1-1-1978

Sampling risk vs. nonsampling risk in the auditor's logic process

William L. Felix

Recommended Citation

Auditing Symposium IV: Proceedings of the 1978 Touche Ross/University of Kansas Symposium on Auditing Problems, pp. 047-056;

3

Sampling Risk vs. Nonsampling Risk in the Auditor's Logic Process

William L. Felix, Jr.
University of Washington

Most of the larger auditing practice units in this country can be described as either making considerable use of statistical methods in current practice or engaging in research and development that in the near future will encourage the use of statistical methods whenever they are appropriate. While the level and nature of the use of these methods varies considerably across these auditing firms, frequently a pervasive deficiency appears to exist in the documented incorporation of the results of such procedures in the audit logic process. In the following paper an examination of this problem is presented, followed by an analysis of the role of sampling evidence in the auditor's logic process. The paper concludes with some recommendations for action.

An Interpretation Problem

The use of statistical sampling methods as a structure for applying auditing procedures results in a confidence interval or an accept/reject decision depending on whether the auditor is using an estimation or a testing approach. (Although only an estimation approach is discussed in this paper, the comments apply with equal force to both approaches.) As an example of the estimation approach, an auditor might specify a 95% confidence interval of $6,934,000 plus or minus $141,700 in sending out positive confirmations of customer accounts receivable and use a mean-per-unit or an auxiliary estimation method to construct the resulting confidence interval. In documenting the results of such an application in the auditor's working papers, a conclusion similar to the following is often found:

> "Based on the above tests, I am 95% confident that the accounts receivable balance of $7,037,000 at 6/30/X7 is fairly stated."

While there are a number of issues in this conclusion that could be argued, the major concern of this paper is that the conclusion implies that the risk of a non-representative sample (the risk of sampling error) is the only audit risk of concern in the confirmation of a sample of accounts receivable. This implication is never correct. Of equal or possibly even greater significance in evaluating the results of the auditing procedure are the auditor's perceptions of (1) how well assistants executed the procedures and computations, (2) the ex post appropriateness of audit procedures used, and (3) the nature of the errors and other facts identified by applying the audit procedures to the sample items.

Based on discussions with a number of staff and supervisory audit personnel in several different practice units, the implication apparent in the above conclusion is a real problem. When questioned about the nature of audit evidence such as a sample of positive confirmations, these auditors were able to effectively discuss all the aspects of the evidence mentioned above, but when they were presented with a confidence interval, the auditors seemed to suffer from a "number fixation" and talk as if the confidence interval had somehow captured all aspects of the audit evidence. In order to explore with some care the nature of this problem and to propose action, the following section analyzes the role of statistical evidence in more detail.

An Intuitive Analysis

The logic process used by auditors to reach an opinion can be viewed as a process of collecting sufficient, competent evidence to drive the risk of undiscovered material errors or omissions in the financial statements to an acceptably low level. However, in order to identify properly the role of statistical methods in a particular audit procedure, a decomposition of this overall audit risk that is consistent with the auditor's professional standards for an examination is needed.

While extensive decomposition of overall audit risk does not seem to exist in the literature, a first level of decomposition is included in **AICPA Professional Standards,** AU Sec. 320B.29. Here, in discussing overall risk, two separate risks are introduced. The first is the risk that the accounting system will generate a material error and the second is the risk that the auditor's examination will not discover a material error given that one has occurred. These two risks are stated in terms of an overall audit risk, i.e., the risk of undiscovered errors that aggregate to at least a material error. The risk of a client accounting system generating an error (or errors) is an assessment problem. This assessment activity is carried out in large part through the process of learning the client's industry, operations and personnel and through the required study and evaluation of internal controls in each transaction cycle component of the accounting system.

The risk of an error not being discovered by the auditor's examination is then minimized by designing and executing a set of audit procedures. These procedures typically include a combination of systems reliability tests (compliance tests) and tests of balances (substantive tests) that will drive the auditor's perception of the risk of undiscovered errors to an acceptably low level. This process in risk terms is susceptible to decision theoretic modeling, as discussed in footnotes 1, 2, and 4.

