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APPLYING BENFORD´S LAW IN FINANCIAL STATEMENTS ANALYSIS

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Abstract
Benford's Law is used to detect manipulation in various spheres of life. Benford's Law can recognize the probabilities of numbers frequencies in a data set. The probabilities are based on mathematical logarithms of the occurrence of digits in randomly generated numbers in large data sets. When comparing the expected distribution following Benford´s Law with the observed distribution in a data set, strong deviations from the expected frequencies may indicate the data to be suspicious and poosiibly manipulated. A digit analysis using Benford's Law is widely used by auditors, forensic accountants and it is also used for tax evasion.
The aim of this article is to verify whether comparable results will be obtained when applying the Benford´s Law to all accounting data from accounting books, data in the financial statements, data from the VAT cotrol statement and to decide whethetr Benford´s Law can be used for special examinations by state authorities as an effective tool to spot anomalies in financial statements and VAT statement in Slovak conditions.

Keywords: *Accounting, Auditing, Benford's Law, Fraud*

1. INTRODUCTION

Over the last 17 years, the financial industry has been plagued by consecutive waves of financial crime (Ondrušová, 2011). Although financial crimes are not a new phenomenon in any sense, both the frequency with which they occur and their scope and impact seem to have increased over the last few decades. Many authors have suggested that financial frauds are more significant than in any other sector of the economy (Freeman, 2010; Fligstein, Roehrkasse, 2013).

Fraud or misrepresentation often creates clear patterns of error within complex financial data. There are developed sophisticated tools and techniques for uncovering these patterns and demonstrating that they are the result of deliberate malfeasance. Numerical data exploration technique that is used for fraud detection is known as Bedford's Law (Baesens, Vlasselaer, Verbeke, 2015).

2. LITERATURE REVIEW

Though it is called Benford's Law, he was not the first to observe this digit bias. Benford's Law was published for the first time in 1881 by American astronomer-mathematican Simon Newcomb, and it was rediscovered only in 1938 by physicist Frank Benford (Pakšiová, Janhuba, 2012). Newcomb was led to the Law by observing that the pages in logarithm tables corresponding to numbers beginning with 1 were significantly more worn than the pages corresponding to numbers with higher first digit. A reasonable explanation for the additional wear and tear is that numbers with a low first digit are more common than those with a higher first digit. (Miller, 2015) Benford's Law refers to the probability of occurrence of numbers d (d = 1, 2, 3, 4, 5, 6, 7, 8, 9) on the first quantifiable features in any sufficiently large set of data. Benford studied the distribution of leading digits of 20 sets of data, including rivers, areas, populations, physical constants, mathematical sequences, sports, an issue of Reader's Digest, the street addresses etc.

Benford's Law explains that number frequencies are skewed more toward lower numbers. Ondrušová (2011) Benford's Law is sometimes referred to as the "first digit phenomenon" but later in the late 80s of the 20th century there were studies on Benford's Law that revealed also the

importance of the 2nd digit position. The following table shows the actual percentages of occurrence for digits 1–9 occupying the locations 1–2 as described in Benford's Law.

Table 1. Benford´s Law

0	1	2	3	4	5	6	7	8	9
0%	30.1%	17.6%	12.49%	9.69%	7.92%	6.69%	5.8%	5.12%	4.58%
11.97%	11.39%	10.88%	10.43%	10.03%	9.67%	9.37%	9.04%	8.76%	8.5%

Source: Tumpach, 2009

Hal Varian suggested that Benford's Law could be used for the detection of possible frauds in the lists of socio – economic data submitted in support of public planning decisions. It is based on the assumption that people tend to fairly evenly create numbers in such a way that it is possible to compare the frequency of the digit on the first position with the division of the frequencies of the first digits using Benford's Law and based on potential differences it may be possible to indicate fraud (Hal Varian, 1972).

