International Journal of Business and Society, Vol. 23 No. 2, 2022, 773-785

DO ANALYSTS' EPS FORECASTS OBEY BENFORD'S LAW? AN EMPIRICAL ANALYSIS

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ABSTRACT

Benford's law gives the expected frequencies of digits in tabulated data. In this study, I investigate the extent to which a sample of analysts' earnings per share (EPS) forecasts obey Benford's law. I conduct Benford's law's second digit and last-two digits tests on a sample of analyst EPS forecasts of S&P 500 firms from 1998 to 2018. Overall, I find that analysts' EPS forecasts obey Benford's law's second digit test but do not obey the last-two digits test. These findings suggest that while analysts do not engage in number invention, they do engage in rounding when making EPS forecasts.

Keywords: Benford's law, earnings per share, forecasting.

Received: 25 January 2021
Accepted: 29 April 2022
https://doi.org/10.33736/ijbs.4837.2022

1. INTRODUCTION

In this study, I investigate the extent to which a sample of analysts' earnings per share (EPS) forecasts obey Benford's law. Benford's law gives the expected frequencies of digits in tabulated data (Nigrini, 2012). These expected frequencies are named after Frank Benford who published the seminal paper on the topic (Benford, 1938). From the outset, it is unclear if analysts' EPS forecasts will obey Benford's law. On the one hand, prior research has established that analysts have strong incentives to produce accurate forecasts (Sedor, 2002). To the extent that analysts strive to produce accurate forecasts, they are likely to rely on established forecasting techniques in forming their forecasts and are not likely to make up or 'invent' numbers in their forecasts. This is likely to lead to analysts' EPS forecasts obeying Benford's law. On the other hand, other streams of research suggest that analysts can also deliberately reduce the effort that they put into making EPS forecasts (e.g. Dechow & You, 2012). To the extent that analysts choose to 'invent' numbers in their forecasts as they reduce the effort that they put into making their forecasts, analysts' EPS forecasts are not likely to obey Benford's law. In addition, analysts may also choose to round their forecasts when they put in less effort in making the forecasts or when they want to communicate uncertainty around the forecasts (Dechow & You, 2012; Herrmann & Thomas, 2005). To the extent

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that such rounding occurs, it is likely to lead to round digits being over-represented in EPS forecasts, and EPS forecasts are hence unlikely to obey Benford's law.

Examining the extent to which analysts' EPS forecasts obey Benford's law is important because it will provide insights into analysts' behavioral tendencies when making EPS forecasts. In particular, given that analysts represent an integral part of the capital market who provide earnings forecasts which stakeholders, including brokers, money managers, and investors, rely on when making decisions (Lang & Lundholm, 1996), insights into the behavioral tendencies of analysts will enhance our understanding of the role that analysts play in the capital markets, and allow users of analysts' forecasts to better evaluate the extent to which they should rely on such information.

I conduct my analysis on a sample of analyst EPS forecasts made for S&P 500 firms between 1998 and 2018. In particular, I conduct Benford's law's second digit and last-two digits tests on my sample of data. These tests compare the frequencies with which the second or the last-two digits of EPS forecasts in my sample appear with their expected frequencies predicted by Benford's law. Overall, I find that analysts' EPS forecasts obey Benford's law's second digit test, suggesting that analysts do not manipulate or invent numbers when making forecasts. However, I find that analysts' EPS forecasts do not obey the last-two digit test, suggesting that, consistent with prior studies (e.g. Dechow & You, 2012; Herrmann & Thomas, 2005), they engage in the rounding of their EPS forecasts.

My study complements prior accounting and finance research which have examined Benford's law. While prior research has examined the application of Benford's law in settings involving fraud detection (Drake & Nigrini, 2000; Durtschi, 2004), financial accounting data (Alali & Romero, 2014), earnings management (Jordan & Clarke 2011; Archambault & Archambault, 2011), tax evasion (Nigrini, 1996), my study is the first to examine the compliance of analysts' EPS forecast data with Benford's law. In this regard, my study complements prior studies by examining how Benford's law can be used to examine both number invention and rounding in analysts' EPS forecasts.

