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# Benford's Law and Digital Analysis: Application on Turkish Banking Sector

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**Abstract**: *We investigate the effectiveness of Benford's Law through a digital analysis of the off-balance sheet account disclosures made by Turkish Banks during the 1990-2010. We found that off-balance sheet account disclosures of the fiscal term 1999 doesn't comply with Benford's Law. Our finding is consistent with the Turkish Banks' practices. We also provide evidence on "The Law of Anomalous Numbers". Our results indicate a link between economic policy and deviation from frequencies of Benford's Law.*

**Keywords**: Benford's Law, Digital analysis, Banking sector, Fraud investigation

**JEL Classification**: G21, M42

## 1. Introduction

The purpose of this paper is to investigate effectiveness of Benford's Law in the financial reports of Turkish Banks. Digital Analysis based on the Benford's Law has been used to detect frauds and manipulations and it has been seen that Digital Analysis provide signal in revealing frauds and manipulations.

Turkish banks have been chosen since creative accounting applications were frequently realized in the Turkish banking sector especially during the 1990-2001. The investigation has been focused on the off -balance sheet account disclosures because fraud and manipulation methods of Turkish Banks were typically required accounting in the off-balance sheet accounts. In order to accurate assess of Digital Analysis, off-balance sheet account disclosures have been studied for the twenty years period 1990-2010. Looking at twenty years period is required because certain terms provide different expectations regarding frauds and manipulations that are likely to be found in the financial reports.

The rest of the paper is arranged as follows. Section 2 reviews literature relating to Benford's law and Digital Analysis. Section 3 describes fraud and manipulation techniques applied by Turkish Banks during the 1990-2001. Section 4 presents our research questions. The method is specified in Section 5. Results are presented and discussed in Section 6. Summary and conclusion are contained in section 7.

## 2. Benford's Law And Digital Analysis

The Digital Analysis is the comparison of the difference between the expected and observed frequencies of the digits. The difference between the expected and observed

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frequencies indicates that the data includes systematic error (Nigrini and Mittermaier, 1997). This systematic error may arise from the measurement methods (Hales, Sridharan, Radhakrishnan, Chakravorty and Siha, 2008) or from the frauds and manipulations in the accounting records (Nigrini, 1996).

On the other hand, although the Digital Analysis reveals the systematic errors, this is not a final evidence for a fraud or manipulation. The Digital Analysis is a method that shows where to look in order to obtain the best result from the data (Nigrini, 1996; (Hales, Chakravorty and Sridharan, 2009). In other words, the Digital analysis is a method that reveals the doubtful data. This property of the Digital Analysis was first proposed by Varian (1972). According to Varian (1972), the fact that a data set complies with Benford Distribution does not confirm the realness and accurateness of that data set, however, the fact that a data set does not comply with Benford Distribution is enough to be suspicious about that data set.

Benford's Law finding a wide application area in the social sciences started in 1881 and spread into a process that has been constituting up to the present day. The first study basis to the Benford's law was published by Simon Newcomb in the American Journal of Mathematics in 1881 with the headline "Note on the Frequency of Use of the Different Digits in Natural Numbers". In this article, Newcomb, researched the probability of the 'digits from "1" to "9" being found in the first digit of any number, and explained the Frequency Law stating that these probabilities are not equal. According to Newcomb (1881), the probability of the digits from "1" to "9" being found in the first digit of any number reduces as the digit grows.

The first statistical evidence in the subject of the frequency law was provided by Frank Benford with the article called "The Law of Anomalous Numbers" published in the Proceedings of the American Philosophical Society in 1938. In the research he made by using 20.229 data from 20 different sources such as river lengths, population, temperature, atomic weights, Benford determined that the first digits of the numbers constituting four or more digits displayed a logarithmic distribution, and he reached the following the conclusion:

$$f(a) = \mathbf{Log}\left(\frac{a+1}{a}\right) \qquad \text{Eq.(1)}$$

The "a" indicates the digits from "1" to "9", and the "f(a)" indicates the probability of a digit taking place in the first digit of a number. According to this, the probability of the digit "1" to take place in the first digit of an any number is,

$$f(1) = \mathbf{Log}\left(\frac{1+1}{1}\right) = 0,3010 \qquad \text{Eq.(2)}$$

The logarithmic relationship which Benford proposed is thoroughly supported by the results of the his statistical study. According to the empirical results of the his study, while the digit "1" took place in the first digit in average 30,6% of the 20.229 data, in 4,7 of them, the digit "9" was reported.