Identifying the Role of Statistical Sampling

In order to identify the role of statistical sampling methods in auditing, further decomposition is necessary. A decision theory approach to this analysis is possible and will be explored in another paper. In the interests of simplicity a less ambitious approach is presented here. In addressing both the assessment problem and the design and execution problem the auditor performs specific procedures that comprise an interrelated evidence collection and evaluation process. These procedures are chosen in both problems to provide cost-effective reduction in overall audit risk. The expected contribution to risk reduction by each procedure could be analyzed by a decomposition of the overall audit risk among the various transactions cycles and balances. However, this analysis is not necessary in this paper other than to observe that it occurs and that each audit procedure used is expected to contribute to the reduction of overall audit risk, not just to a subclassification of overall risk.

Specific audit procedures used in either the assessment problem or the design and execution problem may or may not include the use of statistical sampling methods. In those situations where statistical sampling methods are used, a further two part decomposition of overall audit risk is made explicit. The risk that the sample is not representative of the evidence population being tested is the rather well known risk of sampling error. Using a confidence interval or estimation approach to sampling, this risk is one minus the confidence level. For example, a 6% achieved upper error limit at 95% confidence implies a 5% risk of sampling error. The other part of this level of evidence decomposition for a specific audit procedure is the risk of nonsampling error.

Nonsampling error can be defined by exclusion; that is, all sources of risk of audit estimation or decision error other than the risk of sampling error. However, some analysis of the types of error involved is worthwhile. At least two major sources of nonsampling risk can be identified. They are 1) the risk of error in choosing and/or using the statistical sampling methodology (or other methodology to obtain sample items and relate them back to the evidence population) and 2) the risk of error in choosing and/or using an audit evidence procedure on the basic items in the sample. An example of an error under the first source would be the choice of an inappropriate statistical methodology such as the use of unstratified mean-per-unit estimation on a highly skewed population. Another example of this first source of error would be making computational errors in obtaining the confidence interval. An example of the second source of error would be the use of an ineffective audit procedure such as the use of negative confirmations of accounts receivable for top stratum accounts of a heterogeneous population or in a situation where fraud may be present as a consequence of weak internal control. Another example of this second type of error would be any type of human error or misperception by the auditor such as omitting an audit procedure on one of the sample elements.

At this point the contribution of statistical methods to the audit process can be summarized. By using statistical methods as a framework for planning and evaluating the results of specific audit procedures, the auditor is able to control the risk of sampling error or the risk that the sample is not representative of the population for the audit application. This contribution is directly beneficial to the auditor in that a possible source of estimation or decision error is explicitly documented and evaluated. More indirect benefits are also likely because statistical sampling methods require that some of the judgmental parameters of the testing process be stated specifically. This necessary increase in specification should result in more careful planning and documentation and improved chances that subsequent review will identify nonsampling errors. The contribution to risk reduction implicit in these additional elements is, of course, due to a reduction in the risk of nonsampling error.

A Case Illustration

The following case will illustrate some of the issues regarding sampling and nonsampling risk described above. The auditor's actions are described first, followed by a discussion of the risks of sampling and nonsampling error.

A Description of the Audit

On May, 19X8, Ohio-Indiana Utility company (OIU), a medium size midwestern regional utility company converted to a new EDP system for customer accounts. Because of a lack of controls and poor conversion procedures, a large number of errors in new and discontinued accounts as well as continuing accounts occurred through the end of the year. In addition, the accounts receivable file did not reconcile with the general ledger and it was not clear what problems would arise in attempting a reconciliation.

In planning the year-end audit of OIU, it was decided that extensive reliance on accounts receivable confirmations would be necessary in order to obtain sufficient competent evidence on accounts receivable and sales and that positive confirmation requests should be used. The accounts receivable included approximately 526,000 customers of which about 467,000 are residential and 59,000 are commercial, industrial, and other types of customers. The accounts receivable balance was expected to total approximately $13,400,000.

In order to be as explicit as possible about the planning process and to control the risk of sampling error, statistical methods were to be used in carrying out the confirmation procedure. In this application a relatively precise, two-sided estimate was considered necessary because of the expected weakness of corroborative evidence and the possibility of proposing an upward or downward

Mean-per-unit estimation (MPU/S) with stratification was chosen as the statistical framework for the confirmation procedure to achieve this objective.
adjustment based on the statistically augmented audit procedure.

