APPLICATION OF BENFORD'S LAW FOR DETECTING MANIPULATION IN THE FINANCIAL STATEMENTS IN MACEDONIAN COMPANIES

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Abstract
Financial statements are a key part of the accounting information system, through which communication is established between the information generated within the accounting and the various users of that information. The loss of consumer confidence in the information presented in the financial statements has major consequences for the financial market, and thus for the economy as a whole. It is therefore important to prevent making false financial statements. In many cases, due to inadequate authorization or lack of specific knowledge, auditors are unable to fully establish the existence of irregularities in the financial statements. Such situations, especially in terms of proving anomalies, require the hiring of specialists - forensic accountants and the application of appropriate analytical procedures, techniques and models. Such a model is Benford Law, which is a mathematical-statistical law used to detect anomalies in financial statements. Application of the Benford distribution is appropriate for accounting data because it forms a distribution that combines individual distributions.
The purpose of this paper is to present a new paradigm for recognizing anomalies in accounting analytics and increasing the quality of financial statements, through the application of Benford's law. Benford analysis in this paper will be realized on the data from the audited financial statements in the last 6 years in the company "Alkaloid" -Skopje in R. North Macedonia. This company is on the second position in the ten highest liquid companies on the Macedonian Stock Exchange. The existence of anomalies in the financial statements will be identified through three tests: z-statistics, MAD-Mean absolute deviation and χ^2 *- test. Microsoft Excel will be used for data analysis.*

Key words: Benford's law, forensic accounting, financial statement, fraud, anomalies

1. An introduction to Benford's law

Globalization of economies is a constant challenge for professional accountants who need to quickly find solutions to the new information requirements, thus requiring the creativity to find treatments that bring an advantage to the enterprise, but without conflict with the law.[5]

According to Benford's law, in a large set of numbers (mathematical tables, financial statements, real-life data, etc.) the leading characteristic digits will not be uniformly distributed, as is usually expected, but there will be more small digits. The most important version of Benford's law is related to the distribution of the first leading digits, according to formula:[2]

$$P(D) = \log(1+\frac{1}{D}) \qquad D \in \{1,2,\ldots,9\}, \ [1]$$

where D is a random variable; $D : R \to \{1,2,...,9\}$ and defines the first significant digit of a randomly selected real number.

According to the previous formula, the following values are obtained for the probabilities of the first digit by positions:

$$P(D_1 = 1) = \log(1+\frac{1}{1}) = \log 2 \approx 0,301 \quad [2]$$

$$P(D_1 = 2) = \log(1+\frac{1}{2}) = \log\frac{3}{2} \approx 0,1761 \quad [3]$$

$$P(D_1 = 3) = \log(1+\frac{1}{3}) = \log\frac{4}{3} \approx 0,1249 \quad [4]$$

$$P(D_1 = 4) = \log(1+\frac{1}{4}) = \log\frac{5}{4} \approx 0,0969 \quad [5]$$

$$P(D_1 = 5) = \log(1+\frac{1}{5}) = \log\frac{6}{5} \approx 0,0792 \quad [6]$$

$$P(D_1 = 6) = \log(1+\frac{1}{6}) = \log\frac{7}{6} \approx 0,0669 \quad [7]$$

$$P(D_1 = 7) = \log(1+\frac{1}{7}) = \log\frac{8}{7} \approx 0,058 \quad [8]$$

$$P(D_1 = 8) = \log(1+\frac{1}{8}) = \log\frac{9}{8} \approx 0,0512 \quad [9]$$

$$P(D_1 = 9) = \log(1+\frac{1}{9}) = \log\frac{10}{9} \approx 0,0458 \quad [10]$$

The following table shows the probabilities calculated according to this formula for all digits of the first, second, third and fourth position:

Table 1. Theoretical frequencies according to Benford's law for the digits of the first 4 positions

	position			
digits	1	2	3	4
0		0,11968	0,10178	0,10018
1	0,30103	0,11389	0,10138	0,10014
2	0,17609	0,10882	0,10097	0,10010
3	0,12494	0,10433	0,10057	0,10006
4	0,09691	0,10031	0,10018	0,10002
5	0,07918	0,09668	0,09979	0,09998
6	0,06695	0,09337	0,09940	0,09994
7	0,05799	0,09035	0,09902	0,09990
8	0,05115	0,08757	0,09846	0,09986
9	0,04576	0,08500	0,09827	0,09982

From Table 1 it can be seen that the probabilities for the 4th digit are very close in almost all cases. Due to that uniform distribution for the fourth and all subsequent digits, in practice the

analyzes are usually performed on the first three positions. Also, from the table it can be seen that the first significant digit from the set of smallest digits (1,2) is realized with a probability of approximately 0.5, while the first significant digit from the set of largest digits (8,9) is realized with probability of approximately 0.1. But Benford's law does not only apply to data that do not vary depending on the number system, but also to numbers from different sources. As the number of variables increases, the density of the functions approaches the logarithmic distribution. This fact has been proven by Dr. Theodore P. Hill and according to his research in the case of samples taken from a set of distributions, de facto, is Benford's law.[16] This law is found under different names, such as: First digit law, Newcomb-Benford phenomenon, Logarithmic law, etc.
Figure 1 and Figure 2 show the histogram and polygon of the distribution of relative frequencies of the first significant digits according to Benford's law:

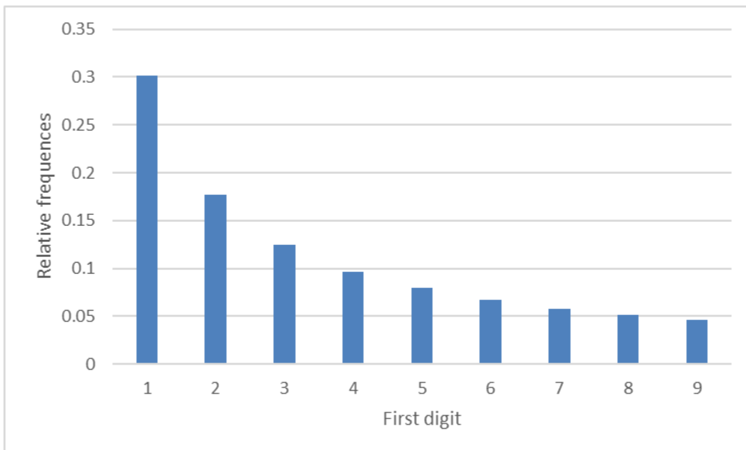

Figure 1. Histogram of the distribution of relative frequencies of the first significant digits according to Benford's law

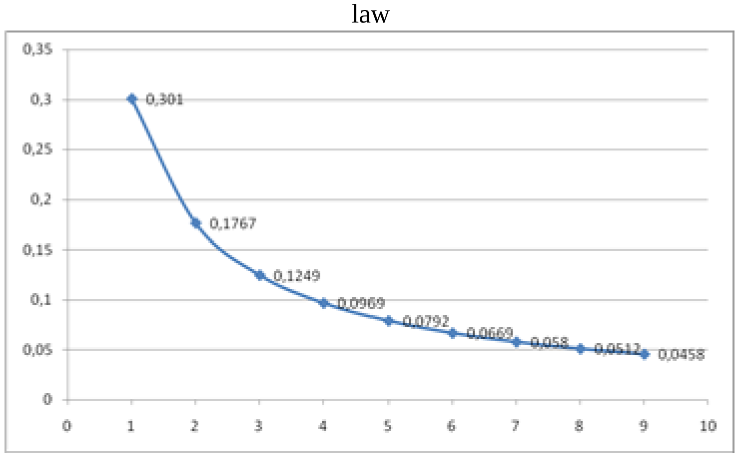

Figure 2. Polygon of the distribution of relative frequencies of the first significant digits according to Benford's law

