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Research on the Nature, Characteristics, and Causes of Accounting Errors: The Need For a Multi-method Approach

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**RESEARCH ON THE NATURE, CHARACTERISTICS,
AND CAUSES OF ACCOUNTING ERRORS:
THE NEED FOR A MULTI-METHOD APPROACH**

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ABSTRACT

Knowledge of the occurrence and detection of errors in accounting populations is of great importance to auditors in assessing risks, evaluating the efficacy of statistical sampling methods, and planning effective and efficient audit procedures to address risks. A significant body of research exists that examines these issues. Prior studies have focused primarily on auditor-detected errors. A basic assumption of these studies is that detected errors are an accurate reflection of all significant errors present. That is, there are not a substantial number of undetected errors, or that undetected errors share the same characteristics (e.g., error direction) as detected errors. However, little evidence exists regarding the accuracy of this assumption. Further, there has been little consideration of factors that may affect differences between detected and actual errors and the implications of these differences on research conclusions.

This paper presents a model of the variables involved in the error generation and error detection processes. Variables that have been explored in prior research are discussed along with those requiring further investigation. Finally, the paper identifies confounding variables to be controlled in future studies and makes suggestions for improving extant error study methods.

RESEARCH ON THE NATURE, CHARACTERISTICS, AND CAUSES OF ACCOUNTING ERRORS: THE NEED FOR A MULTI-METHOD APPROACH

1.0 INTRODUCTION

Over the past twenty years, a significant amount of research has focused on the nature, characteristics, and causes of errors in accounting records. This body of literature, known collectively as “error studies,” was performed primarily by gathering data of actual errors detected by auditors as reported in audit working papers (e.g., Bell, et al. [1998]; Maletta and Wright [1996]; Wright and Ashton [1989]).¹ Kreutzfeldt and Wallace [1986] contains a summary of the error studies prior to 1986. More recently, Eilifsen and Messier [1999] extend Kreutzfeldt and Wallace’s work by reviewing error studies through 1999.

Error studies contribute to our knowledge of the characteristics of **detected** errors (e.g., frequency and direction) and are used to make inferences about the population of accounting errors. However, the extent to which **detected** errors are, in fact, representative of the broader population (including **undetected** errors) remains an open and important question. Conflicting results in some of these studies led Kreutzfeldt and Wallace to “encourage future research to further explain and reconcile disparate findings to date” [1990a, p. 47]. More than a dozen studies have been published since that time, yet the need to provide a further understanding of the divergent findings is still present.

The purpose of this paper is to model the error generation and detection processes and review the prior literature within that framework. Importantly, through the literature review, we

¹ The findings from this research do not distinguish between unintentional and intentional (fraud) errors. This is most likely because auditors report very few instances of fraud (Loebbecke et al. 1989), since the incidence of fraud

trace back to the first error studies (simulations on the effectiveness of statistical sampling techniques), and follow the evolution to archival studies of **detected** errors. Doing so reveals which variables in the model have been explored, and which variables require further exploration, representing promising avenues for future research. The objectives of the paper are to identify potential factors that may help explain the conflicting results of prior studies and to provide suggestions for improving error study methods.

The remainder of the paper is divided into four sections. The next section presents a model of the error generation and error detection processes. The model includes the relationship between errors and inherent and control risks, as well as consideration of a number of other important factors, such as the design and execution of audit tests. Section 3.0 provides a review of the literature, showing which variables of the model have been explored in prior research. Implications of the model and suggestions for future research are discussed in Section 4.0, followed by a summary and conclusions in the final section.

2.0 MODEL OF THE ERROR GENERATION AND DETECTION PROCESSES

The motivation for error studies originated with research on the use of statistical sampling in auditing. In testing the effectiveness of various sampling methods, assumptions were required regarding the frequency and distribution of accounting errors. Kaplan used simulations to test auxiliary information estimators because “there is little empirical evidence on the distribution of book values or errors in auditing populations” [1973, p. 250]. Neter and Loebbecke [1977, 1975] constructed “realistic” populations to study the effectiveness and reliability of statistical sampling procedures, based on actual audit data from four different companies.

Ramage, et al. [1979] greatly expanded upon the work of Neter and Loebbecke [1977, 1975] by examining the error characteristics of 97 different audit populations of one international accounting firm. At about the same time, Kinney [1979] reported the distributions of errors resulting in adjustments from the audits of 44 manufacturing clients of seven different accounting firms. Subsequent error studies (discussed later) replicated and expanded upon the work of Ramage, et al. Importantly, these studies predominately use archival data of **detected** errors obtained from audit workpapers. The implicit assumption of this research is that detected errors are representative of the population of actual errors. In fact, as will be discussed in the next two sections, error generation and error detection are two separate processes as implied by Festge [1979].

2.1 Error Generation Process

Figure 1 provides a model of the error generation and error detection processes. Actual errors (the upper portion of Figure 1) result from inherent and control risk factors. For instance, errors may occur due to inherent risks such as complex judgments or problems in a client setting (e.g., obsolescence of high technology products) or control risks such as weak control procedures in failing to adequately train employees. Moreover, a weak control environment where management is unduly motivated to manage earnings may result in biased accounting methods and disclosures. Also, as indicated by an arrow connecting the control environment to the control procedures, the control risk factors may not be independent. A weak control environment may motivate management to override control procedures or allow them to deteriorate. Thus, inherent and control risks jointly impact the incidence of actual errors.

Figure 1 about here

2.2 Error Detection Process

2.2.1 Risk Assessment

Auditors' ability to detect the presence of errors is referred to as "the error detection process" (bottom portion of Figure 1) and is depicted to be a function of assessed risks, program planning, and execution. Logically, the detection of errors is dependent upon the set of audit tests planned and how competently those tests are performed. As described in auditing standards (e.g., SAS 47), auditors are directed to develop an audit program based on assessed client risks ("a risk-adjusted" program), materiality, and audit risk. These factors are collectively referred to as the "audit risk model." The auditor's materiality assessment is shown in the model to affect audit risk, since this risk is the likelihood of an unqualified opinion being issued in the presence of a material misstatement.² The model in Figure 1 also includes another risk factor referred to as "business risk." This factor relates to risks to the audit firm such as litigation or loss of reputation as a result of a particular client relationship. Although business risk is not included as a component of the audit risk model, there is evidence that this factor significantly impacts auditing testing efforts (e.g., Pratt and Stice [1994]; Miller [1988]).

²It should be noted that although auditor independence also affects audit risk, the impact of independence on audit risk is beyond the scope of this paper.

2.2.2 Program Planning

As the perception of risk increases, auditors may select more reliable tests (nature), expand sample size (extent), perform tests closer to year end (timing), and/or select more experienced staff to perform the tests (staffing). The adequacy of audit program decisions is, thus, dependent at least in part upon the accuracy of auditors' risk assessments. If risks are assessed as too low (high), audit tests will be insufficient (excessive), impacting audit effectiveness (efficiency). In terms of error detection, the most significant concern is assessing risks as too low and, thus, failing to conduct adequate tests to identify the presence of an error. Further, the appropriateness of audit tests depends on the ability of the auditor to design a program plan to correspond with client risks. The complexity of performing this task has led some of the major auditing firms to use computerized decision tools that suggest an appropriate set of audit tests given the auditor's risk assessments (e.g., PricewaterhouseCoopers [Winograd, et al., 2000]; Grant Thornton's "ADAPT" approach [Gillett, 1993]).

2.2.3 Program Execution

Detection of errors is also dependent upon the execution of tests. A very strong set of tests may, nonetheless, fail to identify an error if, for instance, an unrepresentative sample is drawn (sampling risk) or an improperly trained auditor performs or evaluates the test inappropriately (non-sampling risk). Both sampling and non-sampling risk relate to the reliability of the evidence that is used to reach appropriate audit conclusions. Reliability of evidence is an element of "detection risk," as articulated in the audit risk model (SAS 47).

2.2.4 Factors Underlying Error Detection

Underlying risk assessment, program planning, and execution are four broad factors that affect these processes: auditing and firm standards; decision tools; individual auditor characteristics; and environmental factors. Not surprisingly, standards both from the profession (SAS's) and the firm provide guidance that affect risk assessments and program planning and execution (see, e.g., Libby and Libby [1989]; Cushing and Loebbecke [1986]).

The use of decision tools, such as risk questionnaires and standard audit programs (e.g., Mock and Wright [1999, 1993]; Quadackers, et al. [1996], Bedard [1989]; Wright [1988]) in the planning and testing phase are pervasive in audit practice and influence auditor judgments. Mock and Wright [1999, 1993] report that a standard audit program was used in over two-thirds of the engagements studied; they suggest that the use of such programs may account for the lack of variation in audit tests across clients with varying risk levels.

