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Testing the Adaptive Market Hypothesis in Equity Markets in Global Financial Crisis Periods: An Application on Borsa Istanbul Indices*

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Küresel Finansal Kriz Dönemlerinde Adaptif Piyasa Hipotezinin Pay Piyasalarında Test Edilmesi: Borsa İstanbul Endeksleri Üzerine Bir Uygulama

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Abstract

We aim in this study to investigate the existence of the Adaptive Market Hypothesis in the Turkish stock market during the global crisis periods. In other words, it has been investigated whether there are periods in the stock market in Turkey is both efficient and inefficient. For this purpose, Borsa Istanbul's main index (XU100) and selected sector indices (XBANK, XGIDA, XTEKS, XTRZM) were tested in the crisis environments, the Asian Financial Crisis, the American "Dotcom" crisis, the Mortgage crisis, the European debt crisis and finally the Covid-19 crisis. Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio tests were used in the research. According to the results obtained, findings compatible with the Adaptive Market Hypothesis were reached in all Borsa Istanbul indices within the scope of the research. It has been observed that there may be fluctuations in market efficiency at different frequencies and durations in relation to the nature of the crisis and the source of its output. It is thought that the study is original and will contribute to the literature for the following reasons; the Adaptive Market Hypothesis for the Turkish stock market has been tested for all crisis periods in the recent history and the effects of the crises on the sectors are also examined in terms of effectiveness.

Keywords: Behavioral finance, adaptive market hypothesis, automatic portmanteau test.

Makale Bilgileri

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Öz

Bu çalışmada, küresel kriz dönemlerinde Türkiye borsasında Adaptif Piyasa Hipotezinin varlığının araştırılması amaçlanmıştır. Diğer bir deyişle, Türkiye'de borsanın hem etkin hem de etkin olmadığı dönemlerin olup olmadığı incelenmiştir. Bu amaçla, Borsa İstanbul'un ana endeksi (XU100) ve seçilen sektör endeksleri (XBANK, XGIDA, XTEKS, XTRZM), Asya Finansal Krizi, Amerikan "Dotcom" krizi, Mortgage krizi, Avrupa borç krizi ve son olarak da Covid-19 krizi gibi dönemler için test edilmiştir. Araştırmada Otomatik Portmanteau ve Doğal Bootstrap Otomatik Varyans Rasyo testleri kullanılmıştır. Elde edilen sonuçlara göre araştırma kapsamındaki tüm Borsa İstanbul endekslerinde Adaptif Piyasa Hipotezi ile uyumlu bulgulara ulaşılmıştır. Krizin niteliğine ve çıkış kaynağına bağlı olarak piyasa etkinliğinde farklı sıklık ve sürelerde dalgalanmalar olabileceği gözlemlenmiştir. Çalışmanın şu nedenlerle özgün olduğu ve literatüre katkı sağlayacağı düşünülmektedir; Türk pay piyasasında Adaptif Piyasa Hipotezi yakın tarihteki tüm kriz dönemleri için test edilmiştir ve krizlerin sektörler üzerindeki etkileri etkinlik açısından ayrıca incelenmiştir.

Anahtar Kelimeler: Davranışsal finans, adaptif piyasa hipotezi, otomatik portmanteau testi

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Extended Abstract

Introduction and Research Questions & Purpose:

The Adaptive Market Hypothesis (AMH) was proposed by Andrew W. Lo in 2004 as a middle ground theory between the Efficient Markets Hypothesis and Behavioral Finance. According to Lo, the efficiency or inefficiency of markets is not an uninterrupted process. Every market can go through an efficient or inefficient process from time to time.

Therefore, if we can determine the efficient and inefficient periods of any stock exchange in different time periods, we can talk about the existence of the AMH. After all, in this study, we aimed to investigate the existence of the AMH in the Turkish stock market, especially during the global crisis.

Does the equity market in Turkey show AMH characteristics? Do global crisis periods affect market efficiency? Which sectors show more AMH characteristics? Does the nature of the crisis affect different sectors in different ways? This research aimed to find answers to these questions. In this study, XU100, XBANK, XGIDA, XTEKS and XTRZM indices were selected from Borsa Istanbul to examine the market behaviour in different sectors and the Asian financial crisis, the American Dotcom and Mortgage crises, the European debt crisis and finally the Covid-19 pandemic period were examined.

Literature Review:

A lot of research has been done to test whether markets are efficient or not. However, these studies are designed to reveal that the market in question is either efficient or inefficient until Lo. In order to prove the existence of AMH, it is necessary to observe both efficiency and inefficiency. In this respect, it would be more useful to take a look at the literature.

Lo's (2004) research on the American stock market, showing that market efficiency changes over time, provided the first evidence of AMH with Lo's description. Lo also stated in his 2012 study that the existence of market efficiency is not something that can be said as "all or nothing", so he continued to contribute to his hypothesis.

Apart from Lo, other researchers have investigated AMH many times. Lim and Brooks (2006) investigated the presence of AMH in 50 developed and developing country stock markets. According to the researchers, market efficiency periodically changed over time and revealed findings confirming AMH. Urquhart and McGroarty (2016) tested the predictability of returns in the S&P-500, FTSE-100, NIKKEI-225 and EUROSTOXX-50 indices. The researchers stated that the findings indicate that the predictability of returns in stock markets changes over time, consistent with AMH, and that each market adapts differently to certain market conditions.

Although he worked with data from different countries, Özkan's (2020a) studies in Turkey are remarkable. He analysed the BIST-100 index and the benchmark interest rate in Turkey, as well as daily data on gold, silver, Dollar, Euro, Pound, Yen and Yuan and reported that the results were consistent with the AMH.

Methodology:

In this study, the Automatic Portmanteau Test (AQ) developed by Escanciano and Lobato (2009) and the Wild Bootstrap Automatic Variance Ratio Test (WBAVR) developed by Kim (2009) were applied while performing the AMH compatibility test. In order to determine the change in return predictability over time in the tests, two-year (520) sliding window approaches were used in large samples (daily closing data). In the analyses for the selected crisis periods, the length of the moving sub-sample window is chosen to be 30 days, which is sufficient for statistical inferences (Özkan, 2021: 2-3; Mooney, 1996), as the data set is relatively small.

Results and Conclusions:

When the findings obtained are analysed, it is seen that the Turkish stock market is consistent with Lo's Adaptive Market Hypothesis within the series selected for the global financial crisis periods. All indices included in the scope of the analysis yielded results indicating the existence of the AMH. It has been observed that there may be fluctuations in market efficiency at different frequencies and durations in relation to the nature of the crisis and the source of its output.

1. Introduction

Many academic studies have been conducted on whether the future prices of financial assets can be predicted by different analyses and technical methods and whether these predictions can provide returns or not. With the hypotheses developed on this subject, researchers have conducted experimental studies on whether the return is predictable or not and numerous articles have been published. In the literature, two approaches known as the Efficient Market Hypothesis (EMH) and Behavioural Finance (BF) appear as two opposing camps on the predictability of returns. The Adaptive Market Hypothesis (AMH) was developed by Andrew W. Lo (2004) as an approach that can reconcile these two fronts.

Based on information flow efficiency and rational investors, the EMH argues that investment decisions based on past price movements cannot create a value above average return. Accordingly, the price has no memory and the distribution of past prices is random. In other words, past prices are not a meaningful data set for predicting future prices. According to EMH, it is not possible to generate an abnormal return above the average return of the market.

According to behavioural financiers, some assumptions of EMH are unrealistic. For example, a person, who is assumed to make rational decisions, cannot always make the best choice and even if he/she can access information efficiently, he/she may not make the right interpretation and draw a wrong road map for his/her investment. This may prevent the formation of efficient, accurate and real prices in the markets. In this respect, by taking the human emotion factor into account, it may be possible to obtain a return above the normal, average return with anomalies that may occur in a market that may not work effectively contrary to the framework stated by EMH.

For many years, many empirical studies have been conducted on the BF as an alternative to the EMH. Andrew W. Lo's Adaptive Market Hypothesis is very important in terms of approaching the issue from a different perspective. While researchers were conducting tests on whether the financial markets, they studied were efficient or inefficient, Lo was able to move away from the "either true or false" perspective. According to Andrew W. Lo, a market may be efficient in some periods and inefficient in others. With Lo's new approach, peace between the two opposing views, EMH and BF, has found a more harmonious process and the trend that the right thing is not only one of these two has also found ground. According to the EMH, the efficiency or inefficiency of markets is not a process that continues forever, but can be observed as a cycle of efficiency and inefficiency in different periods with dynamics such as the decisions made by people, experience gained over time, new investors joining or leaving the markets and adaptability. The Adaptive Market Hypothesis, which was introduced to the literature with Lo's perspective, is extremely important for taking the discussions on return predictability and generating above-average returns to a new dimension and opening a new page.

This study consists of five chapters. The first chapter is an introduction and summary of the importance of the study. The second chapter outlines the theoretical framework of the study and includes information on the efficient market hypothesis, behavioural finance and the Adaptive Market Hypothesis. The third section contains the data set, constraints and methodology of the study, while the fourth section contains the findings and interpretations of the study. In the fifth section, the implications of the study are given together with the recommendations made.

2. Literature Review

When the literature is reviewed, it is seen that the AMH has been tested with different methods in different markets and also on different instruments. The hypothesis has been tested not only for stocks, but also for commodity prices such as gold and silver. In the literature review below, these studies are given separately for Turkey and the world. We can summarize the studies conducted outside of Turkey regarding AMH as follows;

Lo (2004), the founder of AMH, worked with the monthly return data on the American stock markets for the period between 1871 and 2003, which can be considered as a very long period, and concluded that there were changes in the level of market efficiency over time.