The basic conditions for the application of Benford law are:[10]

- the data represent quantified facts or events;
- there must be no set data range or a minimum or maximum must not be set. The exception is zero, which can be a minimum, if it is data that can only have positive values;
- the data should not represent identification numbers or markings, for example, telephone number, bank accounts, car registration, survey answers in the Likert scale, etc. In other words, the data should not be numerical designations of events, persons, etc.;

- the data distribution should be positively asymmetric, i.e., the median should be smaller than the arithmetic mean, which means that lower values prevail. The data should not be grouped around the arithmetic mean;
- a minimum range of statistical set of 1000 data is recommended. Otherwise, the analysis should allow for larger deviations from the Benford distribution.

2. Benefits and limitations of Benford's law

Benford's law is a useful tool for detecting fraud.[14]There are various advantages to using Benford's law to detect fraud and there is a wide range of applications that are useful for forensic accountants.

Benefits of applying Benford's law to forensic accounting research are:[7]

- Economy-Benford's law is a powerful, economical, and accessible tool for auditors, managers, and analysts to verify the amount of data that has been calculated for possible fraud, error, manipulative bias or other anomalies. Other authors agree with the description of Benford's law as a useful and inexpensive tool for detecting suspicious accounts for further analysis.[8]
- Large data sets-Benford's law is an effective, sophisticated tool for investigating fraudulent audits of large data sets.
- Additional approach to viewing the company's financial data-this method has a diverse approach to numbers. Combined with additional auditing tools, Benford's law helps auditors to reduce the "expected gap" between increasing fraud detection and error detection and business inefficiencies. Digital analysis techniques, such as Benford's law, provide the forensic accountant with a variety of potential computer approaches to successfully conduct financial forensic research. In addition, digital analysis allows the forensic accountant to have an unbiased view of the entire data set, which should help the forensic accountant better plan the workload.
- Easy to apply-This law is applied without difficulty. Digital analysis helps auditors successfully and efficiently, without difficulty, detect groups of transactions that are expected to be counterfeit. Therefore, forensic scientists can easily present the necessary information to managers.[6]
- Proactive approach-Benford law can help detect some forms of fraud very early.[15]

Benford's law has its limitations. The following are significant limitations:

- Sample data, categorical data and data with bandwidth limits-one of the possible disadvantages of using Benford's law is that it cannot be applied to categorical and data with bandwidth limits. Some analyzes prove that the results of the application of Benford's law are more reliable when the account is analyzed as a whole, rather than samples of the account. The reason is that the how are larger number of items or transactions in the data set, the more accurate are the analysis.[4]
- One variable at the same time-this law can be applied to only one variable at the same time and the experiences gained cannot be generalized or applied to other variables or other situations.
- Does not apply to all numerical populations-it is important to note that Benford's law does not apply to all numerical populations. The data must meet the following criteria for law enforcement:

  1. All transactions should measure the same occurrences;

2. There should be no minimum or maximum values embedded in the data set, except for the number zero, which is an acceptable minimum. The presence of a minimum or maximum will disrupt the frequencies of the digits. The numbers should be random in nature;
4. Data should have more observations of small objects than large objects. The number of small financial events is greater than the number of large financial events;
5. The number of data should, in general, have four or more digits for proper application in Benford law and
6. A large data set is required. The small sample can not make the expected Benford frequencies, which will cause deviations from the law. As the data set increases, the expected frequencies of Benford's law are shown to be obtained.

