ARAŞTIRMA MAKALESİ / RESEARCH ARTICLE

IS BENFORD'S LAW EFFECTIVE IN FRAUD DETECTION FOR EXPENSE CYCLE?

BENFORD YASASI GİDER DÖNGÜSÜNDE HİLE DENETİMİ İÇİN ETKİLİ Mİ?

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Abstract

Despite measures taken by firms to prevent fraud, it has been found in recent studies that losses derived from fraudulent activities are increasing on a global basis. International standards on auditing do not define which analytical approaches and technological tools to be used in performing audit. Decisions are left on the auditor's judgment. Auditors try to use digital techniques to deal with mass data sets generated by firms. Academic research may mislead practitioners as controversial outcomes exist in literature concerning empirical research. Benford's Law (BL) is one of the methods used frequently in digital analysis. Although some researchers defend the use of BL in audit, especially in fraud detection, this paper disputes its effectiveness for expense cycle. Different firm's data are tested to conclude that the use of BL is not appropriate for expense items. The reasons of this deficiency are explained in this paper.

Keywords: Benford's Law, Audit, Fraud, Expense Cycle
Jel Classification: M42, M10

Özet

Firmaların hileyi önlemek için aldıkları önlemlere karşın hile kaynaklı zararların küresel bazda artmakta olduğu yakın zamanlı araştırmalarda saptanmıştır. Uluslararası denetim standartları, denetim yapılırken hangi analitik yaklaşımların ve teknolojik yöntemlerin kullanılacağını belirtmemektedir. Kararlar denetçinin yargısına bırakılır. Firmalar tarafından üretilen yığın veri setler ile başa çıkabilmek için denetçiler dijital teknik kullanımına ağırlık vermekte olup Benford Yasası (BL) da denetçiler tarafından veri analizinde sıkça kullanılan yöntemlerden birisidir. Her ne kadar bazı araştırmacılar BL'nin denetimde, özellikle hile tespitinde kullanılmasını savunsalar da bu çalışma gider döngüsü için BL'nin etkinliğini sorgulamaktadır. Bu çalışmada farklı firma verileri ile yapılan testler sonucunda gider hesapları için BL kullanımının uygun olmadığı sonucuna varılmıştır. Bu çalışmada bu yöntemin uygun olmamasının gerekçeleri ayrıntılı olarak açıklanmaktadır.

Anahtar Kelimeler: Benford Yasası, Denetim, Hile, Gider Döngüsü
Jel Sınıflandırması: M42, M10

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1. Introduction

Corporate financial scandals in the 21st century had impacts not only on investors but also on the global economy. Mechanisms for corporate governance and for the oversight of auditors have been implemented. Nonetheless, the three basic motives of fraud triangle[1] which are incentive (or pressure to perform), opportunity and rationalization are permanent. A survey[2] including 7.200 respondents in 123 countries revealed that 49% (2016: 36%) of companies were victims of fraud in 2018, which was the highest rate in the 2000s. The increase is across all territories of the world. Internal actors were the main perpetrators and the dominant factor for fraud is opportunity (59%), followed by incentive (21%) and rationalization (11%). The opportunity factor signals that companies do not have effective internal controls to prevent them. Another survey[3] exposed that almost half of the firms reported a fraud in the past two years. On the other hand, external auditors count on the effectiveness of the internal controls to detect fraud or errors. The ineffectiveness of the internal controls to formulate preventions for fraud, and the limitation of independent auditors who look at the big picture open the doors for fraud. Meanwhile, a survey conducted with 179 firms whose stocks are traded in the stock market showed the management believe the internal control systems has a significant barrier for preventing potential frauds[4]. Therefore, the perception of the efficacy of the internal controls and the reality do not overlap.

