MODELLING STOCK MARKET VOLATILITY: THE CASE OF BIST-100

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Abstract

The interest for the stock market volatility, considered as a marker of inefficient pricing of stock shares and insufficient functionality of the financial markets, has increased during the recent years. This is evidenced by the increasingly risky nature of stock investments and the stock market due to the increase in volatility of the stock prices. The objective of this study is to model and analyze stock return volatility for BIST-100. To fulfill that objective, stock return volatility for BIST-100 1997: 01 – 2015: 03 period was modeled using ARCH, GARCH, EGARCH and TARCH models. It was concluded that the most suitable model for BIST-100 return series was the EGARCH (1, 1). Results demonstrated that while the leverage effect was significant for BIST-100, negative news that affect the markets also increase the volatility. Another finding showed that BIST-100 volatility demonstrated continuity.

Keywords: *Volatility, Stock Market Volatility, ARCH-GARCH-TARCH- EGARCH Models, BIST-100, Turkey*

Clasificare JEL : *G10, G12, G14*

1. Introduction

Uncertainty, instability and risk became prevalent in financial markets during recent years due to the crises and crashes in developing countries. Thus, the markets were oriented towards derivative products for protection against these problems. Together with the increasing use of derivative products, market mobility increased and prediction of this mobility became crucial. In addition, while the problems in markets such as uncertainty and instability highlighted the risk factor, the conditions started to affect both investors and policy makers negatively. Especially due to the abandonment of the fixed exchange rate policy since the 1970's, the concept of risk became significant in financial markets. Along with financial innovations developed against this concept, risk management and alternative products and techniques for protection against the risk factor became increasingly complex. Beginning with the 1980's, sphere of influence of the uncertainties expanded as a result of globalization. These uncertainties were reflected in financial markets as volatility representing the risk. The concept of volatility means the capacity to fluctuate, having important effects on the determination of the structure of financial markets and investment decisions. Volatility became one of the main subjects of research during recent years, since it is prevalent especially in stock returns, foreign exchange and interest rates in financial markets.

This study scrutinized the BIST-100 stock return volatility. After an initial theoretical discussion of volatility and financial market volatility, a detailed take on stock market volatility would be presented. This would be followed by a literature review on BIST-100 studies in Turkey. Finally, BIST-100 stock market volatility would be modeled via the application in data and empirical findings section.

1. Volatility

Volatility, which represents the variations on the return of a financial asset, plays an important role in predicting the returns of financial assets. Since volatility is a significant indicator of the rate of risk for an asset, it recently became a parameter that is used in pricing options and derivatives (Eşrefoğlu, 2002). Volatility could simply be defined as sudden movements in prices (Kanalıcı, Akay and Nargeleçekenler, 2006). Literature review sould show that the concept of mobility was also used to replace volatility. Generally, volatility could be expressed as the versatility, inconsistency or unsteadiness of something. In other words, it is instability of a variable. Volatility, which also means a variable demonstrating very high increase or decrease based on its mean value, occurs commonly in stock values, exchange rates and especially in developing countries in inflation rate and similar variables (Güneş and Saltoğlu, 1998). Thus, volatility, expressed as excessive price fluctuations in stock exchanges, has the power to affect the general economic outlook (Gürsoy, 2000). Besides, since this concept is synchronized with the concepts of uncertainty and risk, mostly used in exchange with these. For example, in common language it has the same meaning as risk (Daly, 1999). Etymology of the word risk is based on the Arabic rızk/risk or risicum in Latin. It could be considered as the possibility of an unwanted event to occur in the future. Another definition of risk is the possibility of not being able to reach a target or to suffer losses within a period of time. Thus, risk refers to the potential problems, threats and dangers that could happen in the future. Investors realize their investments by taking certain risks. The concept of risk, just like volatility, could be considered as the standard deviation or variance of the return. It is measured by beta (β) coefficient. Beta coefficient is a measure used to determine the variation of stock return relative to the market return. Stocks with a beta value of 1 has the same risk as the market. The risk of the stocks with a beta of higher than 1 have a higher risk than the market, where the stocks with a lower beta have lower risk than the market. In that respect, different stocks are compared based on their volatility to determine their risk. Thus, a volatile market; a market with high and frequent fluctuations in prices and returns, translates into risk for the investors and predictions for the future become more and more difficult (Sarıkaya, 2007).