Findings from behavioral research (e.g., Libby and Tan [1994]; Libby and Luft [1993]) indicate that auditor performance is affected by individual characteristics such as knowledge, experience, motivation, ability, and ethics. Further, humans are known to resort to decision heuristics (often with biases) to deal with complex judgment and decision situations. Such heuristics may have functional or dysfunctional effects (e.g., confirmatory testing strategies or professional skepticism and conservatism [Smith and Kida, 1991]).

Finally, a number of “environmental factors” are likely to have a significant impact on auditor judgments. These factors reflect natural elements in the audit professional environment such as accountability [Gibbins and Newton, 1994], time budgets [McNair, 1991], justification

[Ashton 1992], litigation risk [Pratt and Stice, 1994], reliability of evidence [Ramage, et al., 1979], and more broadly, audit costs [Colbert and O'Keefe, 1995]. The competitive environment in public accounting dictates that the auditor develops a cost effective audit program. Therefore, auditors are likely to weigh both risks and costs in designing and executing tests. Very costly audit tests or large samples, for instance, may be utilized only in perceived high risk situations. Each of these environmental factors has been found to significantly affect auditor judgments.

2.2.5 Detected Errors

The product of auditor risk assessments, program plans, and execution of tests affects the eventual set of errors that are detected. The important question raised by the model is how representative detected errors are of actual errors. Festge [1979] raised the same issue in his discussion of Ramage, et al. [1979]. His main concern was the auditor's objectives in testing various accounts. For example, were tests designed specifically to look for overstatement errors? Given the complexity of the error detection process, it is an empirical question as to the extent to which detected errors are representative of actual errors. For example, a deviation of assessed risks from actual risks or improper execution of tests can lead to a failure in detection. Recent audit research findings question whether, in fact, program plans are sufficiently risk-adjusted [Wright and Mock, 1999 and 1993], suggesting that even if risk assessments are accurate, it is not a trivial matter to then appropriately design and execute audit tests. Further, confirmation reliability studies provide evidence that detected errors may not represent the actual error characteristics of the population. For instance, studies by Engel and Hunton [1999], Armitage [1990], Caster [1990], Sorkin [1978], and Warren [1974] all found that accounts receivable

confirmations detected more overstatement than understatement errors even though the actual number of seeded errors of each type was equal. In addition, Waggoner [1990] provides evidence of undetected deviations in an experiment involving assessment of control risk. Thus, collectively, there are reasons to believe that **detected** errors may not be fully representative of the **actual** error population, raising significant questions about the ability to generalize results from studies relying exclusively on detected errors.

3.0 REVIEW OF PRIOR LITERATURE

In this section, findings from the auditing literature are discussed for each of the variables in the bottom portion of the model in Figure 1 (error detection process), leading to an analysis of the findings. As previously discussed, error detection is depicted as having three main components: risk assessment, program planning and execution. Further, error detection is affected by several factors (e.g., auditing standards, decision tools, auditor knowledge, and environmental factors). Findings in the literature are discussed below as they relate to the three components of the error detection process together with the factors affecting that process.

3.1 Risk Assessment

3.1.1 Materiality Assessment

Materiality has been widely defined as an amount that is large enough to influence an individual user's decisions. Materiality directly impacts audit risk and audit program planning. Thus, it is presumed that if materiality is set too high, the discrepancy between actual and detected errors will increase. Although no study has examined this issue, four studies have considered the amount of error(s) that would affect a reasoned decision-maker. In his 1981 study,

Kinney finds that the average magnitude of detected errors deflated by normal earnings is very small for most accounts. In contrast, in a study of quarterly corrections of previously reported quarterly earnings, Kinney and McDaniel [1989] find that the corrected amounts relative to quarterly earnings were material. Through a meta-analysis of nine studies from over 1500 audits across fourteen years, Kinney and Martin [1994] find that average aggregate adjustments resulting from detected errors reduce earnings and assets by two to eight times the *minimum* amount that would materially misstate the financial statements.³ Based on these findings, Kinney and Martin argue that the auditing process does, indeed, improve the precision of the financial statements.

In addition to earnings, materiality may be assessed in terms of the impact on key financial ratios. Turner [1997] finds that immaterial errors may combine to create substantial variances in some ratios, particularly profitability ratios based on income statement amounts.⁴ Turner's study is based on a simulation of seeded errors across three balance sheet accounts and three related income statement accounts that were not only individually immaterial, but also immaterial in the aggregate. Turner calculated a series of ratios based on the tainted data and compared them to the corresponding ratios based on the accurate data.

Given the results in the foregoing studies, while the magnitude of detected errors suggests

³ Kinney and Martin [1994] define the *minimum* amount that would materially misstate the financial statements based on Pany and Wheeler [1989]. Accordingly, aggregate misstatements greater than or equal to either 5 percent of net income or 0.5 percent of total revenue or total assets are considered to be material.

⁴ Interestingly, Dutta and Graham [1998] also demonstrate this point using an analytical approach rather than examining seeded errors.

that auditing serves to improve the decision usefulness of financial statements (by improving precision and reducing bias), the findings by Turner [1997] suggest that auditors need to use more stringent criteria than traditional levels of materiality when evaluating individual detected errors for adjustments.

3.1.2 Audit Risk

Audit risk is defined in auditing standards as the risk an "auditor may unknowingly fail to appropriately modify his opinion on financial statements that are materially misstated" [AU 312.02]. Auditing standards further recommend that auditors set audit risk at an appropriately low level [AU 312.09]. Auditors plan the engagement based upon the level of audit risk they hope to achieve. Thus, it stands to reason that an inverse relationship exists between audit risk and error detection.] That is, as audit risk is set lower, more audit work will be performed and, presumably, more errors will be detected. It also follows that the more errors detected, the greater the likelihood that detected error rates will approximate actual error rates in the population, particularly with regard to material errors since, as noted above, audit risk is based on an ex ante materiality threshold. To date, no research has been done to test these assumptions.

Research on audit risk has focused primarily on the degree to which practitioners use the audit risk model. Daniel [1988], for example, finds that rather than using the components of the audit risk model to assess overall audit risk, practitioners tend to consistently set audit risk at five percent. More recently, Houston et al. [1999] find that the audit risk model captures managers' and partners' planning decisions when errors are discovered, but not when fraud is discovered. Due to the high exposure and sensitivity of fraud, auditors use a much lower detection threshold

in such circumstances than for unintentional errors.

3.1.3 Assessment of Inherent Risk and Control Risk

In contrast to the previously discussed areas of materiality and audit risk assessment, there are many studies relying on detected errors to infer the level of inherent risk and control risk present.

3.1.3.1 Inherent Risk

Inherent risk is the risk that a material error enters into a client's accounts. Not surprisingly, greater inherent risk is associated with a higher rate of detected errors [Wallace and Kreutzfeldt, 1995; Waller, 1993]. Most prior research in the area falls into two categories: (1) error characteristics associated with various financial statement accounts, and (2) risk factors associated with client-specific characteristics.

A common characteristic reported in several studies is that errors in sales and accounts receivable accounts tend to be **overstatements** [DeFond and Jiambalvo, 1991; Icerman and Hillison, 1991 and 1990; Kreutzfeldt and Wallace, 1986; Ham, et al., 1985; Johnson, et al., 1981; and Ramage, et al., 1979]. Another common finding is that errors in cost of goods sold and accounts payable accounts tend to **understate** the account balances [Icerman and Hillison, 1991 and 1990; Kreutzfeldt and Wallace, 1986; Ham, et al., 1985].⁵ Findings for the inventory account are, however, mixed. Icerman and Hillison [1990], Johnson et al. [1981] and Ramage, et

⁵ In contrast, Chan and Mo [1998] find that for local Chinese companies operating in Hong Kong, accounts payable tends to be overstated. However, the authors point out that this finding is due to the inability of the internal control systems of these companies to take into account the unique business practice of Chinese companies; namely, their requirement of prepayments for purchases.

al. [1979] find no directional bias relating to inventory errors, whereas Icerman and Hillison [1991] report that most inventory errors overstate the balance.

In addition to error direction characteristics, Ham, et al. [1987, 1985] find that accounts receivable errors have greater absolute magnitude than inventory errors. For property and casualty insurers, Bell and Knechel [1994] find that loss reserve and reinsurance accounts are the accounts most likely to be subject to errors.

A few studies have focused on the factors associated with client-specific inherent risk characteristics. Client size is one. Several researchers report that client size is inversely proportional to the incidence of detected errors (e.g., Wallace and Kreutzfeldt [1995]; Entwistle and Lindsay [1994]; Icerman and Hillison [1990] and Kinney and McDaniel [1989]).⁶ In contrast, DeFond and Jiambalvo [1991] find no relationship between the incidence of corrected prior errors and company size.

