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Sectoral Volatility in Borsa Istanbul: A GARCH-based Comparative Analysis

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ABSTRACT

The present study aimed to investigate the complex dynamics of sectoral volatility within Borsa Istanbul, an emerging market characterized by its dynamic nature. To achieve this, the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was applied. The research conducted an analysis of a dataset covering the time period from March 1, 2013, to August 16, 2023. The objective was to analyze the reactions of various sectors to market shocks and explore the variations in these responses among different sectors. The results of the study indicated that there were notable variations in volatility patterns across different sectors. Specifically, the BIST Financial Leasing Index (FINK) was found to be more susceptible to external disturbances, displaying a higher level of vulnerability. On the other hand, the BIST Banking Index (BNK) and BIST Financial Index (MALI) demonstrated relatively less pronounced reactions to volatility. These insights can be utilized by policymakers, regulators, and investors to customize risk management strategies, improve market stability, and create portfolios that align with risk preferences. This study enhances the comprehension of sectoral dynamics in emerging economies, providing a basis for future inquiries into the complex interrelationships among sectors, shocks, and patterns of volatility.
Anahtar Kelimeler: Volatility, risk, BIST, GARCH.

Borsa İstanbul'da Sektörel Volatilite: GARCH Tabanlı Karşılaştırmalı Bir Analiz

ÖZ

Bu çalışma, dinamik yapısıyla öne çıkan ve gelişmekte olan bir piyasa olan Borsa İstanbul'daki sektörel oynaklığın karmaşık dinamiklerini araştırmayı amaçlamıştır. Bu amaçla Genelleştirilmiş Otoregresif Koşullu Değişen Varyans (GARCH) modeli kullanılmıştır. Araştırma kapsamında 1 Mart 2013'ten 16 Ağustos 2023'e kadar olan zaman dilimini kapsayan veri setinin analizi gerçekleştirilmiştir. Çalışmanın amacı, çeşitli sektörlerin piyasa şoklarına verdiği tepkileri analiz etmek ve bu tepkilerin farklı sektörlerdeki yansımalarını araştırmaktır. Elde edilen bulgular, farklı sektörler arasında volatilite modellerinde kayda değer farklılıklar olduğunu göstermiştir. Özellikle, BIST Finansal Kiralama Endeksi'nin (FINK) dışsal etkilere karşı daha hassas olduğu ve daha yüksek bir kırılganlık seviyesi sergilediği görülmüştür. Öte yandan BIST Bankacılık Endeksi (BNK) ve BIST Mali Endeksi (MALI) volatiliteye, nispeten daha az tepki göstermiştir. Elde edilen bulgular politika yapıcılar, düzenleyiciler ve yatırımcılar tarafından risk yönetimi stratejilerini özelleştirmek, piyasa istikrarını iyileştirmek ve risk tercihlerine uygun portföyler oluşturmak için kullanılabilir. Bu çalışma, gelişmekte olan ekonomilerdeki sektörel dinamiklerin anlaşılmasını geliştirmekte ve sektörler, şoklar ve oynaklık kalıpları arasındaki karmaşık karşılıklı ilişkilere yönelik gelecekteki araştırmalar için bir temel sağlamaktadır.
Keywords: Volatilite, risk, BİST, GARCH.

Introduction

Volatility, regarded as an indicator of uncertainty and risk in financial markets, assumes an essential function in determining investment strategies, risk management techniques, and policy determinations. A comprehensive knowledge of sectoral volatility dynamics maintains significant importance within the framework of the Borsa Istanbul. This understanding has the potential to provide guidance for portfolio allocation, evaluate market stability, and inform regulatory interventions. This study aims to make a scholarly contribution by utilizing the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model to comprehensively compare and analyze the volatility patterns demonstrated by various sectors within the Borsa Istanbul.

The Borsa Istanbul, being a dynamic emerging market exchange, includes various sectors that demonstrate different reactions to market events, economic fluctuations, and global trends (Ekinci, Akyildirim and Corbet, 2019; İltaş and Demirgüneş, 2020; Ova, 2023). The GARCH model is a frequently used econometric tool within the discipline of volatility analysis. It provides a framework for capturing the dynamic nature of volatility by incorporating historical volatility and recent shocks within the series. The application of GARCH model in this research will offer a reliable framework for determining and contrasting the volatility specific to each sector, thus revealing the complicated relationships between sectors and their inherent risk characteristics.

The main aim of this study is to provide a comprehensive analysis of the reactions exhibited by various sectors within the Borsa Istanbul in response to market shocks, while also examining the variations in these responses across different sectors. This valuable insight is of great importance to investors who are aiming to construct diversified portfolios that are in line with their risk preferences and objectives.

Furthermore, this study provides significant implications for policymakers and regulators who are striving to maintain market stability and develop investor confidence. Policymakers can effectively address systemic risks and develop sustainable market growth by identifying sectors that exhibit greater susceptibility to fluctuations in market volatility, thus enabling targeted measures. In addition, acquiring understanding of the dynamics of volatility within and across sectors may improve the development of efficient risk management strategies, enabling market participants to more effectively navigate periods characterized by increased levels of uncertainty.

The methodology applied in this study includes the collection of an extensive set of data that covers a significant historical span, including various market conditions and economic phases from March 1, 2013, to August 16, 2023. The GARCH model will be used in order to estimate the dynamics of volatility for nine individual sector indices of BIST, facilitating the examination and comparison of volatility profiles across sectors. When the financial literature is analysed, it is seen that there are many studies in this field.

In a study conducted by Gökçe (2001), the researcher examined the effect of volatility on market return and trading volume. The research utilized a total of 2245 daily data sets from the ISE-100 Index, which were traded on the Istanbul Stock Exchange during the period spanning from 1989 to 1997. The data that was examined in the study received analysis using GARCH models. The GARCH model has been determined to be the most suitable model for describing the volatility observed in the ISE-100 Index.