Other Audit Decisions

OIU's accounts receivable population included a number of possible subclassifications for audit purposes. Since the objective of the receivables confirmation procedure was to provide extraordinary substantive evidence in view of the known internal control problems and still stay within reasonable audit costs, some care in deciding how to treat the possible subpopulations was appropriate. The first level subclassification was residential vs. non-residential customers. Residential customers were viewed as very numerous (467,000), with smaller balances (few accounts over $200), and as not being particularly sophisticated in understanding the confirmation request. The non-residential customers were fewer in number (59,000), with larger balances (some balances over $10,000), and as more likely to understand the confirmation request. Given these differences, a judgmental decision was made to treat the two subpopulations separately.

In addition, within both the residential and the non-residential subpopulations there were some negative balances and a large number of zero balances as well as the usual debit balances. It was decided that the zero and negative balance subpopulations would also be tested but evaluated separately because their characteristics for auditing purposes differed from the debit balances. The tests of these accounts are not described here.

The subpopulations subjected to the MPU/S positive confirmation procedure were the debit balance residential and non-residential accounts. Based on the evidence needs in this application, it was judgmentally determined that a 95% confidence level and a precision of plus or minus $130,000 would be used in each subpopulation. The precision is one half of the amount believed to be material for each test. The relatively high confidence level of 95% (low sampling risk) was specified because of the lack of alternative evidence and the possibility of proposing an adjustment. The materiality amount of $260,000 was chosen based on the decision that approximately 10% of the expected net income of $5,000,000 would be material to the financial statements as a whole and that slightly over one half of this amount could be tolerated in these specific tests of accounts receivable.

In order to perform the MPU/S estimation each of the two subpopulations was stratified.

At OIU it was decided to use 4 strata plus a 100% stratum for residential accounts and 5 strata plus a 100% stratum for non-residential accounts. The cum $\sqrt{f}$ method was used to locate the stratum boundaries. The number of strata were chosen based on recommendations in the statistical literature that 5 to 10 strata will usually be a good choice. The cum $\sqrt{f}$ method of locating boundaries is used by dividing the population into a large number of cells. The stratum boundaries are then located by allocating approximately equal sums of the square root of the cell width times the cell frequency to each of the strata. This process is illustrated for the four sampled strata in the residential accounts in Table 1.

After the stratum boundaries were located for the OIU application, a generalized audit software package was used to draw preliminary random samples of 50 accounts from each stratum. These preliminary samples were used to compute the estimated standard deviation of the book values in each stratum which in turn were used to estimate the required samples size for each stratum. The results are summarized in Table 2.

Because the sample sizes are based on the book values of the preliminary samples from each strata, it is very possible that the estimated standard deviation computed from the audited sample values will be larger than those estimated above. This will be particularly true if the errors move the audit values across stratum boundaries. For this reason it is good practice to increase the preliminary sample sizes by about 10% to provide some protection against this event. The result of the larger standard deviations without increased sample sizes would be a resulting confidence interval that is too wide implying that the audit evidence is insufficient.

The results of positively confirming the selected accounts receivable and performing alternative procedures on the non-responses are summarized in

Table 1

Residential Accounts

Class Number	Width of Class	Number of Accounts	$\sqrt{W_iN_i}$	$\Sigma\sqrt{W_iN_i}$
1	10	27,806	527	527
2	10	74,062	866	1,388
3	10	58,744	766	2,154
4	10	33,794	581	2,736
5	10	17,781	422	3,157
6	10	9,471	308	3,465
7	10	6,190	249	3,714
8	10	3,801	195	3,909
9	10	2,546	160	4,069
10	10	1,637	128	4,196
11	50	2,968	385	4,582
12	50	650	180	4,762
13	50	205	101	4,863
14	50	96	69	4,932
15	50	75	61	4,994
16	50	51	50	5,044
17	50	30	39	5,083
18	50	30	39	5,122

1. $\frac{5122}{4} = 1280$
2. $2(1280) = 2560$
3. $3(1280) = 3840$

Table 3. The client book values reported on this table are different from the totals originally used for planning as noted above, because a number of errors in the population were corrected by the client prior to this evaluation. The sub-population book values were obtained from the client's book control accounts, which at the date of the evaluation were reconciled with the detail. Errors on confirmation returns that had been corrected by the client prior to the confirmation return were not considered errors for audit puposes.