3. Application of the Benford law on data from the financial statements of the company "Alkaloid AD"-Skopje in R. North Macedonia

Presentation of the real value of the company's assets is of particular importance for making valid business decisions by top management.[18] The Benford analysis in this paper is realized on the data from the audited financial statements of the company "Alkaloid" -Skopje. The company is second in the list of ten most liquid companies listed on the Macedonian Stock Exchange. The reports are downloaded from the Electronic Information System for Listed Joint Stock Companies (SEI Net)[1] and from the company's website.[2] The number of positions in the financial statements is not the most suitable for one-year testing (due to the small amount of data), so the financial statements for 2015, 2016, 2017, 2018, 2019 and 2020 are tested. Analyzing financial statements for more than a year can be useful in determining the propensity of companies to commit fraud. Microsoft Excel was used to data analysis. To calculate how many times the digits from 1 to 9 appear, the first digits of the column of the sorted data are first separated using the function: LEFT. After that, the numbers from 1 to 9 are inserted in the column First. The total number of data varies depending on the company. In the Count column, the CountIF function is used to calculate exactly how many digits 1 to 9 in the total sample exist. The Actual column calculates the relative current frequencies. The next column is Benford's low which shows the expected frequencies, and finally are calculated the z-statistics and certain conclusions are made.

In order to make the application of Benford's law on the data from the financial statements of the analyzed companies more accurate, additional testing was performed. The existence of anomalies in the financial statements will first be identified through z-statistics. Z-statistics is a statistical measure of how many standard deviations are of average value and allows the auditor to determine empirically whether the deviations from the model are statistically significant. The following mathematical formulas are used when using this test:[3]

$$Z = \frac{|A_i - B_i|}{\sqrt{\frac{B_i \cdot (1 - B_i)}{n}}} \quad [11]$$

where:
A_i - frequency of occurrence of the digit determined by examination of the sample;

[1] https://www.seinet.com.mk/Search.aspx?Word=%d0%b0%d0%bb%d0%ba%d0%b0%d0%bb%d0%be%d0%b8%d0%b4, access 01.10.2021
[2] https://alkaloid.com.mk/godishni-finansiski-izveshtai.nspx, access 01.10.2021

B_i - the theoretical frequency of occurrence of the digit expected by Benford's law;
n - total number of data.

The higher is the z-score, the less likely it is that the unexpected frequencies are the result of chance. The auditor selects the maximum permissible z-score corresponding to the acceptable error level. For example, if the auditor is willing to accept a 5% chance of reaching a wrong conclusion, the auditor will set the maximum allowed z-score to 1.96 (or for a 1% chance, the maximum value of z is 2.57). In other words, there is only a 5% chance that the difference between the actual and expected values will be random. Any z-score that exceeds the maximum allowed z-score may indicate to the auditor the possibility that a fraud or anomaly has been committed, and further investigation is needed.

3.1 Data Analysis

The main activity of "Alkaloid AD" is the production of pharmaceutical, chemical and cosmetic products of herbal origin. In addition to the basic activity, this company, according to the court register, can also perform wholesale and foreign trade with food and non-food products. The company has four profit centers: Pharmacy, Chemistry and Cosmetics, Herbal Medicine and Coatings. The leading profit center is Pharmacy. About 40% of total sales are in markets outside Macedonia. The company operates according to international standards ISO 9001, ISO 14001 and GMP for which have been obtained certificates. "Alkaloid AD" plans to maintain its leadership position in R. Macedonia. The strategic goal of the company is to position itself as one of the leading pharmaceutical companies in Southeast Europe and to expand its market in Western Europe. [3]

The analysis of the data from the audited financial statements of this company from 2015-2020. are given in the following table:

Table 2. Data analysis of the financial statements from 2015-2020 of "Alkaloid AD"

First	Count	Actual	Benford'Law	Difference	AbsDiff	Z-stat
1	210	0,28	0,30103	-0,02103	0,02103	1,255555
2	113	0,150667	0,17609	-0,025423333	0,0254233	1,827915
3	89	0,118667	0,12494	-0,006273333	0,0062733	0,519588
4	55	0,073333	0,09691	-0,023576667	0,0235767	2,182545
5	48	0,064	0,07918	-0,01518	0,01518	1,539598
6	74	0,098667	0,06695	0,031716667	0,0317167	3,475285
7	47	0,062667	0,05799	0,004676667	0,0046767	0,547978
8	84	0,112	0,05115	0,06085	0,06085	7,564315
9	30	0,04	0,04576	-0,00576	0,00576	0,754886
	750	1			0,0216096	