A second client-specific inherent risk factor concerns client management. Management competency, integrity and controls all tend to be inversely related to the incidence of detected errors in the financial statements [Wallace and Kreutzfeldt, 1995]. At the same time, management focus on attaining budgets as well as achieving a particular return on total assets are associated with higher detected errors [Johnson, 1987]. Further, many detected errors result from differences between management and auditor judgment [Bell, et al., 1998].

A third client-specific inherent risk factor relates to client personnel. In general, Johnson [1987] finds that larger errors are detected in companies experiencing personnel problems. Not

⁶ A possible exception is Ham, et al. [1985] who find this relationship for inventory but

surprisingly, employee inability is also the cause for many detected errors. For instance, Bell, et al. [1998] find that manual computations tend to result in more detected errors than automated computations. Similarly, Waller [1993] and Houghton and Fogerty [1991] find a higher likelihood of error with non-systematically processed transactions than with systematically processed ones. Perhaps, as found in Bell, et al. [1998], employees may be either unable to identify or properly process such transactions.

Industry is a fourth client-specific inherent risk factor considered. A few studies report considerable variability in error rates across industries (e.g., Maletta and Wright [1996]; Waller [1993]; Ham, et al. [1985]; and Johnson, et al. [1981]). In other studies, however, no particular industry concentration, in terms of frequency of errors, was found (e.g., DeFond and Jiambalvo [1991]; Kinney and McDaniel [1989]). Through an awareness of the factors that increase inherent risk, auditors can adjust their audit programs accordingly, thereby improving error detection.

3.1.3.2 Control Risk

Control risk is the risk that a client's system of internal controls fails to detect a material error. As expected, a higher control risk has been associated with a higher detected error rate [Chan and Mo, 1998; Wright and Wright, 1996; Wallace and Kreutzfeldt, 1995; Icerman and Hillison, 1990; Roberts and Wedemeyer, 1988]. As the assessed strength of internal controls declines, not only does the frequency of errors increase, but the resultant errors are also more likely to have an effect on income [Wright and Wright, 1996; Kreutzfeldt and Wallace, 1986].

not for other areas.

Indeed, Wallace and Kreutzfeldt [1991] find that the existence of an internal audit department is associated with fewer and smaller (i.e., less material) errors.

In contrast, Waller [1993] finds a low association between the incidence of misstatements and assessed control risk at the assertion level, while in his study of errors in UK audits, Johnson [1987] finds that control risk traits are rarely associated with detected errors. However, Johnson notes that his findings might be due to the broad nature of his internal control evaluation together with the fact that nearly all of the companies in his sample were public firms that may have had at least adequate controls.

Entwistle and Lindsay [1994] also report that few misstatements are caused by failure to comply with internal controls. Further, Bell, et al. [1998] find that audit differences that related to control attributes are rarely associated with inadequate controls over assets/records but rather, are more likely associated with inadequately skilled staff, improper/inadequate independent verifications or improper documents/records. Indeed, Wallace and Kreutzfeldt [1991] cite independence as the most critical characteristic of the internal audit function (a control device) in reducing the magnitude of errors.

On a related note, Ferris and Tennant [1984] find that when auditors identify compliance errors (e.g., a price footing and extension error or an unbilled shipment error), their control assessment is impacted by the nature of the error. That is, they find that assessments of control risk are affected by the perceived type (price footing/extension compared to unbilled shipment), monetary impact (present or absent), and intentionality (related party or unrelated party) of the

error. As auditors detect compliance errors they may re-assess inherent and control risks and adjust their audit programs accordingly, presumably improving error detection.

3.1.4 Business risk

Business risk is the potential loss to an auditor because of a particular client relationship. Four factors have been shown to affect business risk: client size, industry, ownership structure, and client financial condition (e.g., Wallace and Kreutzfeldt [1995]; Maletta and Wright [1996]; and Walo [1995]). Houston, et al. [1999] find that auditors respond to increased business risks by modifying both audit investment (more audit evidence is collected) and audit fee (a risk premium is added).

As previously noted in the section discussing inherent risk, in general, larger companies tend to have stronger internal control systems and fewer relative errors [Wallace and Kreutzfeldt, 1995]. With respect to industry, Maletta and Wright [1996] find industry to be an important consideration for audit planning because fewer errors are found in regulated industries than unregulated industries. For property and casualty insurers, Bell and Knechel [1994] find a higher risk of irregularities with respect to reinsurance because of related party transactions. Interestingly, though, Walo [1995] does not find any differences in audit planning related to clients in industries with a lower (as opposed to higher) incidence of auditor litigation.

The final two client-specific factors impacting auditors' business risk are public (as opposed to private) ownership structure and a weak (rather than strong) client financial condition. Walo [1995] as well as O'Keefe, et al. [1994] find that publicly owned companies increase auditors' business risk thereby increasing the scope of the audit planned by the auditor.

Clients with a weak financial condition also increase the business risk of an audit, and result in an expanded audit scope [Walo 1995]. Relatedly, O’Keefe, et al. [1994] find that increases in a client’s leverage produce increases in the *client’s* business risk, which, in turn, produce increases in the *auditor’s* business risk, resulting in significantly more audit hours assigned to audit managers and partners.

As with assessments of inherent risk and control risk, business risks are expected to impact the audit program the auditor subsequently develops. Presumably, increases in business risk are expected to require enhanced program planning aimed at improving error detection. It may also be argued that business risk affects the level of audit risk. That is, auditors could set the acceptable level of audit risk lower to compensate for a higher perceived level of business risk (see, for example, Arens and Loebbecke [1997]). Houston, et al [1999] do not find support for this presumed relationship between business risk and audit risk, and thus the model in Figure 1 does not show that particular link.

3.2 Program Planning/Development of Audit Program⁷

When controls are strong, auditors are *expected to* rely on them to improve audit efficiency. As a result, it is not surprising that the use of substantive tests is inversely related to assessments of internal control [Hirst and Koonce, 1996; Bedard, 1989; Ferris and Tennant, 1984]. Furthermore, the higher the assessments of inherent and control risks, the more likely auditors are to extend the audit program, thereby increasing the likelihood of detecting errors. This relationship may lead to a potential “self-fulfilling prophesy” problem in evaluating the

⁷ For a comprehensive review of the literature on program planning, see Bedard, Mock

findings of detected error studies. That is, assume that an auditor under-estimates the level of risks (i.e., more errors are present than expected). Since risks are assessed as low, the auditor may accordingly plan a lower level of tests. This plan may then result in the detection of fewer errors than are present. Thus, the findings of prior error detection studies that lower risks are associated with fewer errors may be confounded by the impact of the risk assessment on the effectiveness of audit program plans.

3.2.1 Determining the Nature of Tests

Archival studies by Bedard [1989] and Mock and Wright [1999, 1993] surprisingly do not find a strong association between client risks and program plans (nature and extent of tests). That is, plans do not appear to be “risk-adjusted.” Mock and Wright [1993] contend this may be due to the widespread use of standard audit programs as a result of accountability and defensibility. If such programs are robust in detecting a wide variety of likely errors, this practice may enhance effectiveness but impair efficiency. However, use of a standard program may impair an auditor’s ability to add needed audit tests for unusual types of errors or fraud.

Bell and Knechel [1994] provide an in-depth examination of 259 audit differences from 28 audits of property and casualty insurance companies. They analyzed the audit procedures used to detect errors and found evidence that suggests analytical procedures and client inquiry are highly effective. Those two audit methods uncovered over 56% of the errors detected. In addition, certain substantive procedures were also effective at uncovering errors. Recomputation and vouching procedures uncovered 28% of the errors detected. Similarly, in separate archival

and Wright [2000].

studies of audit adjustments, Wright and Ashton [1989], Kreutzfeldt and Wallace [1986], and Hylas and Ashton [1982] find that “attention-directing” procedures involving client inquiry (particularly through casual conversations), expectations based on prior years' errors, and analytical review are inexpensive audit tools that signaled at least one-third of the detected adjustments.

3.2.2 Determining the Extent of Tests

Mock and Wright [1993] report that the planned extent of tests, rather than the nature of tests is related to the level of (changes in) some client risks. However, Mock and Wright [1999] find a stronger association between risks and nature of testing than between risks and extent of testing. Indeed, Hackenbrack and Knechel [1997] find no evidence that audit effort (measured as total audit hours or audit hours by rank) is associated with control reliance. These findings may be due to economic pressures to control the amount of testing and/or auditors' difficulties in adapting plans to client risks.

