

A REVIEW OF AUDIT RESEARCH

by

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## I. INTRODUCTION

Auditing research has been receiving increased attention by accounting researchers in recent years. As the auditing function comes under closer scrutiny by the general public and regulatory bodies, with its importance being stressed and its methods and results being challenged, increasing research in this area can be expected. To date there has been little attempt to integrate and relate efforts to develop the auditing discipline. Instead, researchers have pursued rather narrow research objectives and too often have failed to consider whether their results fit into the over-all field of auditing. Auditing research thus stands at the crossroads. Efforts can continue to be individualistic, or attempts can be made to put together the research pieces and relate them to each other and to an underlying auditing theory.

One of the major problems that still has not been addressed in the literature is what theory or theories underlie auditing. The purpose of this paper is to present a synthesis of selected auditing research (1) in such a manner as to facilitate the future development of a theoretical framework for auditing and (2) to identify the promising and the not-so-promising paths for future research.

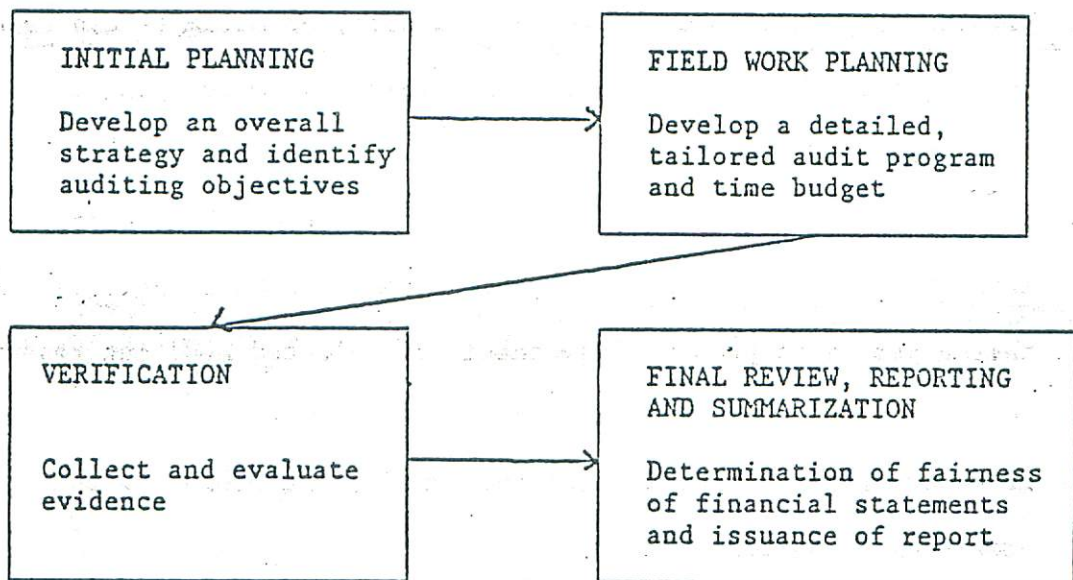
In order to set a context within which auditing theory and research may be discussed, this paper first suggests an audit process model and next identified the five domains of auditing research around which the paper is focused. The second section of this paper then discusses and presents examples of each domain. Conclusions and implications are included in the final section.

## II. AUDITING DOMAINS AND RESEARCH APPROACHES

To facilitate the integration of previous auditing studies, a model of the audit process is presented below. For this purpose, the four phases of an audit engagement identified by Peat, Marwick, Mitchell & Co. (1976, pp. 19-27) have been adopted. These phases and their objectives are found in Figure 1.

Figure 1

### Phases and Objectives of an Audit



In combination, the phases of the auditing process can be seen to lead to a decision as to the "fairness" of the client's financial statements. Various approaches have been taken to study the process auditors follow to reach the final audit judgment. Many of these approaches either implicitly or explicitly imply a theory underlying auditing, and can be classified into domains based on the similarity of their conceptual foundations.

## Domains of Auditing Theory

A recent Committee of the American Accounting Association (1977a) has provided a classification scheme for the several approaches which have been used to develop financial accounting theories. Their scheme has been modified here and used to classify the various research studies which have been conducted in the field of auditing. An outline of the five domains of auditing theory which have been identified appears in Figure 2. A domain of auditing theory is defined as a particular conceptual foundation or approach. For instance, the domain labeled "decision maker" views auditing in terms of the behavioral aspects of auditor decision-making. Because many studies are multipurpose in nature, classification of the research into the domains will not be mutually exclusive. The discussion which follows considers each of the domains and their relation to the audit process.

Figure 2

### The Domains of Auditing Theory

- I. Professional/Institutional
- II. General Audit Theory
- III. Decision Theory
  - A. Overall audit planning and information economics
  - B. Statistical sampling
  - C. Internal control evaluation and compliance tests
  - D. Substantive tests
- IV. Decision Makers
- V. Technical

The professional or institutional domain in auditing is represented by the Auditing Standards Executive Committee of the American Institute of Certified Public Accountants and other groups concerned with auditing practice and standard setting. Fundamental to this level of auditing

theory are the sociological and political aspects of the auditing function, and implicit to all pronouncements of audit standards are welfare-economic considerations. The professional or institutional approach to auditing theory has had an impact on all four phases of the audit process depicted in Figure 1. Examples include requirements that an overall audit plan be developed, that evaluation of internal control be conducted, that accounts receivables be confirmed, and that a disclaimer be issued if sufficient evidence is not obtained.

The general audit theory domain includes the initial inquiries into the conceptual foundations of auditing. Two approaches are prevalent: (1) partially following a normative/deductive approach, the objectives of auditing are identified and auditing principles and practices are logically derived; (2) using a descriptive approach and focusing on auditing practices, principles and objectives are inferred. In both these approaches all four phases of the audit process are involved. However, rather than focusing on the phases individually, the important characteristic of the general audit theory domain is the attempt to integrate and relate the phases into an overall or general theory.