Lim and Brooks (2006) investigated the presence of AMH in 50 developed and developing country stock markets with portmanteau test statistics, and they took the years between 1990 and 2005 as a data set. According to the researchers, market efficiency periodically changed over time and revealed findings confirming AMH.

Lim (2007) analyzed the data set between 1992 and 2005 with the returns of the USA, Japan, Argentina, Brazil, Chile, Indonesia, Malaysia, Mexico, Philippines, South Korea, Taiwan and Thailand stock markets. The researcher stated that the variation in the degree of efficiency of each market is different, which in a way indicates compliance with AMH.

Ito and Sugiyama (2009) worked with monthly rates of return from 1955 to February 2006 and applied autocorrelation tests on the S&P-500 index. Researchers have obtained findings that the efficiency of the market has changed over time.

Lee et al., (2010) investigated whether the efficient markets hypothesis in stock markets in 32 developed and 26 developing countries was valid between 1999 and 2007 by using stagnation tests and stated that the results they reached were inconsistent with the efficient markets hypothesis.

Lo (2012) states in his research that stock markets exhibit a relatively stable risk-return combination from the 1940s to the early 2000s and the principles that constitute the traditional investment paradigm are valid. However, he argues that AMH is more effective in understanding market behavior in the period after the 2000s. According to the AMH, the risk-return relationship may not be linear during periods of high volatility as stated in traditional investment principles. Moreover, market efficiency is not an all-or-nothing feature, but a continuum spanning the entire range between perfect efficiency and complete irrationality.

Zhou and Lee (2013) investigated the efficiency of the real estate mutual fund market in the USA with automatic variance ratio test and automatic portmanteau test, and they concluded that the degree of predictability of return in the market in question depends on time. Therefore, its findings yielded outputs consistent with the Adaptive Market Hypothesis.

Urquhart and McGroarty (2016) tested the predictability of returns in the S&P-500, FTSE-100, NIKKEI-225 and EUROSTOXX-50 indices with different models for the period of January 1990 to May 2014, and stated that they saw the existence of periods in which the return could be predicted statistically significantly. However, at the same time, statistically significant, they also identified periods in which the return could not be predicted in some periods. In this parallel, the researchers stated that the findings indicate that the predictability of returns in stock markets changes over time, consistent with AMH, and that each market adapts differently to certain market conditions.

Hiremath and Narayan (2016) investigated the Adaptive Market Hypothesis in the Indian stock market with the Generalized Hurst example derived using fixed and sliding windows. In the study, it was stated that it was concluded that the market in question was moving towards efficiency, and it was underlined that a positive and remarkable link was determined between the efficiency gap of the Indian market and the financial crises.

Khuntia and Pattanayak (2018) investigated the AMH and the predictability of changing returns in the Bitcoin market. Applying methods in the rolling-window framework to detect linear and non-linear dependence, the researchers stated that the efficiency in the Bitcoin market changes over time and accordingly, the AMH is confirmed.

Phan Tran Trung and Quang (2019) tested the Adaptive Market Hypothesis in two main indices of the Vietnamese stock market (HSX and HNX) with the automatic variance ratio test, automatic portmanteau test, generalised spectral test and time-varying dependent test approaches. The researchers stated that the empirical results confirm the AMH for both Vietnamese stock markets.

Chu et al. (2019) investigated whether two cryptocurrencies, Bitcoin and Ethereum, are consistent with the AMH in the framework of high-frequency trading and stated that their results are consistent with the AMH, indicating that market efficiency changes over time.

Shahid et al. (2020a) tested the existence of AMH in gold, silver and metal returns, using the variance ratio test, Runs test and auto-correlation tests. The researchers concluded that the Adaptive Market Hypothesis is more useful than the traditional efficient markets hypothesis to explain the changes in the returns of the selected instruments, and found fluctuations in the market efficiency of these instruments.

Tripathi et al. (2020) utilised quantitative regression methodology by researching 21 major global market indices between 1998 and 2018. According to the findings, the researchers concluded that market efficiency changes over time and is shaped according to the market situation.

Gemici (2021) tested the validity of AMH in the stock markets of Asia Pacific countries. From the beginning of 1993 to January 2020, the researcher used monthly closing data for a period from the beginning of 1993 to January 2020 and used automatic portmanteau, generalised spectral and wild bootstrap automatic variance ratio tests. According to the results, the existence of AMH in the stock markets of the relevant countries was detected.

Okorie and Lin (2021) evaluated the market efficiency in the US, Brazil, India and Russia stock market indices affected by the Covid-19 pandemic from the Adaptive window. It is stated that the spectral methods used to detect Martingale differences do not reveal any evidence of a significant change in efficiency in the US and Brazilian stock markets in the short, medium and long term. In terms of information efficiency, the researchers stated that in the long run, the Indian stock market became more inefficient after the pandemic, while the Russian stock market showed signs of greater efficiency.

Buğan et al. (2021) aims to examine market efficiency in the global Islamic stock markets in their study. The linear unit root test result shows that the global Islamic stock market indices exhibit random walk properties that are consistent with the Efficient Market Hypothesis. In other respects, nonlinear test results suggest global Islamic stock markets exhibit two-state regime-switching characteristics. The MS-ADF test results indicate that the world and developed Islamic stock markets are stationary only in the high volatility regime and this finding supports the Adaptive Market Hypothesis.

Adaramola and Obisesan (2021) investigated the AMH in the Nigerian equity market for the period 2000-2017 and applied unit root, autocorrelation, variance ratio, Run and BDS tests. According to the results of linear and non-linear tests, the market in question is consistent with the AMH.

Özkan (2021) was one of the researchers who tested market efficiency for a small sample set. Analyses were conducted using the WBAVR test on daily data of the six most affected developed countries (the US, Spain, the UK, Italy, France, and Germany) from the Covid-19 pandemic during the period from July 29, 2019 to January 25, 2021. The results of the analysis demonstrate that the stock markets of these countries deviated from market efficiency in some periods during the Covid-19 pandemic.

Munir et al. (2022) conducted their research with the aim of seeking evidence for the existence of AMH in the emerging markets of South Asia and worked with the data set between 1997 and 2018. The study also examined changing equity market conditions and anomaly profitability. The researchers stated that their findings are consistent with the Adaptive Market Hypothesis.

Karaömer and Kakilli Acaravci (2023), working with daily historical data, investigated the changing cryptocurrency market activity of Bitcoin, Ethereum, Litecoin, Ripple and Cardano. Their findings are consistent with the Adaptive Market Hypothesis. Also, these results indicate that the cryptocurrency market efficiency varies over time. Besides, the cryptocurrency market efficiency varies and generally corresponds to positive or negative news/events.

Bosnjak (2023) purposes in his paper is to evaluate Croatian stock market under adaptive market hypothesis. Findings from the paper supported validity of the adaptive market hypothesis for Croatian stock market. Furthermore, periods lower prices and higher liquidity were more likely to be inefficient and might serve as a signal of trading opportunities on Croatian stock market.

While it is seen that the studies on this subject for Turkey are limited, we can summarize the studies on AMH for Turkey as follows;

Doğukanlı and Ergün (2011) tested the overreaction hypothesis in the Borsa Istanbul indices they selected, using the data set for the period of July 1998 and June 2008, they stated that they did not detect any efficiency even in the weak form.

Ege et al. (2012) investigated the existence of January anomaly in the IMKB-30 and IMKB-50 indices using the power ratio method between 2001 and 2011, and stated that they detected the existence of this anomaly as a result. These results also can be evaluated that the relevant market is not efficient and may provide evidence for AMH.

Ertaş and Özkan (2018) tested the Adaptive Market Hypothesis on the US S&P-500 and Turkish BIST-100 indices and concluded that the AMH outperforms the EMH in explaining the behaviour of both indices.

Mandacı et al. (2019) examined the selected Borsa Istanbul indices (BIST-100, BIST-30 and BIST-Tum) in a daily period within a data set from the beginning of 2002 to April 2017. Using the variance ratio test and BDS test to investigate market efficiency, the researchers stated that index returns are unpredictable according to the variance ratio test, while the existence of the Adaptive Market Hypothesis is confirmed according to the non-linear tests.

Özkan (2020a) analysed the BIST-100 index and the benchmark interest rate in Turkey, as well as daily data on gold, silver, Dollar, Euro, Pound, Yen and Yuan with automatic portmanteau and wild bootstrap automatic variance ratio tests, and reported that the results were consistent with the AMH.

Köse İçigen (2020) tested the existence of AMH by working with daily and monthly periods for the BIST-100 index for a period from the beginning of 1988 to the end of 2017. In his study, the researcher reached the results of the linear Chow Denning, Joint Rank and Joint Sign tests and the non-linear BDS test and stated that AMH is valid in Turkey according to his findings.

Eyüboğlu and Eyüboğlu (2020) investigated the evidence for the existence of AMH by selecting BIST-100, industrial and financial indices from Borsa Istanbul indices, and obtained findings on the validity of AMH with autocorrelation and Runs tests. According to the variance ratio and nonlinearity tests, they show that stock returns are predictable and therefore the market in question is not efficient. Besides the whole period, the data set is divided into sub-periods to examine the evolution of market efficiency. According to this study, there is no autocorrelation in the sub-periods of 1996-1998, 2002-2004, 2005-2007, 2011-2013, 2014-2016 and 2017-2019.It has been determined that stocks are not independent from past movements in 1999-2001 and 2008-2010 periods. These periods coincide with the 2001 crisis and the 2008 financial crisis. In this context, it can be interpreted for BIST-100 that the crises reduce the efficiency of the market.

Kılıç (2020) examined the BIST-100 index within the framework of AMH with automatic portmanteau Box-Pierce, generalised spectral, wild bootstrap automatic variance ratio tests. Kılıç, who investigated a set of data from the beginning of 2013 to 26 April 2019, did not detect a time-varying degree of efficiency in the index in question according to market conditions and concluded that AMH is not valid.