The resulting confidence interval statements were as follows:

1. Residential Accounts: Based on a point estimate of $6,944,389 and a precision of $138,383, the 95% confidence interval is ($6,806,006, $7,082,772).
2. Non-residential Accounts: Based on a point estimate of $5,428,905 and a precision of $133,873, the 95% confidence interval is ($5,295,032, $5,562,778).

Using this evidence the audit staff wrote the following conclusion:

Table 2

Stratum	Dollar Interval	Stratum Size	Estimated Standard Deviation	Estimated Sample Size
Residential				
1	0-19.99	101,868	4.12	147
2	20-39.99	92,538	5.18	167
3	40-79.99	37,243	9.46	123
4	80-499.99	8,288	35.01	101
5	500 and up	51	-	51
		240,238		589
Non-Residential				
1	0-74.99	20,286	22.98	167
2	75-149.99	4,398	21.24	33
3	150-499.99	4,590	110.24	181
4	500-1,499.99	1,389	297.15	148
5	1,500-3,499.99	367	554.17	73
6	3,500 and up	217	-	217
		31,247		819

Table 3

Audited Results

Residential

Stratum	Number	Sample	Mean	Standard Deviation
1	101,868	160	12.15	4.89
2	92,538	190	29.04	4.90
3	37,243	140	55.89	10.33
4	8,288	110	111.95	45.99
5	Audited value of $26,198			

The book value of this subpopulation is $6,955,542

Non-Residential

Stratum	Number	Sample	Mean	Standard Deviation
1	20,286	190	30.16	20.54
2	4,398	40	119.33	37.22
3	4,590	200	245.99	127.56
4	1,389	160	813.77	316.23
5	367	80	2,104.39	544.21
6	Audited value of $1,260,534			

The book value of this subpopulation is $5,446,510

"Based on the satisfactory results of our audit procedured described at (Index), we are 95% confident that the accounts receivable balance is fairly stated as at 12/31/X8."

Discussion of the Sampling Risks

In this circumstance the auditor planned to accept a risk of sampling error up to 5%. The achieved sampling risk may be viewed in a variety of ways, but we will follow our estimation approach and consider each subpopulation.

The residential accounts book value of $6,955,542 is within the achieved 95% confidence interval, but the precision is somewhat larger than the planned $130,000. Most practice units using the estimation approach would accept the results because the confidence limits are less than a material amount of $260,000 from the book value. The achieved sampling risk may be viewed as one minus the auditor's confidence that the book value is not materially ($260,000) in error or approximately .0001%. That this achieved risk is far less than the planned 5% is due of course to the extremely conservative approach of setting planned precision equal to one-half a material error rather than explicitly controlling the β risk and to drawing a sample point estimate very close to the book value. The result for the nonresidential accounts is similar.

Some would argue that the two subpopulations should be combined for evaluation purposes. Combining would result in a point estimate of $12,373,294 (the sum of the separate point estimates) plus or minus an achieved precision of $192,540 (obtained by combining the standard deviations using the square root of the sum of the squares approach). This combination is acceptable for the evaluation of sampling risk on a combined basis, but should be viewed with some caution in the evaluation of other (nonsampling) risks. To the extent that the two subpopulations were divided for reasons other than statistical methodology, the evaluation of the results for these other objectives should be separate. An example of another objective would be to separately evaluate the perceived ability of the two classes of customers to respond to the confirmations correctly.