Another important finding is related to which numbers complied with the law of logarithm more. Acting from the statistical results, Benford concluded that the irrelevant, natural and random numbers show more compliance to the law of logarithm compared to the formal or mathematical numbers. He stated the logarithmic relation as “The Law of Anomalous Numbers”.

Pinkham (1961) showed that Benford’s Law was independent from scale. According to this, when a number sequence following the Benford distribution is multiplied by an constant which is not zero, the number sequence which has just been generated also complies with Benford’s Law. For example, when the lengths of the rivers on the earth are expressed by miles or km, they agree with Benford’s Law in both situations.

Hill (1988) proved that when numbers were generated by human beings, they did not comply with Benford Distribution. In the study he made, he asked to 742 students to generate six-digit numbers. The sequence that was constituted according to the answers of the students doesn’t comply with the Benford distribution according to Chi-Square and Kolmohorov- Smirnoff Test.

Carslaw (1988) applied Benford’s Law in the field of accounting. Carslaw (1988) stated that the managers generally round off the sales amounts to a higher sales amount in order to report more revenue when the corporation revenues remained under certain psychological limits. For example, the managers tend to report a sales amount such as 5.984.000 TRL to report as 6.000.000 TRL. As a result of the studies he made on the sales data of the firms in New Zealand, Carslaw (1988) found that there were more zero figures than the expected, and that fewer “9” figures than the expected in the second digit of the sales amounts due to the fact that the managers tended to round off their sales amounts.

One year after Carslaw (1988), Thomas (1989) determined a surplus of zero in the second Digits of the data set constituting the net revenue data of the United States of America. Furthermore, he stated that there were fewer zero figures in the second Digits in the firms which reported loss.

Nigrini (1994) demonstrated that Benford’s law could be used in fraud detection. On basis of Nigrini’s (1994) study, there is the opinion that the individuals will generate fraudulent numbers which are not compliant with the expected frequencies of the numbers (Benford Distribution) because of their unique psychological and limiting situations. By performing the first two Digit test over the fraudulent wage payments data, the compliance of the data set with Benford’s Distribution was checked. The fraudulent numbers in this 10-year data set which was known to be fraudulent displayed a great deviation according to Benford Distribution. Furthermore, when the data set was divided into two periods of five years, it was seen that the deviation from the Benford Distribution was more in the second five-year period. The reason of this was evaluated as the fact that the fraud realized by the employee was made more routinely.

Nigrini (1996) performed the first and second digit test on the interest income according to the 200.000 tax statements given between 1985 and 1988. In spite of the fact that the data set displays a distribution compliant with Benford distribution, it was seen that the small numbers in the interest income were more than the expected and the big numbers were more than the expected in the interest payments.

Hales et al. (2008) proved that by using the Digital Analysis, the production managers could evaluate, with low costs, the accuracy of the information submitted to them by the employees so that they could make a decision. Hales at al. (2008) state that the Digital Analysis is a cost effective and easily applicable method compared to the methods such as statistical sampling.

Hales et al. (2009) used Benford's Law in order to check the accuracy of the information that was received by the supply chain managers from the suppliers. The results of the study states that Benford' Law is a method which is applicable and one that provides cost advantage in order to detect whether the data sent to the supply chain managers have been manipulated or not.

Furthermore, the Digital Analysis also takes place among the techniques considered as orientated to the detection of the earnings management (Johnson, 2009).

**3. Turkish Banking Sector**

In terms of its structure, Turkish banking sector displays differences between the 1990-2001 and 2002 -2010. Basic characteristics of Turkish banking sector during the 1990-2001 is the fact that 1) the banks invested intensively on the TRL denominated government securities and that they financed these investments with high open positions. This structure is one of the important factor leading the 1994, 2000 and 2001 crisis; 2) certain banks have created distortions in the banking system by employing fraud and manipulation methods.

1999-2001 mid-term presents transformation process from poorly functioning banking system to well functioning banking system. Enacting the Banks Act 1999 is the milestone of the Turkish banking sector. The fundamental reason for enacting the Banks Act 1999 was the Economic Program aiming reduce the rate of inflation. The policy makers considered that the key condition of the success of this economic program was the sound and well functioning banking system.