Carslaw observed that the numbers reported by companies in New Zealand did not contain enough nines in the second digit position. In fact, most of those companies had zeros in this position. He found that New Zealand companies rounded earnings numbers to the next number. If a company had a profit, for example 1.9 million dollars, the numbers were rounded to 2 million dollars. (Carslaw, 1988). The second study was conducted by Thomas who discovered similar findings in the profits of American companies (Thomas, 1989).

Nevertheless, Benford did not provide an explanation as to why we observe a decreasing frequency of occurrence of numbers, in given sets, which start with gradually increasing digits. Not until 1995 the mathematician Thomas Hill managed to prove the essence of this regularity and, in addition, presented its properties and conditions (Hill, 1995).

Mark J. Nigrini has been a pioneer in applying Benford's Law to auditing and forensic accounting. Nigrini performed a study applying Benford's Law to taxpayer data. Based on his research he determined that low-income taxpayers participated in more than unplanned evasion of their higher income counterparts (Nigrini, 1996). Further studies, which may not even mention the dissertation by Nigrini, use analyses with numerals to help identify tax evasion.

Benford's Law has also its limitations and not all data sets conform to Benford's Law. Examples of data sets that are not likely to be suitable for Benford's Law include:

- Numbers assigned to a person (Birth Numbers, Social Security Numbers),
- Telephone numbers, bank accounts,
- Data generated by formulas (e.g. YYMMDDXX),
- Data restricted by a maximum or minimum number,
- Numbers of orders and document numbers (generated by formulas),
- Wages (since minimum and maximum is set),
- Prices which take into consideration the psychological effect on the consumer (e. g. a price is not € 2, but € 1.99, etc.).

3. METHODS AND DATA

This paper will examine if Benford's Law is effective in detecting data bias by analyzing accounting data of selected company. The purpose of this paper is to determine whether there will be comparable results obtained when applying the Benford´s Law to all accounting data from accounting books, data in the financial statements, data from the VAT cotrol statement in selected company. Tests were conducted over a six-year period 2011–2016 in a company with more than 20 000 journal entries per year. The company was audited and there was no suspicion of manipulation of the accounting data or error.

Accountants classify and record the all events having economic effect via journal entries according to debit-credit rules in the system of double-entry accounting. Journal is a record that keeps accounting transactions in chronological order, i.e. as they occur (Krišková, Užík, 2016). The journal include large data set that can be used for applying Benford´s Law. When we analysed financial statements, we analysed separately balance sheet and profit and loss statement and we did not take into account summary lines.

As one of the main measures to detect and prevent tax evasions, so-called VAT Control Statement was introduced in Slovakia since January 1, 2014. The VAT control statement has to be submitted by VAT payer for every taxable period (i.e. calendar month or quarter) for which he/she is obliged to submit VAT tax return (Parajka, 2015). VAT control Statement is also large data set that can be analysed. The VAT control statement contains details of individual accounting transactions that are subject to VAT. When analysing VAT control statement we summarized monthly data for one year and we tested them as a whole.

The accounting records and the VAT control statement have been tested on a company that has provided us with these details, even if these data are not public. The data were analyzed using MS Excel and the software IDEA. MS Excel was used to organize the data into a more useable form. The Excel spreadsheet included journal entries to accommodate the six years of data for each company extracted from their accounting software. The data compiled into the MS Excel spreadsheet were analyzed using the IDEA Software, education edition. Once imported into IDEA Software, the data were analyzed, using the command "Benford's Law."

4. RESULTS

The results are presented in the table form with the actual data percentages of occurrence compared to the expected percentages according to Benford's Law. The tables show the statistics for each individual number in the 1st digit location.