A Discussion of the Nonsampling Risks

The risk of nonsampling error in this illustration can be approached using the framework outlined in the previous section. First consider the choice of auditing procedures (positive confirmations) and the quality of execution of the procedures. The auditor's working paper documentation should include the essence of the narrative in the case illustration. In addition, in arriving at conclusions about accounts receivable, consideration should be given to whether or not the confirmation procedure was effective and whether or not the audit personnel performed the procedure effectively. Specific issues that would have to be considered regarding the effectiveness of the confirmation procedure include:

1. Were the anticipated rate and type of errors found in the sample and if not, why not? (If the anticipated errors were not found, is it possible that the confirmation procedure could not find them? Also, was evidence uncovered to explain the reconciliation problem?)
2. Does the nature of the errors found in the sample indicate any prob-

lem in using confirmation results as evidence or indicate other unanticipated problems affecting the acceptability of the debit balances?
3. Were the subclassifications of the accounts receivable population effective?
4. Should other audit procedures be added as a supplement to or a replacement for the confirmations? (Note that in this case it is possible to argue that overreliance on the confirmations is very likely.)
5. Was the combination of confirmation evidence and "alternative procedures" evidence appropriate?

The quality of the execution of the audit procedures is usually evaluated through discussions with the staff and by careful review of their working papers.

The second part of the evaluation of the risk of nonsampling error is to assess the risk that the statistical methodology or its execution might lead to audit decision errors. The choice of sampling methodology is controversial. The method used in this illustration as well as any other sampling method is not suitable in all audit circumstances. Either through reliance on practice unit policy or published evidence, the reasonableness of the specific method should be evaluated. The stratified mean per unit method is discussed in a number of sources such as the AICPA's **Audit Research Monograph, No. 2** by Neter and Loebbecke, and such references should be consulted in evaluating its use. The robustness of the MPU/S method documented by Neter and Loebbecke in conjunction with highly skewed populations would support the use of the method in this case.

The evaluation of the quality of the execution of the sampling procedure should be an integral part of evaluating the performance of the audit staff on all audit procedures. However, a conclusion such as that illustrated above indicates the importance of careful review by knowledgeable auditors to be sure that both in fact and appearance the statistically oriented evidence is properly integrated into the audit process.

This brief discussion of sampling and nonsampling risks in a specific application is meant to be illustrative. An exhaustive analysis may well be worthwhile, but is not critical to the intent of this paper.

An improved form of the auditor's conclusion could take at least two approaches. Either the conclusion should express the auditor's degree of satisfaction with overall risk, or the conclusion should specifically address both sampling risk and nonsampling risk. In any case both the auditor's understanding and his/her documentation should reflect careful evaluation of the impact of the evidence.

Future Action

First, the current emphasis in statistical methodology training for auditors on alternative methods and their appropriate use needs to be expanded. By using both conceptual arguments and case illustrations, the significance of the risk of sampling error on the audit process should be clarified. This expansion should, of course, be consistent with the practice unit's audit philosophy. In addition, the expanded training should include analysis of and training in writing audit conclusions where statistical evidence is a part of the material being evaluated.

Second, professional standards for auditors should be expanded to identify explicitly the role of statistical evidence in the auditor's logic process and to consider the appropriate form of an audit conclusion that responds in part to statistical evidence. Documentation that is not consistent with the actual use of the evidence, such as the conclusions illustrated in this paper, reflects poorly on the profession. Auditors are encouraged to use statistical methods in both the professional literature and standards. To the extent possible, that literature and those standards should be clear regarding the role of sampling evidence in the auditor's opinion formulation process.

Footnotes

1. Felix, William L., Jr., "A Decision Theory View of Auditing," *Contemporary Auditing Problems,* Howard Stettler (Ed.) (University of Kansas School of Business, Lawrence, Kansas, 1974), pp. 63-71.
2. Kinney, William R., Jr., "A Decision Theory Approach to the Sampling Problem in Auditing," *The Journal of Accounting Research,* Vol. 13, No. 1 (Spring, 1975), pp. 117-132.
3. Neter, John and James K. Loebbecke, *Behavior of Major Statistical Estimation in Sampling Accounting Populations: An Empirical Study* (New York; American Institute of Certified Public Accountants, 1975).
4. Scott, William R., "A Bayesian Approach to Asset Valuation and Audit Size," *The Journal of Accounting Research,* Vol. 11, No. 2 (Autumn, 1973), pp. 304-330.
5. *Statements on Auditing Standards Nos. 1 to 21* (New York, American Institute of Certified Public Accountants, 1978).