A key feature of a 1999-2001 mid-term is that regulation of banking system proceeded strictly and rapidly in the effective legal and institutional infrastructure. Two significant effect of the Banks Act 1999 deserve emphasis against to the structural distortions of 1990-1999 period: 1) Fraud and manipulation in the banking system was prevented; 2) Open positions have been placed under control. However transformation process begun in the 1999 was completed by the end of the 2001.

What is important for our purposes is that however certain limits was set in 1999 to the open positions, banks became face to face with a currency risk in 2001 and lead the economic crisis to be triggered. In spite of the fact that banking sector was well regulated and closely supervised, many banks' currency risk could not be prevented. In the 1999-2001, in order to avoid limits set by the regulatory authorities against the currency risk, the banks reported that they met the foreign currency risk with future, forward and option agreements and they reported their liabilities arising from these agreements in the off-balance sheet accounts (Uygur, 2001).

On the other hand, it was detected by the Board of Sworn Bank Auditors that the only manipulation method in the Turkish banking system was not fictitious future, forward and option agreements, many other fraud and manipulation methods were also employed in the banking system.

Saving Deposits Insurance Fund published the reasons of failures related to the 25 banks. Reasons of failures prepared for each bank separately and announced to the public with the Shelf Cleaning Project consisting of 25 books. In order to understand the Turkish banking sector in 1990-2010, the fraud and manipulation methods reported in 25 books were compiled below (TMSF, 2009).

In the period of 1990-2010, 25 banks were failed. Table 1 states that, three banks failed during the 1994, six failure occurred during the 1999, four banks failed during the 2000 and finally eight banks failed during the 2001.

**Table 1: The Number of the Banks Failed By Years**

| DATE | NUMBER | | DATE | NUMBER |
|---|---|---|---|---|
| **11.04.1994** | 1 | | **06.12.2000** | 1 |
| **20.04.1994** | 1 | | **27.10.2000** | 2 |
| **23.04.1994** | 1 | | **28.02.2001** | 1 |
| **06.11.1997** | 1 | | **15.03.2001** | 1 |
| **12.12.1998** | 1 | | **09.07.2001** | 5 |
| **07.01.1999** | 1 | | **30.11.2001** | 1 |
| **21.12.1999** | 5 | | **18.06.2002** | 1 |
| **18.05.2000** | 1 | | **08.06.2005** | 1 |
| | | | **Total** | **25** |

Tasarruf Mevduatı Sigorta Fonu: Raf Temizliği Projesi. http://www.raftemizligi.com/Content/E-Kitaplar.php

The fraud and manipulation methods requiring accounting in the off-balance sheet accounts and the number of the banks which applied these methods have been demonstrated in the table 2.

**Table 2: The Fraud and Manipulation Methods Applied by Certain Banks**

| Fraud and Manipulation Methods | Number of the Banks Applied The Method |
|---|---|
| Concealment of the Open Position | 13 |
| Participating To The Related Parties | 4 |
| Transactions Made By Means of Off Shore Banks | 8 |
| Providing Cash Loans to the Related Parties | 20 |
| Providing Non-Cash Loans to the Related Parties | 17 |
| Fiduciary Loans | 12 |
| Back to Back Loans | 13 |
| Purchasing Bank by Using Its Own Resources | 5 |
| The Usage of the Bank Resources in Capital Increasing | 4 |
| Other | 8 |

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*Concealment of the Open Position*

The application of the fixed exchange rate or the overvalued exchange rate policy in the economy encouraged the banks to work in open positions. However borrowing foreign currencies to obtain TRL denominated government securities or to provide TRL loans rendered the banking system vulnerable to currency risk. Certain banks tried to keep the open position level within legal limits by fictitious future, forward, and option agreements.

One of the methods frequently used by the banks is the making deposit transactions mutually with a financial institution which is subsidiary. In this method, in return for the foreign exchange deposits made by the bank to the subsidiary, loan is provided by the subsidiary to the bank on the same day as TL equivalence of the abovementioned deposit. In this way, the bank obtains the opportunity of opening a position as much as the amount of the deposit made. The currency risk, however, is maintained on the other subsidiary. Here, the subsidiary is generally established by the dominant partner abroad and it operates only with the purpose of providing an open position to the Turkish bank.

Another method used in order to conceal the open position is to make a future, forward and option agreements with a related financial institution established in the abroad, mostly as an off shore bank.