My study contributes to practice. My findings provide insights for investors and other receivers of analysts' EPS forecasts with regard to how analysts make EPS forecasts. These insights will likely have implications for how they rely on analyst EPS forecasts in making decisions. Specifically, to the extent that my findings suggest that analysts do not manipulate or invent numbers when making forecasts, they will increase users' perceptions of the reliability of analysts' EPS forecasts. To the extent that my findings suggest that analysts engage in the rounding of their EPS forecasts, they will influence investors' perceptions of the level of precision to expect when interpreting analysts' EPS forecasts.

The rest of my paper proceeds as follows. Section 2 develops my hypothesis, Section 3 describes my research design, section 4 presents my results, and section 5 concludes the paper.

2. HYPOTHESIS DEVELOPMENT

2.1. Benford's Law

Simon Newcomb, an astronomer and mathematician, published the first article on Benford's law in 1881 (Newcomb, 1881). Newcomb (1881) established that, according to Benford's law, the probability that a randomly generated number has any particular non-zero first digit is given by:

$$P(D_1=d_1) = log_{10}(1+1/d_1);\quad d_1 \in \{1, 2, \ldots, 9\} \tag{1}$$

where D1 represents the first digit and P represents the probability of observing the event in parenthesis. The probability that a randomly generated number has any particular second digit is given by:

$$P(D_2=d_2) = \sum_{d1=1}^{9} \log10(1 + 1/\, d_1d_2);\ d_2 \in \{1, 2, \ldots, 9\} \tag{2}$$

where D2 represents the second digit and P represents the probability of observing the event in parenthesis. In applying the formula, Benford's law provides that in a randomly generated set of data, numbers within the dataset should have 1 as the most frequently appearing first digit (about 30.1% of the time) and have 9 as the least frequently appearing first digit (about 4.6% of the time). In addition, numbers should have 0 as the most frequently appearing second digit (about 12.0% of the time) and 9 as the least frequently appearing second digit (about 8.5% of the time). Table 1 summarizes these expected digit frequencies based on Benford's law.

Table 1: Expected Digit Frequencies Based on Benford's Law

Digit	1st Position	2nd Position
0	n/a	12.0%
1	30.1%	11.4%
2	17.6%	10.9%
3	12.5%	10.4%
4	9.7%	10.0%
5	7.9%	9.7%
6	6.7%	9.3%
7	5.8%	9.0%
8	5.1%	8.8%
9	4.6%	8.5%

***Note*:** Table 1 presents expected digit frequencies for the first and second digits based on Benford's law.

Benford's law based tests are tests of number invention (Nigrini, 2012). Three commonly employed Benford's law based tests are the first-digit test, the second-digit test, and the last-two digits test. In the first-digit and second-digit tests, the actual frequencies with which a number's first and second digits (respectively) appear in a dataset are compared with their respective expected frequencies predicted by Benford's law. In contrast, the last-two digits tests compares the actual frequencies with which a number's last-two digit combinations appear in a data set with their respective frequencies predicted by Benford's law. While the first-digit and second-digit tests examine a relatively small range of digits – the first digit tests examines digits from 1 to 9 and the second digit test examines digits from 0 to 9 - and represent high level tests which are design to only provide a general indication of abnormal duplications in data, the last-two digits test examines a wider range of digits – it examines hundred digit combinations from 00 to 99 - and is a more focused test that can detect abnormal duplication and possible bias (such as rounding) in the data (Nigrini, 2012; Diekmann, 2007).

