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The Newcomb-Benford Law in the Quantitative Analysis of Stock Prices on the NewConnect Market

Abstract: The aim of the study is to verify the conformity of the empirical distribution of closing prices of companies listed on the NewConnect market in Warsaw with the theoretical Newcomb-Benford law. Furthermore, the study examines whether the degree of conformity with the Benford distribution differs between high- and low-liquidity companies. The study covered 558,294 daily closing prices for 353 companies listed on the NewConnect market from 2007 to 2022. To verify whether the empirical distribution of daily closing prices conforms to the theoretical Newcomb-Benford distribution, statistical tests and the mean absolute deviation (*MAD*) measure were applied. The results indicate that deviations from the theoretical Newcomb-Benford distribution are greater in the early periods of the alternative market and for low-liquidity companies. The originality of this study lies in the application of the Newcomb–Benford law in the statistical analysis of closing prices on the NewConnect

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market. The study contributes to the literature by combining classical goodness of fit tests (Chi^2, Kolmogorov-Smirnov, Chebyshev, Friedman's U, Hotelling) with the *MAD* measure of deviation. This approach allows not only the formal assessment of statistical significance but also the evaluation of the practical magnitude of deviations between the empirical distribution and the theoretical Newcomb-Benford pattern.

Keywords: Newcomb-Benford law, NewConnect market, probability, mathematical statistics

JEL: C12, C14, E44, G14

1. Introduction

The application of the Newcomb-Benford law in financial data analysis is an important area of empirical research, particularly in the context of data quality assessment, anomaly detection, and analysis of financial market efficiency. In this context, it is justified to undertake an analysis for the NewConnect market, which, as an alternative market segment, is characterised by higher volatility and lower liquidity compared to the main markets. The aim of the study is to verify the conformity of the empirical distribution of closing prices of companies listed on the NewConnect market in Warsaw with the theoretical Newcomb-Benford distribution. The study utilised a set of statistical methods found in the international literature to assess the consistency of empirical distributions with theoretical ones. The analysis employed both classical goodness-of-fit tests and the mean absolute deviation (*MAD*). The study was conducted on a large sample of over half a million observations from 2007 to 2022.

The NewConnect market, as a segment of alternative trading in Poland, is characterised by relatively high share price volatility and significant differences in company liquidity. Under these circumstances, examining the reliability and regularity of financial data becomes particularly important, as any deviations from theoretical patterns can signal informational dysfunction or unusual market behaviour. Previous literature has, to a limited extent, analysed the behaviour of closing prices on alternative markets in the context of the Newcomb-Benford law, which is widely used in detecting numerical anomalies. This article conducts a statistical analysis to determine whether the relevant stock market data behave according to the Newcomb-Benford law or deviate from it.

In economic practice, in the process of identifying market anomalies, the increasing importance of two key elements can be observed: fraud analytics methods and automation. These methods use IT, statistical, econometric, and artificial intelligence techniques to detect irregularities (Palshikar, 2022). Equally important are studies aimed at identifying factors that increase the risk of fraud and causes of recidivism (Huang et al., 2017). The Newcomb-Benford law, also referred to in the literature as Benford's law or the law of first digits, describes the frequency distribution of first digits in many naturally occurring datasets (Newcomb, 1881; Benford, 1938). The Newcomb-Benford distribution is a specific code, a sequence of numbers that initially seems trivial, but gradually reveals itself in many contexts. It manifests itself in the surrounding world, composed of seemingly random elements: in sports, music, nature, and also in finance. It indicates that what appears to be random is often not. The distribution of significant digits can, in practice, be applied to verify the reliability of information contained, for example, in yearbooks, statistical reports, tax returns, or financial documents (Farbaniec et al., 2012). The Newcomb-Benford law indicates that more integers begin with smaller digits (1, 2, 3, 4) than with larger ones (5, 6, 7, 8, 9). Empirical studies have shown that, in many real-world applications, the distribution of first digits indeed corresponds to the predictions of this law. A visualisation of the Newcomb-Benford distribution for the first, second and first two significant digits is presented in Figure 1, where the vertical axis shows the probability [%] and the horizontal axis represents the digit.

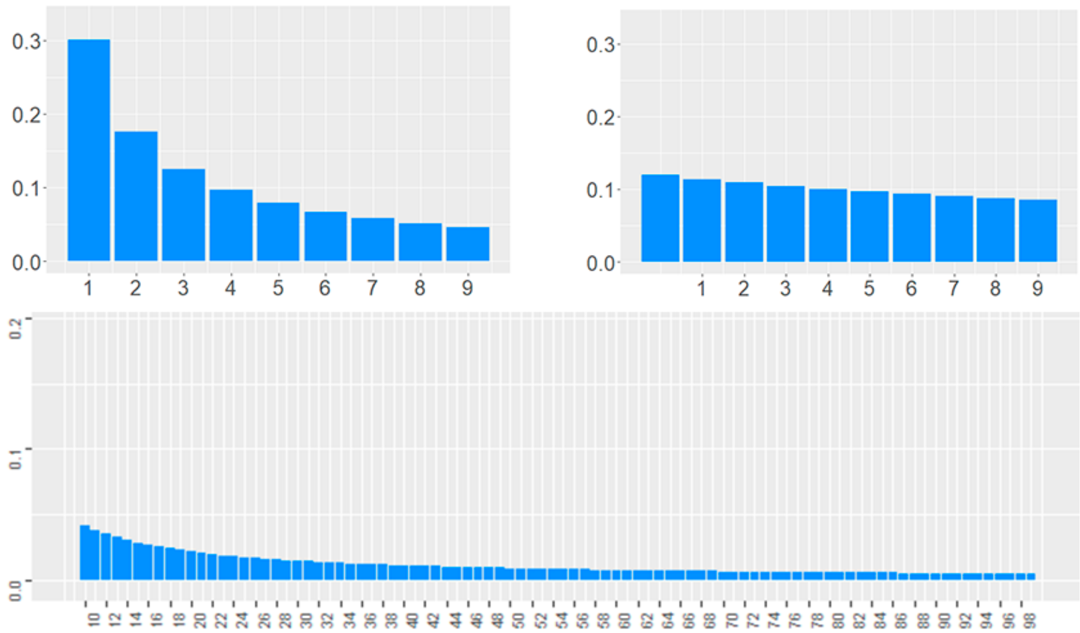

Figure 1. Theoretical Newcomb-Benford distribution for the first and second digit and for the first two digits. Explanation: On the left, the theoretical Newcomb-Benford distribution for the first digit is shown; on the right, the theoretical distribution for the second digit; and at the bottom, the theoretical distribution for the first two digits
Source: own elaboration based on Newcomb, 1881; Benford, 1938.