Bordignon, Caporin and Lisi (2007) studied about the effectiveness of GARCH models in periodic long-memory volatility patterns with volatility of intra daily financial returns. Their study has shown the proposed models include generalized periodic long-memory filters, which are based on Gegenbauer polynomials, into the equation that characterizes the time-varying volatility of standard GARCH models. The empirical application of these models to the Euro-Dollar intra-daily exchange rate serves as evidence of their effectiveness in describing periodic long-memory volatility patterns.

In the research written by Köksal (2009), an analysis was performed on the volatility of stocks within the Istanbul Stock Exchange. The study utilized daily data between 1998 and 2008. The analysis included the utilization of GARCH models. Based on the analysis conducted, it emerged that the EGARCH model showed the most suitable forecasting performance.

In their study, Alagidede and Panagiotidis (2009) performed a comprehensive analysis of volatility in the stock markets of South Africa, Egypt, Nigeria, Kenya, Morocco, Tunisia, and Zimbabwe. These countries were selected due to their possession of the largest securities markets in Africa. The researchers utilized daily return data spanning from 1994 to 2005 for their research. The study utilized GARCH models and the smooth transition regression method. The presence of phenomena such as excess kurtosis, volatility clustering, and leverage effect has been demonstrated. A strong positive correlation was observed between risk and expected return in the stock markets of Kenya, Tunisia, and Morocco.

Through the use of a derivative of the GARCH model, Filis, Degiannakis, and Floros (2011) conducted an investigation into the dynamic connection that exists between stock markets and oil prices. The purpose of their research is to explore conditional correlations and volatility spillovers between major stock indices and crude oil markets. Additionally, they highlight the connection between the movements of stock markets and the pricing of commodities.

In their study, Er and Fidan (2013) applied both parametric GARCH and nonparametric GARCH models to analyze the volatility structures of daily returns observed in the ISE-100 index, which is traded on the Istanbul Stock Exchange. The study period covered the time frame from January 1991 to November 2012. The results of the study indicate that nonparametric GARCH models outperformed parametric GARCH models in terms of accurately modeling volatility.

Through the use of ARCH/GARCH models, Al-Najjar (2016) focused on modeling and estimating the volatility of Jordan's stock market conditions. The study brought to light the significance of mathematical and statistical models, such as the GARCH model, in capturing and forecasting the dynamics of stock market volatility.

According to Cheteni (2017), a GARCH model was applied in order to assess the volatility of the stock markets in South Africa and China, with a particular emphasis on the Johannesburg Stock Exchange and the Shanghai Stock Exchange. In addition to shedding light on the usefulness of GARCH models in volatility assessment, the research offered some insights into the volatility of stock returns in these markets.

Zhang, Lai and Lin (2017) utilized GARCH models for analyzing the day of the week anomaly in the stock returns of the major indices of 28 different capital markets spanning 25 countries globally. The utilization of the GARCH model in the study resulted in statistically significant results. Kapusuzoglu, and Ceylan (2018) investigated the volatility dynamics of Borsa Istanbul sector indices from October 1987 to January 2017, employing GARCH models. Their analysis demonstrated the positive and statistically significant association between trading volume and the number of information events, consequently leading to heightened variability in the sector indices. This period and dataset provide a comprehensive foundation for assessing sectoral volatility within the Borsa Istanbul, while GARCH models offer a robust framework for capturing the time-varying nature of volatility. The research highlighted the intricate interplay between trading volume, information events, and sector indices, shedding light on the factors that contribute to volatility fluctuations.

Nguyen and Nguyen (2019) focused their research on modeling stock price volatility in the Ho Chi Minh City Stock Exchange by using GARCH models. This research demonstrates the extensive use of GARCH in explaining stock market volatility, especially in developing economies. The findings of the study demonstrated that the GARCH model is a useful tool for capturing the particulars of the dynamics of stock market volatility.

In their study, Kumar and Biswal (2019) investigated the levels of stock market volatility in four emerging economies, namely Brazil, India, Indonesia, and Pakistan. The researchers utilized a comprehensive dataset spanning from January 2014 to October 2018 to conduct their analysis. The researchers utilized GARCH models in their analysis, and the findings of the study provided evidence of the presence of volatility clustering and a leverage effect. Specifically, the results indicated that positive news exerts a more pronounced influence on future stock market behavior in comparison to negative news. This study has contributed to the advancement of knowledge regarding the dynamics of volatility and its correlation with news sentiment in emerging markets.

In their study, Ekinci, Akyildirim and Corbet (2019) conducted an analysis to examine the dynamic effects of macroeconomic news releases in the United States on the Borsa Istanbul. The research employed GARCH models for analyzing the effects of macroeconomic news releases in the United States on the Borsa Istanbul. The research indicates that the distribution of macroeconomic news releases in the United States results an important effect on the Borsa Istanbul.

Bhowmik and Wang (2020) carried out a comprehensive literature study on the subject of stock market volatility and return analysis. They emphasized the significance of accurately assessing the volatility of stock index returns in order to reduce the amounts of uncertainty and risk that are present in the market. The findings of their research highlight the relevance of using techniques such as GARCH in order to capture the dynamic character of volatility in stock markets.

Through the use of GARCH models, Chaudhary, Bankhshi, and Gupta (2020) aimed to investigate the influence that COVID-19 has on the stock market indices of the nations with the highest GDP. The research showed the relevance of GARCH in analyzing and explaining the swings in stock market volatility under unusual circumstances by using GARCH to study volatility changes during the pandemic. This was accomplished by applying GARCH to analyze stock market volatility changes.

The GARCH family of models was used in an empirical research that was carried out by Spulbar, Trivedi, and Birau (2020) to investigate aberrant volatility transmission patterns between developing and established stock markets. Through their study, they highlighted the significance of symmetric GARCH models in the process of forecasting the conditional variance of returns from emerging markets.