Thus, volatility, bearing a great significance for individuals in financial markets that are predominantly un predictable and unanticipated, is defined as a departure from the predicted value. An example for this would be the deviation of financial market prices from the asset pricing model value and the deviation of commercial prices from their average values. Volatility is significant in many aspects for the players in financial markets. Because, significant changes in the volatility of financial market prices (returns) have the ability to create negative effects on investors, who prefer to avoid risks. Besides, such changes in volatility also affect consumption patterns, as well as plans such as corporate capital, leverage ratio, business measures and macroeconomic variables (Daly, 1999). Traditional finance theory defines volatility as the risk of variance. The fundamental theories of modern finance such as Arbitrage Pricing Model, Capital Asset Pricing Model and Portfolio Theory, since their aim is to create a balance between risk and prospective return, put a significant emphasis on volatility. In option pricing model established by Black and Sholes (1973), volatility was included in the calculation of the real value of options. In this option pricing model, return volatilities of assets is an important parameter. Furthermore, in the same formula, the significance of the return volatility is exaggerated since it is the only variable that could not be directly observed (Daly, 1999).

2. Volatility in Financial Markets

Financial market volatility is the price volatility that an stock or an index displays within a certain period of time in a financial market. Financial market volatility, also expressed as return variation of financial assets, is an important criterion used in the determination of the risks of financial market investments. Thus, the interest in studies on volatility that occupies a significant place in classical finance theory and shares the same meaning with concepts such as risk and uncertainty has increased during the recent years (Kanalıcı and Nargeleçekenler 2006).

Under effective financial market conditions, variations on prices and returns of financial market assets would reflect the changes in the basic variables of the economy. And when the financial market conditions are not effective, there are two possible outcomes. First is the case where non-economical factors such as false financial policies and irrational investor behavior start to affect financial market volatility. And the second is the case where this volatility starts to affect the remaining part of the economy (real economy). Under both conditions, the volatility in financial markets becomes an independent determinant of the economic equilibrium and necessitates the intervention of policy makers. Volatility, which initially is an internal variable, would become an external variable that would start to affect the dependent variable, the economy (Eşrefoğlu, 2002).

Financial market volatility demonstrated a general increase after the 1080's. This was mainly due to the increasing post-1980's financial liberalization throughout the world. The great collapse of October 1987 in the US is quite interesting in that respect. Increasing financial market volatility is rather significant for both investors in the market and policy makers. Because increasing volatility means increasing risk for the investors, which could result in investors reevaluating their investment decisions. Similarly, policy makers could think that volatility might reflect from financial markets to the real economy harming the economy (Kanalıcı Akay and Nargeleçekenler, 2006). Furthermore, policy makers might consider that increasing volatility could harm financial organizations and orderly functions of the financial markets (Becketti and Sellon, 1989). In this situation, it could be necessary for policy makers to implement structural and regulatory changes for the orderly functioning and to increase the flexibility of the market (Kanalıcı, Akay and Nargeleçekenler, 2006). Thus, it is of utmost significance for both investors and policy makers to determine the reasons for the fluctuations experienced in financial markets and especially in stock markets and to model for the future foresights, for both investors and policy makers (Eşrefoğlu, 2002).

Volatility in financial markets could be based on intra-day, daily, weekly and monthly price changes depending on the time period examined, measurement technique used and the purpose of the research and often defined as the variance of the time series of the return. Prices display high volatility in financial markets and volatility could change in time (Hacıhasanoğlu 2002). Recent studies demonstrated a relationship between financial markets and the general conditions of the economy. Especially in emerging markets, general macroeconomic variables could be effective on stock prices. Resources are usually reinvested in less risky government bonds and foreign currency due to the high volatility in financial markets. Thus, modelling of the volatility in financial markets is important in creating healthy markets, establishing depth and funds transfer in markets. To determine the significance of financial market volatility, it is necessary to analyze stocks, exchange rates and interest rate volatilities separately (Kanalıcı, Akay and Nargeleçekenler, 2006).

3. Stock Market Volatility

Financial volatility is usually perceived as stock market volatility. Stock market volatility could be considered as a sign of failure in effective pricing of stocks and dysfunctional financial markets (Kanalıcı, Akay and Nargeleçekenler, 2006). There are two reasons for the significance of the stock market volatility during the recent years. First is the fact that the performance of options and derivatives markets are closely related to the stock market volatility. Second is the financial crisis experienced in the USA on October 19, 1987. In this period stock prices decreased by 40% and the 508 points fall in Dow Jones index was historical. This volatility caused significant harm in economic transfer channels and resulted in serious crises in financial markets (Sarıkaya, 2007).