The decision theory domain focuses on the usage of decision models to arrive at intermediate and final decisions regarding the fairness of the financial statements. Decision models thus relate to the individual components of the audit process and are partitioned into the four areas displayed in Figure 2.

The overall audit planning and information economics decision models focus on the initial planning aspects of the audit and are concerned with determining the value of audit information. In preparing an audit plan,

the costs of obtaining additional evidence must be weighted against the value of that evidence in reaching the final audit conclusion.

Internal control evaluation and statistical sampling are used mainly in the field work aspect of the audit process. Internal control evaluation focuses on determining the reliance which the auditor chooses to place on the client's accounting system. Statistical sampling involves theories of evidence collection and inference used for planning the audit program. Compliance and substantive tests comprise the verification phase of the audit. Compliance and substantive tests also focus on theories of reliance, as modification in the original audit plan may be indicated as a result of this step.

The decision maker and behavioral aspects of the audit process focus on the characteristics of auditors in their decision process. This domain involves each phase of the audit process, but generally on an individual auditor basis. For example, the behavioral aspects of the auditor's decision regarding the adequacy of internal control or materiality determinations might be considered.

The technical domain of auditing concerns the tools and techniques to perform the various aspects of the audit process. It is best exemplified by the use of electronic data processing in which theories relating to data storage and retrieval are most relevant.

#### Research Approaches

In addition to considering audit research in terms of domains or major theoretical emphasis, existing research may also be reviewed in terms of the research approach utilized. This will permit a two dimensional classification of existing studies as a priori or a

posteriori. A priori studies are concerned with the theory construction level of science. Since in theory, a priori propositions are developed before being empirically tested, their validity must be evaluated through analysis alone with reliance on pure reason. There are three approaches to a priori research: (1) analytical or mathematical studies which focus on deriving relationships, (2) simulation wherein experiments are conducted on a model of the system, and (3) axiomatic approaches which rely on a formal system of deduction.

A posteriori research concerns propositions that are validated through observation and experience. This level of science involves the empirical testing and operationalization of theories. There are three approaches to a posteriori research: (1) laboratory experimentation in which the research is isolated from the realistic situation and the independent variable(s) are manipulated under tightly controlled conditions, (2) field experimentation wherein the research is conducted in a realistic setting and the independent variable(s) are manipulated with conditions as strictly controlled as possible, and (3) field (case) study which may include ex post facto investigations which seek to discover existing relationships among variables.

The various domains of auditing and possible research approaches may be used to classify past efforts to develop the field of auditing. A matrix which posits research approaches with auditing domains is found in Table 1.

The professional and technical domains of auditing have been eliminated from this paper in order to focus on those aspects of auditing research which are more directly concerned with theory formulation.



TABLE 1  
CLASSIFICATION OF AUDIT RESEARCH

| Domain<br>Research<br>Approach | General<br>Audit<br>Theory   | Decision Theory  |  |   | Decision<br>Makers   |   |
|--------------------------------|--|--|--|---|--|---|
|                                |  | Overall audit<br>planning,<br>information<br>economics           | Statistical<br>sampling  | Internal<br>control<br>evaluation   | Substantive<br>tests, analy-<br>tical review   |   |
| Analytical/<br>Mathematical    |  | Demski &<br>Swieringa<br>(1974)<br>Scott (1973)<br>Kinney(1975b) | Kaplan (1975)<br>Maxim et al.<br>(1976)<br>Deakin &<br>Granof (1974)<br>Ijiri &<br>Kaplan (1971)<br>Kinney (1975a)<br>Roberts (1976) | Cyert &<br>Davidson(1963)<br>Brown(1962)<br>Arkin (1963)<br>Tracy (1969)<br>Sorensen(1969)<br>King(1964)<br>Smith (1972)<br>Cushing(1974) | Kaplan (1973)<br>Felix (1974)<br>Kinney (1975a)<br>Loebbecke (1976)<br>Stringer (1975) |   |
| Simulation                     |  | Scott (1975)   | Teitlebaum &<br>Robinson (1975)<br>Kaplan (1973)   | Burns &<br>Loebbecke<br>(1975)  | Barkman (1977)   |   |
| Axiomatic                      | Mautz &<br>Sharaf<br>(1961)<br>AAA (1973)<br>Toba (1975)<br>Kissinger (1977) |  | Loebbecke &<br>Netter (1975)<br>Elliott &<br>Rogers (1972)   | Jancura &<br>Lilly (1977)   |  |   |
| Laboratory<br>Experiment       |  |  |  | Corless (1972)<br>Chesley (1975)<br>Felix (1976)  |  | Corless (1972)<br>Ashton (1974a, b)<br>Hofstedt &<br>Hughes (1977)                      |
| Field<br>Experiment/<br>Survey |  |  | Sauls (1970)<br>Hubbard &<br>Strawser (1972)<br>Hansen & Shaftel<br>(1977)<br>Bedingfield (1975)                                     |   |  | Joyce (1976) Boatsman<br>Moriarity &<br>Barron (1976) Robertson<br>Newton (1977) (1974) |
| Field (Case<br>Study           |  |  |  |   |  |   |

This paper covers a representative subset of the universe of audit research studies and does not aim to be comprehensive in scope. The studies from this subset (identified by their authors) are contained in the matrix and discussed in the following section only in terms of their underlying theories and research findings.

### III. REVIEW OF SELECTED DOMAINS OF AUDIT RESEARCH AND THEIR UNDERLYING THEORETICAL FOUNDATIONS

#### General Audit Theory

As seen in Table 2, only four major studies have taken an approach to auditing theory formulation which focuses on an integrated model of auditing. The first major attempt to developing a general theory of auditing was that of Mautz and Sharaf (1961). While using an axiomatic approach, the study relied on the inductive method to identify concepts relevant to the theory of auditing. The procedures utilized by practicing auditors were first observed. From these observations five concepts were drawn which pervade the auditing process: evidence, due audit care, fair presentation, independence, and ethical conduct. These concepts were evaluated in terms of the philosophical foundations and postulates which underlie auditing theory. Since Mautz and Sharaf addressed what the concepts ought to be ("ideal" concepts), their work can be considered normative in nature.

