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Stock Market Volatility and Its Term Structure: Empirical Evidence From the Turkish Market

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Summary

This paper focuses on the informational efficiency of an emerging stock market of a developing country namely Turkey and also on stock market volatility studied from two different, but complementary perspectives. In the first part, the volatility trend and its term structure throughout the time is analysed. In this context, the realized volatility and the expected volatility are calculated and compared under the Random Walk theory by using the relevant ISE Composite Index closing values ranging between January 4, 1988 and December 27, 1996. In the second part, the structure of the stock market volatility in Turkey has been investigated, both for the 1988-1996 period as a whole and on a yearly basis so as to come up with some conclusion about one of the main parameters used in option pricing, namely volatility. Moreover, in this part, the volatility, starting from January 2, 1997, when two digits have been removed from the index, is analyzed by using ISE-100 and ISE-30 Indices closing values realized between the period of January 2, 1997 – June 18, 1997.

I. Introduction

Informational efficiency is an important factor to enhance overall efficiency in the capital markets. In this respect, the analysis of the trend that market returns show in the capital markets throughout the time provide hints to various parties under the efficient market hypothesis. For instance, the fact that whether stock prices follow a random walk or not in the market is often used as a main indicator in evaluating market efficiency.

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Increases or decreases in stock prices are defined as "volatility" in the market. The volatility in the financial markets always play a vital role in investment decisions and modelling financial markets. Increase in stock price volatility makes both investment in stocks as well as the stock market itself more risky. Here, risk refers to the loss that the investor may bear while expecting to earn high return in the market. In other words, volatility affects the buy-sell decisions of investors, to a large extent. Most of the time, main players of volatile markets are speculators. Short-term capital gains are important for them. Rational investors, on the other hand, usually prefer markets with lower volatility. The reason is that not only the capital gains but dividend gains as well are important for these investors. In other words, if the aim is to attract rational investors into the market, then the volatility should be decreased and the stock prices should be stabilized. In this sense, the introduction of futures market and option markets and the relevant financial instruments, especially during periods of high stock volatility, would most likely help stabilizing the stock returns in the market.

The analysis of price volatility in the financial markets has received considerable attention in the world during the last decade. In Turkey, especially Balaban (1996) has produced some researches to estimate price volatility in the Turkish stock market. The term structure of volatility in the stock market, which will be covered in the first part of this paper, was searched first by Balaban (1996) by using the ISE Composite Index values as a data base. This paper carries this investigation forward and investigates the price volatility in the stock market, by using the ISE Composite Index closing values between January 1988–December 1996.

In the second part of this paper, based on the ISE Composite Index closing values daily, weekly and monthly volatility of the index has been calculated by dividing the end of the day, week (last trading day of the week) or month (last trading day of the month) values to the the previous day, week, or month values, taking their natural logarithm (ln) so as to make them convenient in terms of a normal distribution parameter and using their standard deviation. Furthermore, in this part, the effect of moving two digits from the index on stock volatility is analysed by using the ISE-100 and ISE-30 indices' daily closing values recorded between January 2, 1997 and June 18, 1997.

II. Data and Methodology

In this paper, daily observations of the Istanbul Stock Exchange Composite Index (ISECI) closing prices between January 4, 1988 and June 18, 1997 are employed as a data base[1]. The returns received by investors on the index in predetermined time periods are organized and index data base is made ready for the analysis[2].

2. 1. Term Structure of Volatility

The concept of volatility aims to show the frequent stock price fluctuations in a sensitive market, changing up and down in an uncertain manner. Therefore, when a comparison is to be made in terms of time, percentage changes instead of absolute values should be used. Percentage changes here refers, to the stock rate of return (one stock rate of return or the rate of return of the whole stock portfolio). In this paper, market portfolio (ISE Composite Index) rate of return is used.

This part of the paper is based on Balaban's (1996) work on the investigation of Turkish stock market weak-form efficiency, based on Peters' (1994) work on the term structure of volatility in the U.S. stock market. Balaban (1996), in his paper, tests volatility as measured by standard deviation scales according to the square root of time. This scaling of volatility is derived from the "Brownian motion," a primary model for a random walk process[3]. Einstein's (1908) work on the Brownian motion finds that the distance that a random particle covers increases with square root of time used to measure it. In Peters' (1994) work, this is formulated as follows:

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[1] With a base period of January, 1986, the ISE Index was initially calculated on a weekly basis and has been calculated on a daily basis since October 26, 1987.

[2] Value-weighted index, using closing prices of stocks, the ISE Index ignores the dividend gains paid in cash throughout the calculation.