From the chart, it can be seen that for the first significant digit test, the probability of digit 1 is 30.10%, it decreases to 9.69% for digit 4, and it is 4.58% for digit 9. Furthermore, it should be noted that when considering the sequence of digits in a number from the left, the first significant digit is the first non-zero digit. For the second significant digit test, the expected percentages are: 0 is 11.97%, 3 is 10.43%, 5 is 9.67%, and 9 is 8.50%. The Newcomb-Benford law can also be applied to analyse the distribution of the first two digits. The probability distribution for two-digit combinations (from 10 to 99), similar to the case of a single first digit, is based on logarithms and is non-linear. The combination 10 occurs most frequently, around 4.1%, while 99 occurs least frequently, that is, 0.4%.

2. Literature Review

The Newcomb-Benford law, which provides the expected frequency distribution of the leading digits in numeric datasets, has, especially since the 1990s, been popularised as a diagnostic tool in financial and auditing analyses. Nigrini and other researchers proposed applications of the Newcomb–Benford distribution for detecting irregularities and accounting manipulations, paving the way for the practical use of this method by auditors and financial data analysts (Nigrini, 1999; Henselmann, Scherr, Ditter, 2013).

Regarding capital markets, empirical research yields mixed results. The law of first significant digits was applied in studies on the Warsaw Stock Exchange, showing that stock prices do not conform to this law due to market inefficiency, which violates the randomness assumption crucial to establishing the Newcomb-Benford law in capital markets (Sarkandiz, 2025). Analysis of the leading digits can help predict abnormal returns in both developed and emerging markets. Deviations from the expected distribution may indicate irregular market behaviour or fraud that affects stock returns (Hamida, de Peretti, Belkacem, 2024). At the same time, the literature emphasises that deviations from the Newcomb-Benford distribution should prompt further investigation rather than being seen as definitive evidence of fraud (Aybars, Ataunal, 2016). Riccioni and Cerqueti (2018) conducted an extensive analysis of price and volume data from multiple global exchanges and showed that although many price series exhibit characteristics consistent with Newcomb-Benford, large-scale deviations occur in practice, depending on the type of series (prices vs. volume), the period, and data aggregation. More recent studies extend Newcomb-Benford applications beyond anomaly detection, using it as a predictive tool and a component of decision support systems. Research by Cerqueti et al. (2022) indicates that deviations from Newcomb-Benford may correlate with risk structure and short-term market trends, suggesting the utility of Newcomb-Benford as a supplementary indicator in market risk assessment models (Cerqueti, Maggi, Riccioni, 2024). Studies of stock indices during crises, such as the COVID-19 pandemic, revealed significant deviations from the expected Benford distribution, suggesting irregular trading patterns and increased volatility (Sharif, Jaaman, 2024). It has also been proposed to combine Newcomb-Benford analysis with machine learning to increase the accuracy of anomaly detection and more effectively distinguish errors from fraudulent actions in financial audits (Le, Mantelaers, 2024).

Selected empirical research results concerning the application of the Newcomb-Benford law in the analysis of data from various financial markets are presented below.

Table 1. Empirical studies on the application of the Newcomb-Benford law in financial data analysis

Author(s) and year	Market, type of analysed data	Main results and conclusions
Corazza, Ellero, Zorzi (2010)	S&P 500, stock price series	First-digit distribution is partially consistent with Benford's law; deviations are interpreted as an effect of market dynamics
Karavardar (2014)	Istanbul Stock Exchange, stock indices and prices	No compliance with Benford's law; data do not meet randomness assumptions
Shi, Ausloos, Zhu (2017)	Financial data of industrial sector firms (China, India, Indonesia, Mexico, Turkey, South Africa)	After data cleaning, improved conformity between empirical and theoretical Benford distribution, highlighting the importance of data quality
Jayasree, Jyothi, Ramya (2018)	Stock markets, trading volume, number of transactions, returns (daily data – cross-sectional study)	Trading volume and number of transactions follow Benford's law, while returns show no compliance
Hassler, Hosseinkouchack (2019)	Sample financial data (e.g. revenues, costs, book values)	Classical statistical tests have limited power, suggesting the need to use multiple measures to assess distributional conformity
Ausloos et al. (2021)	S&P 500 index (USA), daily closing prices	Partial compliance with the Newcomb-Benford law; better fit for aggregated data than for raw prices
Freitas et al. (2023)	Brazil Stock Exchange, financial statements of public companies	Partial compliance with Benford's law; the method is useful for detecting accounting anomalies
Hamida, de Peretti, Belkacem (2024)	International stock markets – selected stock indices (returns) from developed and emerging markets, including North America, Europe, and Asia	Deviations from Benford's law may help predict future anomalies and market risk
Sarkandiz (2025)	Warsaw Stock Exchange, stock prices	No compliance with Benford's law; stock prices are not random, suggesting a certain level of market inefficiency

Source: own elaboration.

A review of empirical studies indicates that aggregated data, such as trading volume and stock market indices, more often conform to the theoretical distribution, while stock prices and rates of return often deviate from it. In some cases, deviations are interpreted as a result of market characteristics, financial dynamics, or data quality, and not necessarily as anomalies. At the same time, the research confirms the usefulness of the Newcomb-Benford law as a diagnostic tool for identifying potential anomalies in financial data, although the interpretation of the results should be approached with caution.