A Committee of the American Accounting Association (1973) provided a second major general audit approach to developing theory. A normative, deductive orientation was utilized, beginning with definitions of the relevant concepts and the deviation of relations among these concepts. The objectives of auditing and assumptions which delimit the audit environment provide the theoretical framework. Of major consideration as assumptions are the information needs of financial statement users and the

TABLE 2

SUMMARY OF GENERAL AUDIT THEORY RESEARCH

| Reference                  | Research Approach                   | Underlying Theories                      | Audit Problem Addressed   | Research Results   |
|----------------------------|-------------------------------------|--|---|--|
| 1. Nautz and Sharaf (1961) | Axiomatic<br>Inductive<br>Normative |  | Concepts underlying auditing theory                             | Five concepts which pervade auditing: Evidence, due audit care, fair-presentation, independence, ethical conduct |
| 2. AAA (1973)              | Axiomatic<br>Deductive<br>Normative |  | Deduce a theory of auditing                                     | Identification of objectives, postulates, principles, standards  |
| 3. Toba (1975)             | Axiomatic<br>Deductive<br>Normative | Theory of evidence and evidential matter | Process of reasoning between a proposition and evidence         | Basic reasoning pattern in auditing is heuristic, focusing on elementary propositions and persuasion             |
| 4. Kissinger (1977)        | Axiomatic<br>Deductive<br>Normative | Theory of evidence                       | Possible states regarding the evidence concerning a proposition | Necessary and sufficient conditions for various audit opinions   |

value added by the audit function to those needs. Principles and standards are next addressed in the discussion of how the objectives of auditing are achieved. This discussion considers (1) warranted assertions, (2) propositions, truth, and validity, (3) perceptions, and (4) rational argument in the investigative process. Achieving the objectives of auditing is further discussed in the reporting process with consideration given to the communication, presentation, information receiver, and user behavior aspects of an audit.

The role of theory in providing a conceptual foundation for the audit process of reasoning between a proposition and evidence has been addressed by Toba (1975). The focus is upon the concepts of evidential matter and evidence as the basis for reaching a conclusion about a proposition. Toba asserts that the basic reasoning pattern in auditing is heuristic, where greater consideration is given to elementary propositions and the focus is on persuasion rather than proof. This is a normative, deductive approach, since Toba is concerned with basic concepts and their implications to auditing theory and practice.

Kissinger (1977) recently extended and modified Toba's analysis and identified three possible states regarding the evidence concerning a proposition. A normative definition of the necessary and sufficient conditions which must be obtained for the various audit opinions which may be issued was offered by Kissinger.

Audit Research Concerned With  
Decision Theory And Decision Models

In contrast to the few works that may be classified in the general audit theory domain, a large number of audit studies are directly related to decision theory or decision models. This body of research will be discussed in terms of the four areas contained in Figure 1: overall audit planning, statistical analysis, internal control evaluation, and substantive tests. The emphasis of the discussion will be on the underlying theory of these aspects of auditing, the current status of research findings and areas for future research.

Most auditing research concerned with decision theory and decision models uses the analytical approach, although a few studies also involve the use of simulation or an axiomatic approach. Table 3 contains the major published audit research into decision theory and decision models. Note that most quantitative analysis techniques have been applied in this area, particularly those based on economics and statistical theories.

1. Overall Audit Planning and Information Economics

Audit planning requires a systematic approach and the identification of audit objectives. Information economics offers a cost/benefit analysis of audit planning and implementation. This phase necessitates the identification of audit objectives and the development of an overall strategy. Ijiri and Kaplan (1971) view the audit problem in terms of a vector of possibly inconsistent objectives. The question of how such objectives should be measured and ranked remains unanswered.

Demski and Swieringa (1974) proposed a normative model of the audit choice problem that explicitly recognizes auditor-management

TABLE 3

SUMMARY OF PUBLISHED AUDIT RESEARCH ON DECISION THEORY  
AND DECISION MODELS

| Reference                       | Research Approach   | Underlying Theories  | Audit Problem Addressed  | Research Results   |
|---------------------------------|---|--|--|--|
| <u>I. Information Economics</u> |   |  |  |  |
| 1. Demski and Swieringa (1974)  | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul>             | Decision Theory<br>Information Economics<br>Bayesian<br>Syndicate Theory | Modeling of audit choice problem with a limited amount of cooperation between auditor and auditee                  | Developed a single-audit, single-period model of the audit choice problem in terms of maximization of an expected utility function such that the auditor and auditee jointly share in the audit's direct consequence   |
| 2. Scott (1973)                 | <ul style="list-style-type: none"> <li>• Analytical, Simulation</li> <li>• Normative</li> </ul> | Bayesian<br>Economic Theory<br>Utility Theory<br>Capital Market Theory   | Modeling of the auditor's overall balance sheet problem with respect to specific user's normative decision problem | Developed a model of the auditor's overall balance sheet problem as mirroring the risk preferences and beliefs of some representative investor.<br><br>Examination of the opportunity losses of an investor due to the auditor's errors. This loss function may be tied to Bayesian approach to the auditor's decisions. |
| 3. Kinney (1975b)               | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul>             | Decision Theory<br>Systems Theory  | Modeling the integration of the role of internal control system design, compliance tests and substantive tests.    | Developed a decision theory approach to arrive at the optimum strategy to the problem of audit evidence with respect to the correct mix of compliance tests and substantive tests.   |