A comparison was made between linear and non-linear GARCH models for the purpose of predicting volatility in developing nations by Sharma, Aggarwal, and Yadav (2021). This comparison demonstrated the adaptability of GARCH models in terms of their ability to capture volatility dynamics across a variety of markets. This research provided evidence that GARCH (1,1) models may be used for the purpose of studying volatility in the stock market. Additionally, the study emphasized the need of choosing proper models in order to provide reliable volatility predictions.

The GARCH model was applied by Endri, Aipama, and Razak (2021) in order to conduct an analysis of the volatility of stock prices during the COVID-19 pandemic. This investigation highlighted the significance of the GARCH model in comprehending and modeling times of increased volatility in stock markets. In order to successfully navigate through tumultuous market situations, the research brought to light the need of using robust modeling methodologies such as GARCH.

Viljoen, Conradie and Britz (2022) analyzes the dynamics of parameter estimates and volatility forecasts of GARCH models across different time periods. The dataset utilized in this study consists of the JSE All-Share index for two distinct time periods, specifically, a period characterized by financial stability and a period marked by financial turbulence. The researchers discovered that various factors exert an influence on the performance of GARCH models, thereby determining the most appropriate GARCH model for specific circumstances.

Claudiu et al., (2022) used symmetric and asymmetric GARCH models to explore the linkages between financial markets. Their goal was to evaluate the volatility spillovers that occurred between worldwide developing and established stock markets. Both the presence of volatility spillovers and the interconnection of global financial markets were investigated in this research.

GARCH models have been shown to be widely used in the analysis of stock market volatility across a variety of settings and geographies, as shown by the literature that was evaluated. The studies highlight the significance of GARCH-based analysis in terms of comprehending, anticipating, and controlling volatility in stock exchange markets. As a result, investors, policymakers, and scholars working in the area of finance may get useful insights from these studies.

Method

The time series characteristics of financial asset prices, such as the unconditional distribution of the data, leptokurtosis which means thick tail and extreme weakness in the mean; heteroskedasticity which means the conditional variance is not constant but changes over time; volatility clustering which means that small changes in the conditional variance are followed by small changes and large changes are followed by large changes cannot be captured by linear structure models (Kang, 2008). For this reason, Engle (1982) developed the AutoRegressive Conditional Heteroskedasticity (ARCH) model. The ARCH model can be written as formula 1 (Brooks, 2008):

$$y_t = \beta_1 + \beta_1 x_{2t} + \beta_3 x_{3t} + \beta_4 x_{4t} + u_t \qquad u_t \sim N(0, h_t) \qquad (1)$$
$$h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \cdots + \alpha_q u_{t-q}^2$$

If the value of the u_{t-q}^2 parameters in the equation is large, the calculated conditional variance will be large. If the value u_{t-q}^2 parameters is small, the conditional variance will also be small. Since volatility in financial markets is generally continuous, q is of high degree (Brooks, 2008). Although the ARCH model is frequently used in the literature, this model has some limitations and weaknesses. One of the main limitations encountered in empirical studies employing the ARCH model is the potential for an excessively large lag q during the developing of the ARCH(q) model, which consequently requires the integration of an extensive amount of variables within the model. This argument is in opposition to the principle of parsimony as applied to univariate time series according to Kirchgässner and Wolters (2007).

In the ARCH(q) model, when the number of lags q expands excessively alongside the increase in the number of variables, it becomes impossible to satisfy the condition for the ARCH model to demonstrate positivity. The estimation of volatility can also be at risk of overestimation due to its weak reaction to significant isolated shocks in the return series (Tsay, 2005). To address the issue within the ARCH(q) model, Bollerslev (1986) and Taylor (1986) suggested a modified autoregressive model. The model under consideration is commonly known as the GARCH(p,q) model with generalized autoregressive conditionally heteroscedastic variance, as described by Kirchgässner and Wolters in 2007. The mathematical method known as the generalized autoregressive conditional heteroskedasticity (GARCH) model, as proposed by Bollerslev in 1986, includes a larger amount of historical data and offers a more flexible lag structure compared to ARCH models. The GARCH model is a type of generalized ARCH model that aims to address the limitations of the ARCH model. In contrast to ARCH models, the GARCH model is a type of volatility model that includes the effect of past squared error terms and their lagged values on the conditional variance (Jorion, 2005). The GARCH model allows for the presence of autoregressive and moving average terms in the calculation of the conditional variance (Bulut and Karabulut, 2023). The GARCH model is shown in Equation 2:

$$\sigma_t^2 = a_0 + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} a_i \varepsilon_{t-i}^2 \qquad (2)$$
$$a_0 \geq 0 \text{ ve } \beta_j \geq 0,$$

The parameter referred to as ε_{t-i}^2 in the equation represents the term related with the ARCH model, whereas σ_{t-j}^2 symbolizes the term related with the GARCH model. The parameter denoted as "p" in the formula symbolizes the order of the moving average component within the ARCH model. The degree of the GARCH model is indicated by the q parameter (Demir and Çene, 2012).

In the GARCH(p,q) model, if the value of q is set to 1 and the value of p is set to 0, the model that results is transformed into an ARCH model, specifically referred to as GARCH(0,1). In the present scenario, all parameters within the model possess a value of zero. Therefore, it can be stated that the GARCH(0,1) model is equivalent to the ARCH(1) model. The GARCH(1,1) model can be conceptualized as an ARCH model with an infinite number of degrees and coefficients that decrease geometrically. Due to this explanation, it is more convenient and rational to estimate the GARCH(1,1) model with a reduced number of parameters, as compared to estimating the ARCH model with an infinite degree. The variance equation of the GARCH(1,1) model is shown in Equation 3:

$$\sigma_t^2 = a_0 + \beta \sigma_{t-1}^2 + \alpha \varepsilon_{t-1}^2 \qquad (3)$$

The simple GARCH(1,1) model, is frequently used and is considered as one of the most popular models in the area of study. The adequate performance of the simple GARCH(1,1) model in explaining the volatility of financial time series is generally accepted (Hansen ve Lunde, 2005; Poon ve Granger, 2003).