In orderly and effective stock markets, efficient resource allocation could be maintained when stocks of better functioning corporations obtain cheaper funds compared to worse-off corporations. Under volatile stock market conditions, the desired level of effectiveness is not possible in these markets. Because when there is volatility, translated into risk and uncertainty for the investors, they would we inversely affected and capital costs would increase. Increasing volatility in markets would also increase the volume of speculative investments. Increasing speculative investments would in turn cause an increase and deepening of the problems in the market in social context of investments (Gürsoy, 2000).

It could be argued that in addition to its negative aspects, stock market volatility has positive aspects as well. Thus, positive and negative aspects of the stock market volatility should be determined well. Because, volatility that could be viewed as positive, could appear negative when examined from another point of view. Thus, high stock volatility could mean that this stock would rise extremely, however it could mean that it would slip extremely as well. Therefore investors investing in a volatile stock would either earn a lot or lose a lot if the prices go down (Aygören, 2004). On the other hand, manipulations by active investors to protect themselves against risks caused by volatility are among the negative aspects of volatility that hurt the markets. A long-term investment tool returning high profits in short-term is the positive aspect of the volatility. Since volatility in stock markets enables the investors to increase their saving in short-term, without the need to wait long-term, the investors would reinvest these savings in the market increasing the demand (Zorlu, 2003).

Stock market volatility could be examined in two headings: normal volatility and jump volatility. Normal volatility could be interpreted as the out of the ordinary changes in stock returns. It is the unordinary increases or decreases in the return. On the other hand, jump volatility is the seldom, sudden and extensive changes that occur in the return (Becketti and Sellon, 1989). Financial markets and organizations play a key role in the economy by transferring savings to the investors. A normal level of volatility in financial markets is a natural part of the competitive process and allocation of investible funds. However, extreme volatility in stock markets could harm interest rates and exchange rates. Because, this type of volatility could interrupt orderly functions of the financial system and damage the economic performance (Becketti and Sellon, 1989).

4. Literature Review

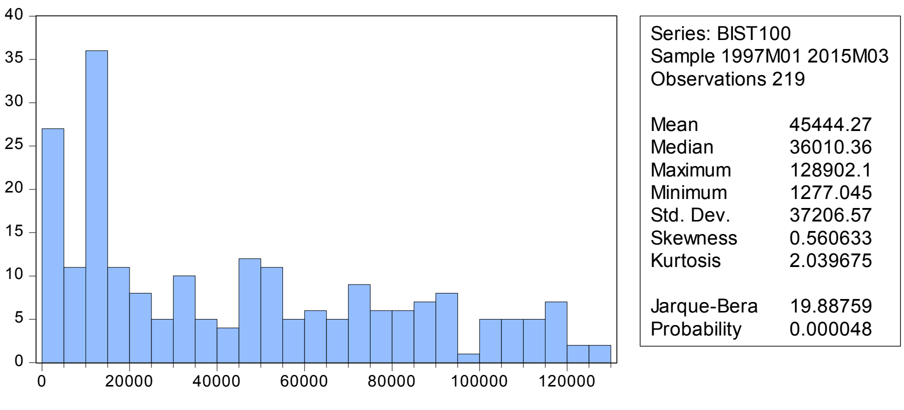
Atakan (2009) modelled the volatility in Istanbul Stock Exchange for IMKB-100 Composite Index in the period of July 3, 1987 – July 18, 2008 using the data for 5157 days and conditional variable variance methods of ARCH and GARCH. The study determined that GARCH (1, 1) model was the most suitable method to model the variance in IMKB-100 Index daily return series (Atakan, 2009). Akar (2008) modelled the IMKB return volatility using IMKB-100, IMKB-50 and IMKB-30 daily closure and IMKB-100 daily volume data and Conditional Heteroscedastic Autoregressive Moving