Extent of tests may be operationalized as simply the sample size. It is not surprising that large samples can yield different results than small samples. For example, Wurst, et al. [1991] find that rectification (i.e., rectifying or “fixing” the sample for all detected errors and making “inferences about the total amount of errors remaining in the unsampled portion of the population” [Wurst, et al., p. 335]) can substantially reduce the risk that the population balance is inappropriately rejected when sample sizes are 150 and 300, but not when the sample size is 65.⁸

3.2.3 Determining the Timing of Tests

⁸ Recent evidence exists that sample sizes in practice now are quite small, e.g., 25-30, and
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Only one error study addresses the issue of the timing of the audit tests - - Cohen and Hanno [2000]. In an experimental study, they find that auditors plan more interim testing when both a strong corporate governance and a strong control philosophy are present (i.e., a significant interaction). However, a high level of variability in responses is present, so timing of tests must depend on other factors not captured in their study.

3.2.4 Determining Staffing for Performance of the Audit

The decision of staffing for the performance of audit tests has received scant attention in the literature. Wright and Wright [1997] find that auditors with greater industry experience tend to use more experienced personnel to perform tests for misstated accounts.

Based on survey information provided about actual audits by partners, O’Keefe, et al. [1994] find that increases in a client’s risk measures result in differences in assigned audit work. Specifically, for a public (as opposed to a non-public) client, all staff levels were assigned significantly more time. Further, Hackenbrack and Knechel [1997] find that public (as opposed to private) clients consume a higher proportion of hours by “high grades” (as opposed to “low grades”) of labor. That is, public clients consume relatively more manager and partner time than do non-public clients. Similarly, O’Keefe, et al. [1994] find that increases in a client’s leverage (a measure of business risk) result in significantly more audit hours being assigned to *partners* and *managers* while increases in a client’s inherent risk result in significantly more audit hours being assigned to *staff* and *senior* auditors.

determined through non-statistical sampling (e.g., Messier, et al. [2000]).

3.3 Program Execution/Conducting Tests and Evaluating Evidence

Given the program the auditor develops for use in detecting errors (Section 3.2), the auditor then proceeds to execute that program, conducting audit tests and evaluating test evidence. This program execution phase directly impacts error detection, and is susceptible to two key risks that will be discussed below: sampling risk and non-sampling risk.

3.3.1 Sampling Risk

The risk an error is not identified through sampling has received some attention in the literature. In their simulation, Neter and Loebbecke [1975] conclude that not all sampling techniques work equally well in all cases. Rather, given differences in error rates among accounting populations (ranging from low to very high), the effectiveness of selection procedures (e.g., simple random sampling or stratified random sampling) or evaluation methods (e.g., using mean-per-unit estimators, difference estimators, ratio estimators, or some combination of these methods) varies considerably for samples of size 65, 100, and 200. Indeed, further work by Neter and Loebbecke [1977] as well as work by Ramage, et al. [1979] indicate that neither ratio nor difference estimators consistently yield reliable results in sampling - - especially when the population error rate is low or the error amounts are large and in only one direction. Nonetheless, Neter and Loebbecke [1977] conclude that using mean-per-unit estimators works reasonably well with stratified random sample sizes of 100 or 200.

Prior research has also discussed the “disposition” of errors identified by statistical sampling. As noted earlier, Wurst, et al. [1991] find that rectification can substantially reduce the

risk that the population balance is inappropriately rejected with larger sample sizes, but not with smaller sample sizes.

Further, inroads have been made into the issue of whether auditors isolate errors detected in statistical (as well as non-statistical) sampling. The consensus of prior research is that auditors frequently isolate errors identified in audit sampling when they believe the errors to be unique in nature (e.g., Wheeler, et al. [1997]; Dusenbury, et al. [1994]; Burgstahler and Jiambalvo [1986]). And, although Burgstahler and Jiambalvo [1986] conclude that isolation of errors identified in audit sampling is not generally appropriate, more recent studies have not only concluded that auditors are judicious in their use of isolation [Dusenbury, et al., 1994] but also that isolation can, at times, be justified on both theoretical and practical grounds [Wheeler, et al., 1997].

In spite of the Dusenbury, et al. and Wheeler, et al. findings, auditors' use of isolation has an important implication for the relationship between detected and actual errors. That is, to the extent that auditors inappropriately isolate errors detected through sampling, they do not project them to the population. Accordingly, with isolation, detected errors may be even less representative of actual errors than in cases where no isolation occurs.

3.3.2 Non-Sampling Risk

The risk an auditor fails to recognize errors by, for instance, misinterpreting the results of audit procedures or failing to use or conduct an effective test has received attention from prior researchers. In general, auditors appear to have their limitations; for instance, Moeckel and Plumlee [1989] find that auditors are generally as confident in inaccurate/incomplete memories as in accurate ones. Anecdotal evidence also suggests that non-sampling risk is a significant

concern in practice. For example, in a recent case (California Micro Devices) the auditors issued an unqualified audit opinion on financial statements that had been materially misstated because they "failed to exercise appropriate professional skepticism" [SEC, 1999]. That is, the auditors failed to investigate the client's write off of about one-third of its accounts receivable balance and, therefore, failed to detect the fraud.

Four non-statistical techniques appear to be effective at detecting errors: client inquiry [Bell and Knechel, 1994; Wright and Ashton, 1989; Kreutzfeldt and Wallace, 1986; Hylas and Ashton, 1982]; developing expectations based on prior year errors [Wright and Ashton, 1989; Kreutzfeldt and Wallace, 1986; Hylas and Ashton, 1982]; analytical review [Bell and Knechel, 1994; Wright and Ashton, 1989; Kreutzfeldt and Wallace, 1986; Hylas and Ashton, 1982]; and recomputation [Bell and Knechel, 1994]. If auditors fail to employ the appropriate statistical or non-statistical tests, they may fail to identify financial statement errors. Findings from behavioral research in auditing reveal that non-sampling risk may also occur as a result of the use of decision heuristics with biases, such as anchoring and adjustment [Kinney and Uecker, 1982], recency effects [Tubbs, et al., 1990; Ashton and Ashton, 1988], and the dilution effect [Hackenbrack, 1992]. For instance, a recency effect implies that the order in which evidence is obtained may impact the final decision made as to whether there is an error or not.

3.4 Factors Affecting Error Detection

Besides sampling and non-sampling risk, several other factors also affect error detection. They are: auditing and firm standards; decision tools/aids; auditor knowledge, experience,

motivation, ability, ethics, and decision heuristics; and environmental factors. The following subsections will discuss the research findings for each of these factors.

3.4.1 Auditing and firm standards

Only one study addresses the impact of auditing and firm standards on detected errors. In their study of 232 quality control reviews of audits of independent school districts in Texas, Deis and Giroux [1992] find that audit quality (defined as the probability that the auditor will both discover and report a breach in the client's accounting system) improves when auditors know their work will be subject to quality control reviews. This also suggests "accountability" at the firm level can increase audit effort, presumably leading to enhanced error detection. Indeed, there have been many behavioral studies of accountability, which generally show that accountability improves performance. However, recent research on "justification" suggests auditors may do what they think a superior wants to see rather than what may be needed.⁹

Tangentially, Elder and Allen [1998] find that auditors from firms with more structured error projection procedures (e.g., computerized work papers) are more likely to project to the population errors detected in sampling than auditors from firms with less structured error projection procedures. Thus, firm standards impact the degree to which errors identified in sampling are projected to the population balance.

⁹ See Rich, et al. [1997] and Gibbins and Newton [1994] for reviews of this literature. We also discuss accountability and justification as an environmental factor affecting auditors' ability to detect financial statement errors in a later section.

3.4.2 Decision tools, decision aids

We are not aware of any study that directly addresses the impact of decision tools and/or decision aids on auditors' ability to detect errors. However, several studies indirectly address this issue. Mock and Wright [1999, 1993], Ashton [1992], Bedard [1989], and Wright [1988] all consider how decision aids affect the design of program plans, which ultimately can affect error detection. Mock and Wright discuss the impact of standard audit programs on program planning, while Ashton examines the impact of justification and mechanical aids on judgment performance. Wright also investigates the effect of prior work papers on program planning, and Bedard examines the impact of prior audit programs on subsequent audit programs. Additionally, Messier, et al. [2000] as well as Kachelmeier and Messier [1990] report on the impact of decision aids on auditors' selection of sample sizes. As noted above (see Section 3.2.2), because extent of tests may be operationalized as changes in sample sizes, auditors' use of decision aids to determine sample sizes can, by extension, affect error detection.

Further, several studies consider how decision aids affect auditors' judgments *related to* error detection. For instance, Bonner, et al. [1996] investigate the effects of decision aids on auditors' judgments about error frequencies while Jiambalvo and Waller [1984] as well as Daniel [1988] study the effects of decision aids on auditors' assessments of audit risk. Davis [1994] investigates whether decision aids impact auditors' judgments about the probability of a going concern problem and Eining, et al. [1997] and Pincus [1989] study whether decision aids affect auditors' judgments about the probability of management fraud. Libby and Libby [1989] look at

a mechanical decision aid to enhance the aggregation of multiple risk factors in control risk judgments.