The need for independent audit increases in order to protect all stakeholders besides shareholders. However, independent auditor's responsibility is to give a reasonable assurance and not a guarantee to detect even if a material misstatement exists due to fraud or error. Auditors face the dilemma to express an opinion by performing audit procedures without the aim to detect a fraud even the auditor with his inmate skepticism has always in mind a fraud may exist. However, the auditor's skeptical mindset forces him to be aware of any potentially fraudulent activity during audit process. Auditors try to use new technologies in order to assist themselves. Increasing accounting transactions and decreasing audit fees[5,6] make auditors develop technological tools to perform audit in a rapid and less costly way. One of the methods to review large data set of accounts of firms is Benford's Law (BL). Benford's rule may review transactions and balances in an easy way to determine whether or not the firm's accounting records follow the rule. Apart from its simplicity and its logic[7], the BL may not be an appropriate methodology for auditors. The time period of selection of data and the statistical outcome of the Benford's rule may be difficult because of the lack of a commonly accepted definition

1   Cressey, D.R. (1973). Other people's money. Patterson Smith: Montclair.

2   PwC (2018). Global Economic Crime and Fraud Survey 2018. https://www.pwc.com.tr/fraud-survey, p. 5.

3   PwC (2020). Global Economic Crime and Fraud Survey 2020. www.pwc.com/fraudsurvey, p. 10.

4   Gökçen, G., Tipi, O. (2019). A Research in Interior Controls and BIST Manufacturing Sector Towards Preventing Potential Frauds in Business, *Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 41(1), p. 165.

5   Beardsley, E.L., Lassila, D.R., Omer, T.C. (2018). How Do Audit Offices Respond to Audit Fee Pressure? Evidence of Increased Focus on Nonaudit Services and their Impact on Audit Quality, *Contemporary Accounting Research*, 36(2), 1.000.

6   Dey, R.M., Lim, L. (2018). Audit fee trends from 2000 to 2014, *American Journal of Business*, 33(1/2), p. 77.

7   Durtschi, C., Hillison, W.A., Pacini, C. (2004). The Effective Use of Benford's Law to Assist in Detecting Fraud in Accounting Data, *Journal of Forensic Accounting*, 1524-5586/Vol.V., p. 17.

of reasonable assurance, limitations of audit methods and the cost constraints[8,9]. Some researchers developed models to improve the application of BL in academic research. Gauvrit and Delahaye[10] defined a generalized BL, and found that the real-world data fit better than BL. Da Silva[11] proposed an upper bound for natural occurring data to increase the accuracy of the BL. Cerioli et al.[12] used approximations and developed goodness-of-fit procedures to alter the BL in case the law doesn't hold in the detection of frauds in international trade.

The BL approach seems not to be an appropriate tool to get effective results in the scope and time pressure of the audit. This paper applies the BL test for different firms' data for the first and then the second digits. The deviations from the BL are examined in the accounting data and reasons for the deviations are listed in a systematic way. These reasons are not firm-specific but can be generalized to all of the firms, especially to the ones which have more detailed and strict internal rules and regulations.

2. Literature

The law originates from Newcomb's[13] observation which says lower digits (such as 1, 2 and 3) appear more frequently than larger digits (9, 8, 7 ..) in relatively big data sets. Benford[14] formulated this by using the logarithmic probability of the digits D being any number from 1 to 9 that the first digits of a data set follow certain frequencies.

$$P(D) = \log_e [(1 + 1/D)] / \log_e (10)$$

The formula calculates not only the probability of the first digit but also that of the others such as the second digit, the first two digits or the last digits. The probability distribution follows a unique pattern for the first digit rather than other rankings or a combination of digits. Benford's first digit probability distribution is driven for observation for numbers that occur randomly in the nature instead of artificially made-up series. It is the starting point for academicians to test the BL in financial statements to identify manipulated accounting data. It is predicted that accounting amounts which are artificially produced due to fraudulent aim will not follow the BL's pattern. The test has efficacy

8   Spathis, C. (2002). Detecting false financial statements using published data: some evidence from Greece, *Managerial Auditing Journal*, 17(4), p. 188.

9   Hogan, C.E., Rezaee, Z., Riley, R.A., Velury, U.K. (2008). Financial statement fraud: insights from the academic literature, *Auditing: A Journal of Practice and Theory*, 27(2), p. 248.