Çipe (2021) questioned the validity of AMH in 33 indices selected from developed and developing countries. The researchers applied two-break unit root tests to linear data sets and ESTAR-type CSR and tau (τ) unit root tests to non-linear data sets. Although the results reveal different findings according to the tests performed, the validity of the AMH for the US, China, Russia, Japan, Japan, India and Poland indices is moderate. On the other hand, AMH is not valid for the UK, Germany, Indonesia, Thailand and Turkey.

Burhan and Acar (2021) investigated the return predictability in Borsa Istanbul (BIST-100 index) within the framework of AMH by considering the daily closing data between 1988 and 2017, and used automatic portmanteau and generalised spectral test. The researchers also studied the Hidden Markov model for the return predictability test. According to the results, strong evidence was obtained for the validity of AMH in the BIST-100 index, and the Hidden Markov model confirmed a periodic return predictability.

3. Methodology

In this study, the Automatic Portmanteau Test (AQ) developed by Escanciano and Lobato (2009) and the Wild Bootstrap Automatic Variance Ratio Test (WBAVR) developed by Kim (2009) were applied while performing the AMH compatibility test.

The Portmanteau test (Ljung and Box, 1978) and the variance ratio test (Lo and MacKinlay, 1988) are widely used in experimental finance as a means of assessing the predictability of asset returns. However, they are well-known to suffer from deficient properties in small samples, especially under conditional heteroskedasticity widely observed in financial data (Charles et al., 2015: 9). In addition, the fact that it requires ad hoc choices in determining the lag length or holding periods further worsens the small sample properties (Özkan, 2020a: 66). While the AQ and WBAVR tests, in which the lag length and holding period selections are made automatically, help researchers to eliminate statistical difficulties in this context, they have been widely used in the literature and have become frequently used methods in market efficiency tests. Notably, these tests are designed to test for the martingale difference sequence property, being robust to non-normality and conditional heteroscedasticity that are typical features of stock returns (Charles et al., 2015: 2).

In order to determine the change in return predictability over time in the tests, two-year (520) sliding window approaches were used in large samples (daily closing data). The shifted sample set approach aims to track the evolution of market efficiency over time and allows us to assess the relative efficiency of markets in pre-crisis and crisis periods, respectively (Lazăr et al., 2012: 340). In the analyses for the selected crisis periods, the length of the moving sub-sample window is chosen to be 30 days, which is sufficient for statistical inferences (Özkan, 2021: 2-3; Mooney, 1996), as the data set is relatively small. In addition, (Charles et al., 2011), in their study using Monte Carlo test, stated that the WBAVR test shows sufficient small sample (size and power) properties and is more successful than other variance ratio tests for return predictability. Kim (2009) proposes a wild bootstrap automated variance ratio test (WBAVR) that does not exhibit size distortion and has desirable power properties under conditional variance (Rahman et al., 2017: 183).

The AQ and WBAVR tests are applied to the first sub-sample window and this window is advanced to one day of observation. The data set is then subjected to the AQ or WBAVR test again and this process is continued until the end of the sample data set. Thus, *p*-values are obtained for each window. For example, when the sliding window process is shown with window size = 5, initially the range from 1 to 5 is from 1 to 5, which represents that 5 days of historical data are used to predict the next day time series data. The window then shifts to the right one day to cover the other 5 days (from 2 to 6) observations to predict the next day. The process continues until the time series data for a specific time period considered for experimental purpose is exhausted (Hota et al., 2017: 1148). In addition, while applying the WBAVR test, the number of bootstrap replications (B) is used as 500 in this study, as it is frequently preferred in the literature and as in Rahman et al. (2017) and Charles et al. (2015).

While the horizontal lines seen in the result graphs indicate the importance level of 5% in red and 10% in blue, the p values seen with the black line indicate that the markets are not efficient in periods when they are below the importance levels. In other words, it shows that the rate of return is predictable in these periods. On the other hand, the p-values in the sections that are above the mentioned importance levels indicate that there is no predictable return, that is, the markets are efficient.

3.1. Automatic Portmanteau Test

The portmanteau test, referred to as the Q tests developed by Box and Pierce (1970), is one of the tools used to test whether a group of autocorrelation coefficients in a financial time series is significantly different from zero (Gemici, 2021: 134). In its simplest form, the employed statistic is just the sample size times the sum of squares of the first sample autocorrelations, which is compared with critical values from a chi-square distribution (Escanciano and Lobato, 2009: 140).

While AQ tests are used for testing time series, they have been tried to be improved over the years due to the difficulties mentioned in the previous section. Escanciano and Lobato (2009) aimed to overcome these limitations in their study since the test is developed under the assumption of independence and the number of autocorrelations p is chosen randomly by the researcher. Accordingly, in their paper published in 2009, they stated that their new approach overcomes both challenges by proposing a Portmanteau statistic that allows for nonlinear dependence and where the parameter p is not fixed but automatically selected from the data (Escanciano and Lobato, 2009: 141).

Box and Pierce (1970) used the following formula to test whether the autocorrelation coefficient in financial time series is different from zero;

$$Q_p = T \sum_{i=1}^{p} \hat{\rho}^2(i) \quad \textbf{(1)}$$

Here, sample size is denoted by T and lag length is denoted by ρ. In this parallel, the hypothesis is established as follows;

$$H_0: \rho_1 = \rho_2 = \rho_3 = \ldots = \rho_k = 0$$

$$H_1: \rho_1 \neq \rho_2 \neq \rho_3 \neq \ldots \neq \rho_k = 0 \quad \textbf{(2)}$$

$\hat{\rho}(i)$, in equation 1 is the sample autocorrelation of the rate of return time series Yt of order i. Lobato et al. (2001) proposed the test statistic in equation 3 when Yt exhibits conditional variance (Özkan and Şahin, 2020: 2397).

$$Q_\rho^* = T \sum_{i=1}^{p} \tilde{\rho}^2(i), \qquad \tilde{\rho}(i) = \hat{y}^2(i) \,/\, \hat{\tau}(i) \quad \textbf{(3)}$$

In this equation $\hat{y}^2(i)$ *is* the sample autocovariance of Y_t at level i and $\hat{\tau}(i)$is the sample autocovariance of Y_t^2 at level i.

In the AQ test developed by Escanciano and Lobato (2009), the most appropriate value of the lag length (p) is determined depending on the data. Accordingly, the equation with asymptotic chi-square distribution depending on the Akaike (AIC) and Bayesian information criterion (BIC) is written as follows:

$$AQ = Q_{\tilde{p}}^*,\ p = \{p\text{: } 1 \leq p \leq d;\ L_p = Q_\rho^* - \pi(p, T, q) \geq L_h,\ h = 1, 2, \ldots, d\} \quad \textbf{(4)}$$

Here d is a fixed upper bound (Escanciano and Lobato, 2009: 143). Note that the penalty term is a balance between AIC and BIC (Charles et al., 2015: 11). (p, T, q) is as follows;

$$\pi(p,T,q) = \begin{cases} p\log(T), max_{1\le i\le d}\sqrt{T}\ |\tilde{\rho}(i)| \le \sqrt{2{,}4\log(T)} \\ 2p \quad ,max_{1\le i\le d}\sqrt{T}\ |\tilde{\rho}(i)| > \sqrt{2{,}4\log(T)} \end{cases} \quad \textbf{(5)}$$

and q is a fixed positive number. Escanciano and Lobato (2009) suggest q =2.4 for the finite sample. The upper bound d does not affect the asymptotic null distribution of the test, although it may have an impact on power if it is chosen too small (Zhu et al., 2017: 904).

3.2. Wild Bootstrap Automatic Variance Ratio Test

Another statistical method frequently used in the literature to test the rates of return of financial time series is variance ratio (VR) tests. The Automatic Variance Ratio Test (AVR) was developed by Choi (1999). The null hypothesis of this test states that the rates of return of the data set are not sequentially correlated and is formulated as follows;

$$AVR(\tilde{k}) = \sqrt{T/_{\tilde{k}}}\,[VR(\tilde{k}) - 1]/\sqrt{2} \quad \textbf{(6)}$$

T is the sample size, $\tilde{k}$ is the optimal choice of k. In the equation $VR(\tilde{k})$ is as follows;

$$VR(\tilde{k}) = 1 + 2\sum_{i=1}^{T-1} m(i/\tilde{k})\,\hat{\rho}_i \quad \textbf{(7)}$$

and, $\hat{\rho}_i = \frac{\sum_{t=1}^{n-i}(Y_t-\hat{\mu})(Y_{t+1}-\hat{\mu})}{\sum_t^n (Y_t-\hat{\mu})^2}$ **(8)**

is the sample autocorrelation coefficient.

$$k(x) = \frac{25}{12\pi^2x^2}\left[\frac{\sin(6\pi x/5)}{6\pi x/5} - \cos 6\pi x/5\right] \quad \textbf{(9)}$$

is the quadratic spectral kernel for the weighting function $k(.)$ (Kılıç, 2020: 33).

Kim (2009) states that AVR can be deficient for small samples (Cavalheiro et al., 2012: 305). In parallel, (Kim, 2009) suggested Mammen's (1993) wild-bootstrap approach to strengthen AVR in cases where the data set is subject to conditional and unconditional variance, which should be done in three stages.

- Form a bootstrap sample of size T,
- *Calculate* $AVR^*(k^*)$ *the AVR(k*)* statistic calculated from $\{Y_t^*\}_{t=1}^T$;
- Repeat 1 and 2 *B times*, to produce the bootstrap distribution of the *AVR* statistic $\{AVR^*(k^*;j)\}_{j=1}^B$

If the p value obtained as a result of the WBAVR test is lower than the value determined as the level of significance, the null hypothesis of "no return predictability" is rejected at the value determined as the level of significance (Özkan, 2020b: 332).