Furthermore, the review of the literature confirms that the Newcomb-Benford law has practical applications in financial data analysis. Despite international studies that examine large sets of stocks and indices in the context of alternative markets with specific liquidity structures and high issuer heterogeneity, there is a research gap. It is observable that scientific research on the detection of stock price manipulation using the Newcomb-Benford law has not yet received significant attention, especially in the Polish literature (Shen, He, Lee, 2024). Hence the need for studies using the distribution of the first significant digits based on stock quotes from the NewConnect alternative market in Warsaw. In the second part of this study, the Newcomb-Benford law is applied to analyse stock quotes for potential deviations from the theoretical Newcomb-Benford distribution.

Based on the results of the literature review and the identified research gap, the following research hypothesis was formulated: The empirical distribution of the first significant digits of the daily closing prices of shares listed on the NewConnect market in Warsaw shows significant deviations from the theoretical Newcomb-Benford distribution, with the magnitude of these deviations being greater for companies with low liquidity.

The hypothesis was tested using both classical goodness-of-fit tests, such as chi-square and Kolmogorov-Smirnov, as well as distance measures, including the mean absolute deviation (*MAD*). The use of both approaches stems from their complementary nature. Statistical tests allow for a formal assessment of the significance of deviations, but in large samples, they are highly sensitive to the number of observations and can indicate significance even with small, practically insignificant differences. Distance measures, on the other hand, allow for an assessment of the actual scale of the discrepancy between the empirical and theoretical distributions, regardless of the sample size. Combining both methods therefore allows for limiting their individual weaknesses and provides a more reliable and interpretatively stable assessment of the consistency of distributions.

3. Descriptive Statistics

Table 2 presents descriptive statistics for the closing prices of companies listed on the NewConnect market for the years 2007–2022.

Table 2. Descriptive statistics of closing prices on NewConnect in the years 2007–2022

Year	Parameter	Overall (N)	Year	Parameter	Overall (*N* = 558,294)
2007	*N*	612	2015	*N*	41,446
	Mean (*SD*)	12.996 (21.58)		Mean (*SD*)	3.124 (7.85)
	Median (*IQR*)	5.27 (1.602–10.837)		Median (*IQR*)	0.92 (0.316–2.98)
	Range	0.6–150.22		Range	0.01–170

Year	Parameter	Overall (N)	Year	Parameter	Overall (N = 558,294)
2008	N	5,168	2016	N	43,857
	Mean (SD)	9.506 (16.434)		Mean (SD)	3.457 (8.028)
	Median (IQR)	3.673 (1.35–9.752)		Median (IQR)	0.91 (0.32–3.042)
	Range	0.071–136.8		Range	0.01–145.8
2009	N	8,171	2017	N	44,325
	Mean (SD)	5.771 (11.252)		Mean (SD)	4.794 (14.345)
	Median (IQR)	2.151 (0.96–4.99)		Median (IQR)	0.9 (0.34–3)
	Range	0.05–81		Range	0.01–215
2010	N	13,619	2018	N	42,218
	Mean (SD)	6.224 (13.94)		Mean (SD)	5.496 (17.052)
	Median (IQR)	2.83 (0.857–5.417)		Median (IQR)	0.819 (0.28–3)
	Range	0.05–171.32		Range	0.01–206
2011	N	24,880	2019	N	41,996
	Mean (SD)	5.586 (12.371)		Mean (SD)	4.727 (20.368)
	Median (IQR)	1.93 (0.754–4.985)		Median (IQR)	0.78 (0.25–3.08)
	Range	0.03–188.033		Range	0.01–1347.17
2012	N	30,179	2020	N	56,928
	Mean (SD)	3.851 (8.661)		Mean (SD)	6.179 (13.795)
	Median (IQR)	1.215 (0.42–3.517)		Median (IQR)	1.438 (0.5–5.7)
	Range	0.01–176		Range	0.007–312.263
2013	N	34,603	2021	N	66,274
	Mean (SD)	2.809 (5.065)		Mean (SD)	8.561 (17.872)
	Median (IQR)	0.995 (0.359–3.093)		Median (IQR)	2.36 (0.843–7)
	Range	0.01–92.484		Range	0.023–595
2014	N	39,162	2022	N	64,856
	Mean (SD)	3.157 (8.949)		Mean (SD)	8.125 (17.75)
	Median (IQR)	0.911 (0.352–3.167)		Median (IQR)	2.06 (0.586–6.94)
	Range	0.01–270		Range	0.023–412

Source: own elaboration based on Stooq, n.d.

For continuous data, the characteristics of the studied group were described using descriptive statistics: mean, median, standard deviation (SD), as well as the first and third quartiles (Q1–Q3) and the range. In the next stage of the analysis, a visualisation was created showing the values taken by the distributions of daily closing prices of stocks in each year from 2007 to 2022. In Figure 2, the y-axis represents the stock closing price (PLN) and the x-axis represents the year.