10   Gauvrit, N., Delahaye J.P. (2009). Loi de Benford généralisée (Generalized Benford's law), *Mathématiques et Sciences Humaines*, 186, p. 12.

11   Da Silva, S.B. (2020). Benford or Not Benford: A systematic but not always well-founded use of an elegant law in experimental fields, *Communications in Mathematics and Statistics*, 8, p. 174.

12   Cerioli, A., Barabesi, L., Cerasa, A., Perrotta, D. (2019). Newcomb–Benford law and the detection of frauds in international trade, *Proceedings of the National Academy of Sciences of the United States of America*, 116(1), p. 114.

13   Newcomb, S. (1881). Note of the frequency of use of the different digits in natural numbers, *American Journal of Mathematics*, 4, p. 39.

14   Benford, F. (1938). The law of anomalous numbers, *Proceedings of the American Philosophical Society*, 78(4), p. 552.

to determine small amounts that have repetitions rather than the large amounts in which auditors are more interested due to materiality concern.

The empirical research in accounting took an interest with Carslaw[15] in New Zealand, and Thomas[16] in the USA who discovered that firms' earnings amounts had not followed the BL distribution pattern. Nigrini[17] enlarged the analysis to relate earnings with tax evaders. Nigrini and Mittermaier[18] used the BL for digital analysis in accounting numbers for practical use. Drake and Nigrini[19] developed the digital analysis techniques for audit usage. Durtschi et al.[20], on the other hand, pointed out that the BL is less effective when the deviated transaction number is relatively low in the data set, and although the data set is not in conformity with BL distribution, there is no fraud.

Busta and Weinberg[21] proposed an analytical procedure using artificial neural network to measure the degree of deviation from the BL to identify manipulated accounting data. More than 10% of deviation shows the fraudulent activity with 68% accuracy. However, they used simulated data instead of real data and 68% of accuracy is not high enough. Bhattacharya, Xu, and Kumar[22] developed the works of Busta and Weinberg[23] to have a genetic algorithm to optimize a neural network based on the BL. They concluded the neural network is a useful classifier to distinguish natural accounting numbers from those that are made-up. Debreceny and Gray[24] researched fraud by using the journal entry data sets of 29 firms of which first digit distribution differed from that expected by the BL. Bella et al.[25] developed a four-stage self-organizing map fraud detection architecture of electronic billing records. Tackett[26] suggested the use of association rules in detecting fraud through finding patterns and relationships when examining a company's digital records. Barney and Schulzke[27] underline how reliable is the BL in audit testing as false positives test results (Type I errors) show that the digital analysis is costly and unnecessary. Auditors use the digital techniques without being conscious of

15 Carslaw, C. (1988). Anomalies in income numbers: Evidence of goal oriented behavior, *The Accounting Review*, 63(2), p. 322.

16 Thomas, J.K. (1989). Unusual Patterns in Reported Earnings, *The Accounting Review*, 64(4), p. 784.

17 Nigrini, M.J. (1996). A taxpayer compliance application of Benford's law, *Journal of the American Taxation Association*, 18(1), p. 75.

18 Nigrini, M.J., Mittermaier, L. (1997). The use of Benford's law as an aid in analytical procedures, *Auditing*, 16(2), p. 55.

19 Drake, P.D., Nigrini, M.J. (2000). Computer assisted analytical procedures using Benford's Law, *Journal of Accounting Education*, 18(2), p. 141.

20 Durtschi, C., Hillison, W.A., Pacini, C., 2004, p. 30.

21 Busta, B., Weinberg, R. (1998). Using Benford's law and neural networks as a review procedure, *Managerial Auditing Journal*, 13(6), p. 359.

22 Bhattacharya, S., Xu, D., Kumar, K. (2011). An ANN-based auditor decision support system using Benford's law, *Decision Support Systems*, 50(3), p. 578.

23 Busta, B., Weinberg, R., 1998, p. 359.

24 Debreceny, R.S., Gray, G.L. (2010). Data mining journal entries for fraud detection: an exploratory study, *International Journal of Accounting Information System*, 11(3), p. 163.