4. Data

In this part of the study, the descriptive statistics of the data set selected for testing the AMH during the global financial crisis, the findings of these analyzes and the comments on the said findings are included. In order to make the study more meaningful, a large data set covering the period between January 3, 1997 and December 31, 2021 for each index was also examined. In addition to Borsa Istanbul 100 Index (XU100), banking (XBANK), food (XGIDA), textile (XTEKS) and tourism (XTRZM) sector indices are included in the scope of the study.

Said crisis periods are the Asian financial crisis of 1997, the American "Dotcom" crisis that broke out in early 2000, the Mortgage crisis that flared up in the United States in 2008 and turned into a global financial crisis, the European debt crisis that emerged immediately after this period, and finally the pandemic period that started at the end of 2019 with the virus known as Covid-19. After the literature research, the periods June 1997-January 1998 for the Asian crisis, March 2000-October 2002 for the Dotcom crisis, July 2007-June 2009 for the mortgage crisis, and December 2009-December 2012 for the European debt crisis were selected. In order to investigate how market efficiency (predictability of return) varies depending upon different major financial crises, we divide our data set into different sub-samples for said crisis period (Shahid et al., 2020b: 70).

Data are obtained from the website tr.investing.com (Accessed on 5 January 2022). In order to investigate how market efficiency has changed during the major global crises in the Turkish equity market, the selected crisis periods, related indices and data set range are shown in the following table;

Table 1. Data Set Descriptions

	XU100, XBANK, XGIDA, XTEKS, XTRZM
Asian Financial Crisis	June 2, 1997 - January 28, 1998
Dotcom Crisis	March 1, 2000 - October 31, 2002
Mortgage Crisis	July 2, 2007 - June 30, 2009
European Debt Crisis	December 1, 2009 - December 31, 2012
Covid-19 Crisis	December 2, 2019 - December 31, 2021

For each specified index, daily returns in the five crisis periods were analyzed. Returns are calculated by taking the natural logarithmic first differences of daily closing prices in order to stationarise the data, and daily rates of return are multiplied by 100 to avoid convergence (Charles et al., 2015: 14). In this parallel, returns are calculated with the following formula;

$$r_t = [ln(P_t) - ln(P_{t-1})] \; X \; 100 \quad \textbf{(10)}$$

Here, $ln(P_t)$ is the natural logarithm of the closing price of the index on day *t,* while $ln(P_{t-1})$ is the natural logarithm of the closing price on day *t-1*. The difference between these two values is taken and multiplied by 100 to calculate the return on day *t* (r_t).

Microsoft Excel 2016, IBM SPSS 24 and R Studio programmes were used in the analyses.

Descriptive statistics for the logarithmic returns of the data for the large sample set (3 January 1997-31 December 2021) are given in Table 2.

Table 2. Descriptive Statistics for Large Sample Sets

	Number of Observations	Mean	Standard Deviation	Skewness	Kurtosis	Jarque-Bera	ARCH-LM
XU100	6249	0,083055	2,267477	-0,090912	7,230737	13597* (0,0000)	850,97* (0,0000)
XBANK	6248	0,081493	2,770691	0,070046	4,587581	5473* (0,0000)	612,02* (0,0000)
XGIDA	6248	0,084624	2,177954	-0,231438	7,668229	15335* (0,0000)	1088,50* (0,0000)
XTEKS	6248	0,072562	2,138185	-0,816176	9,181056	22598* (0,0000)	958,36* (0,0000)
XTRZM	6248	0,060822	2,985208	0,077331	6,686133	11622* (0,0000)	1047,70* (0,0000)

Note: "*", means significant at 1% significance level. Values in parentheses indicate probability values.

Looking at Table 2, it can be said that the highest average return was observed in the XGIDA index, while the lowest average return rate was observed in the XTRZM index. In addition, when the standard deviation data is analyzed, it is seen that the volatility is the highest in XTRZM, while the XTEKS index has the lowest level of volatility. Considering the skewness and kurtosis values, which will give information about whether the data is normally distributed or not, it can be stated that the return rates of the XU100, XGIDA and XTEKS indices are skewed to the left, while the others are skewed to the right. The kurtosis values are greater than 3 for each data set, and the series are flattened and the distributions are pointed, they are leptokurtic sets. According to the Jarque Bera test statistic, each return rate series is significant at the 1% significance level, that is, the series are not normally distributed. Engle's (1982) LM test was used to question the existence of ARCH effect with 5 lags and it was found that all return data showed conditional varying variance. When the results of descriptive statistics are examined, it can be stated that the test methods used are suitable for the data series in question.

Descriptive statistics regarding the logarithmic returns of the data set selected for the crisis periods are given in Table 3 below.

Table 3. Descriptive Statistics for Sub-Sample Sets

	Number of Observations	Mean	Standard Deviation	Skewness	Kurtosis	Jarque-Bera	ARCH-LM
XU100							
Asian Financial Crisis	170	0,470134	2,958714	-1,049112	3,954440	133.1341* (0,0000)	15,986* (0,0068)
Dotcom Crisis	665	-0,066426	3,417159	0,095926	4,401006	527.4922* (0,0000)	111,64* (0,0000)
Mortgage Crisis	502	-0,048328	2,410886	0,084500	2,215232	100.1169* (0,0000)	32,164* (0,0000)
European Debt Crisis	779	0,069957	1,429008	-0,420904	2,521653	225.4213* (0,0000)	70,499* (0,0000)
Covid-19 Crisis	523	0,105650	1,632923	-1,649504	8,630489	1823.9006* (0,0000)	55,826* (0,0000)
XBANK							
Asian Financial Crisis	170	0,544300	3,520155	-0,619397	1,790517	31.2267* (0,0001)	25,02* (0,0001)
Dotcom Crisis	665	-0,096896	3,804901	0,113446	3,081990	259.1526* (0,0000)	51,902* (0,0000)
Mortgage Crisis	502	-0,029967	3,114671	0,180986	1,792830	67.7437* (0,0000)	27,658* (0,0000)
European Debt Crisis	779	0,062570	1,890071	-0,278727	1,476284	79.1538* (0,0000)	54,895* (0,0000)
Covid-19 Crisis	523	0,011829	2,178084	-0,347967	3,911108	335.5791* (0,0000)	27,039* (0,0009)
XGIDA							
Asian Financial Crisis	170	0,371745	2,611480	-0,710229	2,786164	64.5292* (0,0000)	11,342* (0,0450)
Dotcom Crisis	665	0,062911	3,256143	0,167673	6,871736	1288.5473* (0,0000)	172,58* (0,0000)
Mortgage Crisis	502	-0,008510	2,218370	-0,247856	1,962813	83.1339* (0,0000)	26,708* (0,0000)
European Debt Crisis	779	0,091950	1,451291	-0,993499	8,251695	2305.4391* (0,0000)	67,119* (0,0000)
Covid-19 Crisis	523	0,100670	1,691846	-1,626751	7,358805	1383.3807* (0,0000)	54,589* (0,0000)
XTEKS							
Asian Financial Crisis	170	0,232319	2,613778	-1,133775	4,616539	175.8446* (0,0000)	42,088* (0,0000)
Dotcom Crisis	665	0,035041	3,240579	-0,409387	6,196299	1063.3567* (0,0000)	149,84* (0,0000)
Mortgage Crisis	502	-0,038995	1,920051	-0,962729	4,065713	413.9961* (0,0000)	65,005* (0,0000)
European Debt Crisis	779	0,098566	1,553600	-1,034729	10,296592	3530.6376* (0,0000)	124,94* (0,0000)
Covid-19 Crisis	523	0,184833	2,113963	-1,616014	7,398916	1392.9981* (0,0000)	94,264* (0,0000)

Table 3 (Cont.). Descriptive Statistics for Sub-Sample Sets

XTRZM							
Asian Financial	170	0,455340	3,827513	-0,173939	1,035027	7.5034* (0.02348)	12,011* (0,0346)
Dotcom Crisis	665	-0,143280	4,591449	0,260101	3,524430	344.7568* (0,0000)	149,43* (0,0000)
Mortgage Crisis	502	-0,157963	2,830573	-0,194672	2,808914	163.5374* (0,0000)	50,438* (0,0000)
European Debt Crisis	779	-0,026451	1,851172	-0,573871	5,530200	1019.8489* (0,0000)	58,662* (0,0000)
Covid-19 Crisis	523	0,314129	2,855729	-0,709156	2,984764	232.566* (0,0000)	88,116* (0,0000)

Note: "*", means significant at 1% significance level. Values in parentheses indicate probability values.

When the descriptive statistics of the selected Borsa Istanbul indices are analyzed during the determined global crisis periods, it is observed that the highest average return was realized in the banking index (XBANK) during the Asian crisis period. In addition, it can be stated that negative average returns were realized in XU100 and XBANK indices during Dotcom and Mortgage crises, while positive returns were detected in other crisis periods. In the XGIDA and XTEKS indices, only the figures for the Mortgage crisis period indicate a negative average return. While positive returns were observed in the XTRZM index only in the data period selected for the Asian crisis, negative returns were observed in all other crisis processes. Looking at the standard deviation data, it is seen that the highest volatility was observed in the tourism sector index during the Dotcom crisis period, and the least volatility was observed in the XU100 index during the European crisis period. Skewness values indicate left skewness for the Asian, European and Covid-19 period sets of the XU100 and XBANK indices, and right skewness for the Mortgage and Dotcom crisis periods. The XGIDA and XTRZM indices are skewed to the right during the Dotcom crisis and to the left during the other crises. The XTEKS index data set is skewed to the left for all crisis periods. The series with kurtosis values less than 3 are Mortgage and European crisis periods for XU100, Asian, Mortgage and European crisis periods for XBANK, Asian and Mortgage crisis periods for XGIDA, Asian, Mortgage and Covid-19 crisis periods for XTRZM. For XTEKS, the kurtosis values of all data sets are above 3. The outputs of the Jarque-Bera test indicate that the data sets are not normally distributed at the 1% significance level. The existence of the ARCH effect was examined using Engle's (1982) LM test with 5 lags and it was found that all return data showed conditional variable variance. When the results of descriptive statistics are evaluated, it can be stated that the test methods used are suitable for the data series in question.