To evaluate the results from Benford's law based tests, accounting researchers often rely on mean absolute deviation (MAD) as a test to assess the extent of a dataset's conformity to Benford's law (Drake & Nigrini, 2000). The formula to compute MAD is given by:

$$MAD = \sum_{i=1}^{k}|AP - EP|/K \quad (3)$$

where k represents the number of bins, AP denotes the actual proportion, and EP denotes the expected proportion.[1] The larger the MAD, the larger the deviations between actual and expected frequencies in a given dataset. Consequently, the larger the MAD, the larger the non-conformity with Benford's law is. Table 2 summarizes the critical MAD range values for the first-digit and second-digit tests developed by Nigrini (2020) to measure conformity with Benford's law.

Table 2: Critical Range Values for Mean Absolute Deviation (MAD)

Conformity Range	First Digits	Second Digits
Close conformity	0.000-0.006	0.000-0.008
Acceptable conformity	0.006-0.012	0.008-0.010
Marginally acceptable conformity	0.012-0.015	0.010-0.012
Nonconformity	Above 0.015	Above 0.012

Note: Table 2 presents MAD conformity ranges for the first and second digits based on Benford's law.

Benford's law has been examined extensively in a wide range of areas including in mathematics (Hill, 1995; Newcomb, 1881), the physical sciences (Sambridge et al., 2010) and business (Judge & Schechter, 2009; Giles, 2007). Research has also examined Benford's law in the accounting setting. For example, in the area of tax accounting, Nigrini (1996) examined how Benford's law can be used to investigate tax compliance among tax payers. In the area of audit, Nigrini and Mittermaier (1997) examined how Benford's law could be used as an effective aid in analytical procedures in the planning stage of an audit while Nigrini and Miller (2009) examined how second-order tests of Benford's law can be used to detect unusual issues related to data integrity that might not have been easily detectable using traditional audit analytical procedures.

2.2. Analysts' EPS Forecasts

Analysts regularly make forecasts of the EPS of companies that they follow (Walther & Willis, 2013). From the outset, it is unclear if analysts' EPS forecasts will obey Benford's law. On the one hand, prior research suggests that analysts have incentives to provide accurate forecasts. In particular, forecast accuracy is important to analysts because they enhance analysts' reputation (Sedor, 2002), decreases the likelihood of the termination of their employment (Mikhail et al., 1997), and can increase the likelihood of them moving from a lower to higher status brokerage firm (Hong & Kubik, 2003). To the extent that analysts strive to produce EPS forecasts that are accurate, they are likely to rely on forecasting techniques in forming their forecasts (Eckel, 1982), and are not likely to manipulate/invent digits in their forecasts. While some studies have documented that analysts' EPS forecasts can be biased by factors such as unintentional analyst optimism (Sedor, 2002), investor expectations (Walther & Willis, 2013), and career concerns (Hong & Kubik, 2003) in forming the EPS forecasts, such factors are unlikely to lead to deliberate manipulation of digits in a forecast. Accordingly, the results from these studies suggest that

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[1] For example, there are a hundred bins in the last-two digits test.

analysts generally have an incentive to produce accurate forecasts and are unlikely to manipulate their EPS forecasts in a way that causes it to substantially deviate from Benford's law. To the extent that this is true, analysts' EPS forecasts are likely to obey Benford's law.

On the other hand, a separate steam of research suggests that analysts can choose to reduce the effort that they put into making EPS forecasts. For example, in examining the phenomenon of rounding in EPS forecasts, Dechow & You (2012) suggest that analysts can choose the amount of effort that they put into making a forecast. They find that analysts put in less effort (as proxied by rounding) when forecasting earnings for firms which are of less interest to investors and so generate less brokerage business and when forecasting earnings for firms which are unlikely to be raising new financing since these firms are unlikely to become investment banking clients. To the extent that there is evidence that analysts can choose to put in less effort in making forecasts, it is possible that analysts may manipulate/invent the digits contained in their forecasts (without applying appropriate forecasting techniques). Given that prior research provides contrasting evidence as to the extent to which analysts' EPS forecasts are likely to obey Benford's law, I state my first hypothesis in null form, as follows:

Hypothesis 1: There will be no difference between the distribution of the second digits in analysts' EPS forecasts and the Benford distribution.[2]

In examining rounding in analysts EPS forecasts, both Dechow and You (2012) and Herrmann and Thomas (2005) highlight that analysts engage in the rounding of EPS forecasts, particularly under conditions of uncertainty. To the extent that analysts engage in the rounding of their forecasts, round numbers are likely to be over-represented in the ending digits in analysts' EPS forecasts, leading to these forecasts not obeying Benford's law. This leads to hypothesis 2:

Hypothesis 2: The frequency of round numbers in the ending digits of analysts' EPS forecasts will be greater than that predicted by Benford's Law.