[3] It all started in the 1830s, when a Scottish scientist, Robert Brown, observed the motions of pollen dust suspended in water. Brown noticed that the movements followed no distinct pattern, moving essentially randomly, independent of any current in the water. This phenomenon came to be known as the *"Brownian motion."*

$$R = T^{0.5} \quad (1)$$

where R and T denote the distance covered and a time index, respectively. The so called T to the one-half rule is extensively used in financial economics, especially in option pricing, to find, say, annual volatility given the standard deviation of, say, daily, weekly and monthly returns. Annualized risk is simply found by multiplying the standard deviation of daily, weekly and monthly returns by square root of 252, 52 and 12. In the second part of the paper, the development of price volatility will be discussed by using this approach.

Daily ISECI observations range between January 4, 1988 and December 27, 1996. Natural logarithmic returns on the ISECI, amounting to 2,249 observations, are calculated as follows:

$$R_t = \ln (I_t / I_{t-1}) \quad (2)$$

where I_t and R_t denote the index number and return of day t, respectively. ${}_iY_T$ refers to the ith series where the sub-periods have a length of T. Thus, total observations reaching 2,249, 16 different series are constructed; i = 1, 2, 3, ..., 16. In these series, the associated T values are as follows: 1, 2, 4, 5, 8, 10, 16, 20, 25, 32, 40, 50, 64, 80, 100 and 160 day. Note that these T values can also be considered as investment horizons. The T-day returns for the consecutive sub-periods are also calculated in the same way. Upon completion of the returns, series in the way described above, descriptive statistics is calculated for each ${}_iY_T$. The special emphasis is put on the standard deviation. Note that the calculated standard deviations for each investment horizon indicate realized volatility for that horizon.

Expected volatility under random walk theory is derived according to the T to the one-half rule as follows:

$$SD_T = SD_1 * T^{0.5} \quad (3)$$

where SD_T, refers to the standard deviation of T-day returns. SD_1 is daily volatility; i.e., T is equal to one. For each series, expected volatility is calculated in the same way.

The percentage difference between realized volatility and expected volatility for each T-day series is computed to emphasize deviation, if any. In addition, coefficient of variation is calculated to see how standardized volatility changes through time. Finally, the following regression is run to test whether the realized volatility increases by the square root of time:

$$\ln SD_{TG} = A + B * \ln T \quad (4)$$

where SD_{TG} refers to the realized price volatility for each T-day series.

2. 2. Historical Volatility Estimation

It is often difficult to have a healthy estimation about the price volatility. In a sensitive market, where there are frequent upward and downward price movements, out of many investment decisions, option pricing model stands to be very sensitive to these estimations. Usually two approaches are pursued to calculate price volatility: 1) historical volatility and 2) implied volatility. In this paper, since there is no actively operating futures and options market in Turkey yet, only historical volatility approach will be discussed. In order to calculate the implied volatility, there should be an actively operating options market and the price volatility should be calculated from the option prices realized in the market.

The historical volatility estimate is based on the assumption that the volatility that prevailed over the recent past will continue to hold in the future. For this purpose, a sample of returns on the stock over a recent period (daily, weekly or monthly) is taken and the standard deviation of the continuously compounded returns are computed.

The returns can be daily, weekly, monthly or at any desired time interval[4]. If daily returns are used, the result will be a daily standard

[4] There is an important issue concerned with whether time should be measured in calendar days or trading days when volatility parameters are being estimated and used. Empirical research carried out to date indicates that trading days should be used. In other words, days when the exchange is closed should be ignored for the purposes of the volatility calculation.

deviation. To obtain the annualized standard deviation, the model requires the variance to be multiplied by the number of trading days in a year, which is about 252, or the standard deviation by $\sqrt{252}$. If weekly or monthly returns are used, in this case, the result will be weekly or monthly variance (or standard deviation) and must be multiplied by either 52 (or $\sqrt{52}$) or 12 (or $\sqrt{12}$) to obtain an annualized figure.

In this part of the paper, daily, weekly and monthly index observations, ranging between January 4, 1988 and December 27, 1996 is used. By the help of the Equation (1), the natural logarithm of returns are calculated and the rate of changes in the index are made available for the use of normal distribution parameters. From the equality of Equation (1), I_t, for each t value (t = 1, 2, n), the following formula may be written;

$$I_t = I_{t-1}e^{Rt} \qquad (5)$$

In this case, R_t is the continuously compounded return (not annualized) in the *i*th interval. Then, the average of all returns are calculated by using the following equation:

$$\overline{R}_t = \sum_{t=1}^{n} R_t / n \qquad (6)$$

n = number of observations
R= daily, weekly or monthly continuously compounded return of the relevant return obtained at time t
$\overline{R}_t$= mean of the daily, weekly and monthly compounded returns
I_t = index value at the end of *t*th interval (t = 0, 1, 2, 3, ..., n)
τ = length of time interval in years

