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THE APPLICATION OF BENFORD'S LAW IN SALES DATA OF NIGERIAN OIL AND GAS COMPANIES

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Abstract
Manipulated sales data in the financial statements of business organization has continued to distort the quality of information provided to shareholders as well as the public. The objective of this study is to determine fraud in sales data of oil and gas companies listed on the Nigerian Stock Exchange. The study employed Chi-square to determine the significant of the level of deviation of sales data from the proposed Benford's Law. The results of the analysis show that the deviation of sales data from the expected Benford's digits distribution law is not significant. This implies that sales data of oil and gas companies listed on the Nigerian Stock Exchange conform to the proposed Benford's digit distribution law. Based on this finding, the study affirms that sales data as provided by the oil and gas companies listed on the Nigerian Stock Exchange are genuine and are free from manipulation. The study recommends strongly the application of Benford's Law for the investigation of anomalies in accounting data.

Keywords: Benford's Law, Sales, Data, Chi square, First Digit.

Introduction

The demand for Benford's law has continued to increase as the issue of anomalies and manipulations in accounting data has continued to increase simultaneously. Benfords Law as an analytical Phenomenon which has been confirms to be effective in describing the proposed distribution of digits in a numerical data as well as detecting anomalies and manipulation in accounting data (Kumar et al, 2016). Sales data are prone to manipulations and misappropriations and this have negative significant effect on the performance of the company (Oladele et al, 2020). Financial statement fraud in the Nigerian oil and gas companies is very common. This has continued to undermine the confidence of many investors which has affected the growth of the companies. The traditional methods of audits may not be appropriate and effective for ascertaining of these fraudulent activities. Therefore, there is the need for the adoption of a modern method which seems to be more effective in terms of detecting anomalies in accounting data.

Several researchers have adopted Benford's Law in sales data both in develop countries and developing countries as discovered that the model is simple, appropriate and effective in detecting fraudulent activities in accounting data. More significantly, the method identifies digits of manipulations which enable the auditor to carry out further investigation to fish out the accountant or book keeper that is responsible for that fraudulent act (Nigrini, 2012; Hunton et al, 2014).

This study seeks to contribute immensely to the existing literature on Benford's Law by evaluating its applicability to sales data of Nigerian oil and gas companies. Similarly, the findings will promote transparency in keeping the financial statement of oil and gas companies in Nigeria. in conclusion, the findings will provide insight into the effectiveness of Benford's Law as an analytical tool for detecting anomalies in accounting data.

Research Questions:

i. To what extent is Benford's First digit distribution is related to sales data of oil and gas companies listed on the Nigerian Stock Exchange?

ii. To what extent is Benford's second digit distribution related to sales data of oil and gas companies listed on the Nigerian Stock Exchange?

Statement of Null Hypothesis:

i. There is no significant relationship between Benford's first digit distribution and sales data of oil and gas companies listed on the Nigerian Stock Exchange.
ii. There is no significant relationship between Benford's second digit distribution and sales data of oil and gas companies listed on the Nigerian Stock Exchange.

Scope of the Study

This research work is restricted to the applicability of Benford's law to detect fraud in the sales data of oil and gas companies listed on the Nigerian Stock Exchange. The study will only use the First digit distribution and Second digit distribution of Benford's Law to compare with sales data of the oil and gas companies. To carry out the analysis, the study will restricted itself to chi-square out of the appropriate methods, to determine the significant relationship between Benford's first digit distribution, second digit distribution and sales data of oil and gas companies listed on the Nigerian Stock Exchange.

Conceptual Frame work

Sales:

Sales could be defined as the process of exchanging a product or services for money or other forms of compensation. There certain essential elements in sales that must be taken note of in the process of exchanging goods or services. These includes: identifying customer needs and preferences, presenting products or services that meet those needs, negotiating prices and terms, and closing deals and completing transactions (Kotler et al, 2016)

Dixon et al (2012) "Sales is the phenomenon of the human-driven interaction between and within individuals/organizations in order to bring about economic exchange within a value-creation context.