The nominal values of the securities such as the government bonds, treasury bills, the stock certificates of private institutions which are traded by the bank are recorded into the off-balance sheet accounts. Furthermore, future, forward and option agreements are also recorded into the off-balance sheet accounts.

*Participating To The Related Parties*

One of the methods applied by the banks in order to finance related parties is investing directly to the related group company. As a result of the audits made by Board of Sworn Bank Auditors, it was found that an important amount of the fixed assets of certain banks' is constituted by the subsidiaries and associates. An important amount of the bank associates and subsidiaries belong to the group companies. Especially, an extensive associate relationship is constituted due to the fictitious capital increases.

In purchasing the participation shares, the nominal values of the stock certificates of the subsidiaries which have been obtained are recorded into the off-balance sheet accounts.

*Transactions Made By Means of Off Shore Banks*

When the banks cannot finance their group companies directly because of legal limits, they can provide funds to their group companies over legal limits by establishing off shore banks. The Bank opens deposit to the off shore bank. The off shore bank provides loans to group companies by means of securing the deposit that have been made to it. Sometimes, a loan is obtained for the purpose of back to back loan from the off shore bank to a bank in Turkey.

*Providing Cash and Non-cash Loans to the Related Parties*

A great amount of the banks which have been failed provided directly cash loans to their group companies in Turkish Lira and in foreign currency, or as foreign exchange indexed. In some cases, the bank provides loans to several firms which do not seem as directly connected to the group on paper, and these loans provided are later transmitted to the group companies indirectly.

An important part of the direct cash loans provided to the group companies is constituted by foreign exchange indexed cash loans. These loans were provided in great amounts without obtaining the required intelligence and without taking the magnitude of the firm's balance sheet into consideration, and they were closed by opening new loans.

Foreign exchange indexed loans, doubtful foreign exchange receivables, the warranties taken in return for the loans provided to the group companies are requires an accounting in the off-balance sheet accounts.

On the other hand, certain banks provided non-cash loans to the group companies in order to finance those companies. The group companies receive loans from other banks in return for non cash loans they holds. The group companies mostly do not pay back the cash loans they have taken from other banks in return for these non-cash loans. Therefore bank is required to cover its group companies' loan obligation to the other bank. Because of these unpaid but collateral loans, the bank sources are used.

The whole of the non-cash loans are requires an accounting in the off-balance sheet accounts.

*Fiduciary Loans*

The bank opens a deposit in a bank established abroad, and makes an agreement that this deposit is the collateral of the loan that will be provided to related parties. The amount, term and interests of the deposit opened by the Turkish Banks is in compliance with loan provided by the foreigner bank to the related parties. Here, foreigner banks is generally established by the related parties and operates as an off shore bank.

Making deposit into the domestic or foreign banks, the loan agreement that has been signed, are the transactions requires an accounting in the off-balance sheet accounts.

*Back To Back Loans*

This method is applied in the way of two banks making an agreement, and each of them providing to the related parties which they cannot provide a loan within the legal framework by the counter bank. Hence, both banks overcome the legal constraints and limitations. In these transactions, it has been determined by the Board of Sworn Bank Auditors that the amount, term and interest rates of the loans provided mutually are compliant with each other.

The mutual loans at issue can be in TRL, in foreign currency, or foreign exchange indexed. Furthermore, the non-cash loans also subject to back to back loans. Mostly, the guarantee letters in the unit of USD foreign exchange are organized. The TRL loans not paid at due date are transformed into foreign exchange loans or foreign exchange indexed loans.

The foreign exchange indexed loans and the non-cash loans, and the guarantees taken are the transactions requires an accounting in the off-balance sheet accounts.

*Purchasing Bank by Using Its Own Resources*

In this method, a non-cash loan (a guarantee letter) is taken from the bank that was purchased, a loan is taken from another bank based on the non-cash loan taken, and with the loan obtained, the bank from which the non-cash loan is taken is purchased. Later, when the liability is not paid to other bank, loan liability is covered by the bank which gave the non-cash loan and which was purchased.

As another method, the firm which will purchase the bank takes a loan from the bank of another group and later pays this liability by opening a loan from the bank it purchased. These loans are mostly foreign exchange indexed loans.

The non-cash loans, foreign exchange indexed loans, the guarantees taken are the transactions requires an accounting in the off-balance sheet accounts.