3.4.3 Auditor knowledge, experience, motivation, ability, ethics and decision heuristics

As previously noted, auditor-specific characteristics affect an auditor's ability to detect financial statement errors. Indeed, many of these characteristics have been studied in tandem. For instance, Bonner, et al. [1996] find that experienced auditors organize financial statement errors by audit objective rather than transaction cycle thereby enhancing their ability to assess audit risks. Thus, experience affects the way that auditors organize error information. In turn, it is expected that this error knowledge will impact the design of audit programs, ultimately affecting the detection of errors.

Despite differences in knowledge organization, Bonner, et al. [1996] also find that all auditors experience difficulty in both retrieval and aggregation when determining conditional probabilities (e.g., the probability of an error occurring given the existence of a particular risk factor). Further, Ashton [1991] finds that regardless of experience level, auditors do not have very accurate knowledge of the relative frequency with which errors occur, (although this may, in part, be due to the fact that auditors do not often encounter errors).¹⁰ In contrast, Houghton and Fogarty [1991] find that because auditors of longer tenure have greater knowledge of their clients (e.g., knowledge of prior errors), they are better than new auditors at predicting risky areas.

The behavioral auditing literature provides evidence that industry specialization benefits auditors in terms of knowledge of the presence and frequency of unique industry errors, which is

¹⁰ See Nelson [1994] for a review of the literature identifying factors that hinder auditors'

expected to be valuable in planning appropriate audit tests.¹¹ Owghoso, et al. [2000], Solomon, et al. [1999], and Wright and Wright [1997] provide direct evidence of the benefits of industry experience on auditors' error detection. In a case study with seeded errors, Owghoso, et al. find that within industry specialization (banking and healthcare), audit seniors and managers detected more mechanical and conceptual errors, respectively. Outside of their specialization, however, the authors report that both seniors and managers performed poorly in detecting errors. Solomon, et al. found that industry specialists had a greater quantity of knowledge and more specific business operations knowledge stored in, and retrievable from, memory for their industry of specialization relative to another industry. That is, industry experience enhanced auditors' error frequency knowledge and abilities to generate plausible hypotheses for an unexpected fluctuation. Similarly, Wright and Wright provided auditors with a comprehensive case for a retailing client where four material errors were present. They report that industry specialists displayed both superior skills in identifying the errors present (hypothesis generation) and in identifying areas of audit risk.

Indirectly, Taylor [1998] provides evidence of the benefits of industry experience on auditors' error detection. Taylor examined inherent risk judgments of banking and non-banking specialist auditors. His results indicated an increased conservatism (inefficiency) for auditors lacking industry experience and provided limited support that industry specialization enhanced auditor sensitivity to risk variations.

ability to learn and apply frequency knowledge in auditor judgment.

¹¹ See Gramling and Stone [1998] for a comprehensive review of the literature on specialization in the external auditing environment.

In addition to experience, ethical reasoning has also been found to affect an auditor's ability to detect fraud (e.g., financial statement errors). Bernardi [1994] finds that managers with high levels of both domain-specific experience and moral reasoning are better at detecting fraud than managers with low levels of moral reasoning.

Auditor motivation (which gets at the issue of rewards as well as accountability which are discussed below) may also impact an auditor's ability to detect errors. Notably, Libby and Luft [1993] as well as Libby and Tan [1994] synthesize and test prior research that identifies knowledge, ability, and motivation as important performance determinants.

3.4.4 Environmental factors including reliability of evidence and audit costs

As stated earlier, environmental factors, such as accountability and justification, time budgets, reliability of evidence, litigation risk, and other audit costs may affect an auditor's ability to detect financial statement errors.

3.4.4.1 Accountability and Justification

Previous literature has noted that accountability and justification are theoretically distinct concepts (e.g., Johnson and Kaplan [1991]). As such, their differential effects have been reported (e.g., Peecher [1996]; and Koonce, et al. [1995]). We focus here on the combined effects of accountability and justification given that the two concepts are closely linked in practice. For example, given the audit review process, it is expected that accountable auditors would be called upon to justify their decisions. Likewise, justifications, in the absence of an accountability requirement, are likely to be rare.

In a review of the impact of environmental factors in judgment and decision-making research, Arnold [1997, p. 67] notes that “accounting decision makers do not derive judgments in an environment free of repercussions from outside the experimental conditions, but rather...individuals in accounting organizations are generally held to some level of accountability for their decisions.” Indeed, when Gibbins and Newton [1994] asked auditors to provide accounts of situations in practice in which they have been held accountable, they reported that accountability is not only pervasive in the audit environment, but that there are multiple “accountabilities,” such as to peers, the client, and regulatory bodies, and these forces result in a complex set of relationships and expectations. Therefore, if the preferences of the superior are unknown, an auditor who is held accountable for his work is more likely to exert greater effort and care in performing audit tests and, thus, more likely to detect errors. However, the preferences of a superior may also lead an auditor to make judgments to conform with the views of others to curry the favor of those to whom they are held accountable (Lerner and Tetlock 1999). This could lead to less ability to detect errors, if, for instance, the superior stressed audit efficiency and a lower than optimal level of testing is done.

3.4.4.2 Time Budgets

Time budgets are used to motivate staff to work effectively and efficiently [McNair, 1991]. Indeed, the amount of time allocated to audit a client (as a whole and by area) will likely have a significant impact on the nature, timing, extent, and staffing of the audit, and that, in turn, is likely to impact the detection of errors. For instance, if time budgets “are set too tight, they can lead to dysfunctional behavior, such as premature sign-off,” where tests are either not

performed or performed in a haphazard manner [Gist and Davidson, 1999, p. 101]. Premature sign-off would presumably result in fewer errors being detected. If time budgets are too lax, efficiency will be reduced.

In a related vein, a few studies have investigated the impact of time pressure on decision-making quality [Smith, et al., 1997; Brown and Solomon, 1992; McDaniel, 1990]. Findings from these studies indicate that generally, time pressure negatively affects an auditor's decision-making quality. However, previous research suggests that moderate time pressure can enhance performance [Glover, 1997], since decision-makers may narrow their focus to exclude peripheral cues (i.e., task-irrelevant cues) while still considering central cues (i.e., task relevant cues). In addition, processing speed is increased, which enables the decision-maker to consider more central cues within the allotted time. As time pressure increases from moderate to extreme, performance decreases as decision-makers narrow their focus to the extent that central cues are excluded from consideration. This expectation is consistent with prior psychology findings suggesting that time pressure has an inverted “U-shaped” effect on performance (e.g., Payne, et al., 1988).

3.4.4.3 Litigation Risk

No study has demonstrated the impact of litigation risk on detection of errors. However, Brumfield et al. [1983], through recounting of experiences, and Pratt and Stice [1994], through empirical data, document that the litigation environment ultimately affects audit planning decisions. Pratt and Stice [1994, p. 641] note that “litigation risk is considered by auditors in the

planning and pricing of audit services,” with auditors extending testing when litigation risk is considered to be higher.

3.4.4.4 Reliability of Evidence

Two types of audit evidence have received a great deal of attention by researchers studying the reliability of evidence: accounts receivable confirmations and analytical procedures. Confirmation reliability studies are remarkable for the consistency in results. Studies by Engel and Hunton [2001], Armitage [1990], Caster [1990], Sorkin [1978], and Warren [1974] all seeded errors into accounts and sent confirmations to determine if confirmees detect the seeded errors and report them to the auditors. The general finding is that confirmees are more likely to detect and report unfavorable errors (errors that overstate the balance) than favorable errors (errors that understate the balance). Also, a large percentage of the seeded errors are not detected by confirmations. For example, in Caster’s [1990] study, only 47 percent of the errors were detected and reported.

These findings have a significant, yet heretofore not fully considered impact on the interpretation of prior error detection studies. In two different ways, they clearly demonstrate that detected errors may not be representative of the underlying error population. First, the fact that fewer than half the seeded errors are reported to auditors demonstrates that detected error rates can significantly understate actual error rates. Second, the fact that confirmees consistently demonstrate a bias towards reporting more overstatement than understatement errors demonstrates that detected error characteristics can significantly differ from actual error characteristics. Specifically, the statement often found in archival error studies that more

accounts receivable errors overstate the balance than understate the balance is called into question in that this “result” may simply be an artifact of an inherent bias in confirmation evidence.