The standard deviaton of R_t, σ^*, is calculated as follows:

$$\sigma^* = \sqrt{1/n\text{-}1 \sum_{t=1}^{n} (R_t - \overline{R}_t)^2} \quad \text{or} \quad \sigma^* = \sqrt{(1/n\text{-}1) \sum_{t=1}^{n} R_t^{\,2} - 1/n(n-1)(\sum_{t=1}^{n} R_t)^2} \qquad (7)$$

In this case, the annualized standard deviation of R_t would be;

$$\sigma_Y = \sigma^* * \sqrt{\tau} \tag{8}$$

The standard error of this estimation can be shown to be approximately as;

$$\text{Standard Error} = \sigma^* / \sqrt{2n} \tag{9}$$

Choosing an appropriate value for *n* is not easy. *Ceteris paribus*, more data generally lead to more accuracy. However, changes over time and data that are too old may not be relevant for predicting the future. A compromise which seems to work reasonably well is to use closing prices from daily data over the most recent 90 to 180 days.

The ISE Stock Market return on a daily, weekly and monthly basis, referring to the investment made on the index, is calculated separately for each day, week and month and the daily, weekly and monthly changes in return are covered in a time series approach. The probability distribution, upon which the investors base their risk preferences and expectations for price estimations, is provided by drawing the histogram of returns in the market on a daily, weekly and monthly basis.

In the second section of this part, 114 observations are used to calculate the price volatility for 1997. The limited number of the observations stem from the fact that two digits were removed from the ISE-100 index as well as the introduction of a newly-designed index, namely the ISE-30, which went into effect on January 2, 1997.

III. Empirical Results

3. 1. Term Structure of Volatility

Table 3.1 provides summary statistics concerning different investment horizons. Note that the mean returns increase proportionally with risk, as expected. In other words, higher return is obtained in a higher risk environment, which is one of the well-known phenomenon in the financial literature. If volatility is measured by standard deviation, realized volatility shows an up-trend throughout the investment horizons (from 2.91% to 49.88%). Figure 3.1 depicts the trend that mean and standard deviation has followed throughout the investment horizons.

When summary statistics are analysed in Table 3.1, the trend that the skewness and kurtosis has followed may offer investors some insight[5]. As every one knows, skewness shows how far the distribution is from being symmetric. If the distribution is not symmetric, as in the case of normal distribution, it skews either to the left (negative) or to the right (positive). The findings in Table 3.1 point out that skewness has shown a considerable increase between T_1-T_{32} (from -0.06 to 0.50), moving from the right to the left, and then displayed a decrease between T_{40}-T_{80} (from 0.50 to 0.12), and then took on an upward movement in the following investment horizons. This refers to the fact that the distribution of returns increases up to a point (investment horizon), then decreases and becomes symmetric in a certain time span, and then increases again. As to the kurtosis, which provides a measure of the weight in the tails of a probability density function, it follows a decreasing trend after the investment horizon T_4. This may be interpreted as an increase in the standard deviation of returns over time[6].

[5] Skewness and kurtosis of a distribution are calculated as follows:

$$\text{Skewness}_x = \sum_{i}^{n} \frac{(x_i - \bar{x})^3}{\sigma^3} \qquad \text{Kurtosis}_x = \sum_{i}^{n} \frac{(x_i - \bar{x})^4}{\sigma^4}$$

$\bar{x}$ = mean of returns
σ = standard deviation of returns

[6] The skewness and kurtosis are expected to be "0" for distributions, such as the normal, that are symmetric about their mean.

Table 3.1: Summary Statistics (*)

	T-1	T-2	T-4	T-5	T-8	T-10	T-16	T-20
Mean	0.22	0.44	0.88	1.09	1.75	2.17	3.44	4.29
Standard Error	0.06	0.10	0.14	0.16	0.21	0.24	0.31	0.35
Median	0.13	0.36	0.78	0.86	1.19	1.27	2.29	2.56
Standard Deviation	2.91	4.54	6.67	7.55	9.84	11.15	14.78	16.68
Variance	0.08	0.21	0.44	0.57	0.97	1.24	2.18	2.78
Kurtosis	1.40	1.62	1.71	1.51	1.40	1.27	0.95	0.82
Skewness	-0.06	-0.01	0.06	0.08	0.13	0.21	0.26	0.33
Range	22.86	38.33	61.18	66.93	84.99	89.78	122.16	139.90
Minimum	-12.59	-19.27	-28.98	-33.98	-41.42	-43.45	-66.75	-72.64
Maximum	10.27	19.06	32.20	32.95	43.57	46.33	55.41	67.26
Count	2.249	2.248	2.246	2.245	2.242	2.240	2.234	2.230
Confidence L. (95%)	0.12	0.19	0.28	0.31	0.41	0.46	0.61	0.69