25 Bella, B., Eloff, J.H., Olivier, M.S. (2009). A fraud management system architecture for next-generation networks, *Forensic Science International*, 185(1), p. 54.

26 Tackett, J.A. (2013). Association rules for fraud detection, *Journal of Corporate Accounting and Finance*, 24(4), p. 18.

27 Barney, B.B., Schulzke, K.S. (2016). Moderating "Cry Wolf" events with excess MAD in Benford's law research and practice, *Journal of Forensic Accounting Research*, 1(1), p. A82.

their reliability. Nigrini[28] tried to detect the reasons of non-conformity to the BL distribution by improving audit sampling, but concluded the accuracy rate was still questionable. Nigrini[29] used several examples of fraudulent numbers to construct a systematic fraud scheme. He found that deviations from the BL are included in his list of fraudulent numbers. The fraudulent activities do not always decrease the profit as Istrate[30] found by using BL methodology that the bigger companies manipulate more upward the net income than the smaller ones. Besides the companies, González[31] investigated fraud through the household income tax declarations and noted that they do not follow a BL's distribution even though there is no empirical evidence that the income reports are falsified.

3. Research

3.1. Sample

The study focuses on different Turkish firms' accounting records from 2014 to 2018 for the expense transactions.

3.2. Research Design

The BL is used to differentiate data which should occur in a usual way compared to the data created due to fraudulent activity.

According to the BL in audit, auditors should conduct additional tests for the deviation of client's accounting pattern from the BL. If the auditor chooses to continue with additional BL testing, he has to check the deviations. The reasons of the deviations may be acceptable due to the specific operations of the audited firm. Nevertheless, the deviations are shown in the frequency, and not in the absolute amount of the transactions. For instance, there may be deviations for the first two-digit for 75. The amounts in currency may be 750.100, 75.800, 750, 75, 75, 75, 75 and 75. The 75 amounts can be predetermined upper limits sets by the firm for a specific nature of transaction (for instance, daily accommodation allowance –per diem costs), daily transportation limit, bank order limit to pay for job advances). In terms of materiality, the auditor will not be interested in small amounts of transactions unless they are for internal control recommendations for the management. The independent auditor's report should be free from material mistakes. Therefore, the cost-effective way is to check the largest amounts that are 750.000 and 75.800 if necessary.

28   Nigrini, M.J. (2017). Audit sampling using Benford's law: a review of the literature with some new perspectives, *Journal of Emerging Technology Accounting*, 14(2), p. 38.

29   Nigrini, M.J. (2020). The patterns of the numbers used in occupational fraud schemes, *Managerial Auditing Journal*, 34(5), p. 616.

30   Istrate, C. (2019). Detecting earnings management using Benford's Law: the case of Romanian listed companies, *Journal of Accounting and Management Information Systems*, 18(2), p. 212-213.

31   Gonzales, F. (2020). Self-reported income data: are people telling the truth?, *Journal of Financial Crime*, 27:4, p. 1355.

3.3. Findings

Table 1 shows that the expenses of the firm B for the year 2018 follows the BL; thus, the null hypothesis cannot be rejected. All the other samples disobey BL.
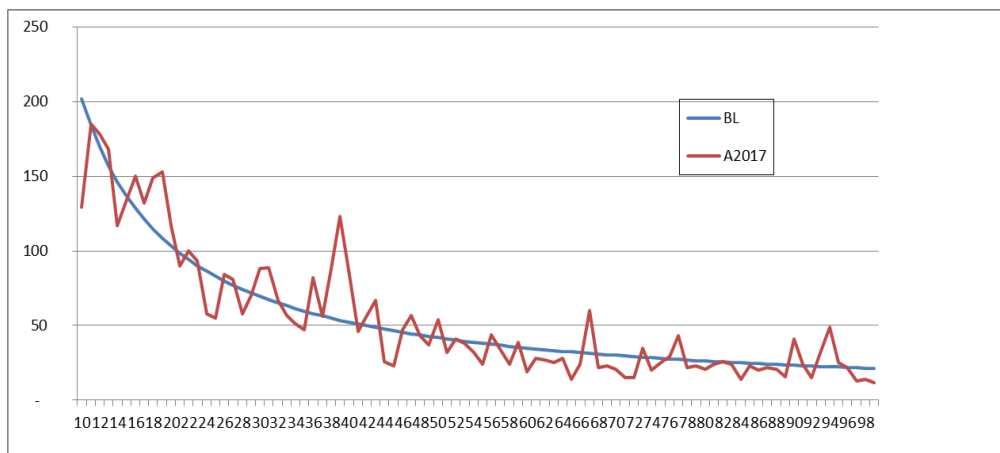
Table 1: Chi-Square Test Statistics