Average (CHARMA) method. For this purpose, he started the IMKB-100 series on January 8, 1990 and IMKB-50 on January 8, 2000 and IMKB-30 on January 8, 1997 and extended the series until December 29, 2004 for all 3 indices. The study found that stock volatility in IMKB was dependent on the interaction between the first and second deferments of the variances. Thus, it was concluded that CHARMA method was effective on modelling Turkish stock market volatility (Akar, 2008). Kutlar and Torun (2012) analyzed the causation relationship between risk and return based on the optimum different variance model for IMKB National 100 index between November 1, 2002 and August 8, 2012. They have initially used symmetrical and asymmetrical GARCH models and determined that TGARCH (1,1) was the most appropriate model for IMKB National 100 index. This finding also meant that leverage effect was valid for IMKB. In other words, bad news increased the volatility (Kutlar and Torun, 2012). Kanalıcı Akay and Nargeleçekenler (2006) modelled financial market volatility using IMKB National 100 closing prices and US Dollar exchange rate between October 23, 1987 and July 28, 2006. Volatility in both series were observed in the study and it was concluded that ARCH (2) model was suitable for the exchange rate and GARCH (1, 2) model was suitable for the IMKB-100 series. They have also stated that volatility in both exchange rate and IMKB variables tend to increase during the years of crises Kanalıcı Akay and Nargeleçekenler, 2006). Günay (2014) researched whether there was a long-term memory in BIST-100 Index volatility using 5825 daily data on BIST-100 Index between January 3, 1990 and May 15, 2013. FIGARCH method was utilized and it was concluded that for BIST-100 Index quadratic and absolute returns the most suitable method was FIGARCH (1, *d*, 1). Finally, it was concluded that there was a long-term memory effect on BIST-100 Index volatility for the period of interest and that this finding contradicted with the weak form of the Efficient Market Hypothesis (Günay, 2014). Kalaycı (2005) explained the stock market return volatility in IMKB by the volatilities of the main macroeconomic variables. In this study, GARCH (1,1) method was preferred in modelling the IMKB return volatility. The study concluded that inflation and money supply affected the volatility, while industry production index, interest rate and exchange rates did not. This finding also means that IMKB return movements were determined outside the basic financial and macroeconomic effects and thus, IMKB was not sufficiently efficient and speculative movements were determinative. According to the author, an increase in number of basic financial and macroeconomic variables that explain the volatility would mean an increase in the depth of IMKB and a decrease in speculative movements (Kalaycı, 2005). In a different study, Tuna and İsabetli (2014) modelled BIST-100 returns using ARCH and GARCH models. They have concluded that the most suitable model was GARCH (1, 1). Since the GARCH (1, 1) model coefficient was high, they have decided that BIST-100 Index volatility was continuous. Therefore, they have mentioned that BIST-100 volatility increased especially in periods of crisis and uncertainty and volatility clusters were observed. According to Tuna and İsabetli (2014), one of the main reasons for that fact was the pressure created by the crises that were experienced every 15 years in Turkey on the investors (Tuna and İsabetli, 2014). Kendirli and Karadeniz (2012) modelled the daily observation data for Istanbul Stock Exchange IMKB-30 Index between January 2, 2008 and March 30, 2012 covering 1057 days with the most suitable method, GARCH (1, 1) after utilizing both ARCH and GARCH methods. Authors stated that volatility was high in certain periods, while it was low in others, in other words there was a clustering of volatility (Kendirli and Karadeniz, 2012).

5. Data and Empirical Findings

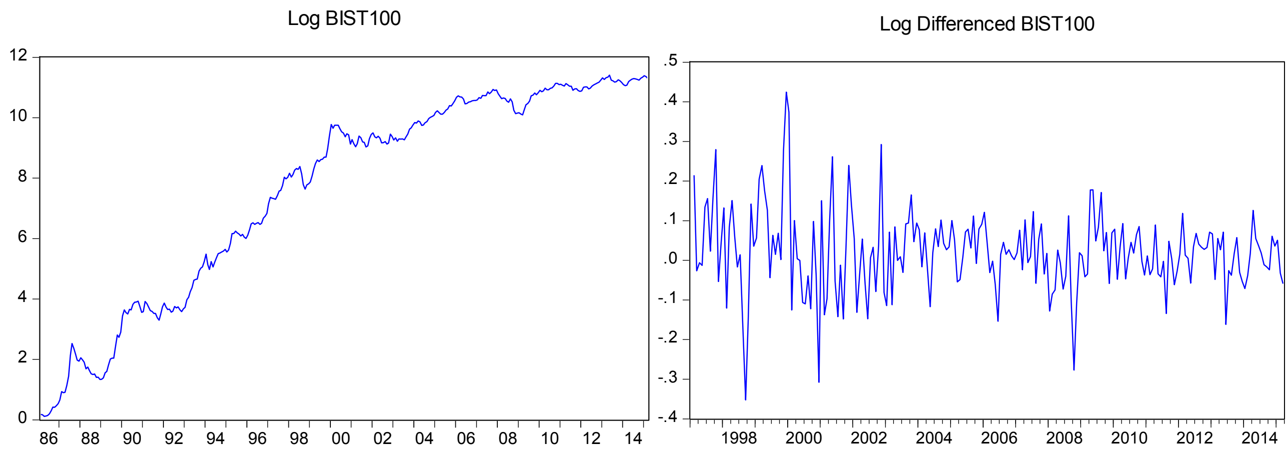
In the study, BIST-100 stock market volatility was modelled using ARCH, GARCH, EGARCH and TARCH models for 1997:01 – 2015: 03 period. The study took the benefit of logarithmic values of BIST-100 Index, making the use of a total of 219 observations. Data set was obtained from The Central Bank of Turkey electronic data distribution system. EVİews 8 software was used to conduct the analyses.