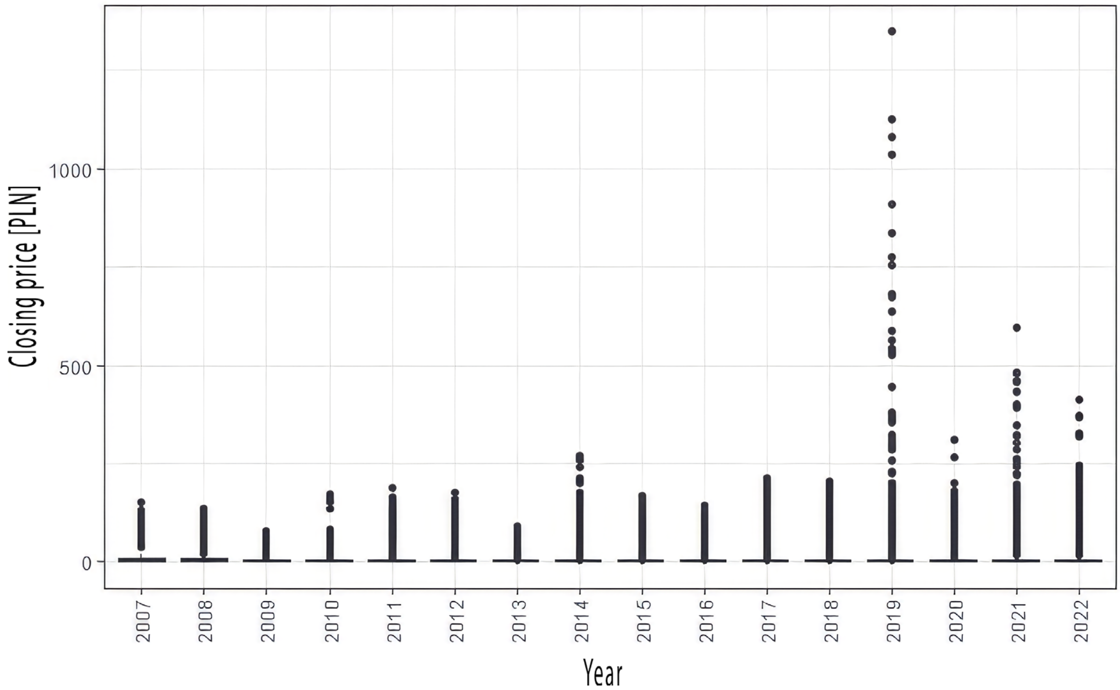

Figure 2. Distribution of closing prices in in the years 2007–2022 (PLN)
Source: own elaboration based on Stooq, n.d.

During the period 2007–2018, the daily closing price was characterised by low volatility and a median concentrated near zero, indicating long-term stability at a low-price level. The year 2019 was marked by the highest volatility in the time series, which is a consequence of the occurrence of outliers. This phenomenon suggests an incidental market shock. After 2019, the NewConnect market entered a new price regime, characterised by increased volatility and a systematic increase in the median closing prices compared to previous years.

4. Research Methods

In this statistical analysis, the conformity of the empirical distribution of daily closing prices of stocks from the NewConnect market in Warsaw with the Newcomb-Benford law was verified. The research material was obtained from https://stooq.pl/db/. The data set covers the years 2006–2022, comprising a total of 558,294 daily closing prices for 353 companies listed on the NewConnect market.

The stages of the conducted study included:
1) a review of domestic and international literature on the Newcomb-Benford law, big data analysis, and statistics;
2) the construction of a database based on stock quotes downloaded from https://stooq.pl/db/;
3) performing tests on the first, second, and first two digits;
4) interpretation of results and formulation of conclusions.

The analysis utilised the probability distribution of the first, second and first two digits according to the Newcomb-Benford law, that is, the first and second-digit tests and the first-two-digit test. Following the practices reported in the literature for such studies, a set of statistical tests was applied to verify the conformity of empirical data representing daily stock closing prices with the theoretical Newcomb-Benford distribution. These included classical goodness-of-fit measures (chi-square test, Kolmogorov-Smirnov test), a Chebyshev distance-based t test, the Freedman-Watson U-square test, and the Hotelling T^2 'joint digit' test. These tests enabled verification of the following statistical hypotheses:

H0: The frequency of individual digits in numbers representing daily stock closing prices (that is, the empirical distribution) is consistent with the theoretical distribution according to the Newcomb-Benford law.

H1: The frequency of individual digits in numbers representing daily stock closing prices (that is, the empirical distribution) does not conform to the theoretical distribution according to the Newcomb-Benford law.

Statistically significant results were reported for significance levels of $p = 0.05$, $p = 0.01$, and $p = 0.001$. For *p*-values below 0.001, the notation $p < 0.001$ was always used. Given the large sample size in this study, even small deviations from the Newcomb-Benford distribution could be statistically significant. Therefore, the analysis was supplemented with visualisations showing the fit of empirical data to the theoretical distribution, as well as by calculating the mean absolute deviation (*MAD*), which provides a quantitative assessment of the degree of conformity between the empirical and theoretical distributions. *MAD* measures the distance between the observed relative frequencies of the digits and the theoretical frequencies predicted by the Newcomb-Benford law. *MAD* is also less sensitive to sample size. In the statistical tests mentioned above, even minor deviations could lead to rejection of the null hypothesis in favour of the alternative (Farhadi, Lahooti, 2022). Based on the literature, acceptable threshold values were identified, allowing for the determination of the range of conformity between empirical results and the Newcomb–Benford distribution (Nigrini, 2012):

1) the first-digit test indicates a critical value exceedance of 0.015;
2) the first-two-digit test indicates a critical value exceedance of 0.0022.

The non-conformity between the digit distribution in empirical data and the theoretical Newcomb-Benford distribution may indicate the presence of heuristics, speculation, or potential manipulation in financial instruments. According to this law, in a given dataset, the distribution of digits in specific significant positions should correspond to the theoretical Newcomb-Benford distribution (Grabiński et al., 2016).

The visualisations for the first and second-digit tests, as well as the first-two-digit test, were presented as follows: in the charts, the first figure (top left) compares the empirical digit distribution with the theoretical Newcomb-Benford distribution for the first digit. The second chart shows the same comparison for the second digit. The third chart represents the cumulative distribution based on groups created according to the first digit (or the first two digits, if such a test is considered), and the sum is calculated for each group to observe whether these sums follow a uniform distribution. The last two charts at the bottom show the differences between the theoretical and empirical values for specific first digits (or the sum of the first two digits).

