling methods.[14] Neither of these scaling methods may be powerful enough for use in audit planning and decision-making since they do not allow a relative comparison of the severity of error <u>within</u> each of the two classes.

II.1.2.2 Miscellaneous Treatments of Materiality

Two approaches to the analysis of materiality have recently been suggested which treat the problem of materiality measurement differently from those approaches that rely directly on the financial statements to generate a self-contained measurement standard. These approaches suggest that materiality is not solely a function of the parameters of a closed system defined by the financial statements. Rather, both these methods place the financial statements in some broader context before attempting to operationalize the concept of materiality. The first of these methods examines the internal financial building blocks of the statements and the second external usage of the statements.

The first of these two methods views the financial statement balances as being the aggregated result of a large number of detailed individual balances. The particular context from which materiality measurement draws meaning under this approach is related to the aggregation process, which generates the relatively small number of items reported in the financial statements.[15] It is assumed under this approach that a loss of information results from such aggregation. The advantage claimed for this method is summarized as follows:

> What is the superiority of our measure over existing measures? The only quantity frequently mentioned by accountants and government agencies is the simple percentage. However, note that such a percentage is <u>not a measure</u> of the loss of information caused by aggregation but rather a <u>criterion</u> for aggregation. For example, the SEC's criterion of 10 percent will treat equally a nine per cent item and a .01 per cent item, although the loss of information caused by each aggregation is certainly different. Generally, aggregation of a .01 per cent item results in a a smaller information loss than that of a 9 per cent item. The information measure enables one not only to compare alternative aggregations (an ordinal measure) but also to quantify the difference between aggregations (a cardinal measure).[16]

As to its criticism of the traditional ratio analysis approach to determining materiality, this argument is compatible with the discussion given previously in this chapter and expanded below.[17]

The traditional methods of determining materiality are coarse and do not possess much measurement power. It does not necessarily follow however that measurements produced by evaluating the aggregation process will lead to better judgments about the materiality of items under review simply because this particular method when employed produces more discriminate measurements. A measurement can be no better than the criterion upon which it is based. If the criterion used as an operational surrogate for materiality is inappropriate, then the measurements developed from the criterion will have only arbitrary significance.

The criterion upon which the measure of the amount of information lost through aggregation is based is known as entropy. Entropy, H, is defined thusly,

$$H = -p \log_2 p - (1 - p) \log_2 (1 - p)$$

where p is the probability that an event will occur. It can be shown that H is in a relative sense then the expected value of the amount of information conveyed by the message which signals that the event with which p is associated has either occurred or not occurred. The measurement of the amount of information loss due to aggregation is adopted from the work of communications theorists such as Shannon.[18] According to the definition of entropy, p represents the probability that a message will occur and (1-p) the probability that it will not. It follows that the amount of information conveyed by a message should be a decreasing function of its probability prior to the message. In other words, the more expected a message the more information it conveys.

At this point it seems appropriate to examine the validity of this measure of amount of information as a criterion for judging whether an aggregation is appropriate for financial reporting purposes. First, it is apparent that the utility of information can be functionally related to surprise only on a very prima facia basis. Take the following situation where consideration is being given to the aggregation of long-lived assets with the following relative dollar structure.

Net Plant	3/8
Net Equipment	1/8
Deferred Franchise Cost	1/8
Deferred Research & Development Expense	3/8
Total Long-Lived Assets	1

If the entropy measurement procedure is utilized here, the measure of information lost if plant and equipment are combined will be be equivalent to the measure of information lost by combining the two deferred items. The impact of these two aggregations would seldom be equivalent to the concerned user of the financial statements from which these items are drawn. In addition, even if this first argument is dismissed, it can be seen that the probability assignments, 3/8 and 1/8, taken from this data are derived from the dollar values assigned nonmonetary assets in the case of deferrals. The probability assignments which lead to the equivalence of information loss measurements are most certainly arbitrary if some allowance is made by the user of the information in order to compensate for the value differential inherent in the comparison of the historical cost measurement assigned nonmonetary assets with the current monetary value measurements assigned to the deferrals.

Secondly, this particular method for measuring loss of information relies on a method for determining probability assignments which is counterintuitive with respect to the determination of materiality, or unexpectedness as a surrogate for the term material. Lev discussed this question by presenting intuitive arguments attempting to rationalize the probability assignment process for which the method calls. The probability or relative "expectedness" of a particular amount is drawn from an inter-item comparison.[19] The larger an item relative to others in the statement category being reviewed for possible aggregation the more expected or less surprising the item. Hence, a high probability assignment is associated with such an amount.

The entropy method gives no weight to the intra-item surprise value of an amount. The impact of information conveyed by an account balance is affected by its stability over time. It is certainly more surprising if the cash balance varies by 95% from one period of time to the next than if it is constant over the same period of time, yet the measurement procedure for expected information value contains no provision for this eventuality. For example, the procedure would suggest that aggregation of cash and marketable securities would be more desirable (that is, less information will be lost) in 197(x) than in 197(x + 1).

	1970(x - 1)	197(x)	197(x + 1)
Cash	1000	1000	50
Marketable Securities	1000	1000	1000
Other Current Assets	3000	3000	3950
	5000	5000	5000

Such a conclusion is intuitively incorrect because of the intertemporal surprise value associated with the cash amounts.

It is for the reasons just discussed that the entropy method is not very robust as a measure of the material effect (or lack of it) inherent in the aggregation of statement balances. As a result the method's use has been prejudged leaving only a very restricted class of materiality decisions for which the method can possibly be of some use.

The method requires first that the candidates for aggregation must have already been selected. This appears to be not very restrictive initially because it simply eliminates consolidation of blindly coincidental items (i.e., cash with goodwill, accounts receivable with inventories, etc.), but it also means that situations along the line of that suggested by the three year case discussed above must be prejudged. If this is not done then the condition placed on use of the method is not sufficient to eliminate incorrect decisions. The condition on use of the method is that relative size of the items must be the only important factor in the aggregation decision. By thus restricting the application of the method it becomes little more than an analysis of the bookkeeping materiality decision rather than a useful approach to the problem of presentation and/or disclosure.

The other newly suggested treatment of materiality employed a technique called the Method of Constant Stimulus Differences. The technique was utilized in an attempt to show the applicability of a psycho-physics law, the Weber-

Fechner Law, to the phenomenon of judgments about the minimum change in Earnings Per Share required to change the price of the firm's stock. The research experiment was designed to test the applicability of the Weber-Fechner Law and to provide, for the specific case where EPS is the stimulus of interest, an estimate of the general constraint contained by the general statement of the Law.[20]

Results of an experiment involving business students showed that under a certain set of controlled conditions in which only EPS was allowed to vary (other information available for inspection was kept relatively constant), a large percentage of students indicated that a change in EPS was the criterion utilized in determining whether stock price would change. More importantly the results show that a minimum change of about 6.5 percent in EPS is required before one-half of the students perceived an "essential" change in stock price as a result of a change in EPS from one reporting date to the next. This was true whether the first period EPS was $2.50 or $5.00. This supports the Weber-Fechner stimulus law which states that the minimum change is directly proportional to the initial amount, k, of the stimulus present. The threshold constant in this case was

6.5 percent. (The minimum change in EPS required to produce a perceived or essential change in the impact of the difference in EPS was defined as the amount at which one-half of the subjects perceived an essential change in the impact of the difference in EPS and one-half did not.)

The external validity of the study is, of course, limited because a student population was chosen. Internally the validity of a finding utilized to discern that a change in stock price would occur is questionable since EPS was the only potential criterion allowed to vary.

This work is roughly a behavioral equivalent to the empirical studies cited above. Though the methodology of the research was different the objective was to shed light on the threshold or standard income percentage which should be used in judging materiality. The primary distinction due this work is that it seeks to define the standard value by examination of the impact of selected information on students as surrogates for users of financial information rather than by inducing the standard percentage from examination of the product of professional accountants.

II.2 Audit Responsibility

The responsibility of an auditor requires that he consider more than the problem of materiality in his assessment of the fairness of financial presentations. An explicit awareness of the relationship between materiality and audit responsibility is seldom mentioned, but there is a distinction between the two. The distinction is important because it forces the auditor to face a more complex measurement problem than those involved with the establishment of a standard value which can be used to test whether an amount is material.

The materiality decision concerns the means, treatment or structure of presentation of a particular item. The auditor is required in addition to judge the accuracy of the figures which are incorporated in financial statement presentation. The auditor must assess the fairness of financial statements not only with respect to reporting structure but also with regard for the accuracy of the figures reported. The majority of the resources consumed during an audit engagement are usually applied to investigation of the second facet of these decisions.

II.2.1 The Concept of Audit Responsibility

Typically, error in amount is due to non-systematic (random) error caused by mistakes or failures in routine processing and recording rather than direct conceptual misspecification of the system, as is more commonly the case with materiality decisions. Typical examples of errors of the first type, non-systematic errors, would be a transposition in the figures entering a data base, an error in inventory price extension or the failure of a data processing program to add back expired sales discounts on past due receivables in violation of the intent of the system. Error in amount is also possible, however, as the result of more deliberate misstatement. For example, the allowance for doubtful accounts may be understated in relation to reasonable expectation derived from available tests of receivables (i.e., aging analyses) and other evidence.

In general the auditor's decisions regarding the reliability of amounts are judgments about the potential impact or disutility of mistakenly reported figures. It is his responsibility to allocate resources and render an opinion in light of the implication which the reliability of an account has on the potential impact of an error.

The auditor's objective must be to express an opinion on the fairness of financial presentations submitted by the client.[21] The auditor's responsibility then must be to determine whether or not the potential impact of error is "sufficiently small" in light of the degree(s) of reliability he ascribes to the statement presentations. Such a judgment requires two prior determinations: first an assessment of the impact or significance of the various degrees of error that the auditor might ascribe to the financial statement presentations and secondly an investigation by the auditor in order to establish the degree(s) of reliability he can assign to the client's financial presentations.

The assessment of the impact of error requires a perception on the auditor's part of whom he serves and to what degree they benefit (or suffer) as a result of his actions. This appraisal also requires a knowledge of how those whom the auditor serves can obtain redress if necessary. The auditor must also be cognizant of any explicit or implied constraints, tests, or standards which can be imposed in order to minimize losses suffered as a result of potential errors in financial statements about which he renders an opinion.

II.2.2 Audit Responsibility and the Accounting Concept of Relevance: A Distinction

The first scheme to be examined in this section was suggested by the Committee to Prepare a Statement of Basic Accounting Theory of the American Accounting Association. Though as the title of the Committee indicates the primary purpose of this report was not to establish a scheme or criteria for use in audit decision-making, it did have as one of its goals to establish concepts from which particular accounting practices can be judged. One conclusion of the Committee report was that relevance of information is the primary criterion for judgment. In addition to relevance the recommended standards for accounting information were verifiability, freedom from bias, and quantifiability.[22]

The primary standard for accounting information, relevance, seems related to the concept of audit responsibility. Unfortunately no clue is given by this scheme which would lead to operational definition for auditing purposes or for accounting purposes. One of the obstacles to operationalizing this scheme especially as it is appropriate to the audit decision-making process is its failure to provide for distinguishing varying degrees or amounts of relevance.

In addition, the scheme itself has been criticized as being without explication, providing neither logical nor operational criteria with which to build a theory of accounting.[23] Finally, the question of relevance to whom remains unanswered by this approach.

A more sophisticated view of relevance than that established by the American Accounting Association Committee attempts to resolve this problem by distinguishing levels of relevance and causes of variation. A four level classification scheme is involved.

The scheme includes, first, a technical level dealing with the expression of information in terms of statistical properties of messages. The semantic or interpretative level involves the conveyance of differences in the meaning of messages. The third or action level of the hierarchy distinguishes messages according to whether different messages would result in different decisions. Finally, the most meaningful level of the hierarchy, but also the level which is the most difficult to operationalize, involves assessment of the difference in goal fulfillment which would result from the interpretation and subsequent action based on receipt of alternative messages.[24]

Analysis with reference to this hierarchy had led to the following conclusions by Shwayder:

> The emphasis in the AAA monograph is clearly on decision relevance. Decision models, for example, are discussed; utility models are not. Relevance often is synonymous with decision relevance. "It is not necessary to know in detail the needs of all the diverse users of accounting information to prepare relevant reports for them for certain classes of information are relevant to many decisions. As mentioned earlier, the Statement's definition allows for result relevance as well as decision relevance but there is no mention of semantic relevance. I advocate its inclusion because it may be the only alternative when the decision environment is very complicated. Since no one of the three standards dominates any other standard in both dimensions of operationality and meaningfulness, accountants will probably have to use all three definitions of relevance.[25]

Shwayder seems to distinguish materiality from relevance by a classification of the cause of differences in the items being compared. Where the same measurement system and the same data base are used to construct amounts which differ, thus implying that one or the other (or both) is in error, the difference evaluation is to Shwayder a question of materiality. If two messages differ in amount because either the data bases (i.e., LIFO vs. FIFO) or the measurement systems (i.e., accelerated vs. straight line depreciation) leading to the respective amounts are different, then the difference in the message is to be evaluated as a question of relevance. As a result differences at the technical level of the hierarchy are restricted to decisions about materiality. Either cause, materiality, or relevance, may be associated with the other three levels.

Perhaps the most significant point for auditing purposes in this discussion is the conclusion that the determination of relevance or materiality will require consideration of the impact of semantic, decision and result facets of financial information. The distinction of materiality from relevance seems somewhat confusing. It may be suggested that for auditing purposes differences at the technical level be used as a criterion and that the impact or significance of these differences be assessed in light of evaluations drawn from the consideration of the consequences of error at each of these three levels of perception.

One final perspective seems appropriate in order to set out that particular connotation which will be attached to relevance in subsequent sections of this dissertation. Basically, general acceptance is used by the auditor as a surrogate for the judgment of relevance. The auditor <u>must</u>

establish whether or not items presented by the client's financial statements are relevant in the sense that they comply with generally accepted practices. At times the auditor may deem it necessary to determine which generally accepted accounting principle is most appropriate. This is most likely to occur, for example, when the auditor is dealing with a change in accounting principles as discussed in Accounting Principles Board Opinion No. 20 or with policy statement issues as discussed by Accounting Principles Board Opinion No. 22.[26] In any of these cases, the process of judging relevance for the auditor is a method of establishing whether a particular kind of error (a violation of generally accepted principles or an inappropriate choice of principles) has occurred.

Except as noted, the auditor works for the most part within the constraints of generally accepted accounting principles which shield him from the routine involvement with the class of problems involving relevance as specially defined by Shwayder. This class of problems is, of course, of great concern to the accounting profession as a whole though because relevance is a key to researching what should be generally accepted. This is an important distinction and is highlighted by a recent opinion survey which disclosed that 82.5% of "Big Eight" practitioners surveyed and 71.5% of other auditors surveyed indicated that the selection of particular principles to apply in financial statement presentations was the responsibility of management not the independent auditor.[27]

The auditor's judgments about the impact of error seem independent of the cause of any error. Whether an error be one arising from a material difference or a relevant difference, the process that the auditor goes through in assessing the impact of the error will be the same. Relevance is dealt with during the audit only as a criterion for distinguishing a particular type of conceptual error. The auditor therefore relies on relevance to <u>define</u> a potential cause of an error not to <u>assess</u> the significance of the impact of such an error should it occur. In latter sections of this dissertation, concern will center on the assessment problem not the possible reporting problems associated with the choice of inappropriate or inconsistent concepts which do not produce significant errors in amount. In other words, where relevance is concerned emphasis will not be placed on the treatment of conceptual error per se, but rather on the financial statement artifact of such error.

II.2.3 Professional Guidelines

Authoritative professional bodies have promulgated statements that address the issue of defining what the auditor is (or is not) responsible for, but these statements give little insight into <u>how</u> or <u>to whom</u> he is held accountable for this responsibility. Later in this work it will be shown how the auditor might personally assess his accountability in view of his perception as to whom and to what degree he is accountable. Some insight will also be given in to how the auditor can utilize this information to optimize performance.

Much of the auditor's responsibility stems from the opinion he renders regarding the fairness of the final figures presented by the client's financial statements. Appendix I contains the standard short form report usually utilized for the expression of such an opinion.

The auditor's responsibilities as defined by professional bodies are twofold. First, the auditor must adhere to a code of ethical practices, and second, he must abide by a particular statement concerning auditing standards and procedures. The code of ethics deals with unsavory practices, constraints on technical practices, promotional prohibitions and relations with fellow members of the profession.[28] Though there are notable exceptions, all of which seem to be covered by the second work as well, the thrust of the code is to provide direct intraprofessional regulation rather than direct protection of those who benefit from the auditor's work.[29]

One of the major committees of the American Institute of Certified Public Accountants has issued a statement which discusses what is expected during preparation and execution of an audit and in the rendering of an opinion. There is a positive statement about responsibility in one chapter of the statements making the independent auditor responsible for compliance with standards accepted by other professional accountants.[30] Most of the discussion of responsibility, however, is devoted to a discussion of that for which the auditor is not responsible (i.e., fraud detection, statement preparation, etc.).

Later in the committee's statement, a set of professional standards are spelled out.[31] The general standards among all of these require that the auditor be independent in attitude and properly educated or trained in accounting theory and auditing procedure. In addition, the auditor is charged with exercising due care, in other words, being reasonably diligent and honest.[32]

In addition to the three general standards, there are sets of standards related to fieldwork (audit planning and execution) and reporting (rendering of an opinion). Guidelines to acceptable practice enumerated under these headings include providing adequate planning and supervision, proper study and evaluating of internal control to determine the extent to which audit procedures are to be restricted, the gathering of "sufficient competent evidential matter" in order to support the opinion rendered and insuring that disclosure in the statements is reasonable adequate.

Basically, these concepts define the auditor's responsibility to the profession. Though these concepts are each discussed in more detail later in the committee's statement, at no point does the work set forth a method to measure the degree of compliance nor does it provide an operational standard for assessing whether these generally accepted standards have been adhered to. In briefly addressing this problem the committee states,

> These standards to a great extent are interrelated and interdependent. Moreover, the circumstances which are germaine to a determination of whether one standard is met may apply equally to another. The elements of "materiality" and "relative risk" underlie the application of all standards, particularly the standards of fieldwork and reporting.[33]

There is no suggestion in the committee's statement of an analytical not even diagnostic method of assessing compliance.

II.2.4 Legal Guidelines

The auditor incurs legal responsibilities each time he attests to the condition of a set of financial statements. For the most part, dictum on auditor's legal responsibility has been developed through tort action in civil courts. Recently, however, the auditor's responsibilities in light of certain criminal statutes have become important in a certain few prosecutions which may become important precedents.

A caveat needs to be injected here in order to provide a perspective on this section which also permeates this entire research effort. There seems to be a difference between the professional and legal responsibilities of the auditor.[34] This work is based on the premise that the professional auditor must view the legal consequences of his actions as at best minimum and incomplete guides to conduct of professional activities. His decisions are (or should be) based on and guided by far more than his potential liability in court. In other words, the professional accountant's responsibilities are much more expansive than his legal liabilities.

The auditor's civil liabilities, since they are based on the tort concept of retribution for damages, developed initially in actions involving contract law. As a result the auditor's primary responsibility has traditionally involved the client as a party entering into contract with the auditor. In certain cases, the civil liability of the auditor has been extended to allow redress for third parties as users of financial statements who have relied on the auditor's opinion.

Apparently, the auditor's legal liability has been further expanded under the Securities and Exchange Regulations so that proof of reliance is eliminated as necessary in order for findings to adversely affect the auditor.[35] Most recently another dimension has been reexamined by the court in such a way as to again widen the type of legal actions to which the auditor is subject.

Apparently, as indicated by court decisions discussed below, compliance with a professional standard (or at least the overwhelming professional opinion) may not be an adequate defense.

II.2.4.1 Traditional Civil Liability

When the auditor enters into contract to perform an audit, he has an implied duty to perform with the skill to be expected of a person with commensurate training and experience. The auditor has traditionally been subject to liability to his client for breach of contract when he fails to meet this standard. However, there is no such duty to parties not in contract with the auditor. As a result, persons other than the client who suffer because of the auditor's actions have sought redress for negligence and/or deceit.[36]

A ruling in 1931 closed ordinary negligence as an avenue for third parties with this often-repeated rationale,

> If liability for negligence exists, a thoughtless slip or blunder, the failure to detect a theft or forgery beneath the cover of deceptive entries, may expose accountants to a liability in an indeterminate amount for an indeterminate time to an indeterminate class. The hazards of a business conducted on these terms are so extreme as to enkindle doubt whether a flaw may not exist in the implication of a duty that exposes to these consequences.[37]

This ruling does not apply in cases where a person[38] or class[39] likely to rely on the auditor's certification are identifiable and known by the auditor to be the primary person(s) for whom the statements and opinion are being prepared.

There is of course a general duty to not willfully misrepresent which the auditor must accept. Deceit requires a false representation or conscious lack of diligence in search for potentially incorrect information. Deceit then extends liability to include persons or classes whose identity is unknown to the auditor and who were not primarily involved in the instigation of the audit.[40]

It appears therefore that in the absence of legislation to the contrary accountants must be negligent to the point of being deceitful in order to be liable to third parties on that grounds. The distinction between such ordinary negligence and gross negligence is the set of standards recognized by the profession. The standard of reasonable care applied to auditors is the same as that applied to lawyers, doctors and other professionals.[41]

II.2.4.2 Expanding Civil and Criminal Liability

Under Section II of the 1933 Securities Act, accountants have recently been held liable for non-fraudulent conduct to third parties despite lack of contractual relationship.[42] Section II is a significant expansion to the auditor's liability to third parties. No proof of fraud or deceit nor even mere negligence is necessary. Generally the plaintiff need show only that he incurred damage and that the character of the financial statements was misleading. The defense available under Section II is proof by the auditor that he conducted a reasonable investigation and had reasonable grounds for belief that the statements were not "materially" misleading. The Act defines the standard of "reasonable investigation" and "reasonable grounds" for belief as "that required of a prudent man in the management of his own property."[43]

Basically, the <u>BarChris</u> case has established that under Section II the auditor must bear the burden of proof in actions involving third parties and that the auditor is liable to third parties for ordinary negligence.[44] The prudent man statement has been relied upon to even further enlarge the scope of auditor's liability. This clause has been interpreted in a recent criminal case to mean that a jury can judge the accountant by other than professional standards. The court has thus exposed the accountant to possible liability for failure to meet a different standard than due care as established by professional standards.[45]

The appeals court in the Continental Vending case stated that the jury was not required to accept the auditor's evaluation of what was material to fair presentation even though such an evaluation was based on performance by the auditor in a manner consistent with professional standards. This particular case involved circumstances where the auditor should have had reason to suspect that ordinary review would be insufficient and where the professional standards involved no specific rules but left the manner of compliance to the judgment of the auditor.[46]

II.2.5 Self-Assessment of Compliance with Audit Responsibility

The standards for which the auditor is responsible have been introduced and a review of how and by whom redress can be obtained when the responsibilities are not met has been given. It remains to be seen, however, how the auditor can account for or plan his own performance in a manner which will enable him to decide whether or not his work is (or will be) satisfactory in accordance with his responsibility.

In this section two suggestions as to how this should be or can be accomplished are presented. For convenience, these schemes will be classified as (1) situation specific and (2) conceptual, depending on the method they suggest as a basis for accountability.

The first scheme suggests that the auditor may view the assessment of this responsibility at three levels.[47] The first of these levels is directly concerned with the materiality question discussed above. It is shared responsibility with the client. For the most part, judgment by the auditor at this level concerns the final qualification of his opinion. If the statements as presented by management do not conform to generally accepted accounting principles, lack disclosure or are inconsistent in application of a principle, then he must qualify his opinion or be prepared to accept the consequences of the error implied in rendering an unqualified opinion. If this latter course is adopted (it seems that it rarely would be), then judgment must be made at a different level--the execution level discussed below.

At the planning level, the auditor must be guided by a duty to satisfy himself that the client's financial statements represent that which they purport. Simultaneously, however, the auditor must perform the audit at the lowest cost consistent with due care or diligence. The standard for measuring adequacy in planning is as follows: "Thus in preparing the audit program he [the auditor] arranges to give thorough coverage to those items which may have a significant effect on the financial statements and to give minimal attention to items which are unlikely, in light of the client's system of internal control, to affect the statements materially."[48]

The cost-benefit type of approach is a quite proper objective but no suggestion is given as to how to achieve such a goal. The author does not present a method for operationalizing the concept. Some additional insight, however, into the manner of achieving this objective is presented. The author accomplishes this by introducing an assertion regarding the test of significance. Specifically the test suggested is whether it is likely that an average prudent investor or reasonable person would be influenced in his decisions if the matter at issue were disclosed or some significant item (say income) were to decrease or increase by the amount in question.

Basically, it is suggested that the proper execution of the examination may require assessment of exceptions or errors discovered during the audit on a basis other than their relative size. Such an item must be assessed in terms of the potential consequences of other errors more likely to occur in the same way or for the same reason.

The decision-specific nature of such judgment by the auditor regardless of the level involved is put forth thusly:

> . . .percentages are not 'magic numbers.' They are useful only to the extent that they help weigh the potential effects of materiality (used to include audit responsibility) decisions on investors. In general it has not been found practicable or desirable to establish, by rule, percentages or percentage ranges which denote materiality or its absence. Variations in the nature of transactions, the history of companies, the circumstances under which transactions occur and other factors have made it seem unwise to establish such rules.[49]

This perspective on the shortcomings of the broad zone measurement approach especially for the auditor's purposes can be generalized by considering the financial statements as a part of a larger (but closed) system.

The auditor must review the economic environment of the firm and the particulars of the statements and the interface between the two before he can assess the impact of a potential error.[50] This system of interaction involving the economic environment and the financial statements is the common ground from which the particulars of any audit situation spring. This does not imply that the commonality in the evaluation of financial statements from one audit engagement to the next can be viewed as subject to the same measurement scaling from one situation to the next.

The second approach to the self-assessment of audit responsibility relies on a single postulate, fairness, and can be succinctly reviewed from the following:

> Thus, the one basic accounting postulate underlying accounting principles may be stated as that of fairness--fairness to all segments of the business community (management, labor, stockholders, creditors, customers, and the public), determined and measured in the light of the economic and political environment and the modes of thought and customs of all such segments--to the end that the accounting principles based upon this postulate shall produce financial accounting for the lawfully established economic rights and interests that is fair to all segments.[51]

Though this statement deals explicitly with accounting, those emphasizing fairness as a foundation for action seem primarily concerned with the audit or attest function.[52] The source of this statement bears out this point.

The second approach to self-assessment of performance on an _ex ante_ or _ex post_ basis differs from the situation specific approach just mentioned in two ways. First a different rationale for inference is employed. Whereas the previous approach suggests that the auditor should induce from a specific situation a proper assessment of his responsibility, the conceptual approach suggests that in any situation the auditor's responsibility be deduced from a single postulate. Secondly, while the criterion for judgment in the situation specific approach is to be the perceived influence of an error on the investor or prudent man the conceptual approach suggests that the influence of error on all concerned parties is to be considered.

The situation specific approach recognizes the need for an operational definition of a criterion for the assessment of responsibility but provides no method for its application. The conceptual approach does not provide an operational definition.

The situation specific approach attempts to come up with a clarification of the criteria (criterion) for self-assessment by limiting the parties to whom the auditor should look for clues as to how to judge the impact of error. It attempts to simplify the measurement process by simplifying the environment. The conceptual approach does not restrict the auditor's search of the environment for signs of potential impact of error. On the other hand, however, this approach does not recognize the need for compatibility and operationality in the definition of the auditor's responsibilities to each of the classes of persons influenced by an audit opinion.

II.2.6 Conclusions About Self-Assessment of Audit Responsibility

The self-assessment of responsibility by the auditor will require operational definition and measurement of the perceived impact of potential error on each class of persons influenced by the financial statements. The allocation of resources will require utilizing these assessments as guides to actions in accordance with the reliability or potential variance the auditor can assign to the various items involved in the financial presentations of the client. These two problems will be referred to as the assessment or measurement problem and the decision problem, respectively.

II.2.6.1 Identifying the Self-Assessment Problem

This chapter and the concluding remarks which follow are concerned almost exclusively with the assessment problem. A final note is appropriate though before dismissing temporarily the decision problem. Since the auditor is uncertain to various degrees as to the exact amount of error, he must be in a position which will enable him to tackle the decision problem with knowledge of the impact of various potential amounts of error. Thus the assessment problem in any given audit situation must deal with the relative severity of various amounts of error rather than merely a standard cut-off point.

A lot of the confusion stems from a failure to distinguish the intertwined problems of assessment and decision. The usual solutions to these two problems have followed one of two basic frameworks. The first of these frameworks calls simply for professional judgment as the solution to both problems. The second framework calls for operationally measuring the degree of impact of an error by utilizing the continuum of percentages associated with an income ratio test as a scale for assessing the potential consequences of error. This procedure is employed in order to solve the assessment problem. The decision problem is then resolved by comparison of any particular error with a fixed percentage (or one from a fixed zone of percentages) to determine whether the impact of the error is sufficient to require qualification of the opinion.

There are some shortcomings which seem apparent in this approach. First where uncertainty about amount exists as it often does in the planning and decision-making stages of an audit, the second rule (the decision rule) is unsatisfactory. This is especially true when there is some probability that the actual error amount might be either greater or less than the amount associated with the fixed percentage serving as a standard. Second, even if certain as to the exact amount of error, it seems that the cut-off point is a decision-specific thing not necessarily subject to standardization.

Furthermore, an error, even though small enough to be of lesser impact if only a dichotomous categorization or coarse measurement is applied, may when considered with other errors lead to the conclusion that in the aggregate their effect should impact on the auditor's decision. Such compatibility requires a relative scaling rather than a binary classification of the relative impact of varying degrees of error.

II.2.6.2 Measurement of Self-Assessed Consequences

The assessment problem requires the selection of a criterion (criteria) and a method of measuring relative impact of an error in accordance with the criterion. It is important to note however that the selection of a criterion is <u>not</u> tantamount to assigning relative measures in accordance with it. This is important because again it requires the separation of joint problems; this time dealing with the measurement of the impact of error. Selection of effect on income as a criterion, for example, does not imply that percentage increments with respect to income are proper measures of equivalent units with respect to this criterion.

In a restricted sense, measurement requires a constant interval or unit of measurement. The unit is such that it can be used as a basis for either a ratio or interval scale. By applying this scale to the difference between the quantities of a particular property inherent in two objects or events it is possible to determine the magnitude of the difference between the amount of the property inherent in each.[53]

If the scale is a ratio scale then not only differences but absolute amounts can be determined by measurement according to the scale. In such cases an absolute zero is always implied.[54] It has been shown already that the percentage scales for measuring materiality do not imply an absolute zero. This was accomplished in two ways. First it was shown that the zero value for a percentage of income scale is not the point at which the significance of an error is at its zero threshold or point of origin. Second, it was demonstrated that this threshold is not necessarily represented by the same percentage value in all audit engagements. The research cited indicated that such a point of origin is usually greater than zero--perhaps in a range between five and fifteen percent.

This lack of ratio scaling ability implies that it is not possible to assert that any scale value according to a scale based on percentage effect on income bears meaningful relationship to another value of that scale in proportion to the number attached to each value. For example, it could be misleading to say that an item with an eight percent effect on income is twice as material as a four percent item. This criticism holds regardless of (1) whether the measurement system qualifies as an interval scale and (2) whether (<u>even if</u>) income effect is an appropriate criterion.

The assumptions of interval scaling operations are less demanding than those of ratio scales. It is possible therefore that fixed interval scaling might be appropriate for the auditor's purposes even though ratio scaling is not. This possibility will now be explored.

If a fixed interval scale assumption holds for any given situation, then the change in impact of error that occurs by moving through any two intervals equal according to the scale would produce identical changes in the impact of error. For example, moving from six to seven percent of income and moving from eleven to twelve percent of income would produce equivalent change effects.

If the fixed interval assumption holds without qualification then there will be a linear relationship between percentage effect on income if it is chosen as the criterion and the magnitude of the impact resulting from the error. Reference can be made to Figure 2.1 in order to observe the effect of this relationship.

If this measurement model is constrained to a five to fifteen percent zone of minimum effect which will be referred to an the minimum threshold, then the relationship between impact measurement scales would be a linear transformation of the form.

$$M = aM' + b$$

where M and M' are values from different scales but nonetheless representing the same impact (say I as shown in Figure 2.1) and a and b are constants, which define the relationship between the scales with $-10\% < b < 10\%$ and $a > 0$.

Does the fixed interval assumption hold? Indeed there is no evidence to suggest that it does. It seems intuitively correct to suggest that the relationship between impact of error and the amount of error is monotonically increasing, but beyond that no particular hypothesis seems to be supportable except by fiat. An empirical investigation of various hypotheses about this relationship seems urgent

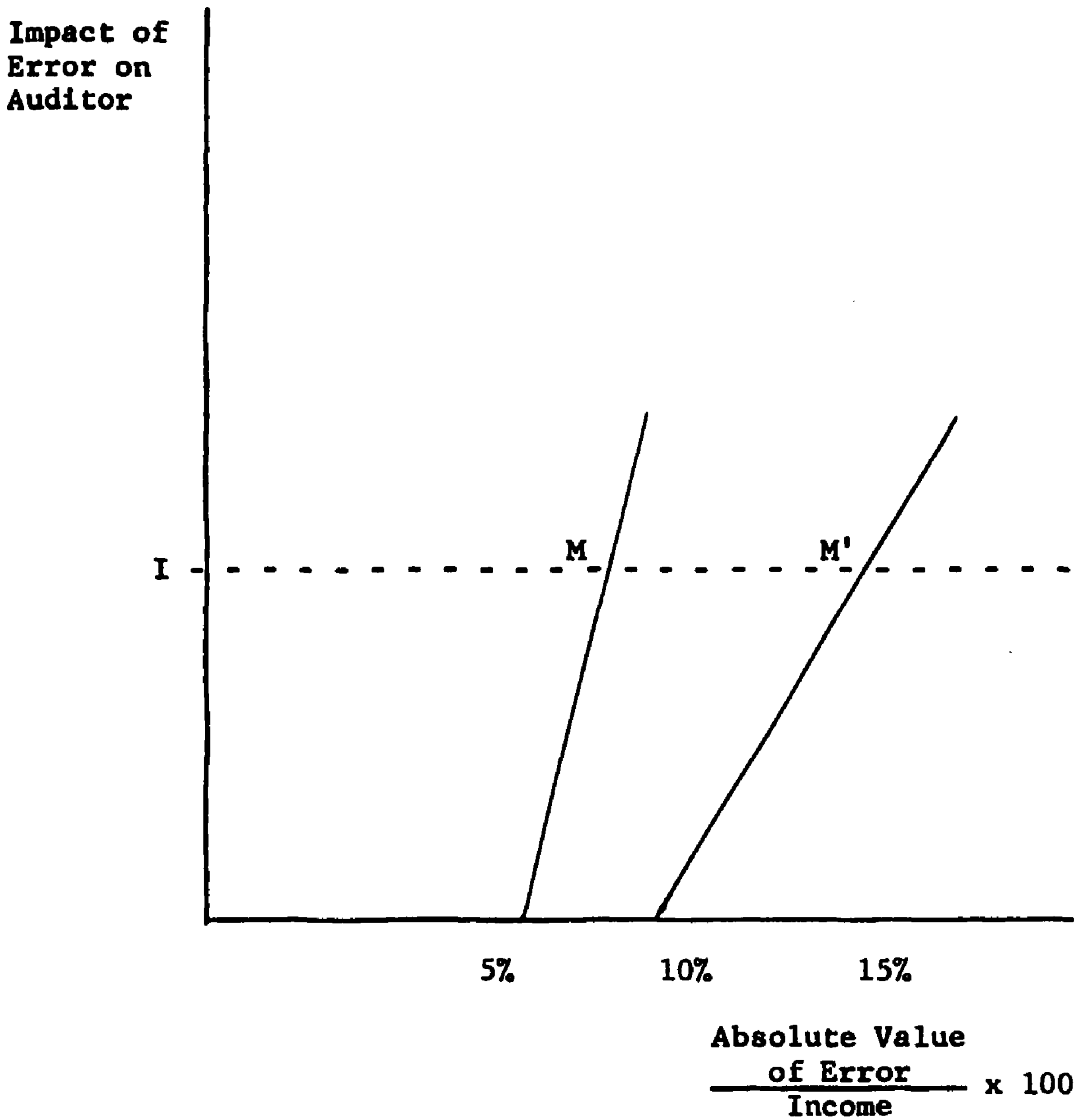

Fig. 2.1.--Impact of error as a linear function of percentage effect on income

and therefore such an investigation is a part of this research.

Furthermore, there is no reason to suppose that the relationship is not unique for any given audit situation. There is no reason to specify that certain parameters should be constrained in the general case (i.e., $-10\% < b < 10\%$ in the model discussed above) nor is it absolutely clear that the same functional form relationship should be common to all audit cases (i.e., even if the linear measurement relation is satisfactory for one engagement, is it necessarily applicable in all other situations?).

II.2.7 A Critical Issue: Judgment Vs. Uniformity

What must be done then in view of the primitive level of knowledge in this area is to define a uniform methodology, not uniform standards. Such a methodology should be free of untested assumptions which are implicit in the specification of standard rules of thumb. Such a method needs to allow, not constrain, operationally defined expression of judgment about the relative impact of error in a form readily synthesized into a framework for audit decision-making. If repeated application of the methodology indicates overwhelming consensus with respect to some general specification of the method, then a standard with regard to that particular specification could be considered.

Utilizing this discussion of desirable methodological attributes as a standard the next two chapters will in turn provide respectively an exploratory evaluation of current audit decision-making practices and a methodology which possesses the desired attributes. Specific attention will be concentrated on the relationship of sampling evidence to the decision-making process.

CHAPTER III

CONTEMPORARY AUDIT DECISION-MAKING

The previous chapter dealt at length with the assessment problem; this chapter explores more thoroughly the decision process. During this discussion reference is made to the guidelines developed in the previous chapter concerning the desirable general characteristics of methods employed in audit decision-making. Previous analysis suggested that an appropriate method for audit decision-making should in any particular situation provide (1) for operational assessment of the consequences of error and (2) for the utilization of such assessments as a basis for decisions regarding the fairness of the client's statement presentations in light of the uncertainty which surrounds the auditor's knowledge of the proper statement figures. Any audit decision system should exhibit these general characteristics.

Since the auditor must be concerned with selection of procedures in order to generate information (evidence) with which to support his findings about fairness, it will be helpful for the sake of completeness to partition the basic decision problem. By developing a decision model for the audit process, it should become easier to rationally evaluate and select those techniques which are both effective and efficient. This implies that a decision model must relate the auditor's objectives to the overall results of a program of audit procedures, but it also suggests that a decision model should permit and even require provision for the rational evaluation and selection of audit procedures in order to obtain decision relevant results.

Basically, then, a decision system should enable the auditor to reach the required decision; it should enable him to determine which procedures might effectively aid him in reaching that decision, and finally, it should permit and facilitate comparison and selection from among alternative procedures. This chapter examines the contemporary audit decision-making process accordingly. Embodied in the discussion is a review of certain paradigms which attempt to structure the rationale(s) which guides the auditor in the allocation of resources and in the evaluation of evidence. Particular emphasis is placed on strategies for sampling design and analysis as applied in auditing.

III.1 Objective of the Attest Function--The Required Decision

The auditor must act in a fashion conducive to the fulfillment of his responsibilities as set forth in the previous chapter. Ultimately, the auditor is retained to render a professional opinion as to the fairness of the client's financial statement presentations. The opinion should be based on both sufficient evidential matter and a review of the system of internal controls maintained by the client.[1]

Other objectives are sometimes ascribed to the auditor in addition to the attestation objective. It has been suggested, for example, that the auditor's review of management effectiveness will become an integral part of the audit process.[2] This is probably quite correct because of the trend toward reliance on systems review during the course of the audit. Reasoning that the management audit should therefore be an objective of the audit, however, does not follow. A more appropriate conclusion is that tools used by the auditor in gaining evidence in support of the auditor's objective are changing. The auditor's objective is not necessarily affected by such a change. The confusion stems from a failure to distinguish between (1) decisions concerning the selection of the most appropriate procedure to use in support of an objective and (2) decisions regarding selection of an objective per se.

III.2 Modeling the Attest Function

The foundations for descriptive modeling of the attest function can be drawn from the pioneering work of Mautz and Sharaf who conclude that:

> Auditing in its entirety is made up of two functions, both closely concerned with evidence. The first is the evidence gathering function; the second is that of evidence evaluation. In many instances in practice, evidence is evaluated as it is gathered so these two functions appear to proceed simultaneously. There is little conscious separation of the two and for the examination as a whole they proceed as one.[3]

These two basic functions are related as shown in Figure 3.1.

The overall audit model can be decomposed or refocused at another level--one dealing with single propositions. From within, the audit is seen as the recognition of propositions in series. Each proposition must be determined to be valid or invalid. The analysis of each proposition proceeds as shown by Figure 3.2.