| Reference                       | Research Approach  | Underlying Theories                         | Audit Problem Addressed             | Research Results  |
|---------------------------------|--|---|-------------------------------------|---|
| 4. Scott (1975)                 | <ul style="list-style-type: none"> <li>• Simulation Analytical</li> <li>• Normative</li> </ul> | Consumption-Investment Model                | Auditor's loss function             | Optimal point estimate financial statements may be biased. Determination of the auditor's loss function   |
| 5. Ijiri & Kaplan (1971)        | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul>            | Statistical Theory Mathematical Programming | Sampling Objectives                 | Establishing four cutoff points that satisfy the four objectives set forth. Discusses the role of prior information by the auditor concerning the population and its sampling implication. Formulates an integrated approach. |
| <u>II. Statistical Sampling</u> |  |   |                                     |   |
| 1. Loebbecke & Neter (1975)     | <ul style="list-style-type: none"> <li>• Axiomatic</li> <li>• Normative</li> </ul>             | Systems Theory                              | Choice of sampling procedure        | Determination of the factors to be considered in choosing a sampling plan: objectives, environment & characteristics of sampling plans  |
| 2. Teitlebaum & Robinson (1975) | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul>            | Statistical Theory Risk Preference          | Risk in audit Sampling              | Beta risk may exceed stated risk. Dollar unit sampling may be worthy of consideration   |
| 3. Kaplan (1975 a)              | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul>            | Statistical Theory                          | Sample size in dollar unit sampling | Procedure allows to calculate in advance and correctly a sample size that will control $\alpha$ & $\beta$ errors in dollar unit sampling  |
| 4. Maxim Cullen & Cook (1976)   | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul>            | Sensitivity Analysis Statistical Theory     | Sampling plans and their costs      | Propose a cost effective sequential sampling plan that includes batching  |

| Reference                    | Research Approach  | Underlying Theories                     | Audit Problem Addressed | Research Results   |
|------------------------------|--|---|-------------------------|--|
| 5. Deakin & Granof (1974)    | <ul style="list-style-type: none"> <li>Analytical</li> <li>Normative</li> </ul>            | Regression Theory                       | Sample sizes            | Propose use regression analysis in forecasting exceptions & estimating sample sizes  |
| 6. Hubbard & Strawser (1972) | <ul style="list-style-type: none"> <li>Survey Research</li> <li>Descriptive</li> </ul>     |   | Sampling Objectives     | The survey of 250 auditors under strong support for representativeness; some support for protection & prevention & strong disagreement with the correction criterion         |
| 7. Kinney (1975a)            | <ul style="list-style-type: none"> <li>Analytical</li> <li>Mixed</li> </ul>                | Stat. Theory<br>Neyman Allocation Model | Sampling Objectives     | The four sampling objectives proposed by Ijiri & Kaplan are actually two.  |
| 8. Kaplan (1973)             | <ul style="list-style-type: none"> <li>Simulation Analytical</li> <li>Normative</li> </ul> | Parametric Statistics Assumptions       | Sampling Problems       | Traditional statistics & distribution fail to fairly represent audit sample populations in many cases.   |
| 9. Hansen & Shaftel (1977)   | <ul style="list-style-type: none"> <li>Field Study</li> <li>Descriptive</li> </ul>         | Mathematical Programming                | Sampling Objectives     | The Ijiri Kaplan mathematical programming formulation is a useful accounting tool and can be solved at small cost via a computer program.                                    |
| 10. Sauls (1970)             | <ul style="list-style-type: none"> <li>Field Study</li> <li>Descriptive</li> </ul>         | Statistical Theory                      | Nonsampling Errors      | Statistical Sampling models do not consider improper responses and non-responses. This may lead the auditor to be greatly in error.  |
| 11. Roberts (1976)           | <ul style="list-style-type: none"> <li>Analytical</li> <li>Normative</li> </ul>            | Statistical Theory                      | Sampling Plans          | A sequential sampling plan can be developed based on modifying the sequential probability ratio test that is:<br>(1) simple, (2) controls both tests (3) saves observations. |



| Reference                   | Research Approach   | Underlying Theories                            | Audit Problem Addressed                        | Research Results  |
|-----------------------------|---|--|--|---|
| 12. Bedingfield (1975)      | <ul style="list-style-type: none"> <li>• Survey</li> <li>• Descriptive</li> </ul>   | Sampling Theory                                | Actual use of statistical sampling in auditing | Estimation and discovery sampling are widely used particularly in transaction and balance verification testing. The advantages of sampling are objectivity and costs while its main disadvantage is difficulty in understanding. Standard sampling procedures seem to exist in most firms |
| 13. Elliott & Rogers (1972) | <ul style="list-style-type: none"> <li>• Axiomatic</li> <li>• Normative</li> </ul>  | Statistical Theory                             | Recommendation of a sampling plan              | Reviews the statistics & objectives around the development of a sampling plan   |
| 14. Ijiri & Kaplan          | <ul style="list-style-type: none"> <li>• Analytical</li> <li>• Normative</li> </ul> | Statistical Theory<br>Mathematical Programming | Sampling Objectives                            | Establishing four cutoff points that satisfy the four objectives set forth<br>Discusses the role of prior information by the auditor concerning the population and its sampling implication. Formulates an integrated approach.   |