Data Set

In this study, nine indices among the sector indices traded in BIST, whose data can be accessed in a reliable way within the dates subject to the research, are analysed. For this purpose, daily data for BIST SINAI (SNAI), BIST HIZMETLER (HIZM), BIST MALI (MALI), BIST TEKNOLOJI (TEKN), BIST BANKA (BNK), BIST BILISIM (BIL), BIST ELEKTRIK (ENR), BIST FINANSAL KIRALAMA (FINK), BIST GAYRIMENKUL YATIRIM ORTAKLIĞI (GYO) indices between 03/01/2013 - 16/08/2023 are used. In the beginning of 2013, the Istanbul Stock Exchange (ISE) completed a process of transition and began operating as a new stock exchange under the name Borsa Istanbul (BIST). Furthermore, the BIST indexes achieved unprecedented levels at this time, providing access to operational data that may help elucidate and comprehend market volatility. The research in this article considers utilizing data from March 1, 2013 as a suitable beginning point. This date corresponds with when Borsa Istanbul began operating with a new identity in contemporary capital markets.

Index returns used in the study were calculated using the formula ln(Pt /Pt-1)*100 and daily price data for the indices were obtained from investing.com website.

Research Ethics

This study does not require ethics committee approval.

Findings

The objective of this study is to investigate the volatility of sectoral indexes at the Borsa Istanbul (BIST) using the generalized autoregressive conditional heteroskedasticity (GARCH) model. This analysis will be conducted by using daily return data collected from the time frame from March 1, 2013 to August 16, 2023. The study used the Eviews 9 software package for data analysis. Table 1 presents the descriptive statistics of the variables.

Table 1
Descriptive Statistics

		TEKN	SNAI	MALI	HIZM	GYO	ENR	FINK	BIL	BNK
Number of Observations		2663	2663	2663	2663	2663	2663	2663	2663	2663
Mean		0.0015	0.0012	0.0009	0.0011	0.0008	0.0013	0.0015	0.0014	0.0008
Median		0.0015	0.0017	0.0011	0.0016	0.0017	0.0021	0.0010	0.0014	0.0004
Maximum		0.1629	0.1353	0.1195	0.1259	0.1536	0.1681	0.1874	0.2192	0.1355
Minimum		-0.1628	-0.1417	-0.1445	-0.148	-0.1863	-0.1757	-0.2405	-0.2052	-0.1506
Std. Dev.		0.0212	0.0157	0.0189	0.0158	0.0179	0.0199	0.0274	0.0204	0.0234
Skewness		-0.4978	-0.8042	-0.5942	-0.8907	-1,0781	-0.5758	-0.3006	-0.4020	0.0572
Kurtosis		11.8999	15.5858	10.0633	15.2078	15.6310	11.3209	14.8996	17.7170	7.72806
Jarque-Bera	Test Statistics	8898.047	17863.16	5692.550	16888.42	18218.40	7829.736	15751.99	24104.39	2481,878
	p Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

When Table 1 is analysed, the mean and median values of the data for 2663 observations differ for each variable. The mean values are close to 0 where it can be accepted normal in normal distrubited time series of returns. The variables demonstrate a wide range of values, with both maximum and minimum values being observed. The result indicates the variables show varying ranges of values in overall terms. While the standard deviation values for SNAI and HIZM indicate a close proximity, it is significant that FINK indicates the highest value. The result points to that the FINK data exhibits an increased tendency for deviation from the mean compared to the other variables, hence indicating a greater level of risk. Skewness values for all variables except for BNK are negatively skewed away from zero. Accordingly, for the variables which have negative skewness values, it can be interpreted that negative gains are more than positive gains. However, the fact that the positive skewness value of the BNK variable indicates positive gains are more than negative gains. The kurtosis values of variables are greater than 3. Since the kurtosis values of variables are quite high, it is seen that the variables have leptokurtic Kurtosis characteristics. Since the kurtosis value of BNK variable is quite close to 3 compared to the other variables, it can be said that the data of BNK variable ise more smilar to the normal distribution. Jarque-Bera test is used to evaluate the conformity of the data to normal distribution. The Jarque-Bera test statistics are very high and their probability values (p-value) are less than 0.01. This indicates that the data do not fit the normal distribution.

Table 2
Unit Root Tests

	ADF		**PP**	
	Test Statistics	**p Value**	**Test Statistics**	**p Value**
TEKN	-54,0194	0,0001	-54,0268	0,0001
SNAI	-53,2442	0,0001	-53,2624	0,0001
MALI	-53,6877	0,0001	-53,7176	0,0001
HIZM	-55,114	0,0001	-55,2404	0,0001
GYO	-52,6308	0,0001	-23,3203	0,0000
ENR	-51,4203	0,0001	-51,2514	0,0001
FINK	-48,4246	0,0001	-48,4268	0,0001
BIL	-49,5187	0,0001	-49,3938	0,0001
BNK	-51,7086	0,0001	-51,6893	0,0001

According to the analysis of the data provided in Table 2, it is given that the Augmented Dickey-Fuller (ADF) unit root test statistics' values are statistically significant for %1 level. Therefore, the null hypothesis related to the existence of a unit root is rejected at all levels of statistical significance.

The analysis of Table 2 demonstrates that the Phillips-Perron (PP) test statistics indicate values that are are statistically significant for %1 level. Hence, the null hypothesis, which suggests an existence of a unit root, is rejected. According to the ADF and PP tests performed, it has been determined that the condition of stationarity is satisfied for all the variables.

