Forensic Accounting: Detecting Financial Anomalies in HDFC Bank Using Benford's Law Analysis

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Abstract—**India's banking sector, especially private sector banks, is an important pillar supporting India's economic infrastructure and financial stability. But this sector faces consistent challenges ranging from financial manipulation, fraudulent activities, and data irregularities that shake the stakeholder's confidence and threaten integrity of the institution. This research investigates the use of forensic accounting techniques, specifically Benford's Law, to detect potential manipulation in the financial statements of HDFC Bank, which is India's leading private sector financial institution. Using a quantitative methodology, this study checks financial data ranging from 2021 to 2025, checking Profit and Loss Statement, and Balance Sheets across multiple digit positions using Chi-Square goodness-of-fit testing. The investigation uses secondary data obtained from audited annual reports and official websites. Findings are varying degrees of conformity as per the expected Benford distributions across different digit positions and financial statement categories, with specific deviations identified in certain data subsets that need further investigation. This research shows that Benford's Law serves as an effective screening tool for identifying red flags in banking financial data, though it should be complemented with additional forensic procedures for detailed fraud detection.**

Index Terms—**Forensic Accounting, Benford's Law, Financial Fraud Detection, HDFC Bank, Chi-Square Test, Private Sector Banking, Financial Statement Analysis, Fraud Prevention**

I. INTRODUCTION

Financial fraud is one of the most significant threats to banking institutions worldwide, with the potential to damage entire financial systems, shake public confidence, and cause economic damage. The concept of fraud covers intentional deception done to obtain unfair or unlawful advantages, including misrepresentation of financial position, manipulation of accounting records, and concealment of material information from stakeholders.

India's private sector banking industry has experienced good growth over the past three decades, covering financial inclusion, credit expansion, and economic development. HDFC Bank, established in 1994, has come out as the flagship institution of this transformation, ranked among the most valuable banks in India with assets exceeding Rs.39 lakh crores as of March 2025. The merger with Housing Development Finance Corporation (HDFC Ltd.) in July 2023 increased the institution's scale and operational complexity, making fraud detection mechanisms important.

Old auditing methodologies, while compliance verification and historical accuracy assessment, are proven insufficient in detecting concealed financial manipulations. These old approaches use sampling techniques and rely on manual review, creating opportunities for fraud schemes to escape detection. Forensic accounting removes this limitation by combining financial expertise with investigative techniques, data analytics, and statistical methods to find hidden irregularities and provide evidence suitable for legal proceedings.

Benford's Law, a mathematical phenomenon discovered by physicist Frank Benford in 1938, based upon earlier observations by astronomer Simon Newcomb in 1881. Benford's Law describes the frequency distribution of leading digits in naturally occurring numerical datasets. Opposite to expectations of uniform distribution, the law predicts that digit 1 appears as the first significant digit approximately 30.1% of the time, while digit 9 appears only about 4.6% of the time. This logarithmic pattern, expressed mathematically as P(d)

= log10(1 + 1/d), remains true for many real-world datasets ranging multiple orders of magnitude, which includes financial data, population statistics, and scientific measurements.

When individuals create false financial figures, they rely to use digits more uniformly or favor certain numbers, creating statistical anomalies that Benford's Law analysis can detect. This makes the technique valuable for analyzing large financial datasets where manual review would be impractical.

Research Objectives

The objectives of the research are designed to check the effectiveness of Benford's Law as a forensic accounting tool in the context of HDFC Bank's financial data:

- To check the conformity of HDFC Bank's financial statement data to expected Benford's Law distributions across first and second digit positions.
- To identify specific digit positions showing statistically significant deviations from expected patterns, indicating potential areas which require further investigation.
- To check the effectiveness of Benford's Law along with Chi-Square testing as preliminary fraud detection tool in large-scale banking financial data.
- To provide evidence supporting the integration of mathematical forensic techniques into audit procedures for private sector banks.
- To develop recommendations for auditors, banking management, and regulatory authorities regarding the implementation of Benford's Law analysis in fraud prevention.

Significance of the Study

This research addresses gap in forensic accounting literature involving private sector banks in India. Many studies have examined public sector banks, the private sector particularly market leaders like HDFC Bank is yet underexplored despite managing large sum of assets and serving millions of customers. By applying mathematical techniques to check actual financial data, this study gives evidence regarding the utility of Benford's Law in detecting anomalies. The findings will benefit multiple stakeholder groups. Ultimately, this research contributes to building more resilient, transparent, and trustworthy financial institutions which is capable of safeguarding stakeholder interests.

II. LITERATURE REVIEW

The literature review compiles existing research across three interconnected domains: the evolution and necessity of forensic accounting, Benford's Law as a fraud detection tool, and empirical studies examining banking sector fraud in the Indian context. This review establishes the theoretical base for the current research and identifies gaps that this study addresses.