*The Usage of the Bank Resources in Capital Increasing*

With this method, the bank provides cash loans to the related parties. The parent company (holding) shares are taken as a guarantee from the firms for which loans are provided. The loans taken are used in the capital increase of the parent company (holding). However, the parent company (holding) later participates in the capital increase of the bank. Foreign exchange, TL and foreign exchange indexed loans are used for the capital increases of the bank and the parent company (holding). In this case, a new source is not created because the capital is increased with the sources of the bank.

The guarantees and the foreign exchange indexed loans taken are the transactions requires an accounting in the off-balance sheet accounts.

*Other Fraud and Manipulation Methods*

As a result of the audits made by the Board of Sworn Bank Auditors, it was seen that many various fraud and manipulation methods are used by the banks.

- Taking guaranty of the group firms in the loan agreements made with individual loan customers,
- Causing tax loss by means of gold forward transactions,
- Fictitious swap transactions for the purpose of understating the group risk,
- Making fictitious gold transactions,

**4. Hypotheses**

We expect that creative accounting applications will be greater in 1999 than former years because the Banks Act of 1999 is the basic source of motivation enabling the deceptive behaviors related to open position. It is confusing that how a strict regulation lead the much more deceptive behaviors? It is important to highlight that Turkish banking system was

already regulated before the 1999. However implementation of regulations were weak. Political interventions prevented the supervisory authorities to undertake adequate regulatory action against the Banks in the system during the 1990-1998. Although this structure has been changed with the banking law in 1999, Turkish banks realized this transformation later than 1999.

On the other hand, Since, in the early stages of 1999-2001 period, Turkish Banks have very low chance to transform rapidly, we expect to see higher level of fraud and manipulation in the early stages 1999-2001 than later years. Therefore, we hypothesize,

$H_1$: Fraud and manipulation level will be greater for 1999 fiscal term than the other years.

Board of Sworn Bank Auditors' investigations shows that banking system was distorted, in terms of fraud and manipulation, by certain banks during the 1990-1998. Therefore, we hypothesize,

$H_2$: Digital Analysis will state evidence regarding to fraud and manipulation during the 1990-1998.

**5. Method**

We investigated the compliance of Turkish Banks' off-balance sheet account balances with Benford's Law. The data, Turkish Banks' off-balance sheet account disclosures by the year, have been obtained from the "Data Query System" included in the web site of the Banks Association of Turkey.

To achieve our objective, we utilize Chi Square test in our study. The Chi Square test was used by Nigrini (1996) and Hill (1996) to compare the frequencies observed and expected.

The trial balances indicate the features of the data which is applicable to the Digital Analysis. The primary assumption required to perform the Digital Analysis is the generation of the numbers naturally. In other word numbers must not generated by human intervention. Furthermore limits preventing the numbers to take place between 0 and 9 must not exist (Nigrini, 1996; Hill, 1995).

The magnitude of the sample is important in terms of the accuracy of the Digital Analysis. The general opinion is that as the number of the data increases, the analysis will give better results(Hales et al., 2008). Hales et al. (2008) stated that the Digital Analysis gives good results on the big samples consisting of data over 500. Hales et al. (2008) proposed that successful results could also be obtained in small samples consisting of 100 samples, however, successful results could not be obtained from samples consisting of 50 data. On the other hand, Hales et al. (2009) stated that "the First Digit Analysis" could be made with the sample in which there were fewer data than 500, however, a sample possessing more than 1000 data was necessary so that the "First Two Digits" or the "First Three Digits" could be made subject to Digital analysis. Therefore, only the first Digit test was employed in our study. Because, the number of the banks in the periods analyzed vary between 50 and 80. In the December 1999 period basically investigated, the Digital analysis was employed on the off-balance sheet accounts of 80 banks.

## 6. Results

The results of the Chi Square test on the off-balance sheet accounts were demonstrated in Table 3.