3. RESEARCH DESIGN

My main sample consists of 846,027 analyst EPS forecasts of firms on the S&P 500 from 1998 to 2018 downloaded from the I/B/E/S database. I also obtained a supplementary sample of 9,149 EPS figures reported by firms on the S&P 500 from 1998 to 2018. To examine hypothesis 1, I first conducted Benford's law's second digit test on the sample of EPS figures reported by firms on the S&P 500 to examine if reported EPS figures obey Benford's law. To the extent that reported EPS figures obey (do not obey) Benford's law, analysts' EPS forecasts are likely to also obey (not obey) Benford's law. Following that, I conducted Benford's law's second digit test on my main sample

[2] I focus on the second digit rather than the first digit of EPS forecasts because the second digit in an EPS figure is less likely to be subject to manipulation that is unrelated to forecasting than the first digit. For example, Cheong & Thomas (2016) highlight that managers regularly manipulate the magnitudes of stock prices and EPS by splitting or reverse-splitting stocks to ensure that the magnitudes of stock prices and EPS values remain within desirable ranges, suggesting that the first digits of EPS forecasts will be manipulated to take on certain values. Consistent with this assertion, I find that five digits (1 to 5) account for 73.52% of first digits in actual EPS figures reported by firms in my sample range.

of analysts' EPS forecasts for firms on the S&P 500 to examine the extent to which they obey Benford's law.[3, 4]

To examine hypothesis 2, I also conduct a last-two digit test on my full sample of EPS forecasts. In addition to being a powerful test of number invention (Nigrini 2012), it will also able to detect rounding in my sample forecasts (Nigrini & Miller, 2009).

4. RESULTS

Table 3 presents the results of the second digit test conducted on my sample of reported EPS figures. Panel A presents the results for the test conducted on the full sample. The 'Second Digit' column presents the second digit integer being examined while the 'Count of EPS' column presents the frequencies of reported EPS figures with second digits corresponding to the integer indicated in the 'Second Digit' column. The 'Proportion of Total Count' column presents the number in the 'Count of EPS' column expressed as a proportion of the total number of reported EPS figures in my sample while the numbers in the 'Benford's Law Proportion' column is computed by applying the Benford's law formula to obtain the expected proportion by which each integer in the 'Second Digit' column should appear. The 'Absolute Deviation' column presents the absolute difference between the 'Proportion of Total Count' and 'Benford's Law Proportion' columns and represents the extent to which each digit in the 'Second Digit' column deviates from Benford's law. The absolute deviations of the digits examined range from 0.0003 (digit 2) to 0.0268 (digit 0). The MAD, computed by taking the average of all 10 absolute deviations reported in the 'Absolute Deviation" column, is 0.0076. Referring to the critical range values for MAD presented in Table 2 indicates that my full sample of reported EPS figures closely conforms to Benford's law's second digit test (close conformity MAD range: 0.000 to 0.008).

Table 3: Second Digit Test for Reported EPS

Panel A: 1998 to 2018				
Second Digit	**Count of EPS**	**Proportion of Total Count**	**Benford's Law Proportion**	**Absolute Deviation**
0	850	0.0929	0.1197	0.0268
1	946	0.1034	0.1139	0.0105
2	993	0.1085	0.1088	0.0003
3	950	0.1038	0.1043	0.0005
4	936	0.1023	0.1003	0.0020
5	945	0.1033	0.0967	0.0066
6	896	0.0979	0.0934	0.0046
7	914	0.0999	0.0904	0.0096
8	896	0.0979	0.0876	0.0104
9	823	0.0900	0.0850	0.0050

[3] EPS forecasts of zero were excluded from the analysis. When negative EPS forecasts were reported, absolute values of these forecasts were used in the analysis.