Attention is focused initially on a particular proposition or hypothesis (say, the Accounts Receivable balance is fairly presented). The auditor must then determine whether he should gather a persuasive degree of evidence about the veracity of the hypothesis or whether he needs to examine evidence to the point of being able to prove or disprove

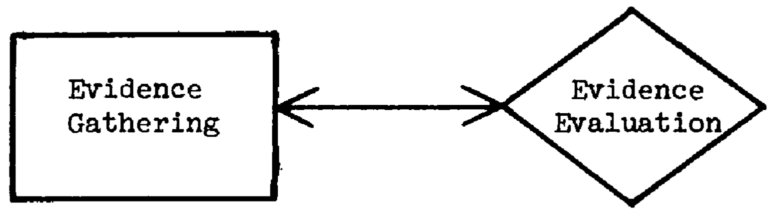

Fig. 3.1.--An overview of the Mautz & Sharaf model

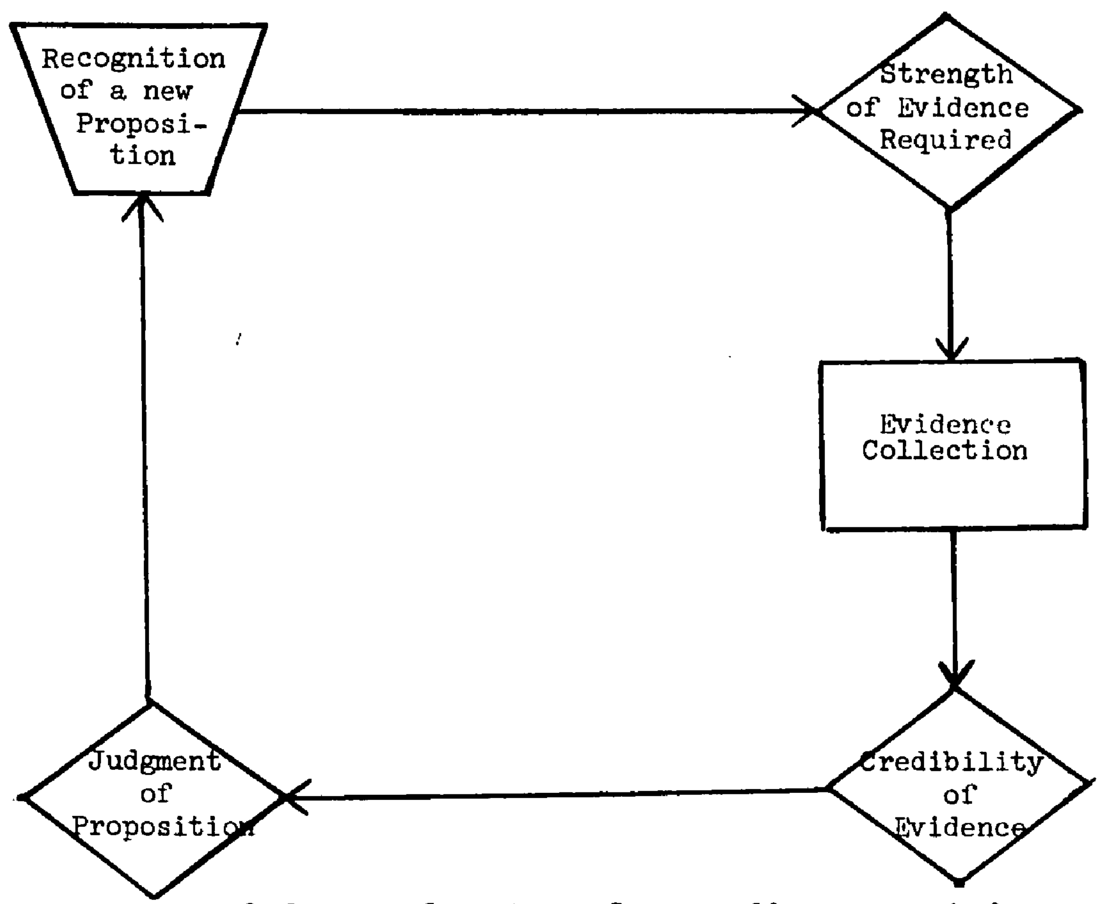

Fig. 3.2.--Evaluation of an audit proposition

the proposition. This decision is equivalent to the issue of whether the proposition represents a "material" amount. Collection of evidence is then done in accordance with the strength of evidence required.

The evidence gathered during examination of the proposition is evaluated according to its validity or authority. Finally, the proposition is adjudged to hold or not to hold in light of the evidence which has come forth.

This approach to modeling the attest function is much more thoroughly elaborated by its authors and is basically sound. Nevertheless, the following capabilities which are desirable in light of the criteria established for the assessment and decision problems seem to have been slighted. First with respect to the assessment problem, the auditor is allowed to distinguish propositions or statement elements as requiring either a high or moderate degree of assurance. As a result there is with respect to the decision problem provision for selection of audit evidence gathering techniques on a qualitative, binary basis. This allows the auditor to only crudely distinguish audit procedures as producing inferences which are of either a high or moderate degree of probability.[4]

As a result, no clear or precise measure of the effectiveness of any audit procedure is available for application by the auditor. No provision is made for explicit comparison of alternative audit techniques, nor is there provision for redefining the evidence gathering function based on prior information from other available evidence.

The last of these items is discussed apparently as being a part of the analysis of subpropositions for each major proposition, but no provision is stated for considering evidence bearing on more than one proposition at a time.

The problem of technique selection is not crucial to the final opinion rendered regarding fairness since all that matters in this regard is whether the auditor has gathered sufficient evidential matter, etc. It was not necessary for Mautz and Sharaf to explicitly provide a guide for selection from among alternative procedures. Nonetheless, this is certainly an important problem if one is concerned with the cost effectiveness of the audit, or the selection from among alternative techniques or strategies.

In general, the selection of audit prodedures is a situation specific matter. Certain information systems can, however, be classified according to the characteristics of the technologies they employ. The analysis of Mautz and Sharif has been extended by Lewis to cover two particular classes of such systems technologies. The paradigms developed compare the distinguishing characteristics of online and traditional systems with respect to internal control features.[5] These paradigms are then utilized as a basis for setting forth the audit techniques which are effective (and not grossly inefficient) in both environments or in only one or the other of these environments.

In addition to the differences in the control structure of systems' technologies which can influence the effectiveness of audit procedures, the processing features of differing systems can influence the type of evidence ultimately available to the auditor. For example, where real-time random access processing is encountered, the auditor may be faced with updating procedures which do not lend themselves to the retention of file or record histories. The ability to conduct verification by inspection or sampling of such items is therefore limited. The cumulative effect of updating may be all that is available from the file. The individual updating transactions need not be retained.

III.3 The Assessment of Procedures

To this point it has been shown that certain situations call for the selection of audit procedures on the basis of whether a particular system's feature will permit the technique to be effective in producing evidence in support of the auditor's opinion concerning fairness of presentation. This section extends this analysis of effectiveness. It was suggested early in the chapter that the selection of technique can be a matter of efficiency, of cost effectiveness, and this section also examines this concept more closely. Emphasis here will be shifted away from the comparison of various systems. Instead, attention will be given to the resource allocation problem as it exists at a micro-level for each audit engagement.

III.3.1 Systems Review vs. Verification--The Generic Source of Evidence

When confronted by a specific system for a particular client, the auditor must choose a basic approach. This requires that the auditor determine the relative weight to be given to review and testing of internal control on the one hand and to verification testing on the other. In other words, he must decide how much effort to devote to testing the information system by review and testing of internal controls and how much effort must be given to an examination by verification tests of the actual data and statements which are the product of that system.

Prior to this century, the entire audit emphasis was placed on detailed verification of the account balances at year's end. The sheer magnitude of transactions as well as the systems evolution discussed above, however, have led to an impetus for reliance on a review of internal controls for the sake of ecomomy as well as effectiveness. At present, determination of the extent of many verification procedures is actually dependent on the auditor's conclusions regarding the adequacy of internal controls.[6]

The evolution of reliance on internal control review has in fact led to a substantial reduction in what would otherwise be required in the way of detailed verification done at year's end. The impact of the evolution has been so pervasive in fact that a professional standard now requires that a proper study and evaluation of the internal controls of the client's information system be conducted and utilized as a basis for reliance in determining the extent to which other auditing procedures are to be restricted.[7]

The effect of this pattern on the resource allocation process is emphasized by the amount of work done during the period under review prior to the end of the client's fiscal year and therefore before the financial statements are available.[8] Increased flexibility in information technology has made systems susceptible to constant change. A subtle program change for example can cause the adequacy of a control to change at any moment. In order to rely, therefore, on his review and testing of internal controls, the auditor will be required to schedule such reviews throughout the period to be reviewed.[9]

The two basic dilemmas then for the auditor are (1) to decide strategically whether to place emphasis on extensive continuous internal control review and testing or to concentrate to a greater extent on the use of verification procedures at year's end, and (2) to decide which audit techniques are the most efficient choices within the context of the strategy chosen. To a large extent these two questions must be solved simultaneously since the strategy will be implemented by application of a preselected group of procedures. It seems appropriate therefore to examine the techniques utilized to assess the value of information produced by such evidence gathering procedures.

III.3.2 Strategies for the Analysis of Evidence

This section will focus on the strategies for analysis of information which is furnished to the auditor by the evidence gathering methods utilized during the audit. The discussion is roughly equivalent to an in-depth examination of current thoughts about how information produced by evidence gathering procedures is related to audit decision-making activity.

III.3.2.1 Judgmental Strategies

Many strategies proposed and adopted for audit use in the analysis of evidence depend entirely on judgmental inference. Generally, analytic strategies of this sort may be classified as exploratory or conclusive depending on the objective of the procedures utilized to generate the evidence to which the strategy is being applied.

Exploratory strategies are associated with such procedures as the review of organizational structure and the examination of the minutes of meetings of the board of directors. The objective of such procedures is the determination of the depth and/or nature of subsequent procedures employed during the audit engagement.

Conclusive strategies are involved directly with the decision problem and therefore lead more directly to the formulation of an opinion regarding the fairness of a financial statement item(s). The employment of judgment may often involve a mixture of these two strategies. For example, the test for proper employment of a check digit during validation of receivables updates is both exploratory--in that it tests for incorporation of such a system's control--and conclusive--in that it sheds light on the accuracy of receivables postings, and hence the receivables balance. The exploratory judgment involves evaluation of the effectiveness of other potential procedures which could be used to investigate the receivables balance. The conclusive judgment involves formulation of beliefs about the dispersion of the probabilities that some balance other than that stated by the client is the proper receivables balance.

The Canadian Institute of Chartered Accountants' Study Group on Audit Technique has proposed a paradigm which is compatible with the use of judgmental evaluations of this sort, but which nonetheless lends structure to the ultimate decision problem. In addition, this method is not incompatible with more formal analytic methods discussed below. Basically the method requires that the auditor make use of a structured cumulative materiality guide in conjunction with an upper dollar limit for the total of non-material items in assessing the adequacy of his work in gathering evidence to support an opinion. The general relationship involved is shown in Exhibit 3.1.

$$\text{Cumulative Materiality Guide} = \begin{array}{c} \text{Known Uncorrected Errors} \\ + \\ .5 \text{ (Accounts reviewed but not verified)} \\ + \\ \text{Maximum Precision of Accounts Sampled} \end{array}$$

Exhibit 3.1.--Determination of the Cumulative Materiality Guide

Source: Douglas R. Carmichael, "The Cumulative Aspects of Materiality," The Journal of Accountancy, Vol. 128, Exhibit 1, p. 66.

Each of the elements on the right side is measured in dollar values. Judgment of the cumulative materiality guide is based on gross profit and related to one of four ranges according to the absolute size of the earnings of the firm in question. The suggested limitations on the appropriate value of the guide are as follows for normal cases:

Gross Profit Range	Range for Upper Limit of Materiality
0-20,000	5%-2% of Gross Profit
20,000-1,000,000	2%-1% of Gross Profit
1,000,000-100,000,000	1%-½% of Gross Profit
Over 100,000,000	½% of Gross Profit

The component parts of the right hand side of the quantity in the paradigm are described at some length. They are derived from the manner in which the audit is carried out and depend on the particulars of the operations performed during the audit. These items are measures indigenous to the audit and independent of the audit environment. The materiality guideline on the other hand is indigenous to the firm and its environment and is independent of the audit. This seems to speak well for the validity of the required comparison test.

Several points are emphasized in the discussion of the construction of the right-hand side of the equation.[10] The known uncorrected errors must each be individually less than the guideline and their net effect on gross profit is included as an element in constructing the right side total. Unverified items are statement balances about which no directly supportive evidence has been produced. In other words, this item represents the total of all items from the statements not belonging to a population at least some of whose elements were sampled for verification of amount.

The third item which completes the right side total is an allowance made for the risk involved in not selecting 100 percent of all items in a population when a sample is utilized. No exact mathematical relationship is put forth to determine how large this value should be, but there is a vague suggestion that the allowance be related to the sample sizes used. This third item applies to all populations <u>randomly</u> sampled regardless of whether the sample is analyzed statistically or as a matter of judgment.

Overall, this approach seems to be the best of the available methods for the decision relevant assessment of audit evidence. It relates the findings of the audit to the decision regarding fairness and makes at least partial provision for efficiency by relating the risk of unverified amounts to the guideline for the upper bound on immaterial error. Finally, it is pragmatic.

On the other hand, it does not provide a methodology for comparing the relative efficiency of competing audit procedures nor does it allow consideration of the probable effect of the uncertainty surrounding the proper balance of items unverified or verified through sampling in light of the various degrees of severity associated with the various possible error amounts. In other words, it is incomplete with respect to the decision problem and relies on a dichotomous rather than continuous measurement in conjunction with the assessment problem.

III.3.2.2 Statistical Strategies

In the previous section certain methods of informal analysis were introduced and related to the audit decision-making process. Attention will now be turned to the use of formal statistical analysis as an aid to audit decision-making. It will be shown that many statistical applications in auditing are incomplete because there is no provision for relating the statistical conclusions to the complete objective of the audit, or in some cases no provision for integrating sampling evidence with other types of evidence which are of some importance to the auditor in forming a conclusion about the fairness of financial statement presentations, or the related problem of audit resource allocation.

Traditionally, the statistical strategies employed or suggested for audit use have supported the independent analysis of the evidence generated by a sampling process. The decision inferences suggested by such analysis are also treated as independent. The result is a forced separation or incompatibility between the inferences supported by the independent statistical analysis and the inferences which the auditor makes on a judgmental basis after consideration of all available evidence, whether generated by a random sampling process or otherwise. This group of classical statistical strategies are reviewed first and are followed by a review of Bayesian statistical strategies which have been suggested for use by auditors.

The Bayesian strategies view the sampling process as independent of other procedures but support the analysis of sample evidence based on its relationship to the auditor's judgments concerning the weight and influence of other types of information. Little effort, however, has been made to formally explore the relationship between such integrated conclusions about the parameters of interest to the auditor and the decision about fairness which he must reach based on such conclusions. No effort is made by these approaches to treat nonsampling techniques as information generating processes, and as a result, no direct comparison of the efficiency of alternative evidence generating processes is available.

III.3.2.2.1 Classical Statistical Analysis

For auditing purposes the two main classical approaches to the analysis of sample information may be viewed according to objective as either estimation or attribute sampling plans. Estimation sampling plans are probably the most widely used in auditing. The purpose of such plans is to test the value of an item (usually the dollar value of some particular balance). Attribute sampling plans are a special case of estimation sampling in which the auditor tests for a particular attribute, say the proportion of error in a population, by examining a sample and tallying the number of items exhibiting the characteristic of interest.

III.3.2.2.1.1 Estimation Sampling

Generally an estimation sampling plan for audit use relies on known or approximate specification of the number of items, N, in the population of concern (say all accounts receivable ledgers) and the variance of dollar value of the individual items in that population, S^2. The auditor then specifies a confidence interval and a precision or reliability level appropriate to the situation and determines a corresponding sample size accordingly.

The usual method relied upon to determine the appropriate confidence interval and reliability level is to relate each of these items to factors more familiar to the auditor's judgment process. Materiality is viewed as the audit construct most closely related to the determination of an appropriate confidence interval. In the usual instance, the confidence interval is set by determining how much variation could be allowed in the balance in question before the deviation of the actual balance from the reported balance was large enough to cause a material error.

Thus, the confidence interval length is set so that its range is from $B_T - a$ to $B_T + a$, where B_T is the actual but unknown proper or true balance and a is the minimum amount of error necessary in order for the reported balance to be materially misstated. The reliability level is usually selected in light of the confidence the auditor places in the ability of the internal control features of the client's information system to insure the production of proper financial statement information. The better these controls are, the lower the reliability level required.[11]

Application of the central limit theorem then allows selection of a sample size in conjunction with the reliability level and confidence interval based on the approximate normality of the distribution of sample means regardless of the population distribution. After the auditor has judged the reliability level, r, which will be required, attention can be turned to the determination of sample size, n.[12] Assuming that the auditor wishes to adopt an unrestricted replacement sampling method, the variance of sample means (referred to often as the standard error of the estimate) will be related the the population variance thusly:

$$s^2 = S^2/n$$

where s^2 is the variance of sampling means and S^2 is the variance of the population of individual items being reviewed. The estimate of the total balance in question will be $N\bar{x}$ where N is the number of items in the population and $\bar{X} = E(x_i)$ with $\bar{x}$ being the sample mean and x_i equal to the value of the ith sample observation (in this case x_i is a dollar amount). The variance of such estimates of the total will be N^2S^2/n.* The objective of the sample size determination can now be expressed as searching for a sample size, n, such that

$$PR(N\bar{x} - a \leq B_T \leq N\bar{x} + a) = r$$

where PR is the cumulative probability for the stated interval. This is equivalent to,

$$PR[(B_T - a)/N \leq \bar{X} \leq (B_T + a)/N] = r$$

but since $\bar{x}$ is normally distributed this relationship can be satisfied if a/N = ks, where k is the minimum number of standard deviations known to contain r percent of the

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*The variance of estimates of the total balance by definition is,

$$E(N\bar{x} - B_T)^2 = N^2E(\bar{x} - B_T/N)^2 = N^2s^2 = N^2S^2/n$$

normal density function.*

Since $s = S/\sqrt{n}$ the appropriate sample size for the desired reliability and stated confidence interval range, r, is determined as follows:

$$\text{with} \quad a/N = ks$$

$$a/N = kS/\sqrt{n}$$

$$\sqrt{n} = kSN/a$$

$$n = k^2S^2N^2/a^2$$

The auditor who selects a sample size in this manner can appropriately conclude before the sample is drawn that the probability that the true balance, B_T, will be contained in the interval constructed based on the sample result is r. Looked at negatively this conclusion is equivalent to the auditor's realization that he can expect based on repeated use of r percent confidence intervals to estimate the location of the actual balance in question incorrectly in 1-r percent of the cases.[13]

The decision procedure relied upon when this approach is adopted is to accept the validity of the balance reported

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*k such that $1 - \int_{-ks}^{ks} f_n(\bar{x})\, d\bar{x} = r$ can be obtained from a table of the cumulative normal $F_N(y\ 0,1)$ where $y = \dfrac{\bar{x} - B_T/N}{S/\sqrt{n}}$ is distributed with mean 0 and variance of 1.

by the client if the reported balance B_R is such that,

$$N\bar{x} - a \leq B_R \leq N\bar{x} + a,$$

or if negative results obtain to qualify the opinion about fairness or to extend audit procedures.[14]

At least four criticisms of the approach seem appropriate from the auditor's point of view. First, the assessment problem is implicitly dealt with as a problem of dichotomous classification. Specifically, the decision to accept or reject the client's balance is based on determining whether the balance lies within the statistical confidence region developed from the sample. Secondly, the confidence interval range is arbitrarily set up symmetrically about the sample mean. The result when this procedure is combined with the dichotomous classification scheme already mentioned is to treat over and under statements as equally critical or important with respect to magnitude. Such an assumption is untested at best and probably incorrect.[15]

The third criticism stems from the inability of such procedures to deal directly with the distribution of the balance rather than the distribution of confidence intervals. Classical statistical inference stands on the notion that only evidence gathered from a random sampling process is admissible in connection with the analysis of information. Unfortunately for the auditor who is interested in various types of evidence, valuable information from other sources must be ignored when <u>statistical</u> inference is made in the manner described.[16] As a result statistical inference based on these procedures will allow the auditor to conclude that the random interval $\overline{X} + kS \sqrt{n}$ will include B_T with probability r but will not allow the auditor to deal with the problem of determining how likely it is that the true balance lies at any particular point within the specified confidence interval.[17] Without such knowledge it is difficult after a sample has been taken for the auditor to determine how potentially severe the consequences of relying on the resultant confidence interval will be. This in turn makes the selection of the tolerance range even more important, and it magnifies the importance of the first two criticisms.

Finally, the objective of balance estimation by statistical means is subject to some scrutiny with regard to its auditing significance. The auditor's basic purpose in most instances is not to estimate an average amount but rather to deal with the amount of error in an account and the frequency of error.[18] It follows that except in cases such as inventory valuation where detailed records are not available the auditor should be concerned about the effect of errors in sample items rather than the prima facia values exhibited by such items.

In addition to these four criticisms, one other point should be considered by the auditor. Traditionally, sampling applications rely on a value of r near zero (usually r is chosen so that $.01 \leq r \leq .10$). The auditor should not rely on similar values of r simply because of tradition. A small value of r may be, for example, difficult to justify if the auditor has either (1) great confidence in the client's system of internal control or (2) a strong belief about the authenticity of the balance under review. Since larger values of r are associated with smaller values of k and hence smaller n's, the result in some audit situations might be a needlessly large sampling cost. The selection of a value for r is especially critical because the auditor has no way to judgmentally influence the statistical inference which results from application of a classical method. It is, therefore, especially important for the auditor to carefully formulate sampling design by exercising control over just such factors as the determination of an appropriate value for r.

III.3.2.2.1.2 Attribute Sampling

Attribute sampling plans are adopted during audits in order to examine some characteristic other than the mean or total dollar value of a balance. Typical applications might be the search for the true proportion of items in a population which contain an error or the ratio of items in a class falling into a particular subclass (i.e., the ratio of past due receivables dollars to the total dollar value of receivables).

The statistical analysis utilized in attribute testing is similar to that employed when examining the total dollar balance of an application except that it is not always possible to relate the selection of an appropriate confidence interval to the concept of a minimum material amount. For example, if the auditor is testing for the portion of sales invoices which were improperly footed it is impossible to set a dollar value materiality limit which can be specifically related to the choice of an appropriate confidence interval for the true proportion of incorrectly footed invoices. In such cases the confidence interval must be arbitrarily determined based on the auditor's judgment if he wishes to plan an appropriate sample size before beginning to take samples.

It is difficult to relate the results of statistical inference drawn in this manner to the auditor's decision problem, because without relating the evidence regarding the attribute in question to other evidence bearing on the fairness of presentation, the auditor can make little headway in evaluating the value of the sample information. It should be noted, however, that unlike the balance estimation procedures discussed above, attribute sampling can be directed at the error rate or even at the magnitude of error, in which case the last disadvantage of balance estimation sampling is overcome. In addition, for cases involving error magnitude testing, the minimum materiality range could be utilized as well.

III.3.2.2.1.3 A Programmed Approach

Ijiri and Kaplan have noted that these classical approaches lead to incomplete inferences regarding the objectives of the audit. They set out broader inference objectives for audit sampling than those associated with the isolated statistical inferences discussed above.

After referring to the typical approach to estimation and attribute sampling as representative sampling, three additional objectives are discussed--corrective sampling, protective sampling and preventive sampling.[19]

The objective of corrective sampling is to select for sample inclusion the maximum number of items which have been incorrectly treated. The measure of the degree to which the auditor meets this objective is defined as the degree to which he reduces the expected number of errors not selected during sampling.

The auditor's interest in verifying the greatest possible dollar value of items through sampling is measured in terms of the ability of the sampling design to maximize the selection of items from high value strata. The auditor's use of this notion is referred to as protective sampling.

For the final objective of preventive sampling, error rate and dollar value are no longer so important as they were for the other objectives. Instead, the auditor is concerned with reducing the probability that the auditor's sampling plan will be predictable. In other words, the auditor concerned with preventive sampling wishes to leave the impression that no particular area is immune to scrutiny by the auditor. Ijiri and Kaplan suggest that the ratio of the number of areas in which a specified minimum number of items have <u>not</u> been selected in the actual sample to the total number of areas available to be examined could be an appropriate measurement factor for assessing degree of compliance with the preventive objective of audit sampling.[20]

An example of how these objectives can be simultaneously evaluated is shown in Exhibit 3.2. In this particular example the preventive objective is not considered in order to simplify to two the number of dimensions involved. The first two constraint equations deal respectively with measures for the representative objectives of estimating error rate and total dollar value of recorded errors. The measure adopted in both cases is estimated variance. The third constraint equation relies on an appropriate bound, g_3, on the expected value of the number of undetected errors in order to force compliance with a corrective objective. The preventive objective is enforced by the fourth constraint which relies on the dollar value of unexamined items as an appropriate measure. The fifth constraint is a hybrid with regard to objective because it deals with both the corrective and protective objectives by setting a minimum acceptable level for the expected dollar value of items which remain in error in the population.[21]

Minimize: $\sum_{i=1}^{a} \sum_{i=1}^{b} n_{ij}$

Subject to:

$$\sum_{i=1}^{a} \frac{w^2{}_i p_i (1 - p_i)}{\sum_{j=1}^{b} n_{ij}} \leq g_1$$

$$\sum_{i=1}^{a} \sum_{j=1}^{b} \frac{w^2{}_i p_i (R\overline{B}_j)^2}{n_{ij}} \leq g_2$$

$$\sum_{i=1}^{a} \sum_{j=1}^{b} p_k (N_{ij} - n_{ij}) \leq g_3$$

$$\sum_{i-1}^{a} \sum_{j=1}^{b} \overline{B}_j (J_{ij} - n_{ij}) \leq g_4$$

$$\sum_{i=1}^{a} \sum_{j=1}^{b} p_i \overline{B}_j (N_{ij} - n_{ij}) \leq g_5$$

$$n_{ij} \leq N_{ij}$$

$$n_{ij} \geq 0$$

for $i = 1,\ldots,a$
$j = 1,\ldots,b$

where,

Exhibit 3.2--A Nonlinear Programming Formulation for the Determination of Minimum Sample Size Subject to Appropriate Allocation Constraints

ij denotes the cell in the i^{th} row and j^{th} column of a two dimensional matrix with a error rate strata and b dollar value strata;

n_{ij} = number of items to be sampled from cell ij;

N_{ij} = number of population items in cell ij;

$w_{ij} = N_{ij} / \sum_{i=1}^{a} \sum_{j=1}^{b} N_{ij}$;

p_i = average probability of error for item in the i^{th} stratum;

$\bar{B}_j$ = average dollar value of items in j^{th} dollar value stratum;

$R\bar{B}_j$ = standard deviation of the distribution of errors in j_{th} stratum;

$$G = \begin{bmatrix} g_1 \\ g_2 \\ g_3 \\ g_4 \\ g_5 \end{bmatrix}$$ minimum performance levels required according to the measures developed for each of the objectives

Exhibit 3.2--Continued

Adapted from: Yuji Ijiri and Robert S. Kaplan, "A Model for Integrating Sampling Objectives in Auditing," Journal of Accounting Research, Vol. 9, No. 1, p. 85.

The advantages of such an approach include (1) its recognition of the ability of samples to provide information about more than a single factor of interest to the auditor and (2) its provision for consideration of auditing information requirements in the determination of sample size and sampling objective(s). The proposed solution method assumes an independence among the constraining measures which may not be realistic, and there is no discussion of how the standard might be selected on a joint basis. Interpreting the impact of sample information on the auditor's overall evaluation concerning fairness of presentation is not discussed.

III.3.2.2.2 Bayesian Statistical Analysis

The basic approach to Bayesian analysis of evidence provides for compatibility of sampling and nonsampling information by allowing both to influence the final statement of probabilistic inference about the parameter being tested. This is accomplished by providing separate but compatible methods for the expression of the information gained from sampling and nonsampling evidence. Sampling evidence is incorporated into the analysis by means of the likelihood generating function which appropriately describes the distribution from which random sample observations are drawn. Information from other sources is utilized to judgmentally construct a prior density function about the actual but unknown value of the item under review. These two functions are then used based on the results of a sample to construct a single distribution which revises information from the prior density function in accordance with the sample results.

The method used to revise the auditor's prior is due to a particular interpretation of the Method of Bayes Theorem, which states that,

$$(1) \qquad Pr(V_i | x_i, \ldots, x_n) = \frac{Pr(x_1, \ldots, x_n | V_i) Pr(V_i)}{\sum_V Pr(x_1, \ldots, x_n | V) Pr(V)}$$

where $Pr(V_i \mid x_i, \ldots, x_n)$ is the conditional probability density of event V_i given sample values $x_1, \ldots, x_n$; $Pr(x_1, \ldots, x_n \mid V_i)$ is the conditional probability of sample result $x_1, \ldots, x_n$ given that V_i obtains, and the $\sum_V$ indicates the sum over all possible events in the set V.

The usual approach to implementing the Bayesian method of analysis for audit purposes focuses on a single parameter of significance such as the probability of an error.[22]

In such cases the auditor first establishes a prior probability of an error, p, by reflecting upon the evidence and information already at hand. (In essence the auditor is choosing from all possible density functions over p the one function which best portrays his beliefs concerning the relative likelihood that the actual but unknown value of p takes on any particular value.) This distribution is a subjective assessment similar to the process of assigning betting odds on an intuitive basis to all possible values of p. The value of p must be between zero and one. The function chosen must, because it is a probability function, be such that,

$$\sum_{p=0}^{1} Pr(p) = 1$$

If the auditor has reason to believe strongly that the actual value of p is located in a particular region of the unit interval then the prior density function chosen for p will be concentrated in that region. Within that region, identified as region P, the quantity $1 - \sum_{P} Pr(p)$ will be very much less than $1 - \sum_{P'} Pr(p)$ for p's which are not in that region. Such beliefs about p might be available for example because of the auditor's initial review of internal control and previous audit engagements with the client or experience with similar clients. In a particular case for example where internal controls appear strong the auditor may believe the probability of p being near zero is relatively high. As a result he should choose a prior density function for p which is appropriately skewed right with respect to the unit interval.

Since the auditor is concerned in this example with the probability of error, the sampling process will be viewed as producing only two types of observations. Sample items will be observed to be either correct or in error. It will be assumed that the auditor has at hand an appropriate definition of what constitutes an error. Sample observations will therefore be drawn from a Bernoulli generating process which yields items containing error with probability p and correct items with probability $q = 1 - p$, so that

$$(2) \quad Pr(x_i \mid p) = p^{x_i} q^{1-x_i} \qquad x_i = 0,1$$

and

$$Pr(x_1, \ldots, x_n \mid p) \propto p^{\sum_{i=1}^{n} x_i} q^{n - \sum_{i=1}^{n} x_i}$$

where x_i is a single observation of a random variable which is characteristically either $x_i = 0$ if no error is present or $x_i = 1$ if there is an error. Since the observations about the random variable are independent, the probability of obtaining $\sum x_i$ successes in n trials is proportional to the product of the individual probabilities of the items.

After a sample has been observed, the sample information can be combined with the prior according to Bayes Theorem in order to produce a posterior density in a manner consistent with the influence of the sample evidence. The posterior density of any p_i in $0 \leq p \leq 1$ is arrived at by weighting the ratio of the conditional probability of the sample result given p_i to be true and the marginal probability of the sample without regard to whether p_i is true by the prior probability of p_i being true,

$$Pr(p_i | x_1, \ldots, x_n) \propto \frac{\left(p_i^{\sum_{i=1}^{n} x_i} q_i^{n - \sum_{i=1}^{n} x_i}\right) Pr(p_i)}{\sum_{p_i=0}^{1} p_i^{\sum_{i=1}^{n}} q_i^{n - \sum_{i-1}^{n} x_i} Pr(p_i)}$$

The posterior density for any particular p_i is the probability that the actual proportion of items in the population which are in error is p_i based on all information including that observed from the sampling process.

The advantages of such an analysis are usually cited as including a reduction in sampling cost where prior knowledge about the parameter is strong. It might, for example, be possible to select an interval containing 1 - r percent or more of the posterior density and have the range of that interval be less than or equal to the confidence interval for identical r associated with classical strategies even though the sample size is smaller than that required by the classical approach. This effect will be most pronounced in cases where a region in which the likelihood of the sample is concentrated is also a range in which the prior density is relatively high. In addition it has been noted that the auditor has significant experience which he already uses in selecting samples on a judgmental basis and that there are important qualitative facets such as internal control which the auditor considers when making estimates.[23]

In addition to these factors it also seems important to note that the Bayesian approach will allow the auditor to state conclusions directly in terms of the parameter under review when dealing with intervals. The Bayesian approach to interval estimation is simple. In order for the auditor to indicate an interval which contains with r percent of certainty the actual value of the parameter under review he simply inspects his posterior distribution and marks off any interval whose cumulative probability is r.

This procedure will allow the auditor to pick any interval which satisfies this rule, whether it is the shortest possible such interval, or the one with symmetry about the mean or the one which includes the entirety of one tail or the distribution. This is important in comparison with the classical method because it does not make sample size determination dependent upon the preselection of any particular one of these intervals based on minimum distance or symmetry. As a result no particular one of them assumes arbitrary importance above and beyond the others. This also means, for example, the auditor need not specify a particular interval length as the only crucial one for decision-making about the parameter of interest.

In addition the ability to state conclusions directly in terms of the parameter of interest allows the auditor to consider the probability associated with the parameter taking on any particular value. He is not for example restricted to statements concerning the cumulative probability that p will lie within ± 2 percent of a particular value of p. He can determine the probability that p is actually equal to any particular value of interest or compare, for example, the probability that p is equal to 1 percent directly with the probability that the error rate is 2 percent.

Most work done to date does not indicate how the auditor should relate the Bayesian statistical methodology to the decisions which the auditor must make concerning the fairness of financial statement presentation. A model presented by Tracy, however, does address this problem.[24] The model itself is based on the concepts shown in Exhibit 3.3. This decision theoretic approach to audit decision-making relies on the construction of a payoff matrix. This particular payoff matrix defines the consequence of each possible outcome from an audit situation in which a processing error rate of more than 5.5 percent is deemed intolerable. The decision of concern to the auditor involves determining whether to extend audit procedures or to rely on the available evidence.

State of Nature	Audit Decision: Do Not Extend Audit Procedures	Audit Decision: Extend Audit Procedures
Acceptable Error Rate	Value to Auditor and Client of Confirming an Acceptable Error Rate in the Payroll Processing System.	Cost of Unnecessary Audit Procedures.
Unacceptable Error Rate	Cost of Failure to Uncover Reasons for Intolerable Error Rate in Payroll Processing System.	Value to Auditor and Client of Uncovering Reasons for Intolerable Rate in Error Rate in Payroll Processing System

Exhibit 3.3.--A Proposed Audit Payoff Matrix

Adapted from: John A. Tracy, "Bayesian Statistical Methods in Auditing," The Accounting Review, Vol. XLIV, No. 1, Exhibit IV, p. 97.

As a result of defining the auditor's problem in this manner, there are four state action pairs which could occur. In otherwords, there are four possible payoff relevant outcomes in this situation. Each outcome consists of some combination of actual processing error rate and a decision on the part of the auditor to extend or not to extend audit procedures. Each of these pairs is distinct because each involves a different combination of error rate and decision.

In the event that the true rate of error were known to the auditor, he would be able to assign probability one to one or the other of the decision relevant partitions of error rates; that is, he would know with certainty whether the error rate was greater than 5.5 percent. In such a situation the auditor's decision could be based on a simple comparison of the utility of the consequences which would occur under each of the decision alternatives given his knowledge of the actual error rate.

In the typical case, the auditor will not know the actual error rate referred to in decision theoretic terms as the true state of nature. Utilizing the subjective probability distribution developed over the true state of error rate, the auditor will be able to determine the expected value of the competing decision alternatives. This can be accomplished by using the cumulative probability associated with each of the two decision relevant states as weights in determining a weighted average of payoffs for any fixed decision alternative. This is equivalent to finding the weighted average (expected value) of any particular column in Exhibit 3.3. According to the decision theoretic view, then, the correct choice for the auditor will be that decision alternative with the greatest expected value.

The audit decision process is not as simple as this model suggests. This model does, however, point up the need to consider both the probability of making a correct decision and the consequences of such a decision (action) as relatives to be compared with the consequences and probability of incorrect or wrong decisions.

Tracy points out the difficulty of determining the value and cost elements of the payoff matrix. The cost of unnecessary audit procedures is the only one whose specification will be relatively easy, and even here there may be some question as to whether the auditor or client will bear this cost. It also seems that it might not be appropriate to assume cost and value to be equivalent measures in certain cases. If the auditor's utility for money is not linear then a transformation is required before comparing the utility of the consequence of incurring cost with the directly assessed values which appear as payoff assessments.

Finally, from the point of view of the overall audit decision process, this particular model seems incomplete because it does not deal with the magnitude of errors nor with the relationship between the magnitude of error and the consequences of audit decision. It treats the assessment of payoff as independent with respect to the magnitude of error, relying instead solely on the probability of error to determine the payoffs associated with a given audit decision. The model cannot therefore be used in dealing directly with the decision regarding fairness of presentation.

III.4 Conclusion

This chapter reviewed various paradigms and statistical models which have been suggested for audit decision-making purposes. Each model was examined according to its capability to assist the auditor in reaching a decision regarding the fairness of financial statement presentation, which was stated as the proper objective of any general model of the audit decision-making process. Each model was therefore presented from two perspectives: (1) how thoroughly it enables the auditor to assess the consequences of errors which could influence the fairness of financial presentation and (2) how well it provides a means for the auditor to utilize such assessments as a basis for decision-making in light of the uncertainty which surrounds the auditor's knowledge of the proper statement figures.

The models were also viewed from a third perspective, namely how completely they treated not only the primary decision about fairness, but whether they also provided the auditor with the capability to evaluate the contribution of any particular audit procedure by assessing its ability to produce evidence relevant to the primary decision.

Even though many of the models reviewed have adequate and thorough treatments of the audit decision process from one or the other of these perspectives, none gave a thorough, complete treatment according to both. The next chapter, Chapter IV, sets forth a proposed model for audit decision-making which integrates these perspectives. Chapter V reports an exploratory study of professional attitudes concerning the criteria for audit decision-making and the assessment of the consequences of error in the certification of financial statements. The study explores the extent to which certain factors in the audit decision-making process are perceived by the profession as impersonalistic and generalizable rather than a matter of personalistic freedom of choice or situation specific. The purpose of the study is to give insight into the validity of various assumptions or hypotheses which can properly be relied upon in modeling the audit decision process.

CHAPTER IV

A MODEL FOR AUDIT DECISION-MAKING

This chapter is concerned with the integration of the assessment and decision problems which were discussed in Chapters II and III, respectively. The particular framework adopted to structure the integrative model is decision theoretic. The decision theoretic approach is adopted first because as the term itself implies it facilitates a rational comparison of available alternatives, and hence selection of the alternative which is most favorable. This approach enables the auditor to distinguish the consideration of the consequences of alternative actions from consideration of the uncertainty which surrounds the outcome of choice. This approach also permits the auditor to take into account the uncertainty which can surround inferences made on the basis of imperfect knowledge about actual conditions or facts. It provides a method for the synthesis of fact and judgment which is so crucial to the audit decision-making process. The Bayesian philosophy of inference is incorporated in this approach. The expression of judgment about the auditor's degree of uncertainty concerning actual underlying conditions is treated as a process which stems from the consideration of the weight of all available information whether it is produced by a random generating process or by other means.

It should be noted that this approach requires the determination of mathematical expectations concerning losses and that these expectations are relied upon as measures of risk. In other words, it is assumed here that the auditor's decisions are risk neutral rather than risk averse or risk preferring. This assumption implies that the auditor is ambivalent toward choosing between (1) the benefits of a hypothetical but certain payoff or loss equal to the expected value of the uncertain payoff or loss with which he is actually faced, and (2) the benefits of pursuing the actual situation to an ultimate (terminal) conclusion involving a presently uncertain payoff or loss.

The concept of risk associated with expectation may not be universally acceptable to the auditor. The concept is, however, well defined with assumptions and implications which are apparent. While the auditor may choose to be less formal in analysis than the model suggests, the model and the theory of expectations upon which it rests do provide an intuitively appealing structure for the solution of some otherwise vexing problems.

Decision analysis based on this approach requires a delineation of the alternative decision-making processes (experiments) and reduction or transformation of beliefs to probabilistic form, and a willingness to assess in concrete terms the benefits (or losses) with which the auditor is faced in a given decision-making situation. During discussion of the model, no effort is made to dwell on the tremendous amount of judgment required of the auditor in order to properly flesh out particulars. In fact the freedom presented to the auditor by this model is one of its strong points.

It should be noted as well that as is the case with all models, there are simplifications involved in this modeling effort.