**Table 3: Chi Square Values**

| Term | Chi Square Values | | | Term | Chi Square Values | | |
|---|---|---|---|---|---|---|---|
| | Off-Balance Sheet Accounts | TRL Transactions | Foreign Currency Transactions | | Off-Balance Sheet Accounts | TRL Transactions | Foreign Currency Transactions |
| 1990 | 4,66 | 5,58 | 5,95 | 2001 | 5,81 | ----- | ----- |
| 1991 | 15,05 | 12,27 | 2,44 | 2002 | 9,14 | 6,68 | 4,67 |
| 1992 | 8,28 | 1,41 | 8,21 | 2003 | 14,66 | 5,69 | 11,84 |
| 1993 | 8,12 | 4,61 | 7,31 | 2004 | 3,17 | 0,93 | 11,72 |
| 1994 | 3,97 | 8,02 | 8,82 | 2005 | 6,13 | 9,66 | 6,07 |
| 1995 | 10,19 | 13,51 | 9,06 | 2006 | 7,70 | 8,91 | 5,44 |
| 1996 | 5,16 | 9,18 | 3,80 | 2007 | 9,39 | 14,49 | 11,40 |
| 1997 | 6,26 | 3,98 | 13,04 | 2008 | 4,65 | 2,4 | 1,74 |
| 1998 | 9,40 | 11,59 | 5,27 | 2009 | 6,64 | 8,07 | 9,22 |
| **1999** | **18,39** | **9,21** | **19,40** | 2010 | 5,13 | 2,00 | 12,31 |
| 2000 | 7,17 | 7,22 | 8,50 | | | | |

The degree of freedom of the Chi Square test for the First Digit Analysis is 8 (v=r-1; 9-1). The critical value in the 5% level of significance and 8 degree of freedom is 15,507. The fact that the Chi Square value calculated exceeds the test statistic (15,507) indicates that the related data is not compliant with Benford Distribution.

Table 3 state that, the Chi Square value (18,39) for the off-balance sheet account disclosures in 1999, is greater than the critical value (15,507). Result of Chi Square test indicate that, at P<.05 (Chi-Sq. Crit Value=15,507), off-balance sheet account disclosures of the fiscal term 1999 doesn't comply with Benford's Law. Therefore H1 is confirmed.

On the other hand, Turkish banking practices shows that, in general, foreign exchange denominated transactions were subject to fraud and manipulation. Chi Square test confirms Turkish Banks' practices because chi square value of 19,40 is greater than the critical value of 15,507, indicating that foreign exchange denominated transactions for the fiscal term 1999 state greater fraud and manipulation level than TRL denominated transactions.

Table 4 summarizes Chi Square calculation for 1999 fiscal term. As stated in Table 4, the frequency of the balance sheet accounts beginning with the figure "1" is 26. In other words, the off-balance sheet accounts of 26 of the 80 banks operating in the Turkish banking sector as of 1999 start with the figure "1". According to Benford's theoretical probability, however, the off-balance sheet accounts of the 24 (80*0,3010) of the 80 banks should start with the figure "1".

Table 4 also indicates that there is a significant difference between the observed and the expected frequencies for the off-balance sheet disclosures beginning with the figure "5". On the other hand, the figures "4" ,"7" , "3" and "9" also display a significant deviation from Benford Distribution.

However results do suggest fraud and manipulation for the 1999 fiscal term, Digital Analysis did not completely detect the fraud and manipulations. It is important to note here

that 1990-1998 period was subject to fraud and manipulation applications. Calculated Chi Square values of the each year's during the 1990-1998 period less than the critical value of 15,507. Therefore $H_2$ is rejected. Digital analysis failed to detect fraud and manipulation applications during the 1990-1998 period.

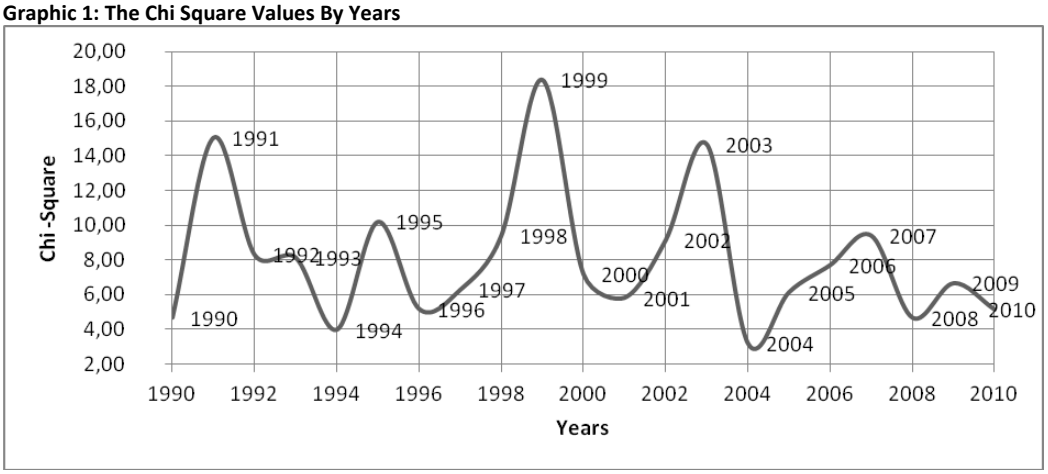
**Table 4: The Chi Square Value Calculation Table for the 1999 Fiscal Term**