| Reference   | Research Approach                                 | Underlying Theories                                     | Audit Problem Addressed  | Research Results   |
|---|---|---|--|--|
| III. Internal Control Evaluation                                      |   |   |  |  |
| 1. Cyert & Davidson (1963)<br>Arkin (1963)                            | •Analytical<br>•Normative                         | Classical Statistical Hypothesis Testing and Estimation | Internal Control Compliance Tests  | Demonstrated examples  |
| 2. Tracy (1969)<br>Sorensen (1969)<br>Smith (1972)<br>Knoblett (1970) | •Analytical<br>•Normative                         | Bayesian  | Whether to extend audit procedures; relationship between internal control and audit size | By considering both the costs of auditor's investigation and of failing to make investigations the Bayesian statistical method would be preferable to the classical method.  |
| 3. Brown (1962)<br>King (1964)<br>Cushing (1974)                      | •Analytical<br>•Normative                         | Mathematical Optimization Theory                        | Evaluation of internal controls  | Demonstrated the mathematical approach and/or statistical basis for audit reliance on internal control   |
| 4. Corless (1972)<br>Chesley (1975)<br>Felix (1976)                   | •Laboratory Experiments<br>•Descriptive<br>•Mixed | Subjective Probabilities Elicitation Theory             | Assessing prior probability distributions  | Auditors were willing to specify information from which prior distributions can be conducted; there were substantial inconsistencies in the way some auditors specified information about the prior distributions. |
| 5. Burns & Loebbecke (1975)   | •Axiomatic Simulation<br>•Normative               | Systems Theory  | Evaluation of internal controls  | A computer-simulation of internal controls in which alternative combinations are evaluated through test checks   |
| 6. Jancura & Lilly (1977)   | •Axiomatic<br>•Mixed                              |   | Evaluation of internal controls  | Discussed SAS #3 on evaluating internal controls in an EDP environment   |

| Reference   | Research Approach                                 | Underlying Theories                  | Audit Problem Addressed                          | Research Results   |
|---|---|--------------------------------------|--|--|
| IV. <u>Substantive Tests and Analytical Review</u>    |   |                                      |  |  |
| 1. Kaplan (1973)                                      | • Analytical<br>• Normative                       | Stochastic Process                   | Estimating Error Rate and Distribution of Errors | Proposed a stochastic model for variables estimation   |
| 2. Felix (1974)<br>Kinney (1975a)<br>Loebbecke (1976) | • Analytical<br>• Normative                       | Decision Theory Sensitivity Analysis | Estimating the true dollar value of an account   | Demonstrated the decision theory approach to variable estimation and factors which will affect the auditors' final decision and expected utility             |
| 3. Barkman (1977)                                     | • Analytical; Simulation<br>• Normative           | Within Item Variation                | Interval estimation                              | Proposed and demonstrated an approach to obtain the distribution of a particular account item value and construct credence interval for various sample sizes |
| 4. Stringer (1975)                                    | • Analytical<br>• Normative                       | Regression Analysis                  | Identifying unusual fluctuations                 | Regression analysis could be an important tool for auditors to assist in making judgments as to the reasonableness of reported balances                      |
| 5. Albrecht and McKeown                               | • Laboratory Study<br>• Analytical<br>• Normative | Statistical Theory                   | Analytical Review                                | Regression analysis and Box Jenkins time series analysis seemed to perform well on real audit data for analytical review purposes.                           |

interrelationships by allowing for a limited amount of cooperation between the two. Using the framework of information economics a single-period model of the audit choice problem was developed in terms of the maximization of an expected utility function such that the auditor and management jointly share in the audit's direct consequences.

Scott (1973) presented a general model of the auditor's choice problem from a decision theory point of view. The audit problem was related to the capital market by viewing the auditor as mirroring investors' risk preferences and beliefs. The auditor was viewed as selecting a vector of balance sheet numbers to summarize posterior probability distributions of the audited firm's balance sheet parameters. In a second article Scott (1975) used a specific, well-defined, normative decision problem where unaudited financial statements have potential usefulness, and assessed the auditor's implicit loss function. The problem for the auditor becomes one of choosing the balance sheet valuation numbers so as to minimize expected utility loss. Simulation was then used to investigate the shape of the auditing loss function and the costs, to users, of uncertainty in the reported numbers.

Another information economics approach to the overall audit process is a model proposed by Kinney (1975b). The role of internal control system design, compliance testing, analytical review and tests of details in audit planning are integrated. Kinney developed a decision theory approach to arrive at an optimum strategy to the problem of audit evidence with respect to the correct mix of compliance tests, tests of details and analytical review.

## 2. Statistical Sampling

Statistical sampling deals with the evidence collection strategy in terms of approach, sample size and inference. Bayesian analysis and optimization techniques can be applied in the sampling process to determine optimal sample sizes. The objective of statistical sampling is the selection of a sample with known precision and reliability, yielding an economic resolution of the auditor's basic attestation question. Sampling involves the extrapolation from an audited sample to the entire population and can be applied to the different phases of the audit process. This possibility has been extensively discussed in relation to sampling objectives (Ijiri and Kaplan, 1971; Hubbard and Strawser, 1972; Hansen and Schaftel, 1977). One of the important questions in sampling was observed by Saul (1970) when considering the effect of nonsampling errors on sampling plans. Different audit objectives will lead to diverse sampling objectives and perhaps to alternate sampling approaches such as the ones prescribed by Ijiri and Kaplan (1971): representative sampling, corrective sampling, protective sampling and preventive sampling. Ernst & Ernst (1976), on the other hand, lists five audit sampling objectives: protection, estimation, correction, prevention and discovery.

Figure 3 summarizes the key sampling issues to be discussed. The accept decision means that the auditor concluded that the book value is not materially in error.

Figure 3

Errors and the Auditor's Decision

| Decision | State of Nature      |                          |
|----------|----------------------|--------------------------|
|          | Materially Misstated | Not Materially Misstated |
| Accept   | Beta error           | Correct Decision         |
| Reject   | Correct Decision     | Alpha error              |

Alpha errors occur when a sample leads to an incorrect rejection decision while beta errors occur when a sample leads to an incorrect acceptance decision. Sampling is used for two interdependent purposes: estimation and hypothesis testing. Attribute sampling estimates the rate of occurrence of a certain attribute. Estimation can be performed through a variety of methods including simple extension, difference and ratio techniques.