Table 3
BDS Tests

	Dimension	**BDS Statistic**	**Std. Error**	**z-Statistic**	**Prob.**
TEKN	2	0,02335	0,001637	14,26394	0.00
	3	0,030755	0,001821	16,89037	0.00
	4	0,029261	0,00152	19,25247	0.00
	5	0,024391	0,001111	21,94798	0.00
	6	0,019166	0,000752	25,4779	0.00
SNAI	2	0,015032	0,001558	9,648073	0.00
	3	0,022119	0,001729	12,79334	0.00
	4	0,020634	0,00144	14,33303	0.00
	5	0,016403	0,00105	15,62268	0.00
	6	0,012141	0,000709	17,12669	0.00
MALI	2	0,008762	0,001266	6,920499	0.00
	3	0,011656	0,001291	9,028734	0.00
	4	0,010384	0,000988	10,51404	0.00
	5	0,007968	0,000662	12,04008	0.00
	6	0,005423	0,00041	13,21312	0.00
HIZM	2	0,016221	0,001468	11,05182	0.00
	3	0,022249	0,001603	13,87682	0.00

	4	0,020213	0,001314	15,38254	0.00
	5	0,015461	0,000943	16,39117	0.00
	6	0,010839	0,000627	17,29253	0.00
GYO	2	0,016435	0,001452	11,32001	0.00
	3	0,022597	0,001566	14,43281	0.00
	4	0,020045	0,001267	15,8236	0.00
	5	0,015371	0,000898	17,12177	0.00
	6	0,010836	0,000589	18,39777	0.00
ENR	2	0,01875	0,001431	13,10185	0.00
	3	0,022878	0,001516	15,08987	0.00
	4	0,020308	0,001205	16,84923	0.00
	5	0,01493	0,000839	17,79027	0.00
	6	0,010395	0,000541	19,21626	0.00
FINK	2	0,041181	0,002022	20,36509	0.00
	3	0,061415	0,002463	24,935	0.00
	4	0,063442	0,002252	28,1776	0.00
	5	0,057609	0,001803	31,95181	0.00
	6	0,04918	0,001337	36,79119	0.00
BIL	2	0,02191	0,0016	13,69356	0.00
	3	0,029629	0,001779	16,65573	0.00
	4	0,027619	0,001484	18,61057	0.00
	5	0,022376	0,001084	20,63268	0.00
	6	0,016927	0,000734	23,07099	0.00
BNK	2	0,009714	0,001308	7,425446	0.00
	3	0,01222	0,00133	9,184367	0.00
	4	0,010909	0,001015	10,74425	0.00
	5	0,008752	0,000679	12,89595	0.00
	6	0,006214	0,00042	14,79804	0.00

The z-statistics obtained from the BDS nonlinearity test are presented in Table 3. Based on the estimated results, it can be concluded that the null hypothesis, which suggests independence and similarity in variable distribution, is rejected at a significance level of 1% across all variables in all embedded dimensions. This result provides evidence for the presence of nonlinearity in the variables of research. The results obtained from the BDS nonlinearity test offer additional evidence that supports the appropriateness of employing the non-linear econometric methods such as GARCH model in this study.

Table 4
GARCH Model Results

	ω	**α**	**β**	**LOG(L)**	**AIC**
TEKN	3.22E-05***	0.2125***	0.7286***	6874.301	-5.1610
SNAI	1.84E-05***	0.1969***	0.7417***	7635.955	-5.7332
MALI	2.76E-05***	0.1093***	0.8163***	6949.662	-5.2176
HIZM	1.93E-05***	0.1936***	0.7436***	7580.748	-5.6918
GYO	3.46E-05***	0.2338***	0.6788***	7231.397	-5.4293
ENR	4.36E-05***	0.2128***	0.6878***	6924.149	-5.1985
FINK	4.43E-05***	0.2969***	0.6959***	6338.247	-4.7583
BIL	3.01E-05***	0.2481***	0.7037***	6988.717	-5.2469
BNK	2.67E-05***	0.1052***	0.8485***	6419.065	-4.8189

*p<0.1, **p<0.05, ***p<0.01 showa significance levels.

In Table 4, The metric α denotes the immediate impact of disturbances on volatility. A higher α value indicates a more pronounced response to recent market developments.

According to the results of the GARCH models related to the variables listed in Table 4, it becomes evident that the ARCH term, which serves as an indication of the shock effect, demonstrates statistical significance and an upward correlation through all variables. The statistical significance of the GARCH term is observed through all variables at a significance level of 1%. Moreover, it exerts an important effect on the conditional volatility. The GARCH term, indicating the periodical persistence of volatility, explains the concept that historical volatility can be leveraged as a predictive indicator for expected volatility.

As seen the results presented in Table 4, it becomes obvious that the BIST Financial Leasing Index (FINK) demonstrates a significantly greater ARCH parameter, thereby indicating an increased reaction to external shocks in contrast with the other indices under consideration. The empirical analysis reveals that FINK demonstrates an increased vulnerability to external shocks, resulting in higher levels of variations in return values compared to the other indices under analysis. BIST Banking Index (BNK) and BIST Financial Index (MALI), which have the lowest ARCH parameter, respond less to shocks than other indices. This shows that the volatilities of BNK and MALI indices react less to shocks and due to this reaction, the fluctuations in the return values are less than the other indices analysed, in other words, they are less affected by unexpected news.

When the GARCH parameters expressing the effect of past periods on volatility are analysed, it is concluded that the volatility in the BIST Banking Index (BNK) is more affected by the shocks in the previous period than other indices. This situation can be interpreted that this volatility caused by unexpected developments does not occur suddenly but spreads over time and therefore lasts longer. Among the other indices analysed, BIST Real Estate Investment Trust (GYO) is the least affected by unexpected developments in the previous period.

Conclusion, Discussion and Recommendation

This research examines sectoral volatility in the Borsa Istanbul (BIST) market using the Generalized Autoregressive Conditional Variance with Volatility (GARCH) model. Investors, policymakers, and financial experts value sectoral volatility knowledge. This research shows how different sectors respond to market shocks, filling a gap in the literature. Since it highlights these reactions, it provides realistic risk management and investment solutions.

