

Auditor's Guide to Tests Using Benford's Law

**Using XL Audit Commander and Benford's
Law to identify unusual transactions**

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Overview of Audit Procedure

Steps for Identifying Unusual Groups of Transactions

The use of Benford's law for identifying unusual groups of transactions has been discussed extensively and has been used in tax compliance and other areas. The purpose of this document is to describe and provide a practical approach that auditors can apply and incorporate in their audit work.

The fundamental premise is that a transaction population which is expected to exhibit a degree of randomness can be measured against an expected distribution such as would be obtained by applying Benford's law. Generally, accounting information which is based upon computations, e.g. multiplying a unit price by a quantity to provide an extended line amount, and then summing those extensions to an invoice total, should generally conform to with Benford's law, barring any unusual circumstances.

One of the key hurdles for applying such an audit test is simply the level of effort which would be required in comparing a transaction distribution against the amounts expected using Benford's law and then assessing any differences using techniques such as Chi Square etc.

Another hurdle has been simply developing graphic support to enable a fairly easy visual assessment of the results.

Audit Procedure – Benford's Law

There are primarily six types of audit tests which can be applied against a population of transactions in order to assess if the distribution of digits is as would be expected. Those tests are as follows:

Test performed	Test Code
Analyze the distribution of the first (leading) digit	F1
Analyze the distribution of the first two (leading) digits	F2
Analyze the distribution of the first three (leading) digits	F3
Analyze the distribution of the last (trailing) digit	L1
Analyze the distribution of the last two (trailing) digits	L2
Analyze the distribution of the second (leading) digit	D2

Objectives

Identify the group of transactions which has the largest deviation between observed and expected, as measured by Chi Square test. This is the group that is considered the most likely to contain possible audit exceptions or otherwise warrant further review.

Measure of Deviation

The deviation of the distribution of digits between what is observed and what is expected can be measured in a variety of ways. However, one of the most simple means is to perform the "Chi Square" test. This is a standard statistical test for measuring the degree of similarity between elements in a table. The results of the test produce a "Chi Square" statistic. Based upon this statistic, and the number of "degrees of freedom", it is possible to assign a probability that any variation between actual and observed is due to chance alone.

The range of probabilities can vary from 0 to 100%, although it is very unlikely that either extreme value (0% or 100%) would ever be obtained during audit tests. A probability close to 1, i.e. 100% indicates that it is almost certain that any variation is due to chance alone, i.e. that the population does conform with that which would be expected using Benford's law.

A probability of less than 5% indicates that it is almost certain that the population of transactions does *not* conform to with that which would be expected using Benford's law.

Assessing Effectiveness of Controls

A thorough test for conformity of certain populations with Benford's law can provide an effective test over controls, especially any that would tend to prevent simply "making up" data.

Drill Down Approach

Often, the most feasible approach is to first perform an overall test to determine conformity with Benford's Law for the first digit only. Then it may be desirable to further drill down to specific components. For example, if the population being tested is vendor invoices, first obtain an overall assessment for all vendors. Then the next step can be a vendor by vendor analysis.

Other Analytical Considerations

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In order for the population to conform with Benford's law, there are certain conditions which must exist. First, there should be no artificial upper or lower limits on what the values of the data can be. Second, the data values themselves should be based upon computations, and not be fixed amounts. Other factors may also need to be considered.

Processing Approaches

Analysis for compliance with Benford's law is most effective if it can be applied to a fairly wide range of transaction types. By reviewing such a range, it is more likely that any unusual patterns or situations will be identified for review. However, in instances of significant volume or activity, in order for a thorough and effective analysis to be performed, a fair amount of computer analysis time may be required. This processing can often be done in an "unattended" mode.

Areas of Application

Tests of compliance of transaction populations has been applied in a number of areas, such as:

- Insurance Claims**
- Corporate Income Tax**
- Employee Expense reports**
- Vendor Invoices**
- Accounts Receivable**
- Accounts Payable**
- Fixed Asset Records**

A case study, which includes data and detail steps is available at <http://ezrstats.org/Auditnet/poarticle.php>

Identifying groups of unusual transactions

The steps below can be taken to perform an audit test of compliance with Benford's Law.

