STATISTICAL SAMPLING FOR SALES AND USE TAX AUDITS

Tennessee Department of Revenue

Audit Division – Electronic Data Group

Questions or Concerns

More information may be found on the Department of Revenue's website
https://www.tn.gov/revenue

You are encouraged to ask questions of the EDG auditor or field auditor during the audit process. You may also email questions to support.data@tn.gov.

Introduction

The Tennessee Department of Revenue (the Department) uses statistical sampling in sales and use tax audits when the volume of records is so great that an examination of all records is impractical. This manual describes how the Department uses statistical sampling in sales and use tax audits.

The appendices contain examples which demonstrate the content of the information provided to taxpayers during a statistical sampling audit. For a specific audit, however, the form and format of the information may be different from the examples.

Benefits of a Statistical Sample

Statistical sampling benefits the taxpayer in the following ways:

- Statistical sampling is an accurate method of sampling.
- Used consistently over time, statistical sampling yields reliable results.
- The taxpayer is encouraged to participate in the selection of accounts to be audited. The taxpayer has the opportunity to include records in the audit population for which the possibility of an overpayment of tax exists.
- As necessary, records are combined to create unique transactions.
- The audit population is the list of unique transactions from which a sample (subset) is chosen for review.
- The process of selecting records for examination is objective. The unique transactions in a statistical sample are selected randomly. A statistical sample is chosen in such a way that each unique transaction in the audit population has a known probability of being selected. Random selection ensures complete objectivity in the sample selection.
- The sample is representative of the audit population. Statistical sampling is based on the random selection of sampling units from the entire audit population. Each unique transaction in the audit population which has a chance of being included in the sample is a sampling unit. Each sampling unit in the audit population has a known probability of being selected.
- The Department projects credits based on the results of a statistical sample. The audit population may have records showing over- and underpayment of taxes. If so, both types of errors will be reflected in the sample. Projecting the results of a statistical sample that results in a credit to the taxpayer is evidence of the Department's confidence in the implemented methodology.

Population Stratification and Sample Selection

Verifying the Electronic Data

The data received from the taxpayer is verified for correctness and completeness. This is accomplished by verifying the electronic data with the taxpayer's books and records. Selected accounts/sales in the data are totaled for a given time period (e.g., a year). The auditor compares these totals with the totals from the taxpayer's books and records. The taxpayer supplies any and all additional records needed to reconcile differences. Timing issues, manual adjustments to accounts, etc., may cause amounts to not match perfectly. Still, the Department expects the amounts to closely agree.

Selection of Accounts

While all transaction types are subject to audit, refinement of the audit population conserves both Department and taxpayer resources. To this end, it is important that the taxpayer sufficiently explain the chart of accounts to the auditor. Typically, in consultation with the taxpayer, the auditor determines which accounts are selected for review.

Defining the Audit Population

The audit population, commonly called "sampling frame" in statistical literature, is the total set of unique transactions from which the sample is selected. The audit population is derived from the data records submitted by the taxpayer. Records outside the audit period are removed. Also, records with no tax implication (e.g., payroll entries) are usually excluded. As necessary, data file records (e.g., line items) are combined to create unique transactions (sampling units). The criteria for combining data records to form unique transactions vary across audits. This is largely due to differences in accounting systems and methods. Even so, the Department's procedure is consistent.

The taxpayer is encouraged to participate in the process of defining the audit population.

Once the audit population has been defined, a summary is prepared that reconciles the number of unique transactions in the audit population with the number of records received from the taxpayer. The summary is included in the sampling plan given to the taxpayer. Appendix 1 is an example of a sampling plan for an expense audit population. To ensure reproducibility of the audit population, documentation is also included in the final audit work papers.

Population Stratification

Stratification is the process of dividing a population into groups, called strata. Grouping is done in such a way that units within a stratum (singular of strata) are more alike than units compared across strata. Most often, in sales and use tax audits, the audit population is stratified on the dollar amount of the transaction.