The effectiveness and efficiency of analytical procedures at detecting errors has also received a great deal of attention in the literature. As previously noted, prior research has found analytical procedures to be a highly effective and efficient procedure for detecting the errors identified in archival studies (e.g., Bell and Knechel [1994]; Wright and Ashton [1989]; Kreutzfeldt and Wallace [1986]; Hylas and Ashton [1982]; Kinney [1979]). Also, a number of studies examine the efficacy of various regression methods for conducting analytical procedures. (See Wallace, et al. [1995] for a summary of this research.) More recently, Chen and Leitch [1998] simulate the monthly financial statements of 150 companies with seeded errors to assess the error detection performance (including Type II or β risk) of structural analytical procedures relative to other analytical procedures.¹² They conclude that because structural and stepwise models seek to determine the “correct” balance in an account by incorporating the structure of a firm’s financial and economic activities, they are superior to ARIMA, X-11, and Martingale models in detecting errors. Similarly, Wilson and Weld [1997] report that auditors using

¹² The “other” models include: stepwise, ARIMA, X-11, and Martingale models. Structural models directly incorporate structural relationships within the entity (i.e., endogenous variables) as well as within the economic environment of the organization (i.e., exogenous variables) in determining “correct” account balances. Stepwise models similarly incorporate endogenous and exogenous variables in determining “correct” account balances, but do so indirectly using regression analysis. In contrast, ARIMA (auto-regressive, moving average), X-11, and Martingale models determine “correct” account balances using the unadjusted balance of a particular account, time series models that explicitly incorporate trends and seasonal variations in account balances, and the balance of an account from a prior period, respectively.

regression analysis to estimate account balances when performing analytical review should transform the data to reduce autocorrelation. By doing so, auditors reduce Type I errors and, thus, improve audit efficiency.

Despite the aforementioned virtues of analytical procedures for detecting errors, in a review of the literature on analytical review (AR), Koonce [1993] reports that auditors experience difficulty in the diagnostic phases of AR (e.g., problem representation, hypothesis generation, information search and hypothesis evaluation). These findings are particularly true for inexperienced auditors. Koonce further reports that in planning, auditors have a bias toward expanding “detailed testing when AR indicates potential problem areas. However, when AR indicates no apparent problems, auditors are generally unwilling to reduce subsequent testing” [Koonce, 1993, p. 71]. However, empirical results by Pasewark and Strawser [1992] show evidence of auditor willingness to reduce testing when the findings of analytical procedures are favorable. This difference from earlier studies cited in Koonce may be due to greater reliance on analytical procedures as a result of competitive pressures to improve audit efficiency.

Accordingly, while AR may have the potential to be effective and efficient for identifying errors, because auditors have difficulty with the diagnostic phases of the task it is unclear whether AR is truly effective in detecting errors in the accounts.

3.4.4.5 Audit Costs

In an archival study of compliance with GAAS based on the Oregon State Board of Accountancy Enforcement program from 1978-1987, Colbert and O’Keefe [1995] find that compliance with GAAS’s reporting standards is less likely for small audit firms (five or fewer

partners) as well as when the client is a local government as opposed to a profit making or not-for-profit entity. Because of the costs associated with investments in knowledge and the ability of the auditor to discover errors, small audit firms are less likely to keep abreast of changes in GAAS and are more likely to be in noncompliance. Similarly, because a great deal of industry-specific knowledge is required to audit local governmental units (including generally accepted governmental auditing standards together with the Single Audit Act *in addition to* GAAS), auditors from smaller firms who audit local governmental entities are less likely to keep abreast of changes in the industry-specific knowledge required for those types of audits.

With the exception of Colbert and O'Keefe's study, there is no prior research that directly examines the impact of audit costs on error detection. However, it is reasonable to posit that some necessary audit tests may not be performed or the extent of testing reduced in an attempt to control costs, especially in today's competitive audit environment. The effect of this action may result in the non-detection of some errors that are present.

4.0 IMPLICATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This section of the paper identifies variables or issues revealed by the model that are largely unexplored or in need of further research. Methodological suggestions are also provided to address the central issue posed by this review, i.e., the problem of drawing inferences from studies of detected errors to accurately reflect actual errors. Specifically, a multi-method approach is called for to overcome some of the problems inherent in archival research on detected errors.

4.1 Risk Assessment

4.1.1 Materiality Assessment

How does materiality impact the correspondence between actual and detected errors? If materiality is set too high, several large errors may go undetected. If materiality is allocated to specific accounts (e.g., Dutta and Graham [1998]), how does that impact error detection? These questions have not been addressed to date in the error detection literature. An audit simulation, in conjunction with a field experiment, could be performed to provide insights regarding these questions. For instance, auditors could be placed in an audit simulation with seeded errors and the experimenter would manipulate materiality. For example, auditors may be given preliminary results from inventory counts, where one case sets materiality at \$10,000 and another sets materiality at \$50,000. In each case, auditors would be asked about the extent of additional testing based on the findings to date. Results would be compared to assess whether the materiality manipulation affected the detection of errors.

4.1.2 Audit Risk

How does audit risk affect the design of program plans? Do audit risk considerations (i.e., Type II or β risk) impact error detection? If so, how? Are **detected** errors more representative of **actual** error characteristics as audit risk is set lower (e.g., from 10% to 5%)? Also, what affects the auditor's assessment of audit risk? Is the relationship between acceptable audit risk and level of testing the same regardless of the scope of the audit (e.g., financial statement or fraud audit)? All of these questions are unanswered. A simulation, with seeded errors, and a laboratory-type experiment, with auditors as subjects, would need to be carefully designed to study these questions. In particular, to establish a benchmark, a case for a particular

audit area could be utilized that was subject to intense audit efforts by a participating firm where a high level of confidence exists that all errors were detected. The research could then examine the correspondence between differing levels of audit risk and the error detection capabilities.

4.1.3 Assessments of Inherent Risk and Control Risk

Extensive research has been conducted in this area. A major open issue is the extent to which inherent and control risk assessments lead to a self-fulfilling prophesy, that is, the higher the risk assessments, the more testing that is done, hence the greater the number of errors detected. However, Mock and Wright [1999, 1993] do not find strong evidence that audit programs are indeed risk adjusted. Are auditor risk assessments accurate? Some research suggests they are accurate, e.g., Bedard and Wright [1994]; Waller [1993]. Do auditors adjust plans significantly in response to risk assessments? If so, how does this impact error detection? In the past, firms tended to employ a standard audit program that tested for a broad array of errors (see, e.g., Bedard [1989]). However, firms indicate they will now and in the future perform more analytical procedures and less substantive testing (e.g., KPMG's Strategic Systems Lens or BMP Approach). As a result, greater focus will be placed on a narrower set of evidence, and, thus, it is critical that this evidence is highly diagnostic in detecting errors that may be present in the client's setting.

Many of the archival error studies were specifically performed to help auditors assess inherent risk (e.g., Wallace and Kreutzfeldt [1995]; Waller [1993]; Houghton and Fogarty [1991]; Wright and Ashton [1989]; Johnson [1987]; Kreutzfeldt and Wallace [1986]). The research shows which accounts are most affected, the direction of the effects, and client-specific

risk factors (e.g., size, client management, client personnel, and industry). A major shortcoming to date has been the failure to consider and control for potentially biased audit evidence (e.g., confirmations) and the above mentioned self-fulfilling prophecy problems. A full-scale audit simulation would be necessary to address these concerns with alternative tests conducted and seeded errors in accounts along with various levels of assessed inherent and control risks. In this case, a simulation has a major advantage over an archival study, because it is not necessary to control for potentially biased auditing procedures. For example, it is possible that other accounts receivable audit procedures (e.g., vouching subsequent cash receipts) would detect more of the understatement errors, thus compensating for the bias inherent in the confirmation process. This question has not been studied to date. If that is the case, and it can be shown that archival error rates are truly representative of actual error rates, we would feel more comfortable with suggestions, such as in Nelson [1994], to provide auditors with summary error frequency knowledge as derived from archival studies.

4.1.4 Business Risk

Most of the research in this area has focused on how the factors affecting business risk (e.g., industry, ownership structure, client financial condition) impact audit planning. For example, Pratt and Stice, [994] found that certain factors such as the client's financial condition resulted in higher assessed levels of business risk and a corresponding increase in the amount of audit evidence to be examined. However, no research has been done to assess whether differences in business risk actually affect error detection. These results would then need to be

compared to findings related to some of the studies we recommend above, such as, how differences in audit plans impact detection of errors.