According to Oxford English Dictionary (OED) "sales are the activity or business of selling products or services, or the amount of goods, or services sold" (Alter, 2008)

Sales in marketing is defined as the process of persuading potential customers to purchase a product or service, and converting them into paying customers (Kotler et al, 2016)

Benford's Law:

Benford's Law could be defined as an observation that is linked to the frequency distribution of leading digits in numerous sets of real-life numerical data. Benford's Law Assumes that in the collection of various real-life sets of numerical data, 1 appears as the leading significant digit about 30% of the time, whereas 9 appears at less than 5% as a larger number (Nathan & Betsy, 2023).

Benford's Law could be describing the relative frequency distribution for leading digits of numbers in a life-data set. Smaller digits are expected appear more frequently than the larger digits. Accordingly, 1 occurs more frequently as leading digits at about 30% than larger number 9 which is expected to appears at 4% and there about (Jim, 2024).

Benford's digit distribution law could be defined as an observation relating to several real-life numerical data set, the small number 1 appears at 30% as the leading digit than the large digit 9 which occurs at less than 5% (Amo &Theodore, 2011).

> *Another authority defined Benford's law as an analytical model used to detect anomalies or fraud or manipulations or human errors in accounting which includes tax returns or financial records. Benford's Law could also employ to forecast the distribution of digits in real-life data sets that are yet been collected.*

Empirical Literature

Akintoye et al (2020) carried out an empirical study to investigate into the relationship between Benford's Law and Sales data of Nigerian companies. The study employed secondary data sourced from the financial statements of 30 Nigerian companies listed on the Nigerian Stock Exchange (NSE) covering the period from 2015 to 2020. Chi-square was employed to determine the relationship between the actual observations and expected observations. Their findings show that Sales data of Nigerian Companies listed on Nigerian Stoch Exchange conform to the proposed Benford's Law. This result is probably genuine or free of manipulation since it follows the proposed Benford's Law.

Similarly, Oyedele et al (2020) examined the relationship between sales data of Nigerian oil and gas companies from 2015 to 2020. The data for the study was sourced from the financial statements of 10 oil and gas companies in Nigeria. Z-test was employed for the analysis. Their findings show that there is no significant relatoionship existing between the accounts of oil and gas companies in Nigeria and the proposed Benford's Law.

Adewale et al (2020) examines the relationship between sales data of Nigerian Telicommunication companies and Benford's digit distribution law covering the period from 2015 to 2020. The data for the analysis was sourced from the annual reports of 10 Nigerian Telecommunication companies. Chi-square was employed to determine the significant relationship between the variables of interest. Their findings show that sales data deviated from Benford's digit distribution law indicating that there is no significant relationship existing between the sales data of Nigerian Telecommunication companies from 2015 to 2020 and the proposed Benford's digit distribution.

Oyedele et al (2020) examines the relationship between Benford's digit distribution law and Sales data of Nigerian Banking Companies. The secondary data for the study was sourced from the annual reports of some selected oil and gas companies covering the period from 2010 to 2015. Z-statistics was employed to determine the significant relationship between the

variable of interest. Their findings show that sales data of Nigerian Banking Companies deviates from the proposed Benford's digit distribution law.

Another study, by Oladele et al. (2019), shows that there is no significant relationship between sales data of Nigerian Construction Companies and the Benford's digit distribution law. They employ Benford's law and Z-statistics in sales data of Nigerian Construction Copmpanies from 2015 to 2020.

Nigirni (1999) examined the relationship between sales data of US companies and Benford's digit distribution law. The data for the study was sourced from the financial statements of 20 US companies. The methodology employed for the study is the chi-square test. The findings of the study indicate that sales data deviated from Benford's law meaning that there is no significant relationship existing between sales data of US companies and the proposed Benford's digit distribution law.