[4] To the extent that managers manipulate EPS to fall within desirable magnitude ranges, the first digits of analysts' EPS forecasts are not likely to obey Benford's law. In contrast, the second digit in an EPS forecast, which I follow Günnel & Tödter (2007) in defining as the first digit after the decimal point in a EPS figure, is less likely to be subject to such manipulation (that is unrelated to forecasting) and is more likely to reflect the natural spread of digits in forecasting.

Panel B: 1998 to 2007

Second Digit	Count of EPS	Proportion of Total Count	Benford's Law Proportion	Absolute Deviation
0	392	0.0980	0.1197	0.0217
1	431	0.1077	0.1139	0.0062
2	458	0.1144	0.1088	0.0056
3	446	0.1114	0.1043	0.0071
4	401	0.1002	0.1003	0.0001
5	383	0.0957	0.0967	0.0010
6	407	0.1017	0.0934	0.0083
7	382	0.0955	0.0904	0.0051
8	387	0.0967	0.0876	0.0091
9	315	0.0787	0.0850	0.0063

Panel C: 2008 to 2018

Second Digit	Count of EPS	Proportion of Total Count	Benford's Law Proportion	Absolute Deviation
0	458	0.0890	0.1197	0.0307
1	515	0.1001	0.1139	0.0138
2	535	0.1039	0.1088	0.0049
3	504	0.0979	0.1043	0.0064
4	535	0.1039	0.1003	0.0036
5	562	0.1092	0.0967	0.0125
6	489	0.0950	0.0934	0.0016
7	532	0.1034	0.0904	0.0130
8	509	0.0989	0.0876	0.0113
9	508	0.0987	0.0850	0.0137

Notes: Table 3 presents statistics for the second digit test performed on actual EPS figures reported by firms. The Count of EPS column presents the number of EPS figures that have second digits matching the digit shown in the corresponding row in the Second Digit column. The Proportion of Total Count column presents the proportion of EPS figures that have second digits matching the digit shown in the corresponding row in the Second Digit column. The Benford's Law Proportion presents the expected proportion of EPS figures that have second digits matching the digit shown in the corresponding row in the Second Digit column based on Benford's Law. The Absolute Deviation column presents the difference between the Proportion of Total Count and Benford's Law Proportion columns. Panel A presents the statistics for the second digit test performed on EPS figures reported from 1998 to 2018. Panel B presents the statistics for the second digit test performed on EPS figures reported from 1998 to 2007. Panel C presents the statistics for the second digit test performed on EPS figures reported from 2008 to 2018.

I also conducted Benford's law's second digit test on sub-samples of the reported EPS data. Specifically, I split my sample into one containing EPS reported from 1998 to 2007 - representing EPS reported before the 2008 global financial crisis (Earle, 2009) – and another containing EPS reported from 2008 to 2018 – representing EPS reported following the occurrence of the financial crisis. Panel B of Table 3 presents the results of the second digit test conducted on the sub-sample of reported EPS from 1998 to 2007 while panel C presents the results of the second digit test conducted on the sub-sample of reported EPS from 2008 to 2018. The absolute deviations for EPS reported from 1998 to 2007 range from 0.0001 (digit to 0.0217 (digit 0). The mean absolute deviation is 0.0071, indicating close conformity with Benford's law. The absolute deviations for EPS reported from 2008 to 2018 range from 0.0036 (digit 4) to 0.0307 (digit 0). The mean absolute deviation is 0.0112, indicating marginally acceptable conformity with Benford's law. Overall, these results suggest that reported EPS figures by firms on the S&P 500 conform to Benford's law. The global financial crisis represents a key event that influenced financial markets, with the

European Union and the United States both responding to the crisis by changing the rules for the functioning of financial services and markets, and by establishing new oversight bodies (Ferran et al., 2012). While these changes would have increased the complexity faced by analysts in making EPS forecasts, the similar results that are observed for the periods before and after the global financial crisis suggests that analysts' forecasting behavior was not influenced this complexity.