Stratification improves efficiency while preserving validity. When multiple methods exist for estimation and all other things being equal (e.g., same precision and reliability), the method requiring the smallest sample size is considered the most efficient. For a given precision and a specified confidence level, stratification usually requires a smaller sample size than would be required if simple random sampling without stratification were used. As used in this manual, precision is the absolute value of the difference between the appropriate 75% one-sided confidence limit and the estimated total population assessment expressed as a percentage of the estimated total population assessment. Confidence level is the amount of certainty, expressed as a percentage, associated with the procedure and formulas used to compute a confidence interval.

Additionally, stratification offsets the effect of extreme values (skewed distributions). Almost all businesses have transactions covering a wide range of values (i.e., transactions are highly variable). Stratification ensures the sample reflects the entire audit population.

In order to stratify data, each item in an audit population must have some quality or quantity which can be used to group the records. For sales and use tax audits, the desired basis for stratification is the difference between the actual tax due and the amount of tax paid for each transaction. Since this difference is unknown, the transaction amount is generally used for stratification. Review of statistical literature shows this to be common practice.

Any group of transactions that is to be 100% audited is referred to as a detailed stratum. For example, auditors usually choose to review all transactions above a specified dollar threshold. Such use of a detailed stratum ensures that large transactions do not have undue influence on the audit results. The remainder of the audit population is stratified on transaction amount.

The boundaries used to separate one stratum from another must be determined. Statistical literature provides a variety of techniques for choosing strata boundaries. Of those, the Dalenius-Hodges method is the standard to which other algorithms are often compared. The Dalenius-Hodges method is also referred to as the cumulative square root of f (cum$\sqrt{f}$) procedure. The process begins by grouping the data into initial classes. Then, the square root of the frequency of each class is summed over the entire population. Strata are formed by combining classes so that the total accumulation of the square root of the frequency is evenly distributed over the desired number of strata. For further explanation, the interested reader is referred to a statistical text such as Cochran (Cochran, William G. (1977) Sampling Techniques, Third Edition. John Wiley & Sons: New York) or Roberts (Roberts, Donald M. (1978) Statistical Auditing. American Institute of Public Accountants, Inc.: USA).

Using the cum$\sqrt{f}$ method to determine the stratification boundaries of sales and use tax data commonly results in a large number of observations being placed in the first few strata. While statistically valid, taxpayers may perceive such stratification as unfair because the average error in each stratum's sample is extrapolated to the corresponding stratum population. To address this concern, the Department adds a second criteria to stratification: in most instances, no more than 15% of unique transactions from the audit population are placed into a single stratum. This criteria requires professional judgment in the creation of strata boundaries. Still, the sample is representative of the population. Any errors (positive or negative) found in the sample are representative of errors in the population. The Department's usual procedure is to combine the cum$\sqrt{f}$ method with the stratification determined from professional expertise.

The taxpayer is encouraged to participate in the stratification process. Once the audit sample is randomly selected, stratification boundaries cannot be changed.

Sample Size

Accepted statistical practices are used in making the assumptions necessary to determine sample size. Methodology and a mathematical example are given in the Department's Technical Supplement.

In general, the wider the range of transaction amounts (i.e., the greater the data variability), the larger the sample size. Sample size is also influenced by error rate, desired precision, and specified confidence level. When determining total sample size and how the sample is allocated to strata, the Department typically uses the following:

- Confidence level. The Department uses a 75% confidence level for a one-sided confidence interval.
- Precision. The Department uses 10%.
- Expected error rate. This can vary based on the expectations of the auditor regarding the occurrence of errors in the population. When no information is available, five percent (5%) is used.
- Minimum sample size in a stratum. The Department requires a minimum stratum sample size of 70. In cases where the stratum has less than 70 transactions, 100% of the items are audited (i.e., the stratum becomes a detailed stratum).
- Allocation method. The Department uses Neyman allocation to determine the portion of the sample to be randomly selected from each stratum. Neyman allocation weights strata so that more of the sample is chosen from larger strata and from strata with more internal variability. See the Department's Technical Supplement for more detail.