5. Results

The hypothesis regarding the conformity of closing price distributions with the Newcomb–Benford law was tested using several different tests, as described in the methodology, similar to previous studies. The results of all statistical tests indicated that the empirical distribution of closing prices exhibited deviations from the Newcomb-Benford law. *MAD* values were 0.003 for the first digit and 0.001 for the first two digits. These *MAD* values (0.003 for the first digit and 0.001 for the first two digits) are very low, indicating only minor differences between the empirical and theoretical distributions. This means that, despite the statistical significance of deviations indicated by the goodness-of-fit tests, the actual magnitude of these differences is negligible. In practice, this suggests that the distribution of digits in closing prices is close to the Newcomb-Benford distribution, and the observed deviations may result from the large number of observations and the high sensitivity of the applied statistical tests. These conclusions are also supported by the visualisation presented below.

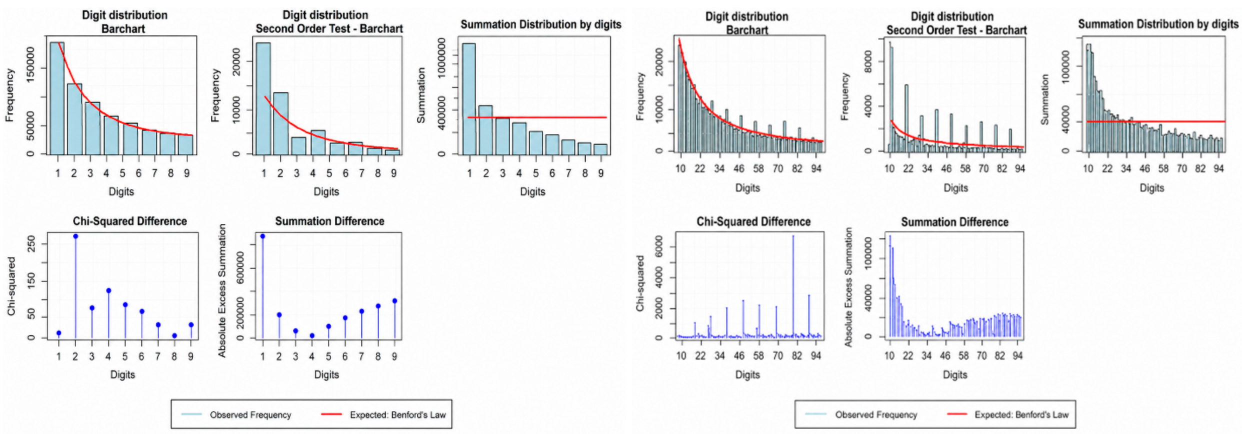

Figure 3. Visualisation of the conformity of closing prices with the Newcomb-Benford distribution for the first, second, and first two digits

Source: own elaboration based on Stooq, n.d.

The visualisation shows a general conformity of the trend with the Newcomb-Benford law: for both the first digit and the first two digits, the distribution of closing prices exhibits a characteristic decreasing shape consistent with the theoretical distribution. Noticeable differences for certain digits indicate that the data are not perfectly aligned with the theoretical distribution, which is confirmed by the previous statistical tests ($p < 0.001$).

In the next stage of the study, a comparison was made between the initial and final periods. For 2007, the *MAD* values for closing prices were 0.05 for the first digit and 0.008 for the first two digits, exceeding the critical values for both tests.

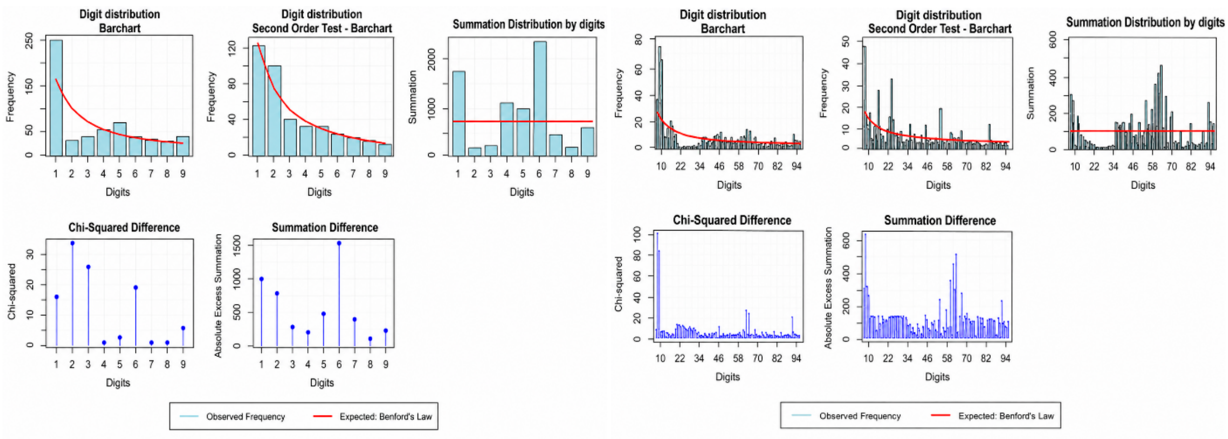

Figure 4. Visualisation of the conformity of closing prices with the Newcomb-Benford distribution for the first, second, and first two digits in 2007

Source: own elaboration based on Stooq, n.d.

These results were compared with those for 2022. For 2022, the *MAD* values for closing prices were 0.007 for the first digit and 0.001 for the first two digits. Thus, they do not exceed the critical thresholds indicated in the methodology.