Evolution and Necessity of Forensic Accounting

Rezaee and Burton (1997) had given perceptions of forensic accounting's future role, predicting growth in demand for specialized forensic skills and education. Their analysis has been validated by later decades of expanding forensic accounting applications across corporate, governmental, and legal sectors.

In the Indian context, Moid (2016) and Dhami (2015) stated the inadequacy of conventional auditing approaches in detecting escalation of white-collar crimes and sophisticated financial manipulations. Their research emphasizes that forensic accounting covers more than traditional audit boundaries, using investigative techniques specifically designed to detect, analyze, and provide legal evidence of financial fraud.

Benford's Law: Theoretical Foundation and Fraud Detection Applications

Benford's Law provides the mathematical foundation for this research. Benford discovered that the distribution held consistently across naturally occurring numerical collections, so he proposed the general law that bears his name.

Recent research by Cano-Rodríguez (2025) checked the relationship between Benford's Law conformity and actual accounting quality, finding that while conformity generally correlates with higher quality financial reporting, the relationship is not always true. Some business factors can cause deviations, while sophisticated manipulators aware of Benford's Law may try to fabricate data that conforms to expected distributions. This highlights the importance of using Benford's Law as a screening mechanism that triggers further investigation rather than as definitive proof of fraud or legitimacy.

Empirical Studies in Banking Fraud Detection

Dhawan and Sood (2022) and Singh and Kaur (2020) provided evidence from actual fraud cases in Indian banking, giving knowledge about fraudster methodologies and vulnerabilities in existing detection systems. Their case study analyses showed common patterns which includes systematic manipulation of non-performing asset classifications, fraudulent loan approvals through collusion networks, and exploitation of gaps in internal control systems.

Mittal, Kaur, and Gupta (2021) examined the role of big data analytics in forensic accounting applications, showing that combining Benford's Law with advanced data mining techniques improves detection sensitivity and reduces false positive rates.

Research Gap Identification

Even though detailed research on forensic accounting and Benford's Law globally, and growing attention to Indian banking fraud exists, but gaps remain in the literature. Most existing studies are focusing on public sector banks, leaving private sector institutions even though of their substantial and growing market presence. HDFC Bank, as India's largest private sector bank by market capitalization and asset size, represents an important research subject, following the 2023 merger with HDFC Ltd.

Also existing research uses only first-digit analysis, while multi-digit testing can provide enhanced detection capabilities and reduce false positives. There is also limited research examining Benford's Law application to contemporary banking data from 2021-2025, a period having digital transformation, pandemic-related economic disruptions, and major consolidation activities. This research addresses these gaps by providing multi-digit Benford's Law analysis of HDFC Bank's recent financial data, contributing original empirical evidence to the forensic accounting literature.

III. RESEARCH METHODOLOGY

Research Design

This study uses a quantitative research design using descriptive and analytical methodologies to examine financial data from HDFC Bank Limited. The research uses a positivist paradigm, statistical analysis, and hypothesis testing to identify patterns and anomalies in financial statement data. The design covers mathematical forensic techniques (Benford's Law) with statistical testing procedures (Chi-Square) to provide analysis suitable for academic research and professional application.

Research Hypotheses

The study tests the following hypotheses:

Null Hypothesis (H0): There is no significant association between observed digit frequencies in HDFC Bank's financial data and the expected digit frequencies as per Benford's Law.

Alternative Hypothesis (H1): There is a significant association between observed digit frequencies in HDFC Bank financial data and expected Benford's Law frequencies.

Data Sources and Nature

This research relies on secondary data obtained from official, publicly available sources. Financial data is extracted from HDFC Bank's audited annual reports; quarterly financial statements filed with regulatory authorities and verified through the bank's official investor relations disclosures. The data includes financial statement figures from Profit and Loss Statements and Balance Sheets.

Study Period

The research covers financial data offinancial years 2021 through 2025 (March 2021 to March 2025), performing a five-year longitudinal analysis. The five-year timeframe provides sufficient data volume for statistical testing.

Analytical Tools and Techniques

This research uses complementary analytical approaches: Benford's Law digit frequency analysis and Chi-Square statistical testing.

1. Benford's Law (First Digit and Second Digit Analysis)
2. Chi-Square Goodness-of-Fit Test

The analytical process proceeds through the following systematic steps: Data Collection, Data Cleaning, Digit Extraction, Frequency Calculation, Expected Frequency Determination, Statistical Testing, Interpretation, Documentation:

IV. DATA ANALYSIS AND FINDINGS

This section presents Benford's Law analysis of HDFC Bank's financial data covering the period 2021-2025. The analysis studies both first and second digit distributions across financial statement figures, applying Chi-Square goodness-of-fit tests to identify potential anomalies. Results are presented through detailed statistical tables and interpretative commentary.