There are three phases to the process:

Phase	Description
1	Identify the data to be analyzed
2	Obtain the data in electronic format
3	Convert the data to the industry standard "tab separated values (TSV)" format
4	Sort the data, if tests are to be performed at a control break

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5	Design and code the scripts
6	Run the scripts
7	Review the output (both graphical and text)
8	Determine which areas may require further audit effort

Identify the data to be analyzed

This will be a general assessment of the area to be reviewed, and will include the specific fields (e.g. invoice amounts, employee expense report totals, etc) that will be analyzed.

Obtain the data in electronic format

Determine where the data is stored electronically, e.g. Excel Workbook, magnetic tape, database etc.

Convert the data to industry standard "tab separated values" (TSV)

Converting data to tab separated values is discussed in our White Paper "Process to Convert data in various formats to TSV" and can be downloaded from <http://www.ezrstats.com/Downloads.htm>.
(http://www.ezrstats.com/doc/Process_To_Convert_Data_To_TSV.pdf)

Benford Formula

All of the formula used in the computations of Benford's Law are contained in a workbook which is available at <http://ezrstats.com/download/Benford's%20law.xls>. There is further discussion of the applications of Benford's Law at <http://ezrstats.com/Benford.htm>.

Data Sources which can be analyzed

There are four primary formats of data which can be used to test the application of Benford's Law:

1. Worksheet range (contiguous block of data on an Excel worksheet)
2. Selected Range (an area within an Excel sheet which has been highlighted)
3. Data File (In tab separated value format)

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4. Database (e.g. MS-Access, MySQL, etc.)

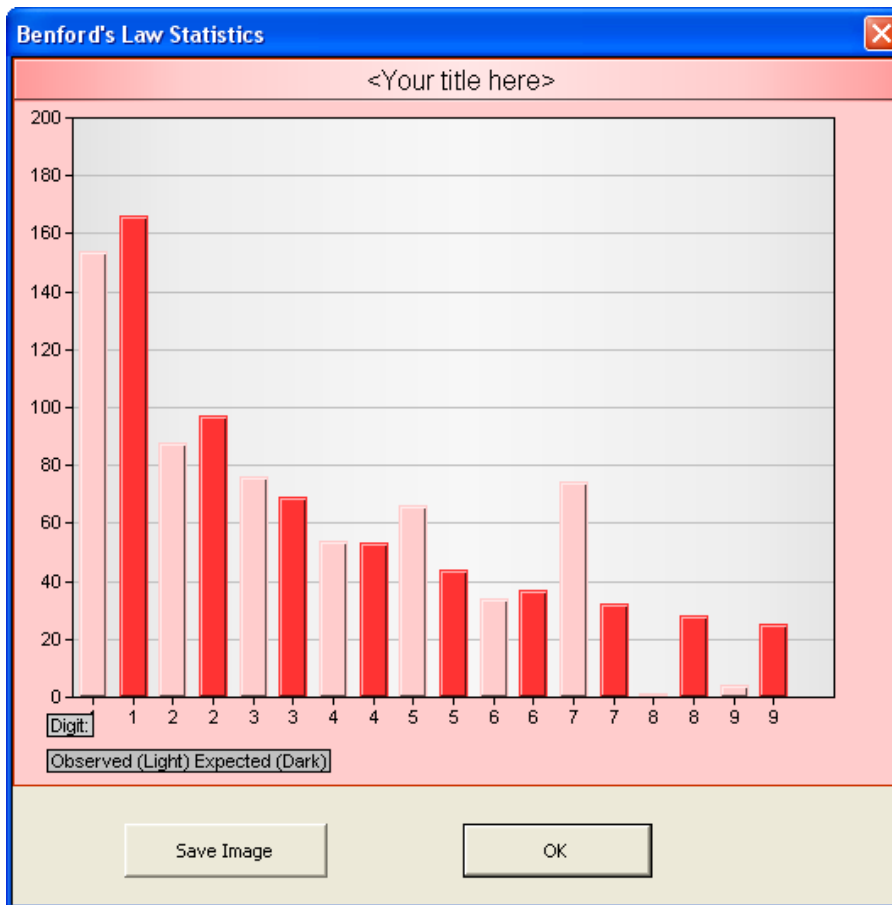
Two types of Analysis

To analyze an entire population, use the "Benford Command"

To analyze components within a population, use the Benford Analysis command.