Next, I conducted Benford's law's second digit test on my sample of analyst EPS forecasts. Table 4 presents the results for the test. Panel A presents the results for the test conducted on my full sample of analyst EPS forecasts. The absolute deviations for EPS reported for the full sample ranges from 0.0000 (digit 3) to 0.0366 (digit 0). The mean absolute deviation is 0.0104, indicating marginally acceptable conformity with Benford's law. Panel B of Table 4 presents the results of the second digit test conducted on the sub-sample of analyst EPS forecasts from 1998 to 2007 while panel C presents the results of the second digit test conducted on the sub-sample of analyst EPS forecasts from 2008 to 2018. The absolute deviations for EPS forecasts from 1998 to 2007 range from 0.0014 (digit 2) to 0.0367 (digit 0). The mean absolute deviation is 0.0085, indicating acceptable conformity with Benford's law. The absolute deviations for EPS reported from 2008 to 2018 range from 0.0014 (digit 3) to 0.0365 (digit 0). The mean absolute deviation is 0.0117, indicating marginally acceptable conformity with Benford's law. Overall, these results suggest that analyst EPS forecasts for firms on the S&P 500 conform to Benford's law.

Table 4: Second Digits Tests for Analysts' EPS Forecasts

Panel A: 1998 to 2018

Second Digit	Count of EPS	Proportion of Total Count	Benford's Law Proportion	Absolute Deviation
0	70,289	0.0831	0.1197	0.0366
1	86,823	0.1026	0.1139	0.0113
2	88,798	0.1050	0.1088	0.0039
3	88,289	0.1044	0.1043	0.0000
4	86,673	0.1024	0.1003	0.0021
5	88,701	0.1048	0.0967	0.0082
6	86,028	0.1017	0.0934	0.0083
7	86,767	0.1026	0.0904	0.0122
8	84,657	0.1001	0.0876	0.0125
9	79,002	0.0934	0.0850	0.0084

Panel B: 1998 to 2007

Second Digit	Count of EPS	Proportion of Total Count	Benford's Law Proportion	Absolute Deviation
0	22,837	0.0829	0.1197	0.0367
1	29,763	0.1081	0.1139	0.0058
2	30,352	0.1102	0.1088	0.0014
3	29,563	0.1074	0.1043	0.0030
4	28,181	0.1023	0.1003	0.0020
5	27,953	0.1015	0.0967	0.0048
6	28,125	0.1021	0.0934	0.0088
7	27,727	0.1007	0.0904	0.0103
8	26,115	0.0948	0.0876	0.0073
9	24,744	0.0899	0.0850	0.0049

Panel C: 2008 to 2018

Second Digit	Count of EPS	Proportion of Total Count	Benford's Law Proportion	Absolute Deviation
0	47,452	0.0832	0.1197	0.0365
1	57,060	0.1000	0.1139	0.0139
2	58,446	0.1024	0.1088	0.0064
3	58,726	0.1029	0.1043	0.0014
4	58,492	0.1025	0.1003	0.0022
5	60,748	0.1065	0.0967	0.0098
6	57,903	0.1015	0.0934	0.0081
7	59,040	0.1035	0.0904	0.0131
8	58,542	0.1026	0.0876	0.0150
9	54,258	0.0951	0.0850	0.0101