The main value of this study is its ability to help investors build varied portfolios that match their risk tolerance. Identifying volatile areas may help investors reduce risk and increase profits. Investors may optimize benefits and minimize risk. Public policymakers may use the data to establish regulatory frameworks to stabilize financial markets. Predicting sector-specific responses to market shocks may improve policy interventions and strengthen the economy. The larger financial community should also evaluate the implications of this findings. Understanding volatility dynamics may help financial organizations create effective risk management policies to weather economic uncertainty. This research helps explain how external shocks propagate across sectors in emerging economies. This is especially true for topic-focused researchers. This study highlights the importance of sectoral analysis in financial markets and provides practical advice for practitioners and policymakers. The research uses the GARCH model to give precise volatility patterns for financial sector decision-making and strategic planning. By leveraging a comprehensive dataset spanning from March 1, 2013, to August 16, 2023, a detailed study was conducted to examine the developments in volatility within various sectors. This analysis provides light on the significance of historical volatility in understanding sectoral behaviors.

The findings derived from the GARCH models underscored the significance of the ARCH term as an indicator of shock effects, revealing its consistent statistical significance and positive correlation across variables. Notably, the BIST Financial Leasing Index (FINK) exhibited heightened vulnerability to external shocks, resulting in substantial fluctuations in return values. On the contrary, the BIST Banking Index (BNK) and BIST Financial Index (MALI) demonstrated comparatively lower sensitivity to shocks, reflecting reduced volatility responses. Interestingly, the GARCH parameters indicated that the volatility of the BIST Banking Index (BNK) was more influenced by shocks from previous periods, suggesting a gradual propagation of volatility over time.

Our analysis supports earlier studies on the fluctuation of different sectors in developing economies, validating the effectiveness of GARCH models in this specific situation. Gökçe (2001) shown that GARCH models are successful in measuring volatility in the ISE-100 Index. Our research also confirms the suitability of these models for analyzing the Borsa Istanbul. Kapusuzoglu and Ceylan (2018) emphasized a notable correlation between trading volume, information events, and volatility in Borsa Istanbul sector indexes, aligning with our conclusion that external shocks impact sectoral volatility. In their study, Ekinci, Akyildirim, and Corbet (2019) demonstrated the influence of U.S. macroeconomic news on the volatility of Borsa Istanbul's market. They used GARCH models for their analysis. Our work builds upon this research by highlighting the diverse reactions of various sectors to these shocks.

Our research enhances the existing body of knowledge by offering comprehensive analysis of vulnerabilities specific to different sectors. We find that the BIST Financial Leasing Index (FINK) is particularly prone to external shocks, displaying higher levels of volatility compared to indices such as the BIST Banking Index (BNK) and BIST Financial Index (MALI). This level of detail provides a more comprehensive understanding of market dynamics. Moreover, our research encompasses a more up-to-date and prolonged period from March 1, 2013, to August 16, 2023, including current market circumstances and economic developments. This improves the significance of our results for contemporary investment and policy choices.

Furthermore, our work enhances the comparative examination of sectoral volatility in comparable markets by specifically examining the unique features of a growing market such as Borsa Istanbul, hence providing useful insights. This study expands upon the research conducted by Al-Najjar (2016) on Jordan's stock market and Nguyen and Nguyen (2019) on the Ho Chi Minh City Stock Exchange. Specifically, it aims to enhance our comprehension of sector-specific volatility in Turkey.

Identifying sectors with different degrees of susceptibility to market shocks is crucial for practitioners, including investors and portfolio managers. The findings suggest that the BIST Financial Leasing Index (FINK) is highly vulnerable to external shocks, displaying significant volatility in its return values. In contrast, the BIST Banking Index (BNK) and BIST Financial Index (MALI) exhibit less sensitivity, resulting in less significant fluctuations in volatility. These observations allow investors to create stronger portfolios by spreading assets across industries with varying levels of volatility. By adopting this approach, individuals may enhance their ability to handle uncertainty and maximize their financial gains, by matching their investing strategies with their willingness to take risks and their desired investment objectives.

Policymakers and regulators may use these discoveries to improve the stability of the market and strengthen the trust of investors. The research demonstrates that industries such as banking exhibit a persistent propagation of volatility over time, as opposed to abrupt occurrences. This understanding enables policymakers to develop focused policies that target particular weaknesses inside the market. For example, recognizing that the progressive dispersion of volatility in the banking sector implies that policies focused on intervening early may be more successful in reducing long-term instability. In addition, acknowledging the increased susceptibility of sectors such as financial leasing might lead to the creation of rules that provide extra protection against external disturbances, thereby reducing systemic risk.

Our study highlights the need of developing risk management methods and regulatory frameworks that are specifically designed to address the unique volatility characteristics of various industries in emerging markets such as Borsa Istanbul. Our research offers sector-specific insights that might assist investors in building diversified portfolios that can withstand market shocks, hence improving their risk-adjusted returns. At the same time, authorities may use these results to carry out specific actions that stabilize unpredictable sectors and promote stability in the entire market. Our research provides valuable insights by recognizing the varying effects of external shocks on different sectors. This helps bridge the gap between theoretical models and real-world applications, ultimately aiding financial practitioners and regulatory authorities in making more informed decisions. This comprehensive approach not only improves academic comprehension but also offers practical suggestions that might strengthen the resilience and effectiveness of financial markets in developing countries.

Contribution Rate of Researchers

The author's contribution rate is 100%.

Conflict of Interest

I declare that there is no conflict of interest in the study.

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Genişletilmiş Özet

Giriş

Volatilite, belirsizlik ve riskin bir göstergesi olarak yatırım stratejilerini, risk yönetim tekniklerini ve politika kararlarını etkilemektedir. Bu çalışmada, Borsa İstanbul'daki farklı sektörler tarafından sergilenen oynaklık modellerini kapsamlı bir şekilde değerlendirmek ve karşılaştırmak için Genelleştirilmiş Otoregresif Koşullu Değişen Varyans (GARCH) modeli kullanılmıştır.

Borsa İstanbul, dinamik ve gelişmekte olan bir hisse senedi borsası olarak, piyasa olaylarına, ekonomik dalgalanmalara ve küresel trendlere farklı tepkiler veren çeşitli sektörleri kapsamaktadır. GARCH modeli, volatilite analizi için yaygın olarak kullanılan bir ekonometrik araçtır ve tarihsel volatilite ile maruz kalınan şokları birleştirerek volatilitenin dinamik doğasını yakalamaktadır. Bu araştırmada GARCH modeli, sektöre özgü volatiliteyi tanımlamak ve sektörler arasında karşılaştırma yapmak için bir çerçeve oluşturmak üzere uygulanacaktır.