Figure 1. BIST-100 Index Return Distribution Statistics



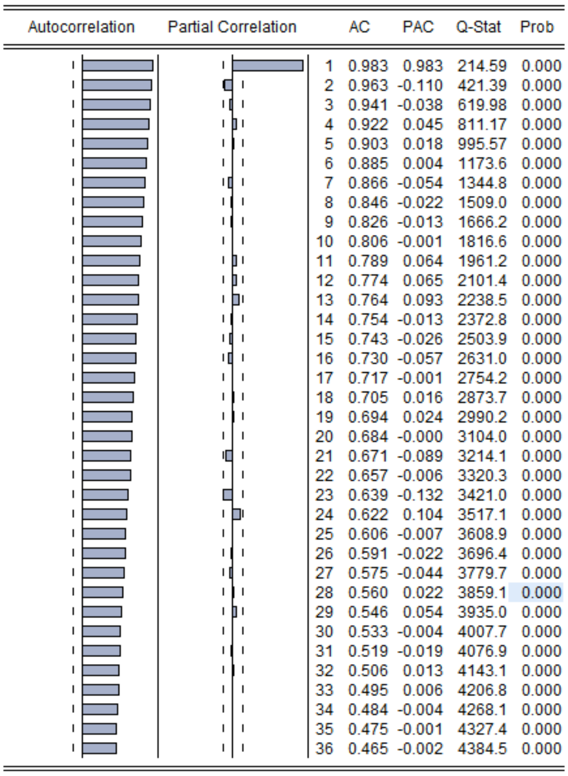
Before modelling the stock market, descriptive statistics were initially calculated to have information on the general characteristics of the series. The findings are displayed in Figure 1. Figure 1 demonstrates that BIST-100 Index return series was not thick tail since the kurtosis coefficient was less than 3; and displayed a right-skewed structure since the skewness coefficient was positive. According to Jarque-Bera test statistics, a deviation from normal was observed. In other words, BIST-100 return series did not have a normal distribution. After the examination of the descriptive statistics of the series, it was considered beneficial to analyze the time path graph of the series prior to unit root analysis. Figure 2 displays the time path graphics for BIST-100 series.

Figure 2. Time Path Graphics for BIST 100 Return Series for Level and First Differences



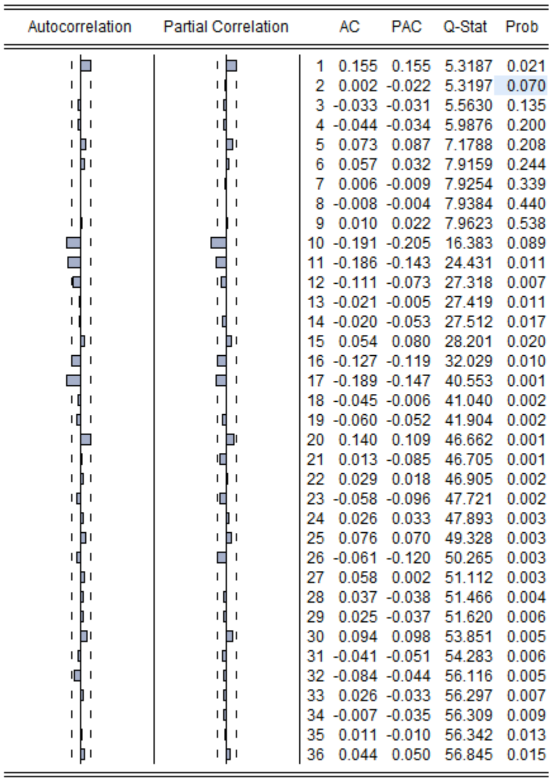
BIST-100 return series time path graphic in Figure 2 demonstrates an upward progress. In other words, series had an upward increasing trend. Figure 2 also demonstrates in the time path graphic of the differenced series that the series was distributed around the average. Thus, series could most probably have a unit root. But, it was not possible to be sure. To make sure, unit root tests should be conducted on the series and a decision should be reached whether the series was stable. To determine whether the series possessed a unit root, it was considered necessary to analyze correlograms, i.e. autocorrelation (ACF) and partial correlation (PACF) coefficients. Figure 3 displays ACF and PACF for BIST-100 return series.