5. Empirical results

The graphs below show the *p* values produced by the AQ and WBAVR results for the large sample set of the indices evaluated within the scope of the research, respectively (January 3, 1997-December 31, 2021).

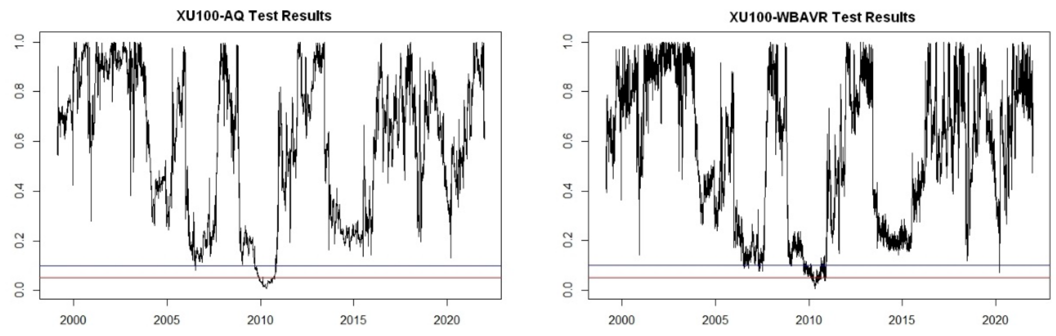

Figure 1. XU100-Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

When the results in Figure 1 are evaluated, it can be seen that between 2005 and 2011 periods with return predictability can be detected, while the XU100 index is effective in other periods, that is, a process in which the return is unpredictable. In the WBAVR results, unlike the AQ test, it was determined that the predictability of return, that is, the market, was not efficient at the beginning of 2020.

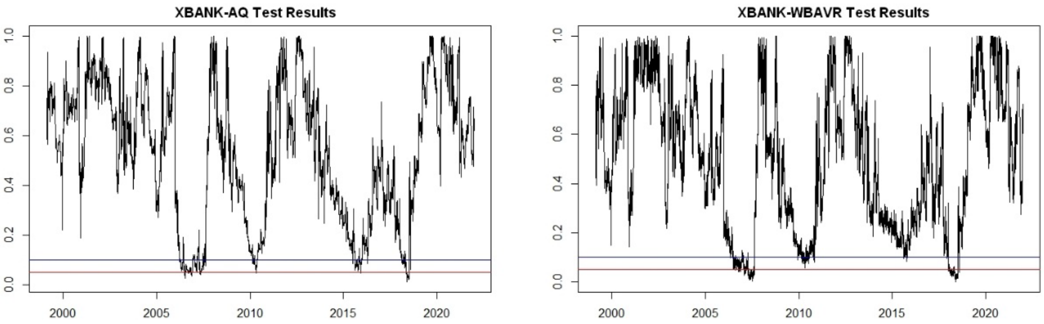

Figure 2. XBANK-Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 2 indicates that the return is predictable according to the AQ test statistic for the XBANK index for the years 2006 and 2011, as well as for the years 2015 and 2019. While the graph showing that the market was not efficient in the period between 2006 and 2011 is quite evident, there are also consequences for the predictability of returns, especially in the period between 2015 and 2019. While the WBAVR test results point to the predictability of returns in the XBANK index between 2006 and 2011, it also shows that the market in question was not efficient for the years 2017 and 2018. Unlike the AQ test results, it can be said that the sign that the market was not efficient in the WBAVR test in 2015 and 2016 was not very strong.

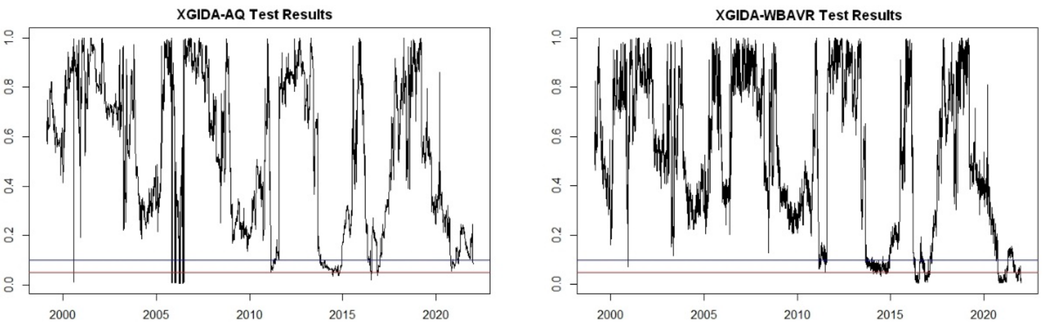

Figure 3. XGIDA-Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 3 shows the AQ and WBAVR results for the XGIDA index. According to the results of both tests, it has been determined that the *p* values have gone through periods below the significance levels with 2011. In the AQ test statistics, unlike WBAVR, the periods in which the market was not efficient in 2005 and 2006 can be followed. In addition, this situation is observed again after 2000. According to the results of both statistics, it can be said that the XGIDA index shows efficient and inefficient processes in the selected period, and this can be considered as a proof of AMH.

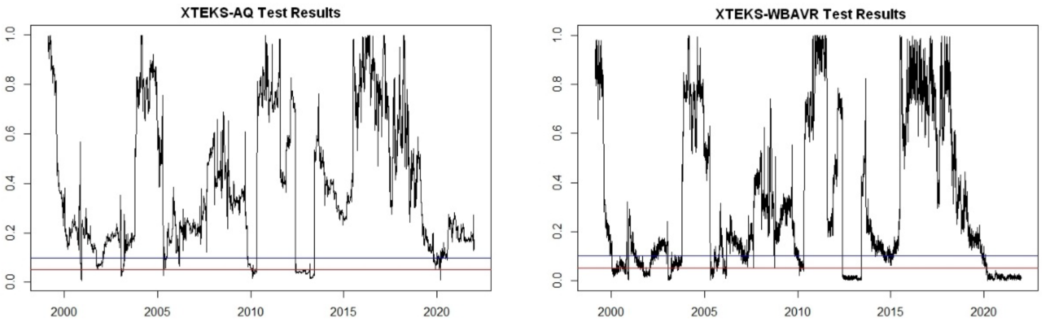

Figure 4. XTEKS-Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

The results of the XTEKS index are shown in Figure 4. Both test results are generally consistent with each other with some differences. The tests seem to indicate that between 2000 and 2005, there were periods of predictability of returns in the relevant market. In the period between 2010 and 2015, *p* values indicate an inefficient market. As the difference between the AQ and WBAVR results, we can say that for this index, WBAVR reveals a significantly inefficient market image of XTEKS after 2020. For the AQ test statistic, the *p* values have risen above the significance levels since the beginning of 2020, showing that there is no return predictability.

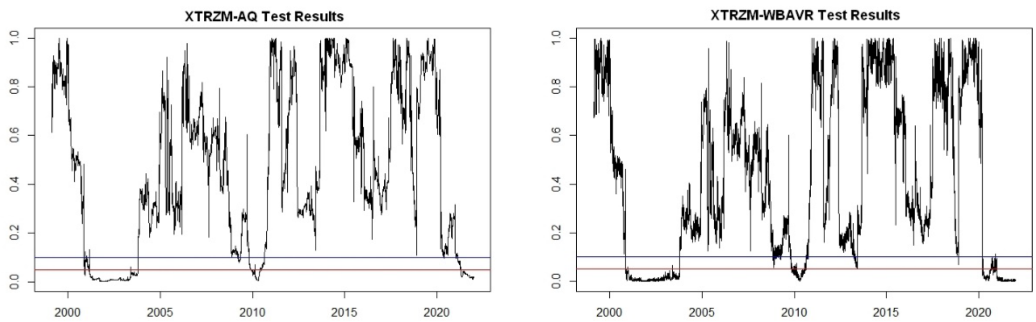

Figure 5. XTRZM-Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 5 reflects the results of XTRZM, the AQ and WBAVR of the index covering the stocks of tourism sector companies. According to AQ statistics, while the XTRZM index showed a predictable structure of returns in 2000 and 2005, it also showed an inefficient market feature in 2010 and after 2020. WBAVR test results, similar to the AQ outputs, reveal determinations regarding the inefficiency of the market in the same periods. In other periods, this sector index shows an efficient market structure.

When we evaluate the analysis results for the period between January 3, 1997 and December 31, 2021, in general, we can say that the XU100 indices have less predictable returns periods than other sector indices. However, it can be determined that the findings indicating the inefficient periods of the market are more common in the XTEKS and XTRZM indices.

The graphs below show the *p*-values produced by the AQ and WBAVR results for the data set determined within the framework of the selected crisis periods of the indices evaluated within the scope of the research, respectively.