	All Observations		Over 100 TRY		Over 1.000 TRY	
	Number of Obs.	Chi-square	Number of Obs.	Chi-square	Number of Obs.	Chi-square
A2018	4.877	135	4.672	156	3.770	380
A2017	4.901	61	4.648	73	3.571	239
A2016	3.377	78	3.283	87	2.639	211
A2015	3.205	25	3.125	29	2.451	138
A2014	3.184	36	3.107	38	2.347	98
B2018	3.187	15 *	2.357	67	914	111
B2017	2.728	28	1.925	43	693	109
B2016	2.567	39	1.801	55	593	140
C1	2.106	27	1.167	89	392	124
C2	1.952	95	925	103	300	26
C3	5.367	267	3.418	439	1.366	306
C4	4.959	174	2.169	232	927	230

*: Significant at the .05 percent level. Critical chi-square value is 15,5.

A, B and C stand for different firms. The four digits (20XX) that follow A and B stand for the expenditures related to the one-year period. 1 to 4 that follows C stands for the expenditures related to different projects that may be more than one year period.

Certain limitations of the BL were explained by Kumar and Bhattacharya[32] and this study underlines the reasons of the nonconformity which are common for most of the firms nowadays.

Graph 1: Two-digit Distribution to Detect Anomalies

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32   Kumar, K., Bhattacharya, S. (2007). Detecting the dubious digits: Benford's law in forensic accounting, *Significance: Magazine of the Royal Statistical Society*, 4(2), p. 82.

According to Graph 1, the most divergent two-digit numbers are 10 with minus 73, and 39 with plus 69 deviations compared to the BL. Two-digit distribution to detect anomalies for the data of the company in Graph 1 and other companies are studied.

The reasons for the anomalies are as follows:

a. The deviations mostly arise from specific expenses that repeat them every month during the year. For instance, a purchase agreement concerning meal for the employees, raw materials or trade goods have the same invoice amount every month.

b. Internet and telephone expenses have the same invoice amount each month.

c. Company management usually determines an expense limit for food, accommodation or transportation expenses. Company does not pay over the expense limit. Accounting departments record the expense documents up to the limit in order not to pay excess amount to the employees. Thus, the same amount appears in the accounting transactions. For instance, the company has many employees who travel for business purpose and determines a maximum transportation expense of TRY 50. All of these TRY 50 expenses deviate from the BL; nonetheless, these expenses arise from the need of controlling company expenses.

d. Most of the employees have a similar salary so the data deviates from the BL pattern. Almost all the firms have employees who work for minimum salary. Departments also have employees (technicians, salesmen, accounting staff, call center operators) who fulfill the same job so the same salary is paid to all of them.

Other findings are as follows:

3.3.1. Monthly or yearly sample selection

The data is studied for different time periods. As the audit is performed as interim and year-end audit, the auditor examines the interim period from 1 January to the date of the interim, such as 31 August, 30 September or 31 October. The lower the size of the transactions, the higher the probability of the BL is expected to divert. Thus, when the full period of 12 months is subject to the BL test, the probability to adhere to the BL increases. The interim audit aims to verify internal controls and perform tests on the system. However, the scope of the year-end audit aims to verify year-end balances. BL tests are related to interim audit and are not consistent with the aim of year-end audit. The BL should be performed during interim audit which decreases the success of the test due to a lower size of the accounting transactions compared to the full year transaction size.