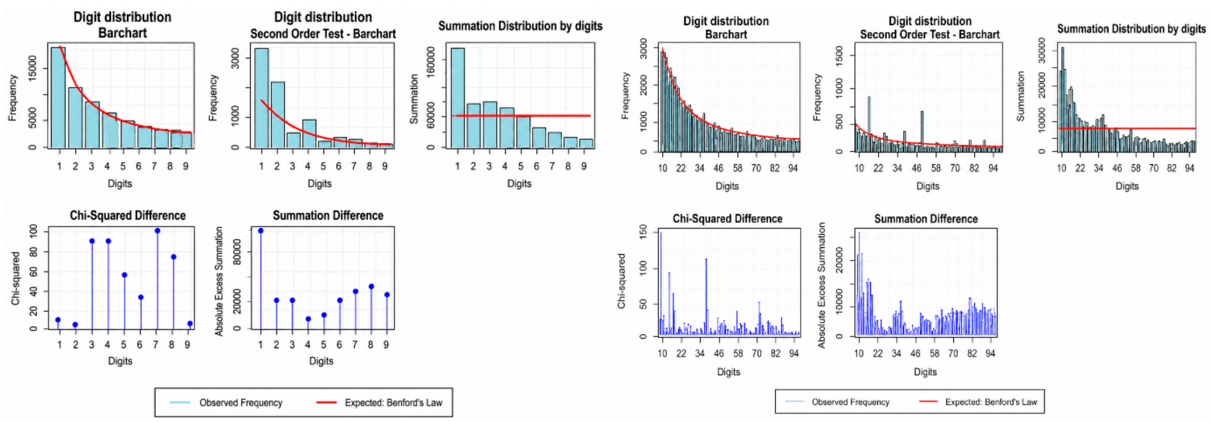

Figure 5. Visualisation of the conformity of closing prices with the Newcomb-Benford distribution for the first, second, and first two digits in 2022

Source: own elaboration based on Stooq, n.d.

In 2007, the distribution of the first, second and first two digits of closing prices showed noticeable deviations from the theoretical Newcomb-Benford distribution. The charts from this period indicate that the frequency of certain digits significantly differs from the expected line (red), e.g., for digits 1, 5, and 6. In 2022, the digit distribution is closer to the theoretical pattern.

In the next stage of the analysis, the data were divided into two groups to examine whether companies in the low-liquidity range (closing price not exceeding 1 PLN) exhibit greater deviations from the theoretical distribution than those outside this range. For this data aggregation, the hypothesis regarding the conformity of closing price distributions with the Newcomb-Benford distribution was also tested.

Table 3. Goodness-of-fit tests for the Newcomb-Benford distribution for low- and high-liquidity companies in terms of closing prices

High-Liquidity Companies					
Distribution Type	**Chi^2 Test**	**Kolmogorov-Smirnov Test**	**Chebyshev Distance Test**	**Friedmann U Test**	**Hoteling's Test**
First Digit	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Second Digit	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
First Two Digits	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Low-Liquidity Companies					
Distribution Type	**Chi^2 Test**	**Kolmogorov-Smirnov Test**	**Chebyshev Distance Test**	**Friedmann U Test**	**Hoteling's Test**
First Digit	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Second Digit	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
First Two Digits	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001

Source: own elaboration based on Stooq, n.d.

The results of all the statistical tests indicate statistically significant deviations of the digit distributions of closing prices from the theoretical Newcomb-Benford distribution for both low- and high-liquidity companies. For low-liquidity companies, the *MAD* was 0.031 for the first digit and 0.004 for the first two digits. For high-liquidity companies, the MAD was 0.025 for the first digit and 0.003 for the first two digits. Comparison of the two groups suggests that high-liquidity companies exhibit slightly lower *MAD* values, indicating closer conformity with the theoretical pattern. On the contrary, low-liquidity companies show larger deviations, which may result from the more pronounced impact of individual transactions on price levels. The degree of conformity between the compared distributions can be observed in the visualisation presented below.

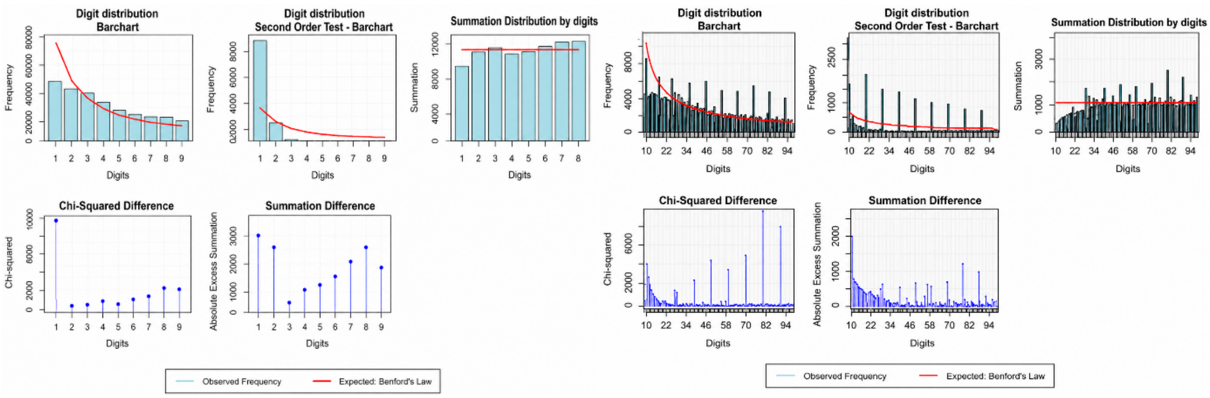

Figure 6. Visualisation of the Conformity of Closing Price Distributions for Low-Liquidity Companies with the Newcomb-Benford Distribution for the First Digit, Second Digit, and First Two Digits

Source: own elaboration based on Stooq, n.d.

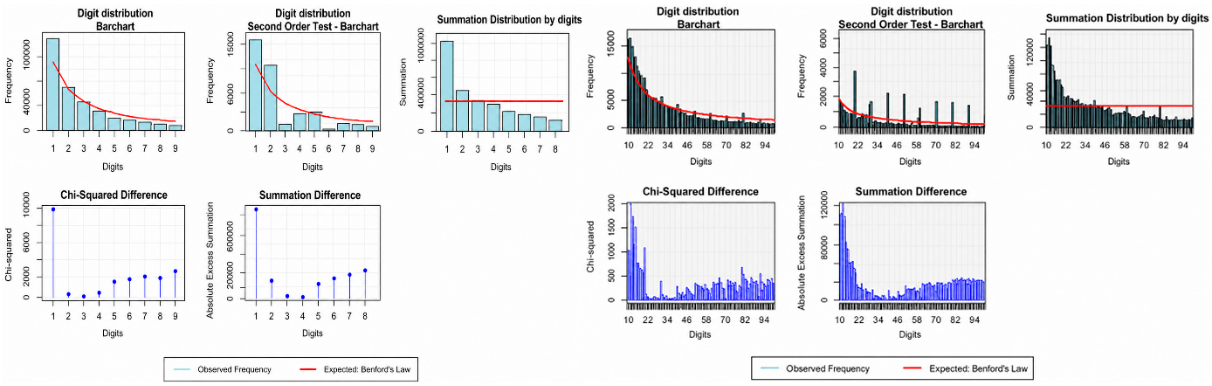

Figure 7. Visualisation of the Conformity of Closing Price Distributions for High-Liquidity Companies with the Newcomb-Benford Distribution for the First Digit, Second Digit, and First Two Digits

Source: own elaboration based on Stooq, n.d.