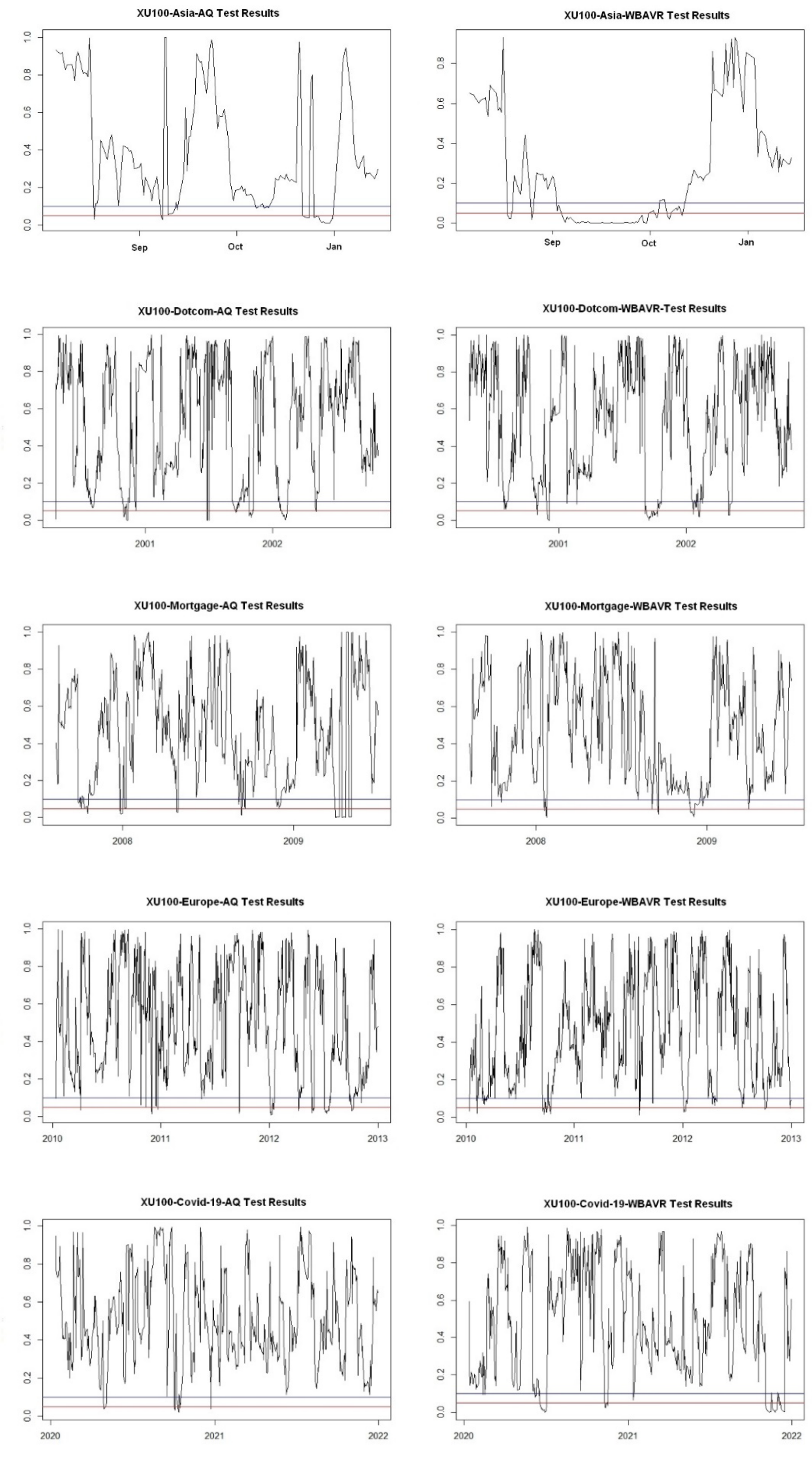

Figure 6. XU100-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 6 shows the results generated from the AQ and WBAVR test results of the XU100 index for the selected crisis periods. Although efficient and inefficient processes appear from time to time in different periods within the data range selected for each crisis period, in conclusion, both AQ and WBAVR test findings indicate that the return predictability in the series in question changes over time. Therefore, the results indicate that within each crisis period, there are periods of return predictability of the relevant index, and at the same time, there are periods when returns are unpredictable, that is, when the market is efficient. In this respect, these findings are consistent with the AMH.

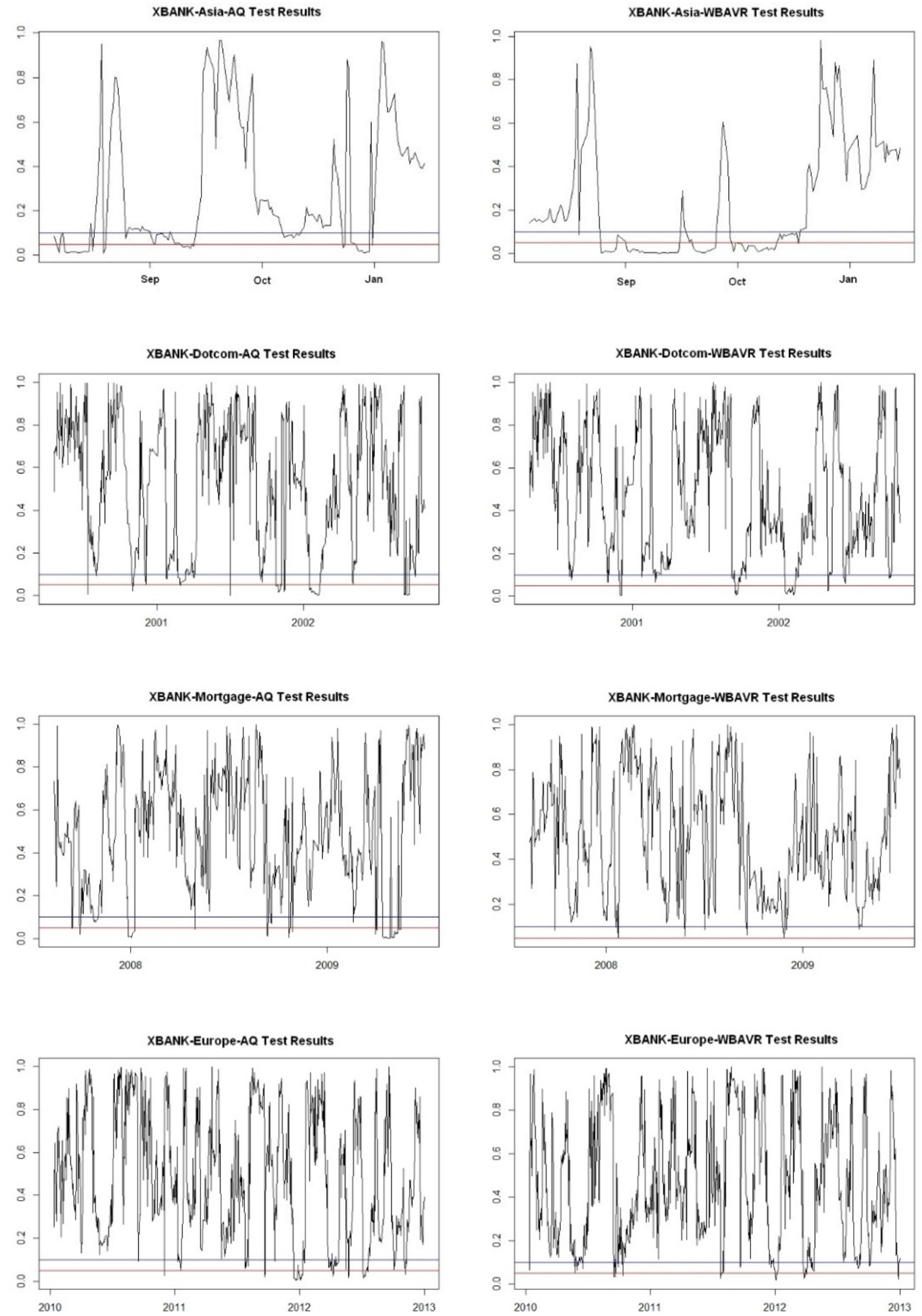

Figure 7. XBANK-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

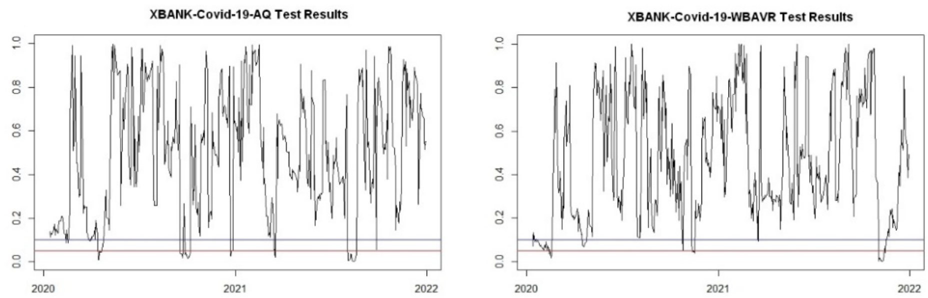

Figure 7 (Cont.). XBANK-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 7 shows the results of the AQ and WBAVR tests for the XBANK index. Although the results of both analyses reveal similar findings, the graphs observed during the European debt crisis differ slightly. Nevertheless, these results indicate that return predictability has changed over time, producing outputs that support the AMH.