The data examined is tested not only for the 12-months period but also for a monthly basis. The results show that the significance of the test decreases when the BL is applied to months compared to a full year period. The applicability of the BL does not create value for small samples occurring due to monthly periods.

3.3.2. Selecting all or above a certain limit

As Table 1 supports in most of the cases, the larger the data set, the greater the probability to adhere to the BL is. On the other hand, including small numbers does not improve the quality of audit evidence which is measured by the appropriateness of the evidence. This means that the opinion of the auditor which is based on the relevance and reliability of the audit evidence in providing the support for reaching the conclusion is not affected. In terms of the quantity of the evidence which is measured by the sufficiency of the audit evidence, small numbers are not a measure for obtaining sufficiency[33]. The aim of the modern independent audit is to select appropriate and sufficient number of transactions in order to minimize audit costs while arriving at a conclusion over financial statements as a whole. Thus, empirical data points out that the BL works better with a great size of transactions but does not distinguish any relevance or reliability between numbers such as TRY 1 and TRY 1.000.000.

3.3.3. Materiality

According to international auditing standard (ISA) 320[34], materiality for the financial statement as a whole should be established by the auditor to obtain a reasonable assurance about the financial statements which are free from material misstatements, whether due to fraud or error. The auditor obtains reasonable assurance by obtaining sufficient appropriate audit evidence to reduce audit risk to an acceptable low level. The strategy of the auditor is to consider accounting transactions with large amounts that will impact the financial statements over the determined materiality level. While the BL is interested in large data sets as much as possible, the auditor directs himself to risky matters and high amounts that may influence his opinion which is based on reasonable assurance. In terms of materiality audit approach, the best strategy is to concentrate directly on risky areas and important high amount transactions instead of auditing whole accounting transactions. As for the fraudulent activities, fraud is done for large amounts. Small amounts of fraud do not have a material impact on the sustainability of the business.

3.3.4. Tax

Tax accounts should be audited like the other accounting accounts by the auditor to reach an opinion. Tax accounts are not similar to other accounts as some taxes should be calculated and declared by the client. Service purchases from foreign suppliers is an example. Due to the specific nature of the trade transactions abroad, tax knowledge and expertise are needed. Clients may not declare some taxes voluntarily or due to lack of knowledge. Tax accounts involve additional expertise other than the independent audit. Audit may not always assess the transactions in terms of tax dimensions. The BL test intends to capture abnormal behavior and cannot differentiate between the tax effects. In two

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33   ISAs. International Standards on Auditing issued by International Auditing and Assurance Standards Board. (ISA 200: Overall Objectives of the Independent Auditor and the Conduct of an Audit in Accordance with International Standards on Auditing)

34   ISA 320: Materiality in Planning and Performing an Audit.

identical transactions, a tax might be calculated and paid over one transaction, while in the other transaction it may be forgotten. The BL approach cannot contribute to independent audit in terms of tax perspective.

4. Conclusion

The BL may work in natural events such as river lengths, population and land areas of countries. The application of the BL to accounting and tax numbers directed academicians to find out whether fraudulent activities may be detected with this method. Although most of the accounting transaction sets have a similar BL frequency shape, statistical tests usually fail to accept that the observed data are in conformity with the BL.

The research is limited to the purchase and expense cycles which are important in the financial statement, and hence for the independent audit. This paper tests BL for different firm's annual expenses, and reveals that most of the data does not follow BL pattern. The first-digit and second-digit tests of BL are applied. The study further investigates the reasons of the nonconformity, and concludes BL is not a proper method to use in the audit of purchase and expense cycles. The paper offers a methodology for error or fraud detection in expense cycle.