Notes: Table 4 presents statistics for the second digit test performed on analysts' EPS forecasts. The Count of EPS column presents the number of EPS forecasts that have second digits matching the digit shown in the corresponding row in the Second Digit column. The Proportion of Total Count column presents the proportion of EPS forecasts that have second digits matching the digit shown in the corresponding row in the Second Digit column. The Benford's Law Proportion presents the expected proportion of EPS forecasts that have second digits matching the digit shown in the corresponding row in the Second Digit column based on Benford's Law. The Absolute Deviation column presents the difference between the Proportion of Total Count and Benford's Law Proportion columns. Panel A presents the statistics for the second digit test performed on EPS forecasts reported from 1998 to 2018. Panel B presents the statistics for the second digit test performed on EPS forecasts reported from 1998 to 2007. Panel C presents the statistics for the second digit test performed on EPS forecasts reported from 2008 to 2018.

I also conducted complementary analysis by conducting Benford's law's second digit test on analyst EPS forecasts by the sector in which firms operate in. Table 5 presents the number of S&P 500 firms in my sample per sector, as defined by the Global Industry Classification Standard (GICS) (Hrazdil et al., 2013).

Table 5: S&P 500 Firms by Sector

Sector	No of Firms
Consumer Discretionary	82
Consumer Staples	34
Energy	31
Financials	69
Health Care	61
Industrials	67
Information Technology	72
Materials	25
Real Estate	33
Telecommunication Services	3
Utilities	28

Note: Table 5 presents the number of firms by sector, as defined by the Global Industry Classification Standard (GICS).

Table 6 presents the results of Benford's law's second digit test conducted on my full sample of analysts EPS forecasts by sector. Across sectors, mean absolute deviation ranges from 0.0058 (real estate) to 0.0157 (financials). My results indicate that the energy, information technology, and real estate sectors exhibit close conformity with Benford's law.

The health care sector exhibits acceptable conformity while the industrials and utilities sector exhibits marginally acceptable conformity with Benford's law. The consumer discretionary, consumer staples, financials, materials, and telecommunication services sectors exhibit nonconformity with Benford's law.

Overall, these tests address hypothesis 1 by providing insights into the extent to which the distribution of the second digits in analysts' EPS forecasts conform to the Benford distribution.

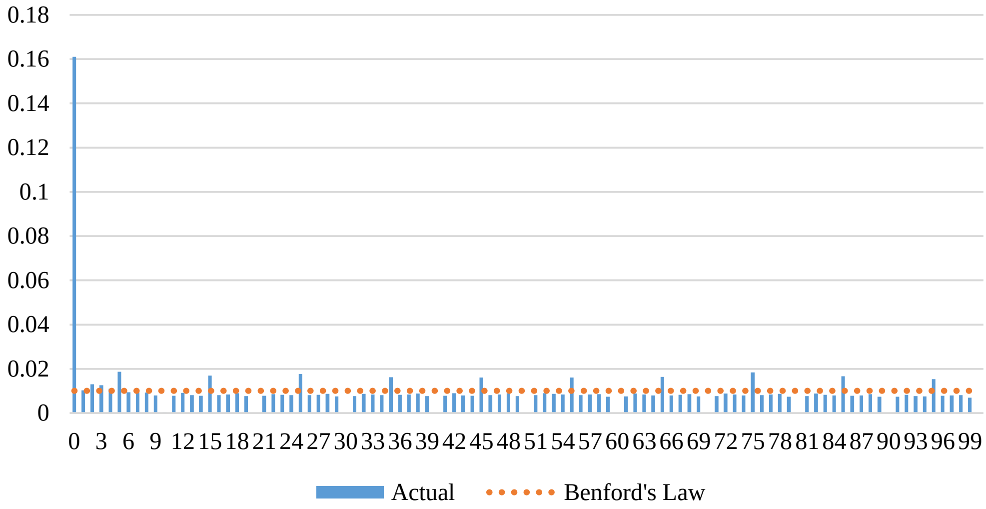
Table 6: Second Digit Test for Analysts' EPS Forecasts by Sector From 1998 to 2018