Sampling involves choosing a subset of the total population, valuing this subset in relation to one of its attributes, extrapolating the total population value based on the sample total, and testing hypotheses to evaluate if the sample total is significantly different from the company's book value. Reliability is calculated through the integration of sample reliability, internal control reliability, and the acceptable range for errors. The comparison of the sample-based estimation and the book value and the allowable error lead to the acceptance or rejection of the basic representativeness hypothesis. In the event of a rejection, further procedures can be used to expand the sample and reestimate the allowable range. Efficiencies on the process may be gained by the method proposed by Roberts (1976).

An interesting extension of classical statistical sampling (Felix, 1974) is the use of Bayesian theory to improve sampling estimation. Bayesian methods are particularly useful for field auditors in those situations which require reestimation once the sample characteristics are known.

### 3. Internal Control Evaluation and Compliance Tests

Internal control evaluation involves the scrutiny of the features of the internal control system as well as compliance testing. Among the many forms of internal control evaluation that have been proposed, three main lines of thought stand out: (1) the analytical school which suggests mathematical approaches to systems evaluation (Brown, 1962; King, 1964; Cushing, 1974), (2) the Bayesian school which applies Bayesian revision and decision theory to compliance testing (Tracy, 1969; Knoblett, 1970; Corless, 1972) and (3) the systems school which brings in concepts from computer systems analysis to the evaluation of internal controls (Burns and Loebbecke, 1975; AICPA, SAS #3).

One important aspect of internal control evaluation is the tests of system operation and design compliance, wherein, the auditor uses sampling techniques to estimate the error rate. The process is called attribute estimation.

Statistical sampling for compliance testing in auditing has often been advocated (Cyert and Davidson, 1963; Arkin, 1963). Most of the literature shows the use of classical statistical techniques in auditing. Some exceptions will be mentioned. Tracy (1969) explored the advantage of using Bayesian estimation in compliance testing. He demonstrated how a

nondiffuse prior distribution over the relevant states of nature can result in greater confidence, for a given sample size, than classical methods. Sorensen (1969) also illustrated a Bayesian approach to compliance testing by explicitly considering the cost of an auditor's investigation and the cost of failing to make investigations. Smith (1972) addressed the relationship between internal controls and audit sample size remarking that both involve subjectivity. He argued that Bayesian methods enable the auditor to bring a subjective judgment to bear in a more insightful manner.

One major problem in applying Bayesian statistics in auditing is assessing prior distributions of the audit population, e.g., error rate distributions in an internal control procedure. Corless (1972) conducted a payroll error rate laboratory experiment in which 88 auditors were asked to express prior probability distributions. In this experiment he used two assessment methods: (1) the method of fractiles (bisection), and (2) a fixed interval method. Results indicated that auditors are willing to specify information from which prior distributions can be constructed, but there are substantial inconsistencies in the way some auditors specify information about the prior distributions. Felix (1976) asked 10 auditors in individual interviews to assess their prior probability distributions based on a case description of an order-receiving, shipping and billing system. The subjects were asked to assess their prior distributions using two methods: (1) the method of fractiles (bisection), and (2) inferring prior probabilities from the subject's beliefs regarding an equivalent prior sample. The second method may appear useful for auditors, but is still in need of future research. Chesley (1975) presented a review of



subjective probability elicitation techniques which may help in understanding different techniques.

#### 4. Substantive Tests

Substantive testing includes both analytical review as well as tests of details. Analytical review uses both financial ratio analysis and regression analysis. In the auditing procedure of tests of details the auditor would like to estimate the true dollar value of an account. This is called variables estimation. Kaplan (1973) proposed a stochastic model which focused attention on the need to estimate two different parameters in an audited population: the error rate and the distribution of errors for items found to be in error. Scott (1973) (see the Information Economics section of Table 3) presented a general model of the auditor's overall balance sheet problem, estimation of the true dollar values of balance sheet accounts, from a decision theory point of view. The statistical model indicated how the auditor can obtain posterior distributions from which the balance sheet point estimate is prepared.

Felix (1974) advocated a decision theory view of substantive tests. He explored the problem of deciding whether to examine additional audit evidence by considering not only relative probabilities, but also the costs and benefits involved. Kinney (1975a) also proposed a decision theory approach to variables estimation. A sensitivity analysis was conducted in relation to the misspecification of parameters concerning the audit decision model. The decision seemed to be sensitive to variable sampling cost and the ratio of material error to the standard deviation. Loebbecke (1976) discussed the use of decision theory in auditing from a practitioner's point of view. Some factors which affect the risk of issuing an unqualified opinion when material error exists in the financial

statements were indicated. He concluded that formal decision theory is a valuable approach for allocating scarce audit resources to the various audit areas.

One of the problems in variables estimation is the estimation of the population's expected value and variance. Barkman (1977) used computer simulation to generate a particular accounting item's values and thus obtain the distribution of this item and construct a credence interval for various sample sizes. He formally recognized the stochastic nature of accounting data, especially the variation existing among the possible values of a random variable (within item variation). It was demonstrated that a credence interval provides an auditor with a quantitative measure of the impact of within item variance.

Analytical reviews are generally limited to analysis of financial data. The analytical review process involves two steps: (1) the identification of any unusual fluctuations, and (2) the investigation of such fluctuations. Most of the audit firms use relatively unsophisticated statistical routines such as ratio analysis and visual comparisons with other data and rely on simple modeling techniques to analyze financial data. Stringer (1975) suggests that regression analysis can be an important tool to assist auditors in making judgments regarding the reasonableness of reported balances. Because regression analysis is an objective technique, Stringer felt it could be useful in quantifying the degree of reliability from substantive tests. He did note, however, that judgment is needed to assess potential causal relationships and avoid invalid conclusions and generalizations. Albrecht and McKeown (1977) added the Box Jenkins method as one of the tools that may be used in analytical review with results tentatively stated as being as reliable as the regression method.