Figure 3. Correlograms of the level and first difference for BIST-100 return series



	AC	PAC	Q-Stat	Prob
1	0.983	0.983	214.59	0.000
2	0.963	-0.110	421.39	0.000
3	0.941	-0.038	619.98	0.000
4	0.922	0.045	811.17	0.000
5	0.903	0.018	995.57	0.000
6	0.885	0.004	1173.6	0.000
7	0.866	-0.054	1344.8	0.000
8	0.846	-0.022	1509.0	0.000
9	0.826	-0.013	1666.2	0.000
10	0.806	-0.001	1816.6	0.000
11	0.789	0.064	1961.2	0.000
12	0.774	0.065	2101.4	0.000
13	0.764	0.093	2238.5	0.000
14	0.754	-0.013	2372.8	0.000
15	0.743	-0.026	2503.9	0.000
16	0.730	-0.057	2631.0	0.000
17	0.717	-0.001	2754.2	0.000
18	0.705	0.016	2873.7	0.000
19	0.694	0.024	2990.2	0.000
20	0.684	-0.000	3104.0	0.000
21	0.671	-0.089	3214.1	0.000
22	0.657	-0.006	3320.3	0.000
23	0.639	-0.132	3421.0	0.000
24	0.622	0.104	3517.1	0.000
25	0.606	-0.007	3608.9	0.000
26	0.591	-0.022	3696.4	0.000
27	0.575	-0.044	3779.7	0.000
28	0.560	0.022	3859.1	0.000
29	0.546	0.054	3935.0	0.000
30	0.533	-0.004	4007.7	0.000
31	0.519	-0.019	4076.9	0.000
32	0.506	0.013	4143.1	0.000
33	0.495	0.006	4206.8	0.000
34	0.484	-0.004	4268.1	0.000
35	0.475	-0.001	4327.4	0.000
36	0.465	-0.002	4384.5	0.000

BIST-100 Series Level Correlogram



	AC	PAC	Q-Stat	Prob
1	0.155	0.155	5.3187	0.021
2	0.002	-0.022	5.3197	0.070
3	-0.033	-0.031	5.5630	0.135
4	-0.044	-0.034	5.9876	0.200
5	0.073	0.087	7.1788	0.208
6	0.057	0.032	7.9159	0.244
7	0.006	-0.009	7.9254	0.339
8	-0.008	-0.004	7.9384	0.440
9	0.010	0.022	7.9623	0.538
10	-0.191	-0.205	16.383	0.089
11	-0.186	-0.143	24.431	0.011
12	-0.111	-0.073	27.318	0.007
13	-0.021	-0.005	27.419	0.011
14	-0.020	-0.053	27.512	0.017
15	0.054	0.080	28.201	0.020
16	-0.127	-0.119	32.029	0.010
17	-0.189	-0.147	40.553	0.001
18	-0.045	-0.006	41.040	0.002
19	-0.060	-0.052	41.904	0.002
20	0.140	0.109	46.662	0.001
21	0.013	-0.085	46.705	0.001
22	0.029	0.018	46.905	0.002
23	-0.058	-0.096	47.721	0.002
24	0.026	0.033	47.893	0.003
25	0.076	0.070	49.328	0.003
26	-0.061	-0.120	50.265	0.003
27	0.058	0.002	51.112	0.003
28	0.037	-0.038	51.466	0.004
29	0.025	-0.037	51.620	0.006
30	0.094	0.098	53.851	0.005
31	-0.041	-0.051	54.283	0.006
32	-0.084	-0.044	56.116	0.005
33	0.026	-0.033	56.297	0.007
34	-0.007	-0.035	56.309	0.009
35	0.011	-0.010	56.342	0.013
36	0.044	0.050	56.845	0.015