Basic data classification procedures are at the heart of audit planning and initial reviews of data populations. This basic information should be known before further investigation/analysis is performed.

The procedures described here are an efficient and effective way to quantify transactions in populations and determine their basic nature. The procedure requires the use of the XL Audit Commander, a free tool available for download from http://ezrstats.org/Audit_Command.htm. The tool is installed as an Excel add-in, and as such, requires Excel 2000 or later. The tool works only on Windows operating systems.



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Test data used

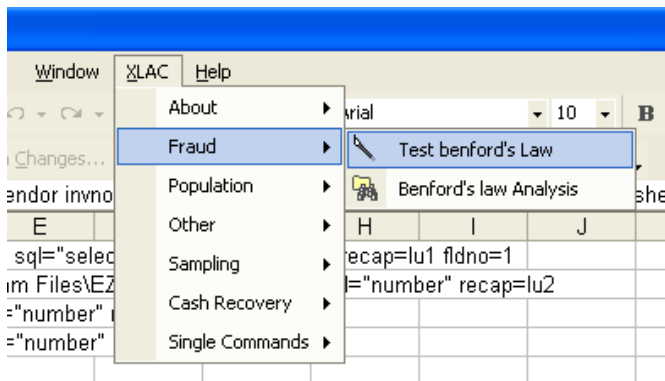
The test data used for this article is that provided with the standard installation of the XL Audit Commander software. This data is contained within both text files, an Access database, as well as a workbook which can be downloaded from <http://ezrstats.com/online/inno/QS.xls> (about 3 MB in size).

User Interface

The tool can be used in a combination of four modes:

1. Menu – a graphical system to gather the required information
2. Command Bar – commands are typed as text
3. System registry – commands are stored in the system registry and then loaded for selection, modification and processing
4. \$Cmd worksheet – the main processing parameters are stored on a worksheet

The menu system allows the necessary data to be gathered in a graphical manner. Once the data has been gathered, the “Process” button is clicked and the commands are then written to the toolbar for processing. An example of the main menu is shown below (Note the added menu option “XLAC” which appears at the top of the menu bar).

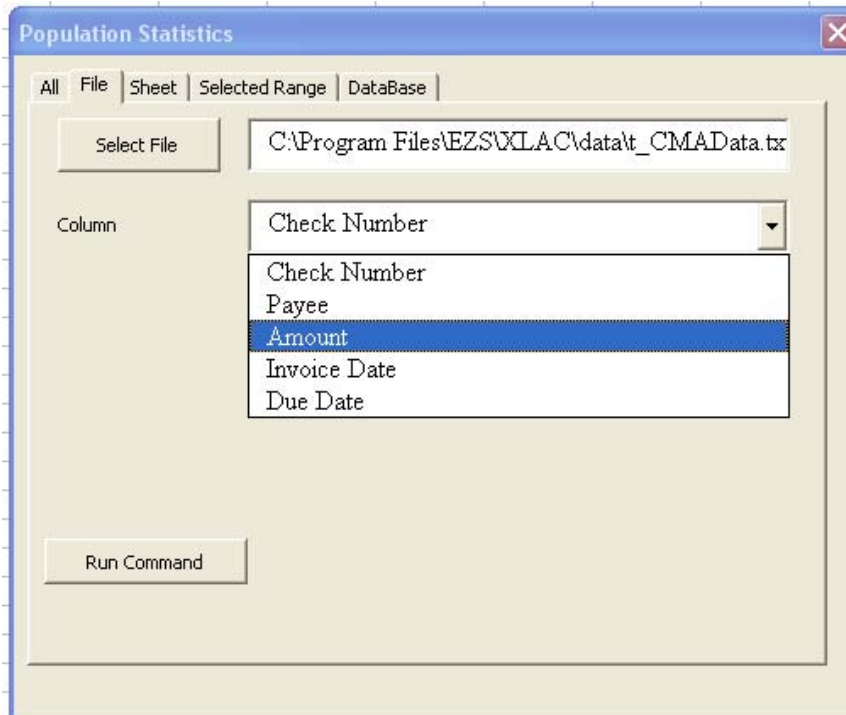


Commands which can process data from a variety of sources will have a dialog which allows the details of those sources to be specified. After these details have been entered and the “Run Command” button has been clicked, the system will construct the command to be processed and display the command in the toolbar. The command can now be processed or edited.