## 5. Conclusions on Decision Theory and Decision Models

Many decision theory studies have been discussed, in particular those dealing with statistical sampling. The research questions cover the same topics as in the classical statistical sampling process. Among these are questions concerning sampling objectives (Ijiri and Kaplan, 1971), questions concerning actual sample distribution and population (Kinney, 1975a), questions concerning sample size determination (Deakin and Granof, 1974), and questions concerning sampling methods (Kaplan, 1975; Maxim, Cullen and Cook, 1976). Two views of sampling dominate: (1) the systems view and (2) the matching of particular sampling plans and techniques to particular audit questions and situations.

The area of evaluation of internal controls is probably the one in most need of research. Problems here are elusive and hard to quantify. These evaluations have usually proceeded with a checklist, based on traditional audit procedures with modifications when problem areas are perceived. It is therefore rather heuristic and does not take into consideration the overall system of internal controls. A systems approach to this evaluation would be far more desirable. This approach would allow for the examination of another problem that has been ignored in the literature: the effect of overlapping internal controls. This could also be combined with set theory for the representation of interdependent internal controls and used for the development of some type of optimal strategy in the design of these same controls.

Finally, the area of substantive tests have been much more thoroughly explored in the professional and institutional literature as well as in academic research and textbooks in response to the day-to-day needs of audit work and teaching. This area is deemed as the least promising for major research breakthroughs.

Audit Research Concerned  
with Auditors as Decision Makers

The previous section was concerned with auditing decisions without consideration of human information processing (HIP) aspects. Research into the behavioral aspects of auditor decision models has resulted in a number of primarily descriptive theories as to the structure of the underlying judgmental models (i.e., linear, configural, distributive, etc.) and with regard to the weighting (scaling) of various cues (i.e., the ratio of an item to net income may explain 70 percent of the variability of materiality judgments). At the same time there are normative theories, such as Bayes' Law, which indicate how cues should be processed into auditor judgments. Figure 4 contains the major theories which underlie the audit research on auditors as decision makers. These theories are classified in terms of their normative/descriptive orientation.

Audit research on human information processing has dealt with a number of auditor judgments such as (1) evaluation of the quality of internal control systems (Ashton, 1974a,b), (2) specification of subjective prior and posterior distributions for payroll errors given internal control and sample cues (Corless, 1972), (3) determination of the amount and types of substantive tests to conduct on receivables (Joyce, 1976) and (4) materiality-disclosure decisions (Moriarity and Barron, 1976; Newton, 1977; Hofstedt and Hughes, 1977). Each of these studies may be summarized in terms of the research approach used, the (sometimes implicit) theory tested, the audit problem addressed and research findings as in Table 4.

TABLE 4

SUMMARY OF PUBLISHED AUDIT RESEARCH  
ON DECISION MODELS AND HIP

| Reference            | Research Approach  | Underlying Theories  | Audit Problem Addressed   | Research Results   |
|----------------------|--|--|---|--|
| 1. Ashton (1974a, b) | <ul style="list-style-type: none"> <li>Laboratory Experiment</li> <li>Descriptive</li> </ul>     | <p>I. <u>Individual Level of Analysis</u></p> <ul style="list-style-type: none"> <li>Lens-Type Models</li> <li>Consensus Consistency</li> </ul>                  | Modeling of Internal Control Strength Judgments   | <p>Simple linear model performed well</p> <p>Individual differences were significant</p> <p>Interjudge ratings were highly correlated (.7) which indicates consensus</p> <p>Ratings over time were highly correlated (.8) which indicates consistency</p> <p>Significant self-insight was observed</p>   |
| 2. Corless (1972)    | <ul style="list-style-type: none"> <li>Laboratory Experiment</li> <li>Mixed</li> </ul>           | <ul style="list-style-type: none"> <li>Bayesian Individual Differences</li> <li>Conservatism</li> </ul>  | Evaluation of Auditor probability judgments (priors and posteriors) concerning error distributions in payroll | <p>Judgmental priors based on identical cues exhibited significant variation among auditors</p> <p>Priors were not consistent upon retest in one fourth of cases</p> <p>Judgmental posteriors differed from Bayesian in terms of characteristic values (i.e., mean, median) and effect of sample size (i.e., conservative)</p> <p>Auditors seemed to utilize classical approach (ignoring priors) when sample error rate was high</p> <p>Most demographic differences had no effect on judgments</p> |
| 3. Joyce (1976)      | <ul style="list-style-type: none"> <li>Field Experiment (Survey)</li> <li>Descriptive</li> </ul> | <ul style="list-style-type: none"> <li>Lens-Type Models</li> <li>Individual Differences</li> <li>Consensus</li> <li>Consistency</li> <li>Self-Insight</li> </ul> | Modeling of judgments concerning type and amount of substantive accounts receivable tests to perform          | <p>Simple linear models performed well</p> <p>Significant individual differences in weighting of cues</p> <p>Less consensus than found by Ashton (1974)</p> <p>High judge consistency upon retest</p> <p>Less self-insight than found by Ashton</p>  |