4.2 Program Planning

When controls are strong, auditors are expected to rely on them to improve audit efficiency. That is, in such a situation, auditors should perform less costly tests (nature), test fewer items (extent), perform more interim testing (timing), and/or utilize less experienced personnel (staffing). Despite this, Bedard [1989] finds that auditors frequently employ a “same-as-last-year” (SALY) heuristic in developing their audit programs. She posits that the use of the SALY heuristic may impair audit efficiency. Further, Mock and Wright (1999, 1993) find that auditors frequently do not test controls, presumably because for smaller clients extending substantive tests is viewed as more efficient than doing an extensive evaluate and testing of controls. An experiment could be conducted to assess whether and to what extent use of the SALY heuristic impairs audit efficiency and/or effectiveness. For instance, cases could be developed where the situation had changed dramatically since the previous year. In one case, aimed at assessing efficiency, the client may have corrected a major flaw in its internal controls based on last year’s audit suggestions in the management letter. In another case, aimed at assessing effectiveness, the client may have installed a new computer system that has not as yet been tested. Subjects would be given last year’s workpapers and asked to write programs for this year’s audit. If subjects employ the SALY heuristic, they will not be sensitive to these dramatic changes. The only prior study to address this issue (Wright 1988) finds that auditors tend to

continue conducting even ineffective tests but appear to adapt the program to changes in risks.

However, further study of this matter is needed.

4.2.1 Nature of Tests

Most of the research on the nature of audit tests has been concentrated on two specific types of audit evidence: analytical procedures and confirmations (primarily accounts receivable). In large part, the research has focused on assessing the effectiveness of these procedures at detecting errors. But very little research has been done to assess the effectiveness of other types of audit evidence. How reliable are bank confirmations or legal letters of representation? Does vouching invoices over a certain dollar amount catch all the errors of a certain size? Is recalculation of client figures effective? How many errors are detected through verbal inquiry? Some of these questions may be difficult to study, but others could be done with controlled field experiments. For example, an archival and longitudinal study of legal letter representations could be performed, following up on the actual disposition of cases, thus, comparing the actual outcome to the predicted outcome in the legal letter. 13

13 An exploratory experimental study on this issue was performed by Krogstad et al. (2000). Using law students, they find that attorneys are less willing to provide estimates of the likelihoods [and more accurate estimates as compared to a delphi panel] and amounts of litigation contingencies when (1) there is a potential loss of privilege and (2) there is increased uncertainty about unfavorable outcomes. They also find an interaction between materiality and privilege such that with privilege when materiality is low, lawyers are less willing to provide auditors information. These results question the value of attorney letters in providing candid and complete evidence on litigation contingencies.

4.2.2 Extent of Tests

In years past, when statistical sampling was more in vogue, auditors tended to draw large samples of transactions, often in excess of 100, to test such things as payroll transactions, sales, and cash disbursements. As noted earlier, (e.g., Messier et al [2000] auditors now draw extremely small samples (e.g., 25-30 transactions). The rationale for such small samples is that very few errors occur in routine transactions due to automation of accounting (e.g., Bell and Knechel [1994]). Instead, the major risks are in non-routine transactions, such as estimates. How correct is this assumption? Presumably, the more transactions that are tested, the more errors will be detected. Also, there is the perverse effect that auditees may strategically place errors in such transactions knowing that auditors do not test them. An audit simulation with seeded errors could be performed with extent of tests as a manipulated variable to assess the impact of sample size on error detection.

4.2.3

Timing of Tests

No study has directly examined the issue of timing of audit tests relative to error detection. When auditors perform substantive tests at an interim date, they also perform certain roll-forward procedures in order to satisfy themselves of the year end balance. Accordingly, the issue of timing of tests is confounded with the reliability of roll-forward procedures. Thus, research on the effect of timing of tests on error detection cannot be studied without controlling for the reliability of roll-forward procedures, an issue for future research.

4.2.4 Staffing

Audit staffing has also received little attention in the error detection literature to date. Firms tend to assign staff such that more experienced auditors work on the accounts perceived to be most troublesome (i.e., error prone). But audit cost, audit risk, and business risk also appear to be factors that impact audit staffing decisions. Thus, any study of the effects of audit staffing on error detection would have to control for each of these potential confounding variables. It is unlikely that this could be achieved in an archival study or field experiment. Also, it would be difficult to determine what the “correct” level of staffing is for any given engagement. A Delphi panel of highly experienced auditors [Wright, 1988], however, can be used to arrive at a surrogate measure.

4.3 Program Execution

4.3.1 Sampling Risk

Neter and Loebbecke [1977, 1975] suggest that auditors need to choose the appropriate statistical sampling procedures and evaluation methods given the particulars of the population. But in practice, few auditors appear to have an adequate background in statistics to heed this advice. As discussed, Bedard [1989] finds that auditors generally select audit procedures by using the SALY heuristic (also, see Mock and Wright [1999, 1993]). Chan and Mo [1998] report that auditors use “judgmentally determined” samples; they don’t consider population particulars when selecting samples. A verbal protocol case could be developed to determine how auditors select samples and whether or not they do consider population particulars. Given the use of

convenience samples instead of statistical sampling techniques, this is particularly becoming a concern.

4.3.2 Non-sampling Risk

Since non-sampling risk, by definition, covers all risks that are not sampling risk, this factor is covered throughout this section of the paper, e.g., the abilities of auditors to correctly assess risks, the potential self-fulfilling prophesy issue, and the use of decision heuristics with biases. While many of these topics (e.g., recency effects) have been investigated in prior behavioral research with respect to general audit decision-making, similar studies could be designed to directly examine the relationship between non-sampling risk factors and detected errors.

4.4 Factors Underlying the Error Detection Process

4.4.1 Auditing and Firm Standards

Several issues remain unstudied relating to the impact of auditing and firm standards on error detection. Ideally, the effectiveness of a new statement or new audit procedures should be assessed *before* the Auditing Standards Board issues a new Statement on Auditing Standards or a new Auditing Procedures Study. Two recent examples of research on auditing standards are Libby and Kinney [2000], who examine the effectiveness of Statement on Auditing Standards Number 89, and Messier, et al. [2001], who examine the effectiveness of new guidelines for non-statistical sampling. Research has also been conducted on the effectiveness of the peer review process [Wallace, 1991]. Presumably, peer review has a positive impact on quality control procedures of firms. This, in turn, would affect audit planning, tests conducted, and ultimately

error detection. However, because it is difficult to control for a number of potential confounding variables, such studies are rarely undertaken.

Changes at the audit firm level are similarly complicated to study. Firm-wide differences in approaches to an audit (e.g., structured or unstructured) would be difficult to study because of confounding variables, but Elder and Allen [1998] report that different approaches to projecting errors from samples to populations made a difference in how many errors were actually projected. A longitudinal study of one firm may be the only way to address this issue. Samples of audit workpapers for years prior to and after a fundamental change in firm standards (e.g., instituting a peer review process) could be conducted. However, the archival nature of such a study and the potential for confounding variables over time would make this approach subject to some limitations that have been discussed above.

4.4.2 Decision Tools/Aids

Auditors have a number of decision aids and tools at their disposal, including checklists, decomposition-and-mechanical-aggregation (DAMA) aids, expert systems, and generalized audit software, to name a few. To date, no prior studies have investigated the impact of decision tools/aids on error detection. However, Messier, et al. [2001] as well as Kachelmaier and Messier [1990] found that decision aids may hinder audit judgment in a sampling application. Kachelmaier and Mesier [p. 223] reported that some subjects seemed to work “backwards in an attempt to circumvent the decision aid.” In their review of prior decision-aids literature, Bonner, et al. (1996) report that checklists and DAMA aids have mixed results in terms of aiding auditor judgment in a variety of contexts other than error detection. Thus, the question of whether

decision aids and tools are effective in detecting errors remains largely unanswered. A laboratory experiment with seeded errors could be conducted to address this issue. Different treatment groups of subjects (auditors) would receive various decision aids and tools and the control group would make their decisions without any decision aids or tools.

4.4.3 Auditor knowledge, experience, motivation, ability, ethics, and decision heuristics

A great deal of research has been devoted to studying auditor characteristics. The findings of this work suggest that industry specific knowledge, experience, motivation, ability, and ethical behavior all enhance auditor performance, which presumably would ultimately improve the auditor's ability to detect errors. The heuristics literature generally shows that auditors are prone to the same sorts of biases as psychology students and other subjects.¹⁴ For example, when auditors anchor on last year's numbers, they do not make sufficient adjustments. A variation of this is the SALY heuristic. Some research has been done to design procedures to help auditors overcome the biases inherent in heuristic decision approaches. For example, Kennedy [1993] looks at mechanisms to reduce recency bias such as accountability.

Ashton et al. [1988] provide a list of research questions, many of which remain unanswered more than ten years later. For example, "How effective are auditors at integrating several pieces of evidence when the evidence is described in the same mode versus different modes." [1988, p. 118]. Questions such as this can be used to study the impact of auditor characteristics on error detection.