BIST-100 Series First Difference Correlogram

Level correlogram of BIST-100 series in Figure 3 demonstrates that the series did not have a stable structure. Because all ACF and PACF coefficients were outside the confidence interval. However, in the correlogram for the first difference of the series in Figure 3, it could be observed that most of the ACF and PACF coefficients were within the confidence interval. Thus, it could be deducted that the level values of the series were not stable, on the contrary, when the first difference for the series was taken, it became stable. However, it is known that the most accurate way to determine whether a series is stable in time series analysis is to apply unit root analyses. Thus, ADF, Phillips-Perron (PP), KPSS and Ng-Perron unit root tests were conducted to determine whether the BIST-100 series were stable. Table 1 demonstrates unit root tests for BIST-100 return series.

Table 1. Unit Root Tests Results for BIST-100 Return Series

	Intercept	**Trend and Intercept**	**None**
ADF Test	-0.212438	-2.900323	1.223979
PP Test	-0.060753	-2.620409	1.465177
KPSS Test	1.806197	0.270324	-
ADF-GLS Test	1.000461	-2.292319	-

Critical values for ADF test (for %1): 1st column: -3.460453, 2nd column: -4.000907, 3rd column: - 2.575662. Related hypothesis: H_0: unit root exists in series and H_1: unit root does not exist in series. Critical values for PP Test (for %1): 1st column: -3.460313, 2nd column: -4.000708, 3rd column: -2.575613. Related hypothesis H_0: unit root exists in series and H_1: unit root does not exist in series. Critical values for KPSS Test (for %1): 1st column: 0.739000, 2nd column: 0.216000. Related hypothesis H_0: unit root does not exist in series and H_1: unit root exists in series. Critical values for ADF-GLS Test (for %1): 1st column: -2.575662, 2nd column: -3.461700. Related hypothesis H_0: unit root exists in series and H_1: unit root does not exist in series.

Table 1 shows that, $\boldsymbol{H_0}$ hypothesis was accepted for ADF, PP and ADF-GLS test results, while H_0hypothesis was rejected for the KPSS test. Thus, it was observed that BIST-100 return series was not stable based on ADF Test, Phillips-Perron Test, KPSS Test and ADF-GLS Test results. Therefore the same unit root tests were applied again after taking the first differences of the series and this time it was observed that the series became stable. Then, it was necessary to determine the most suitable method by using the stable series. ARMA models, which contained different latency lengths suitable for the structure of the series, were used. Model determination phase was designed on the basis of Box-Jenkins (1976) methodology. Table 2 demonstrates the results for predicted alternative models for BIST-100 series based on the following criteria: (1) significance of the parameters; (2) high determination coefficient (R^2); (3) as low as possible AIC and SIC information criteria; (4) significant F statistics of the model (Kanalıcı Akay and Nargeleçekenler, 2006). F statistics were found to be significant in all models, thus suitability was valid for all models. Table 2 shows other selection criteria for the models

Table 2. Suitable Model Selection Results for BIST-100 Return Series

MODEL	R^2	AIC	SIC
AR(1)	0.990195	19.27333	19.30438
AR(2)	0.977383	20.10732	20.13847
AR(3)	0.964706	20.55038	20.58163
AR(4)	0.952157	20.85255	20.88390
MA(1)	0.724192	22.61200	22.64295
MA(2)	0.698009	22.70269	22.73364
MA(3)	0.690491	22.72728	22.75823
MA(4)	0.683114	22.75083	22.78178
ARMA(1,1)	0.990437	19.25755	19.30413
ARMA(1,2)	0.990191	19.28291	19.32949
ARMA(2,1)	0.990565	19.24220	19.28893
ARMA(2,2)	0.977457	20.11323	20.15996
ARMA(3,2)	0.969590	20.41068	20.45756
ARMA(2,3)	0.977429	20.11447	20.16120
ARMA(3,3)	0.964718	20.55930	20.60618
ARMA(1,3)	0.990205	19.28143	19.32801
ARMA(3,1)	0.979439	20.01930	20.06618

Table 2 demonstrates that the most suitable model with respect to the above mentioned four selection criteria of (1) significance of the parameters; (2) high determination coefficient (R^2); (3) as low as possible AIC and SIC information criteria; (4) significant F statistics of the model, was ARMA (2,1) model. Prediction results for ARMA (2, 1) model are displayed in Table 3.