Theoretical Framework

2.3.1 Information Manipulation Theory (IMT)

The underpinning theory for this study is the information manipulation theory (IMT). This theory was propounded by Steven McCcornack in 1992.This theory is all about manipulation of information in many ways with their discourse. Fraudulent financial reporting violates IMT due to the untruthful representation of the financial statements. This however, affects the quality of information provided to shareholders as well as the public. This theory is relevant to this study as the objective is to determine manipulations, or errors in sales data of oil and gas companies listed on the Nigerian Stock Exchange using Benford's first and second digits law. The inability of the sales data to conform to the proposed first and second digit distribution of Benford's law is an indication that manipulation of information has taken placed.

Methodology

The objective of the study is to apply Benford's Law to detect fraud in the sales data of oil and gas companies listed on the Nigerian Stock Exchange. The

research design employed for the study is the descriptive research design. This research design is appropriate for this type of study because it involves the use of secondary data collected from annual reports of 9 listed oil and gas companies on the Nigerian Stock Exchange to determine the relationship between Benford's first and second digit distribution with sales data of the selected companies.

Model Specification

The model use for this study is adopted from Ngirini (2018). The empirical model could be written as follows:

BFD =F (Sal)

BSD = F (Sal)

$BFD_t = \beta_0 + \beta_1 Sal_t + \varepsilon_t$ (1.1)

$BSD_t = \beta_0 + \beta_1 Sal_t + \varepsilon_t$ (1.2)

Where;

BFD_t = is Bendford's First Digits Distribution,

BSD_t = is Benford's Second Digits Distribution

Sal_t = is Sales Data

ε_t = is the error term which we sort to minimize,

β_0 is the constant, and β_1 in the equation represent the coefficients of the dependant variables model.

Benford's Digit Distribution Equation

Nigrini (2012) states that the probability of occurrence of the digit is obtained by means of a mathematical formula:

$P(D_1 = d_1) = \log 1 + 1/ d_1$ (1.3)

Where:

P = probability

D1 = first column in probability

d_1= First digit

Log = base 10 logarithms.

Table 1: Benford's First Significant Digits distribution Percentages

Numbers	1	2	3	4	5	6	7	8	9
$Pr(D_1 = d)$	30.103	17.609	12.494	9.691	7.92	6.695	5.799	5.115	4.576

Source: Nigrini (2012)

Based on the above table, 1 is expected to occur at 30.1%, 2 at 0.17% in a reducing mode down to 9 in a randomly collected datasets.

Table 2: Benford's First Significant Digits distribution Percentages

Numbers	1	2	3	4	5	6	7	8	9
$Pr(D_1 = d)$	30.103	17.609	12.494	9.691	7.92	6.695	5.799	5.115	4.576

Source: Nigrini (2012)

Based on the above table, 1 is expected to occur at 30.1%, 2 at 0.17% in a reducing mode down to 9 in a randomly collected datasets.

The decision rule is that any actual observation that deviates from expected the first and second digits frequency distribution of Benford's Law indicates anomalies in the accounting data.

Chi-square (to determine significance)

The study employs the chi-square distribution to determine the Significance of deviations.

Chi-square examines whether the sum of the squared deviations between the observed relative frequencies (h_d) and the probabilities under the null (p_d) are significantly different from zero. Denoting the sample size by N, the test statistic has an approximate X^2 distribution with 8 (9) degrees of freedom when test the nine first digits as well as the ten second digits.

The study ascertained the level of significance of deviation ($\alpha = 0.05$). The study will accept or reject the null hypothesis base on set significance level. The critical values of the Chi-squared test (theoretical) are taken from the Chi-squared distribution table, and in addition to the chosen degrees of freedom considered. The Chi-Square is calculated using the below formula:

$$X^2 = N \sum \frac{(h_d - p_d)^2}{pd} \quad (1.4)$$

Where:

H_d = Observed relative frequency

P_d = the probability under null

N = sample size

Notably, the chi-square test provides a P-Value to help determine the correlation if any between the variables.