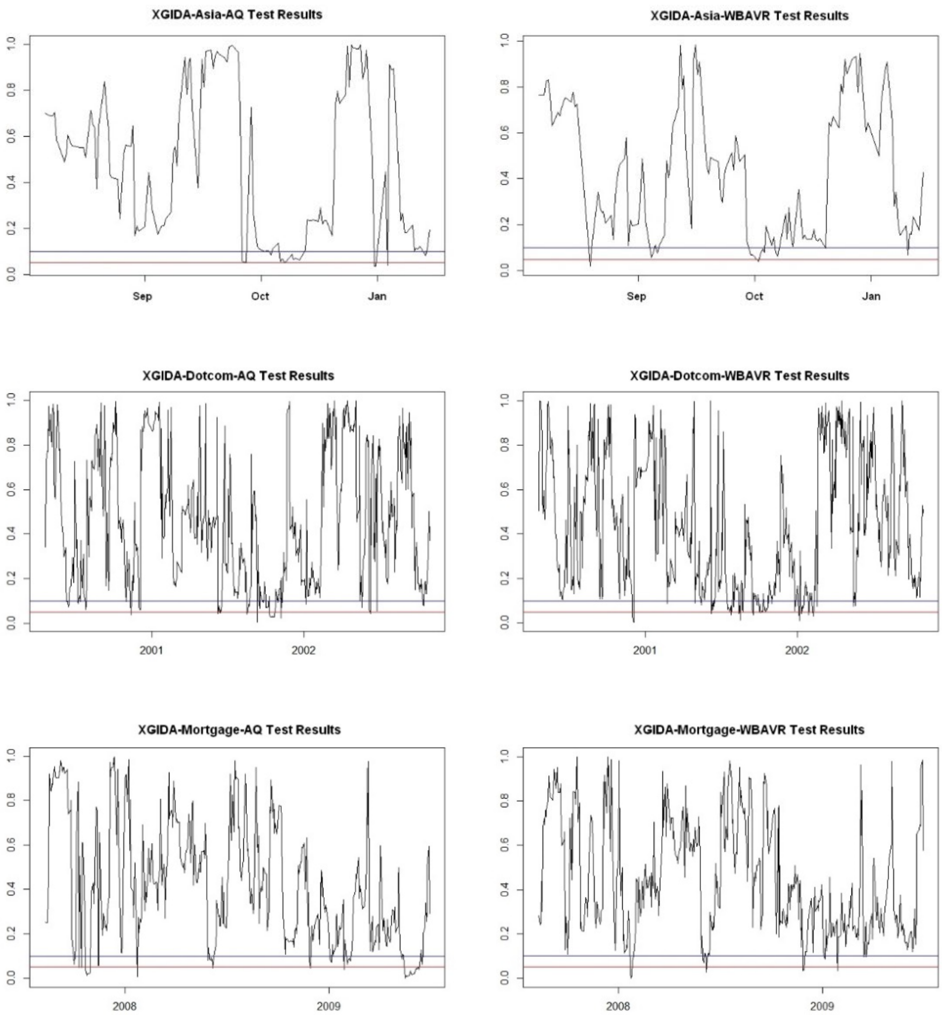

Figure 8. XGIDA-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

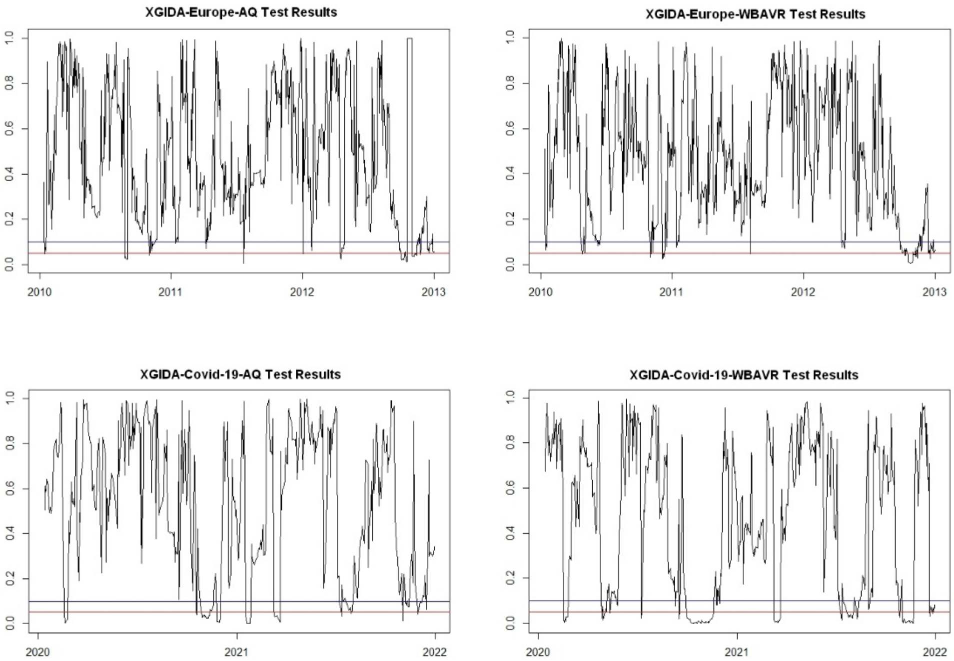

Figure 8 (Cont.). XGIDA-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 8 shows the results of the analysis for the XGIDA index for the selected crisis periods. Although the findings show that market efficiency has changed from time to time in line with the crisis period results of other indices, it is noteworthy that return predictability has shown sharper changes, especially during the Covid-19 and European debt crisis periods.

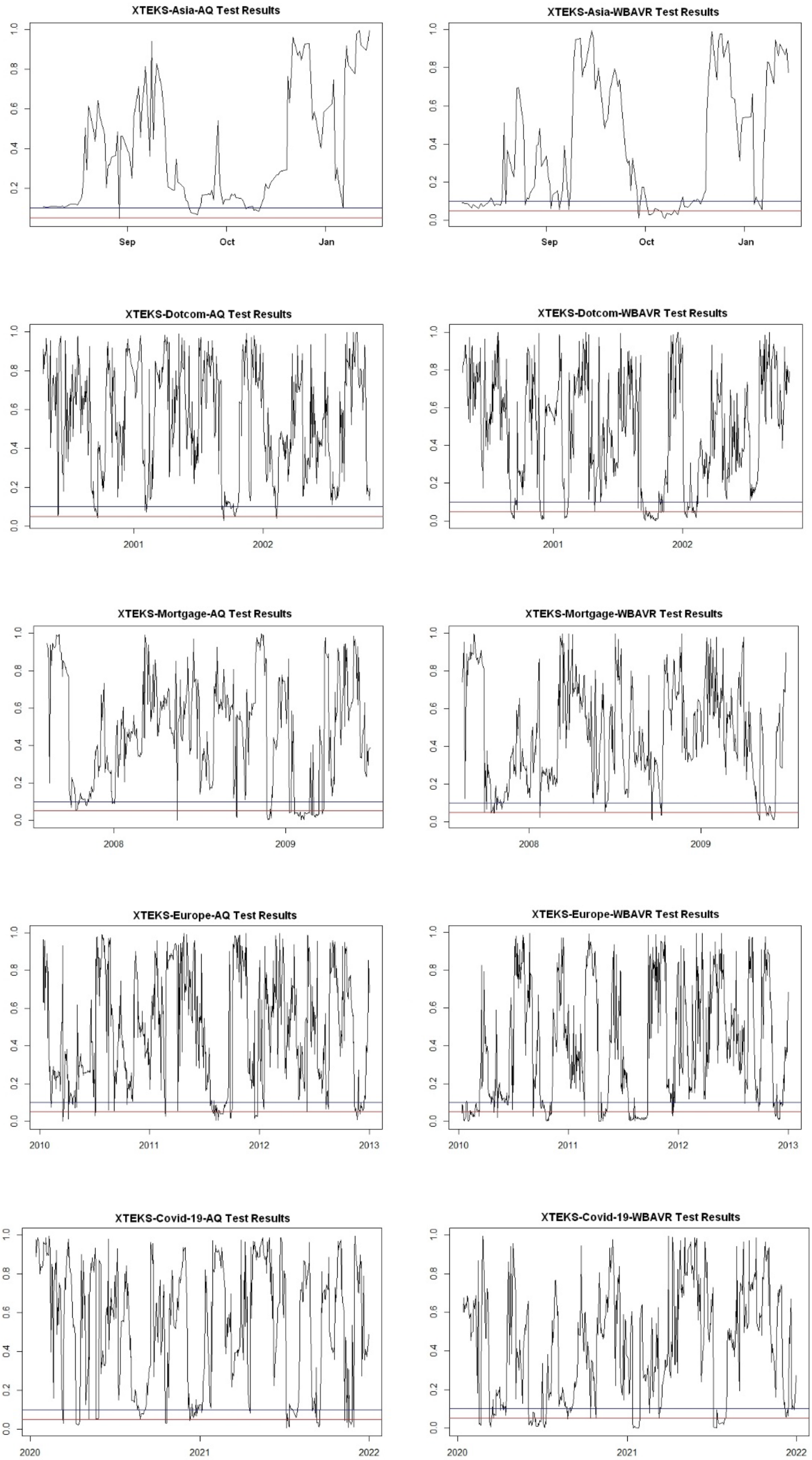

Figure 9. XTEKS-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

The AQ and WBAVR results for the XTEKS index in Figure 9 produce similar results to each other, revealing the variability in return predictability during these crisis periods.