Bu çalışmanın temel amacı, Borsa İstanbul bünyesindeki çeşitli sektörlerin piyasa şoklarına nasıl tepki verdiğine dair bir analiz sunmak ve bu tepkilerin sektörler arasındaki farklılıklarını keşfetmektir. Bu analiz, risk tercihleri ve hedefleriyle uyumlu çeşitlendirilmiş portföyler oluşturmak isteyen yatırımcılar açısından oldukça değerli çıktılar elde etmektedir. Finansal literatürde GARCH modellerini kullanarak volatiliteyi inceleyen çok sayıda çalışma bulunmaktadır.

Gökçe (2001), İMKB-100 Endeksi'ne ait 2245 günlük veri setini kullanarak volatilitenin piyasa getirisi ve işlem hacmi üzerindeki etkisini GARCH modelleri ile araştırmıştır. Çalışmada, GARCH modellerinin İMKB-100 Endeksi oynaklığını açıklamak için uygun olduğu bulunmuştur. Bordignon, Caporin ve Lisi (2007) GARCH modellerine Gegenbauer polinomlarını dahil ederek, günlük finansal getirilerdeki periyodik uzun hafızalı volatilite modellerini incelemişlerdir. Araştırmaları, bu modellerin bu tür oynaklık modellerini tanımlamadaki etkinliğini göstermiştir. Köksal (2009), 1998-2008 yılları arasında İstanbul Menkul Kıymetler Borsası'ndaki hisse senedi piyasası oynaklığını analiz etmiş ve EGARCH modelinin en iyi tahmin performansını sunduğunu bulmuştur. Alagidede ve Panagiotidis (2009), GARCH modelleri ve yumuşak geçiş regresyonu kullanarak 1994-2005 yılları arasındaki günlük getiri verilerini kullanarak Afrika hisse senedi piyasalarındaki volatiliteyi kapsamlı bir şekilde incelemiştir. Aşırı basıklık, volatilite kümelenmesi ve belirli piyasalarda pozitif risk-getiri korelasyonu gibi olgular tespit etmişlerdir. Er ve Fidan (2013), 1991-2012 yılları arasında İMKB-100 endeksi günlük getirilerine hem parametrik hem de parametrik olmayan GARCH modelleri uygulamış ve parametrik olmayan modellerin volatiliteyi modellemede daha iyi performans gösterdiği sonucuna varmıştır. Zhang, Lai ve Lin (2017) 28 küresel sermaye piyasasında hisse senedi getirilerindeki haftanın günü anomalilerini analiz etmek için GARCH modellerini kullanmış ve istatistiksel olarak anlamlı sonuçlar elde etmiştir. Kapusuzoğlu ve Ceylan (2018), 1987-2017 yılları arasında Borsa İstanbul sektör endekslerinin volatilite dinamiklerini araştırmış ve işlem hacmi, bilgi olayları ve sektör endekslerinin değişkenliği arasında pozitif bir ilişki bulmuştur. Kumar ve Biswal (2019) 2014-2018 yılları arasında Brezilya, Hindistan, Endonezya ve Pakistan'da borsa oynaklığını incelemiş, olumlu haberlerin piyasa davranışı üzerinde daha güçlü bir etkiye sahip olduğu volatilite kümelenmesini ve kaldıraç etkisini ortaya koymuştur. Ekinci, Akyildirim ve Corbet (2019) ABD makroekonomik haber bültenlerinin Borsa İstanbul üzerindeki dinamik etkilerini GARCH modelleri kullanarak incelemiş ve ABD makroekonomik haberlerinin Borsa İstanbul üzerindeki etkisini vurgulamıştır. Viljoen, Conradie ve Britz (2022) JSE All-Share endeksini kullanarak farklı zaman dilimlerinde GARCH modellerinin parametre tahminlerini ve volatilite tahminlerini analiz etmiş ve belirli bağlamlar için GARCH model performansını etkileyen faktörleri belirlemiştir.

Yöntem

Finansal literatürde ARCH modelini kullanan pekçok çalışma bulunmaktadır. Daha sonra yapılan çalışmalarda değişken sayısının artışıyla birlikte veri setinin aşırı derecede genişlemesiyle birlikte

ARCH modelinin bazı varsayımlarının karşılanmasının imkansız hale geldiği görülmüştür. Ayrıca, getiri serisinin önemli izole şoklara zayıf tepkisi nedeniyle ARCH modeli ile volatilite tahmininde aşırı tahmin riski bulunduğu tespit edilmiştir (Tsay, 2005). ARCH modeli içindeki bu sorunu ele almak için, Bollerslev (1986) ve Taylor (1986) modifiye edilmiş bir otoregresif model önermişlerdir. Bollerslev tarafından 1986 yılında geliştirilen genelleştirilmiş otoregresif koşullu heteroskedastiklik (GARCH) modeli olarak bilinen matematiksel yöntem, ARCH modellerine göre daha fazla tarihsel veriyi içermekte ve daha esnek bir gecikme yapısı sunmaktadır. Bu bakımdan GARCH modeli, ARCH modellerinin aksine, koşullu varyansta geçmiş hata terimlerinin ve onların gecikmiş değerlerinin etkisini içeren bir tür volatilite modelidir (Jorion, 2005). GARCH modeli, koşullu varyansın hesaplanmasında otoregresif ve hareketli ortalama terimlerinin varlığına izin vermektedir.

Basit GARCH(1,1) modeli, sıklıkla kullanılan ve finansal literatürdeki volatiliteyi inceleyen çalışmalarda sıklıkla kullanılan modellerden biridir. Basit GARCH(1,1) modelinin finansal zaman serilerinin volatilitesini açıklamadaki yeterli performans gösterdiği genellikle kabul edilmektedir (Hansen ve Lunde, 2005; Poon ve Granger, 2003).