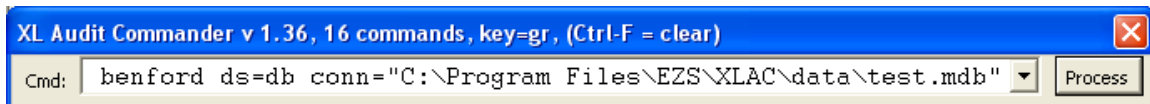
When the command is run, it may be necessary to re-run it with different parameters. This can be done by overtyping on the command line or else processing the menu item again.

Below is an example of the menu dialog:

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The command bar alternative is to use just the command bar and type the commands directly. An example is shown below



Procedural Steps

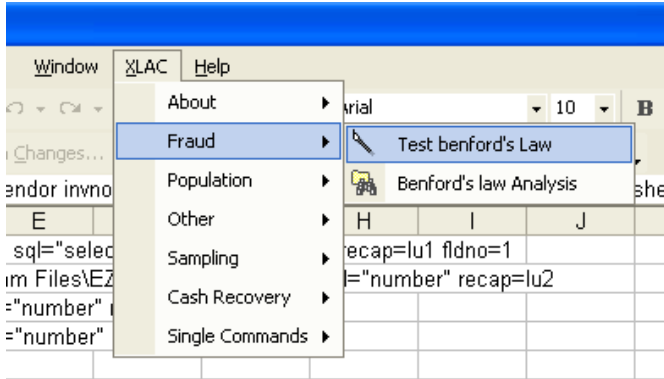
Step by step example

In this exercise the basic population statistics for the variable “Amount” will be obtained from the file t_CMADData.txt. Note that the command can be entered directly into the XL Audit Commander toolbar, or else the menu system used. Procedures for analyzing data from a worksheet range or selection,, or from a database are very similar.

Step 1

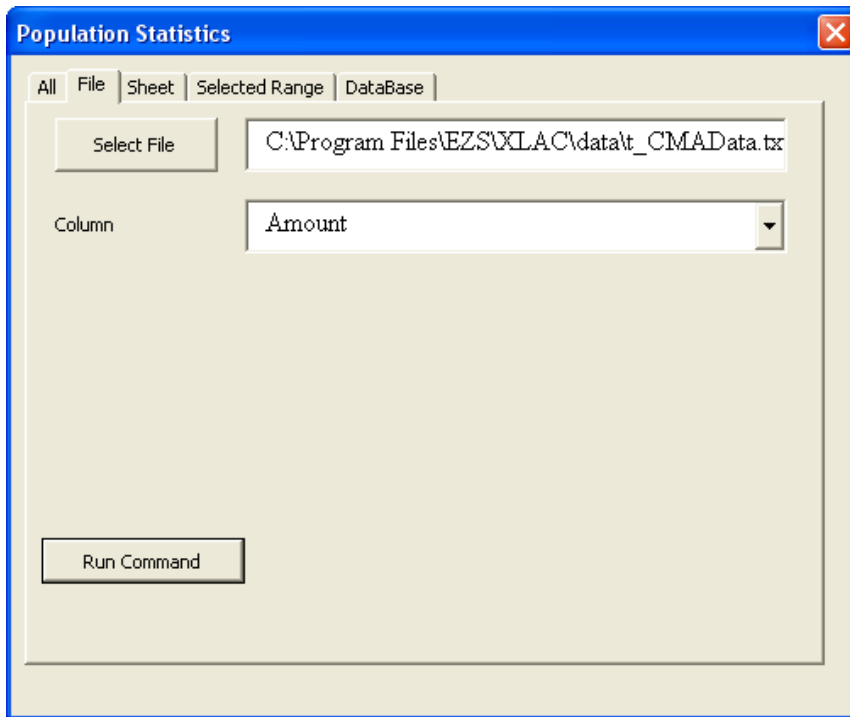
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The first step is to select the menu option for population statistics, by clicking on the "XLAC" menu toolbar at the top of the excel workbook:



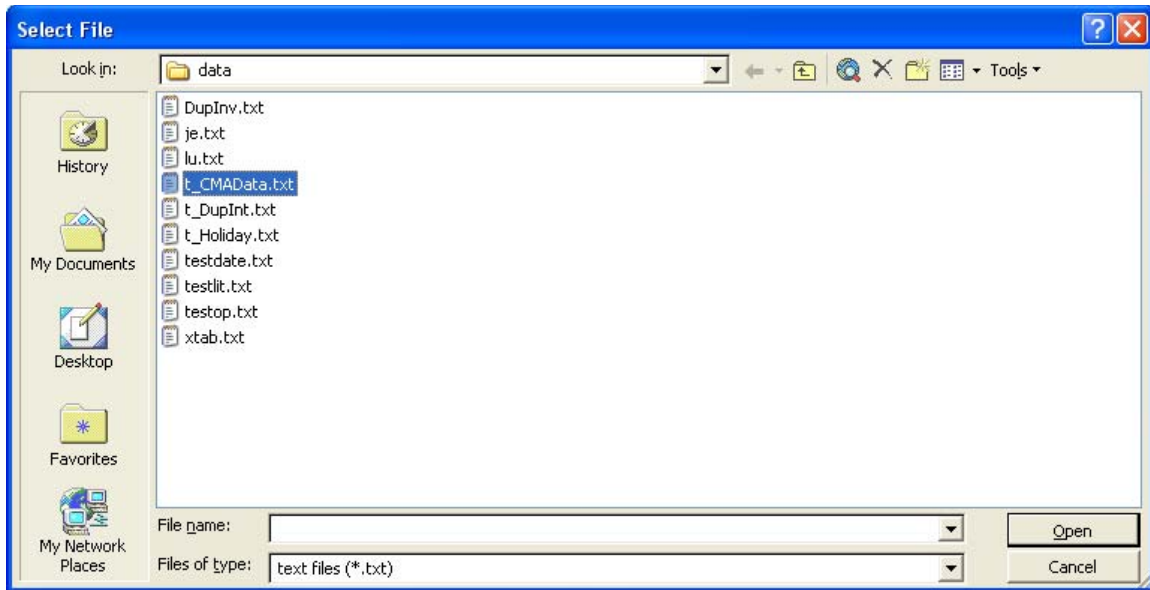
Step 2

Select the file to be processed, then the column to be analyzed:

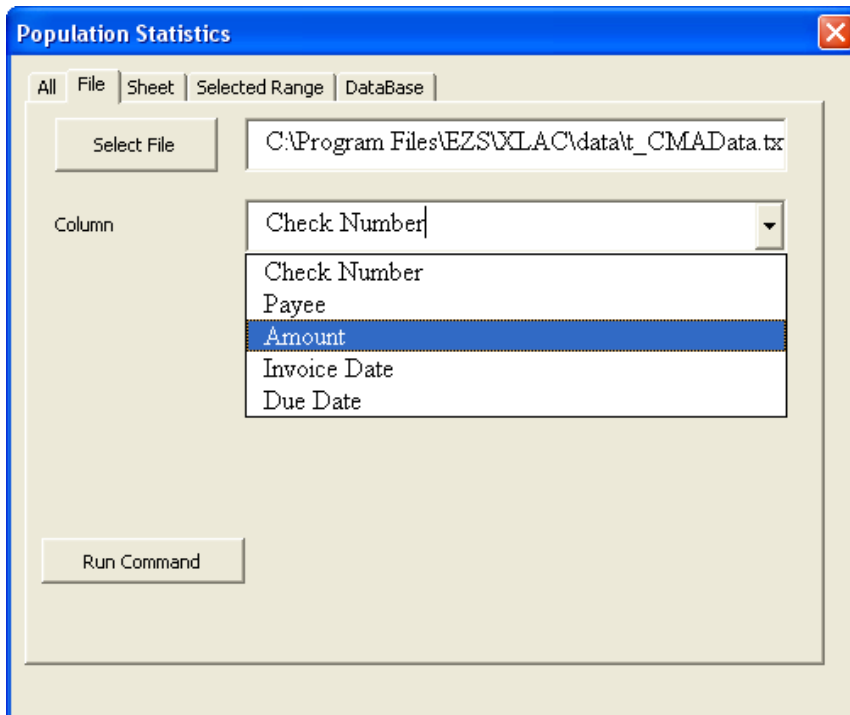


Step 3 – Click the "Select File" button and then select the file to be processed.