Sampling Plan

A customized sampling plan is provided to the taxpayer. Please see Appendix 1 for an example. The sampling plan provides a record identification summary, identifies the sampling unit, gives the detailed stratification, and indicates the total sample size and allocation of the sample to each stratum. The taxpayer is given the opportunity to respond to the sampling plan before the audit proceeds.

Occasionally during an audit, the audit period will change because of the loss of periods due to the expiration of the statute of limitation. In these situations, the transactions that fall within the lost period(s) are removed from the audit population. The taxpayer is provided with a memo explaining the situation and showing the revised allocation of the population within the stratification.

Sample Selection

Once the sample is allocated to the strata, each stratum is randomly sampled to select the unique transactions to be audited. Sufficient documentation is maintained to recreate the sample. For example, when a random number generator is used to select the sampling units, the unique random number generator seed is documented. If additional sample items are required, then the same random number generator and seed used to obtain the initial sample is used to obtain the supplemental sample.

Audit Results

Several steps are involved in determining the final disposition of an audit. The auditor examines each transaction in the sample to determine taxability and the amount of error (tax owed minus tax paid). The amount of tax error is known as a "difference" in statistical literature. If the correct tax has been remitted for a transaction, then that transaction has zero tax error (i.e., zero difference). If the correct tax has not been remitted for a transaction, then the tax error may be an over- or under-payment (i.e., the difference may be negative or positive). The differences found in the sample are then used to estimate the total population tax error (i.e., total difference estimate).

Average Tax Error

For each stratum, the average tax error for the sample is determined by summing all the errors in the stratum sample and dividing by the stratum sample size. For example, 70 transactions from a stratum are examined. Three transactions are found to have tax errors. For one transaction, the tax error is an under-payment of 26 cents ($0.26). The other two transactions also have under-payments of 49 cents ($0.49) and 86 cents ($0.86). So, the average sample error for the stratum is:

$$\frac{\$0.26 + \$0.49 + \$0.86}{70} = \$0.023$$

Projected Sum Error

The average sample error in each stratum is extrapolated to obtain the projected error per stratum. This is achieved by multiplying the average tax error found in each stratum sample by the number of population records contained in the associated stratum. For example, a stratum contains 2,899 audit population transactions with a sample average tax error of $0.023. The extrapolated total error for the stratum is

$$(\$0.023) * (2{,}899) = \$66.68$$

Estimated Audit Population Total Tax Error

To estimate the total tax error in the audit population, the strata projected errors are summed. The strata projections and resulting total are a part of each audit results report. An example of such a report is given in Appendix 2. In the example, the estimated total assessment for state tax is $20,092.80. Similar reports are generated for local tax, taxes allocated to designated state revenue funds, etc.

Confidence Level and Confidence Interval

"Confidence level" and "confidence interval" are statistical concepts covered in many statistics textbooks. The interested reader is encouraged to consult such a text for general background material on confidence level and confidence interval.

As of the date of this manual revision, Tennessee Department of Revenue management has established the policy that any assessed value be such that there is 75% confidence that the taxpayer owes at least as much as is being assessed. This is achieved by assessing at the lower limit (LCL) of a one-sided 75% confidence interval. In the case of a credit, the Department wants to be 75% confident that the State owes the taxpayer at least as much as is being credited. Thus, refunds are determined by the upper limit (UCL) of a one-sided 75% confidence interval. Confidence limit computational details are contained in the Department's Technical Supplement.

Audit Decision

A 75% one-sided confidence interval is computed and used to determine if the audit results in an assessment, no tax due, or a refund. Table 1 (right) describes the four possible audit decisions.