Table 3. ARMA (2, 1) Model Predictions

Parameters	ARMA (2,1) for BIST-100 series
δ	45854.85
ϕ_1	1.070341
ϕ_2	0.981560
θ_1	1.053007
R^2	0.990565
$\overline{R^2}$	0.990477
AIC	19.24220
SIC	19.28893
SSE	2.81E+09
OLB	-2084.779
F-Statistics	11234.15

In Table 3; parameter δ is the constant term for the model; ϕ_1 and ϕ_2 are autoregressive parameters; θ_1 are the moving average parameters; R^2 is the determination coefficient; $\overline{R^2}$ is the corrected determination coefficient. ARMA (2, 1) prediction results for BIST-100 return series are the most suitable model with respect to the above-mentioned criteria of (1) significance of the parameters; (2) high determination coefficient (R^2); (3) as low as possible AIC and SIC information criteria; (4) significant F statistics of the model. Because the parameters predicted were statistically significant (Kanalıcı Akay and Nargeleçekenler, 2006).

Table 4 demonstrates the results of ARCH_LM test conducted to determine the existence of ARCH effect following determination of the most suitable model for BIST-100 return series, as proposed by Engle (1992).

Table 4. ARCH-LM Test Results for BIST-100 Return Series

Heteroskedasticity Test: ARCH

F-statistic	4.413546	Prob. F(1,215)	0.0368
Obs*R-squared	4.364997	Prob. Chi-Square(1)	0.0367

Table 4 shows the determination of the ARCH effect on BIST-100 series as a result of the ARCH test conducted for BIST-100 return series. Thus, it was concluded that BIST-100 series could be predicted using different ARCH models. Table 5 demonstrates the prediction results for ARCH, GARCH, TARCH and EGARCH models on BIST-100 series.

Table 5. Alternative ARCH, GARCH, TARCH ve EGARCH Models Prediction Results for BIST-100 Return Series

	ARCH (1)	ARCH (2)	GARCH (1,1)	GARCH (2,1)	GARCH (1,2)	GARCH (2,2)	TARCH (1)	EGARCH (1,1)
AIC	23.6201	23.6505	23.4335	23.5378	23.3940	23.4474	23.4329	23.2304
SIC	23.6665	23.7124	23.4954	23.6152	23.4714	23.5402	23.5103	23.3078
OLB	2583.40	2585.73	2561.97	2572.39	2556.64	2561.49	2560.90	2538.73

Table 5 demonstrates that the most suitable model for BIST-100 return series based on AIC, SIC and OLB criteria was the EGARCH (1, 1) model. To observe whether ARCH effect has disappeared in this model, ARCH-LM test was repeated and since the probability value of F statistic for the test was over 5%, it was concluded that there was no ARCH effect left in EGARCH (1, 1) model. ARCH-LM test results conducted for EGARCH (1, 1) model are displayed in Table 6.

Table 6. ARCH-LM Test Results for EGARCH (1, 1) Model

Heteroskedasticity Test: ARCH

F-statistic	0.142435	Prob. F(1,216)	0.7062
Obs*R-squared	0.143659	Prob. Chi-Square(1)	0.7047

6. CONCLUSION

Studies on national financial markets demonstrate a continuous increase in risks and uncertainties due to various reasons that affect the markets for both investors and policy makers, especially in emerging financial markets. This situation, christened as volatility in financial economics literature, affects especially the investment decisions at a great extent, in financial markets. Primarily in periods of high uncertainty, economic and social expectations cause volatility increases in the prices of many financial assets. In such periods, certain investors gain significant earnings, while others suffer important losses due to high volatility.

Measurement of this risk and uncertainty in financial markets gained significance during the recent years. Thus, this study also aimed to model the return volatility for BIST-100 market in Turkey for the period of 1997: 01 – 2015: 03, using ARCH, GARCH, EGARCH and TARCH models. As a result, it was concluded that the most suitable model for the BIST-100 return series was EGARCH (1, 1). Thus, it could be stated that the leverage effect was significant for BIST-100, while bad news also increased the volatility. The analyses conducted determined that EGARCH (1, 1) model coefficient had a high value. Another important result of the study was the continuity of the volatility observed in BIST-100 return series. In other words, a shock that affected the markets in period t, would continue its effects in the period t+1 and in consequent periods as well. It could also be stated that especially in periods of crisis and uncertainty, volatility increased and volatility clusters were observed. Thus, it could be argued that the volatility of BIST-100 affected the efficiency if the market adversely. That in turn presented further evidence that BIST-100 was not an efficient market.

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