IV. 1 The Model in General Form

This model describes a system of decisions and procedures which the auditor can employ as a guide in order to achieve optimum audit performance.* The model is flow-charted in Figure 4.1.

IV.1.1 Some Basic Elements of the Model

As required by professional standards, the first set of procedures (1) employed are those associated with the traditional review of internal control. This process acquaints the auditor with the client system, its management, and the procedures employed. The results of these audit procedures are at least three-fold. First the review of

*During discussion of the general model, the symbol Σ is used to represent summation over either a discrete or continuous domain.

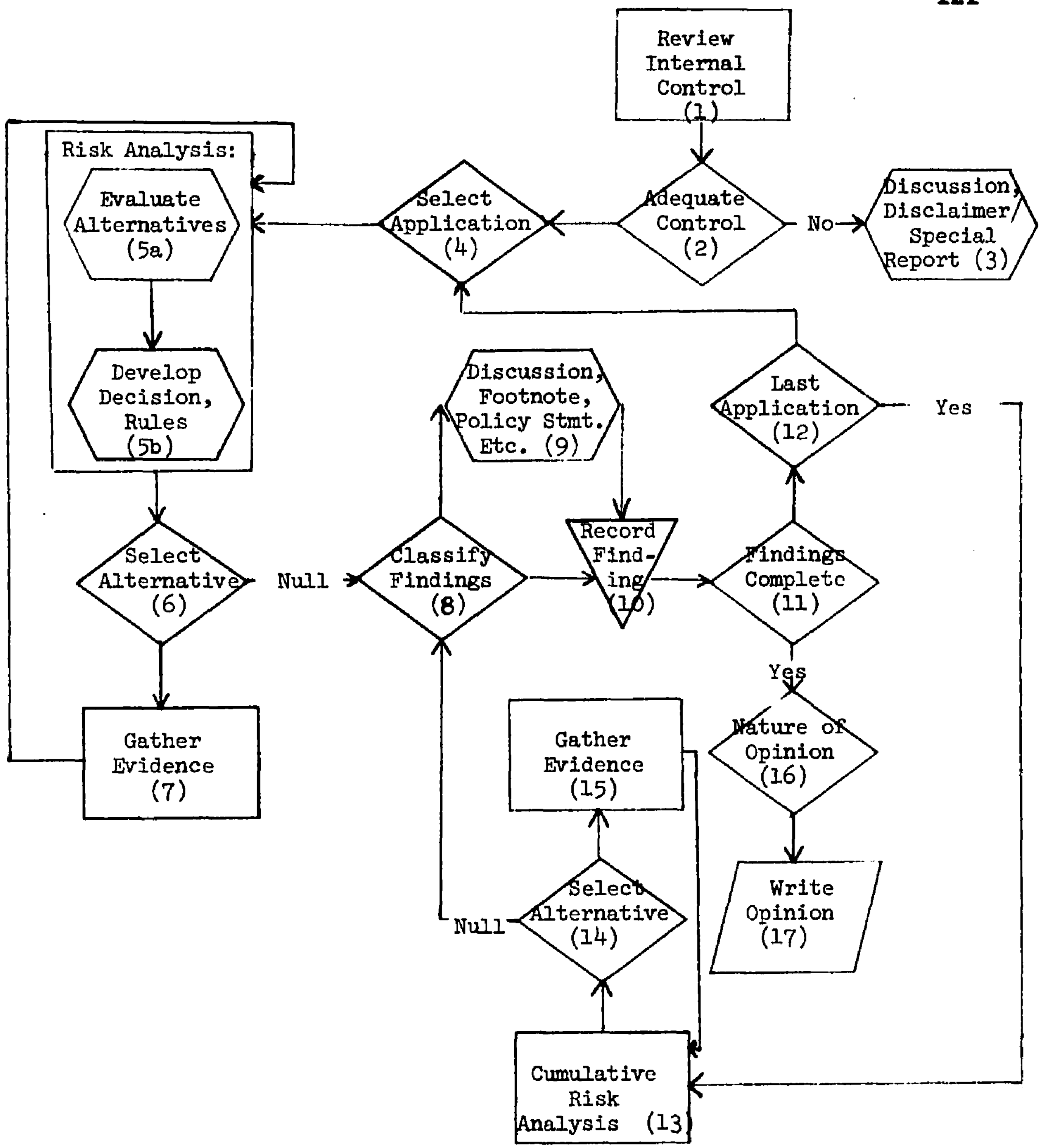

Fig. 4.1--Outline for a general model of audit decision-making

internal control furnishes information which should be at least partially indicative of the confidence which the auditor should place in the potential of each of the components of the client's information processing structure to produce error-free financial reports. This information has a direct bearing on the utility of competing audit procedures. Secondly the auditor should be able to use information gained from the review of internal controls to formulate judgments regarding the consequences of errors which may have been generated by the system. These attitudes ultimately affect the payoffs of alternative actions. Finally, this process should be viewed as the foundation for formation of personal (judgmental) probabilities concerning the proper content of the firm's financial statements.

While at this time the contents of such reports are presumed to be wholly concerned with the appearance of the usual accounting measurements, the approach described here does not suffer from loss of generality because of this. Should society deem it appropriate to expand or alter the scope of the "financial" statements which should be submitted for attestation, this system with its stated objective should remain robust.

The auditor having reviewed internal control must draw a conclusion concerning adequacy of this system of controls as shown by element (2) in Figure 4.1. If the control system is inadequate, then discussion with the client will be required (element (3) of the model) and a disclaimer of opinion or some special report will result. Adequate overall internal control will allow the auditor to proceed with his examination of individual applications (i.e., inventory, cash, accounts receivable, etc.).

No particular method for selecting one particular application before another is pursued here. It should not however be assumed that a uniform random strategy is the appropriate one to adopt. It may for example behoove the auditor to count cash on the closing date rather than a week later. In order to simplify, this model simply does not treat the problem of application selection in detail. For convenience it will be assumed that the audit proceeds sequentially through the scrutiny of one application at a time.

Having selected an application for close scrutiny (Step 4), the auditor must proceed toward formulation of an opinion concerning the proper presentation of that application by the client's financial statements. The auditor's decision regarding the fairness of the client's presentation of the results for the application in question will eventually depend on the degree to which evidence (already available or still to be gathered) supports a finding that the client's representation of the results of the application are in harmony with the auditor's conclusions about the proper presentation of the application. All this is modeled by elements (5) through (8) in Figure 4.1.

If it is assumed for the time being that the auditor has a particular procedure in mind for potential use in generating evidence about the application in question, then the auditor is faced with the decision identified as element (6) in the model of the audit decision-making process. The auditor at this point must decide whether to gather additional information about the application under review. Certain basic elements for resolving this decision problem are available to the auditor at this point. The foundation techniques for making such systematic decisions involving uncertainty have been made available from a variety of sources.[1]

In this case the decisions or action alternatives are to either formulate an audit conclusion regarding the application balance in question or gather additional evidence about the results of the application. The various amounts which have some probability of being the proper balance for the account(s) in question are the set of all possible states of nature. The consequences of the error which would be associated with the difference between each possible true balance and the application balance as represented by the client are quantified and referred to as a loss function or payoff matrix. For reference let,

a_1 = Formulate a conclusion concerning the application

a_2 = Gather additional information

A = The set of available actions = $[a_1, a_2]$

b_i = ith possible proper balance

B = The set of possible true states

l_{ij} = Payoff (loss) associated with decision j given b_i

p_i = Probability of ith balance being the true balance b_i with, $\sum_b p_i = 1$

By comparing the net risk associated with alternative decisions, the auditor can select the better course of action. Now the analysis is of special interest since deferring a decision (not choosing a_1) really defers substantive action and hence the possibility of loss. It can be concluded, therefore, that in an immediate temporal sense each element l_{i2} is equal to zero. Any loss, l_{i1}, is a function of the size of the error and probably increases as the size of the error involved increases. (Little is actually known about the nature of this loss function so supposition will have to serve where details concerning it are involved.)*
Discussion of p_i will be temporarily deferred.

The risk, R_j, attaching to a decision a_j will be defined as the expected value of the potential losses

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*For empirical exploration and tests of hypotheses concerning l_{ij}, see infra Chapter V.

associated with taking action a_j, so that,

$$4.1 \qquad R_j = E(l_{ij}) = \sum_{B} l_{ij} p_i$$

R_j is a measure of the effectiveness of the jth decision. Obviously the decision to gather additional information will always be less risky (more effective) in this sense unless the true balance is known with certainty to be the statement balance. The decision of whether to proceed really turns on the efficiency of the audit procedure, that is the relationship of the risk of a_1, and the relative advantage (if any) which would be derived from employing scarce resources (not only money but talented or skilled manpower as well) to gather additional information concerning the application in question. In examining the immediate advantage there is a kind of role reversal with respect to a_1 and a_2. Specifically, if implementation of the first course of action a_1 is adopted, there is no immediate resource consumption, while on the other hand, there is some cost or consumption associated with a_2, the act of gathering additional evidence. The magnitude of the relative advantage of a_2 and whether the relative advantage is positive or negative depends on the difference between the expected value of the evidence which will be gathered if a_2 is chosen and the cost of implementing and carrying out the evidence gathering procedure associated with a_2.

In choosing between a_1 and a_2, the decision rule to be applied is simply to select that one of the two action alternatives with lower net risk, G. If,

u_j = Relative advantage as seen in advance of adopting a_j before taking terminal action a_1

a^* = Risk associated with better action <u>or</u>, the better action itself (the proper interpretation can be taken from context)

then element (5) of the decision model is accomplished by evaluating, $(\sum_B l_{ij}p_i + u_j)$ for each a_j,

and

4.2 $$a^* = \mathrm{MIN}(\sum_B l_{ij}p_i + u_j) = \mathrm{MIN}(G_j)$$

The selection of the better action a^* is marked (6) in Figure 4.1. Procedures for more formal determination of efficiency are discussed in the next section. It should be noted that as specified here, the lower a G the better the alternative.

If a_2, the further collection of evidence, is rejected, then the auditor according to the nature of the conclusion as shown at element (8) must either record his findings about the application--this process of storage is marked (10)--or discuss any negative findings with the client in order for the client to prepare any footnotes, corrections, or policy statements, etc. deemed necessary, as illustrated by (9) and record the result.

On the other hand, the auditor's analysis may indicate the need for additional information before reaching an audit conclusion about the application involved. If so the auditor should adopt a_2 and proceed to collect such evidence as element (7) of the model indicates.

IV.1.2 An Extension Regarding Selection of an Audit Procedure

Thus far it has been assumed that the auditor was concerned with choosing to adopt one particular procedure for the purpose of obtaining additional evidence or to proceed without additional information concerning the application being reviewed. The auditor may however have available several alternative procedures from which to choose in order to gather more information.

At this point the auditor should not limit his thinking; instead he should search for all feasible information gathering techniques. The techniques considered should not be limited to those which provide classically significant sample data. The alternatives should also include special methods of internal control review and tests which are applicable to EDP systems. Methods of the latter type include test decks, controlled program copies, detailed documentation review and parallel runs of special programs. Computerized extensions of traditional procedures such as footing and sorting should also be considered as methods of treating sample data. Packages of the last type are available in various forms as generalized audit routines. In such cases the action set, A, is no longer dichotomous but contains in addition to the option of proceeding without additional evidence several alternative procedures which if selected would represent the taking of actions $a_2, a_3, \ldots, a_r$, respectively. Action a_1 deserves additional discussion at this point.

The dynamic relationship between the selection of procedure and the formulation of conclusion about the application can now be discussed by considering a set of decision choices which will be available to the auditor after he has carried out any particular one of the a_j's, $2 \leq j \leq r$. Typically, the auditor may be considering the adoption of one or the other of two decisions, d_1 and d_2 such that,

d_1 = Conclude that the application results are fairly stated

d_2 = Conclude that a correction is required in order to fairly present results of the application.

If the auditor chooses to make such a decision without gathering additional information then he will by default be choosing a_j from set A such that $j = 1$ as described above and as shown by the tree diagram in Figure 4.2. It is assumed here that it costs nothing to actually perform either act d_1 or d_2, though in practice d_2 may not be cost free. The fact that d_2 is not cost free is often demonstrated in practice by the passing of small adjusting entries because they would be a "waste of time."

At this point it will be beneficial to redefine and

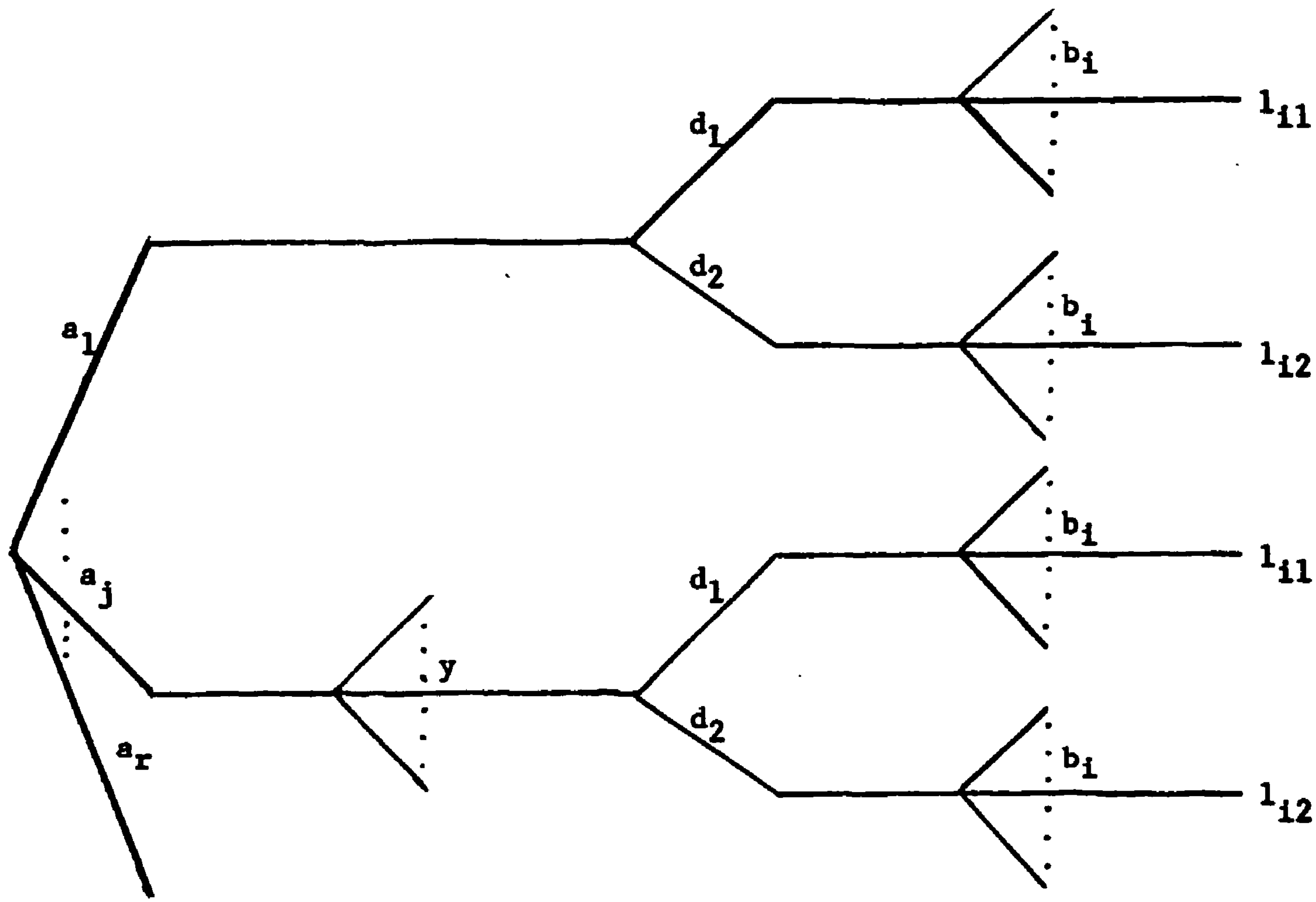

Fig. 4.2.--Diagram of procedure selection problem

explore more fully the relative advantage associated with each of respective a_j's in the set A. Henceforth, the relative advantage of any a_i will be represented by U_j.

The purpose of this evaluation of the U_j's is to determine the relative advantage or efficiency of all alternatives open to the auditor. The analysis required for this determination is represented by elements (5a) and (5b) of the model in Figure 4.1. By viewing the audit as an information gathering and decision making system, each alternative method or procedure can be considered as an information system or channel, so that the foundations for further analysis can be drawn from a branch of decision science concerned with the economics of information.[2]

If each audit procedure is assumed to be capable of producing a finite number of groups of known results or signals to which discriminate significance can be attached then the marginal probability of any particular result (signal), y, for a given audit procedure will be

$$4.3 \qquad Pr(y) = \sum_{B} Pr(y|b_i)p_i$$

This probability of a particular message result can be developed as Equation 4.3 shows based on the auditor's prior subjective probabilities of the various states and on the known or estimated conditional probabilities represented as $Pr(y|b_i)$'s. The prior probabilities of the various states are, it should be recalled, the various possible true or proper balances that for the application in question have some probability greater than zero of actually occurring. The $Pr(y|b_i)$'s depend on properties exhibited by the evidence gathering procedure being considered. $Pr(y|\cdot)$ is, for example, known in conjunction with statistical procedures as the particular likelihood function associated with any established random generating process. In certain cases, therefore, the general character of $Pr(y|\cdot)$ may be known to the auditor. For example, the auditor may be interested in estimating the true proportion of receivables which are past due. If so the auditor in drawing randomly from all receivable balances will be taking observations according to a Bernoulli likelihood function. The general parameters of such an observation process are well known. In other cases, such as the consideration of the accuracy or dependability of say an examination of a voucher block, characterization of the probability of any particular result given the relationship between the client's representation of the application results and the true or proper balance will depend on the auditor's judgment about the situation and experience with the procedure for definition. Since many of the procedures available for use by the auditor fall into this last category, the freedom of the model in this respect seems most appropriate.

This function characterizes the process of inquiry involved with a particular procedure.[3] It should be pointed out that this technique of information channel evaluation does not require a one to one correspondence between the actual balances and the information signals generated by a particular audit method.[4] As suggested earlier, it is in part the uniqueness of the messages possible from one procedure as opposed to another which determines the ability of various procedures to reduce the uncertainty surrounding the reliability of some facet of the financial information system.[5] The choice of method depends also on the consequences of uncertainty about various components of the system. Therefore a method most efficient for one facet of the system might not be so for another.

The next task in working toward obtaining the U_j's is specified as element 5(b) in the model and consists of developing a decision rule for each information gathering procedure being reviewed. To do this, each message possible for a given audit method is taken in turn. With the message fixed the expected loss or risk associated with a given action/message combination is determined by taking the product of the state/message probabilities and the state/action payoffs over all possible states given the message. If $2 \leq j \leq r$ the auditor will in effect want to determine which of the two decisions, d_1 or d_2, he would want to select if a particular message, y, from the set of all possible messages

Y_j that the procedure associated with a_j can produce, were to appear as the result of adopting a_j. This will once again be the decision with a lower risk attached to it. Therefore, if,

$r_y{}^*$ = Risk of optimal decision following the appearance of a given message y

$D = \{d_j: \ j = 1, 2\}$

l_{ij} = Loss incurred as a result of the consequences should both b_i and d_j obtain

then,

$$r_y{}^* = \min_{D} \sum_{B} Pr(b_i|y)l_{ij} \tag{4.4}$$

This process is repeated for each message. The set of emerging $r_y{}^*$'s then represents the best decision rule for the audit method under review.

Each audit procedure under consideration is treated in turn in order to determine its optimal decision rule. It should be noted again that neither the message/state pairs nor the relevant payoff matrices need be identical among competing evidence generating procedures producing different message sets. This is a distinguishing feature of information economics.[6]

The marginal probability of each message for a given procedure can now be employed to determine the risk associated with any a_j. The product of each such marginal message probability with the previously determined risk associated with the best action conditional upon that message enables the auditor to determine the expected risk of the particular audit method or procedure when utilized in conjunction with its optimal decision rule. Let

R_j^* = Expected risk of employing optimal decision rule associated with a_j,

4.5(a) $$= \sum_{Y_j} Pr(y) \underset{D}{MIN} \sum_{B} Pr(b_i|y) l_{ij}, \text{ for } 2 \leq j \leq r$$

or simply,

4.5(b) $$R_1^* = \underset{D}{MIN} \sum_{B} l_{i1} p_i$$

since a_1 is associated with a null information channel, or in other words with a course of action leading to immediate decision without benefit of additional information.

What Equation 4.5(a) suggests is that the auditor evaluating potential use of a particular audit procedure should determine the _a priori_ expected value of the best decision in light of whatever evidence, y, may be made available as a result of carrying out the procedure.

The relative advantage or efficiency, U_j, of any a_j depends in part on the ability of the procedure associated with a_j to reduce the risk of decision-making and in part on the cost of carrying out the procedures associated with a_j should $a_j = a^*$. Therefore, if

G_j^* = Effectiveness or expected net risk if a_j is adopted

C_j = Cost of implementing method or procedure associated with action a_j

then

4.6 $$G_j^* = R_j^* + C_j$$

The cost, C_j, for a_1 is zero since a_i represents an immediate decision based on the evidence at hand rather than further resource consumption in order to gather additional evidence. By the same token, for all other a_j, $j \neq 1$, C_j will be greater than zero.* It follows that the best course of action, a^*, can be selected from among all a_j in A according to the following:

4.7 $$a^* \Rightarrow \underset{A}{\text{MIN}}\ (Rj^* + Cj) = \underset{A}{\text{MIN}}\ (Gj^*)$$

The relative advantage of any particular a_j depends on the reduction of net risk which the auditor can expect to obtain following his adoption of a_j. This can be determined by comparing G_j^* with G_1^* where G_1^* is the expected net risk of adopting the null audit procedure, which, recall, is represented by a_1. Thus,

4.8 $$U_j = G_1^* - G_j^*$$

---

*It is assumed throughout the rest of this work that the l_{ij}'s are measured in dollar value equivalents so that the auditor would as soon give up l_{ij} dollars as accept the consequences of the outcome associated with state/action pair (b_i, a_j) and vice versa. By the same token the C_j's are also assumed to be dollar value equivalents. Because both R_j and C_j are therefore based on similar measurements, they are assumed to be additive.

If for any reason the assumption of additivity is deemed inappropriate then some other procedure might be appropriate as a guide to determination of a*. The auditor may, for example, be able to arrive at only an interval scaling of the l_{ij}'s. If so, then the measurement values computed for the R_j's would not be additive with respect to and the relative advantage of the best action a* from all available actions in set A is determined as

$$U^* = \max_{A} (G_1^* - G_j^*)$$

It can be seen first that when the auditor's best choice is to do nothing more in the way of additional evidence collection he gains nothing since $G_1^* - G_1^*$ is zero, and furthermore, that if U* is zero indicating that a_1 is the optimal action the relative advantage of all other audit procedures being considered will be less than zero. Thus the auditor will have in effect concluded that they cost more than they are worth. This procedure matches intuitively with the crux of the decisions facing the auditor in elements (6) and (8) of the model.

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dollar value equivalent measures of the C_j's. In such a case the auditor could chose a* by rank ordering of a vector set with one two dimensional vector associated with each a_j. Such a vector for any a_j would be defined as,

$$\bar{a}_j = \begin{bmatrix} R_j \\ C_j \end{bmatrix}.$$

The decision rule for a* would then be

$$a^* \Rightarrow \min_{A} (\text{Rank Order } [\bar{a}_j])$$

with rank order established by convention so that the most preferred $\bar{a}_j$ receives the lowest rank assignment, the next most preferred a_j the second lowest rank, etc.

Alternatively, the auditor might be able to assess dollar value equivalents for the l_{ij}'s and hence to have dollar value (ratio) measurements available for the R_j's.

IV.1.3 Extensions Necessary to Complete the Decision-Making Process

Having selected a course of action, a^*, the auditor can proceed to collect additional evidence accordingly if $a^* = a_j : 2 \leq j \leq r$--such procedures are indicated by element (7) in Figure 4.1--or immediately conclude as shown by (8) whether to adopt d_1 or d_2 as per Equation 4.6. In this second case, where $a^* = a_j : j = 1$, if d_1 is indicated the auditor will want to record (10) his conclusion that the application results as presented by the client are acceptable.

It might also be supposed that the cost of carrying out each of the a_j is also available, but that the auditor wishes to give less weight to the C_j's than to the dollar value equivalents for the R_j's. This might be the case for instance, because some portion of these amounts (the C_j's) can be passed through to the client by incrementing the fee for the engagement. In such a situation the auditor could develop a weighting vector for decision-making purposes in order to appropriately determine the G_j^*'s. The G_j^*'s would be determined as follows:

$$G_j^* = \bar{w} \cdot \bar{a}_j$$

where

$$\bar{w} = \begin{bmatrix} 1 \\ h \end{bmatrix}$$

h = weight required to convert any cost, C_j, to dollar value equivalence for decision-making purposes; $o < h < 1$.

The selection of a value for h might for example represent the proportion of cost which would be absorbed by the auditor, or it might be more subjectively determined.

If however d_2 is the better decision, given $a^* = a_1$, then as illustrated by Step (9), the auditor's choice will be to discuss with the client any necessary correction entries, footnotes or policy statement disclosures, etc. as dictated by the situation.

If the auditor chooses to gather more evidence, then upon completion of whatever process he selected for this purpose he will find himself in a position to repeat as often as necessary the risk analysis and decision process as illustrated by Figure 4.3.* Each time the auditor collects a set of evidence, he must revise his prior based upon the information actually furnished by whatever audit procedure he has just completed. (It should be recalled that the prior referred to here is the prior probability function over B and is the set of p_i's which result from the mapping of each respective possible true balance into the unit interval as specified above for Equation 4.1.) If a formal procedure is desired for obtaining the revised p_i's they can be determined as follows:

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*In the discussion in previous sections concerning the selection of an a_j it was assumed for the sake of clarity and simplicity that a terminal action, d_1 or d_2, would follow evaluation of the evidence, y, produced by any a_j, $j \neq 1$, as shown by Figure 4.2. This is tantamount to assigning probability one to course of action a_1 following the first collection of evidence as shown in Figure 4.3.

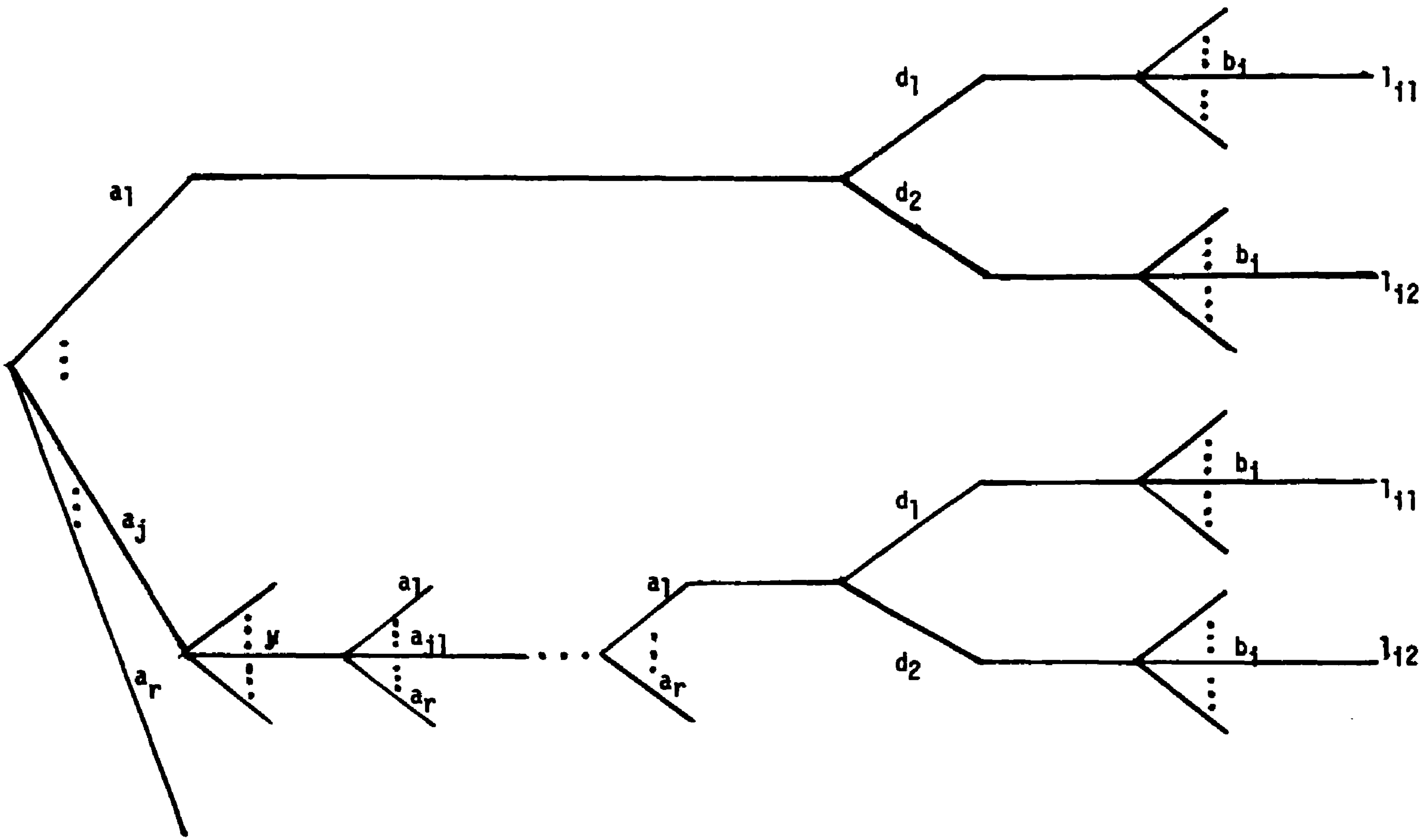

Figure 4.3.--Diagram of extended procedure selection problem

If,

$\tilde{p}_i = Pr(b_i | a_j, y)$ = The revised probability of b_i being the proper balance for the application under review given that result y was obtained following implementation of the procedure associated with a_j.

Then since a_j is known at this point,

$$\tilde{p}_i = \frac{Pr(y|b_i) \cdot p_i}{\sum_B Pr(y|b_i) \cdot p_i} \tag{4.9}$$

This is an application of Bayes Theorem and will be more fully developed in the next section. Theoretically the process should continue until the net risk of immediate final declaration concerning the application is lower than the net utility to be gained by further investigation.

Once the auditor has reached and recorded some finding concerning any one application he will, unless he has completed the examination (information gathering) stage of the audit or unless he has completed his primary review of all the applications involved in the presentation of the client's financial statements, choose another application for close scrutiny. This series of implied decisions is marked and can be traced beginning with (4) and moving through (12) back to Step (4) in the decision model.

If the auditor has completed the information gathering stage of the audit, then at Step (11) instead of proceeding to Step (12) he will be in a position by reviewing all his recorded findings to determine the nature of the opinion to be rendered regarding the client's financial statements (i.e., determine content and wording of the opinion in order to produce as befits the situation an unqualified opinion, a qualified opinion, a disclaimer, or an adverse opinion). Finally, of course, the audit report or certification statement will be prepared to accompany the presentation of the statements which have now been audited. This stage of the auditor's work is described by elements (16) and (17) in Figure 4.1. This stage of the audit cannot be reached however until it has been preceded by an analysis of the statements as a whole in order to guard against undesirable or ameliorative cumulative effects.

When the findings regarding each individual application have been completed, as determined by the decision marked (12), the auditor can then review this set of findings as a whole in order to decide whether they fit together, or in other words how the results of applications interact to influence the overall fairness of the financial statement presentations. Since the auditor is still uncertain to various degrees about what the proper results of each application should be, it follows that his decision concerning overall fairness must also be made in light of uncertainty concerning the proper result to be shown by the statements as a whole.

Let,

T_i = The ith possible proper complete set of financial statement presentations

t_i = Probability that T_i is the most appropriate of all T_i's

o_j = jth decision concerning overall fairness

L_{ij} = Loss incumbent upon the auditor if both t_i and o_j obtain

Essentially at least four o_j's should be considered, one for each of the types of opinion listed above, but consideration of only two o_j's will be sufficient here. Namely

o_1 = Accept results as fair

o_2 = Take exception to results

A situation now emerges for the auditor which is basically parallel to the one he dealt with after having selected in Step 4 a particular application for review, except that now he is scrutinizing the cumulative effect of all applications on the uncertainty about the statements as a whole rather than only one portion of those statements. On occasion the auditor may also wish to consider whether it would be worthwhile to gather additional information before choosing between the o_j's and the analytical methods for doing this have been presented above except for the proper substitution of T_i, L_i, and related terms. The process of doing all this is described in the model as elements (13), (14) and (15). After an o_j has been chosen, the auditor will have decided not to gather any more evidence (he will therefore have chosen a null channel) and will wish to carry out the procedures indicated by Figure 4.1 in order to complete the audit.

IV.2 Illustration of Specification for Solution of an Audit Decision-Making Problem

As mentioned earlier, it shall be assumed that the auditor wishes to allocate the resources under his direction in that manner which maximizes the expected benefits of his decision. In other words, from all possible resource allocations the auditor will select a single allocation plan whose relative advantage is greater than (or equal to) the relative advantage to be gained from the adoption of the other allocation plans. This is equivalent to a restatement of the decision rule (Equation 4.5) stated above which enables selection of the procedure with minimum net expected risk.

Assuming that the initial review of internal control is completed and, for the moment, that it has become necessary to concentrate on gathering additional evidence, an example involving two competing procedures can be considered.

Specifically, let the auditor be concerned with choosing the better of two alternative resource allocation plans. Let the first alternative plan, audit procedure a_V, require verification of a manual nature. The second alternative resource allocation plan, a_C, will require computer review and testing of the application being scrutinized.

The auditor must compare the net risks of the alternative plans, which in effect are alternative plans for obtaining information about a subset of the financial transactions which transpired during the period and which involved a particular accounting application. The items about which the auditor will draw a conclusion have only certain characteristics which will be of interest in the determination of the relative advantage of the alternative sampling plans. Usually the auditor is concerned with the existence of or absence of error in the final or aggregate presentation of the results of the application. In addition with respect to any error in this aggregate result, he is also concerned with the magnitude of error and its direction--whether the error is an over- or under-statement. In other words, he needs information which will help reduce the uncertainty surrounding the difference between the aggregate result presented by the client's financial statements, b_s, and the proper balance which is not known with certainty but which exists in B.

The heart of the accounting application is a series of records which report transactions involving the balance in question. These entries are a controlled process which generates errors. In this example the auditor is concerned with selection of either a_v which is aimed at a direct inference about the total effect of errors generated by this process or with a_c which it will be assumed is a procedure for testing the programmed controls devised for the process.

IV.2.1 Verification as a Strategy of Inquiry

If the auditor were to choose the verification technique, plan a_v, then he would be selecting transactions or subsidiary balances from a control balance presumably on a random basis. Having gathered the sample evidence consisting of n such items, he might proceed as follows: First, for each item in the sample some procedure will be performed (i.e., confirmation, inspection, observation, etc.), to determine whether or not the item was correctly stated.

Ultimately the auditor's concern will be to appraise the seriousness of the magnitude and direction of error as estimated for the population as a whole. Before making such an appraisal, however, the auditor should evaluate the sample in light of other knowledge and beliefs which he possesses concerning the error characteristics of the population. Such knowledge might be available from such sources as previous audits of the same client, experience with similar clients, and an initial purview of internal control.

IV.2.1.1 Explicit Consideration of Error Rate and Error Amount

For items which have been incorrectly recorded, two interesting error features, magnitude and direction (over-statement and under-statement), will be recorded. Two distinct processes of inquiry are therefore involved in this strategy, and plan a_v can be analyzed accordingly.

The sample items may be viewed as forming three mutually exclusive subsets about which the auditor has prior opinions (developed from non-sample evidence before the sample was taken). The first subset of sample observations are those which resulted in over-statements (positive error). The second subset consists of items which resulted in understatements (negative error). The third subset includes by default all other items--items treated correctly or items treated improperly but which nonetheless have not adversely effected the resulting amounts recorded for statement purposes. An item in this class could for example have been improperly recorded but subsequently corrected by the client or it could be a payment inadvertently posted to the wrong account receivable ledger. The result of the posting error is an overstatement for one ledger balance and an understatement for the other. Both errors are equal to the amount of the posting. For reporting purposes these errors offset one another, so that the total amount of accounts receivable shown by the client's financial statements will not be changed by correcting the error. In the ensuing discussion it will be assumed that the probability of the type of error included in the third class is very much less than one, so that they do not reflect negatively on the overall system of internal controls.

A constant, Δ, will be associated with the third subset. This constant will be the least significant amount handled by the financial information system (i.e., one cent or one dollar). The actual domain of items in the third subset will therefore be the interval between plus and minus Δ even though the density of items observed in the third subset will be degenerate at zero.

IV.2.1.2 Prior Densities

The density function over these three classes is multivariate. For sampling purposes consider the partitioning of the population discussed above and illustrated by Figure 4.4 The auditor's random sampling can therefore be viewed in part as a bivariate Bernoulli process which produces positive error with probability p_1, negative error with probability p_2, and neither type of error with probability p_3.* The q_j's represent the probabilities that the observation from a random drawing will not belong to the class associated with j, so that $q_j = 1-p_j$. Therefore,

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*This is a bivariate rather than trivariate process because any one of the p_j's, $j = 1,2,3$ is functionally dependent once specification of the other two p_j's is complete.

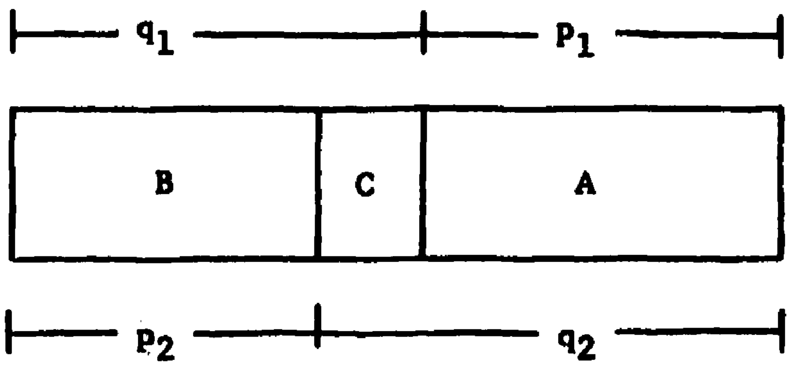
4.10 $$\Pr(X_i|p_1,p_2) = p_1^{x_{i1}} p_2^{x_{i2}} p_3^{x_{i3}}$$

and

4.11 $$\Pr(X_1,\ldots,X_n|p_1,p_2) \propto \prod p_j^{\sum_{i=1}^{n} x_{ij}}$$

where X_i is characterized by three elements, x_{i1}, x_{i2}, x_{i3}, with $x_{ij} = 1$ if the observation falls into the jth subset and $x_{ij} = 0$ if the observation belongs to one of the other two subsets. For each observation X_i, therefore, one of the x_{ij} will be equal to one and the other two x_{ij}'s will be zero. For example, if the third sample observation, X_3, is an item whose effect is to overstate income, then $x_{31} = 1$ and $x_{32} = x_{33} = 0$. Since observations from the random variable, X, are independent and identically distributed, the probability of obtaining $\sum_{i=1}^{n} x_{ij}$ observations for the three subsets in n trials is proportional to the product of the n individual observation probabilities as shown by Equation 4.11.

All this depends on specification of the value of two of the three p_j's. The true proportion of items belonging to each of three subsets is unknown, but the auditor may have a prior opinion about the probability density over p_1, p_2, and p_3. In most cases, because of the great variety of shapes which the bivariate beta distribution can take on in accordance with various parameter specifications, this distribution can be used to portray a prior opinion about



Items in first subset, A, are associated with positive error amounts (overstatements)

Items in second subset, B, are associated with negative error amounts (understatements)

The third subset, $C = [A \cup B]'$

Fig. 4.4.--Partitioning of population for audit sampling purposes

the p_j's. The bivariate beta also called the bivariate Dirichlet is appropriate for use in expressing a prior opinion about the density of the p_j's because it has a closed domain. In standardized form this domain includes only the interval from zero to one for each variable. Such a domain is exactly what the auditor requires because the density for the p_j's must be such that the probability of any p_j being greater than one or less than zero is zero. In most applications where internal control is satisfactory, the auditor would also have reason to believe that the true portion of positive (negative) error items is small and that moderate or large values of p_1 (p_2) are highly improbable. The value of p_3 will therefore be quite high. In such cases, a typical prior probability density function for the unknown portions, p_1, p_2, p_3 can be seen in Figure 4.5. In particular, the prior density shown by Figure 4.5 indicates that p_1 is believed to be somewhat larger than p_2 but both p_1 and p_2 are very much smaller than p_3. The marginal density of p_1 or p_2 will be relatively peaked and will indicate a strong feeling about the expected value of p_1 or p_2 as the case may be.