Table 2. Digit frequencies for first position in journal entries

	Frequency according Benford's Law	**Y 2016**	**Y 2015**	**Y 2014**	**Y 2013**	**Y 2012**	**Y 2011**
1	**30.1 %**	29.14 %	29.24 %	29.16 %	30,75 %	29.16 %	29.1 %
2	**17.61 %**	18.7 %	18.67 %	18.7 %	17.8 %	18.7 %	18.1 %
3	**12.49 %**	12.65 %	12.61 %	12.59 %	14.98 %	12.59 %	11.54 %
4	**9.69 %**	10.1 %	10.06 %	10.15 %	8.9 %	10.15 %	9.15 %
5	**7.92 %**	8.1 %	8.11 %	8.13 %	7.69 %	8.13 %	8.20 %
6	**6.69 %**	6.5 %	6.45 %	6.47 %	6.2 %	6.47 %	6.52 %
7	**5.8 %**	5.45 %	5.4 %	5.35 %	4.9 %	5.35 %	5.16 %
8	**5.12 %**	4.9 %	4.89 %	4.81 %	4.23 %	4.81 %	5.9 %
9	**4.58 %**	4.46 %	4.57 %	4.64 %	4.52 %	4.64 %	4.11 %

Table 3. Coefficient of correlation after application of Benford´s Law on journal entries

	Y 2016	**Y 2015**	**Y 2014**	**Y 2013**	**Y 2012**	**Y 2011**
Number of journal entries	**32761**	**29812**	**31302**	**21911**	**21692**	**20458**
Coefficient of Correlation	0.9928	0.993	0.9925	0.994	0.9927	0.9982

According table we can say that accounting data were not manipulated. Manipulation would be indicated if digits 1–9 appeared in the first position significantly more or less often than expected. As presented in the tables 2–3, it is highly likely that the journal entries were not manipulated.

Table 4. Digit frequencies for first position in profit and loss statements

	Frequency according Benford Law	**Y 2016**	**Y 2015**	**Y 2014**	**Y 2013**	**Y 2012**	**Y 2011**
1	**30.1 %**	39.39 %	54.84 %	14.81 %	42.31 %	14.29 %	23.08 %
2	**17.61 %**	6.06 %	3.23 %	25.93 %	3.85 %	38.1 %	19.23 %
3	**12.49 %**	6.06 %	6.45 %	11.11 %	19.23 %	9.52 %	15.38 %
4	**9.69 %**	6.06 %	6.45 %	11.11 %	11.54 %	14.29 %	11.54 %
5	**7.92 %**	3.03 %	9.68 %	22.22 %	3.85 %	4.76 %	11.54 %
6	**6.69 %**	6.06 %	9.68 %	3.7 %	3.85 %	4.76 %	7.69 %
7	**5.8 %**	3.03 %	6.45 %	0 %	3.85 %	0 %	7.69 %
8	**5.12 %**	21.21 %	3.23 %	7.41 %	7.69 %	14.29 %	0 %
9	**4.58 %**	9.09 %	0 %	3.7 %	3.85 %	0 %	3.85 %

Table 5. Coefficient of correlation after application of Benford´s Law on journal entries

	Y 2016	**Y 2015**	**Y 2014**	**Y 2013**	**Y 2012**	**Y 2011**
Number of entries	**33**	**31**	**27**	**26**	**21**	**26**
Coefficient of Correlation	0.69688	0.84948	0.51244	0.84908	0.50690	0.8950

Table 6. Digit frequencies for first position in balance sheet

	Frequency according Benford´s Law	**Y 2016**	**Y 2015**	**Y 2014**	**Y 2013**	**Y 2012**	**Y 2011**
1	**30.1 %**	39.02 %	26.83 %	26.83 %	25.64 %	22.22 %	22.22 %
2	**17.61 %**	14.63 %	14.63 %	14.63 %	17.95 %	14.81 %	14.81 %
3	**12.49 %**	7.32 %	12.2 %	12.2 %	20.51 %	37.04 %	40.74 %
4	**9.69 %**	12.2 %	9.76 %	9.76 %	5.13 %	7.41 %	11.11 %
5	**7.92 %**	4.88 %	14.63 %	14.63 %	10.26 %	11.11 %	7.41 %
6	**6.69 %**	7.32 %	4.88 %	4.88 %	17.95 %	0 %	0 %
7	**5.8 %**	7.32 %	7.32 %	7.32 %	0 %	7.41 %	0 %
8	**5.12 %**	7.32 %	9.76 %	9.76 %	2.56 %	0 %	0 %
9	**4.58 %**	0 %	0 %	0 %	0 %	0 %	3.7 %