	T-25	T-32	T-40	T-50	T-64	T-80	T-100	T-160
Mean	5.36	6.87	8.64	10.86	13.96	17.61	22.17	36.95
Standard Error	0.40	0.45	0.51	0.57	0.64	0.71	0.83	1.09
Median	3.33	3.99	6.73	9.01	11.08	16.53	20.77	31.75
Standard Deviation	18.83	21.33	23.88	26.73	29.81	33.28	38.27	49.88
Variance	3.54	4.55	5.70	7.14	8.89	11.08	14.65	24.88
Kurtosis	0.70	0.83	0.73	0.31	-0.55	-0.82	-0.35	-0.18
Skewness	0.44	0.50	0.47	0.40	0.26	0.12	0.29	0.40
Range	129.20	152.58	179.11	182.76	155.05	163.62	215.42	245.88
Minimum	-53.56	-67.44	-74.36	-72.80	-56.20	-59.39	-68.73	-73.18
Maximum	75.64	85.14	104.75	109.96	98.85	104.23	146.69	172.70
Count	2.225	2.218	2.210	2.200	2.186	2.170	2.150	2.090
Confidence L. (95%)	0.78	0.89	1.00	1.12	1.25	1.40	1.62	2.14

(*) Statistical results, other than kurtosis, skewness and count, are calculated as percentages.

Table 3.2 compares realized and expected volatilities across investment horizons and presents such standardized measures of dispersion as coefficient of variation[7]. As noted from Table 3.2, the coefficient of variation inversely changes with the length of

[7] Coefficent of variation, which is a statistical indicator used to compare the risk of different distribution functions, is calculated as follows:
Coefficient of variation = $\sigma / \overline{X}$

investment horizon; i.e., it decreases as investment horizons become longer (from 13.21 to 1.35). Therefore, long-term investors face less risk per unit of return compared to short-term investors. Although this may seem as a conflicting issue when compared with the continuous increase in standard deviation throughout the investment horizons, it may be used as a relative indicator in the market. Maybe another point that may deserves attention in Table 3.2 is that realized price volatility is always high than expected price volatility for all investment horizons. The calculated deviation of the difference between these two price volatility estimates varies between 10.58% and 35.69%.

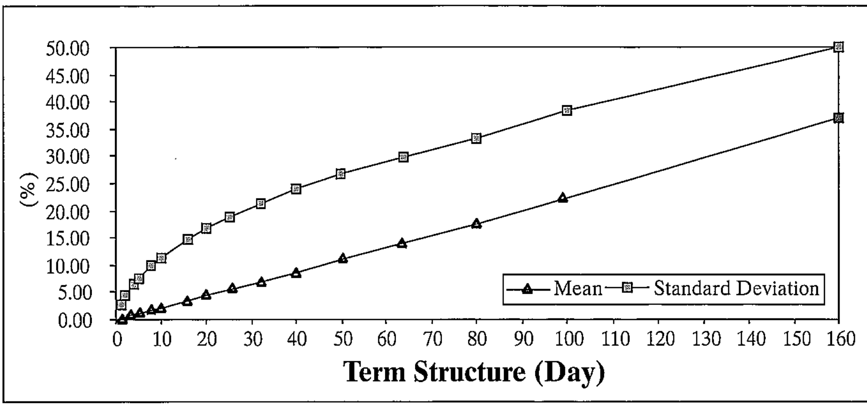
Table 3.2: The Term Structure of Volatility Between 1988-1996

Term Structure (Day)	Mean (A)	Realized Volatility (B)	Expected Volatility (C)	Difference (D)= (B-C)	Coefficient of Variation (E)= (B/A)
1	0.22	2.91	-	-	13.21
2	0.44	4.54	4.11	10.58	10.35
4	0.88	6.67	5.81	14.69	7.61
5	1.10	7.55	6.50	16.23	6.90
8	1.75	9.84	8.22	19.74	5.63
10	2.17	11.15	9.19	21.33	5.13
16	3.44	14.78	11.62	27.12	4.29
20	4.29	16.68	13.00	28.31	3.88
25	5.36	18.83	14.53	29.57	3.51
32	6.87	21.33	16.44	29.76	3.10
40	8.64	23.88	18.38	29.91	2.76
50	10.86	26.73	20.55	30.05	2.46
64	13.96	29.81	23.25	28.22	2.14
80	17.61	33.28	25.99	28.03	1.89
100	22.17	38.27	29.06	31.70	1.73
160	36.95	49.88	36.76	35.69	1.35

Table 3.3 presents regression results for the so-called t to the one-half rule. Note that volatility increases by the 1.81 (1/0.5513) root of time in the Turkish stock market. Therefore, it is found that volatility increases faster than the square root of time. Although this

is in conflict with the random walk theory, derived from the Brownian motion, it is a good indicator showing that the returns obtained in the market move in a certain scale proportional with respect to the time, which may be interpreted as an adjusted version of the random walk theory.