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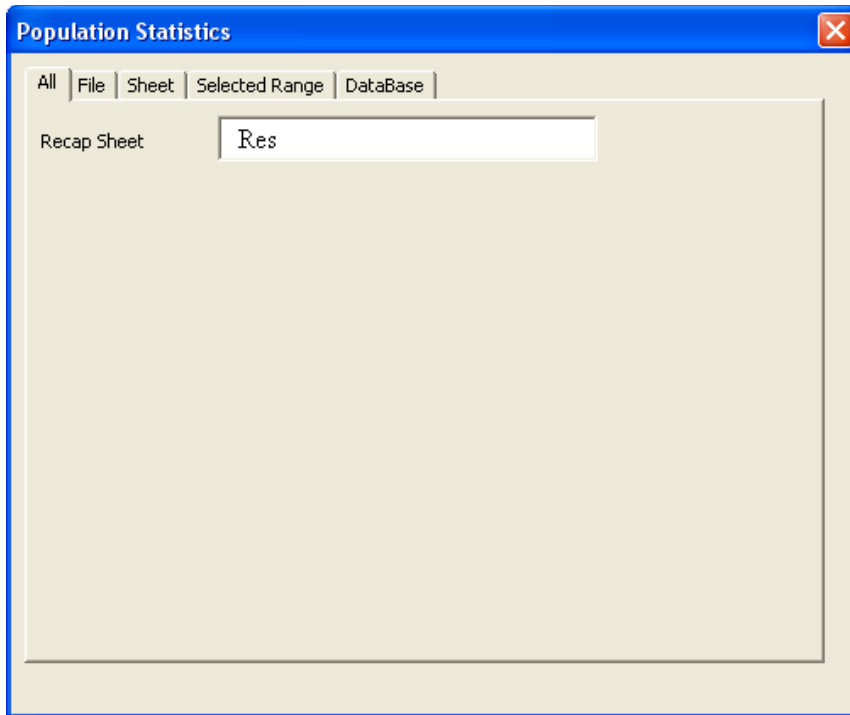


Step 4 – From the drop down list, select the column name to be analyzed (this is the column of numeric values of interest).

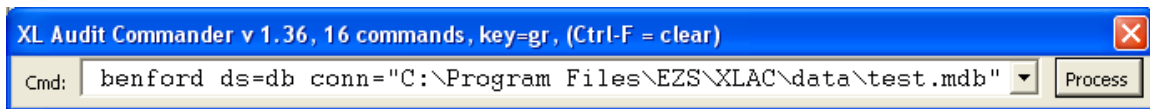


Step 5 – Click the “All” tab and specify the name of the sheet to contain the results

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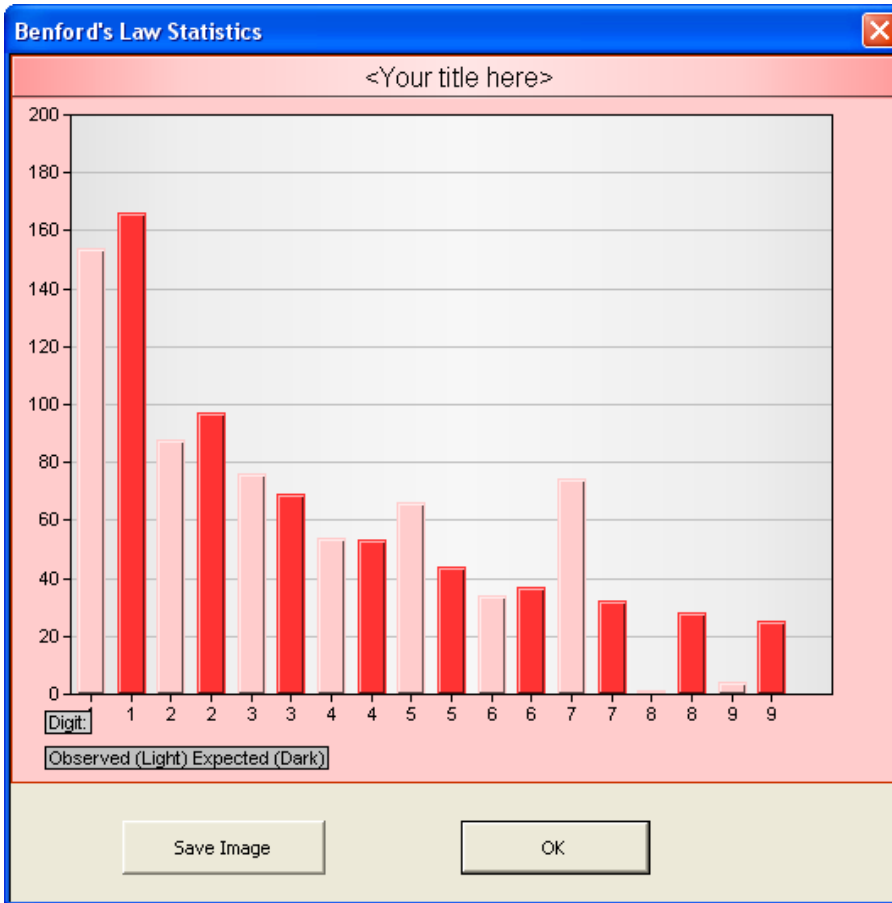