From the Z-stat. column in the table, it can be concluded that there is a statistically significant deviation in the digits 4, 6 and 8, because the corresponding value of z is greater than 1.96. The rows in the 4-th and 6-th digits are marked in yellow because the deviation is not very large in these digits, while the row in the 8-th digit is marked in red because the deviation in this digit is

[3]https://www.mse.mk/Repository/Catalogues/MK/65bff55c-e5dd-478e-a593-344818e54a13.pdf, access 05.10.2021

significantly larger. The following diagram shows the actual occurrences of the digits in relation to Benford's law, which will also give an overview of the deviations:

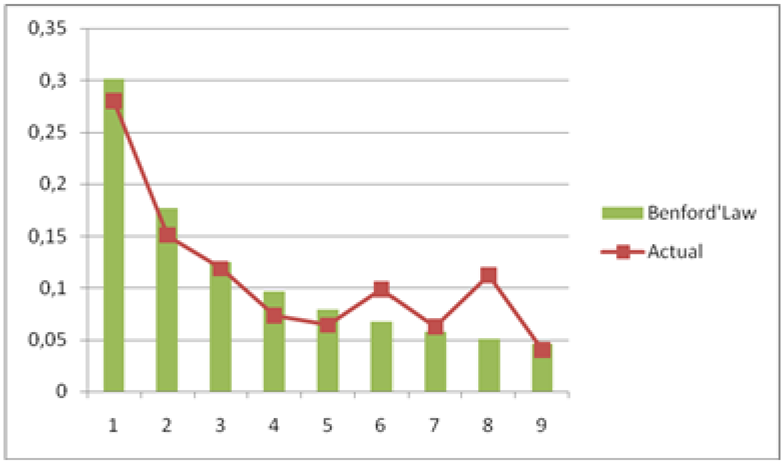

Figure 3. Comparison of the appearance of the digits from the financial statements in period 2015-2020 of Alkaloid AD in the first position, with those according to Benford's Law

For a more detailed test of Benford's law over the data from the financial statements of the surveyed company, the χ^2- test and the test of average absolute deviation (MAD) will be conducted. χ^2-test, is similar to the z-test and it's very sensitive to the sample size. Also, this test is based on the analysis of absolute frequencies and can give an answer how many of the obtained frequencies deviate from the expected frequencies. The following formula is used to perform this test:

$$\chi^2 = \sum_{i=1}^{9} \frac{(A_i - B_i)^2}{B_i} \quad [12]$$

where:

A_i - absolute frequency of occurrence of the digit determined by examination of the data

B_i - theoretical absolute frequency of occurrence of the digit expected from Benford's law.

The limit value of this test for the first digit is 15.51. If the value obtained is greater than 15.51, the null hypothesis that the distribution of the first digit corresponds to the expected distribution according to Benford's law is rejected. The obtained value of the χ^2-test for 8 degrees of freedom is compared with the critical p-value depending on the desired degree of confidence. Whereas, the MAD test is defined as the sum of the absolute values of the differences between the occurrence frequencies of each of the digits and the expected occurrence frequencies according to Benford's law. This sum is divided by the number of digits considered in the lead position. It is actually represented by the following mathematical formula:

$$MAD = \left(\sum_{i=1}^{n} |A_i - B_i| \right) / n \quad [13]$$

A_i -frequency of occurrence of the digit i determined by examination of the data;

B_i -theoretical frequency of occurrence of the digit i expected from Benford's law;

n -number of leading digits

From the actual data of the financial statements, these two tests are calculated, which are presented in the following table:

Table 3. χ^2-test and MAD test

First digit	Benford'Law	Actual relative f	Actual absolute f	Expected absolute f	Difference	Abs. Difference	Hi-square
1	0,30103	0,28	210	225,7725	-2,103	2,103	1,10186917
2	0,17609	0,150666667	113	132,0675	-2,5423333	2,542333333	2,75290708
3	0,12494	0,118666667	89	93,705	-0,6273333	0,627333333	0,23624166
4	0,09691	0,073333333	55	72,6825	-2,3576667	2,357666667	4,30187193
5	0,07918	0,064	48	59,385	-1,518	1,518	2,18267618
6	0,06695	0,098666667	74	50,2125	3,17166667	3,171666667	11,2690098
7	0,05799	0,062666667	47	43,4925	0,46766667	0,467666667	0,28286616
8	0,05115	0,112	84	38,3625	6,085	6,085	54,2921188
9	0,04576	0,04	30	34,32	-0,576	0,576	0,54377622
	1	1	750			2,160962963	76,963337

According to the obtained results, the average absolute deviation is 2.16 and belongs to the category of large deviation (above 0.0015 is a large deviation from the limit values for this test). The value of the χ^2 - test is 76.96, $p < 0.05$, df = 8, which means that the actual and expected values do not match enough, because the obtained value is significantly higher than the limit value for this test.

Although should be taken into account the condition that the minimum range of the statistical set should be 1000 data (and in this case the range is 750 data) and the analysis should allow larger deviations from the Benford distribution, all tests confirm the deviation of the distribution of the first digit from the investigated set.

In order to see in more detail when these deviations were made, further research will be followed by analysis of the data from the financial statements for the individual years in the specific company. Namely, it is necessary to see whether the total deviation of the individual digits is a result of their deviation in the individual years or the deviations of those digits in each individual year are not statistically significant (and in that case the positions starting with those digits should be further checked). In any case, the deviation from the digit 8 is very significant (because their percentage is not small, i.e., it is 11.2% of the total number of positions in the financial statements from 2015-2020). The "five-digit test" developed by Mark Nigrini will also in the next research will be made to detect anomalies and separate suspicious data from the entire data set.[1] Given the fact that in the first phase, which we conducted in this paper, large anomalies in the data were discovered, it is necessary to continue research on the second digit, the first two digits and the first three digits. The test of the last two digits is used to detect fictitious and rounded numbers.

Conclusion

Today, when with information technology the data can be sorted and processed in various ways, there is an opportunity to display distorted data about the real work of companies. Manipulation of financial statements by management is a topic that always attracts attention. The purpose of the conducted research was to point out the existence of a justified suspicion that the companies in R. North Macedonia incorrectly presents its revenues and cash inflows from business activities in the financial statements.

Of particular importance in detecting false business results is Benford's law, according to which the first digits of the numbers that are "in use" are not equally represented, i.e., that as the first digit is more often are the digits 1 or 2 than 8 or 9. Digital analytics tools based on Benford law are now included in many popular software packages, and the forensic accountant can design the software environment on his own.

Because the potential cost of undetected manipulation or fraud is high, a forensic accountant that using this technique must be careful not to overestimate the reliability of such tests. In the field of forensic accounting, analysis of the distribution of the first digit and the first two digits is recommended. The analysis of the numbers identifies the anomalies, not the manipulations, so it is necessary to use other forensic methods in order to identify the possible manipulations.

The main advantages of applying Benford's law in forensic accounting are that the calculation is simple, revealing all the items in which there are some anomalies that the auditor should pay attention to, freedom in choosing reports and time period for the needs of the analysis of the distribution of the numbers.

The measurement of the quality of the financial statements on which the Benford law is based can be performed with various statistical tests, as follows: Z - test; χ^2 -test, and MAD (Mean absolute deviation) test.

The purpose of this paper was through the application of Benford's law with the three listed tests to see if there are anomalies in the presentation of data in the consolidated financial statements in the company "Alkaloid AD"-Skopje. According to the obtained values of all tests, it was confirmed that the company "Alkaloid AD" found deviations of the first digit of the Benford distribution, which suggest anomalies and possible manipulations in the financial statements.

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