Figure 3.1: The Mean and Term Structure of Volatility Between 1988-1996



3. 2. Historical Volatility Estimation

Table 3.4 provides summary statistics concerning the daily, weekly and monthly calculations of price volatility. The latter, following an up trend in the market, figures out to be 46.13% on a daily, 54.09% on a weekly, 55.95% on a monthly and 59% on a 2- and 3-month basis. Another important point that may be noted in Table 3.4 is that the skewness, being very low (-0.05%) on a daily and weekly basis leading almost to a normal distribution, stands to be about 40% on a monthly basis (1, 2 and 3 month). This means that the figure that shows the probability distribution of returns has skewed to the left throughout the time.

Table 3.3: Regression Results

Multiple R	0.9994167
R Square	0.9988337
Adjusted R Square	0.9987504
Standard Error	0.0283872
Observations	16

ANOVA	df	SS	MS	F	Significance F
Regression	1	9.661698877	9.661699	11,989.68	6.15239E-22
Residual	14	0.011281682	0.000806		
Total	15	9.67298056			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	1.1287121	0.016220721	69.58458	3.47E-19	1.093922088	1.163602122
X Variable 1	0.5513704	0.005035466	109.4974	6.15E-22	0.540570411	0.56217043

Table 3.4: Daily, Weekly and Monthly Summary Statistics Between 1988-1996 (*)

	Daily	Weekly	1 Month	2 Months	3 Months
Mean	0.0022	0.0107	0.04425	0.09038	0.13753
Standard Error	0.00061	0.00349	0.01561	0.02353	0.02905
Median	0.00132	0.00881	0.02302	0.07015	0.13473
Standard Deviation	0.02906	0.07501	0.16152	0.24225	0.29765
Variance	0.00084	0.00563	0.02609	0.05869	0.0886
Annualized Standard Deviation	0.46133	0.54094	0.55951	0.59339	0.5953
Kurtosis	1.39767	2.12069	0.34235	0.39184	-0.6098
Skewness	-0.0571	-0.0491	0.40709	0.40898	0.15825
Range	0.2286	0.66929	0.86006	1.32738	1.30977
Minimum	-0.1259	-0.3398	-0.3388	-0.4455	-0.4459
Maximum	0.10268	0.32951	0.52125	0.88185	0.86386
Count	2,249	462	107	106	105
Confidence L. (95%)	0.0012	0.00686	0.03096	0.04665	0.0576

(*) Statistical results, other than kurtosis, skewness and count, are calculated as percentages.

Table 3.5 shows the histogram of the distribution of returns on a 1, 2 and 3-month basis in the market. Column "Bin" shows the rate of return whose range is automatically (or manually, if necessary) set; "Frequency" column shows the number of observations at each range and "Cumulative %" column reflects the probability that the expected returns would be realized. Figures 3.2 to 3.6 provide the realized probability distribution of the market. "Cumulative" column in Table 3.5 specifies the area that this probability distribution occupies according to the relevant returns in the table.

When the histogram table is referred to, for instance, while the probability of getting a return over 0.05% on a daily basis is 51.45%, the probability of getting a return over 9.12% (21.8%), on a monthly (2-month basis) is 35.51% (31.13%). Figures 3.2 to 3.6 show this fact clearly in all dimensions. In this sense, the introduction of options contracts that would be traded in the futures and options market with a 1-month expiry cycle would be more suitable to reduce the uncertainty in the stock market. However, since this paper is an ex-ante study, the initiation of an options market with 3-month cycle option contracts may reduce more effectively the skewness in the probability distribution.