Sector	No of EPS Forecasts	Mean Absolute Deviation	Conformity Range
Consumer Discretionary	144,714	0.0122	Nonconformity
Consumer Staples	45,013	0.0136	Nonconformity
Energy	107,809	0.0066	Close conformity
Financials	131,224	0.0157	Nonconformity
Health Care	90,821	0.0098	Acceptable conformity
Industrials	98,463	0.0111	Marginally acceptable conformity
Information Technology	140,370	0.0075	Close conformity
Materials	35,905	0.0138	Nonconformity
Real Estate	18,125	0.0058	Close conformity
Telecom Services	8,339	0.0292	Nonconformity
Utilities	25,244	0.0118	Marginally acceptable conformity

Note: Table 6 presents statistics for the second digits tests for analysts' EPS forecasts by Sector, as defined by the Global Industry Classification Standard (GICS), from 1998 to 2018.

To examine hypothesis 2, I conduct Benford's law's last-two digits test on my full sample of analysts EPS forecasts. There are a hundred possible last-two digit combinations ranging from 00 to 99. The expected proportions of each of these last-two digit combinations based on Benford's law are equal at 0.01 (Nigrini, 2012). Figure 1 displays the results of the last-two digits test. It compares the proportion of last-two digit combinations in my sample of analyst forecasts with the expected proportion of these combinations based on Benford's law.

Figure 1: Benford’s Law’s Last-Two Digits Test



Notes: Figure 1 presents Benford’s law’s last-two digits test performed on analyst EPS forecasts of S&P 500 firms from 1998 to 2018. It compares the actual frequencies of last-two digits of analysts’ EPS forecasts with their expected frequencies based on Benford’s law.

Results (untabulated) indicate that absolute deviations range from 0.0003 (digits 01) to 0.1511 (digits 00). Mean absolute deviation for the test is 0.0045, corresponding to nonconformity with Benford's law. In addition, the last-two digit combinations with the five largest absolute deviations are 00 (absolute deviation=0.1511), 60 (absolute deviation=0.0100), 70 (absolute deviation=0.0100), 80 (absolute deviation=0.0100), 90 (absolute deviation=0.0100). I note that these five last-two digit combinations each end with the round digit, 0, consistent with prior studies which have documented the phenomenon of rounding in analysts' EPS forecasts (Dechow & You, 2012; Herrmann & Thomas, 2005). Overall, these results are consistent with hypothesis 2.

5. CONCLUSION

In this study, I examine whether analysts' EPS forecasts obey Benford's law. I conduct Benford's law's second digit and last-two digit test on my sample of data of analyst EPS forecasts of S&P 500 firms from 1998 to 2018. Overall, I find that while analysts' EPS forecasts obey the second digit test they do not obey the last-two digits test. These findings provide important insights into how analysts make EPS forecasts. In particular, they highlight that analysts generally do not engage in number invention in forming their forecasts. At the same time, it also provides evidence that analysts do engage in rounding when making their EPS forecasts.

The limitations of my study relate to the generalizability of my results. In my analysis, I examine a sample of analyst EPS forecasts made for S&P 500 firms. Given that S&P 500 firms are relatively large firms with large followings, it is likely that analysts will choose to exert more effort to make their EPS forecasts relative to smaller, less well followed firms (Dechow & You, 2012). To the extent that this is true, my sample of forecasts are more likely to obey Benford's law because analysts are more likely to put in more effort in making these forecasts. At the same time results in my study are less likely to generalize to a sample of relatively smaller firms for which analysts may put in less effort when forming forecasts. In this regard, future research may investigate whether analyst EPS forecasts obey Benford's law when such forecasts are made for relatively small firms. Further, while I find that my sample of analysts' EPS forecasts obey Benford's law's second digit test overall, my analysis of the second digit test by sector (see Table 6) suggests that this conformity may not apply across all sectors. Future research could examine the factors that lead to analyst EPS forecasts in specific sectors not conforming to Benford's law.

ACKNOWLEDGEMENT

I thank Mark Nigrini for insightful comments on an earlier version of the paper.

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