Table 1 Decision Matrix for 75% One-Sided Confidence Intervals

Total Population Assessment	75% One-Sided Confidence Interval	Decision	Interpretation
Assessment > $0	LCL > $0	Assess at the LCL.	The Department of Revenue is 75% confident that the taxpayer owes at least the LCL amount.
Assessment > $0	LCL < $0	No tax due. No refund.	The Department of Revenue is not 75% confident that the taxpayer owes any additional tax.
Assessment < $0	UCL > $0	No tax due. No refund.	The Department of Revenue is not 75% confident that the taxpayer is due a refund.
Assessment < $0	UCL < $0	Refund at the UCL.	The Department of Revenue is 75% confident that the taxpayer is due at least the UCL amount.

In Table 1, the column labeled "Total Population Assessment" refers to the estimated population total tax error. In the sample report located in Appendix 2, the sum of the column labeled "Projected Assessment" is the value which Table 1 refers to as "Total Population Assessment." Likewise, at the bottom of the example report, the same quantity is labeled "Estimated Total Due." The point is that whether called "total population assessment," "projected assessment," "estimated total due," or some similar phrase, the sample data is used to estimate the true total population tax error. Since the true value is unknown, the estimated value is used for assessment purposes. The implemented statistical methodology provides a measurable level of confidence in using the estimated value for determining tax or refund due.

To illustrate an audit decision, refer again to the example in Appendix 2. For state taxes, $20,092.80 is the estimated total due and $18,685.47 is the 75% one-sided lower confidence limit. Since both values are greater than zero, the lower confidence limit of $18,685.47 is the amount the Tennessee Department of Revenue assesses the taxpayer for state tax. The Department is 75% confident that the taxpayer owes at least $18,685.47 in state tax.

Precision

A measure used to evaluate the results of a statistical sample is the sampling precision. Precision is a measure of sampling errors. Precision does not measure non-sampling errors (e.g., human error, lost or misplaced files, etc.). As used in this manual, sampling precision is the absolute value of the difference between the one-sided confidence limit and the estimated audit population total tax error expressed as a percentage of the estimated audit population total tax error. The closer the precision is to zero, the more precise the estimate.

Frequently, the precision of a sample can be improved by taking a larger sample. Both the Department and the taxpayer have the right to request a larger sample in order to improve sampling precision. Statistical theory provides for additional sample units to be randomly selected to achieve a desired precision while maintaining the integrity of the statistical sampling process. Note, it typically takes four times as large a sample to reduce a given precision by half. If the sample is expanded, results of the expanded sample are binding.

Reporting of Results

A full audit report is provided to the taxpayer upon conclusion of the audit. For each statistical sample performed in the audit, the full audit report includes a copy of the implemented sampling plan, the actual sample records, and an audit results report. (See Appendix 2.) As part of the audit results report, separate summaries for state versus local taxes are given. Additionally, the Department is legislatively required to allocate any change in the taxpayer's state tax liability (either an assessment or a refund) to the appropriate state revenue fund. Thus, a breakdown of allocations to certain state designated funds is also given in the report.

Conclusion

This manual provides an overview of the statistical sampling process used by the Tennessee Department of Revenue. The Technical Supplement provides additional details on the topics of statistical sampling methodology, stratification, and sample size calculation. The Department readily provides the Technical Supplement to interested parties. Also, the referenced texts are excellent sources for the statistical theory used.

Statistical sampling is one way the Tennessee Department of Revenue seeks to enforce tax laws fairly and consistently. Additionally, the Department seeks to educate and assist taxpayers. The Tennessee Department of Revenue welcomes questions and comments. If you have any questions or comments regarding this manual or the Department's statistical sampling procedure, please send e-mail to support.data@tn.gov.

Proceed to the next page for appendixes.

MEMORANDUM

DATE: MAY 31, 2018
TO: **MY COMPANY, INC.**
FROM: **FIELD AUDITOR, EDG AUDITOR**
RE: MY COMPANY, INC. EXPENSE SAMPLING PLAN

The following describes the specific statistical sampling method applied to the above taxpayer's expense data. This statistical sample will be performed in accordance with the manual entitled *Department of Revenue Statistical Sampling for Sales and Use Tax Audits*, revised November,2020.

Electronic data for expenses from July 2013 to June 2017 were provided to the Tennessee Department of Revenue by My Company.