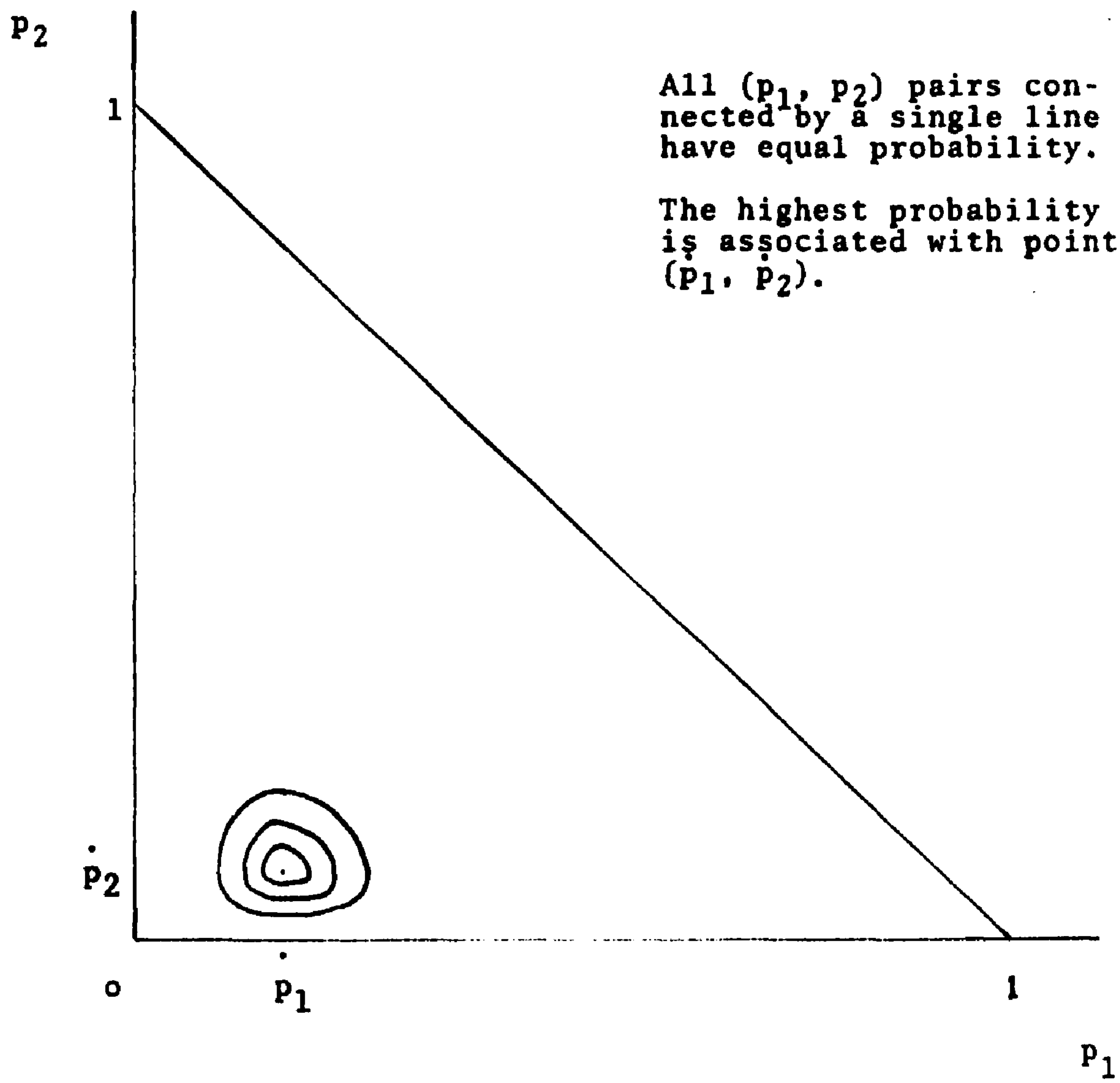


Fig. 4.5--Typical Bivariate Beta (Dirichlet) Density for p_j's

In certain cases or in order to be conservative, the auditor might wish to make use of a prior which gives equal weight to all possible combinations of values for p_1, p_2. If so he should choose the bivariate Dirichlet density with $\alpha_1 = \alpha_2 = \alpha_3 = 1$. The marginals for p_1 and p_2 will then appear as shown in Figure 4.3 by function b. The Dirichlet distribution will be in this case a flat surface with constant density. Use of such a prior will result in a posterior which yields numerical results similar to those obtained by classical methods.[7] (As discussed in the previous chapter, however, the inferences will not be the same.)[8] Appropriate specification of the α_j's for the Dirichlet distribution can also result in marginal beta densities like that shown by function c in Figure 4.6. This sort of marginal will result if for example $\alpha_1 = \alpha_2 = 1$ and $\alpha_3 > 1$.

In general, the joint density for p_1 and p_2 is,

$$4.12 \qquad Pr(p_1, p_2, p_3 \mid \alpha_1, \alpha_2, \alpha_3) \propto \prod_{j=1}^{3} p_j^{\alpha_j - 1}$$

with constant of proportionality,

$$\frac{\prod_{j=1}^{3} \Gamma(\alpha_j)}{\Gamma(\sum_{j=1}^{3} \alpha_j)}$$

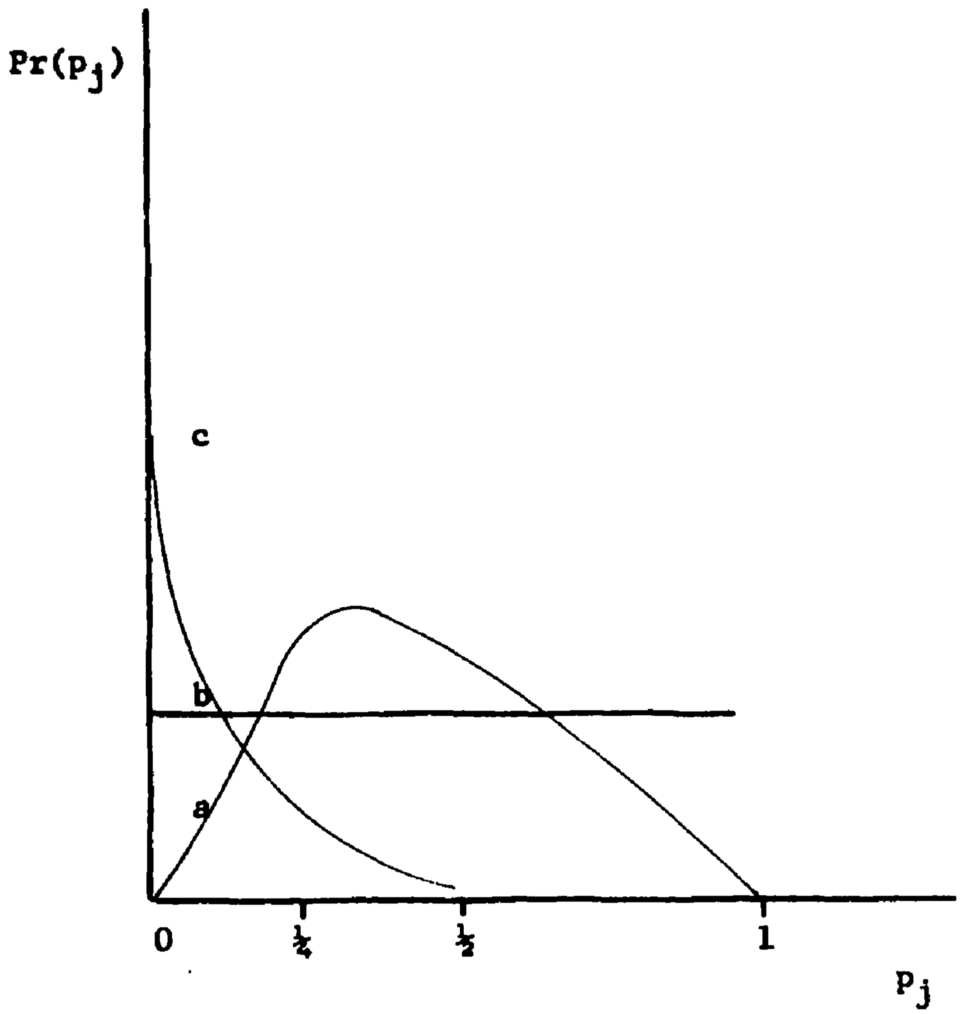


Fig. 4.6.--Typical Beta family prior densities for error rate p_j

The marginal density of any p_j will be

4.13 $$Pr(p_j|\alpha_1,\alpha_2,\alpha_3) = \frac{\Gamma(\alpha_1 + \alpha_2 + \alpha_3)}{\Gamma(\alpha_j)\Gamma(\alpha_1 + \alpha_2 + \alpha_3 - \alpha_j)} \cdot$$

$$p_j^{\alpha_j-1}(1 - p_j)^{\alpha_1 + \alpha_2 + \alpha_3 - \alpha_j - 1}$$

for $0 \leq p_j \leq 1$

with the following characteristics according to the assumption associated with function a in Figure 4.6 as discussed above. For p_1 or p_2 (for $j = 1$ or 2),

$$\alpha_j < \alpha_1 + \alpha_3 - \alpha_j$$

and variance of $p_j << 1/12$.

Turning to the magnitude of positive errors leads to consideration of a second type of sampling process. The items involving error in amount form subsets of the population which can be classified as positive or negative. The magnitude of the positive error associated with an item which is overstated may be viewed as a Poisson distributed random variable with unknown parameter $\lambda_1 - \Delta$, where λ_1 is the mean or expected magnitude of positive error.* Δ, as previously discussed, is the minimum possible error (say one cent or one

*Choosing the Poisson as a representative process for the generation of error magnitudes is an assumption. Future research efforts would be required to penetrate the fuzziness which surrounds the actual definition of this generating process in any given situation.

dollar) which can be produced by the client's system. As described here the Poisson is a conditional distribution with respect to the whole population. It is a density over the mean of items in subset A only, whereas p_1 is the proportion of items in the whole population which belong to subset A.

The auditor can assess a prior probability distribution for the unknown parameter $\lambda_j - \Delta$ just as he did for p_j except that in this case an open-ended distribution from the gamma family is more convenient. The gamma is appropriate because it is bounded in standard form by zero on one end of its domain but unbounded on the other end. The auditor's situation is analogous because as described above, he is dealing with the absolute magnitude of an error which when translated by the amount $-\Delta$ cannot be less than zero but can take on any value greater than zero.

The auditor's prior assessment of λ_j may be more vague than his prior estimate of p_j. If this is the case, the gamma distribution chosen as representative of prior judgment about the expected value of the jth type of error will be relatively flat or relatively imprecise, indicating respectively either a large γ_j or large θ_j (see Figure 4.7). The general form for the prior gamma distribution of λ_j is,

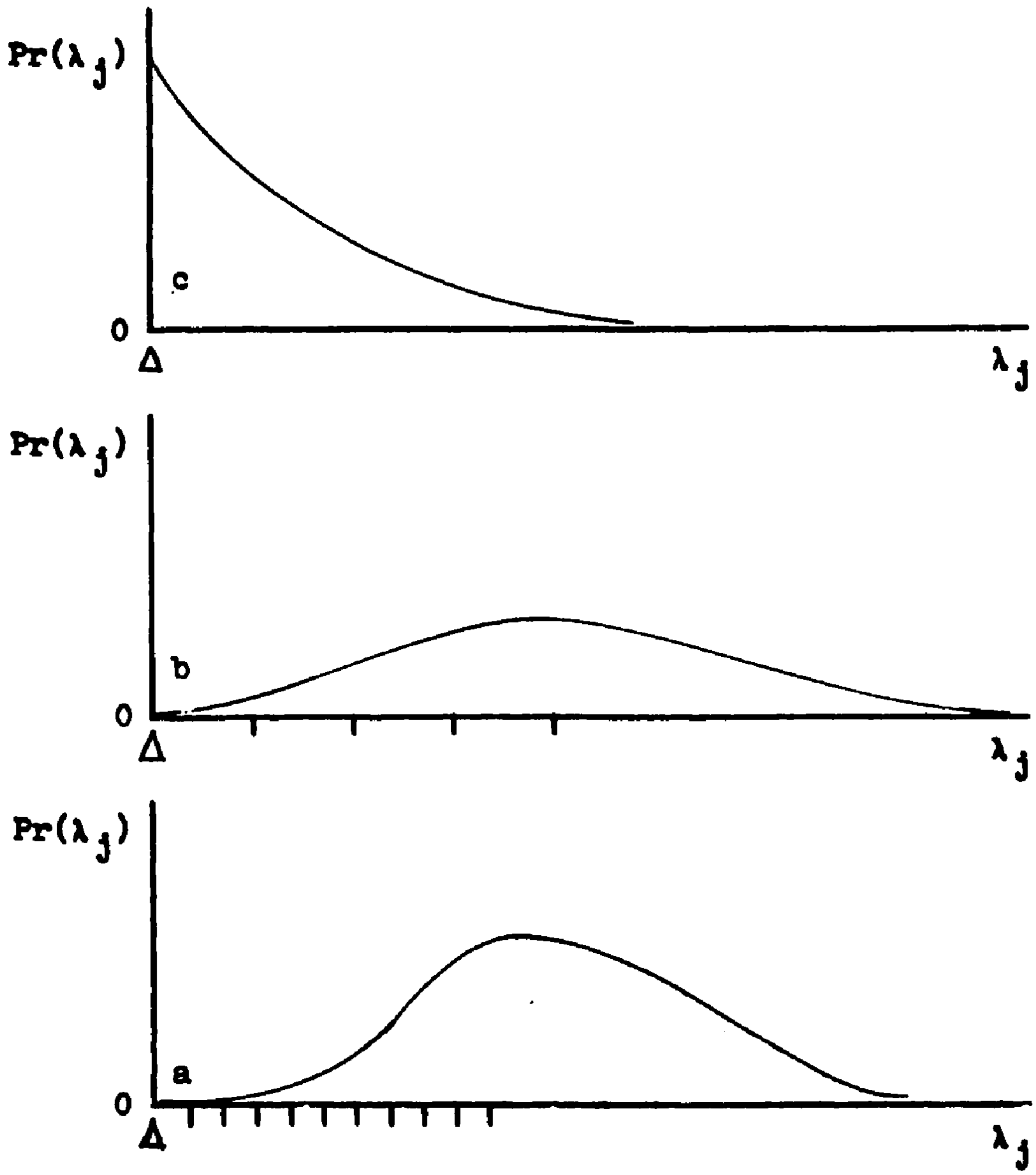


Fig. 4.7.--Typical Gamma family prior densities for λ_j

4.14 $$\Pr(\lambda_j|\gamma_j,\theta_j) = \frac{\theta_j^{\gamma_j}}{\Gamma(\gamma_j)}(\lambda_j-\Delta)^{\gamma_j-1}e^{-\theta_j(\lambda_j-\Delta)}$$

for $\lambda_j \geq \Delta$ (λ_j cannot be less than Δ because such errors belong to subset C)

$\Pr(\lambda_j|\ \gamma_j,\theta_j) = 0$ Elsewhere

It is quite possible that the available information indicates in the judgment of the auditor that the probability associated with any given average error amount (magnitude) is greater than the probability associated with any larger amount and less than that associated with any error that is smaller. If so, the auditor might choose a gamma density with $\gamma_j = 1$; the form of such a prior density is shown by Figure 4.6 (c).

The Poisson generating process used to describe the density of positive error has the form:

4.15 $$\Pr(x'_{ij}|\lambda_j - \Delta) = e^{-(\lambda_j-\Delta)}(\lambda_j - \Delta)^{x'_{ij}-\Delta} \text{ for all } x'_{ij}$$

and

4.16 $$\Pr(x'_{1j},\ldots,x'_{r_j j}|\lambda_j - \Delta) \propto (\lambda_j - \Delta)^{\sum_{r_j} x'_{ij} - r_j\Delta} e^{-r_j(\lambda_j-\Delta)}$$

with $r_j = \sum_n x_{ij}$ for a fixed value of j.

(Recall that x_{ij} is either zero or one as discussed following Equation 4.11.)

where x'_{ij} indicates the magnitude of an item whose error is greater than zero and r is the number (or set) of items from n which belong to subset A, if $j = 1$; B, if $j = 2$.

IV.2.1.3 Fractile Assessment Procedures for Specification of Prior Densities

This section sketches a method which can be used by the auditor in order to assess the parameters of a prior density once the distribution family for such expression of belief has been chosen. To construct a prior, the auditor can use the method of fractile assessments to specify the value(s) of the parameter(s) of the distribution he has chosen as convenient (possibly because it is a natural conjugate for the generating process with which he is concerned) in any particular situation.

In this section attention will focus on the assessment of the bivariate beta since it is in a sense the most general distribution so far discussed. The other distributions mentioned have been univariate. The assessment procedures for univariate distributions are similar to those discussed below except that the entire density rather than a marginal density can be assessed at one time.

Suppose that the auditor wishes to assess a bivariate beta (Dirichlet) density function $Pr(p_1, p_2, p_3 \mid \alpha_1, \alpha_2, \alpha_3)$. The auditor should assess marginal beta densities as discussed below for, say, p_1 and p_2. The result of this procedure will be specifications of α_1 and $\alpha_2 + \alpha_3$ for p_1 and α_2

and $\alpha_1 + \alpha_3$ for p_2. These results are likely to indicate two different values for α_3 -- an outcome which is inadmissible. The auditor should then take a value of α_3 which is typical in light of both values previously obtained. Using this typical value of α_3, the auditor should then reassess marginals to obtain adjusted values for α_1 and α_2. Care must be taken at this point to insure values of α_1 and α_2 such that $\alpha_1 + \alpha_2 < \alpha_1 + \alpha_2 + \alpha_3$.

As LaValle points out this procedure is especially suited to the type of situations that are typically found by the auditor. That is situations in which the dimensionality of the Dirichlet is small and opinions about the p_j's are simultaneously pronounced or simultaneously vague.[9] In particular, the auditor works with the smallest possible number of dimensions for the Dirichlet because the number of classifications or subsets of interest to the auditor is three. As discussed above, the auditor will also typically have strong beliefs about p_j's (i.e., that both p_1 and p_2 are very likely to be $\ll 1$ and that p_3 is very likely to be $\gg 0$).

The assessment of the marginals for p_1 and p_2 can be accomplished by envoking the following procedure. The auditor can assess his prior judgments about p_j by assessing two fractiles of p_j and then finding the $(\alpha_j, \alpha_1 + \alpha_2 + \alpha_3 - \alpha_j)$ pair in a table of beta density fractiles which corresponds most closely with his assessed fractiles.* Since two parameters must be specified initially, it is usually convenient to assess first the median and then either the .25 or .75 fractile of the marginal density of p_j.

The fractiles themselves represent the specific value of p_j, say $\dot{p}_j$, at which the auditor believes the fractile percentage represents the probability that the actual but unknown value of p_j will lie below the value $\dot{p}_j$. For example, in dealing with the median or .50 fractile, the auditor would choose $\dot{p}_j$ for the .50 fractile as .08 if he believes it equally likely that the value of p_j will be less than or greater than (technically $\geq$) .08. The auditor could then assess the .75 fractile by indicating a belief that if the actual value of p_j is greater than .08, it is equally likely that p_j will be less than or greater than ($\geq$) .10. The .75 fractile in such a case is .10. The auditor by reference to a beta distribution table can then determine that these fractiles correspond most closely with a beta with $(\alpha_j, \alpha_1 + \alpha_2 + \alpha_3 - \alpha_j)$ pair equal to (2,22).

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*Such a table is from several sources including a text by Irving LaValle.[10]

IV.2.1.4 Revision Based on Sample Results

The revised (posterior) density for the p_j's incorporates the information furnished by sample observations $X_1, \ldots X_n$, and is determined as follows:

4.17
$$Pr(p_1, p_2, p_3 \mid X_1, \ldots, X_n) = \frac{Pr(p_1, p_2, p_3 \mid \alpha_j\text{'s}) \cdot Pr(X_1, \ldots, X_n \mid p_1, p_2, p_2)}{\int_{p_2=0}^{1-p_1} \int_{p_1=0}^{1} Pr(X_1, \ldots, X_n \mid p_1, p_2, p_3)\, dp_1\, dp_2}$$
$$\propto \prod p_j^{\alpha_j + \sum_{i=1}^{n} x_{ij} - 1}$$

where it should be recalled x_{ij} is equal to one if the ith observation X_i was from the jth subset and $x_{ij}=0$ otherwise. The posterior density is a Dirichlet distribution (both prior and posterior will belong to the same family as long as the auditor adopts a prior from the Dirichlet family to accompany the bivariate Bernoulli sampling process) with constant of proportionality,

$$\frac{\prod \Gamma(\alpha_j + \sum_{i=1}^{n} x_{ij})}{(\alpha_1 + \alpha_2 + \alpha_3 + n)}$$

Similar results obtain when using the Gamma-Poisson combination in conjunction with the sampling of error size, so that both prior and posterior belong to the same family of distributions--the Gamma family--in this case. Therefore, 4.18 $$\Pr(\lambda_j | x'_{1j} \ldots x'_{r_j j}) =$$

$$\frac{\Pr(\lambda_j | \gamma_j, \theta_j) \cdot \Pr(x'_{1j} \ldots x'_{r_j j} | \lambda_j - \Delta)}{\int_0^\infty (\lambda_j | \gamma_j, \theta_j) \cdot \Pr(x'_{1j} \ldots x'_{r_j j} | \lambda_j - \Delta) d\lambda_j}$$

$$\propto (\lambda_j - \Delta)^{\gamma_j + \sum_{r_j} x'_{ij} - r_j \Delta - 1} e^{-(\theta_j + r_j)(\lambda_j - \Delta)}$$

which is gamma distributed with constant of proportionality,

$$[(\theta_j + r_j)^{\gamma_j + \Sigma x'_{ij} - r_j \Delta}] / \Gamma(\gamma_j + \Sigma x'_{ij} - r_j \Delta)$$

IV.2.2 The Relationship Among Statement Presentation, Error and Loss

The true values of p_1, p_2, λ_1, and λ_2 are unknown, but the auditor now has available posterior distributions which reflect the probability densities as inferred from prior opinion modified in light of the sample evidence. The auditor can now utilize these distributions for inference about the error characteristics of the application being audited.

The error, ϵ, for the population of transactions which constitute the application balance in question is a function of the four parameters, p_1, p_2, λ_1, and λ_2, and the number of transactions, N,

4.19 $$E(\epsilon) = (p_1\lambda_1 - p_2\lambda_2)N$$

where λ_2 is an absolute value. ϵ is related to the general model as follows if the ith possible balance b_i is in fact the proper balance for the application in question.

$$4.20 \qquad \epsilon = b_s - b_i$$

$$b_i = b_s - \epsilon$$

so that by examining ϵ the auditor is examining a linear transformation of b_i.

The density of ϵ is perhaps best obtained at this point by a discrete approximation and numerical computation of

$$4.21 \qquad Pr(\epsilon) = \sum_{\epsilon_1} Pr(\epsilon_1) \cdot Pr(\epsilon_2 = \epsilon_1 - \epsilon) \quad \text{for } \epsilon \neq 0$$

with $\qquad \epsilon_j = p_j \lambda_j N$

so that $\qquad Pr(\epsilon_j) = \sum_{p_j} Pr(p_j) \cdot Pr(\lambda_j = \epsilon_j/(p_j N))$.

The true probability of zero effective error can be determined by summing (1) $Pr(\epsilon=0)$ as determined by applying Equation 4.21 and (2) the probability of $p_3=1$ as determined by Equation 4.13

As discussed above the true sampling process for p_j's is a bivariate Dirichlet. If the auditor chooses to ignore the dependence of the p_j's on one another, other density functions might be considered as approximations. It might be convenient computationally for example to consider the Poisson distribution for describing the p_j generating process. The Poisson can be used to approximate the Bernoulli distribution which describes the density of any independent p_j. Unlike the Bernoulli whose domain is closed on the unit interval, the Poisson is confined only to values greater than or equal to zero. For this reason best results are obtained using such an approximation when n is rather large and p_j is small. These assumptions fit quite well with the typical audit situation. If this alternative is adopted the auditor could develop a Gamma-Poisson conjugate relationship. A gamma prior could in such instances be constructed to reflect existing knowledge concerning Np_j (i.e., the total number of items in subset A if $a_j = a_1$) and the Poisson likelihood function for np_j and sample observation say W would be,

$$4.22 \qquad Pr(W|p_j,n) = \frac{e^{-np_j} np_j^{W}}{W!}$$

with $\qquad W = \Sigma x_i$ for fixed j

and since N the size of the population has a degenerate density, the prior for Np_j is, $PR(Np_j)$ and the posterior gamma density for Np_j is

$$4.23 \qquad Pr(Np_j|W,n) \propto (p_j)^{\delta_j + \Sigma x_i} e^{-(\pi_j + n)(Np_j)}$$

where δ_j and π_j are the gamma constants set by the auditor to structure his prior in a fashion like that demonstrated above for γ_j and θ_j, respectively.

It might also be possible for the auditor to use a multivariate normal prior for error rates and/or a univariate normal for each of the error magnitudes, while assuming normality as well for the respective generating processes. For large n, as is usually the case in audit examination, the central limit theorem shows that λ_j's will be approximately normally distributed. The normal density can also be used as an approximation of the Bernoulli likelihood function. The domain of the normal density, however, is not constrained. Caution should be observed in using the normal approximation in conjunction with p_j's since best approximations are obtained for $np_j > 5$ and with p_j near zero such approximation may be inaccurate.

IV.2.3 Assessment of the Density of Error

Distinct consideration has been given to p_j and λ_j thus far for two reasons. The method described allows the auditor to segregate formulation of prior opinions about the probability of error and the magnitude of error. This feature could be of greatest value in making assessments when the auditor has a stronger prior knowledge about one of these two components of error. Where internal control is good, for example, the auditor might feel strongly that the probability of error is small but be less certain in his knowledge about the distribution of the amount of an error. In addition, this description has permitted a contextual demonstration of an appropriate relationship between the study of error rates by the auditor and the utilization of the information furnished by such a study in order to support decision relevant conclusions regarding the fairness of the client's financial statement presentations.

If, however, the auditor finds it more convenient to develop directly a density for ϵ or, ϵ/N or the ϵ_j's he can certainly do so. In any case, throughout the remainder of this chapter, it will be assumed that the density function over ϵ has already been compiled either by evaluation of Equation 4.20 or through direct assessment of a density for ϵ without recourse to development of densities for the p_j's and λ_j's.

IV.2.4 Computer Oriented Review and Testing as a Strategy of Inquiry

If the auditor pursues the second plan, a_c, then he will be testing such controls over the processing of the application as the batch total check, check digit, valid character checks, etc. The inferences about ϵ will be less direct than was the case for a_v. The details of transactions will not be the focal point of the inquiry process.

Perhaps the auditor will be able to distinguish three classes of messages which can arise in conjunction with information channel a_c. Suppose that the auditor, since he cannot make direct inference about ϵ based on evidence from plan a_c, believes it appropriate to classify the control of the system as excellent, average or below average according to the results of the tests associated with a_c. The evidence can influence the auditor's judgment about ϵ. Suppose that the inquiry or likelihood process is hypothetically as follows:

Messages/ States		M_1	M_2	M_3	Prior
$\epsilon < \dot{\epsilon}_1$	T_1		.1	.9	.1
$\dot{\epsilon}_1 \leq \epsilon < \dot{\epsilon}_2$	T_2	.5	.5		.1
$\dot{\epsilon}_2 \leq \epsilon < \dot{\epsilon}_3$	T_3	.8	.2		.2
$\dot{\epsilon}_3 \leq \epsilon < \dot{\epsilon}_4$	T_4	.5	.5		.4
$\dot{\epsilon}_4 \leq \epsilon$	T_5		.1	.9	.2
					1.0

Such a likelihood function will be developed from the auditor's experience with the tools of plan a_c. The interpretation give to the inquiry function shown above will be reviewed in order to given an illustration of the type of reasoning involved. In this case all possible values of ϵ have been broken into five regions, an open region on each end and three closed regions defined by bounds $\dot{\epsilon}_1$, $\dot{\epsilon}_2$, $\dot{\epsilon}_3$, and $\dot{\epsilon}_4$. The elements of the matrix, p_{ij}'s, are such that $\sum_{j=1} p_{ij} = 1$. In effect then each row represents the conditional probability distribution of messages given that any particular ϵ_i in the region associated with row i occurs.

Now consider a discrete numerical evaluation of the auditor's prior density of ϵ such that the densities of state regions T_1 to T_5 are as shown above. The auditor can now determine the probability of obtaining any M_k should plan a_c be adopted. To do this he must first determine the joint probability of each message/event pair. The marginal probability of each message will be equal to the row total for M_i in the joint probability matrix. In this particular example the joint probability matrix is as follows:

	M_1	M_2	M_3	Prior
T_1		.01	.09	.1
T_2	.05	.05		.1
T_3	.16	.04		.2
T_4	.20	.20		.4
T_5		.02	.18	.2
Marginal $Pr(M_i)$	.41	.32	.27	1.0

The marginal probability density over M as derived should serve as a check of the auditor's thinking. At this point the auditor can examine the $Pr(M_k)$'s to determine whether they are consistent with what he believes is likely to occur in the way of evidence (M_1 or M_2 or M_3) if a_c is adopted. If there is a discrepancy then the auditor should consider reformulating his inquiry function (assuming that the prior density function is appropriate).

IV.2.5 Loss Associated With Error

Before formalizing a loss function, a further look at the consequence of each decision is appropriate. If d_1 is chosen, then the auditor will advise the client of his intention to qualify his audit report unless the error can be substantially reduced through correction procedures. For purposes of simplification, the assumption will be made that the qualified opinion is never given so that the loss associated with d_1 will be determined by the consequences which are associated with a corrected balance rather than the balance presently reported by the client.*

If d_2 is chosen the auditor will conclude that the client's financial statement presentation will be acceptable without correction. If d_2 is chosen, then the loss associated with any ϵ becomes more serious as ϵ becomes larger. It seems reasonable to hypothesize that for values of ϵ near zero the auditor has little to fear from such possibilities as third party suits for negligence, punitive damage enforcements, loss of prestige and clientele, etc. On the other hand, the loss associated with large ϵ is less remote and larger. It may well be that the loss for any ϵ and d_2 is

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*If the auditor concludes that a correction is appropriate then he will ask the client to record the appropriate adjustment. Usually, the client will make the correction if possible in order to receive a "clean" or unqualified auditor's report to accompany the financial statements presented to the public.

related to ϵ in a manner similar to the following*

$$4.24 \qquad l_{i2} \propto 1 - e^{-a_j \epsilon_{ij}}$$

The constants a_1 and a_2 need not be equal. These two constants determine how rapidly the loss approaches some upper bound K_1 and K_2 respectively as λ_j becomes larger. If for example $a_1 > a_2$ and $K_1 > K_2$ then the consequences of $\epsilon > 0$ (an overstatement) are more serious than understatement of equal magnitude. A situation of this type is sketched in Figure 4.8.

If the auditor chooses d_1 instead of d_2 then he will be taking a course of action which will lead to a shift in the loss function due to correction of the balance as initially presented. Therefore if the magnitude of ϵ is thought of as fixed with respect to the initial balance, then d_1 will have the effect of shifting the loss function by the amount of the correction. The result is in effect a rescaling of ϵ. For example, if the auditor is considering a correction of amount z in order to correct what he believes is an overstated balance then the loss function will shift right so that zero loss will be incurred if $b_i = b_s - |z|$ since $b_s - |z|$ will be the balance reported if d_1 is chosen. The loss function for d_1 is therefore,

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*An empirical investigation of the views of professional accountants concerning the appropriate specification of such a function is reported in Chapter V.

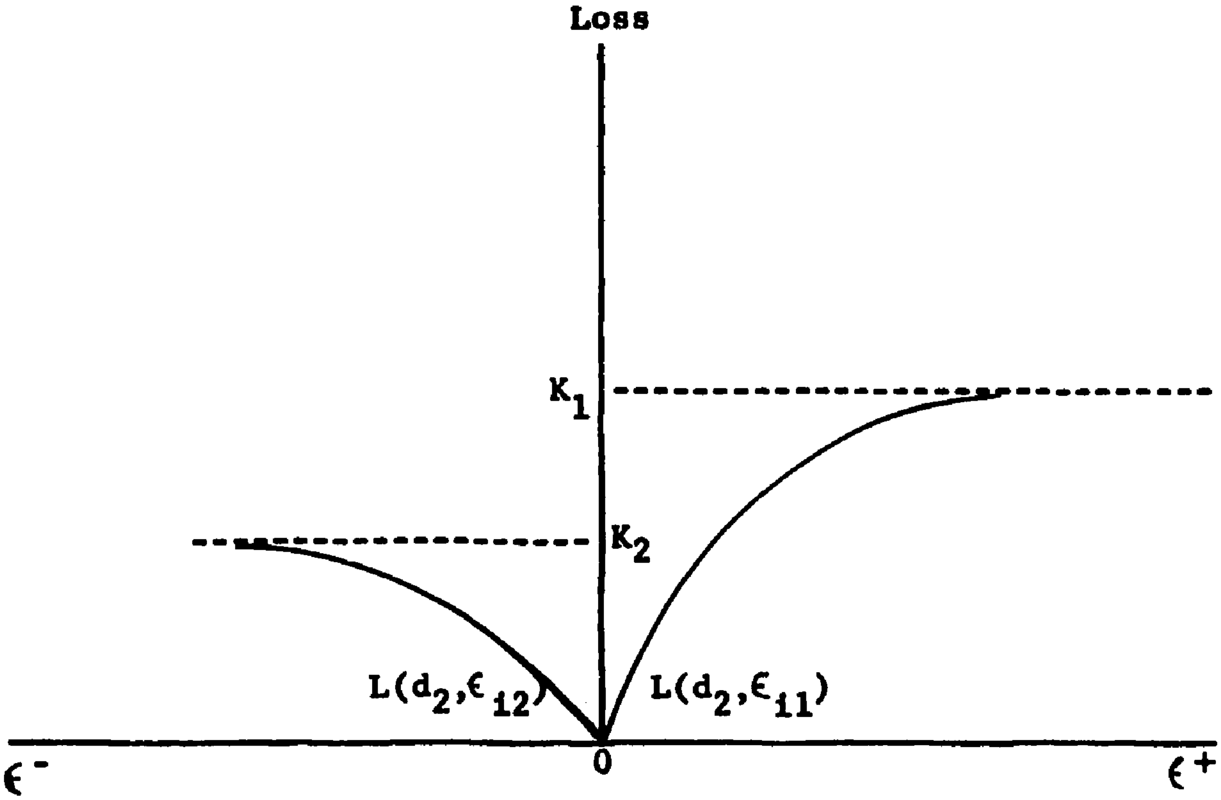

Fig. 4.8.--Loss function over ϵ if d_2 is chosen

4.25 $$l_{i1} \propto K_j - K_j e^{-a_j(\epsilon_{ij} + z)}$$

as illustrated in Figure 4.9.

The magnitude of l_{ij} is determined by scaling constants K_1 and K_2 for $j = 1$ and 2 respectively. These constants represent respectively, the maximum expected loss to the auditor which could occur as the result of large uncorrected understatement or overstatement. These amounts are shown as the asymptotes in Figures 4.8 and 4.9.

Cost functions for implementation of a_c and a_v will not be discussed at length since these should be readily determinable in any particular instance. Here it will simply be assumed that the costs of implementing a_v or a_c are known to be, say, C_v or C_c respectively.

IV.2.6 Evaluation of Plans a_v and a_c

Having specified loss functions for d_1 and d_2, the auditor can evaluate the alternative plans a_c, computer review and testing, and a_v, verification sampling, by comparing the net risks associated with the plans. For the sake of tractability and convenience a discrete analysis will be utilized to explore such risks. In addition, the inquiry process associated with a_v will be viewed as producing signals not about the p_j's and λ_j's but about the density of the mean error of all items in the population. The relationship between ϵ and μ is such that

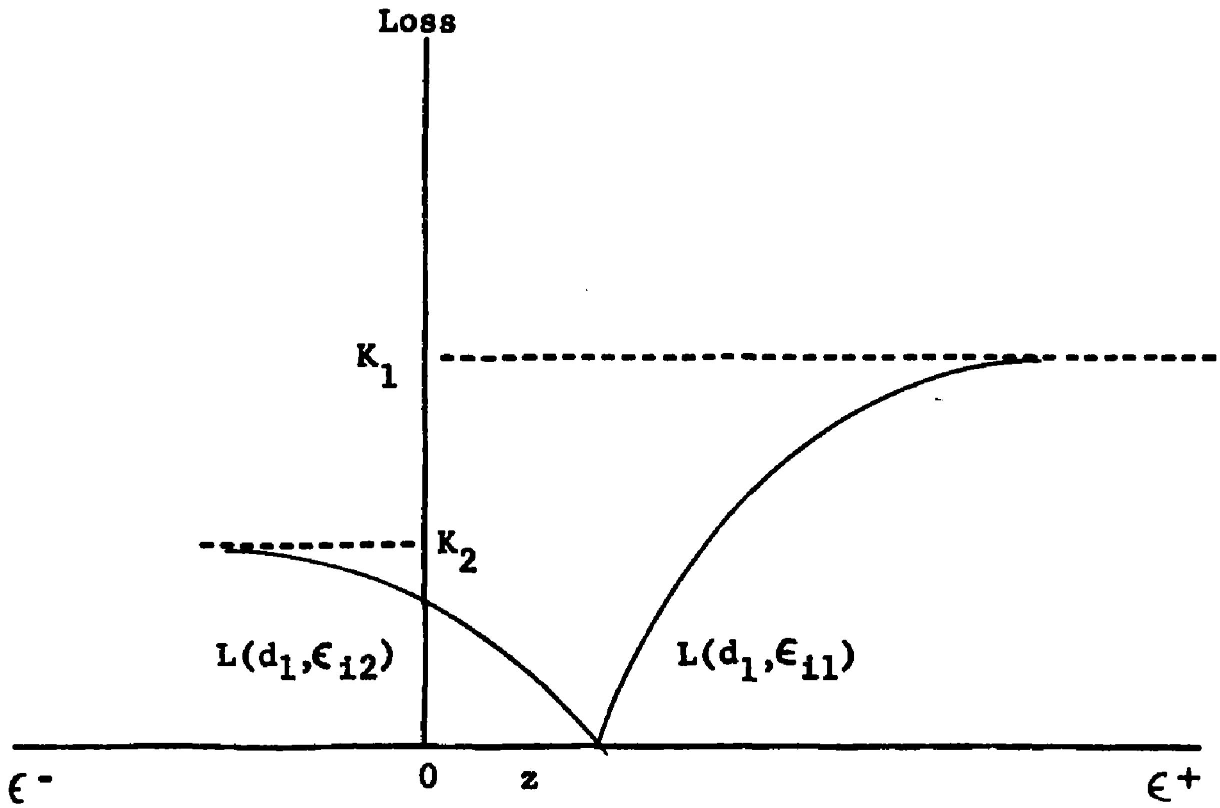

Fig. 4.9.--Loss function over ϵ if d_1 is chosen

4.26 $$\epsilon = N\mu$$

and

$$\Pr(\epsilon) = \Pr(\mu = \epsilon/N)$$

For convenience assume the likelihood function for the error generating process is normal with variance σ^2. Then the posterior density for μ will be determined by the prior (normal) density over ϵ and the likelihood function as follows for the discrete case,

4.27 $$\Pr(\epsilon|x_1 \ldots x_n) = \Pr(\epsilon|\bar{x}) = \frac{\Pr(\mu) \cdot \Pr(x_1 \ldots x_n|\mu)}{\Sigma \Pr(\mu) \cdot \Pr(x_1 \ldots x_n|\mu)}$$

where x_i represents the amount of error (if any) in the ith observation. The likelihood function associated with μ is

4.28 $$\Pr(\bar{x}|\mu) = \Pr(x_1 \ldots x_n|\mu) \propto e^{\frac{-n}{2\sigma^2}(\mu - \bar{x})^2}$$

where $\bar{x} = \Sigma x_i/n$.

For convenience the same discrete error regions will be used in connection with a_v that are associated with the discrete likelihood process assigned to plan a_c and a discrete number of signal regions for $\bar{x}$, the sample mean, will also be assumed. It would, of course, be possible to construct a more numerous set of smaller regions for use with

a_v if desired but this will not be done here.

For a_v, the sampling verification plan, then the following is appropriate if the value of l_i for i = mean value of ϵ region T_j is used to approximate the loss of any ϵ_i in T_j. The risk of a_v can then be approximated as follows:

$$4.29 \quad R^*_{a_v} = \sum_{Y_{a_v}} PR(\bar{x}:\bar{x}\epsilon M_j) \text{MIN} \begin{cases} \sum_T PR(\bar{x}|T_j) \; K_i(1 - e^{-a_i \epsilon_{mj}}) \\ \sum_T PR(\bar{x}|T_j) \; K_i(1 - e^{-a_i(\epsilon_{mj} + z)}) \end{cases}$$

where M is the discrete set of all μ regions and,

$$PR(\bar{x}:\bar{x}\epsilon M_j) = \int_{M_j} Pr(\bar{x}) \, d\bar{x}$$

in our case the number of M_j's is set at five.*

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*The cumulative densities for these M_j's are determined by evaluation of

$$Pr(x_1, \ldots, x_n | T_{ij}) = \int_{(\epsilon|N)=(b_j|N)}^{(\epsilon|M)=(b_{j+1}|N)} Pr(x_i, \ldots x_n | \mu) d\mu$$

for b_j = ϵ region bound j and j = 0 to 4.