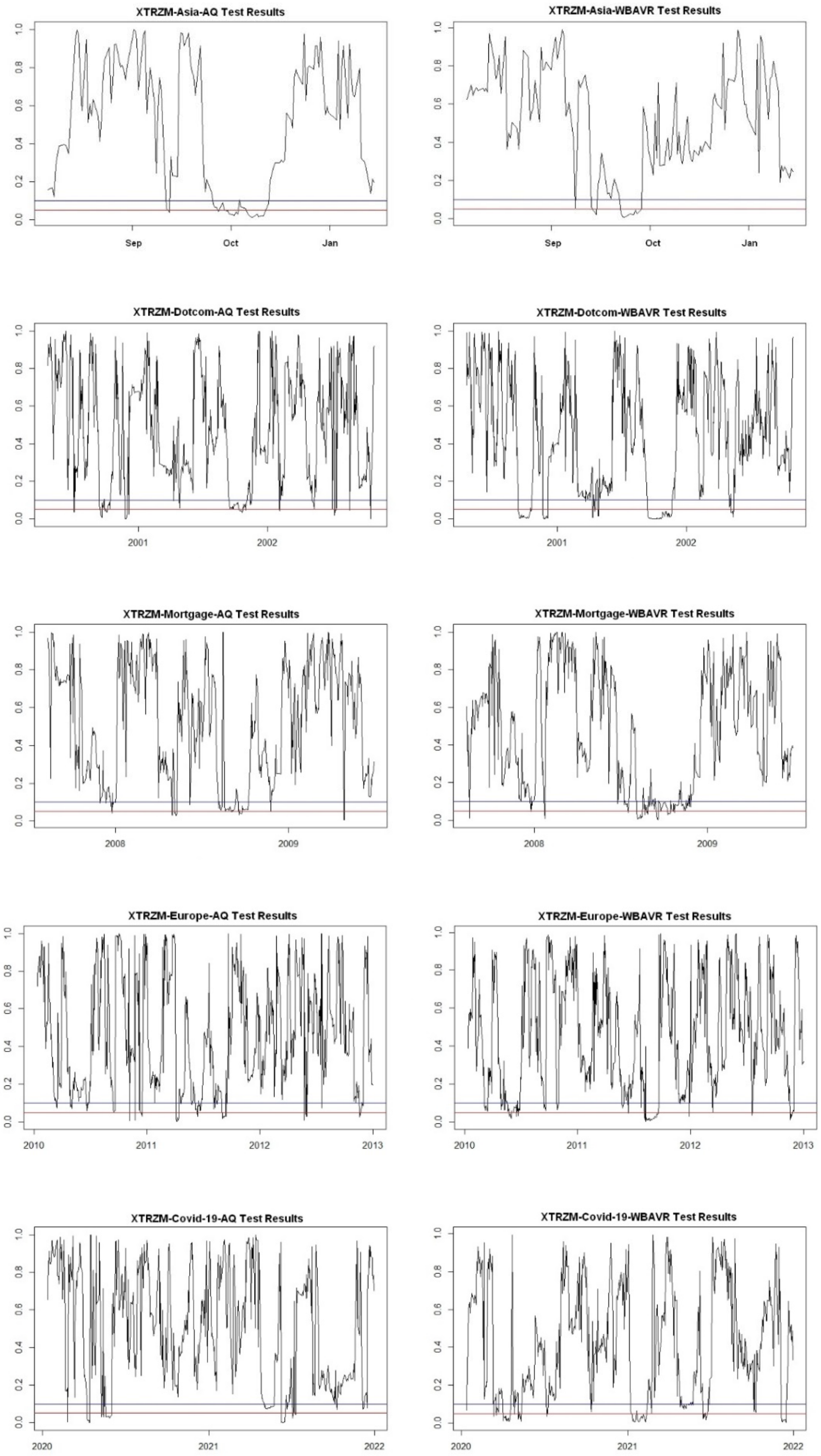

Figure 10. XTRZM-Crisis Periods Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio Test Results

Figure 10 shows the *p*-values of the AQ and WBAVR tests, which show that the return predictability of the XTRZM index changed over time during the global crisis periods. The findings indicate results consistent with AMH.

When the AQ and WBAVR findings of the indices investigated in the data sets selected by taking into account the major crises are evaluated in general, it can be said that there is evidence that return predictability has changed over time in each index during these crisis periods. During the Asian crisis period (June 1997-January 1998), it is noteworthy that the results indicating inefficiency in the XBANK index were observed more frequently, while the inefficient period was longer in the XU100 index in the related period according to WBAVR (compared to the AQ findings). During the dotcom crisis (March 2000-October 2002), *p*-values generally produced similar graphs supporting AMH. During the mortgage crisis (July 2007-June 2009), the AQ test showed that the return predictability of the XU100 and XBANK indices changed with more frequent frequencies than the WBAVR in 2009. During the European debt crisis (December 2009-December 2012), AQ and WBAVR outputs yielded similar results and findings consistent with the existence of AMH were obtained. During the Covid-19 (December 2019-December 2021) epidemic crisis, more inactive periods and data volatility were detected in the XTEKS, XGIDA and XTRZM indices compared to the others.

The chart showing in which crisis period the volatility in the *p*-values of the indices analysed within the scope of the study is significantly higher than the others, and therefore which crises affect the return predictability of which indices more than others, is given below.

Table 4. Return Predictability and Index-Crisis Relationship

	XU100	XBANK	XGIDA	XTEKS	XTRZM
Asian Financial Crisis	x	x			
Dotcom Crisis	x	x	x		x
Mortgage Crisis	x	x			
European Debt Crisis	x	x		x	
Covid-19 Crisis			x	x	x

In the table, the "x" sign indicates which index had more volatile and/or longer periods of return predictability during the relevant crisis period.

6. Conclusions

In this study, XU100, XBANK, XGIDA, XTEKS and XTRZM indices were selected from Borsa Istanbul to examine the market behaviour in different sectors and the Asian financial crisis, the American Dotcom and Mortgage crises, the European debt crisis and finally the Covid-19 pandemic period were examined. The analyses are conducted with the Automatic Portmanteau and Wild Bootstrap Automatic Variance Ratio tests, which work very effectively in financial time series with non-normal distribution and conditional heteroskedasticity. In order to determine the change in return predictability over time in the tests, two-year (520) sliding window approaches were used in large series of daily closing data, and 30-period sliding window approaches were used in smaller time series examined for crisis periods.

When the findings obtained are analysed, it is seen that the Turkish stock market is consistent with Lo's Adaptive Market Hypothesis within the series selected for the global financial crisis periods. All indices included in the scope of the analysis yielded results indicating the existence of the AMH. However, AQ and WBAVR tests revealed slightly different findings regarding the frequency and duration of changes in return predictability over time in some indices. Depending on the nature and origin of the crisis, market efficiency may fluctuate with different frequencies and durations. During the Asian financial crisis and the mortgage crisis periods, the return predictability of the XU100 index and the XBANK index was more volatile in parallel with the weight of banks and financial companies in the indices, while the results in the XTEKS, XGIDA and XTRZM sector indices were found to change with faster frequencies during the crisis period caused by the outbreak of the Covid-19 virus. Although these findings require more empirical studies for more precise results, it can be said that these findings indicate that market efficiency may be changing to different degrees in different sectors in parallel with the nature and cause of the global crisis in the Turkish stock market.

Since the Asian, Mortgage and European debt crises were basically financial crises, it can be stated that return predictability in XU100 and XBANK indices changed with faster frequencies and/or periods of market inefficiency were observed for longer periods. Kamışlı and Sevil (2018) stated in their study that the volatility relations between sector index returns were affected by the 2008 Mortgage Crisis and the European Debt Crisis, which affected the financial sector. These researchers also suggested that investors who want to invest in stocks in the services sub-sector indices should watch sector-specific events as well as political and social events. On the other hand, since the Covid-19 crisis was an epidemic-induced crisis, the curfews imposed by the governments in the relevant period and the measures taken to reduce the spread of the epidemic indicate that the volatility in return predictability was more pronounced in the tourism, food and textile sectors. The decrease in human mobility and the disruption of the global supply chain during the pandemic may explain the fact that these sectors were more affected. Regarding this issue, Çilek (2022) stated in his study that the tourism industry has gone through a rather stagnant period with the measures and bans applied during the Covid-19 period and is among the disadvantaged industries. According to the study by Cho and Saki (2022), specifically, the textile and apparel industry has been affected more adversely than have other industries, including transportation, entertainment, and hospitality. In his study, Doruk (2022) used the expressions "When the financial reports are examined, it is seen that the companies in the food industry mostly experience temporary demand shocks caused by the COVID-19 shock, and the food industry around the world has experienced significant supply chain problems during the COVID-19 period, especially in raw materials." However, it should be kept in mind that these *p*-values and graphical outputs do not indicate that the relevant index has been affected more positively or negatively, but only give clues about the frequency and duration of changes in return predictability. Therefore, it can be stated that the efficiency level of the market coincides with the events affecting the financial markets (Eyüboğlu and Eyüboğlu, 2020: 648). In times of economic or political crises, stock returns have been highly predictable with a moderate degree of uncertainty in predictability (Kim et al., 2011: 868). In addition to this, Smith and Dyakova (2015) stated that predictability largely coincides with times of crisis. Özkan (2021) also highlighted that stock market efficiency is commonly affected by different occurrences, to different degrees.

When the findings are evaluated in terms of fund managers, portfolio managers, investors and researchers who invest in the equity markets, it is important in terms of showing that there are periods in the market where returns can be obtained above the normal, accompanied by the results determined regarding the validity of APH in the Turkish equity market. These market participants may shape different strategies with the emergence of the potential for return predictability, especially during the volatility periods brought about by crisis periods. In terms of the statistical study, it can be said that the results of the AQ test statistic are more sensitive and consistent for periods with relatively short data sets, while the WBAVR test results can produce more consistent and stable findings for long-term time series. At this point, it can be suggested to researchers to use AQ for small sample sets and WBAVR for long sets when working with financial time series.

Çelik and Taş (2007), Zhang et al. (2012), Ajao and Osayuwu (2012), Tokić et al. (2018), Ggayi (2021), Doley (2022) and Ildırar and Dallı (2021) stated that they obtained findings that the markets were efficient, while Phiri (2015), Zhao et al. (2017), Altunöz (2021), Diallo et al. (2021) and Thompson and Ward (1995) conducted studies that produced the conclusion that markets are not efficient. These studies can also be indirectly evaluated as evidence that the predictability of returns may change over time. The results of this study conflict with Kılıç (2020) and Çipe (2021), who did not find evidence for the validity of AMH, from studies that tested the Turkish equity market within the framework of the Adaptive Market Hypothesis. On the other hand, these results are similar to those of Köse İçigen (2020), Gemici (2021), and Eyüboğlu and Eyüboğlu, who tested the validity of the AMH and found evidence for it.

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