Table 1: First Digit Benford's Law Analysis – Profit and Loss statement of HDFC Bank (2021-2025)

Digit	Observed Data(Count)	Actual Proportion (AP) %	Benford Data	Expected Proportion (EP) %	ABS	Chi-Square
1	48	30.57%	30.10%	0.47%	47.26170932	0.011533081
2	33	21.02%	17.61%	3.41%	27.64632767	1.036731089
3	21	13.38%	12.49%	0.88%	19.61538165	0.09773799
4	12	7.64%	9.69%	-2.05%	15.21487204	0.679296035
5	8	5.10%	7.92%	-2.82%	12.43145563	1.579686207
6	14	8.92%	6.69%	2.22%	10.51064597	1.158405636
7	6	3.82%	5.80%	-1.98%	9.104735675	1.058721962
8	8	5.10%	5.12%	-0.02%	8.030946024	0.000119246
9	7	4.46%	4.58%	-0.12%	7.183926018	0.004708954
	157	1				5.626940201
					Table Value	15.50731306

Table 2: First Digit Benford's Law Analysis – Balance sheet of HDFC Bank (2021-2025)

Digit	Observed Data(Count)	Actual Proportion (AP) %	Benford Data	Expected Proportion (EP) %	ABS	Chi-Square
1	44	34.11%	30.10%	4.01%	38.83286944	0.687542245
2	28	21.71%	17.61%	4.10%	22.71577242	1.2292367
3	10	7.75%	12.49%	-4.74%	16.11709702	2.321688325
4	15	11.63%	9.69%	1.94%	12.50139168	0.499387885
5	10	7.75%	7.92%	-0.17%	10.21438074	0.004499451
6	4	3.10%	6.69%	-3.59%	8.636135862	2.488816304
7	9	6.98%	5.80%	1.18%	7.48096116	0.308446862
8	6	4.65%	5.12%	-0.46%	6.598675396	0.054315784
9	3	2.33%	4.58%	-2.25%	5.902716282	1.427438049
	129	1				9.021371604
					Table Value	15.50731306

Analysis of Benford's Law Results for Table 1 and Table 2

The application of Benford's Law to both the Profit and Loss statement (Table 1) and the Balance Sheet (Table 2) concludes a strong conformity between the actual frequency of leading digits and the distributions predicted by Benford's Law. In the Profit and Loss account, the first digit "1" appears just over 30% of the time, close to the estimated 30.1%. Other digits also follow the expected pattern, with minor deviations for digits like "2" and "6", but no digit deviates large as to raise concerns. Statistical measures such as the Chi-Square value are remaining below critical thresholds.

Coming to the balance sheet figures, the results show a similar trend, with the digit "1" leading in frequency and most digits are matching their expected proportions. Slight differences can be seen in certain digits, such as "3" and "6", but these too remain within an acceptable margin. The Chi-Square

value for the balance sheet also falls significantly below the critical threshold, supporting the conclusion that the numbers conform to the natural law governing digit occurrence in large financial datasets.

Summarising the findings from both tables suggest that the financial statement data of HDFC Bank displays no suspicious or irregular patterns that would state manipulation or unusual presentation. The close conformity across both income and position statements shows that reported data is consistent with what would be expected as genuine, naturally occurring financial information. While this analysis does not entirely eliminate the possibility of manipulation, it provides strong evidence of data integrity.

Table 3: Second Digit Benford's Law Analysis – Profit and Loss statement of HDFC Bank (2021-2025)

Digit	Observed Data(Count)	Actual Proportion (AP) %	Benford Data	Expected Proportion (EP) %	ABS	Chi-Square
0	15	9.55%	11.97%	-2.42%	18.7929	0.765506676
1	20	12.74%	11.39%	1.35%	17.8823	0.250787275
2	16	10.19%	10.88%	-0.69%	17.0816	0.068486474
3	21	13.38%	10.43%	2.95%	16.3751	1.306233245
4	15	9.55%	10.03%	-0.48%	15.7471	0.035445156
5	19	12.10%	9.67%	2.43%	15.1819	0.960214967
6	18	11.46%	9.34%	2.12%	14.6638	0.759027704
7	15	9.55%	9.04%	0.51%	14.1928	0.045908618
8	9	5.73%	8.76%	-3.03%	13.7532	1.642738435
9	9	5.73%	8.50%	-2.77%	13.345	1.414689022
	157	1				7.249037572
					Table Value	16.919

Table 4: Second Digit Benford's Law Analysis – Balance sheet of HDFC Bank (2021-2025)