For a_c the risk evaluation requires:

$$4.30 \quad R^*_{a_c} = \underset{Y_{a_c}}{\Sigma} PR(M_k) \ \text{MIN} \begin{cases} \underset{T}{\Sigma} PR(M_k|T_j)K_i(1 - e^{a_i\epsilon_{mj}}) \\ \underset{T}{\Sigma} PR(M_k|T_j)K_i(1 - e^{a_i(\epsilon_{mj} + z)}) \end{cases}$$

The better plan, a^*, from a_v or a_c will then be

$$4.31 \qquad a^* = \underset{a_c, a_v}{\text{MIN}} [R^*_{a_c} + C_c, R^*_{a_v} + C_v]$$

Of course, if risk associated with the better decision from the set of d_1, d_2 (plan a_1) is less than the net risk of a^* then neither plan a_c nor a_v should be used. The net risk of a_1 is

$$4.32 \qquad R^*_{a_1} = \text{MIN} \begin{cases} \underset{T}{\Sigma} PR(T_j)K_i(1 - e^{a_i\epsilon_{mj}}) \\ \text{or} \\ \underset{T}{\Sigma} PR(T_j)K_i(1 - e^{a_i(\epsilon_{mj} + z)}) \end{cases}$$

If $a^* = d_1$, then the conclusion about the application should be that associated with $R^*_{a_1}$.

IV.2.7 A Simple Numeric Example

Consideration will turn now to a simple example which will help demonstrate these concepts and one other, the expected value of perfect information. Consider the case in which for a certain cost the auditor can ascertain the proper balance with certainty. This quantity, the expected value of perfect information, will determine the maximum benefit which the auditor can expect to receive given his prior over ϵ. In this example the set of conclusions will be limited to two, namely to correct by a certain amount or to leave the balance uncorrected. Strictly speaking of course, the auditor will know exactly what correction was required if he knew with certainty what the proper presentation should be. Here however it will be assumed that for planning purposes the auditor has a fixed correction in mind and wishes to explore the potential consequences of proceeding to adopt either a_v, a_c or a_1 following which he will select the best decision d_2, no correction, or d_1, correction by the fixed amount.

Consider the discrete loss function in Figure 4.10, and likelihood functions for a_v (with 100 percent sample) and a_c, as shown in Figure 4.11, along with a uniform prior over ϵ. The loss function represents the auditor's assessment of the consequences of error. In dealing with the assessment problem, the auditor specified maximum losses for severe over- and understatement as 2K and K respectively. The auditor's losses due to the impact of error are seen to decrease as the error approaches zero. For the discrete region surrounding zero the loss is zero if the auditor chooses to conclude that there is no correction needed--decision d_2. If d_1 is selected (and recalling that the cost

	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}
d_2	K	.9K	.7K	.4K	0	.8K	1.4K	1.8K	2K	2K
d_1	K	K	.9K	.7K	.4K	0	.8K	1.4K	1.8K	2K

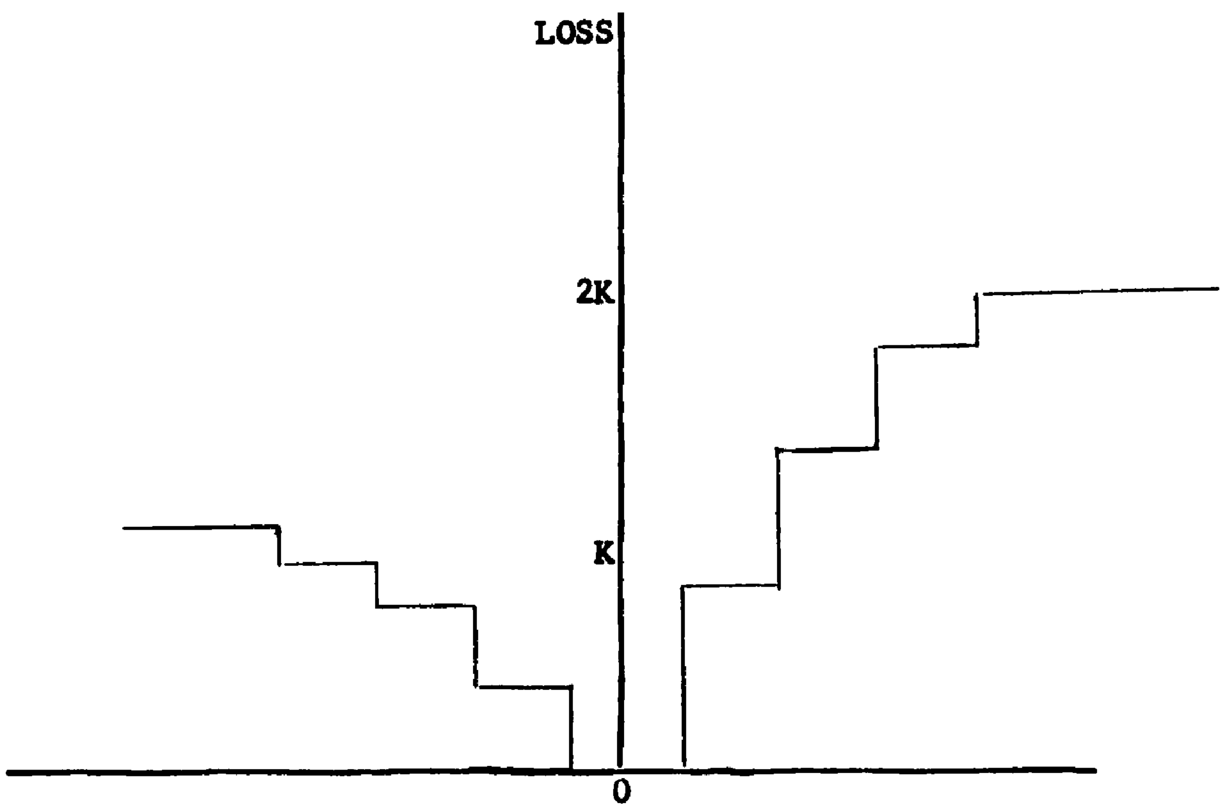

Fig. 4.10.--Discrete loss function

Plan a_c

	S_1	S_2	S_3
T_1		.5	.5
T_2		.5	.5
T_3	.5	.5	
T_4	.5	.5	
T_5	.5	.5	
T_6	.5	.5	
T_7	.5	.5	
T_8		.5	.5
T_9		.5	.5
T_{10}		.5	.5

Plan a_v (100% Sample)

	M_1 $(N\bar{X}<\dot{\epsilon}_1)$	M_2 $(\dot{\epsilon}_1 \le N\bar{X} < \dot{\epsilon}_2)$	M_3 . . . $(\dot{\epsilon}_2 \le N\bar{X} < \dot{\epsilon}_3)$	M_{10} $(\dot{\epsilon}_{10} \le N\bar{X})$
T_1	1	0	0 . . .	0
T_2	0	1	0 . . .	0
T_3	0	0	1 . . .	0
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
T_{10}	0	0	0	1

Fig. 4.11.--Conditional likelihood functions

of correction is assumed to be negligible), then the loss function shifts with respect to ϵ by the amount of the correction z.

The likelihood or inquiry function associated with plan a_c is such that the auditor expects that regardless of the amount of error the implementation of a_c is as likely to result in finding an average control system as not, and that for smaller error amounts the system is as likely to be found in excellent condition as not. Finally, should a relatively large error amount be present then a_c is as likely as not to indicate that the detailed control for the application in question is below average. The likelihood process for 100 percent sampling assumes that by examining every transaction the auditor would be able to detect with certainty the amount of error actually associated with the balance being reviewed.* The joint distribution of likelihood functions and prior density are shown in Figure 4.12.

The risk associated with immediate decision without benefit of additional information is,

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*The auditor may in fact examine every transaction and still have less than perfect information about the balance under review. Such lack of perfect information may be caused by non-sampling error. This would be the case for instance, if the auditor were to overlook some type of error while examining the transactions. A 100 percent sample might also yield less than perfect information if the balance in question is based in part on contingent events or estimates. Examples of such items are allowances for uncollectible receivables and depreciation based on salvage value and life expectancy estimates.

Plan a_c

Joint Density of T & S	S_1	S_2	S_3	Prior
T_1		.05	.05	.1
T_2		.05	.05	.1
T_3	.05	.05		.1
T_4	.05	.05		.1
T_5	.05	.05		.1
T_6	.05	.05		.1
T_7	.05	.05		.1
T_8		.05	.05	.1
T_9		.05	.05	.1
T_{10}		.05	.05	.1
Marginal Probability	.25	.50	.25	1.0

Plan a_v (100% Sample)

Joint Density of T & M	M_1 $(N\bar{X}<\dot{\epsilon}_1)$	M_2 $(\dot{\epsilon}_1 \le N\bar{X} < \dot{\epsilon}_2)$	M_3 $(\dot{\epsilon}_2 \le N\bar{X} < \dot{\epsilon}_3)$	...	M_{10} $(\dot{\epsilon}_{10} \le N\bar{X})$	Prior
T_1	.1	0	0	....	0	.1
T_2	0	.1	0	...	0	.1
T_3	0	0	.1	...	0	.1
⋮	⋮	⋮	⋮		⋮	⋮
T_{10}	0	0	0		.1	.1
Marginals	.1	.1	.1	...	.1	1.0

Fig. 4.12.--Joint likelihood functions

$$4.33 \qquad R^*_{a_1} = \text{MIN}\begin{cases}\sum_T PR(T_j)L(T_j,d_1)\\ \sum_T PR(T_j)L(T_j,d_2)\end{cases}$$

For a_v

$$4.34 \qquad R^*_{a_v} = \sum_M PR(N\bar{x}|M_i) \ \underset{D}{\text{MIN}}\begin{cases}\sum_T PR(T_j|N\bar{x}\epsilon M_i)L(T_j,d_1)\\ \sum_T PR(T_j|N\bar{x}\epsilon M_i)L(T_j,d_2)\end{cases}$$

and for a_c

$$4.35 \qquad R^*_{a_c} = \sum_S PR(S_i) \ \underset{D}{\text{MIN}}\begin{cases}\sum_T PR(T_j|S_i)L(T_j,d_1)\\ \sum_T PR(T_j|S_i)L(T_j,d_2)\end{cases}$$

Evaluation shows:

$$4.36 \qquad R^*_{a_1} = \underset{D}{\text{MIN}}\begin{cases}.1(K+.9K+.7K+.4K+0+.8K+1.4K+1.8K+2K+2K)\\ .1(K+K+.9L+.7K+.4K+0+.8K+1.4K+1.8K+2K)\end{cases}$$

$$= \underset{D}{\text{MIN}}\begin{cases}.1(11K)\\ .1(10K)\end{cases}$$

$$R^*_{a_1} = R_{d_2} = K$$

and,

$$4.37 \qquad R^*_{a_v} = \sum_M .1 \ \underset{D}{\text{MIN}}\begin{cases}L(T_j:M_i \rightarrow T_j \text{ with probability } 1,\ d_1)\\ L(T_j:M_i \rightarrow T_j \text{ with probability } 1,\ d_2)\end{cases}$$

which by examination of the loss functions leads to the following decision rule—d_1 is optimal for $M_i:M_i \rightarrow T_j$ with $i \leq 5$ and d_2 otherwise. This suggests that if plan a_v with 100 percent sample is adopted the auditor will in making a decision following the complete sample choose not to recommend correction by amount z unless the mean for detected errors was greater than the upper bound on region T_5.

This examination indicates that,

$$4.38 \quad R^*_{a_v} = .1(K+.9K+.7K+.4K+0+0+.8K+1.4K+1.8K+2K) = .9K$$

$$\text{and EVPI} = R^*_{a_1} - R^*_{a_v} = K - .9K = .1K$$

Finally, for plan a_c evaluation reveals the following:

$$4.39 \qquad R^*_{a_c} = (.25) \min_D \begin{cases} \sum_{i=3}^{7} .2L(T_i,\ d_1) \\ \sum_{i=3}^{7} .2L(T_i,\ d_2) \end{cases}$$

$$+ (.5) \min_D \begin{cases} \sum_T .1L(T_i,\ d_1) \\ \sum_T .1L(T_i,\ d_2) \end{cases}$$

$$+ (.25) \min_D \begin{cases} \Sigma\ .2L(T_i,\ d_1) \text{ for } i=1,2,8,9,10 \\ \Sigma\ .2L(T_i,\ d_2) \text{ for } 1=1,2,8,9,10 \end{cases}$$

so,

$$4.40 \qquad R^*_{a_c} = (.25)\ (.2) \min_D \begin{cases} 3.3K \\ 2.8K \end{cases}$$

$$+ \ (.5)\ (.1) \min_D \begin{cases} 11K \\ 10K \end{cases}$$

$$+ \ .25 \ (.2) \min_D \begin{cases} 7.7K \\ 7.2K \end{cases}$$

which indicates that for S_1, d_1 is more risky than d_2, for S_2, d_1 is also more risky than d_2 but that for S_3, d_1 is less risky than d_2. The best decision rule for a_c would accordingly suggest that if he must choose either d_1 or d_2 and that he wishes to reach a decision following implementation of plan a_c,

4.41 $$R^*_{a_c} = .05(2.8K) + .05(10K) + .05(7.2K)$$

$$R^*_{a_c} = K$$

Because under these conditions $R^*_{a_c} = R^*_{a_1}$, the auditor could expect to gain nothing by implementing a_c. The efficiency or relative advantage of a_c is actually negative if the cost of implementation is considered. An audit procedure can be of value only if it has some probability of changing the auditor's decision rule. In this case S_3 will accomplish this, but the risk is so high under either decision choice if S_3 occurs that the advantage of being able to change decision is offset by the high risk the auditor must face as a result of the large error which must be present in order for a_c to produce S_3.

The plan requiring verification, however, can be of some value to the auditor since $R^*_{a_c}$ is less than $R^*_{a_1}$. This depends on the cost of sampling and on the size of the sample employed.

If for example the auditor is considering plan a'_v, which calls for a sample of size n rather than a complete sample, then he will wish to determine the expected value of something less than perfect information from a channel which will produce a sample mean for error, $\bar{x}$, which will be constructed from sample observations drawn from a population which is assumed to be normally distributed with known variance S^2. In this particular case it might be that the width of discrete message regions over $\bar{x}$ is such that $2(S/\sqrt{n})$ is somewhat smaller than the message region, and by consulting a normal probability density table the auditor is able to approximate the likelihood function for a_v' as shown in Figure 4.13.

Risk analysis for a_v' shows that,

4.42 $$R^{*\prime}_{a_v} = \sum_M PR(M_i) \min_D \begin{Bmatrix} \sum_T PR(T_i|M_i)L(T_i, d_1) \\ \sum_T PR(T_i|M_i)L(T_i, d_2) \end{Bmatrix}$$

$$= .1[\text{MIN}\begin{Bmatrix} .85(K)+.15(.9K) \\ .95(K)+.15(K) \end{Bmatrix} + \text{MIN}\begin{Bmatrix} .15(K)+.70(.9K)+.15(.7K) \\ .15(K)+.70(K)+.15(.9K) \end{Bmatrix}$$

$$+\ldots+ \text{MIN}\begin{Bmatrix} .15(1.8)+.70(2K)+.15(2K) \\ .15(1.4K)+.70(1.8K)+.15(2K) \end{Bmatrix}$$

$$+ \text{MIN}\begin{Bmatrix} .15(2K)+.85(2K) \\ .15(1.8K)+.85(2K) \end{Bmatrix}]$$

	M_1	M_2	M_3	M_4	. . .	M_7	M_8	M_9	M_{10}
T_1	.85	.15	0	0	. . .	0	0	0	0
T_2	.15	.70	.15	0	. . .	0	0	0	0
T_3	0	.15	.70	.15	. . .	0	0	0	0
	.	.	.	.		.	.	.	.
	.	.	.	.		.	.	.	.
	.	.	.	.		.	.	.	.
T_8	0	0	0	0	. . .	.15	.70	.15	0
T_9	0	0	0	0	. . .	0	.15	.70	.15
T_{10}	0	0	0	0	. . .	0	0	.15	.85

Fig. 4.13.--Conditional likelihood for sample plan a_v'

$= .1[.985K+.885K+.685K+.385K+.18K+.18K+.77K$
$+1.37K+1.77K+1.97K]$

$R^{*'}_{a_v} = .918K$

Based on this analysis the auditor can conclude that the expected benefit from plan a_v' will be $R^*_{a_1} - R^*_{a_v} = K - .918K = .082K$. If the cost of implementing a_v' is less than .082K then the auditor can expect to benefit more by sampling in accordance with a_v' rather than reaching an immediate conclusion about whether to adopt d_1 or d_2.

IV.2.8 Consideration of Sample Size

The question of determining sample size, n, may arise during evaluation of the sampling plan referred to as course of action a_v. The sample which offers the greatest relative advantage will be the one of size n* which maximizes the difference between the expected value of sample information and the total cost of obtaining the sample. The expected value of sample information (EVSI) for a sample of size n is

4.43 $$EVSI = R^*_{a_1} - R_{a_v|n}$$

where $R^*_{a_v|n}$ is the expected risk as seen in advance of making a terminal decision after evaluating the result of a sample of size n.

Due to the low unit cost of audit sampling, and the relatively large amount of effort which would be required to make a sequentially optimal evaluation after each observation, the auditor will most likely prefer instead to fix n^* before sampling begins.

The optimal sample size, n^*, as shown by Figure 4.14, can be determined generally as follows. First, the expected value of perfect information, EVPI is determined. Second, the EVSI is determined as a function of n. The total cost, TC, of sampling can be determined as the sum of the fixed cost of implementing a_v plus the variable cost as a function of n observations. The optimal sample size is then determined by finding that n which maximizes EVSI-TC. This is equivalent to finding the n which satisfies the following condition,

$$\frac{\partial(\text{EVSI} - \text{TC})}{\partial n} = 0$$

or equivalently, n such that

$$\frac{\partial\,\text{EVSI}}{\partial n} = \frac{\partial\,\text{TC}}{\partial n}$$

$$= \frac{\partial(a + bn)}{\partial n}$$

$$= b$$

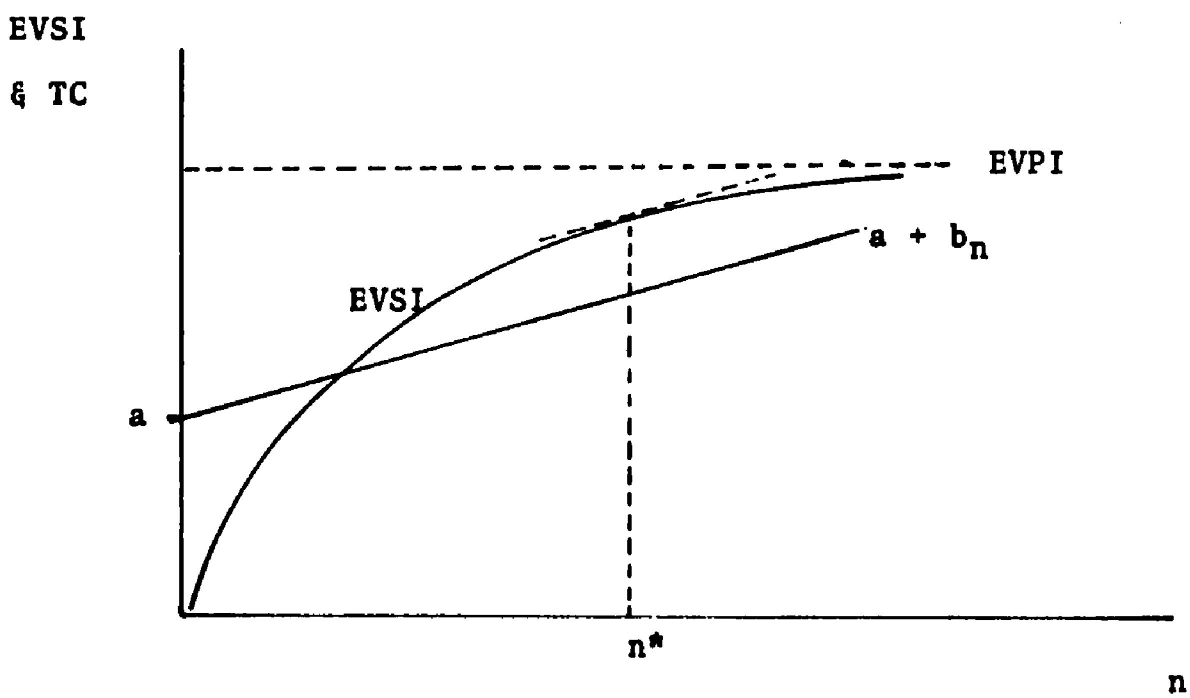

FIGURE 4.14.--OPTIMAL SAMPLE SIZE

where a = fixed cost of sample plan a_v

b = marginal cost of taking an observation

If the functional relationship between n and EVSI can not be conveniently determined an approximation can be used. The auditor can test the difference EVSI - TC for several difference n's and select an n at or near the best result. This can be done by selecting the n associated with the best result or by extrapolation.[11]

IV.3 Conclusion

The model presented in this chapter demonstrated the relationship between the auditor's decisions concerning resource allocation and his decisions concerning whether to recommend correction of financial statement presentations. This approach takes account of the uncertainty which surrounds the auditor's knowledge concerning (1) the actual error in financial statement presentation as well as (2) the variety in the types of information which can be gathered depending on whatever evidence generating procedure or audit technique the auditor selects.

The discussion of the model reveals in general form much that is unknown regarding the common characteristics of audit procedures. It would be worthwhile for example to catalogue the audit procedures which are frequently employed. This will constitute definition of the set of all available audit procedures referred to above as the set A. Once this is accomplished, the signals or messages which each procedure can produce should be studied and set out. This must be done in order to know potentially just what can be found out from each audit procedure. This is important because in general the auditor will not know which outcome actually occurs. He will only know what message or audit evidence is available. The inquiry function relates all possible messages to all possible proper balances (outcomes). It will not be possible to completely develop the inquiry function for an audit procedure unless all signals or classes of signals are known.

In addition, the probability densities associated with inquiry function for each audit procedure should be researched in some detail. This will help develop a clearer understanding of the inferences which can be made about the probability of various possible outcomes in light of whatever evidence might be produced by a particular audit procedure. This in turn will allow the auditor to better understand and anticipate the effectiveness of alternative techniques. Finally, it seems urgent that the impact on the auditor of the consequences of uncorrected error in financial statement presentation be explored. Such an exploration of loss should provide the auditor with a sturdier criterion for decision-making under conditions of uncertainty. The availability of such loss functions should also lead to better assessments of the efficiency of competing alternative audit procedures.

Testing the model for sensitivity with regard to (1) changes in loss functions, (2) assumptions about the likelihood (inquiry) function associated with alternative techniques, or (3) changes in prior densities would also be of benefit in helping understand which elements of the audit decision process are the most critical or most likely to change the auditor's decisions if improperly or inadequately specified. Theoretically, it might also be of interest to explore techniques which will lead to inclusion of dynamic consideration of the correction amount, z, which was assumed here to be fixed. Appendix II is a note about one approach to this problem.

CHAPTER V

AN EMPIRICAL INVESTIGATION OF THE CONCEPT AND MEASUREMENT OF AUDIT RESPONSIBILITY

This chapter summarizes a study that explored current professional attitudes about audit responsibility. The study examined the impact on the auditor of the consequences of error in financial statements. The study was specifically concerned with errors in statements about which the auditor had rendered a professional opinion. (Use of the word auditor refers to both the auditor and his firm as parties jointly and severally responsible for the opinion.)

Chapter II set out several perspectives from which the concept of the auditor's responsibility has been viewed in the past. These various perspectives each suggested one or more constructs which have some bearing on the auditor's assessment of his responsibility. One purpose of the exploration reported here was to determine the relative importance to auditors of constructs drawn together from several of the perspectives discussed in Chapter II. The previous chapter presented a model for use in audit decision-making under conditions of uncertainty. One of the elements of that model was a loss function. By defining such a loss function, the auditor has effected an operational definition or measurement of audit responsibility. This study explored the relationship between the auditor's reported perception of audit responsibility and his reported measurement of this concept in a particular situation. An independent study of certain characteristics of the reported loss assessments was also carried out. The findings of this study are also reported here.

In short, this study examined the auditor's perspective of audit responsibility in two ways. First the study examined the relative importance assigned by auditors to a set of constructs which are common to most audit decision-making situations where the risk of error is present. Second the study revealed the results of attempts by this same set of auditors to measure audit responsibility by assessing loss. These assessments were made on the basis of a specific audit decision-making situation.

The objectives of this report are four-fold. The report attempts first to illuminate the degree of consensus (or lack of it) within the profession regarding the concept of audit responsibility. This is done by comparing the relative importance assigned to the constructs of audit responsibility by each of several professional accountants. It is anticipated that a consensus regarding these constructs will lend a definitive structure to the concept of audit responsibility to which each of the constructs contributes partial substance or meaning. The dissemination and discussion of this information (or similar information from an expanded study) should help crystallize a previously amorphous concept. This could lead to more uniform interpretations of audit responsibility. In addition, understanding of the concept in this fashion should facilitate its operational measurement. Wider public dissemination of this information could allow concerned parties to more readily understand the views of the profession regarding its own responsibilities.

The second objective of this study is to explore the possibility that different views of the concept of audit responsibility may be reflected in differing perceptions regarding the loss function associated with an operational measurement of the concept. The third objective of the investigation is the exploration of measurement assumptions surrounding the concept. Several assumptions about the measurement of the impact of error or the auditor were discussed in previous chapters. Some results developed in this segment of the investigation may serve as criteria for validation of these previously untested assumptions.

Finally certain results of the investigation are to be used as validation criteria for the model explained in the previous chapter. Specifically, the results afford the opportunity to validate both the structure and assumptions of the sequential audit decision-making model presented previously.

V. 1 Research Questions Associated with the Empirical Study

This study seeks answers to several questions raised in previous chapters concerning the concept of audit responsibility and the desirable properties associated with the measurement of this concept. It is hypothesized that auditors differ little in ranking factors which influence the perceived consequences of errors. Two auxiliary or supportive hypotheses are advanced in conjunction with this first major hypothesis. It is hypothesized 1) that there will be no difference among professional accounting firms regarding the concepts of audit responsibility, but 2) that there will be differences in perception among professional accountants at various levels of management responsibility. These hypotheses regarding whether such differences among firms or between partners and management level personnel exist will be tested statistically.

These hypotheses rest on the following development. First the members of the public accounting profession share a common body of knowledge. Most all certified accountants have received several hours of advanced accounting credit at the college or university level. In most cases this training is highly specific and uniform in content. Each certified accountant must in fact demonstrate familiarity with this body of knowledge by passing a uniform examination. This examination is administered and scored nationally by The American Institute of Certified Public Accountants. Unification of thought regarding audit responsibility is also fostered by a professional standard requiring the review of the work of subordinates.[1] Such review acts as a control. It trains or molds the senses of the less experienced auditor. As a result, experience teaches the auditor to distinguish the important from the unimportant in much the same manner as do his supervisors.

Those who are in higher positions are brought together by the common concerns of legal, public and professional responsibilities. These persons work together in order to enforce and codify professional standards and generally accepted accounting principles. Finally, the independent rather than client preferential attitude which auditors are professionally bound to strive toward reinforces the pressure for uniformity in professional outlook and practice.

These four factors then--a common body of knowledge; professional supervision; a commonality of legal, public and professional responsibilities; and an allegiance to professional rather than client centered goals--give reason to believe that auditors will possess similar perceptions of the concept of audit responsibility.

Despite these pressures toward homogeneity among the perceptions of all independent auditors, a few significant differences may yet arise. The organization of auditing practices may lead to such differences. It is hypothesized that management level personnel will differ from partners in their view of the importance of a few of the constructs of audit responsibility. This reasoning follows in part from differences which are caused by an employer-employee relationship. In addition, the task assignments given partners and management level personnel may also lead to slightly different perceptions about the importance of some facets of the auditor's responsibility. As partners, men have a personal stake in the fortune and reputation of the firm as well as the profession. Management level employees share most of this same professional and public responsibility but little of the proprietary responsibility for the firm's practice. Perhaps therefore partners will assign more importance to the reputation of the firm. The tasks of partners deal less often with technical features of audits. Partners however deal more often with client relationships, administrative control and recruitment policies. The impact of error on client officers and the partner's own professional reputation or pride may therefore seem more important to partners. On the other hand, management personnel deal more frequently with technical problems of accounting and auditing. They may therefore be more concerned about the technical or task oriented consequences of error. Technical consequences include statement related effects such as the income effect or the working capital effect of an error.

The second major hypothesis focuses on the possibility that operational measures of audit responsibility may be influenced by differences in perception of the concept. In particular this study examines three characteristics of the loss assessment process. Each of these characteristics may vary because of differences in the perception of the underlying concept. The first of these characteristics is functional form. The functional form chosen to portray the relationship between the amount of error and the magnitude of loss may differ according to the auditor's perception of his responsibility. Those auditors who foresee an ever increasing loss associated with ever increasing amounts of error may view audit responsibility differently from their peers. These individuals are more likely to feel that the economic responsibility for damage due to error falls directly on the auditor. In other words they are likely to see less possibility for economic risk sharing with parties such as the client corporation or its stockholders. These auditors may feel for example that the legal recourse against the auditor is likely to follow losses by such parties.

Some auditors may choose functions which are asymptotic with respect to loss. Others may choose more exponentially shaped, ever increasing loss functions. It is hypothesized that auditors choosing exponentially shaped loss functions will be less concerned with certain factors. These factors include 1) the impact of error on financial analysts and 2) losses suffered by stockholders. These same auditors may be more concerned about 1) personal liability, 2) sanctions such as suspension from practice or 3) monetary losses to the accounting firm.

It is also hypothesized that different concepts of audit responsibility will lead to use of different levels of measurement in the assessment of loss. The foundations for such beliefs are as follows. The assessment of cardinal values for loss requires a ratio scaling. Such scaling is easily obtained in terms of dollar values. If the monetary concerns of the firm are of great significance to the auditor then ratio scaling will be more easily accomplished. It is believed therefore that those assigning dollar value measures to loss (rather than some ordinal measurement) will attach less importance to some second and third party factors. For instance these auditors may be significantly less concerned about the client's losses or the impact of error on financial analysts. These same auditors may be more concerned about first party factors such as the firm's direct monetary losses or the loss of other clients because of bad publicity.

The third major research hypothesis involves the assumptions of current materiality measurement practices. As discussed in Chapter II there are untested assumptions which implicitly characterize current measurement practices. These assumptions regarding the impact of error may be inappropriate for audit decision-making under conditions of uncertainty. This is true even though the criterion for such measurement, income effect, may be inappropriate. Included among the particular assumptions to be examined in conjunction with this major research hypothesis are 1) whether there is a perceived linearity in the relationship between the negative utility to the auditor associated with an error in audited statements and the amount of such an error; 2) whether a dichotomization with respect to the impact of such error is sufficient to describe the relationship between the amount of error and its impact; 3) whether there is a symmetry between the impact on the auditor of errors involving overstatements and those involving understatements and 4) whether there is a symmetry between threshold amounts of error for over-and understatements. It is hypothesized that none of these assumptions will gain wide support. A statistical hypothesis test is associated with the last of these assumptions.

One other major research question will be explored. The discussion in Chapter II and the model developed in Chapter IV hold several implications regarding the relative importance of some items included in this study. The question then is whether these implications are refuted by the findings of this investigation.

Specifically, if, as Chapter II indicates, income effect is an appropriate criterion for judging the severity of error, then it should be highly ranked. By the same token non-income effects should be relatively less important. The model suggests that internal control review which is required by professional standards should hold a dominant position in the auditor's decision process. It was noted, as well, in Chapter II that adherence to professional standards can be a defense against liability for many of the adverse consequences of error. It can therefore be anticipated that greater weight will also be given to the item dealing with failure to comply with a professional standard.

The model in Chapter IV suggests that some cardinal measure of loss such as dollar value equivalence would be an appropriate way to assess audit responsibility. If this is so then non-monetary items such as bad publicity, professional pride, and public reaction against the client should be ranked relatively low.

There are several other factors involved in the ranking procedure described below. It is anticipated that these items will belong to the "middle ground." That is, none of these factors is expected to receive an extreme ranking.

These then are the hypotheses which will be examined. This set of hypotheses is pertinent for purposes of this research effort. They do not exhaust the potential of the data and additional insights might be generated by additional treatments of the data.

V.2 A Description of Data Collection Procedures

Information was gathered through a series of structured interviews. Initially, in each interview, demographic information was collected which characterized the individual respondent. Subsequently three basic techniques were employed in each interview. Details of materials and questions utilized during the interviews are available in Appendix III.

V.2.1 The Q-Sort

The first major research hypothesis suggested that a rating method needed to be used which would allow the ordering of several factors along a somewhat complex dimension. Basically, the method needed to provide a consensus rank ordering based on the responses of a set of professional accountants. The problem of defining audit responsibility is however a complex one involving a number of different constructs. An allowance for a sense of personal uncertainty about the exact rank order of each item was therefore a factor to be considered.

The particular method chosen for the task, as described here, was the Q-sort method.* The twenty items shown in Exhibit 5.1 were sorted by each professional accountant who

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*The Q-sort grew out of a general methodology developed for the study of verbalized attitudes, self-description, preferences and other issues. A salient principle in the methodology is that it is more important to compare within persons than between them. In other words the method relies on comparative ratings, not on absolutes. The Q-sort has been widely used to study issues ranging from psychotherapy to advertising (See Wittenborn, J.R., 1961).

participated directly in the study. These items represent the salient constructs associated with the various perspectives of audit responsibility mentioned earlier. These items are representative of the legal, technical, professional, personal and environmental influences on the auditor. Each of these influences adds substance to the auditor's perception of his responsibility. Each of the potential consequences of error included in the Q-sort is representative of one or more of these influences. Taken as a whole the items should adequately represent the salient features of each of these influences. In other words these items are meant to allow a rather complete specification of the auditor's perspective of his responsibility. The process which led to the selection of twenty items is discussed in the section on validity.

Each item was presented on a three-by-five card separate from the other nineteen items. Rather than rate each item separately, as would be required by an absolute ranking method, the auditor was asked to express comparative preferences by "sorting" the items into five piles. The end piles were for the most important and least important item, respectively. A fixed approximately normal distribution

Loss suffered by client corporation's officers as a result of the error.

Censure of firm by other professional accountants.

Effect of the error on stated income figure.

Resultant unfavorable publicity about the profession.

Resultant losses suffered by client corporation.

Loss of future engagements with other clients.

Impact of error on financial analysts.

Losses suffered by creditors of client corporation.

Degree to which audit complied with professional standards.

Degree of financial stability (solvency, liquidity) demonstrated by client's statements.

Resultant public outcry against the client.

Injury to professional pride.

Suspension of license to practice.

Effect of the error on non-income items.

Loss suffered by client's current stockholders as a result of the error.

Personal liability.

Loss of future engagements with the client.

Loss suffered by client's potential (future) stockholders as a result of the error.

Unfavorable publicity about the firm.

Monetary losses to the firm resulting from court settlements or judgments.

Exhibit 5.1.--The Twenty Consequences in Random Order

for the number of items in each pile was determined as follows.

To fit a normal distribution to the sort of twenty items it was necessary to divide the items into groups or clusters of unequal size. Because the interval between -3σ and $+3\sigma$ contains virtually all (99.7 per cent) of the items in the distribution, this range can be used as a basis for determining the number of items to place in each of five classes in order to produce an approximately normal distribution of sorted items. If the range $\pm 3\sigma$ is divided by the number of classes, five, then each class is allotted 1.20σ. With the aid of a table of cumulative normal probabilities the number of items in each class was determined as shown by Table 5.1.

TABLE 5.1

NORMAL DISTRIBUTION OF Q-SORT ITEMS

Group	σ Range	Percent of Items in Range	Number of Items
I	-3.0σ to -1.8σ	3.5%	.7
II	-1.8σ to -0.6σ	23.8	4.76
III	-0.6σ to $+0.6\sigma$	45.1	9.02
IV	$+0.6\sigma$ to $+1.8\sigma$	23.8	4.76
V	$+1.8\sigma$ to $+3.0\sigma$	3.5	.7

The integer fit used to approximate this distribution of twenty items, required sorting into classes or piles of size 1, 5, 8, 5 and 1, respectively. The result is a fixed distribution somewhat flatter than the normal distribution. Such a distribution (slightly flatter than the normal) has been found desirable in previous studies.[2]

There is some overlap for hypothesis testing purposes, regarding the data generated by the different techniques employed. However, the data collection interviews were conducted so that the Q-sort of items bearing on the structure of a general concept of audit responsibility was completed first. Then data collection moved on the matters directly concerned with the measurement of loss (the amount of audit responsibility) which accompanies varying amounts of error in certified financial presentations.

V.2.2 Loss Assessment

The major technique utilized to explore the measurement issues required the respondent to peruse a set of information containing some particulars regarding internal control and a set of financial statements (income statement and balance sheet) for a hypothetical client called Flexico. The data or responses given in this portion of the interview were all based on the respondent's opinions regarding the potential consequences to the auditor as a result of an error in the client's (Flexico's) receivables balance. The respondent was asked to consider a situation in which error (if any) would be discovered subsequent to the completion of the Flexico engagement and after the issuance of financial statements bearing the auditor's opinion.

This technique ascertained the respondent's beliefs concerning the relationship between the amount of error and the expected loss (negative terminal value) suffered by the respondent and his firm in their capacity as professional accountants to Flexico. The respondent was directed to consider for comparison two types of situations, in one situation no error is discovered after the issuance of Flexico's financial statements. In the other error is discovered subsequent to the completion of the engagement and issuance of financial statements.

Each situation consisted of either three or four conditions. The three or four conditions in each situation occur simultaneously and taken as a whole represent a single situation.

The situation involving no error was presented on a card labeled as the Standard Audit Situation. This situation involved the simultaneous occurrence of four conditions which were presented to each respondent as,

Condition 1: You completed a satisfactory review of Flexico's internal control system and completed all such tests, confirmations, etc. which you considered necessary in order to properly support a decision regarding the fairness of Flexico's financial statement presentations.

Condition 2: You have rendered an unqualified opinion on the financial statements of Flexico.

Condition 3: The true balance of Accounts Receivable is $3,840,000 as reported.

Condition 4: There is no challenge to your opinion; it is accepted as proper by all concerned parties.

Certain respondents objected to the word "true" in Condition 3; when this was the case, the word "proper" was suggested in its place. Perhaps this indicates a concern about alternative but acceptable treatments leading to different accounting results.

Each respondent was then asked to review a second situation labeled A consisting of three simultaneous conditions.

Condition 1: You completed a satisfactory review of Flexico's internal control system and completed all such tests, confirmations, etc. which you considered necessary in order to properly support a decision regarding the fairness of Flexico's financial statement presentations.

Condition 2: You rendered an unqualified opinion on the financial statements of Flexico.

Condition 3: The true balance of Accounts Receivable is $__________.

The basic idea of all that followed concerning the Flexico case was to ascertain and measure to the extent possible, the relative preference of the respondent for the Standard Outcome (Condition 4 in the Standard Audit Situation) as opposed to outcomes in which subsequent error was discovered.*

Initially, the respondent was asked to compare the Standard Audit Situation and a situation involving a

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*The investigation did not deal with the probability of such an error <u>not</u> being discovered. The loss function presented in the previous chapter therefore has the following theoretical relation with the loss function, L', discussed here:

$$L(\varepsilon_i, d_2) = L'(\varepsilon_1, d_2 | \ Pr(\text{discovery}) = 1).Pr(\text{subsequent discovery})$$

(The density function for subsequent discovery would incidentally be a fruitful ground for additional research. It is possible for example that discovery is also a function of the amount of error.

5 percent overstatement of net income before tax and extraordinary items, arising from an error in receivables presentation. This process was repeated using a 10 percent error, and then a three-way comparison of zero, five and ten percent error was considered. All this was done with the aid of diagrams or histograms displaying the concept of differing amounts of relative preference for various outcomes. Reference may be made to Diagrams 1 and 2 in Appendix III.

Next the respondent was asked to consider continuous changes in an ever-increasing amount of income overstatement accompanied by a corresponding error in receivables. The respondent was offered a set of six monotonically increasing functional forms. The respondent selected that form which best expressed his perception of the relation between expected loss (dispreference) and amount of overstatement. The functional forms presented in unscaled graphical form were as shown in Appendix III: (1) a dichotomous step function, (2) a linear function, (3) a linear function with maximum and minimum bounds, (4) a logistics curve, (5) a modified exponential, and (6) an exponential curve. In addition to these six functional forms, the respondent had the option of drawing some other function.