| Reference                              | Research Approach  | Underlying Theories   | Audit Problem Addressed  | Research Results   |
|--|--|---|--|--|
| 4. Moriarity and Barron (1976)         | <ul style="list-style-type: none"> <li>Field Experiment</li> <li>Descriptive</li> </ul>      | Lens-Type Models<br>Individual Differences                                | Modeling ordinal materiality judgments in terms of structure and weight-<br>of cues.         | Models from conjoint measurement differed significantly among auditors (8 additive, 3 nearly additive, 4 configural)<br>Significant difference on cue weightings and direction of effect                                 |
| 5. Newton (1977)                       | <ul style="list-style-type: none"> <li>Field Experiment</li> <li>Normative</li> </ul>        | Utility Risk Preference   | Effect of item uncertainty and individual risk preference on materiality judgments           | Auditors are not risk neutral<br>Auditor risk preferences were reasonably consistent<br>Item uncertainty and risk preference effects were significant determinants of judgments  |
| 6. Hofstede and Hughes (1977)          | <ul style="list-style-type: none"> <li>Laboratory Experiment</li> <li>Descriptive</li> </ul> | Lens-Type Models<br>Individual Differences<br>Convergence<br>Self-Insight | Modeling of materiality judgments in terms of environmental variables and prior dispositions | Simple linear models performed well (as well as configural, better than aggregate)<br>Significant individual differences in terms of cues attended to and weightings<br>Little evidence of convergence                   |
| II. <u>Aggregate Level of Analysis</u> |  |   |  |  |
| 1. Hofstede and Hughes (1977)          | See above  | See above   | See above  | Simple linear model has moderate explanatory power ( $R^2 = .40$ ) with configural model adding little<br>Subject's self-insight into cue weightings tended to overweigh value of minor cues (i.e., perceptual leveling) |
| 2. Boatsman and Robertson (1974)       | <ul style="list-style-type: none"> <li>Field Experiment</li> <li>Descriptive</li> </ul>      | Lens-Type Models  | Modeling of materiality judgments based on environmental (company related) cues              | Aggregate model (based upon discriminant analysis) reasonably accurate in predicting individual judgments<br>Single cue explained most of judgment with two others contributing (3 cue model outperformed 1 cue model)   |

Figure 4

Major Theories Underlying Audit Research into the Human Information Processing Aspects of Decision Models

| Primarily Normative Theories  | Mixed Theories  | Primarily Descriptive Theories  |
|---|---|---|
| Utility<br>Subjective Expected Utility<br>Risk Preference<br>Bayesian | Convergence<br>Consistency<br>Consensus<br>Conservatism | Lens-type Models:<br>Additive<br>Linear<br>Configural<br>Distributive<br>Individual Differences<br>Self-Insight |

First consider research related to the normative theory category contained in Figure 4. The referenced theories provide guidance as to how cues should be processed into posterior probabilities (Bayes' Law); how preferences should operate to be consistent; and how risk, uncertainty and preference should be combined into decision rules (subjective expected utility theory). Audit research in this area is only generally consistent with theory. Although auditors are able to specify materiality-uncertainty indifference points in ways that are consistent with imputed risk preferences (Newton, 1977), some decision inconsistencies were noted. There is also some evidence that auditors, like other researched subjects, do not always impound priors and cues into posteriors in accordance with Bayes' Law. In cases where sample evidence varies significantly from priors which are based on internal control evaluations, posteriors are generated in ways more akin to classical statistics (Corless, 1972).

A larger number of studies has focused on decision models in the descriptive categories of Figure 4. The development of descriptive theory is often an attempt to induce general laws based upon observation. In the decision models and human information processing areas, this involves questions concerning the structure of the underlying HIP model and the weighting (scaling) of various cues.

At the the individual decision maker level, descriptive research has emphasized questions of model structure, cue weightings and the significance of individual differences. Based on conducted research, simple linear models explain the greatest proportion of judgment variance (Ashton, 1974a; Joyce, 1976; Hofstedt and Hughes, 1977). In contrast, a recent study by Moriarity and Barron (1976) has identified significant numbers of estimated models of materiality judgments which are configural. Each of these studies has also observed significant individual differences among auditors in the apparent weightings of cues.

Theories which have been categorized as "mixed" are also included in Figure 4. They involve the empirical description of human information processing where standards of comparison exist such as consistency which involves reaching the same judgment when identical cues are available. The empirical results in the mixed theory category concerning the convergence, consensus and consistency of auditor judgment is somewhat mixed. Although some studies (Ashton, 1974a,b) have observed what has been labeled an encouraging amount of consensus and consistency, others (Joyce, 1976) are less encouraging.

Decision models have also been studied on a group (aggregate) basis. Hofstedt and Hughes (1977) investigated HIP models which were common to



all subjects and found that about forty percent of overall variance in materiality judgments could be explained with a simple linear model. Similarly, Boatsman and Robertson (1974) derived a discriminant function which could predict auditor materiality judgments accurately, based upon three cues.

In summary, audit research into decision models focusing on HIP and judgment is in an early state of development. As a research area from which audit theory may be derived, it still suffers from both lack of research and lack of accepted theory in related disciplines such as psychology. This is in part a result of the complexity of human judgment as is evident in the referenced audit studies which show significant individual differences.

#### IV. SUMMARY AND CONCLUSIONS

The objective of this paper was to synthesize major audit research efforts and thus identify a common link or underlying audit theory. Four phases of the audit process as performed in practice were identified and auditing theory was divided into five key domains. Emphasis was given to three domains: general audit theory, decision theory/decision models and decision makers/behavioral. The indepth analysis of the literature in these three areas led to Tables 2,3, and 4 which classify and describe some of the more important contemporary audit research works.

A tentative integrated model is needed to integrate the key phases and theories underlying audit research related to decision theory/decision models. This integrated model would allow for the utilization of diverse approaches such as information economics, statistical sampling and Bayesian revision in the testing of a single hypothesis.

A few suggestions were proposed throughout the paper and ensued directly from obvious hiati in the literature examined. A systems approach to internal controls evaluation was suggested. The examination of internal controls in terms of set theory and the analysis of overlaps was found to be potentially fruitful. The discussion of applications of information economics to the different aspects of the audit process found a void in the literature concerning cost benefit analysis of the tradeoffs between internal control evaluations and substantive testing.

A set of more creative and tentative research suggestions would entail approaches such as: (1) the utilization of pattern recognition techniques in the identification of abnormal trends in audit data, (2) the development of an additional reliance term in the combined reliance equation that represents biases in the auditor's information processing approach (e.g., conservatism), (3) utilization of factor analysis for the analytical review process, and (4) breakdown of the individual key audit decisions and evaluation of their interrelationships. In conclusion, auditing would benefit most from original and creative approaches to the resolution of the real problems that auditors face in their day-to-day routines.

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