| D | Probability | Expected | Observed | Chi-Sq. |
|---|---|---|---|---|
| 1 | 30,10% | 24,08 | 26,00 | 0,15 |
| 2 | 17,61% | 14,09 | 12,00 | 0,31 |
| 3 | 12,49% | 10,00 | 7,00 | 0,90 |
| 4 | 9,69% | 7,75 | 12,00 | 2,33 |
| 5 | 7,92% | 6,33 | 14,00 | 9,28 |
| 6 | 6,69% | 5,36 | 4,00 | 0,34 |
| 7 | 5,80% | 4,64 | 1,00 | 2,85 |
| 8 | 5,12% | 4,09 | 3,00 | 0,29 |
| 9 | 4,58% | 3,66 | 1,00 | 1,93 |
| | | **80,00** | **80,00** | **18,39** |

However Digital Analysis failed to detect fraud and manipulations for the 1990-1998 period, Chi Square values display unexpected trend by the years. The greatest chi square value was calculated for 1999, and the smallest was calculated for 2004. Generally, the Chi Square values appears to be low in 1994, 2000-2001 and 2008, when the Turkish Economy went through crisis.

Graphic 1 confirms the idea that while the Chi Square values appear to be high in the years before the crisis, it drops down in the year when the crisis occurred.

**Graphic 1: The Chi Square Values By Years**



Results do seem to present evidence of "The Law of Anomalous Numbers". Graphic 1 shows that chi square values react to economic policy. The arguments which led us to this conclusion are as follows;

1) The economy policies applied in Turkey, over valuation of the foreign currency, encouraged the banks to invest intensively on the TRL denominated government securities and finance these investments with open positions. However, in the years when the economic depressions realized, the possibility of investing on the government securities by creating an open position disappears. Therefore, the Chi Square values calculated for the year -end balance sheets when the economic depressions were experienced are lower compared to the years before the crisis. This situation is in a characteristic that supports "The Law of Anomalous Numbers" because the off-balances sheet account balances constitute according to the economy policies rather than naturally. The economy policy applied determines the money positions and security investments of the banks.

2) A great majority of the fraud and manipulation types is related to financing group companies who do not have an opportunity of obtaining loans from the bank within the legal framework. It is obvious that when the crisis approaches, group companies necessitate more resources to operate. This condition leads greater level of fraud and manipulation to finance related parties. Therefore, the Chi Square values increases until the year that economic depression occurred. Finally, bank failures during the economic depression period lead the decrease of chi square values.

**7. Conclusion**

This paper uses the Digital Analysis methodology to study effectiveness of Benford's Law. We examine annual off-balance sheet disclosures of Turkish Banks over the period 1990-2010 and test whether results of digital analysis conforms the expected fraud and manipulation level realized in Turkish Banking System. Our finding provide partial support for the idea that Digital Analysis could be applied as a statistical audit tool in order to determine the fraud and manipulations. First, as it is expected, Digital Analysis suggest no fraud and manipulation regarding 2000-2010 period. Second, Digital Analysis successfully signed frauds and manipulations in the 1999 fiscal term however it was inadequate for the fraud and manipulations realized during the 1990-1998. Third, Digital Analysis confirms Turkish Bank's practices regarding foreign exchange denominated transactions for the 1999 fiscal term.

Our finding provide support for the proposition of Varian (1972) that states data set complies with Benford Distribution does not confirm the realness and accurateness of that data set, however, the fact that a data set does not comply with Benford Distribution is enough to be suspicious about that data set.

Results also provide support for the Law of Anomalous Numbers that is stating the irrelevant, natural and random numbers show more compliance to the law of logarithm compared to the formal or mathematical numbers. The Law of Anomalous Numbers is valid for the Turkish Banking System with regard to economic policy.

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