The functional form chosen was discussed in an attempt to scale either or both axes and to determine specific characteristics of the function chosen in light of the environment represented by the Flexico case. These procedures were repeated for the case of understatement of income caused by an error in receivables. This was done in order to ascertain the respondent's perceptions concerning the effects on loss of varying the amount of understatement.

V.2.3 Exploration of Additional Issues

The final portion of the interview was devoted to a discussion with the respondent of two broad concerns. The first of these concerns was centered on two questions: (1) whether criteria other than percentage effect on income might be appropriate for assessing the impact of error and (2) if there are such other criteria how important are they and when might they be called into play. The second concern was the degree to which the auditor as a decision-maker approaches the planning of the engagement as a process requiring a series of independent judgments or conclusions about the various elements or balances presented by the client's financial statements. In conjunction with this issue the significance of compounding or off-setting cumulative errors was also discussed.

V.3 Sample Characteristics

Twenty-four professional accountants were interviewed during the data collection phase of this research. Each respondent was either a partner or was working at the management level just below the rank of partner, as shown by Table 5.2. All were Certified Public Accountants, and all were functioning primarily within the audit staff of the firm. Each of the respondents worked in the Chicago office of one of three national auditing firms which agreed to participate in the research effort. The participants from one of these firms were selected by a random drawing from all management level and partner level personnel assigned to the audit staff in the Chicago office. In the other two firms the sample was selected from the same class of personnel but selection was on the basis of availability.

Each of the firms agreed to allow between one-third and one-half of those eligible to be interviewed. Eligibility was determined according to the criteria established

TABLE 5.2

CLASSIFICATION OF RESPONDENTS BY FIRM

Positions	Firm A	Firm B	Firm C	Total
Partners	3	3	2	8
Management Personnel	4	3	9	16
Total	7	6	11	24

above. As a result, a total of twenty-four interviews were conducted. The total number of eligible persons on the staff of Firm C was larger than the number from Firms A or B. The largest number of respondents were therefore chosen from Firm C. From one firm respondents were selected on an equiprobable basis without regard to their status as a partner or manager. Another firm chose arbitrarily the number of partners to be included. The remaining firm agreed to provide a proportionally representative number of partners and management level personnel.

It was decided that all required information from any respondent should be gathered in approximately one hour. This was done because of the number of respondents surveyed and the limited amount of time each respondent was likely to have available.

V.4 Findings

The findings of this empirical study are presented under three headings. First, findings concerning descriptive statistics are presented which in one sense or another summarize the data. Secondly, a set of inferential statistical tests run on the data are reported. Finally, an analysis or synthesis of some of the information not subjected to statistical analysis is presented. A matrix of basic data is included here as Appendix IV.

V.4.1 Descriptive Statistics

The consensus ordering of the items from the Q-sort is given in Table 5.3. This combined or composite judgment gives equal weight to the responses of each of the twenty-four subjects. The ranks presented are based on the rank order of the means of the twenty-four individual ranks assigned to each item.

This procedure for forming consensual judgment from rank ordered data sets is a simple and conventional one.[3] It results in consensus orderings which are almost invariably quite equivalent to orderings derived from a host of more complicated schemes.[4]

The item dealing with compliance with professional standards is listed as the most important of the twenty items. The mean value of the ranks assigned to this item was 1.96. The value assigned an item by any particular auditor was determined according to the pile in which he placed that item. The item placed in the most important pile was assigned a value or score of one. The five items in the next pile were assigned value two and so on so that the one item deemed least important was scored five. Both the items dealing with the loss of future engagements with the client and damage to professional pride had mean scores of 3.58. The variances associated with the rankings of items ranged from .276 for the item dealing with current stockholders loss to 1.359 for suspension of license to practice. The absolute frequencies associated with the variance of these two items and the item deemed most important based on consensus appear in Table 5.4.

With respect to the functional forms illustrated in Figure 5.1, the frequencies of choice were as shown by Table 5.5.

Of the twenty-four accountants interviewed, six (25 percent) indicated that the loss function for negative error (understatement) was symmetrical in all respects to the loss function associated with overstatements. These six and six others, a total of 12 persons (50 percent) indicated that the thresholds for expected loss were the same for over- or understatement. The mean dollar value of the overstatement threshold was $62,042. This indicates

TABLE 5.3

CONSENSUS RANKINGS

Group Rank	Individual Rank	Identification Number	Item	Mean Score
1	1	1	Degree to which audit complied with professional standards.	1.96
	2	2	Effect of the error on stated income figure.	2.04
	3	3	Loss suffered by client's current stockholders as a result of the error.	2.12
2	4	4	Losses suffered by creditors of client corporation.	2.46
	5	5	Degree of financial stability (solvency, liquidity) demonstrated by client's statements.	2.71
	6	6	Resultant losses suffered by client corporation.	2.75
	7	7	Monetary losses to the firm resulting from court settlements or judgments.	2.79
	8	8	Loss suffered by client's potential (future) stockholders as a result of the error.	2.96
3	(9)	9	Personal liability.	3.08
	(9)	10	Unfavorable publicity about the firm.	3.08

TABLE 5.3--Continued

Group Rank	Individual Rank	Identification Number	Item	Mean Score
	11	11	Suspension of license to practice.	3.12
	(12)	12	Impact of error on financial analysis.	3.17
	(12)	13	Loss suffered by client corporation's officers as a result of the error.	3.17
	14	14	Resultant public outcry against the client.	3.38
	15	15	Censure of firm by other professional accountants.	3.46
4	(16)	16	Loss of future engagements with other clients.	3.50
	(16)	17	Effect of the error on non-income items.	3.50
	(16)	18	Resultant unfavorable publicity about the profession.	3.50
5	(19)	19	Loss of future engagements with the client.	3.58
	(19)	20	Injury to professional pride.	3.58

TABLE 5.4

THE DISTRIBUTION OF SELECTED ITEMS

Score	Frequency of Score Values for: Current Stockholders' Loss $\sigma^2 = .276$	Compliance with Standard $\sigma^2 = .873$	Suspension from Practice $\sigma^2 = 1.359$	Hypothetical Randomly Placed Item $\sigma^2 = .833$
1	2	9	2	1
2	17	9	6	6
3	5	4	6	10
4	0	2	7	6
5	0	0	3	1

TABLE 5.5

FUNCTIONAL FORM SELECTIONS

	Expected Loss due to Overstatement		Understatement		Total	
Linear	2	8.3%	1	4.2%	3	6.3%
Step	1	4.2	2	8.3	3	6.3
Bounded Linear	1	4.2	0	0	1	2.1
Logistic	6	25.0	7	29.2	13	27.1
Modified Exponential	3	12.5	4	16.7	7	14.6
Exponential	6	25.0	6	25.0	12	25.0
Other	5	20.7	4	16.7	9	18.6
Total	24	100.0%	24	100.0%	48	100.0%

that on the average the respondents believed that if their firm were auditor for Flexico the auditor would first encounter adverse consequences as the amount of subsequently discovered income effective error reached $62,042. This is about 5 percent of income before tax and extraordinary gain. The mean value for the understatement threshold was $105,708.

V.4.2 Statistical Tests

The scores given to each of the Q-sort items by each respondent were correlated with the responses of each of the other respondents using Kendall's Correlation Coefficient in order to examine the agreement among the auditors as to the relative rank order placement of the twenty items. Of the 276 such correlations,

4 showed negative correlations which are significant at the .05 level or less;

6 showed negative correlations significant at levels between .05 and .10;

121 showed positive correlations significant at the .05 level or less; and

34 showed positive correlations significant at levels between .05 and .10.*

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*This correlation procedure, rather than the Pearson or Spearman procedure, was used because the data being considered was ordinal and contained many tied ranks.

Because the first major research hypothesis suggests that a consensus will exist, positive correlations are expected. A one-tailed significance test was therefore used because of the explicit expectation of positive correlation.

In conjunction with the same consensus hypothesis, a test of group concordance was run. The single statistic produced by this test is called the Kendall Coefficient of Concordance. This statistic, W, gives a measure of agreement between the twenty-four independently ranked sets of twenty consequences. Designed for use with such rank ordered data as was produced by this investigation, the value of W has a maximum value of one. Such a result would indicate perfect agreement among all the twenty-four sets of rankings.[5] The value of W obtained was .386. This result indicates a significant consensus at the .01 level.

A series of statistical hypotheses were tested in order to examine, for various partitionings of the sample of twenty-four persons, whether there was disagreement among groups as constituted according to a given partitioning. The twenty-four respondents were first grouped into subsets (partitions) according to a criterion (i.e., according to whether they were from Firm A or B or C). After the subsets had been defined, a series of twenty tests were run comparing the subsets on each of the twenty Q-sort items.

For example, the operational hypothesis that the three groups of scores given by Firms, A, B, and C to the item "Degree to which audit complied with professional standards," represent samples from the same population or from identical populations was tested by applying the Kruskal-Wallis one-way analysis of variance procedure. This was designed for use with ordinally ranked data. The assumptions underlying this test are that the observations of any one sample (the set of responses to one item given by those employed by one firm) are independent of the observations of other samples, that all observations within a given sample are from the same population, and that the samples are of approximately the same form.[6] This test was also chosen because unlike the usual F and χ^2 tests for variance analysis this test does not assume normality.[7] The test determines whether different samples should be regarded as coming from the same population. The question answered by this test is whether any difference among the sets of scores from different groups is significant or due merely to chance variations. For the instance cited, the resultant statistic, called an H statistic, was equal to 2.528 (corrected for tied ranks). The H statistic is approximately chi-square (χ^2) distributed and has two degrees of freedom since three samples are involved. The hypothesis that the three groups of scores differ only because of chance variation was used as the null statistical hypothesis. The probability of $H \geq 2.528$ is greater than 25 percent under the null hypothesis. Therefore the null hypothesis cannot be rejected at significance levels of 1, 5, or 10 percent. The implication then is that there is no significant difference between firms regarding the relative importance of professional standards. In this particular case the null hypothesis could not have been rejected even at much higher (less certain) levels. This is so because of the difference between the H value at the 10 percent significance level, 4.61, and the H value of 2.528 actually obtained. A summary of statistical procedures appears in Appendix V.

This same statistical procedure was used to test the other other nineteen items. The results are shown in Table 5.6.

For each of the Q-sort items the hypothesis that there was agreement between the group of scores given by partners

TABLE 5.6

RESULTS OF K-W TESTS OF Q-SORT SCORES

PARTITIONED BY FIRM

Item Identification Number	Value of H Statistic	Remarks*
1	2.528	
2	4.234	
3	.360	
4	3.184	
5	1.159	
6	.261	
7	.294	
8	.311	
9	1.461	
10	1.325	
11	2.880	
12	.489	
13	2.686	
14	2.099	
15	.053	
16	.261	
17	3.442	
18	.802	
19	.561	
20	4.108	

Number of groups = (Firm A, 7; Firm B, 6; Firm C, 11)

*None of these items show significant difference among the groups at .10 level or better ($H \geq 4.61$).

for that item and the group of scores given by managers for that item was tested. The results of the Wilcoxon-Mann-Whitney W-M-W) test used to compare these two samples are shown in Table 5.7. The U statistic is produced by this test. The K-W test is used where the number of partitions is greater than two and the W-M-W test is used when there are two partitions. The objective and assumptions of the W-M-W test are the same as those of the K-W test discussed above. The K-W test extends the W-M-W procedures to accommodate more than two samples.[8]

The K-W test was used to examine the hypotheses that the ranks assigned each Q-sort item by those who selected different functional forms were in agreement. The particular classifications used to partition the respondents and the results of these tests according to functional protrayal of the impact of over- and understatement are given by Tables 5.8 and 5.9, respectively, Both of these sets of tests were run in order to provide information for analysis of portions of the second major research hypothesis. That hypothesis, it may be recalled, concerns the relationship between basic perception of the concept of audit responsibility and the operational assessment of loss. Other aspects

TABLE 5.7

RESULTS OF W-M-W TESTS OF Q-SORT SCORES

PARTITIONED BY POSITION IN FIRM

Item Identification Number	Value of U Statistic	Remarks
1	40.0	
2	62.0	
3	46.0	
4	53.0	
5	61.5	
6	65.0	
7	65.5	
8	66.5	
9	62.5	
10	54.0	
11	48.5	
12	64.0	
13	55.0	
14	59.5	
15	60.0	
16	53.0	
17	27.5	Significant difference at .02 level
18	44.0	
19	65.0	
20	40.0	

Number of partitions = 2 (Partners 9, Management level 15)

TABLE 5.8

RESULTS OF K-W TESTS OF Q-SORT SCORES PARTITIONED BY FUNCTIONAL FORM CHOSEN FOR IMPACT OF OVERSTATEMENTS

Item Identification Number	Value of H Statistic	Remarks
1	7.280	Significant difference at .10 level
2	1.876	
3	2.142	
4	1.874	
5	2.121	
6	.215	
7	.758	
8	1.776	
9	4.381	
10	.206	
11	4.085	
12	4.167	
13	.825	
14	1.194	
15	3.748	
16	5.762	
17	5.063	
18	.783	
19	2.409	
20	1.889	

Number of partitions = 4 (logistic 6, Mod. exponential 3, Exponential 6, Other 9)

TABLE 5.9

RESULTS OF K-W TESTS OF Q-SORT SCORES PARTITIONED BY FUNCTIONAL FORM CHOSEN FOR IMPACT OF UNDERSTATEMENTS

Item Identification Number	Value of H Statistic	Remarks
1	2.930	
2	.811	
3	1.558	
4	3.449	
5	5.515	
6	4.442	
7	3.956	
8	1.429	
9	12.897	Significant difference at .005 level
10	4.284	
11	7.357	Significant difference at .10 level
12	6.446	Significant difference at .10 level
13	2.662	
14	7.490	Significant difference at .10 level
15	6.822	Significant difference at .10 level
16	1.224	
17	10.117	Significant difference at .01 level
18	1.507	
19	4.948	
20	2.500	

Number of partitions = 4 (Logistic 7, Mod, exponential 4, Exponential 6, Other 7) of this same hypothesis are also associated with the next two sets of tests as discussed below.

The W-M-W test was used to examine agreements in Q-sort ranks between those who believed that the impacts of over- and understatements were symmetric in all respects and those who did not hold that such an equivalence would be appropriate. The results are given in Table 5.10.

Some of the respondents were willing to assign dollar value equivalents to the impact of subsequently discovered errors of various amounts. Others were willing to give comparisons of the relative impact of equivalent amounts of over- and understatements but not willing to attach dollar value equivalences to the measure of such impacts. Remaining members of the group of twenty-four respondents did not invoke either type of measure in assessing the impact of error. Those in this last group gave ordinal comparisons within the over- and understatement ranges. They were not however willing to assess ordinal comparisons between the impacts of error in the two ranges. The scores given for each Q-sort item were partitioned accordingly and the results of a K-W test of each item appear in Table 5.11.

TABLE 5.10

RESULTS OF W-M-W TESTS OF Q-SORT SCORES PARTITIONED BY SYMMETRY

Item Identification Number	Value of U Statistic	Remarks
1	53.00	
2	44.00	
3	41.00	
4	41.00	
5	47.00	
6	42.00	
7	41.50	
8	49.00	
9	37.50	
10	36.00	
11	29.00	
12	39.00	
13	52.50	
14	31.50	
15	51.00	
16	45.00	
17	26.00	Significant difference at .10 level
18	38.50	
19	41.00	
20	52.00	

Number of partitions = 2 (Symmetry in effects of over- and understatement 6, Lack of symmetry 8)

TABLE 5.11

RESULTS OF K-W TESTS OF Q-SORT SCORES
PARTITIONED BY TYPE OF MEASURE USED

Item Identification Number	Value of H Statistic	Remarks
1	1.952	
2	.572	
3	1.547	
4	2.116	
5	6.024	Significant difference at .05 level
6	5.242	Significant difference at .10 level
7	.153	
8	1.706	
9	1.428	
10	4.664	Significant difference at .10 level
11	.894	
12	.893	
13	5.108	Significant difference at .10 level
14	1.537	
15	.263	
16	1.121	
17	1.125	
18	1.870	
19	1.625	
20	2.203	

Number of partitions = 3 (Dollar measure 7, Relative measure <u>between</u> ranges 11, Relative measure <u>within</u> ranges 6)

The difference between the impact thresholds reported for overstatement and understatement were tested through use of the W-M-W, U statistic. The value obtained was 341.5 which indicates a significant difference in the magnitude of these thresholds at the .12 level. This result is not significant however at levels less than or equal to .10. A Student's-t test was used to test the hypothesis that the differences between the over- and understatement thresholds as reported by each respondent could have come from a population in which the magnitude of both thresholds is equal. The value of the t statistic with 23 degrees of freedom is 1.95 which indicates a significant difference at the .05 level where the alternative hypothesis is that the threshold for understatement is higher than the threshold for overstatement.

V.4.3 Additional Findings

Each respondent was given the opportunity to mention other factors which might generally be considered as contributing to the assessment of consequences. The only factor mentioned more than once was the impact of error on the opportunity for promotion. This of course was not mentioned by any of the partners.

Analysis of the discussions which took place at the end of each interview indicated that income effects are the most prominent criterion used by these accountants to gauge the severity of error. A few respondents mentioned income trends as an equally important criterion. Secondary criteria for use in making such judgments included the effect of error on owners' equity. This was usually mentioned as coming into play when the income criterion would be inadequate because of near zero or erratic earnings behavior. The effect of an error which would place the client in default on required minimum working capital or cash balances was frequently mentioned as an important secondary criterion for specific asset balances. In particular this was deemed important if collateral or indenture agreements contained provisions specifying that such requirements be met in order to avoid default.

These discussions indicated that the discovery of isolated error during examination of any particular application usually has a slight or no effect on the audit review of other applications. Most of the respondents indicated that errors which are serious in amount must be corrected even if offset by an error(s) whose effect on income is the reverse. Consensus among these respondents also indicated that several small errors whose cumulative effect is serious usually require some type of adjustment in some or all of the accounts involved.

V.5 Discussion of Findings

This section presents conclusions or inferences about the major empirical research hypothesis and other comments on the exploratory findings. These conclusions are based on an analysis of the findings just reported. In addition, whenever it seems appropriate, comments concerning the validity of the decision model presented in the previous chapter are included as part of the discussion.

V.5.1 Initial Comments on the Consensus Rank Ordering

Several comments seem tenable based on examination of the the consensus rank ordering. Since professional standards require an initial review of internal control and the Q-sort item dealing with professional standards is ranked as most important the validity of placing such a review in a commanding position in the audit decision-making model described in the previous chapter seems to be supported. Perhaps because their dollar value impact on the auditor is small other professional items were ranked low (i.e., those ranked 15, 18 and 20).

It is also noteworthy that the lows of future engagements and revenues from the client if the auditor subsequently loses the company as a client is regarded as relatively unimportant. This was not anticipated by the hypotheses regarding the consensus ordering. Perhaps this indicates a desire to avoid client relationships where "trouble" might be present or perhaps a desire to avoid affiliation with firms which are as one respondent put it "playing games" or "squirreling away income" for doctoring up lean years. This may also indicate that the subsequent loss or risk of loss associated with a client which has once made such an error is higher than the present utility of the income which the client would provide the auditor in the future.

Examination of the items ranked two to five shows that generally the auditor is concerned with relating his loss or responsibility to the financial losses which are suffered by those with equity interests in the client firm and whose interests are affected by volatility of the price-earnings ratio of the client. From a different perspective it seems that the auditor is most concerned with shielding himself from the impact of error by(1) complying with professional standards in order to rely on due care as a defense and (2) minimizing tangible losses to those parties most likely to seek and obtain redress from the auditor. The latter is a feat most easily obtained by taking care to avoid income effective error and by being fortunate enough to have a client whose financial condition is solid and capable of weathering the effect of subsequent error disclosure without drastic market effects.

The situation is perhaps viewed as though the occurrence of such effects is almost a precondition for many of the items which appear subsequently in the consensus rank ordering. These latter items include court settlements, personal liability, suspension from practice, and loss of other clients.

V.5.2 The "Measurement Assumptions" Hypothesis

The responses to the question concerning (1) the criteria used in assessing the impact on the auditor of subsequently discovered error, (2) the high placement of the income effect item in the consensus ranking (it was second) and (3) the much lower rank of the item dealing with non-income effects (it was ranked seventeenth) support that portion of the third hypothesis which holds in part that income effects are the predominant criterion for use in measuring or assessing the impact of error. During the discussion a typical response was that "income effects are ten times as important as non-income effects."

The items in the second group of the consensus rank ordering (Items No. 2-5) are related more to technical features of the market or environment of the client. The importance attached to these items may be evidence in support of a finding that the scalings of the income effect of an error and loss are situation specific. Furthermore, this may indicate that the thresholds of percentage effect on income with regard to the impact of such error may vary according to the environment confronting any particular client. In short, the relative impact of an error is probably not a constant function of income from one situation to the next.

In 41 percent of the cases either the logistic function or the modified exponential was chosen by the auditors interviewed as the functional form most representative of the relationship between loss and size of income effective error. These functions as can be seen in Figure 5.1 have much in common. Both are asymptotic with respect to loss and both after a point show ever-decreasing positive increments in loss or negative utility as the size of the error increases. In other words, with respect to over- and understatement taken separately, after a point--for all points in the case of the modified exponential function-- $\frac{d^2L(\varepsilon)}{d}$ is negative and both are continuous and $\frac{dL(\varepsilon)}{d}$ exists at all points greater than the threshold values. This implied limit on loss may be associated with the point at which bankruptcy would be declared.

Furthermore, the significant differences were obtained for the minimum amount of error required to produce a noticeable negative effect on the auditor with respect to over- versus understatement of income. This seems even more clearly to indicate that a single percentage cannot be relied upon to serve as a standard for determining whether an error is "material in amount." This could be so even for all cases of income effective error within the same engagement. This would be true even if the proper or correct balance were known with certainty. Perhaps this is an indication that the doctrine of conservatism is strong within professional accounting circles. It may, however, be waning since one-half of those who were interviewed indicated that the threshold for negative effect was the same as the threshold for positive effect.

Unfortunately even this degree of perceived equality of thresholds may have the effect of partially obscuring the need to determine whether various assumptions about dichotomous effects are valid. Two cases in point are (1) the assumption of linearity of loss as a function of income effect and (2) the assumption that an error is going to have either no effect or a fixed negative effect if greater than a certain amount. In conjunction with the Flexico situation, for example, only 6.3 percent of the respondents chose the functional form embodying the linearity assumption. The functional form appropriate for the second assumption was also chosen by only 6.3 percent. As hypothesized therefore these assumptions may not always be valid for use in assessing the consequences of subsequently discovered error.

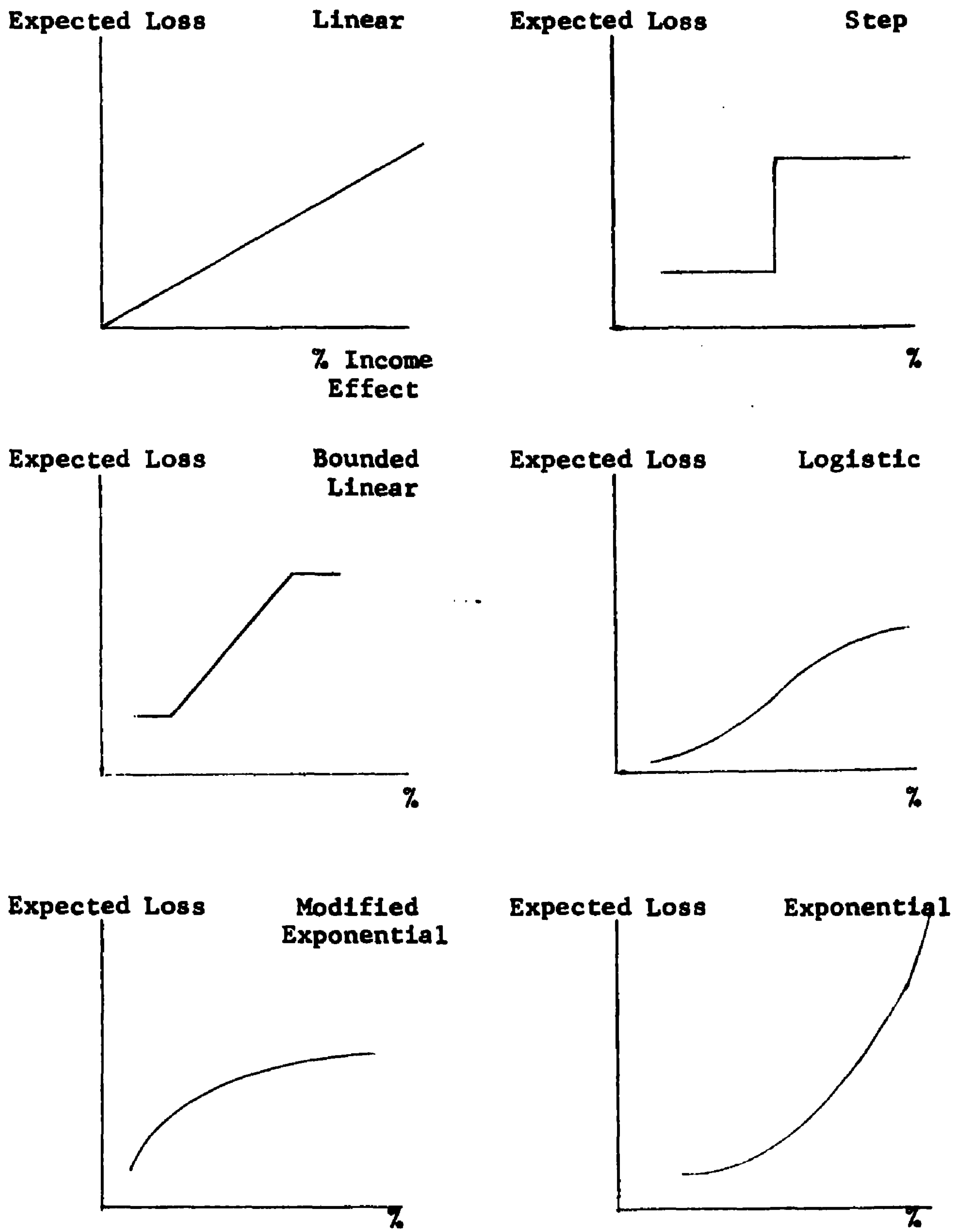

Fig. 5.1.--The functional forms presented to each respondent

To the extent that Flexico is representative of real firms, it seems as hypothesized that the symmetry of loss assumption will not always hold. This assumption, as may be recalled, would require a symmetry with respect to the losses incurred as a result of over- versus understatements. In this study only 25 percent of the accountants interviewed demonstrated concurrence with this assumption.

This may point to an interesting implication regarding the benefit derived from the usual classical statistical interval estimation procedure discussed in Chapter III. Recall that in Chapter IV ε was defined as the amount of error in a given balance. Recall also that B represents a possible value of the statement balance and that in particular B_T is the proper balance. Finally, recall that L(.) represents the value of a loss at a particular point. Without specifying a particular density for ε or a particular loss function over ε, simply assume that with reference to Figure 5.2 the auditor's sampling procedure had led to a 95 percent confidence interval, say $\overline{ab}$. Even if the loss in region $\overline{ab}$ is zero and the loss functions for positive and negative error are exactly symmetric except for thresholds so that any $L(|B^-|) = L(|B^+|-t)$ the auditor would be better off to rely on a somewhat longer 95 percent confidence interval which was shifted left from b.

The auditor who adopts such a strategy may then be viewed as acting as though he were relying implicitly upon the loss function L' as a surrogate for L shown in Figure 5.2 rather than the loss function, L', implicitly associated with the method of confidence interval determination spelled out in Chapter III. This effect becomes even more important if, as many respondents indicated, the loss functions for B are such that $L(|B^+|) > L(|B^-|-t)$. The basic recommendation arising from this is that even if adopting classical procedures the auditor should not automatically use a confidence range based on the sample mean ± a fixed amount if he wishes to relate the selection of a confidence interval to his judgment concerning what should be considered a "material" error.

The major research hypothesis concerning untested measurement assumptions coincides with the results just discussed and with the findings reported earlier. The hypothesis contends that certain assumptions characterizing current measurement practice may not be appropriate. The

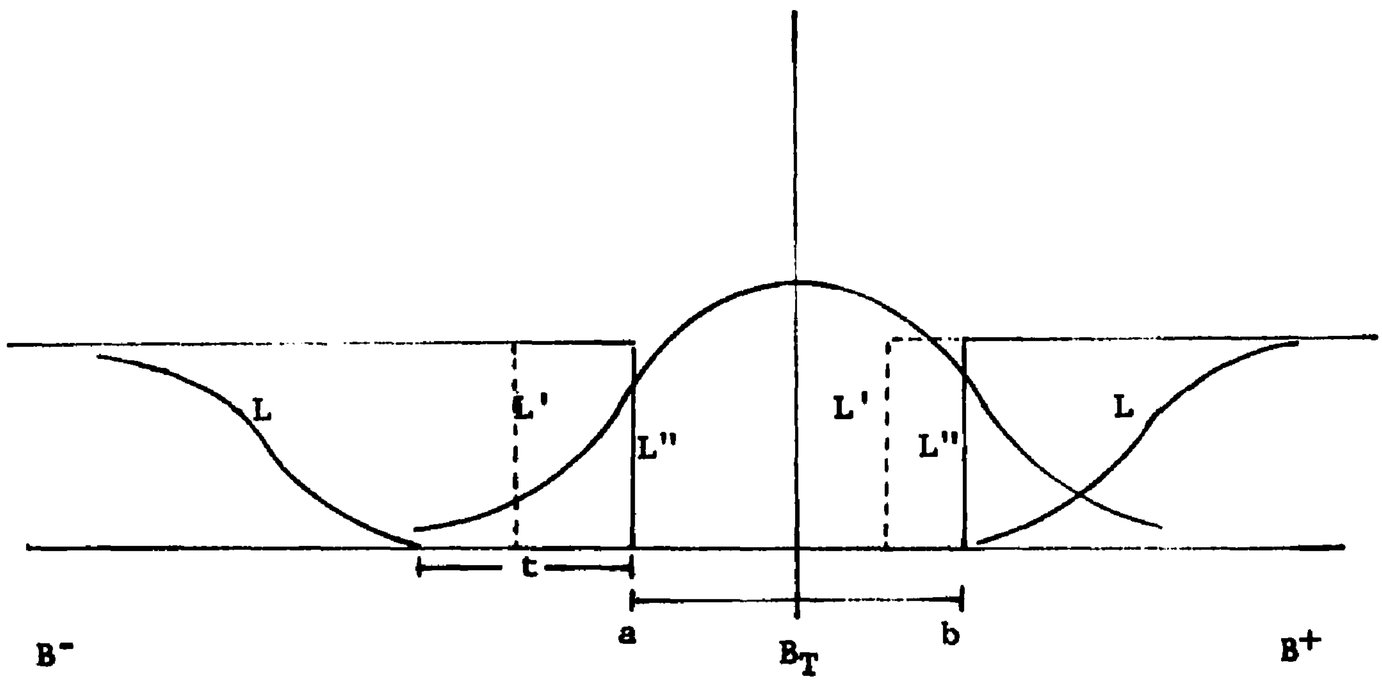

Fig. 5.2.--Confidence interval bias

hypothesis also contends that income effects are the major criterion for judging the impact of error.

V.5.3 The "Homogeneity in Rank Order" Hypothesis

As reported earlier, positive interpersonal correlation results were obtained. There was also an absence of extreme differences between the ranks of any of the Q items among the three firms, and a significant consensus was produced. These factors indicate that the consensus ordering or general perception of the concept of audit responsibility is fairly well established and shared in common among professional accountants, as was hypothesized. Those who have been exposed to a particular "treatment" namely partnership status do however seem to place more importance on professional pride than do the management level accountants. This is evidenced by the mean score on the item concerning professional pride being 2.9 for partners but only 3.8 for management level personnel. Perhaps this indicates that as members of the firm, partners feel more strongly that a part of themselves rides with the firm and that they have influenced or left their mark on the direction of the firm or profession and therefore feel a greater responsibility for professional and/or firm-wide policies in areas such as limitation of practice, ethics, procedural rulings, etc.

As the discussion of hypotheses in Section V.1 indicates, a somewhat greater heterogeneity was expected between personnel levels than was found regarding the relative ordering of these twenty items. The actual finding in this area may indicate that the homogeneity regarding the concept is even more persuasive than expected.

V.5.3 The "Effects of Rank Perception on Measurement" Hypothesis

Findings associated with the second major research hypothesis appear to only partially support the hypothesis that in general differing views of the concept of audit responsibility will be reflected in different perceptions regarding various elements of the utility structure associated with an operational measurement of the concept. Specific findings indicate that only the item concerned with professional standards differed greatly in placement between auditors according to whether they chose the exponential functional form for the expression of the relationship between the amount of overstatement and the impact of such error. The mean placement of this item among those who chose the exponential form was 2.8. For the other three groups classified as shown in Table 5.8, the means were all less than or equal to 2.0. Nine of the twenty-four respondents ranked this item as the most important, but none of these chose the exponential form with regard to overstatement. This may suggest an implication about those who see ever-increasing danger for the auditor as the result of ever-increasing amount of income overstatement. Respondents in this group did not perceive a danger level which "tails off" after such an error becomes relatively large. This may indicate that they do not feel as strongly that professional standards can be an effective defense in protecting the auditor from risk sharing with the public and the client in the event of such an error.

The difference in data sets between over- and understatement criteria tests is the result of the following pattern of shifts in functional form selections with respect to the impact of over- vs. understatements:

UNDERSTATEMENT

OVER STATEMENT	4	5	6	Other	Total
4	5	1			6
5		2		1	3
6		1	5		6
Other	2		1	6	9
	7	4	6	7	24

As a result of these shifts, the partitioning according to understatement functional form selections gives more solid support for the second major hypothesis since there are more extreme differences than was the case for overstatements. The six Q-sort items which showed the most difference according to this criterion were those dealing with personal liability (Item 9), suspension from practice (Item 11), impact of error on financial analysts (Item 12), public reaction against the client (Item 14), criticism of the auditor from within the profession (Item 15), and non-income effects (Item 17).

An examination of the mean scores in each of these cases will give insight into the possible causes of such differences.

Functional Form For Understatement	Number of Respondents	Mean Score on Item 9	11	12	14	15	17
Logistic	7	3.1	3.0	2.9	3.6	3.7	4.1
Modified Exponential	4	4.0	4.0	2.8	3.0	3.8	2.3
Exponential	6	2.0	2.2	4.0	3.8	2.7	3.8
Other	7	3.4	3.6	2.7	3.0	3.7	3.3

As these mean scores indicate, those choosing the exponential function with respect to understatement seem to have contributed most to four of these six instances of heterogeneity. This group produced the extreme score in a fifth item. In addition as previously observed the scores for the corresponding overstatement group seemed at odds with the scores of other groups with regard to the item regarding professional standards. Perhaps those who structured loss according to the exponential pattern may indeed differ from other auditors in their perception of the concept of audit responsibility.

Further exploration of these items suggests a basic underlying dimension for the cause of such difference. Those auditors who seem to feel more strongly about the potential for ruin as a result of error seem to attach more importance to personal concerns than do the other respondents.

This is demonstrated by the relative magnitude of the mean scores shown above for each of the six Q-sort items. Recalling that those items with lower scores are perceived to be more important, it can be seen that those choosing the exponential relationship for understatement attached more relative importance to both tangible and intangible personal concerns. These include items such as personal liability (Item No. 9), suspension from practice (No. 11), and censure or criticism of the firm by other professional accountants (No. 15)--all items of a rather internal or personal nature. By the same token, this group attached less importance on a negative basis to the more intangible externalities, such as the reaction of financial analysts or public reaction disfavorable to the client's image. No immediate explanation of the higher ranking given the effect of non-income errors by those four persons who chose the modified exponential is apparent.

This same item, non-income effect of an error, was the one item from the twenty Q-sort items that showed the most disagreement in ranking according to whether the property of symmetry with respect to the impact of over- and understatements was indicated by the respondents. Partitioning according to this criterion shows a mean score for the non-income effect item of 3.7 for those eighteen respondents who did not indicate agreement with the assumption of symmetry. A mean score of 2.8 was obtained for those six auditors who perceived a symmetry with respect to the impact associated with over- and understatements. Perhaps the following explains the lesser importance assigned to this item by those who distinguished between the impact of over- and understatement of income. These accountants may have been able to more sharply distinguish loss according to this one criterion (income effect) while those who expressed a symmetry may have done so because the definition of loss of impact of error was not as sharply defined by this single criterion. For this second group of individuals, loss may depend rather on some multi-dimensional structure for judging the impact or disutility of error. This could also indicate that those who were more conservative (asymmetry group) are more concerned with income bias.

The partitioning of the twenty-four auditors according to the strength of measure used in expressing the relationship between the size of income effective error and the impact of such error, as shown in Table 5.11, indicates relatively large differences among the rankings assigned by the three groups to four of the Q-sort items. These items (Numbers 5, 6, 10, 13, respectively) are indicative of the client's financial stability, losses suffered by the client, bad publicity about the auditing firm, and losses incurred by the client's officers. As shown by the following mean scores of each of the three groups on each of these items, those who willingly associated dollar value measurements with their perception of the behavior of loss with respect to income effective error gave substantial difference rankings to the first three of these four Q-sort items.

Measurement Level	Number of Respondents	Mean Score on Item 5	6	10	13
Ordinal comparison within over- and understatement ranges	6	2.2	2.3	3.3	3.7
Ordinal comparison between over- and understatement ranges	11	2.6	2.6	3.3	3.1
Dollar value certainty equivalents	7	3.3	3.3	2.6	2.9

One inference which can be made based on these results is that those who most sharply define the impact of error in these dollar terms rather than ordinal terms tend to attach less importance to the immediate environmental paramenters of the client. Such parameters are associated with items number 5 and 6. On the other hand, these persons apparently attach more importance to the confidence placed in the images of individual leaders within both organizations--the auditing firm, and to a lesser extent the client corporation.

V.6 Discussion of the Empirical Methodology

The concerns of this section are the validity and reliability of the results of this investigation. Validity is basically associated with the question, "What did this study measure?" Reliability addresses the question, "How well did the methods employed perform the measurement function?" The following passages elaborate on these points. First the following on validity from Selltiz, *et al.*,

> Certain basic questions must be asked about any measuring instruments: What does it measure? Are the data it provides relevant to the characteristic in which one is interested?
>
> The *validity* of a measuring instrument may be defined as the extent to which differences in scores on it reflect true differences among individuals, groups, or situations in the characteristic which it seeks to measure.[9]

Second, regarding reliability from the same source.

> Scores on measuring instruments usually reflect not only the characteristic which the instrument is attempting to measure, but a variety of constant and random errors. The evaluation of the reliability of any measurement procedure consists in determining how much of the variation in scores among individuals is due to inconsistencies in measurement. When independent but comparable measures of the same thing are obtained, they will yield the same results to the extent that the measurements are free from random or variable errors.[10]

V.6.1 Validity

In examining the validity of the research method both internal and external validity will be reviewed. Internal validity deals with whether the experimental treatments made a difference in this experimental instance. External validity examines the generalizability of the observed results.[11] Where response sets are referred to, interest is in mental attitudes, biases, or predispositions on the part of the individual respondents which would cause differences in otherwise identical measurements among individuals.

V.6.1.1 Internal Validity and Response Sets

Precautions were taken to bolster the validity of the interview by guarding against general treatment effects.

Use of the Q-sort technique and administrative instructions helped insure uniformity among the effect of the treatment received by each respondent. Another strength in this research procedure was the fact that a single investigator conducted all the interviews.

In order to reduce reactive effects, the role of the investigator was held to a minimum earlier in the interview by placing the more interactive segments of the interview near the end. The Q-sort was therefore administered first. By placing the Q-sort first in the arrangement of the interview the respondents were not conditioned by exposure to the specific situation involving the Flexico case. They were not therefore predisposed to sort the cards on the basis of a particular situation which would have been shared in common among all (and only) the respondent immediately before performing the defining Q-sort. This was also done in part in order to proceed from the general to the specific as recommended for questionnaires or surveys.[12] In an effort to neutralize reactive effects that could possibly be due solely to the order in which the Q items or functional forms were presented, both the Q-sort cards and the functional forms were randomly shuffled before each interview.

The differential effects possible from sampling were minimized as much as possible by random selection of persons in one firm and by requesting "representative" samples from the other two firms. Some difference in responses could therefore be due to non-random selection but the finding just reported seems to bolster confidence that this threat to validity was minimal since the scores from random and non-random samples produced no significant differences.

Interaction among respondents was recognized as a threat to validity so most respondents were asked not to discuss the interview with those who were still scheduled to participate. (All participants within any one firm were notified of participation several days before interviewing began.) Another threat to internal validity was avoided by pretesting in a fourth accounting firm whose personnel were not involved in the sample.