Table 3.5: Frequency Distribution of the ISE Composite Index According to 1, 2 and 3-Month Returns

1 Month			2 Months			3 Months		
Bin	Freque.	Cumula. %	Bin	Freque.	Cumula. %	Bin	Freque.	Cumula. %
-0.33882	1	0.93	-0.44553	1	0.94	-0.4459	1	0.95
-0.25281	2	2.80	-0.31279	4	4.72	-0.3149	4	4.76
-0.1668	3	5.61	-0.18005	7	11.32	-0.1839	10	14.29
-0.0808	18	22.43	-0.04732	26	35.85	-0.0529	19	32.38
0.00521	24	44.86	0.08542	17	51.89	0.078	15	46.67
0.09122	21	64.49	0.21816	18	68.87	0.20898	10	56.19
0.17722	16	79.44	0.3509	18	85.85	0.33996	17	72.38
0.26323	11	89.72	0.48363	12	97.17	0.47093	15	86.67
0.34923	7	96.26	0.61637	0	97.17	0.60191	8	94.29
0.43524	2	98.13	0.74911	2	99.06	0.73289	3	97.14
More	2	100.00	More	1	100.00	More	3	100.00

Figure 3.2: Frequency Distribution of Daily Returns

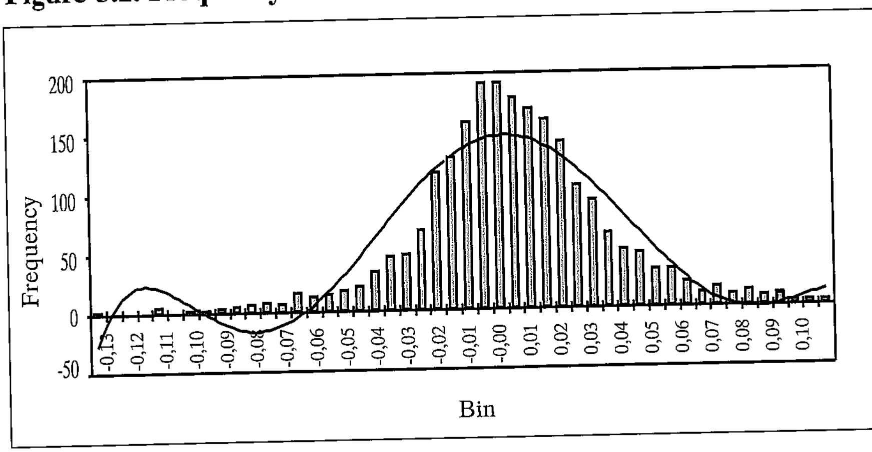


Figure 3.3: Frequency Distribution of Weekly Returns