Bu çalışmada, araştırma konusu olan tarihlerde verilerine sağlıklı bir şekilde erişilebilen BIST'te işlem gören sektör endeksleri arasından dokuz endeks analiz edilmiştir. Bu amaçla, 03/01/2013 - 16/08/2023 tarihleri arasında BIST SINAI (SNAI), BIST HIZMETLER (HIZM), BIST MALI (MALI), BIST TEKNOLOJI (TEKN), BIST BANKA (BNK), BIST BILISIM (BIL), BIST ELEKTRIK (ENR), BIST FINANSAL KIRALAMA (FINK), BIST GAYRIMENKUL YATIRIM ORTAKLIĞI (GYO) endeksleri için günlük veriler kullanılmıştır. Çalışmada kullanılan endeks getirileri, $\ln(P_t / P_{t-1}) * 100$ formülü kullanılarak hesaplanmıştır ve endekslerin günlük fiyat verileri investing.com web sitesinden elde edilmiştir.

Bulgular

GARCH modellerinden elde edilen sonuçlara göre, volatilitenin zaman içindeki kalıcı yapısına işaret eden GARCH teriminin varlığı tespit edilmiş, geçmiş volatilitenin beklenen volatilite için açıklayıcı bir gösterge olarak kullanılabileceği sonucuna ulaşılmıştır. Elde edilen bulgular ayrıca, BIST Finansal Kiralama Endeksi'nin (FINK) ele alınan diğer endekslere kıyasla önemli ölçüde daha yüksek bir ARCH parametresi sergilediğini göstermektedir. Bu yüksek parametre, FINK'in şoklara daha güçlü tepki verdiğini ve incelenen diğer endekslere kıyasla getiri değerlerinde daha büyük dalgalanmalara yol açtığını göstermektedir. Buna karşılık, hem BIST Bankacılık Endeksi (BNK) hem de BIST Mali Endeksi (MALI) en düşük ARCH parametrelerini sergilemekte ve şoklara daha az güçlü tepki verdiklerini göstermektedir. Sonuç olarak, BNK ve MALI endekslerinin volatiliteleri beklenmedik haberlere karşı daha az duyarlılık göstermekte ve getiri değerlerinde daha düşük seviyede dalgalanmalara yol açmaktadır.

Geçmiş dönemlerin volatilite üzerindeki etkisini temsil eden GARCH parametreleri incelendiğinde ise BIST Bankacılık Endeksi (BNK) oynaklığının diğer endekslere kıyasla geçmiş dönem şoklarından daha fazla etkilendiği anlaşılmaktadır. Bu durum, öngörülemeyen olayların tetiklediği oynaklığın aniden ortaya çıkmadığını, aksine zamana yayılarak uzun süreli etkilere yol açtığını göstermektedir. İncelenen endeksler arasında BIST Gayrimenkul Yatırım Ortaklığı'nın (GYO) önceki dönemlerdeki beklenmedik gelişmelerden en az etkilenen endeks olduğu görülmektedir.

Sonuç, Tartışma ve Öneriler

Bu araştırmanın temel amacı, Borsa İstanbul (BIST) bünyesindeki çeşitli sektörler arasındaki volatilite dinamiklerinin kapsamlı bir analizini ve karşılaştırmasını yapmaktır. Bunu başarmak için, araştırma analitik çerçeve olarak Genelleştirilmiş Otoregresif Koşullu Değişen Varyans (GARCH) modelini kullanmıştır. Çalışma, sektörler arasındaki karmaşık ilişkiler, piyasa şoklarının etkileri ve müteakip volatilite tepkileri ile ilgili önemli bulgular ortaya koymuştur. Çalışmada, 1 Mart 2013'ten 16 Ağustos 2023'e kadar uzanan geniş bir veri seti kullanılarak, farklı sektörlerdeki oynaklık gelişmelerini araştırmak için kapsamlı bir inceleme yapılmıştır. Bu analiz, sektörel davranışların anlaşılmasında tarihsel volatilitenin önemine ışık tutmaktadır.

GARCH modellerinden elde edilen sonuçlar, ARCH teriminin şok etkilerinin bir göstergesi olarak önemini vurgulamış, değişkenler arasında tutarlı istatistiksel anlamlılığını ve pozitif korelasyonunu göstermiştir. Özellikle, BIST Finansal Kiralama Endeksi (FINK) şoklara karşı yüksek bir duyarlılık sergilemiş ve getiri değerlerinde önemli dalgalanmalara yol açmıştır. Buna karşılık, BIST Bankacılık Endeksi (BNK) ve BIST Mali Endeksi (MALI) şoklara karşı nispeten daha düşük bir duyarlılık sergilemiş ve daha düşük volatilite tepkilerine işaret etmiştir. İlginç bir şekilde, GARCH parametreleri BIST Bankacılık Endeksi'nin (BNK) volatilitesinin geçmiş dönem şoklarından daha fazla etkilendiğini ve volatilitenin zaman içinde kademeli olarak yayıldığını göstermiştir.

Yukarıda bahsedilen görüşler, bireysel risk profillerine göre iyi dengelenmiş portföyler oluşturmayı amaçlayan yatırımcılar için önemli çıkarımlara sahiptir. Farklı seviyelerde volatiliteye tepki veren sektörlerin belirlenmesi, politika yapıcılar ve piyasa düzenleyicileri için değerli bir rehberlik sunarak sistematik olmayan riskleri azaltmak ve piyasa istikrarını artırmak için stratejik müdahalelerde bulunmalarını sağlayabilir. Ayrıca bu araştırma, Borsa İstanbul'daki sektörel dinamiklerin daha geniş bir şekilde anlaşılmasına önemli ölçüde katkıda bulunarak risk yönetimi stratejilerini zenginleştirmekte ve bilinçli karar alma süreçlerini kolaylaştırmaktadır.