Degree of freedom:

Df = N - 1

(1.5)

Decision Rule:

Accept null hypothesis when the P-value at 0.05% is greater than X^2

Rejects null hypothesis when the P-value at 0.05% is less than X^2

(https://www.cuemath.com/en-gb/about-us/ retrieved 15/04/2024)

Chi-square Analysis

The Relationship between Benford's Law and Sales using Chi-square

1ST DIGIT	COUNT	FREQUENCY	OV %	EV %	OV – EV	∑(OV– EV)² /10
1	35	0.3804	38.04	30.1	7.94	7.0048
2	17	0.1848	18.48	17.6	0.88	0.0860
3	4	0.0434	4.34	12.5	-8.16	7.3984
4	10	0.1084	10.84	9.7	1.14	0.1444
5	2	0.0217	2.17	7.9	-5.73	3.6481
6	6	0.0652	6.52	6.7	-0.18	3.6000
7	3	0.0325	3.25	5.8	-2.55	0.7225
8	10	0.1084	10.84	5.1	5.74	3.6608
9	5	0.0543	5.43	4.6	0.83	0.0765
9	**92**		**100**	**100**		**26.3415**

Sources: Researcher's computation

4. The Relationship between Benford's Law and Sales using Chi-square

2ND DIGIT	COUNT	FREQUENCY	OV %	EV%	OV - EV	$\sum(OV-EV)^2/10$
0	13	0.1413	14.13	11.97	2.16	0.46656
1	12	0.1304	13.04	11.39	1.65	0.27225
2	16	0.1739	17.39	10.88	6.51	4.23801
3	10	0.1084	10.84	10.43	0.41	0.01681
4	8	0.0869	8.69	10.03	-1.34	0.17956
5	4	0.0434	4.34	9.67	-5.33	2.84089
6	2	0.0217	2.17	9.34	-7.17	5.14089
7	9	0.0978	9.78	9.04	-0.74	0.05476
8	7	0.0760	7.60	8.76	-1.16	0.13456
9	11	0.1196	11.96	8.50	-6.46	4.17316
						17.518

Discussion of Findings

Hypothesis 1: There is no significant relationship between Benford's First Digit Distribution and Sales Data of oil and gas companies listed on the Nigerian Stock Exchange.

Chi-square decision rule is that when the T-value is greater than the X2 value, the study rejects the null hypothesis. Looking at table 3, we can see that the X2 value is 26.34 where as the T-value is 15.51. The X2 value is greater than the T-value, therefore, the study fail to accept the null hypothesis meaning that the first digit distribution of sales data conforms to the expected Benford's First Digit Distribution Law.

Hypothesis 2: There is no significant relationship between Benford's Second Digits Distribution Law and Sales Data of oil and gas companies listed on the Nigerian Stock exchange.

Chi-square decision rule is that when the T-value is greater than the X2 value, the study rejects the null hypothesis. Looking at table 4 above, we can see that X2 value is 17.92 and the T-value is 16.92. The X2 value is greater than the T-value, therefore, the study fail to accept the null hypothesis meaning that the second digit distribution of sales data does not deviate significantly from the proposed Benford's Second Digit Distribution Law.

The study concludes that there is a significant relationship that exists between Benford's Law and Sales Data of oil and gas companies listed on the Nigerian Stock Exchange from 2012 to 2022.

Relating this result to the Information Manipulation Theory to the findings of this study, it is evident that it does not hold. The conformity of the sales data to the Benford's first and second digit distribution Law shows that sales data are genuine or free from manipulation. The finding also is evident that Benford's Law is an effective analytical model for the detection of fraud in sales data. The finding of this study is related to the study of Akintoye et al (2020). On the other hand, it is against the findings of Oladele et al (2020) and Ayedele et al (2020)

Conclusion

This study is evident that Benford's law is reliable and effective in determining anomalies in sales that of oil and gas companies listed on the Nigerian Stock Exchange.

Similarly study confirm that there is a significant relationship existing between Benford's Law and sales data of oil and gas companies listed on the Nigerian Stock Exchange during the period covered.

Finally, the study contributes to the existing literature in the application of Benford's Law to determine anomalies in accounting data.

Recommendation

i. Auditors should adopt Benford's Law instead of the traditional method of auditing.
ii. Further researchers can capitalized on the areas not covered by this study.
iii. The government of Nigeria can make it compulsory for accounting and audit students study Benford's Law.

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