Social desirability as a potential response bias was taken into account in the attempt to neutrally phrase the questions at the end of the interview by avoiding direction of wording effects. Attempts to push the respondent into selection of a particular functional form or Q-sort arrangement in response to occasional questions was avoided. This was accomplished by stressing that there was no "correct" response. There was no attempt to force the respondents into acquiesence concerning measurement levels or amounts with which they were not comfortable.[13]

In order to further control response bias, the measurement task based on review of the Flexico case was first defined for the auditor with the aid of histograms (Diagrams I and II in the respondents material in Appendix III) which allowed the auditor to understand in a basic discrete fashion the nature of the measurement task. An explicit control check to more fully insure validity of the experiment was exercised by use of the "nonsense" question regarding preference for no error or a 5 percent income effective error. This was an attempt to make certain that the respondent thought about and understood the task. The attempt here was to avoid ambiguity in the meaning of responses which could have occurred by allowing the auditor to invent his own goal nnd/or task with respect to the operational measurement of loss in a specific situation.[14]

Part of what was attempted by way of experimental design was first a definition or measurement of a response set--the auditor's <u>a priori</u> structuring of the concept of audit responsibility as a source of response bias. This was followed by the observation of the effect of the response set on loss definition behavior (resolution of the assessment problem) in a specific situation in which the concept was put to use. In this sense, the characteristic response set was defined for each respondent by his Q-sort rankings for each of the twenty constructs. The observation of loss definition behavior was based on the hypothetical Flexico situation. An experimental situation had to be used in order to provide comparability among the twenty-four observations of such behavior.

The validity of the content of the interview techniques refers to whether the intended measurements were actually elicited by the interviews. In other words, was the method sensible for the purpose intended.[15] Basically efforts in this direction were aimed at minimizing communication problems--insuring that the meaning of questions, responses and instructions were shared in common by respondents and the investigator. Satisfactory completion of this requirement was achieved only after three pretesting sessions and many revisions and simplifications. Some additions and some deletions of Q-sort items were made in order that all were meaningful in terms of the concept of audit responsibility. At the same time an effort was made to be exhaustive with respect to as man facets of this concept as possible as a result of this effort. In addition the techniques for measurement of self-assessed consequences required careful dissection and improvement of the case in consultation with three groups of auditors and re-examination of the utility assessment procedures in order that they not depend on the assumption of cardinal measurement. In other words, provision was made for expressing the measurement of impact in relative rather than absolute terms with respect to the comparison of various error amounts. It was during this period that it became apparent that income effect would be by far and away the best criterion choice for the assessment of loss. Pretesting then was done in order to eliminate the exotic elements of the method, which might have arisen either explicitly or implicitly because of omission.

V.6.1.2 External Validity

This study is exploratory in nature (no similar test or replication are available). In addition there is limitations caused by characteristics of the sampling plan.

Therefore, no claims of generalizability can be made here with respect to the external validity of the findings.

External validity may have been lowered by confinement of the sampling to the Chicago area and due to the small sample size. On the other hand the size of the sample from the total number of audit staff partners and management level personnel is relatively high--over one-third in all three cases. All were national firms with mandatory national professional training courses, a circumstance which may extend generaliziability. No smaller regional practices were involved however and this may limit external validity.

In order to provide as much homogeneity or control as possible in the treatment to which each auditor was exposed, only receivables errors were discussed. By concentrating on receivables, the opportunity to directly extend results to other applications of concern to the auditor such as payables, inventories, cash, etc., was sacrificed. Finally it should be noted that the external validity of results depends as well on how well the Flexico situation models real world audit situations.

V.6.2 Reliability

This section deals with steps taken to determine whether the measurements or observations recorded during the interviews were accurate and precise. The degree of measurement error involved it the measurement process determines reliability. In terms of scientific measurement accuracy may be associated with the variance between actual and recorded value, while precision deals with the variance in repeated observations of the same actual value. In terms more closely associated with this study, interest in reliability means interest in variation of the individual Q-sort items being tested and variation due to the operation of the measurement.

A test of the first type of variation for the Q-sort was accomplished by treating the twenty items as having been tested by each of the twenty-four respondents and dividing the respondents into randomly selected halves. The correlation between the sum of scores of the two halves was .855. Because this result is high, i.e., in the direction of +1.00, it indicates good reliability.[16] An estimate of total reliability of the accuracy with which the Q-sort is measuring the relative importance of the twenty items concerning audit responsibility was then obtained.[17] This was done by application of the Spearman-Brown Prophecy Formula.* The resulting reliability estimate was .92 which also indicates good reliability.

The best test of this sort of reliability would have a set of individuals respond two times to the Q-sort procedures. Resource limitations, however, made this unobtainable within the scope of this project.

The reliability of the consensus ordering of the Q-sort items was also tested. The basic concern here was to examine the reproducibility of the consensus ordering result. The kind of composite reliability meant here is the degree of correspondence to be expected when the consensus order obtained in this study for the twenty Q-sort items is correlated with a consensus which might be derived from an equivalent set of judges. In other words, if resources were to be committed to (1) gathering judgments from another set of auditors sampled from the same population of auditors,

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* $r = \frac{2P}{1+P}$

4 = Estimate of reliability
P = Correlation between halves

(2) deriving a second consensus evaluation, and (3) correlating this second consensus evaluation with the consensus evaluation derived and reported above, the resulting correlation would be the reliability coefficient discussed here.[18] The reproducibility obtained from the Spearman-Brown Formula for the consensus rank order was .87,* which is considered respectable in typical research contexts.[19]

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*For the general case the Spearman-Brown Formula is

$$R = \frac{N(P)}{1+(N-1)(P)}$$

CHAPTER VI

CONCLUDING REMARKS

Earlier in this work some assumptions underlying methods currently used to judge the severity of error in financial statement presentations were set forth. Analysis suggested that these assumptions may render the usual materiality tests inadequate for audit decision-making purposes. This was shown to be particularly true when uncertainty exists regarding the proper balance of an account.

In general current methods were shown to be inadequate because they were either too coarse or too rigid to hold under conditions of uncertainty. Coarseness is caused by reliance on dichotomous classification of the impact of error. Typically for example an error is recognized only as "material" or "immaterial." Current methods may also be inadequate because they rely on rigid assumptions of two types. It may be inappropriate to rely on a fixed interval as a standard unit for measuring the impact of error. It may not for example be appropriate to assume that a four percent error is twice as severe as a two percent error. Rigidity may also become apparent when it is assumed that a symmetry exists regarding the impact of over- and understatements. In other words, the impact of say a five percent understatement of income may not be as severe as the impact of a five percent overstatement.

A methodology for gathering and analyzing evidence about these aspects of audit decision-making was developed accordingly. Among those accountants surveyed, responses indicated that these assumptions represent real flaws in audit decision-making procedures. The realiability coeffecients associated with the findings resulting from implementation of this methodology were high. Replications of the experiments cited should be performed before generalization of the findings can be confirmed. This methodology also provided a means for exploring an alternative theory of audit decision-making advanced in this work.

A discussion of the effects of such assumptions on auditing theory was also undertaken. It was shown that some of these assumptions may have biased or frustrated attempts to model audit decision-making processes. One area most critically affected has been the resolution of resource allocation decision. Current models do not adequately treat the relationship between resource allocation decisions and subsequent decisions regarding the accuracy of financial statements. As a result no comprehensive theory of audit decision-making has been previously set forth.

Criticism is best made when some alternative is suggested in order to alleviate the problem. A model for audit decision-making was therefore put forth which did not rely on adoption of these questionable assumptions in order to resolve the auditor's decision problems concerning resource allocation, conclusion about fairness and the rendering of an opinion. Empirical findings seemed to indicate that many critical aspects of the model were valid in light of current professional thinking, about the decision and assessment problems. All this was discussed in some detail in previous chapters of this work.

The primary contributions of this research work then were threefold. First, several propositions regarding potential inadequacies in current methods for audit decision-making were set out. Second, a methodology for testing these propositions was developed and implemented on a small scale. Finally, a theory for improved audit decision-making was presented.

While making contributions as cited above, this work also points out the need for research into several closely related areas. To have more aptly modeled the audit decision-making process, for example, does not mean that the model is without flaws regarding operational implementation. Many of the reasons why immediate implementation is not yet feasible were mentioned at the end of Chapter IV as suggestions for additional research. Full implementation will require resolution of one other issue as well.

The axiom of comparison of cost and benefits may appeal to the rationality in all of us but be difficult nonetheless. Even though it does remedy some flaws of previous works, the model nonetheless rests on assumptions of its own. Many of the smaller assumptions or conveniences were pointed out during discussion of the model, but the assumption of willingness to assess losses in concrete, cardinal terms stated at the beginning of Chapter IV needs airing here. A majority of those spoken with during the course of this research did not respond with dollar value measurement functions for the assessment of loss. The model relies on a comparability between measurement of cost and losses which can be reached only if the same utility index is applied to both measurements. If such comparability cannot be specified then the efficiency of competing alternatives becomes difficult to measure in terms suggested by the decision model. Effectiveness of alternatives, however, can be measured with only ordinal loss measures available and most auditors had much less difficulty in arriving at such relative rather than absolute measurement of the impact of various amounts of error.

It is plausible to suggest that mediating circumstances may have been involved which lowered the incidence of dollar value assessments. First the situation was hypothetical. All particulars about the Flexico engagement were not known to the auditor nor could they ever be made known with such a research method. Secondly, the loss for any subsequently discovered error is probabilistic. (Respondents who were willing to give dollar value assessments were instructed to give expected (average) values and/or a range of loss values for particular points along the error axis.)

None of the auditors involved in this research had apparently had experience with the construction of such loss functions. Some familiarity with the method might increase the incidence of successful dollar value assessments. Finally, possibly because this situation was hypothetical, some respondents may have been reluctant because of their identification with their firm to commit to record the loss they would expect the firm to be subject to in such a situation.

The figures given by those who responded with dollar values are not given because it would be difficult to draw meaningful conclusions from the limited amount of data. It does, however, seem appropriate to report or point out some of the apparent keys to the definition of cardinal (dollar value) loss functions. These keys were relied upon as guides by those auditors who gave dollar value certainty equivalents as measurements of the impact of various error amounts. The auditors in this group frequently referred to one or more of the keys in the list which follows:

1. At what point will the impact of error due to over- (under-) statement be equal to the dollar amount of the error?
2. At what point will the dollar value impact of error first exceed the fee for the engagement?

3. What is the difference in dollar terms between the amount per (1) or (2) and the maximum loss which could be expected? (applicable only where function chosen implies a maximum loss)
4. What is the difference in dollar terms between the impact of a 5% and 10% income effective error?
5. What effect will changes in aggregate market value as related to price-earning ratio have on ultimate exposure of the auditor for a given error amount?
6. At what point will error be large enough so that the opinion should be changed and what does this mean in terms of exposure?

This discussion could well serve as a springboard for further research into methods paving the way for professional development training in the area of audit planning. Research aimed at making the model completely operational could also be undertaken. This could be done on a stepwise basis beginning with (1) the decision theoretic approach to interval specification, (2) enlarging to encompass use of prior densities and then into (3) the problems of likelihood or inquiry function specification and (4) ordinal specification of loss functions for the purpose of comparing audit procedures and finally (5) the formal integration of cardinal loss functions (possibly in conjunction with or for review by other parties such as the legal profession, financial analysts, controllers and quasi-legislative federal agencies).

Antagonists may point out that the model developed here is Bayesian and therefore subjective. Criticism may be directed at the use of Bayesian method on the ground that inferences are not supportable in court. Recent debates on validity of such inference in the Harvard Law Review, however, indicate that the legal profession is already considering the implications of such inference, so that "the door is open."[1]

The selection of income effect as a criterion may also be debated. For purposes of this study, income effect was chosen as the criterion from which a perspective on the impact of the consequences of error could be best examined. Whether income effect or some income related criterion such as percentage of earning trend is appropriate, the flexibility of the situation specific method for definition of loss functions is robust enough to provide for appropriate solution to the assessment problem.*

In fact, it would be possible to use some other criterion not directly related to income such as owners' equity, or percentage effect on total assets or working capital. This could be done where income or income trend are inappropriate (i.e., when income and income trend are very small or when trend is erratic, etc.). Though not discussed in detail in earlier portions of this work, it would be possible using the procedures suggested in the discussion of the model to assess loss and analyze risk according to several criteria in sequence. In terms of the audit decision-making model presented here, this might for example mean risk analysis in light of income effects of possible errors, according to the density associated with income effective errors in a given application. Subsequently a second risk analysis would be made with a loss function representing the effects of some other type of error and a density for that second type of error. This second analysis might be, say, an analysis of risk due to possible working capital effects.

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*To be robust the validity of results must not be seriously affected by whatever changes in the assumptions on which the model is based are being contemplated.

In general, there may be disutilities regarding error in terms of such different criteria. Assuming independence (i.e., an error with given impact l_1 because of income effect would have total impact $l_1 + l_2$ if the error also had impact l_2 associated with it as a result of effect say on working capital), then the general model could be extended directly to include such situations. This would require iteration of the risk analysis process and aggregation of risks.

In some situations a single parameter may be judged all-important (perhaps income effect, perhaps something else). The auditor would accordingly simply confine himself to the unidimensional case ($m = 1$) as discussed in previous chapters. If more criteria are of some importance the number of loss and density assessments would simply be increased and risks aggregated as appropriate.

It is quite possible that such an approach would put an end to the quarreling between various proposals lauding exclusive use, or regulation regarding use, of some single criterion. It may also help resolve a current three-sided debate among (1) those advocating income effect as all important, (2) those who believe only income trend to be meaningful in today's market, and (3) those who hold that any or all such factors can be important and that therefore only unadorned professional judgment can resolve the issue of materiality in any particular situation.

APPENDIX I

INDEPENDENT AUDITOR'S SHORT FORM REPORT

We have examined the balance sheet of X Company as of June 30, 19__ and the related statement(s) of income and retained earnings for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

In our opinion, the accompanying balance sheet and statement(s) of income and retained earnings present fairly the financial position of X Company at June 30, 19__ and the results of its operations for the year then ended, in conformity with generally accepted accounting principles applied on a basis consistent with that of the preceding year.

Source: Committee on Auditing Procedures <u>Auditing Standards and Procedures</u> Statements on Auditing Procedure, No. 33 (New York: American Institute of Certified Public Accountants, 1963), p. 57.

APPENDIX II

A NOTE ON OPTIMAL CORRECTION

One way to approach the problem of determining an appropriate correction amount just before terminal action is taken would be to proceed as follows. If the auditor is faced with a terminal decision, say, deciding what correction amount to recommend in light of all information (including a subset of that information, y) which has been produced thus far by the investigation, then one way to choose a correction amount, z, is to select that z which minimizes expected loss. That is, choose,

$$d^* \Rightarrow \underset{D}{\mathrm{MIN}}\ E[L(\epsilon,d)] = R(z^*|y)$$

the particular z, called z*, associated with d*, the best decision ($d^* = d_i : d_i \Rightarrow z^*$) in light of available evidence. The risk associated with z* is, $R(z^*|y)$. For any z risk is

$$R(z|y) = E[L(\epsilon,d_i : d_i \Rightarrow z)] = \int L(\epsilon_i+z)Pr(\epsilon_i|y)d\epsilon$$

or if $L(\epsilon_i + z)$ is capable of piecewise integration then,

$$R(z|y) = \int_{-\infty}^{T^-} L(\epsilon_i+z)Pr(\epsilon_i|y)d\epsilon + 0 + \int_{T^+}^{\infty} (\epsilon_i+z)Pr(\epsilon_i|y)d\epsilon$$

were T^- and T^+ are thresholds for impact of under- and overstated errors respectively.

$R(z|y)$ can be viewed as a function of z so that

$$d^* \rightarrow \underset{z}{\mathrm{MIN}}\ R(z|y)$$

so that the optimal decision rule for z* is to pick z* so that

$$\frac{\delta R(z|y)}{\delta z} = 0$$

If the auditor is considering the adoption of an audit technique, plan a_j, which is capable of producing any one of a number of y's from the set Y, then the expected risk, R_j, associated with implementation of a_j followed by selection of the appropriate z* in light of the information actually produced by a_j is,

$$R_j^* = \sum_{Y} Pr(y)\ \underset{z}{\mathrm{MIN}}\ R(z|y).$$

APPENDIX III

ADMINISTRATIVE INSTRUCTIONS pp. 285-290

RESPONDENT MATERIALS pp. 291-295

INTRODUCTION

Thanks for coming in to participate in the exercise. We are grateful for your assistance and wish you to know that your responses will be kept anonymous. In fact, we only need to know your position, years of public accounting experience and length of time you have been at your current level in the firm.

We will be concerned several times during the next few minutes with the Flexico Corporation so please examine this material before we go on.

Hand Subject

Flexico Facts

Introduction to Q-Sort

In some of the situations which follow you will be assessing the results of occurrences which might follow the rendering of an unqualified opinion. Several factors may influence your assessment of the impact that an error in statement presentation will have on you and your firm.

Hand Subject

Card Packet

Each of these cards represents one such factor.

Please examine each of these items. Are there any additional factors which are significant.

Record at #1

In making a decision concerning the fairness of financial presentation certain of these factors have greater bearing on your assessment of potential consequences of error than others.

Please sort the cards into 5 piles of 1, 5, 8, 5, & 1 cards respectively. Place the factor which has the greatest bearing on the assessment of consequences in the first pile and so on.

Take up Q-Sort

Introduction to Loss Assessment

The questions which follow are related to certain aspects of the Flexico statements which you have just reviewed. In answering the questions, please utilize the material on Flexico as a point of reference.

There is no correct answer to the questions to which you will be responding. In fact, we hope to learn more about the attest function from studying your responses.

Certain feasible but hypothetical situations which might arise as a result of an opinion rendered on Flexico's statements will be presented. Your responses may at times be based on subjective judgment. Please respond as if you were in a forced choice situation. View yourself as a decision-maker who cannot turn back once the decision called for has been made.

Based on your review of the material presented concerning Flexico, consider the situation which is described by the four simultaneous conditions appearing on this situation card.

Hand Subject Standard
Audit Situation Card

The fourth condition will be referred to as the <u>Standard</u> <u>Audit</u> <u>Outcome</u>.

Hand Subject
Situation Card A

** The blank space on this card will be explained in a moment.

Please examine this second situation and compare it with the Standard Audit Situation.

Consider the situation described by Situation Card A in which the true balance mentioned in Condition 3 is $3,904,000 causing a 5% overstatement of net income before tax and extraordinary gain.

Which situation is preferable, the Standard Audit Situation or Situation A? Why?

Let's associate with your preference for the Standard Audit Outcome a comparative measure which defines your degree of preference for the Standard Audit Situation. We will call this a measure of expected loss. Let's attach an arbitrary value of "X" to this loss.

Display Diagram #1

Now consider a situation identical to Situation A but with the true balance of Accounts Receivable overstated by $128,000 causing an income effective error of 10%.

Your preference for the Standard Audit Situation in comparison with the new situation could be defined in the same manner as was described before.

Is the expected loss greater than X? (Yes)--Question #2 (#3). Is its impact:

More than twice as great

Twice as great

Less than twice as great

as the impact of the error.

Display Diagram #2

Hand Subject

Overstatement Packet

We can vary the amount in Condition 3 so that various overstatements arise. Which of these cards do you believe most closely depicts the relationship between expected loss and increasingly large overstatements?

Would you prefer to show your own representation?

If yes, Hand
Subject Loss Blank

Return to ** and Repeat
For Understatement (X + Y, etc.)

#4 Is A $\begin{matrix}\text{G.T.}\\ \text{L.T.}\\ \text{Eq.}\end{matrix}$ A'?

#5 Define relationship between -0- error & A, i.e., monetary losses--to various parties' probabilities of critical events maximum expected loss, etc.

#6 What criteria other than % effect on income might be appropriate for judging the impact of error?

#7 When might it be appropriate to utilize some criteria other than % effect on income?

#8A To what degree is the audit engagement viewed as a series of independent judgments concerning individual balances?

#8B How do you assess the significance of (1) compounding and (2) off-setting cumulative errors?

Flexico Facts

Flexico is a small manufacturer of industrial electronic components. Flexico has been in existence for eleven years. For the last six years, they have been a client of your firm.

Flexico has its plant and headquarters in a suburban community west of Chicago. Flexico is publicly held with a simple capital structure. The manufacturing process requires assembly work but not fabrication.

The firm distributes through direct salesman and manufacturers' representatives. Most sales are from lots made to customer specifications. The firm employs a billing clerk who utilizes an electronic posting machine to simultaneously prepare customer ledger and statement postings and sales journal records upon receipt of sales invoice and shipping report. Incoming payments are listed for posting by an accounting clerk. Funds are deposited daily by the treasurer's office where the deposit tickets are prepared. Posting of collections is made by the billing clerk from the list prepared by the accounting clerk. Sales orders are reviewed by the credit manager at the time of sale and his approval is required for shipping. The treasurer and credit manager periodically review Accounts Receivable for doubtful accounts. There are no serious internal control weaknesses.

The Flexico engagement normally requires professional time as follows:

Staff	380 - 450	Hours
Manager	40 - 60	Hours
Partner	15 - 30	Hours

A normal fee structure is utilized in determining the Flexico billing.

FLEXICO INC.

Comparative Income Statements

For Years Ending December 31, 1970 & December 31, 1971

	1971	1970
Sales	$ 16,510,000	$ 15,730,000
Cost of Goods Sold	11,810,000	11,200,000
Selling & Admin. Expenses	3,100,000	2,880,000
Other Expenses	320,000	340,000
Income Before Tax and Extraordinary Gain	$ 1,280,000	$ 1,310,000
Income Tax	590,000	630,000
Income Before Extraordinary Items	$ 690,000	$ 680,000
Extraordinary Gain	30,000	
Net Income	$ 720,000	$ 680,000
EPS	$1.20	$1.13 1/3
EPS Before Extraordinary Gain	$1.15	$1.13 1/3

FLEXICO INC.

Comparative Balance Sheets
As of December 31, 1970 & December 31, 1971

	1971	1970
Current Assets:		
Cash	$ 720,000	$ 550,000
Accounts Receivable	3,840,000	3,500,000
Inventory	3,500,000	3,200,000
Prepayments	110,000	80,000
Total Current Assets	$8,170,000	$7,330,000
Long-Lived Assets:		
Property	$2,190,000	$2,310,000
Other Assets	140,000	120,000
Deferred Development Expense	80,000	100,000
Total Long-Lived Assets	$2,410,000	$2,530,000
Total Assets	$10,580,000	$9,860,000

	1971	1970
Current Liabilities:		
Accounts Payable	$ 820,000	$ 700,000
Notes Payable	1,170,000	1,090,000
Accruals	1,520,000	1,380,000
Total Current Liabilities	$3,510,000	$3,170,000
Long-Term Liabilities:		
Bonds Payable	$ 720,000	$ 810,000
Deferred Tax	210,000	180,000
Total Long-Term Liabilities	$ 930,000	$ 990,000
Owners Equity:		
Common Stock	$3,000,000	$3,000,000
Retained Earnings	3,140,000	2,700,000
Total Owners Equity	$6,140,000	$5,700,000
Total Equities	$10,580,000	$9,860,000

Standard Audit
Situation Card

Condition 1: You completed a satisfactory review of Flexico's internal control system and completed all such tests, confirmations, etc. which you considered necessary in order to properly support a decision regarding the fairness of Flexico's financial statement presentations.

Condition 2: You have rendered an unqualified opinion on the financial statements of Flexico.

Condition 3: The true balance of Accounts Receivable is $3,840,000 as reported.

Condition 4: There is no challenge to your opinion; it is accepted as proper by all concerned parties.

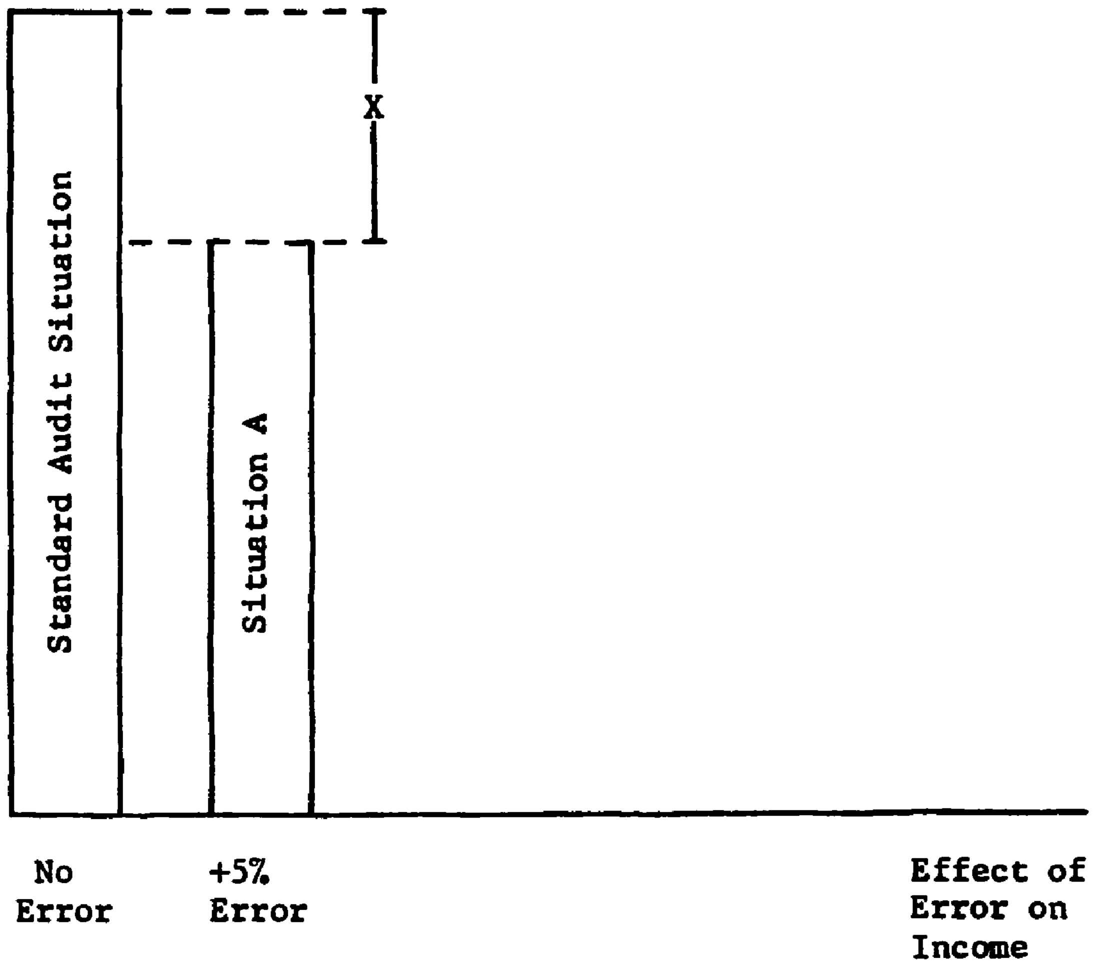
Situation
Card A

Condition 1: You completed a satisfactory review of Flexico's internal control system and completed all such tests, confirmations, etc. which you considered necessary in order to properly support a decision regarding the fairness of Flexico's financial statement presentations.

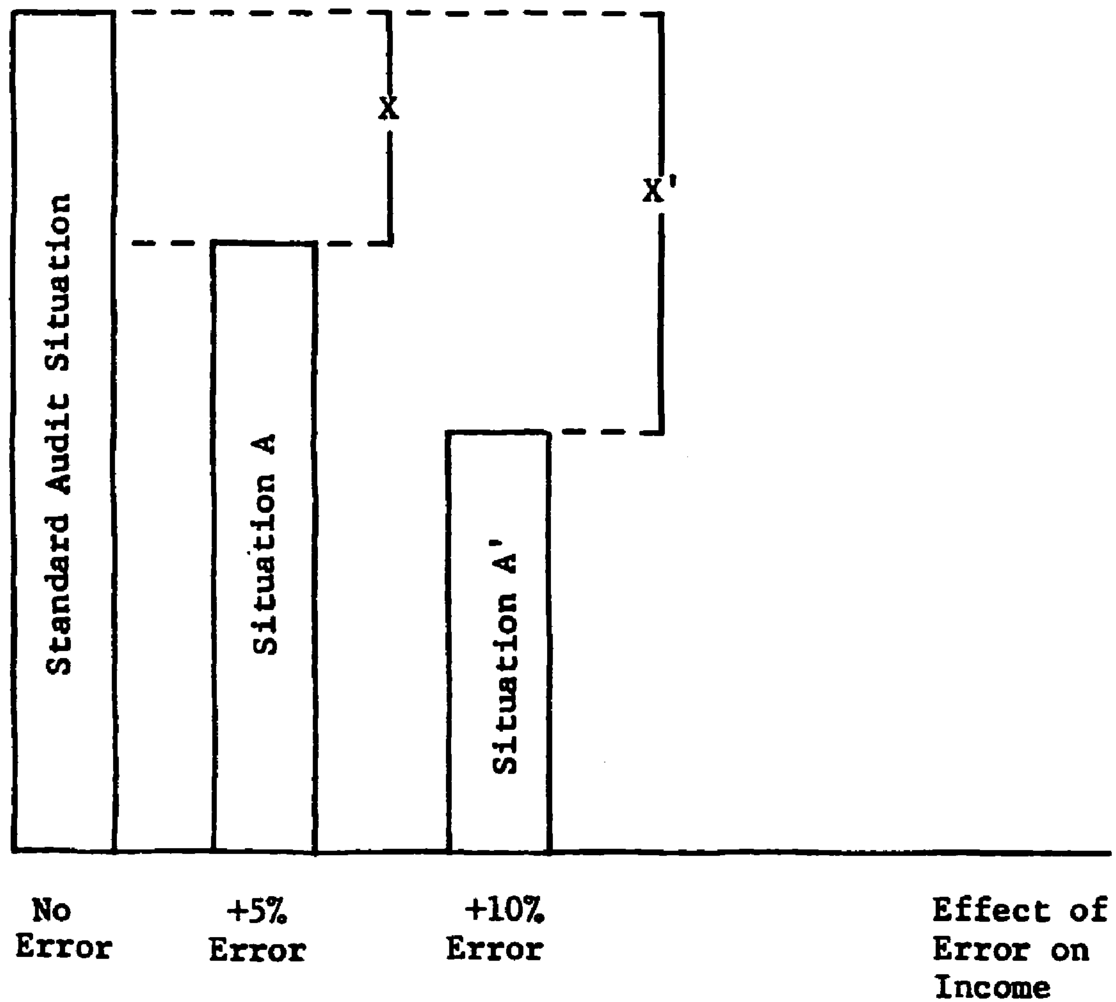
Condition 2: You rendered an unqualified opinion on the financial statements of Flexico.

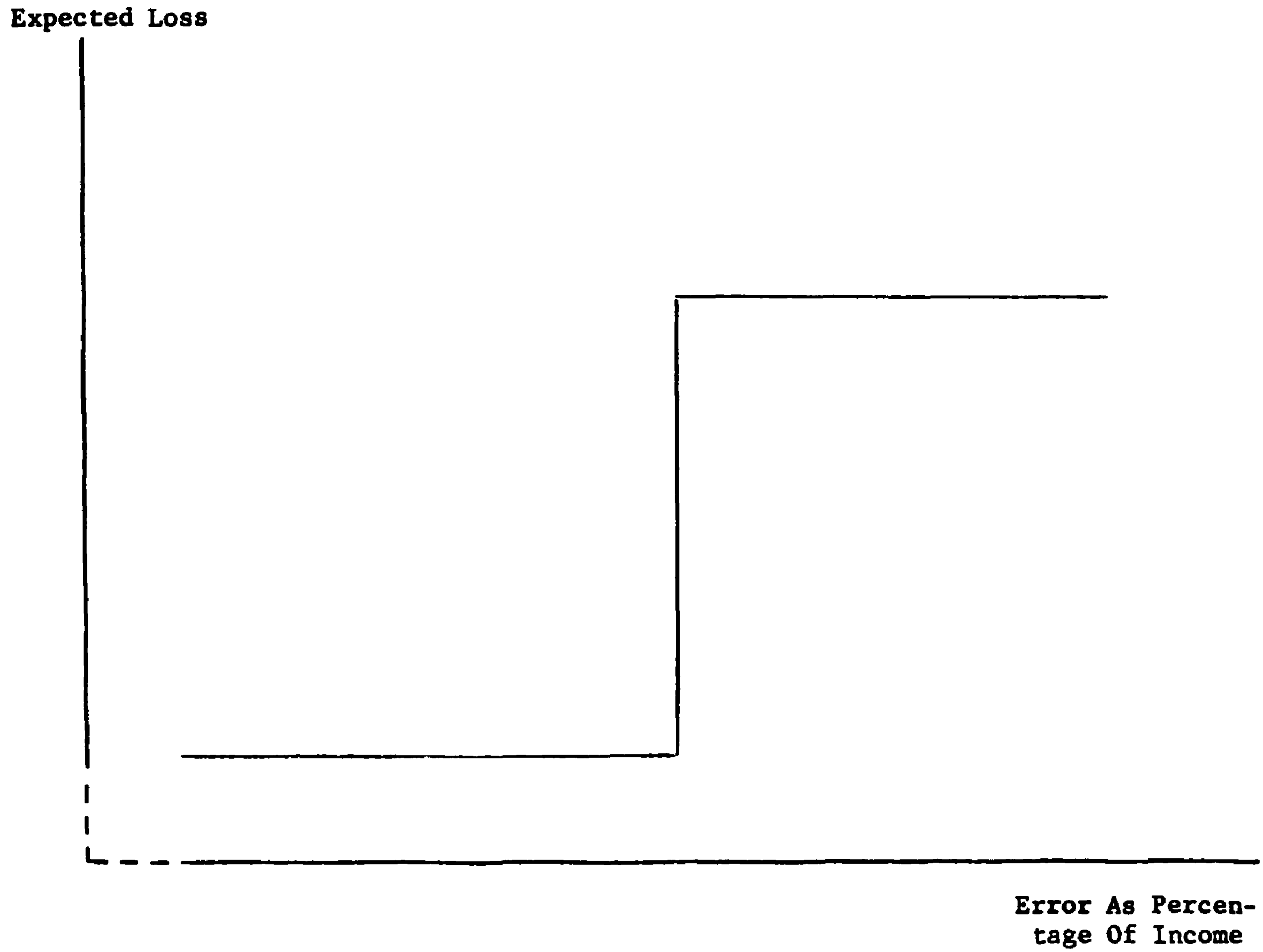
Condition 3: The true balance of Accounts Receivable is $__________.