¹⁴ It should be noted, however, that Smith and Kida [1991] suggest that for auditors, some heuristics (e.g., conservatism) may be functional and there are differences in the *extent* to which auditors are prone to biases.

4.4.4 Environmental factors including reliability of evidence and audit costs

As was demonstrated earlier in the paper with accounts receivable confirmations and analytical procedures, reliability of evidence may be a significant confounding variable when an archival approach is employed to study error detection. It is also clear from the earlier discussion that little is known about the reliability of most forms of audit evidence. Thus, while confirmation evidence is biased towards finding more overstatement than understatement errors, an open question exists about potential biases in all other forms of audit evidence. For example, a common finding in archival studies is that inventory errors tend to be both over and understatements. But nothing is really known about the reliability of inventory audit procedures such as observation. An inventory audit simulation, with seeded errors, could be conducted, similar to the confirmation studies, to determine the reliability of inventory audit evidence, and to determine if such evidence is inherently biased. Similar cases could be designed to study other types of audit evidence.

Another open area for research is the impact of attempts to minimize audit costs on error detection. For example, do tighter time budgets result in fewer errors being detected? This issue could be addressed with an audit simulation with seeded errors, in which different treatment groups received different time budgets for the same audit situation and were asked to design audit program plans. Asare, et al. [2000] look at analytical procedure follow-up testing and examine information search and effectiveness in identifying a seeded error with time budgets and accountability. They find that these factors affect the depth, breadth, and nature (error versus non-error) of testing. Relatedly, analysis of archival data regarding errors that were originally

undetected but later came to light (e.g., restatement situations, litigation situations, etc.) might yield important insights into “what went wrong,” suggesting issues impacting error detection and/or ways to improve practice.

5.0 SUMMARY AND CONCLUSIONS

A review of the error detection literature, in conjunction with the model of the error generation and detection processes in Figure 1, identifies important directions for future research. One important issue involves research methodology. A major limitation of archival research is the lack of control over possible confounding variables, and, importantly, concern over the representativeness of detected errors of the actual underlying error population. A multi-method approach (e.g., using audit simulations with seeded errors together with laboratory-type experiments and comparing the results) is suggested. Another possibility is to audit 100 percent of the transactions in a given account that has already been audited using standard audit procedures, and compare the results of the 100 percent audit to the standard audit to determine whether any material errors were missed under the standard approach, and which of the tests in the comprehensive audit uncovered the error(s).

The model indicates the variables that effect error detection. It is important to control for these variables in future research. One of the more important variables is reliability of audit evidence. In their 1989 paper, Spires and Yardley reviewed the empirical research on the reliability of auditing procedures and concluded “with the possible exception of receivable confirmations, the research is sparse” [1989, p. 65]. Since that time, more is known about analytical procedures, but research on the reliability of most other auditing procedures remains

limited. Research with seeded errors is necessary to test the reliability of other audit procedures, such as recalculation, physical observation, scanning, vouching, etc. Using cases with seeded errors, the researcher controls the size and direction of errors, and can thereby determine the effectiveness of the procedure and possible biases inherent in the procedure.

In considering the reliability of various types of audit evidence, additional questions can be investigated. For instance, Caster and Pincus [1996] provide a model of factors that affect the persuasiveness of audit evidence. This research should be extended to provide a ranking of audit procedures in terms of effectiveness and efficiency at detecting errors under different client conditions. For example, inventory observation might be an effective and efficient audit procedure for detecting errors - - but only when the auditor is reasonably knowledgeable about the nature of the client's inventory. In addition, new audit technologies (e.g., embedded audit modules and continuous auditing) are appearing and need to be compared to more traditional types of evidence. How effective are these newer procedures at detecting errors?

Despite the presence in audit practice of a large number of decision tools and aids, very little research has been conducted to test the effectiveness of these decision tools and aids, particularly with respect to error detection. As firms begin to change their approaches to auditing and increase the use of expert systems and computerized audit software, the need for research on the effectiveness of these techniques increases.

Error detection is the primary objective of the audit process. That is, the auditor wants a high level of confidence that there are no material misstatements that go undetected. Thus, the relationship between error generation (what causes errors) and error detection (how errors are

identified) continues to be a very significant area of interest and concern to both auditing practitioners and researchers.

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1. Neter, J. and J. K. Loebbecke. 1975. *Behavior of Major Statistical Estimators in Sampling Accounting Populations: An Empirical Study*. New York: AICPA.

To assess the precision and reliability of using various estimators in audit sampling, the authors in this study simulate a number of **sample** populations based on four **actual** accounting populations (two each for accounts receivable and inventory) with different error characteristics. The error characteristics include error rate (high or moderate), error type (overstatements and/or understatements) and error size (small, moderate or large). For each of the four populations, samples are selected using simple random sampling without replacement for both the entire sample as well as for strata of the sample. The authors then utilize various estimators (e.g., mean-per-unit, difference, ratio, or some combination) to assess the population balance. Neter & Loebbecke find that error characteristics impact the adequacy of using various estimators in audit sampling. Specifically, ratio and difference estimators may not yield reliable results especially when the population error rate is low or the error amounts are large and in only one direction. As a result, auditors need to understand the relative effectiveness of various statistical procedures in order to select the best procedure given the characteristics of the population.

2. Ramage, J. G., A. M. Krieger and L. L. Spero. 1979. An empirical study of error characteristics in audit populations. *Journal of Accounting Research* 17 (Supplement): 72-102.

In this study, the authors use archival data from ninety-seven audits completed by Peat, Marwick, Mitchell, & Co. to describe error characteristics for accounts receivable and inventory accounts. The authors conclude that errors in accounts receivable are infrequently encountered, but when they occur, they tend to be small to moderate in amount and in the direction of overstating the account balance. Inventory errors, on the other hand, are more frequently encountered, are small in amount, and unbiased in terms of direction.

3. Hylas, R. E. and R. H. Ashton. 1982. Audit detection of financial statement errors. *Accounting Review* (October): 751-65.

Hylas & Ashton use archival data from 152 Peat, Marwick, Mitchell, & Co. audits, resulting in a sample of 281 misstatements requiring financial statement adjustment to assess error characteristics (client size and industry, error size, account effected, income effect), error cause and error detection (i.e., event signaling the error). The authors find that error rates are lower for larger clients and vary considerably across industries. Errors averaged less than 3% of total assets for each account affected, with only about 9% of errors exceeding 2% of total assets. The four accounts most commonly affected by errors are: inventory; accounts receivable; property, plant and equipment; and accounts payable. The authors report that the average income effect of the errors is evenly distributed between over- and under-statements. Hylas & Ashton further find that personnel problems as well as cut-off or accrual errors are the two most common causes of errors and that substantive tests of details, expectations from the prior year, analytical procedures, and client inquiry are the four most common ways to detect errors.

4. Kreutzfeldt, R. W. and W. A. Wallace. 1986. Error characteristics in audit populations: their profile and relationship to environmental factors. *Auditing: A Journal of Practice and Theory* 6 (Fall): 20-43.

Kreutzfeldt & Wallace use archival data from 260 Arthur Andersen & Co. audits, resulting in a sample of 1506 misstatements to replicate and extend Hylas & Ashton (1982). Different from Hylas & Ashton, this study also focuses on the relationship between errors and company and environmental factors. Of note, the authors find that more and greater errors are found on audits where the assessed strength of management controls is low. Further, more and greater errors are found on audits where there is greater inherent risk (e.g., low profitability, low liquidity). The authors find little association between the incidence and/or size of errors and external environmental factors.

5. Houghton, C. W. and J. A. Fogarty. 1991. Inherent risk. *Auditing: A Journal of Practice and Theory* 10 (Spring): 1-21.

The authors of this study use archival data from 480 Deloitte, Haskins & Sells audits, resulting in a sample of 2,272 misstatements, to determine the characteristics of errors in order to help the auditor identify inherently risky areas during audit planning. The authors find that non-systematically processed transactions result in a large majority of errors (64%) while another

group of errors (10%) could be predicted by auditors ex ante based on knowledge of industry and business risks as well as prior errors.

6. Warren, C.S. 1974. Confirmation informativeness. *Journal of Accounting Research*. 12 (Spring): 158-177.

Warren selected a sample of accounts of the Michigan State University Credit Union to measure the informativeness of the positive, negative, and blank types of confirmations. Approximately 70% of the accounts in the sample were seeded with errors. Large errors were defined as 10% of the balance while small errors were defined as 5% of the balance. Also, the errors were in both directions (i.e., overstatements as well as understatements).

Warren measured informativeness in terms of the probability of receiving an inaccurate response. He found that negative confirmations are least informative and that positive confirmations are as informative as blank confirmations. Also, confirmeres treat favorable errors differently than unfavorable errors.

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Figure 1: Model of Error Generation & Error Detection Processes