The figures presented above also suggest that larger deviations can be observed for low-liquidity companies, where the discrepancies appear to be quite significant for closing prices.

6. Conclusions

The literature review confirmed that the Newcomb-Benford law has practical applications in financial data analysis. The results obtained by other authors studying various financial market data indicate that research using the Newcomb-Benford law is gaining popularity and may contribute to the development and dissemination of algorithms designed to identify market anomalies.

The results of the statistical analysis using the Newcomb-Benford distribution for data from the NewConnect market showed that greater discrepancies between the empirical distribution (closing prices) and the theoretical distribution were observed in the early periods of the alternative market (2007 compared to 2022) and mainly affected low-liquidity companies. The fact that low-liquidity companies exhibit significantly larger deviations from the Benford distribution for closing prices may indicate that their prices are more susceptible to unnatural fluctuations, e.g., due to a limited number of transactions, stock market manipulation, or behavioural aspects of market activity.

The study also allowed for an analytical and methodological conclusion regarding the diagnostic value of this type of analysis. To assess the conformity of empirical data distributions with the theoretical Newcomb-Benford distribution, both classical statistical methods, such as the chi-square and Kolmogorov-Smirnov tests, and descriptive statistical methods, including measures based on Euclidean distance and mean absolute deviation (*MAD*), can be used. Due to the high sensitivity of statistical tests, distance-based measures should be applied as a complementary approach. The optimal solution is to combine these methods. Although statistical tests such as chi-square, Kolmogorov-Smirnov, Chebyshev, Friedman's U, or Hotelling's T^2 allow a formal evaluation of the conformity of the empirical digit distribution with the theoretical Newcomb-Benford distribution and are widely used in the literature, their results are strongly dependent on sample size. In large samples, even small, practically negligible deviations can lead to statistical significance ($p < 0.001$), which can result in the misinterpretation of data as 'nonconforming' with the Newcomb-Benford distribution. Therefore, a meaningful complement to classical tests is the use of the MAD indicator or Euclidean distance, which measure the actual scale of differences between the empirical and theoretical distributions. Unlike hypothesis-based tests, *MAD* is sensitive to the magnitude of actual differences rather than merely to sample size.

The empirical analysis allowed for a positive verification of the research hypothesis, as significant deviations were found in the distribution of the first digits of the daily closing prices of shares listed on the NewConnect market from the theoretical Newcomb-Benford distribution. At the same time, the obtained results indicate that the magnitude of these deviations is variable and depends on the companies' liquidity and the period of market operation, confirming the conclusions regarding the specificity of the alternative market. However, it should be emphasised that the interpretation of the results requires caution due to the sensitivity of the statistical tests used and methodological limitations.

The interpretation of the study results is subject to certain methodological limitations. It should be noted that the significant-digit tests used in the digital analysis of the Newcomb-Benford law are predictive in nature, which means that detected distortions and discrepancies signal potential anomalies in the analysed data set. Therefore, the interpretation of results should be approached with caution due to factors such as the limited power of some statistical tests, the specific nature of the market, and the sensitivity of the results to the quality and structure of the analysed data.

References

Ausloos M., Ficcadenti V., Dhesi G., Shakeel M. (2021), *Benford's laws tests on S&P500 daily closing values and the corresponding daily log-returns both point to huge non-conformity*, "Physica A: Statistical Mechanics and its Applications", vol. 574, 125969.

Aybars A., Ataunal L. (2016), *An application of Benford's Law to fundamental accounting figures reported by Borsa Istanbul (BIST) companies*, "Journal of Economics Finance and Accounting", vol. 3(3), pp. 234–243.

Benford F. (1938), *The law of anomalous numbers*, "Proceedings of the American Philosophical Society", vol. 78(4), pp. 551–572.

Cerqueti R., Ciciretti R., Dalò A., Nicolosi M. (2022), *Mitigating contagion risk by ESG investing*, "Sustainability", vol. 14(7), 3805.

Cerqueti R., Maggi M., Riccioni, J. (2024), *Statistical methods for decision support systems in finance: how Benford's law predicts financial risk* "Annals of Operations Research", vol. 342(3), pp. 1445–1469.

Corazza M., Ellero A., Zorzi A. (2010), *Checking financial markets via Benford's law: the S&P 500 case*, [in:] C. Pizzi (ed.), *Mathematical and statistical methods for actuarial sciences and finance*, Springer Milan, Milano, pp. 93–102.

Farbaniec M., Grabiński T., Zabłocki B., Zając W. (2012), *Wykorzystanie prawa Benforda w analizie poprawności danych finansowych na przykładzie informacji o obrocie towarowym*, [in:] *Portal Innowacyjnego Transferu Wiedzy w Nauce*, Wyższa Szkoła Handlowa im. B. Markowskiego, Kielce, pp. 194–208.

Farhadi N., Lahooti H. (2022), *In Data We Trust: Proving Market Manipulation on the Tehran Stock Exchange*, "International Journal of Business and Management", vol. 17, no. 4, pp. 1–16.