Table 7. Coefficient of correlation after application of Benford´s Law in balance sheet

	Y 2016	**Y 2015**	**Y 2014**	**Y 2013**	**Y 2012**	**Y 2011**
Number of entries	**41**	**41**	**38**	**39**	**27**	**27**
Coefficient of Correlation	0.9415	0.8904	0.8773	0.7792	0.5978	0.5749

Table 8. Digit frequencies for first position in VAT control statement

	Frequency according Benford's Law	Y 2016	Y 2015	Y 2014
1	**30.1 %**	30.09 %	30.04 %	29.91 %
2	**17.61 %**	17.81 %	17.34 %	17.87 %
3	**12.49 %**	11.98 %	12.64 %	12.64 %
4	**9.69 %**	10.0 %	9.96 %	9.95 %
5	**7.92 %**	7.98 %	7.98 %	8.03 %
6	**6.69 %**	6.45 %	6.45 %	6.07 %
7	**5.8 %**	5.65 %	5.16 %	5.55 %
8	**5.12 %**	5.19 %	5.04 %	5.24 %
9	**4.58 %**	4.49 %	4.27 %	4.82 %

Table 9. Coefficient of correlation after application of Benford´s Law on VAT control statement

	Y 2016	Y 2015	Y 2014
Number of entries in VAT control statement	**11311**	**10046**	**9423**
Coefficient of Correlation	0.9996	0.9995	0.9993

We analyzed separately balance sheet and profit and loss statement. The tables 4–7 reveals that the actual frequency of digits 1–9 occurring in the first position of the journal entries differs from the expected rate. If we strictly follow Benford´s Law we can say that it is highly likely that the financial statements were manipulated. But based on analyses of journal entries (all accounting transactions booked in journal) we can say that accounting data were not manipulated.

The tables 5 and 7 display the actual number of entries. We can say that correlation is higher it there are higher number of entries in financial statements. There are more entries in balance sheet and also higher correlation.

When comparing table no. 2 and 9 we can see that there are not big differences in correlation. We can conclude that both journal entries and VAT control statemet comply Benford´s Law and both contain sufficient data to apply Benford Law. Using this experiment, we have found that although Benford's Law indicates fraud in the companies, it cannot indicate the fraud in financial statements. The results of analyses in the 6 years are comparable, despite the fact that the first two years there were different prescribed financial statements as in previous year (number of lines in financial statements changed, summary lines were not included).

One of the enduring problems with Benford's Law is false positives (conclusion of nonconformity when the data are not biased, and therefore in conformity). False positives are more prevalent with smaller data sets. This was confirmed while testing balance sheet and profit and loss statement.

Benford’s Law is effective in detecting data bias in journal entries but ineffective in detecting the bias in financial statements. Benford’s Law is not applicable for automagical examinations by state authorities if only financial statements are available.

5. CONCLUSION

This research study has applied Benford's Law in selected company and demonstrates that Benford's Law is effective in detecting data bias in journal entries but ineffective in detecting the data bias in

financial statements but on other hand Benford´s Law can be perfectly applied on data from VAT control statement. It is important to note that there are some limitations in Benford's Law. The probability that Benford's Law will detect fraud financial statements is very low. The use of Benford's Law in audit or special examinations by state authorities focused on VAT control statement can be an effective tool to spot anomalies in data. Based on the analyses it is obvious that Benford's Law is applicable only for bigger data sets. If analysed data do not comply with the expected observed frequency of the first difit as expressed by Beford´s Law it is probable that the involved data were manipulated and further investigation or testing is reqired. Conversly, Benford´s law cannot detect all frauds in data sets and however data set somples with benford´s law, it can still be fraudulent. The purpose of further research is to analyze multiple companies, but the limitation is that these data (except for financial statements) are not public. According to our information, the Slovak state authorities, despite of having a large amount of data submitted by companies, still do not use the Benford´s Law or similar statistical tool to analyze these data.

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