Digit	Observed Data(Count)	Actual Proportion (AP) %	Benford Data	Expected Proportion (EP) %	ABS	Chi-Square
0	18	14.06%	11.97%	2.09%	15.3216	0.468216541
1	10	7.81%	11.39%	-3.58%	14.5792	1.438286918
2	7	5.47%	10.88%	-5.41%	13.9264	3.444897243
3	18	14.06%	10.43%	3.63%	13.3504	1.619335762
4	13	10.16%	10.03%	0.13%	12.8384	0.002034098
5	18	14.06%	9.67%	4.39%	12.3776	2.553918511
6	12	9.38%	9.34%	0.04%	11.9552	0.00016788
7	14	10.94%	9.04%	1.90%	11.5712	0.509806195
8	9	7.03%	8.76%	-1.73%	11.2128	0.436686986
9	9	7.03%	8.50%	-1.47%	10.88	0.324852941
	128	100.00%				10.79820308
					Table Value	16.919

Analysis of Second Digit Benford's Law (Tables 3 & 4)

The Benford's Law test applied to the second digits of HDFC Bank's Profit and Loss statement (Table 3) and Balance Sheet (Table 4) shows a pattern of conformity to expectations. In both data sets, the frequency distribution of second digits generally align with the natural logarithmic pattern predicted

by Benford's Law, with digits like "0", "1", and "3" closely matching the expected frequencies. Some variance is noted for example, digit "2" and "5" in the balance sheet show deviation but these differences are not at statistically significant levels. The Chi-Square values for both tables are well below their critical limits, showing that the numbers behave much as would be expected in a genuine, unmanipulated financial dataset.

Concluding the results from Tables 3 and 4 build upon the findings from second-digit analysis, are consistent with natural data creation processes. No irregular clusters or outlying digit behaviour was observed that would highlight toward fabricated or manipulated figures. While minor fluctuations are always exist in any real-world dataset, but there is no sign here of systematic bias or fraud. Overall, the second digit analysis strengthens confidence in the quality and authenticity of HDFC Bank's financial reporting.

Hypothesis Testing Result:
For all four tests (First Digit – P&L, First Digit – Balance Sheet, Second Digit – P&L, Second Digit – Balance Sheet), the calculated Chi-square values (5.62, 9.02, 7.24, and 10.79 respectively) are less than the critical table values at $\alpha = 0.05$ (15.507 for first digit and 16.919 for second digit).Therefore, the null hypothesis (H0) is accepted: There is no significant difference between observed digit frequencies and expected Benford digit frequencies.

V. CONCLUSION

This research is to evaluate the integrity of HDFC Bank's financial statements by using Benford's Law. Applying first and second digit analysis to both profit and loss and balance sheet data, the study found a high degree of conformity between the observed digit frequencies and as per predicted by Benford's Law. The statistical results indicated that HDFC Bank's reported numbers behave much like those produced through natural, unmanipulated processes.

The consistent results across multiple years and statement categories provide strong evidence that the bank's financial disclosures are reliable and do not provide any evidence of manipulation or fabrication. While no single method can guarantee the complete absence of fraud, but this study shows that if there is any misrepresentation, it is either immaterial or emerged through means less likely to affect digit patterns.

So the findings support the importance of Benford's Law as an efficient and objective method for the detection of irregularities in financial data. The research suggests that such analytical techniques should be integrated into broader forensic and audit frameworks, serving as a first line of defence to highlight potential risks, guide targeted investigative efforts, and reinforce stakeholder trust in reported financial information. For HDFC Bank, the strong degree of conformity observed here suggests that corporate governance, disclosure practices, and internal controls are operating effectively during the period under study.

VI. SUGGESTIONS AND RECOMMENDATIONS

The results of this research confirm that Benford's Law is an important tool for initial screening of financial reporting quality in banking. To increase its effectiveness, some steps are recommended for auditors, management, regulators, and other stakeholders. Auditors should implement Benford's Law tests into their procedures when reviewing large financial datasets, using both first and second digit analysis to strengthen reliability. Combining these tests with other forensic methods such as trend analysis and ratio comparisons will provide more oversight and improve the chances of detecting subtle forms of manipulation.

Banking management should invest in training staff and usage of technology, enabling the ongoing use of forensic analytics for both regular reviews and special investigations. Automated systems for continuous monitoring can increase detection capabilities and highlight unusual patterns before significant damage occurs. Institutions should also consider implementing internal reviews using Benford's Law before annual external audits, creating safeguards against fraud and error.

Regulatory bodies may include digit analysis requirements in audit standards for financial institutions. It can encourage consistent practices and provide standards to check data quality industry-wide.

Benford's Law should be seen as considered as a part of a wider strategy which includes ethical leadership,

effective controls, and transparent disclosure. It helps organizations by giving early warning signals, rather than replacing human judgment or exhaustive audit work. Implementing these recommendations will help a banking sector that is resilient, trustworthy, and well-prepared to counter the risks done by financial irregularities.

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