Freitas C.R.M., Souza J.M. de, Oliveira M.C. de, Quirino R.B.L.F., Santos Carvalho E. dos (2023), *Lei de Newcomb-Benford: Identificação de Red Flags em Companhias Abertas Listadas na B3 Newcomb-Benford Law: Identification of Red Flags in Publicly Traded Companies Listed on B3*, "International Journal of Accounting and Reporting", vol 17, pp. 1–22.

Grabiński T., Farbaniec M., Woźniak-Zapór M., Zając W. (2016), *Metody i narzędzia weryfikacji rzetelności danych liczbowych*, Oficyna Wydawnicza AFM, Kraków.

Hamida A.B., Peretti C. de, Belkacem L. (2024), *The link between abnormal numbers and price movements of financial securities: How does Benford's law predict stock returns?*, "International Review of Financial Analysis", vol. 95, 103517.

Hassler U., Hosseinkouchack M. (2019), *Testing the Newcomb-Benford law: experimental evidence*, "Applied Economics Letters", vol. 26(21), pp. 1762–1769.

Henselmann K., Scherr E., Ditter D. (2013), *Applying Benford's Law to individual financial reports: An empirical investigation based on SEC XBRL filings*, "Working Papers in Accounting Valuation Auditing", no. 2012–1, pp. 1–21.

Huang S.Y., Lin C., Chiu A., Yen D.C. (2017), *Fraud detection using fraud triangle risk factors*, "Information Systems Frontiers. A Journal of Research and Innovation", vol. 19, pp. 1343–1356.

Jayasree M., Jyothi C.P., Ramya P. (2018), *Benford's law and stock market – The implications for investors: The evidence from India Nifty Fifty*, "Jindal Journal of Business Research", vol. 7(2), pp. 103–121.

Karavardar A. (2014), *Benford's Law and an analysis in Istanbul stock exchange (BIST)*, "International Journal of Business and Management", vol. 9(4), 160.

Le L., Mantelaers E. (2024), *Benford's Law and Beyond: A framework for auditors*, "Maandblad voor Accountancy en Bedrijfseconomie", vol. 98(7), pp. 427–438.

Newcomb S. (1881), *Note on the frequency of use of the different digits in natural numbers*, "American Journal of Mathematics", vol. 4(1), pp. 39–40.

Nigrini M. (2012), *Benford Law. Applications for Forensic Accounting, Auditing and Fraud Detection*, John Wiley & Sons Inc., Hoboken.

Nigrini M.J. (1999), *The peculiar patterns of first digits*, "IEEE Potentials", vol. 18(2), pp. 24–27.

Palshikar G.K. (2022), *The Hidden Truth – Frauds and Their Control: A Critical Application for Business Intelligence*, "Intelligent Enterprise", vol. 5(9), pp. 46–51.

Riccioni J., Cerqueti R. (2018), *Regular paths in financial markets: Investigating the Benford's law*, "Chaos, Solitons & Fractals", vol. 107, pp. 186–194.

Sarkandiz M.R. (2025), *Identifying the Hidden Nexus between Benford Law Establishment in Stock Market and Market Efficiency: An Empirical Investigation*, https://arxiv.org/abs/2501.02674 (accessed: 5.12.2025).

Sharif S.N., Jaaman S.H. (2024), *Mathematical forensic tool to test the effect of Covid-19 outbreak: The case of the Dow Jones index*, [in:] *AIP Conference Proceedings*, vol. 2905, no. 1, 030019, AIP Publishing LLC, Melville.

Shen W.C., He H., Lee C.C. (2024), *A Teaching Case: Applying Benford's Law to Detect Credit Card Fraud Using Microsoft Excel*, "Journal of Forensic Accounting Research", vol. 9(1), pp. 116–130.

Shi J., Ausloos M., Zhu T. (2018), *Benford's law first significant digit and distribution distances for testing the reliability of financial reports in developing countries*, "Physica A: Statistical Mechanics and its Applications", vol. 492, pp. 878–888.

Stooq (n.d.), https://stooq.pl/db/ (accessed: 10.06.2026).

Prawo Newcomba-Benforda w analizie ilościowej cen akcji na rynku NewConnect

Streszczenie: Celem badania przedstawionego w artykule było zweryfikowanie zgodności rozkładu empirycznego kursów zamknięcia spółek notowanych na rynku NewConnect w Warszawie z teoretycznym prawem Newcomba-Benforda. Dodatkowo zbadano, czy stopień zgodności z rozkładem Benforda różni się pomiędzy spółkami o wysokiej i niskiej płynności.

Próba badawcza objęła 558 294 dziennych kursów zamknięcia dla 353 spółek notowanych na rynku NewConnect w latach 2007–2022. Do zweryfikowania, czy empiryczny rozkład danych reprezentujący dzienny kurs zamknięcia akcji notowanych na rynku NewConnect jest zgodny z teoretycznym rozkładem Newcomba-Benforda wykorzystano statystyczne testy i miarę średniego odchylenia absolutnego (*MAD*).

Otrzymane wyniki dają podstawę do sformułowania wniosku, iż rozbieżność od rozkładu teoretycznego Newcomba-Benforda w przypadku dziennych kursów zamknięcia pochodzących z rynku NewConnect jest większa w początkowych okresach funkcjonowania obrotu alternatywnego i dla spółek o niskiej płynności.

Oryginalność opracowania polega na zastosowaniu prawa Newcomba-Benforda w analizie statystycznej kursów zamknięcia akcji na rynku NewConnect. Badanie wnosi wkład do literatury poprzez połączenie klasycznych testów dopasowania (chi^2, Kołmogorowa-Smirnowa, d Czebyszewa, U Friedmana, Hotellinga) z miarą skali odchyleń *MAD*. Takie podejście pozwala nie tylko na ocenę formalnej istotności, lecz także na określenie praktycznej wielkości odchyleń między rozkładem danych empirycznych z teoretycznym wzorcem Newcomba-Benforda.

Słowa kluczowe: prawo (rozkład) Newcomba-Benforda, rynek NewConnect, prawdopodobieństwo, statystyka matematyczna