External auditors have a limited time to verify the year-end balances of financial statements. Their audit plan is not designed for forensic audit. Additionally, they focus on accounting records and third-party confirmations as the audit standard ISA 505[35] describes the procedure for external confirmations. They do not compare purchasing or selling prices, and investigate any relationship between the executives of the company and the shareholders of the firms. The owners and executives are the ones who give damage the company more than employees and managers. Auditors should concentrate on the decisions of the owners and executives. The fraudster of the company needs an accomplice who is usually from the external environment. An auditor should be interested in the high-volume suppliers and customers, as well as the new established firms. The owners of these firms should be obtained and checked for any relation that may exist with the owners and executives of the company. The material fraud occurs with the business organized with suppliers or customers whose shareholders have a connection with the owners or the executives of the company. The traditional auditing process does not include this kind of research in their audit plan so global fraud activities continue to rise. Occupational fraud accounts for approximately 5% of the revenue loss of companies and the largest losses to firms derive from the activities of owners and executives[36]. To detect the fraud, auditor should investigate the relations of owners and executives with the firm's important customers and suppliers. A survey point outs 60% of firms do not have a program to address bribery and corruption risk[37]. Companies should implement anti-fraud controls to deal with fraudsters.

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35   ISA 505: External Confirmations.

36   ACFE (2020). Report to the Nations: 2020 Global Study on Occupational Fraud and Abuse. Austin, USA: Association of Certified Fraud Examiners, p. 44.

37   PwC 2020, p. 7.

The importance of fraud detection is high in the period of low economic activities and even higher in recession. After the outbreak of coronavirus in the first quarter of 2020, the effective utilization of firm's resources and fair presentation of the financial statements became vital. A global recession is expected for a few quarters, and fraud may damage companies, distort the sustainability of the business which in normal economic activity period would not have a major impact. In the period of recessions, companies should invest in internal controls to improve the effectiveness of operations, and detect potentially fraudulent activities.

References

ACFE (2020). Report to the Nations: 2020 Global Study on Occupational Fraud and Abuse. Austin, USA: Association of Certified Fraud Examiners. Retrieved from https://acfepublic.s3-us-west-2.amazonaws.com/2020-Report-to-the-Nations.pdf

BAMEY, B.B., Schulzke, K.S. (2016). Moderating "Cry Wolf" events with excess MAD in Benford's law research and practice, *Journal of Forensic Accounting Research*, 1(1): A66–A90. https://doi.org/10.2308/jfar-51622

BEARDSLEY, E.L., Lassila, D.R., Omer, T.C. (2018). How Do Audit Offices Respond to Audit Fee Pressure? Evidence of Increased Focus on Nonaudit Services and their Impact on Audit Quality, *Contemporary Accounting Research*, 36(2): 999-1.027. https://doi.org/10.1111/1911-3846.12440

BELLA, B., Eloff, J.H., Olivier, M.S. (2009). A fraud management system architecture for next-generation networks, *Forensic Science International*, 185(1): 51-58. DOI:10.1016/j.forsciint.2008.12.013

BENFORD, F. (1938). The law of anomalous numbers, *Proceedings of the American Philosophical Society*, 78(4): 551-572.

BHATTACHARYA, S., Xu, D., Kumar, K. (2011). An ANN-based auditor decision support system using Benford's law, *Decision Support Systems*, 50(3): 576–584. DOI:10.1016/j.dss.2010.08.011

BUSTA, B., Weinberg, R. (1998). Using Benford's law and neural networks as a review procedure, *Managerial Auditing Journal*, 13(6): 356-366. https://doi.org/10.1108/026.869.09810222375

CARSLAW, C. (1988). Anomalies in income numbers: Evidence of goal oriented behavior, *The Accounting Review*, 63(2): 321-327.

CERIOLI, A., Barabesi, L., Cerasa, A., Perrotta, D. (2019). Newcomb–Benford law and the detection of frauds in international trade, *Proceedings of the National Academy of Sciences of the United States of America*, 116(1): 106-115. https://doi.org/10.1073/pnas.180.661.7115

CRESSEY, D.R. (1973). Other people's money. Patterson Smith: Montclair.