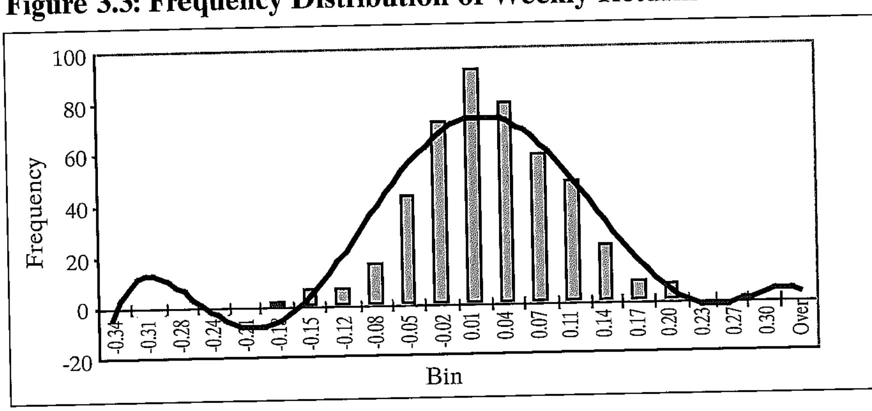


Figure 3.4: Frequency Distribution of 1-Month Returns

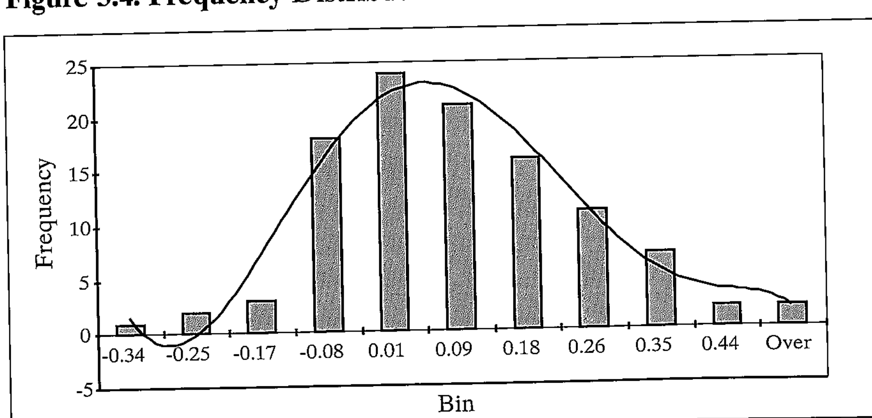


Figure 3.5: Frequency Distribution of 2-Month Returns

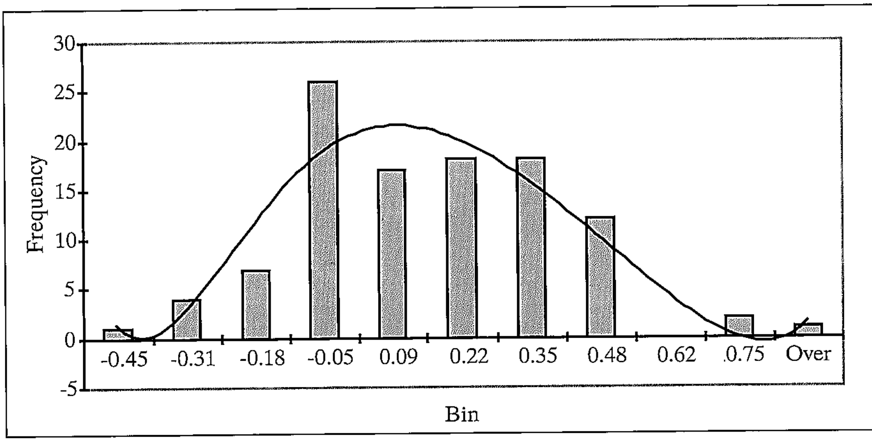
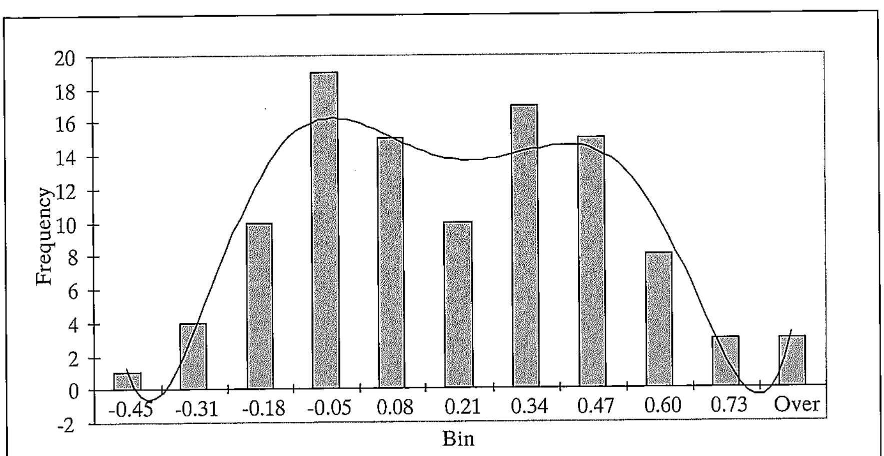


Figure 3.6: Frequency Distribution of 3-Month Returns

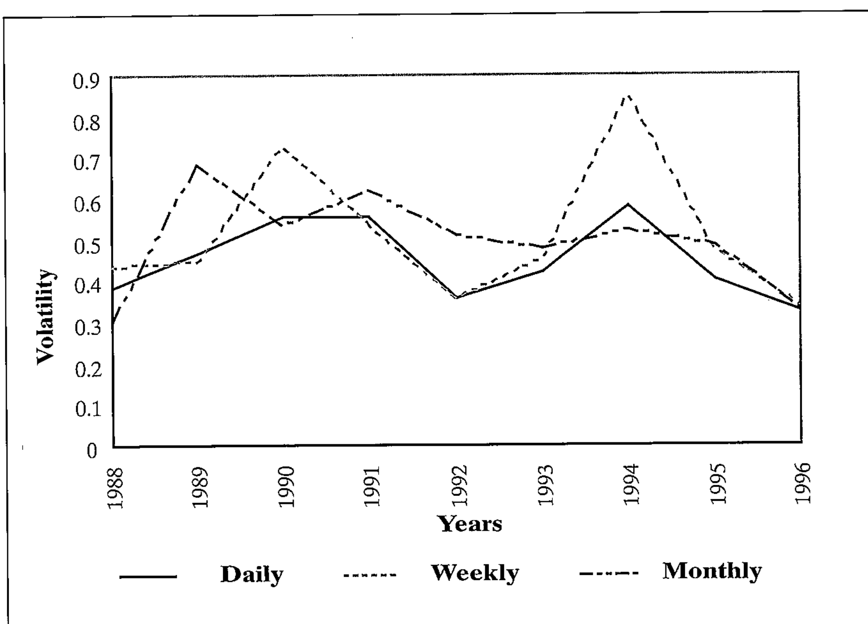


When the period of 1988-1996 is scrutinized on a yearly basis (Table 3.6), the result is that the annualized standard deviation varies over years and reaches its peak level in 1994 (58.16% on a daily basis) during which the economy has witnessed a serious financial crisis. On the other hand, when the year 1996 is considered, one can note that the volatility, on a daily, weekly and monthly basis, almost converges and comes to a certain level, at 32%-34% (Figure 3.2). This may be interpreted as a good point for Turkey.