NET EXPECTED BENEFITS

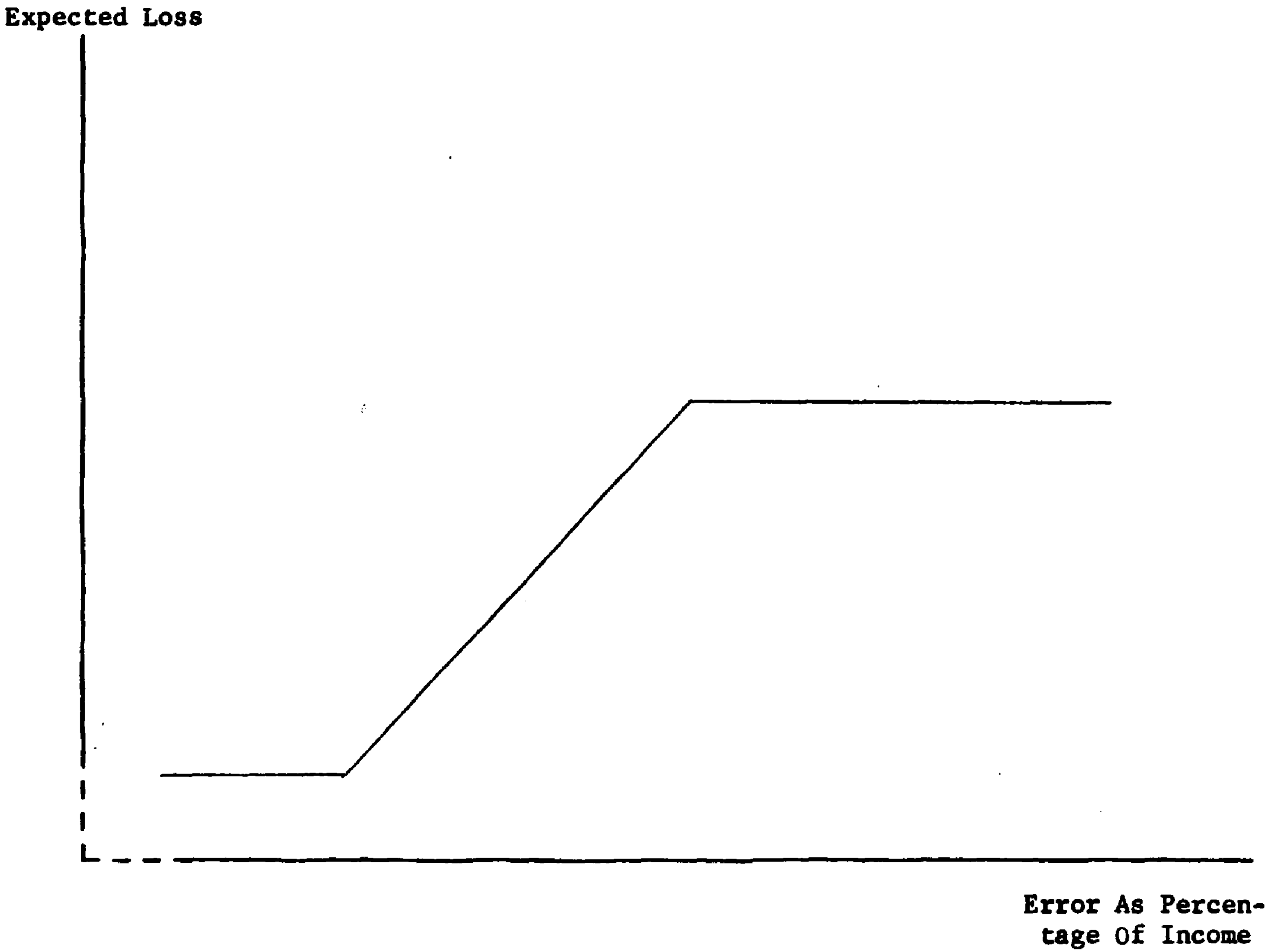


NET EXPECTED BENEFITS




Expected Loss
Error As Percentage Of Income


Expected Loss
Error As Percentage Of Income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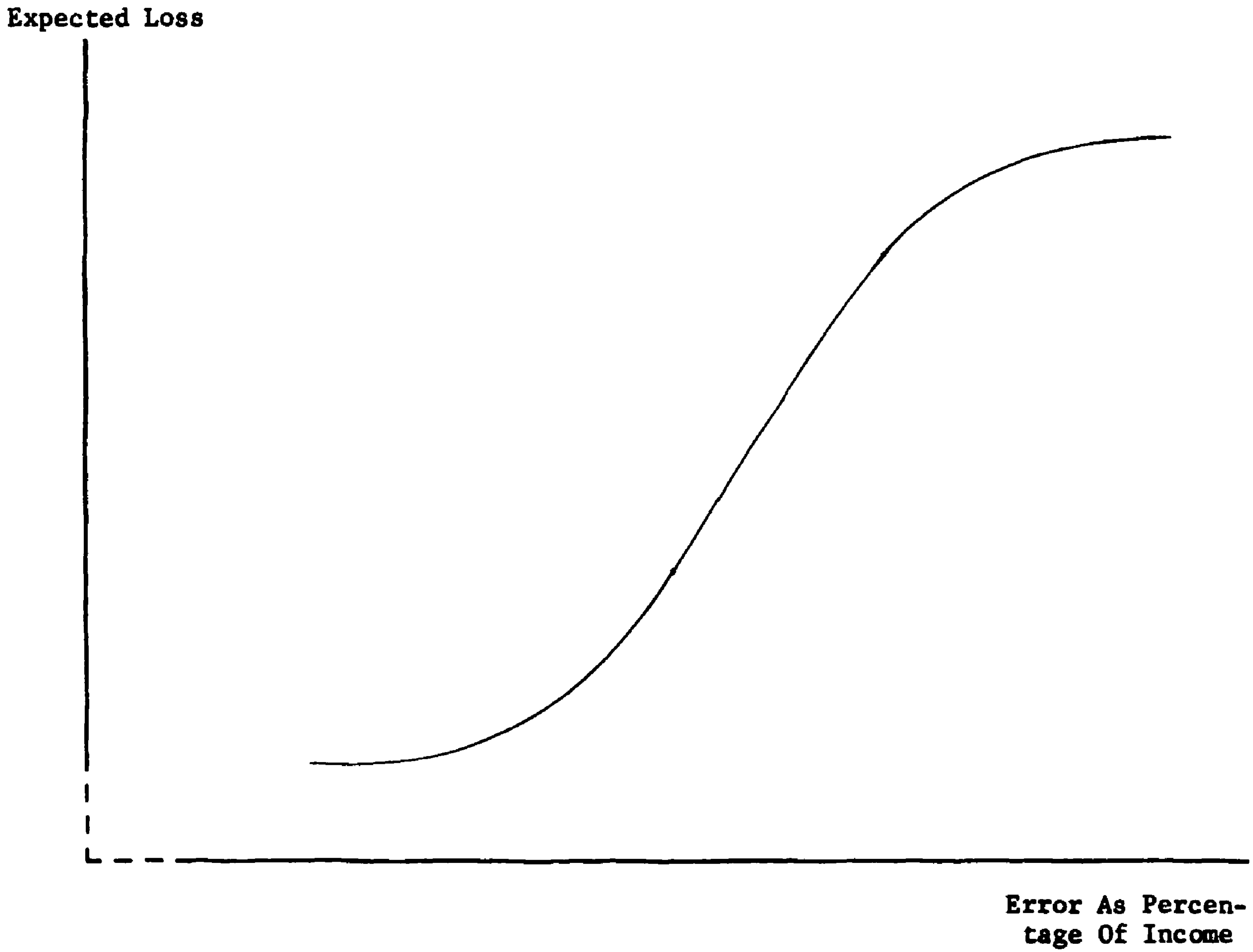
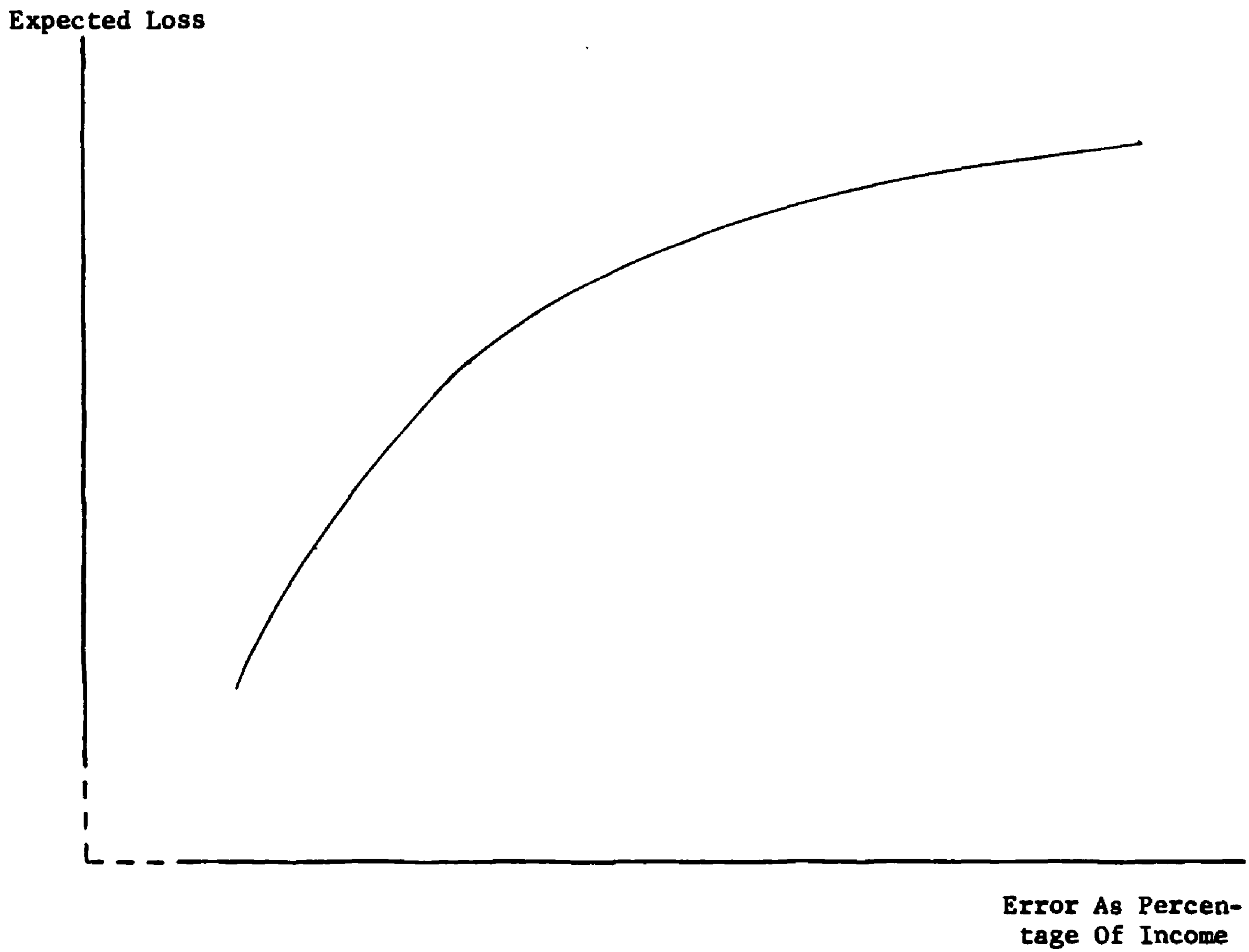
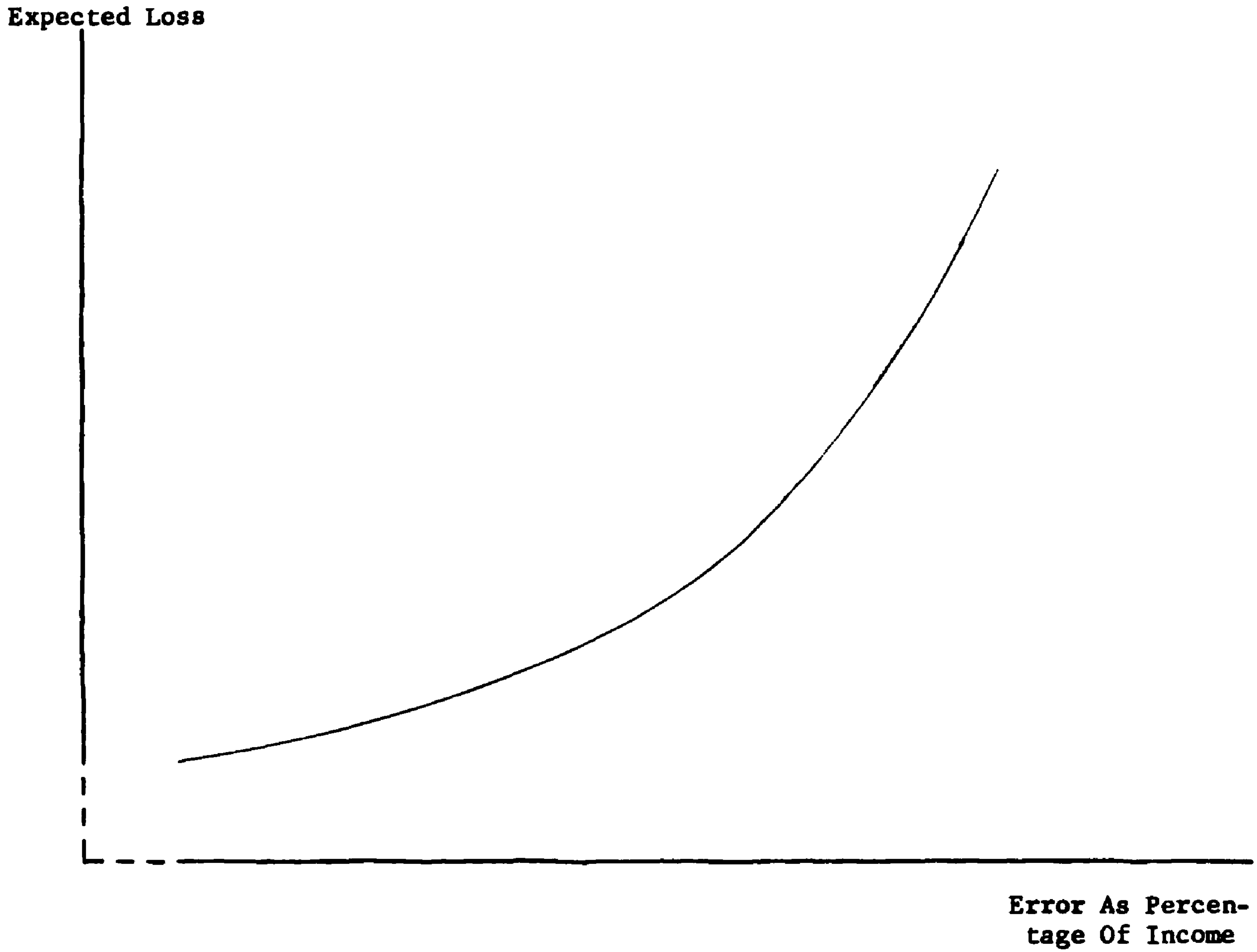
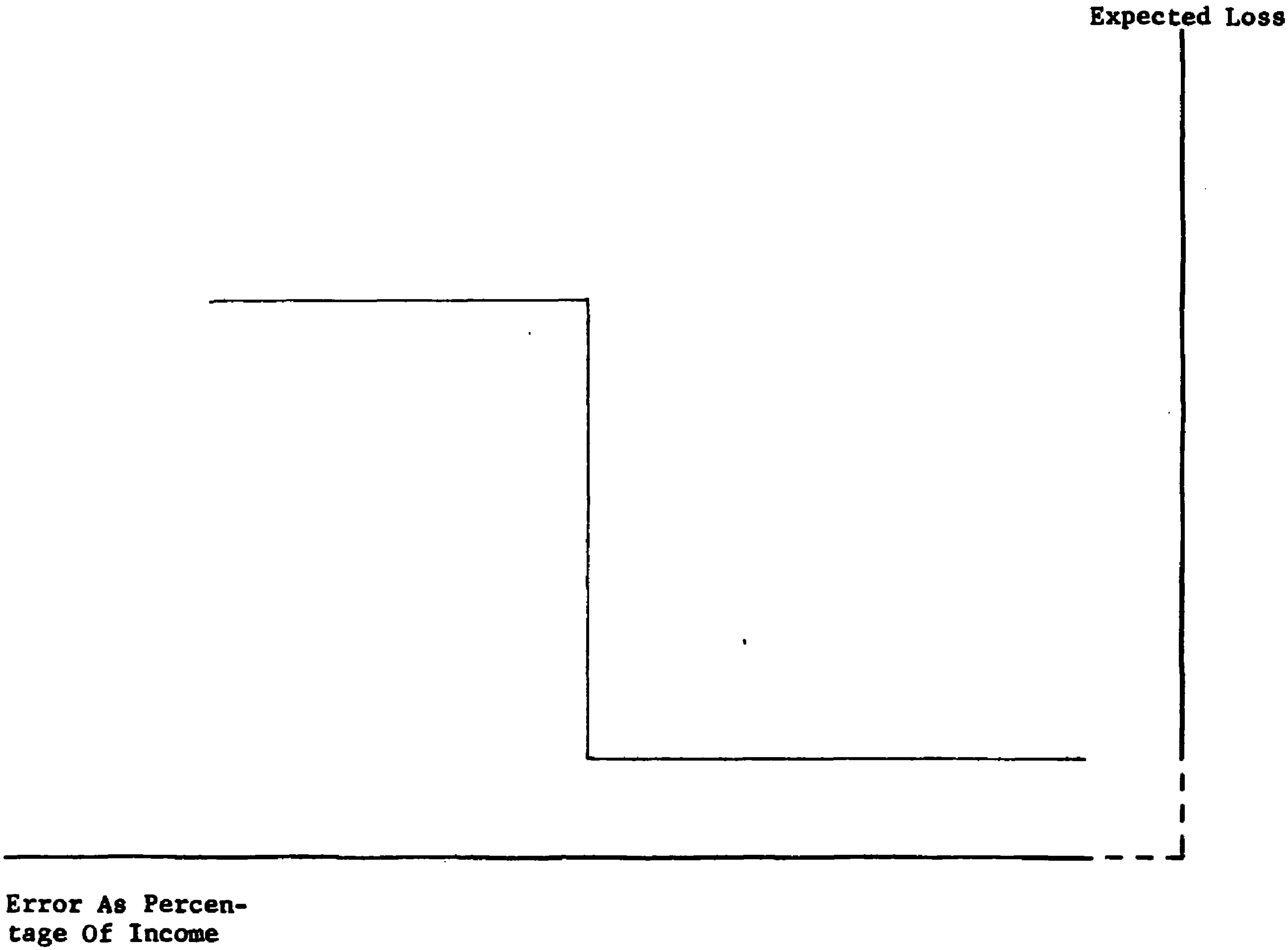
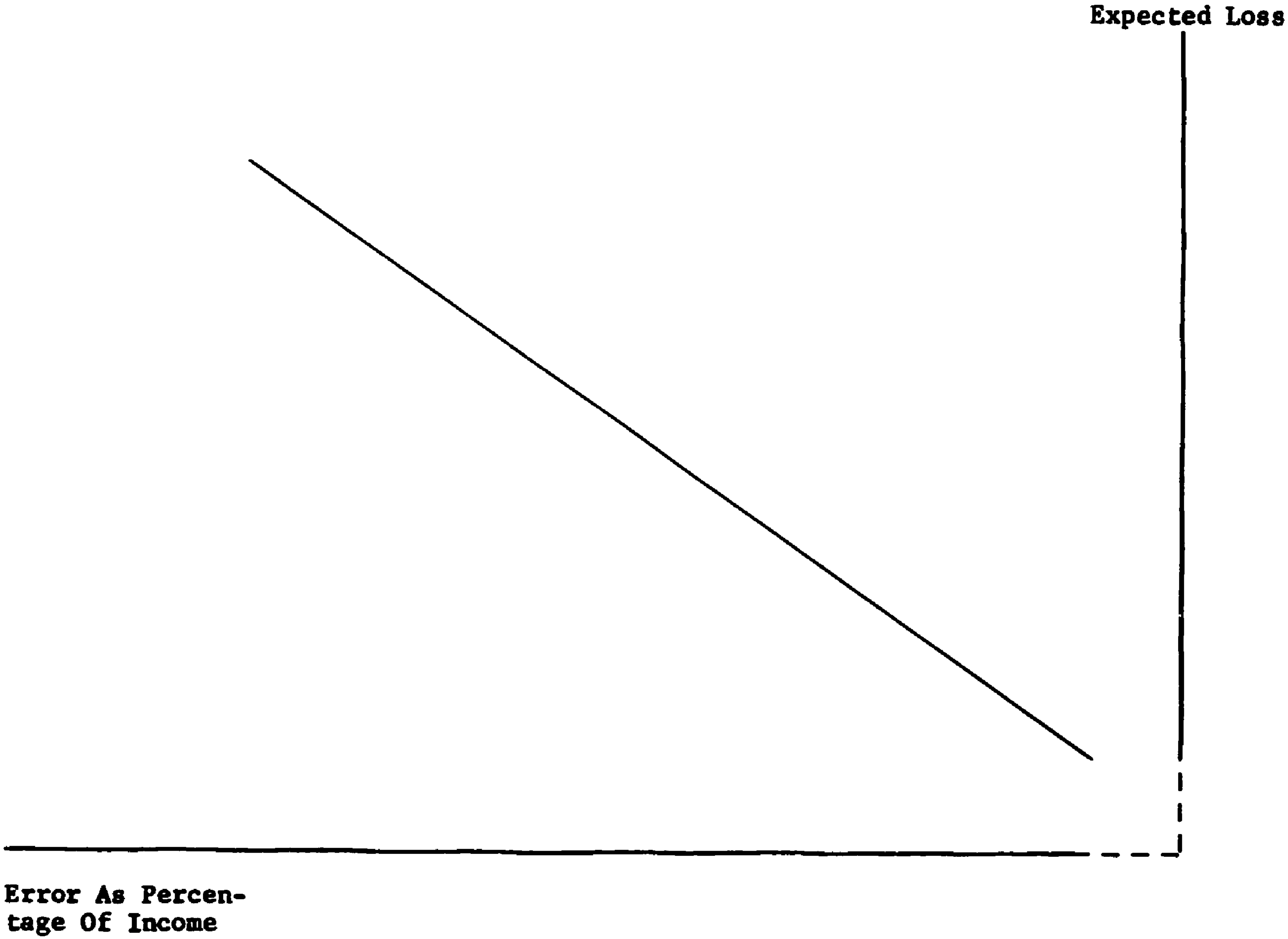
Error As Percentage Of Income

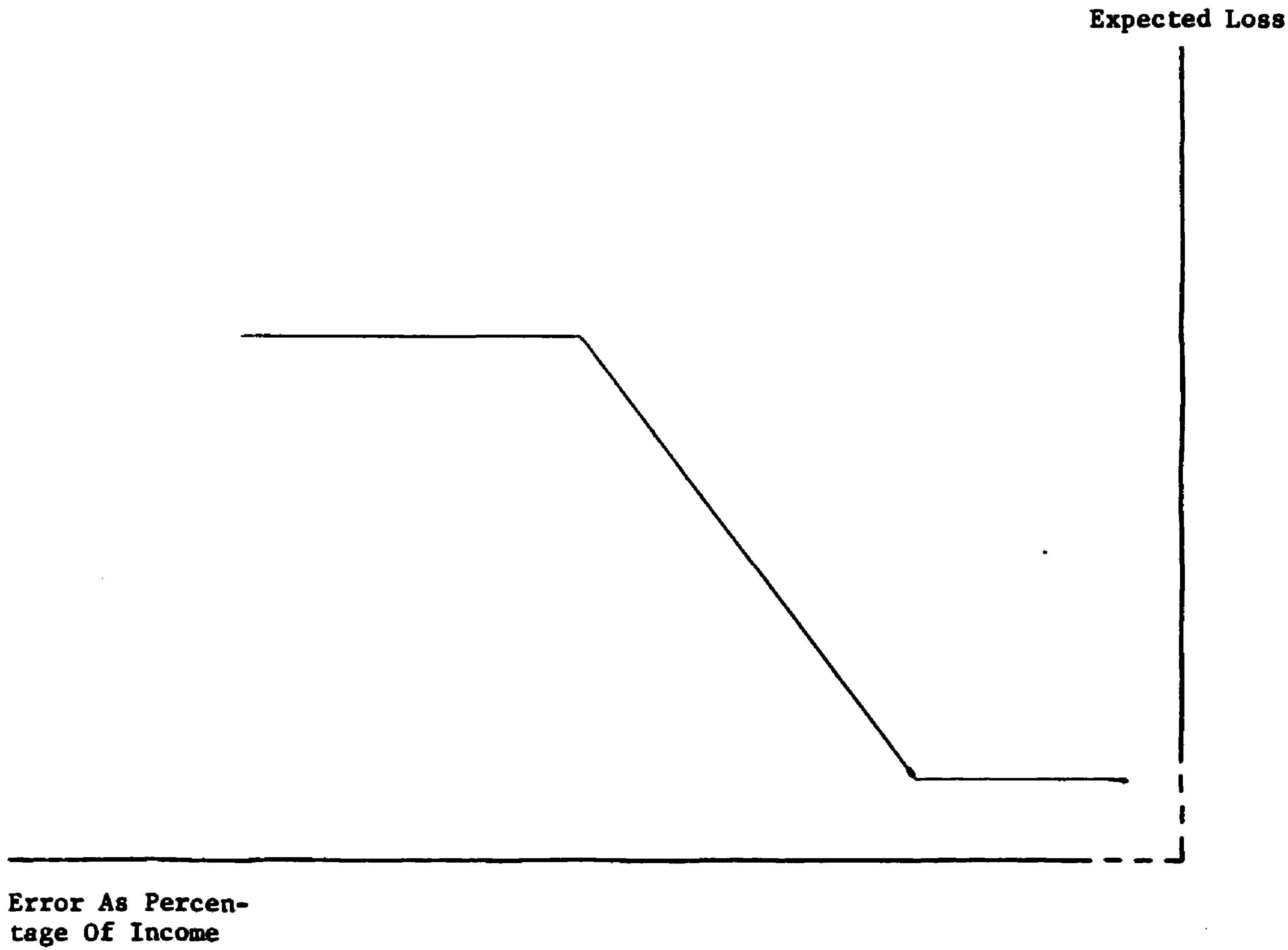

Expected Loss
Error As Percentage Of Income

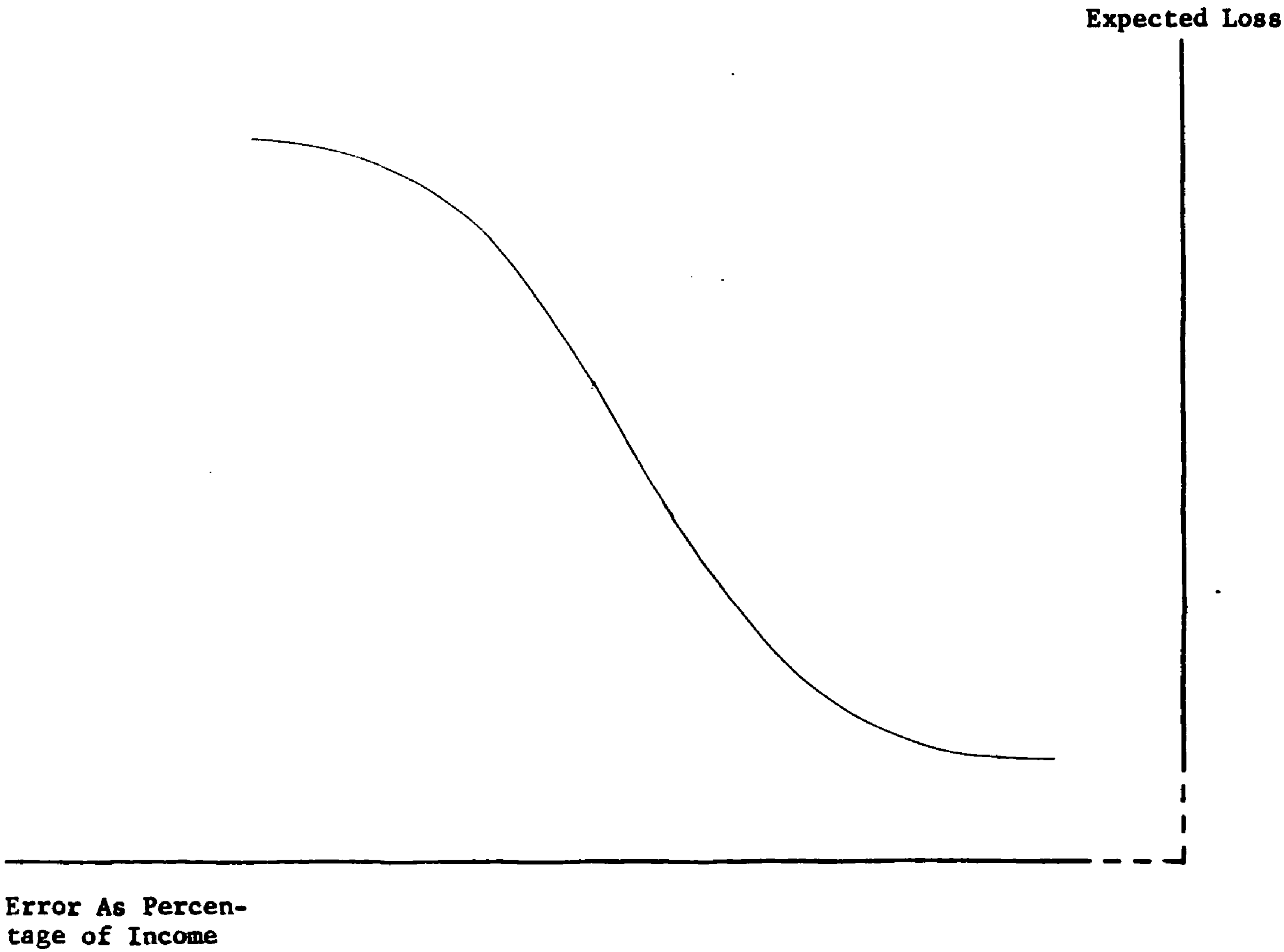

Expected Loss
Error As Percentage Of Income

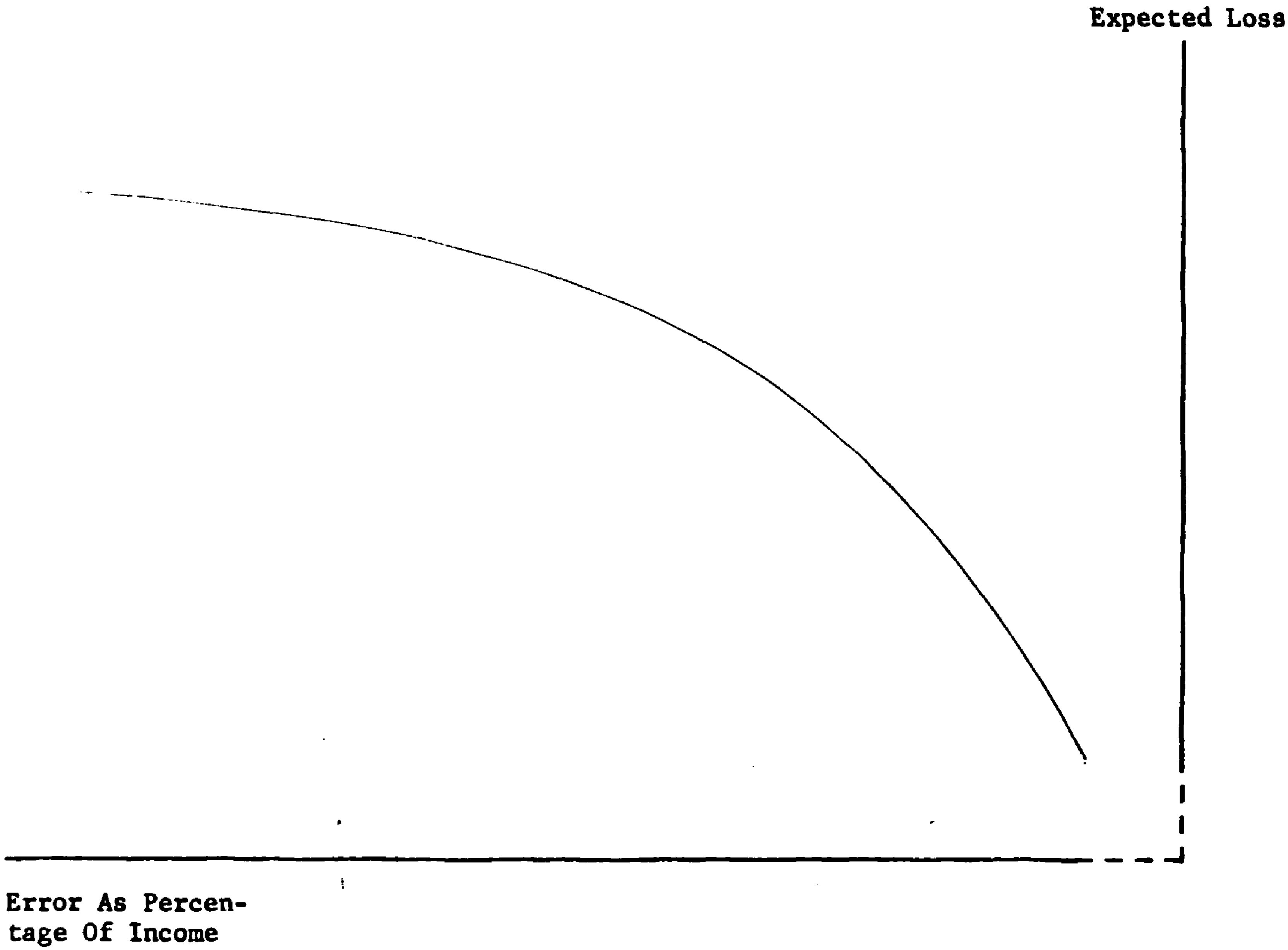

Expected Loss
Error As Percentage Of Income

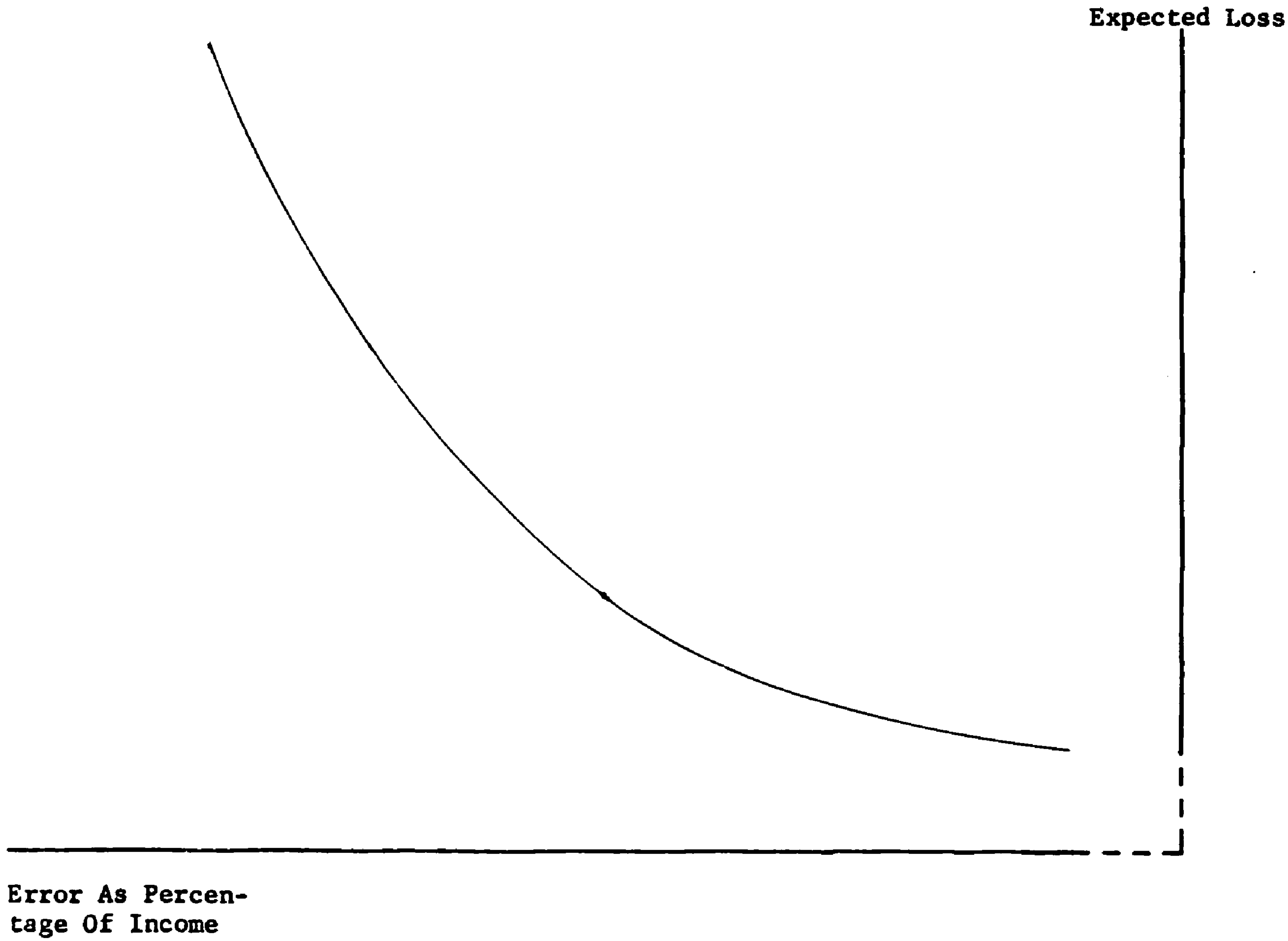

Expected Loss
Error As Percen-
tage Of Income


Expected Loss
Error As Percentage Of Income


Expected Loss
Error As Percen-
tage Of Income


Expected Loss
Error As Percentage of Income


Expected Loss
Error As Percen-
tage Of Income


Expected Loss
Error As Percentage Of Income

APPENDIX IV

INTERVIEW RESULTS

Q-SORT RANKS

Case No.	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
1	3	4	2	4	3	4	3	2	1	5	3	3	4	2	3	4	3	2	2	3
2	3	3	2	3	2	4	3	2	1	3	4	4	4	2	2	4	3	5	3	3
3	3	4	3	4	3	5	2	2	4	2	3	3	2	3	1	3	4	2	4	3
4	3	4	3	3	2	3	2	1	2	3	3	5	4	3	2	4	4	3	4	2
5	3	2	3	3	3	4	4	2	1	2	3	4	2	5	2	3	4	3	4	3
6	3	3	3	4	5	2	4	4	1	3	4	4	2	3	3	2	3	3	2	2
7	2	4	2	4	2	3	3	2	3	3	2	5	3	3	1	4	3	3	4	4
8	4	2	1	3	3	4	3	2	4	2	4	4	3	3	2	3	5	2	3	3
9	3	4	1	4	3	4	2	2	3	3	3	4	5	2	2	4	3	2	3	3
10	3	4	2	3	3	4	3	3	1	2	4	3	4	5	2	3	4	2	3	2
11	3	3	1	3	3	4	4	2	2	2	4	4	3	5	2	4	3	2	3	3
12	3	2	2	3	3	3	5	2	3	4	4	4	2	4	2	1	4	3	3	2
13	4	4	2	5	3	3	3	2	1	2	4	3	3	4	2	3	3	4	2	3
14	5	3	2	4	2	3	3	3	1	2	3	2	4	4	3	4	4	3	3	2
15	2	3	2	3	2	4	5	4	3	3	4	3	1	4	2	3	3	4	2	3
16	3	4	3	5	2	3	4	2	2	3	4	4	1	3	2	3	3	4	3	2
17	3	4	3	3	3	4	2	3	1	2	4	4	2	4	2	3	5	2	3	3
18	4	4	1	4	3	2	3	2	2	2	3	4	3	5	3	2	4	3	3	3
19	3	3	1	3	3	4	2	3	2	2	3	2	4	2	3	4	4	3	5	4
20	3	5	1	4	3	3	4	3	2	4	3	3	4	4	2	2	2	3	2	3
21	3	4	3	2	2	3	4	3	1	4	2	2	5	4	2	3	3	4	3	3
22	3	2	3	3	4	4	4	3	2	3	4	3	2	4	2	1	5	3	3	2
23	4	4	2	3	2	3	1	3	2	2	3	4	5	3	2	4	3	3	3	3
24	3	4	1	4	2	4	3	2	2	2	3	5	3	3	2	3	4	3	4	3

ADDITIONAL RESPONDENT DATA

Case No.	Demographic Data				Functional Form Codes and Parameters						
	Firm	Position	Years Experience	Years in Position	Function Chosen +	Function Chosen -	Threshold Amount +T	Threshold Amount -T	Measure	5/10 Ratio	Sym.
1	1	2	2	1	5	5	30	30	1	2	1
2	1	1	5	3	5	5	64	64	0	2	0
3	1	1	3	1	5	2	61	614	1	2	0
4	1	2	2	1	7	7	77	77	2	2	1
5	1	2	3	2	4	4	64	128	0	2	0
6	1	1	5	3	1	6	64	64	1	3	0
7	1	2	2	2	6	5	64	64	2	2	0
8	2	1	5	2	6	6	0	0	2	2	1
9	2	1	5	4	4	5	64	128	1	3	0
10	3	2	3	2	4	4	38	77	2	2	0
11	3	2	2	2	8	4	64	128	2	2	0
12	3	2	3	2	6	6	64	160	2	2	0
13	3	2	3	2	8	8	64	38	2	2	0
14	3	2	2	2	9	9	64	95	0	2	0
15	3	2	2	2	6	6	30	109	1	2	0
16	2	1	3	2	4	4	20	20	2	2	0
17	2	2	2	1	4	4	54	54	2	2	0
18	2	2	2	1	6	6	38	38	0	1	0
19	3	2	5	3	7	7	51	51	2	2	1
20	3	2	3	3	3	4	13	26	1	3	0
21	3	2	3	3	2	2	153	153	2	1	1
22	3	1	4	1	6	6	192	207	1	1	0
23	3	2	2	1	4	4	92	154	0	2	0
24	3	1	3	2	1	1	64	64	0	3	1

APPENDIX V

SUMMARY OF STATISTICAL PROCEDURES

The procedures for the Wilcoxon-Mann-Whitney tests and the Kruskal-Wallis tests for small sample sizes applied in analyzing the data in order to produce the results reported in Chapter V are summarized by Siegel as follows:

Summary of Wilcoxon-Mann-Whitney Procedures

1. Determine the values of n_1 and n_2. n_1 = the number of cases in the smaller group; n_2 = the number of cases in the larger group.
2. Rank together the sources for both groups, assigning the rank of 1 to the score which is algebraically lowest. Ranks range from 1 to $N = n_1 + n_2$. Assign tied observations the average of the tied ranks.
3. Determine the value of U by applying the formula,

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R1$$

where R_1 = sum of the ranks assigned to group whose sample size is n_1.

4. For n_2 between 9 and 20, the significance of any observed value of U may be determined by reference to Table K, (which is located on page 274 of Siegel).

5. If the observed value of U has an associated probability equal to or less than the previously set level of significance, α, reject H_o in favor of H_1.[1]

Summary of Kruskal-Wallis Procedure

1. Rank all of the observations for the k groups in a single series, assigning ranks from 1 to N.

2. Determine the value of R_j (the sum of the ranks) for each of the k groups of ranks.

3. Determine the value of H by applying the formula,

$$H = \frac{\frac{12}{N(N+1)} \Sigma \frac{R_j^2}{n_j} - 3(N+1)}{1 - \Sigma T / N^3 - N}$$

where $T = t^2 - t$ (t is the number of tied observations in a tied group of scores).

4. The method for assessing the significance of the observed value of H depends on the size of k and on the size of the groups:

   a. If $k = 3$ and if $n_1, n_2, n_3 \leq 5$, Table O may be used to determine the associated probability under H_0 of an H as large as that observed.

   b. In other cases, the significance of a value as large as the observed value of H may be assessed by reference to a Chi-square table with,

$$df = k - 1 \text{ (df = degrees of freedom)}$$

5. If the probability associated with the observed value of H is equal to or less than the previously set level of significance, α, reject H_0 in favor of H_1.[2]

APPENDIX VI

FOOTNOTES

CHAPTER I

[1]Committee on Auditing Procedure of the American Institute of Certified Public Accountants, Proposed Statement on Auditing Procedure: The Auditor's Study and Evaluation of Internal Control, Exposure Draft, (N.Y.: The American Institute of Certified Public Accountants, 1972), p. 11.

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CHAPTER II

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[2]Eldon S. Hendriksen, Accounting Theory (Homewood, Illinois: Richard D. Irwin, Inc., 1970), p. 105.

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[4]Paul Frishkoff, "An Empirical Investigation of the Concept of Materiality in Accounting," Empirical Research in Accounting: Selected Studies, A Supplement to Journal of Accounting Research, Vol 8, pp. 125-128.

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[11]*Ibid.*, p. 94.

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[13]Thornton L. O'Glove, and Robert A. Olstein, "No Small Issue: 'Materiality' May Mean a Great Deal to Investors," Baron's, July 17, 1972, p.8.

[14]S.S. Stevens, ed., "Mathematics, Measurement and Pschophysics," Handbook of Experimental Psychology (New York: John Wiley & Sons, Inc., 1951) pp. 21-22.

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[16]*Ibid.*, p. 260.

[17]*Supra*, p. 25-29.

[18]C.E. Shannon, "A Mathematical Theory of Communication," Bell System Technical Journal, Vol. 27 (1948), pp. 383-394.

[19]Lev, *op. cit.*, pp. 251-255.

[20]J. Rose, *et al.*, "Toward an Empirical Measure of Materiality," Empirical Research in Accounting: Selected Studies, (1970), p. 140, A Supplement to Journal of Accounting Research, Vol. 8.

[21]Committee on Auditing Procedure, "Auditing Standards and Procedures," Statements on Auditing Procedure No. 33 (New York: American Institute of Certified Public Accountants, 1963), Chapter 6.

[22]Committee to Prepare a Statement of Basic Accounting Theory, A Statement of Basic Accounting Theory (Evanston, Illinois: American Accounting Association, 1966), pp. 144-146.

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[24]Keith Shwayder, "Relevance," Journal of Accounting Research, Vol. 6, No. 1 (Spring, 1968), pp. 87-91.

[25]Ibid., p. 91.

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[30]Committee on Auditing Procedure, op. cit., Chapter 1.

[31]Ibid., Chapter 2.

[32]#3 Cooley, Torts 335 (4th Ed. 1932).

[33]Committee on Auditing Procedure, op. cit., p. 17.

[34]Norman Olson, "Auditor in Legal Difficulty--What's the Answer?" The Journal of Accountancy, Vol. 129, No. 4 (April, 1970), p. 39.

[35]Saul Levy, Accountants' Legal Responsibility (New York: American Institute of Accountants, 1954), p. 7.

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[43]Katsoris, op. cit., p. 212.

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[46]David B. Isbell, "The Continental Vending Case: Lessons for the Profession," The Journal of Accountancy, Vol. 130, No. 2 (August, 1970), p. 36.

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VITA

Name: BART HOPKINS WARD

Place of Birth: Flushing, New York

Date of Birth: June 29, 1945

Colleges Attended and Degrees:

Bachelor of Business Administration
The University of Oklahoma
1967

Master of Arts
The University of Oklahoma
1970