DA SILVA, S.B. (2020). Benford or Not Benford: A systematic but not always well-founded use of an elegant law in experimental fields, *Communications in Mathematics and Statistics*, 8: 167-201. DOI: 10.1007/s40304.018.00172-1

DEBRECENY, R.S., Gray, G.L. (2010). Data mining journal entries for fraud detection: an exploratory study, *International Journal of Accounting Information System*, 11(3): 157-181. DOI: 10.1016/j.accinf.2010.08.001

DEY, R.M., Lim, L. (2018). Audit fee trends from 2000 to 2014, *American Journal of Business*, 33(1/2): 61-80. https://doi.org/10.1108/AJB-10-2016-0033

DRAKE, P.D., Nigrini, M.J. (2000). Computer assisted analytical procedures using Benford's Law, *Journal of Accounting Education*, 18(2): 127-146. DOI:10.1016/S0748-5751(00)00008-7

DURTSCHI, C., Hillison, W.A., Pacini, C. (2004). The Effective Use of Benford's Law to Assist in Detecting Fraud in Accounting Data, *Journal of Forensic Accounting*, 1524-5586/Vol.V.: 17-34.

GAUVRIT, N., Delahaye J.P. (2009). Loi de Benford généralisée (Generalized Benford's law), *Mathématiques et Sciences Humaines*, 186: 5-15.

GONZALES, F. (2020). Self-reported income data: are people telling the truth?, *Journal of Financial Crime*, 27:4, 1349-59. https://doi.org/10.1108/JFC-08-2019-0113

GÖKÇEN, G., Tipi, O. (2019). A Research in Interior Controls and BIST Manufacturing Sector Towards Preventing Potential Frauds in Business, *Marmara Üniversitesi İktisadi ve İdari Bilimler Dergisi*, 41(1): 145-169. DOI: 10.14780/muiibd.582316

HOGAN, C.E., Rezaee, Z., Riley, R.A., Velury, U.K. (2008). Financial statement fraud: insights from the academic literature, *Auditing: A Journal of Practice and Theory*, 27(2): 231–252. https://doi.org/10.2308/aud.2008.27.2.231

ISAs. International Standards on Auditing issued by International Auditing and Assurance Standards Board. (ISA 200: Overall Objectives of the Independent Auditor and the Conduct of an Audit in Accordance with International Standards on Auditing; ISA 320: Materiality in Planning and Performing an Audit; ISA 505: External Confirmations)

ISTRATE, C. (2019). Detecting earnings management using Benford's Law: the case of Romanian listed companies, *Journal of Accounting and Management Information Systems*, 18(2): 198-223.

KUMAR, K., Bhattacharya, S. (2007). Detecting the dubious digits: Benford's law in forensic accounting, *Significance: Magazine of the Royal Statistical Society*, 4(2): 81-83. https://doi.org/10.1111/j.1740-9713.2007.00234.x

NEWCOMB, S. (1881). Note of the frequency of use of the different digits in natural numbers, *American Journal of Mathematics*, 4: 39-40.

NIGRINI, M.J. (1996). A taxpayer compliance application of Benford's law, *Journal of the American Taxation Association*, 18(1): 72-92.

NIGRINI, M.J. (2017). Audit sampling using Benford's law: a review of the literature with some new perspectives, *Journal of Emerging Technology Accounting*, 14(2): 29-46. https://doi.org/10.2308/jeta-51783

NIGRINI, M.J. (2020). The patterns of the numbers used in occupational fraud schemes, *Managerial Auditing Journal*, 34(5): 606-626. https://doi.org/10.1108/MAJ-11-2017-1717

NIGRINI, M.J., Mittermaier, L. (1997). The use of Benford's law as an aid in analytical procedures, *Auditing*, 16(2): 52-67.

PWC (2018). Global Economic Crime and Fraud Survey 2018. https://www.pwc.com.tr/fraud-survey

PWC (2020). Global Economic Crime and Fraud Survey 2020. www.pwc.com/fraudsurvey

SPATHIS, C. (2002). Detecting false financial statements using published data: some evidence from Greece, *Managerial Auditing Journal*, 17(4): 179–191. DOI: 10.1108/026.869.00210424321

TACKETT, J.A. (2013). Association rules for fraud detection, *Journal of Corporate Accounting and Finance*, 24(4): 15-22. https://doi.org/10.1002/jcaf.21856

THOMAS, J.K. (1989). Unusual Patterns in Reported Earnings, *The Accounting Review*, 64(4): 773-787.