Step 6 – Click the “File” tab and then click the “Run Command” – this will build the XL Audit Commander command string for processing.



Step 7 – Click the “Process” button on the right to execute the command.

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A chart similar to the one above will be displayed (colors can be customized).

The output from the test will also be written to a worksheet as follows:

Benford Report				
High digit	7	Total	ChiSQ	d-stat
Chisq	0	711.04	7	0.3667
df	8	4,268.67	9.2	0.3562
D-stat	0.0871	11,414.83	24.7	0.6
Digit	Observed	Expected	13.9	0.75
1	154	166		
2	88	97		
3	76	69		
4	54	53		
5	66	44		
6	34	37		
7	74	32		
8	1	28		
9	4	25		

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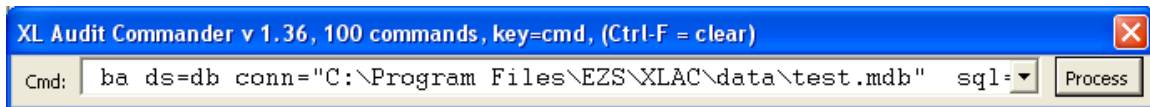
Step 8 – Review the results of the analysis which are shown on the worksheet specified.

Note that if a very large number of rows exist in the file processed, the analysis may take some time. Generally a “status update” is provided on the status bar to indicate the row number of the current row being processed.

Drilling Down

It is also possible to drill down further using the Benford Analysis command which shows the Benford's Law statistics by component. Note that the data does not need to be first sorted.

An example of the Benford Analysis command is shown below:



In this example the vendors invoices contained within an MS-Access database are being tested using the command:

```
ba ds=db conn="C:\Program Files\EZS\XLAC\data\test.mdb" sql="select  
vendor, amount, invoicedate, type from inv where type = 'J' order by  
vendor" recap=res fldno=0 iamount=1
```

Note that only invoices of type 'J' are being tested. The results are as follows:

Benford Summary Report				
Variable	Count	Total	ChiSQ	d-stat
V200	9	711.04	7	0.3667
V201	18	4,268.67	9.2	0.3562
V202	20	11,414.83	24.7	0.6
V203	11	9,737.98	13.9	0.75

This report indicates that vendor V202 has the largest difference between actual and expected as measured by the Chi Square statistic (here a value of 24.7). This is also confirmed by the fairly large d-statistic from the Kolmogorv-Smirnov test which yields .6.

Related Areas of Interest

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Further data classification procedures are described for use of data stratification techniques at

http://ezrstats.com/online/AuditGuide/Procedures_For_Data_Stratification.pdf. For working with date values, there is an article at

http://ezrstats.com/online/AuditGuide/Testing_For_Holidays.pdf. Basic data extraction procedures are described at

http://ezrstats.com/online/AuditGuide/Basic_Data_Extraction_Techniques.pdf.

Summary and conclusion

Tests for compliance with Benford's Law are at the heart of any audit or review where the data and transactions are available in electronic format. By using a few simple commands, it should be relatively simple to obtain information of use in audit planning, audit sampling and analytic review.