The sampling unit is summarized unique transaction identified by Vendor Name, Invoice Number, and Invoice Date. The Record Identification Summary is given in the following table.

Record Identification Summary

Number of records in data	46,992
Number of records removed because they are outside the audit period: 01/01/2014-12/31/2016	-3,496
Number of records removed because they are not in the auditors' list of selected accounts.	-6,238
Sub-Total	37,258
37,258 line items represent 18,457 unique transactions from which the sample was pulled.	
The line items with the same Vendor Name, Invoice Number, and Invoice Date were indexed and summed together to identify unique transactions.	

The sample population is stratified on the data field Invoice Amount and is divided into 11 strata. The detailed stratification is attached. The last stratum will be audited in detail.

The statistical software package used to randomly select each stratum sample is the Tax Stratification and Estimation Program (TSEP), version 5.5.6051.

Overpayments will be allowed within the statistical sample and will not be eligible for future refunds. All results will be projected using a one-sided 75% confidence interval.

Please advise us by June 14, 2018 if you have any questions or concerns about this sampling plan.

Expense Stratification and Sample Size Report
My Company, Inc.

Stratum	Lower Boundary	Upper Boundary	Stratum Size	Stratum Total	Standard Deviation	Sample Size
1	$0.00	$24.99	2,899	$47,479.35	6.77	70
2	$25.00	$54.99	2,703	$107,665.71	8.6	70
3	$55.00	$99.99	2,642	$201,827.33	13.12	70
4	$100.00	$169.99	2,553	$332,705.53	19.32	70
5	$170.00	$299.99	2,428	$552,894.27	37.12	70
6	$300.00	$499.99	1,909	$745,231.31	55.54	70
7	$500.00	$999.99	1,376	$945,223.19	139.62	70
8	$1,000.00	$1,999.99	1,140	$1,605,577.03	226.18	115
9	$2,000.00	$4,999.99	514	$1,667,372.23	846.34	122
10	$5,000.00	$9,999.99	233	$1,716,548.66	1,441.71	124
11	$10,000.00	$51,867.30	60	$986,835.61	8,056.65	60
		Totals	18,457	$8,909,360.22		911

Sample size of 911 out of 18,457

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Assessment Results Report
My Company, Inc.
State Use Tax
Difference Estimator

Stratum	Lower Boundary	Upper Boundary	Total Errors	Sample Size	Average Error	Stratum Size	Projected Assessment
1	$0.00	$24.99	$1.61	70	$0.023	2,899	$66.68
2	$25.00	$54.99	$0.00	70	$0.000000	2,703	$0.00
3	$55.00	$99.99	-$1.08	70	-$0.015429	2,642	-$40.76
4	$100.00	$169.99	$17.32	70	$0.247429	2,553	$631.69
5	$170.00	$299.99	$451.24	70	$6.446286	2,428	$15,651.58
6	$300.00	$499.99	$0.00	70	$0.000000	1,909	$0.00
7	$500.00	$999.99	$92.41	70	$1.320143	1,376	$1,816.52
8	$1,000.00	$1,999.99	$148.50	115	$1.291304	1,140	$1,472.09
9	$2,000.00	$4,999.99	$0.00	122	$0.00	514	$0.00
10	$5,000.00	$9,999.99	$0.00	124	$0.00	233	$0.00
11	$10,000.00	$51,867.30	$495.00	60	$8.25	60	$495.00
Totals			$1,205.00	911		18,457	$20,092.80

Summary Statistics

Statistic	Value	Statistic	Value
Estimated Total Due:	$20,092.80	Confidence Level:	75.00%
Traditional Lower Confidence Limit:	$18,685.47	Sample Size:	911
		Population Size:	18,457

Date/Time this assessment was calculated: 06/22/2018 7:24:04 AM using TSEPWin5.5.6051

The difference estimator is an estimate of the total population tax error. For each transaction in the sample, the difference between tax due and tax paid is obtained. The sample data (differences) are used to project the total difference (tax error) in the audit population.