Table 3.6: Mean, Variance and Annualized Volatility Between 1988-1996

	Daily Basis			Weekly Basis			Monthly Basis		
Years	Mean	Variance	Annual Standard Deviation	Mean	Variance	Annual Standard Deviation	Mean	Variance	Annual Standard Deviation
1988	-0,002423	0,000591	0,38576	-0,01218	0,003617	0,43369	0,07548	0,00766	0,30314
1989	0,006973	0,000857	0,46469	0,034417	0,003831	0,44635	0,160429	0,03895	0,68363
1990	0,001392	0,001237	0,5584	0,00577	0,010146	0,72634	-0,01017	0,02369	0,5332
1991	0,001375	0,001216	0,55359	0,003726	0,005583	0,53882	0,003298	0,03194	0,61914
1992	-0,000309	0,000506	0,35704	-0,00147	0,002494	0,36012	-0,01884	0,02178	0,51122
1993	0,006633	0,000698	0,41953	0,032181	0,003996	0,45586	0,141052	0,01914	0,47923
1994	0,000889	0,001343	0,58166	0,002755	0,013901	0,85021	0,027669	0,02297	0,52503
1995	0,001869	0,000646	0,40353	0,00791	0,004261	0,47069	0,041955	0,01963	0,48534
1996	0,003752	0,000425	0,3274	0,017655	0,002225	0,34011	0,061727	0,00907	0,32983

Figure 3.7: Annualized Volatility Between 1988-1996



The last drawing of this part is related to the effects created by the removal of two digits from the index and the introduction of the ISE-30 index has on volatility. The study, conducted by using the same methodology applied in the fist part, reveals the fact that the mean of the daily compounded return of the ISE-100 and ISE-30 index returns figures out to be 0.41% and 0.51%, respectively, in the first half of 1997. The price volatility for the first half of the year 1997 stands to be 3.14% (49.91%) and 3.5% (55.56%) on a daily basis (annualized basis) for the ISE-100 and the ISE-30 indices, respectively. In other words, the new approach led to a considerable increase in price volatility in the stock market. Although it is early to make comments on this issue, the continuation of high price volatility would prompt a higher setting of a "volatility parameter" in theoretical option pricing in the futures market. One solution may be to add two decimals to the index value that is computed and announced to the public so as to keep upward and downward movements in stock prices to a comparatively lower extent.

IV. Conclusion

The first major finding of this study is that, although the term structure of volatility in the Turkish stock market is not totally consistent with the "Brownian motion" approach, it somehow shows a random walk with the square root of time (1.81); i.e., investment horizons. In other words, while the ISE Composite Index returns change proportionally with time, the risk, measured as the standard deviation of returns, increases faster than the square root of time.

One interesting result is that the skewness of returns decreases between 40-80 days' (2-4 months) time period and follows a steady trend. There are some reasons to support the 3-month investment horizon of Turkish investors. First, Turkey is a high-inflationary developing country. Inflation, which disturbs the entire economic activity, has dramatically increased uncertainty in the Turkish financial markets. As such, economic agents have obviously prevented to make long-term plans. Second, the financial markets have been dominated by the public sector securities to finance budget deficits. It should be noted that the government borrowing in Turkey was heavily concentrated on the 3-month maturity. Third, financial intermediaries have generally announced a 3-month period for portfolio management. The last conclusion involves the financial statements which provide useful information for investors and decision-makers which are published quarterly.

Another finding of the study is revealed when daily, weekly and monthly probability distribution of returns are examined. The probability distribution becomes skewed to the left, starting from a 1-month investment horizon.

Another important outcome is the fact that on, a yearly basis, daily, weekly and monthly volatility that follows a fluctuating trend, between 1988-1995, converges and becomes almost the same (32%-34%) in 1996, displaying a slight difference. This may be interpreted as a signal of improving efficiency in the stock market through time.

The last finding of the study is related to the two-digit removal issue concerning the index. By the end of the first half of 1997, the daily (annualized) volatility figures out to be 3.14 % (49.91%) and 3.5% (55.56 %) for the ISE-100 and the ISE-30 indices, respectively. This is a considerably high figure, especially when compared with volatility figures experienced in the past. One solution may be to add two decimals to the index value so as to keep the upswings in stock prices to a restricted range.

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