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ADAPTIVE MARKET HYPOTHESIS: INSIGHTS FROM BRIC-T COUNTRIES' STOCK MARKETS

Sureyya Yilmaz Ozekenci[1]

Abstract

Comparing the Efficient Market Hypothesis and Behavioral Finance, the Adaptive Markets Hypothesis (AMH), which identifies the extremes of these two hypotheses and adapts them to each other, argues that calendar anomalies can coexist, but also focuses on how investor behavior reacts to changing market conditions. This study aims to investigate whether the stock markets of BRIC-T countries are consistent with the AMH, including crisis periods, using daily data for the period 01.01.2000-31.12.2023. To this end, daily index return series of each country were constructed and analyzed with the help of Wild-bootstrap Variance ratio test, BDS test and Ljung and Box Q Portmanteau tests. According to the Wild-bootstrap Variance ratio test, both EMH and AMH are not valid in the equity markets of BRIC-T countries; according to the BDS test results, AMH is valid and according to the Ljung and Box Q Portmanteau test results, AMH is valid. Therefore, it is concluded that AMH is more successful than EMH in explaining the equity markets of BRIC-T countries.

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[1] Vocational School, Çağ University, Türkiye, e-mail: sureyyayilmaz@cag.edu.tr, ORCID: https://orcid.org/0000-0003-4150-4101.

Introduction

The Efficient Market Hypothesis (EMH), a prominent concept in financial literature developed by Eugene Fama in 1970, posits that all available information is instantaneously reflected in market prices. It asserts that stock prices are predictable based on current information and that investors cannot consistently achieve excessive returns (Patil & Rastogi, 2019; Malkiel, 2003). EMH can be summarized by two core principles: (1) current information is reflected in stock prices, and (2) investors cannot earn risk-adjusted excess returns (Degutis & Novickyte, 2014). Despite extensive research, no consensus has emerged regarding the validity of EMH (Frennberg & Hansson, 1993; Dockery & Kavussanos, 1996; Narayan & Smyth, 2004; Mlambo & Biekpe, 2007; Borges, 2010; Nguyen & Ali, 2011; Nguyen et al., 2012; Zafar, 2012; Boboc & Dinică, 2013). This lack of agreement has led researchers to explore the notion that investors make decisions that deviate from rationality, giving rise to the field of behavioral finance. Behavioral finance integrates finance, psychology, and decision-making sciences, positing that psychological factors can lead investors to behave irrationally, often influenced by cultural, structural, and traditional factors (Fuller, 1998; Barberis & Thaler, 2003). As discussions surrounding EMH and behavioral finance continue, Lo (2004, 2005, 2007, 2012) introduced the Adaptive Markets Hypothesis (AMH), which reconciles the extremes of these two frameworks. AMH posits that EMH and market anomalies can coexist and emphasizes how investor behavior adapts to changing market conditions. Unlike EMH, which assumes rationality, or behavioral finance, which focuses on irrationality, AMH defines investors as intelligent, forward-thinking, and competitive, capable of adapting to economic realities (Lo, 2012). Lo (2005) outlines several components of AMH: (1) Investors act in their own best interests, (2) Investors can make mistakes, (3) Investors learn from their mistakes and adjust their behavior, (4) Competition fosters adaptation and innovation, (5) Market ecology is shaped by natural selection and (6) Market dynamics evolve over time. This study aims to investigate whether the equity markets of BRIC-T countries align with AMH, particularly during all crisis periods, using daily data from 01.01.2000 to 31.12.2023. The research focuses on the BRIC-T countries as developing nations and specifically examines data intervals during crises, including the significant impacts of the COVID-19 pandemic. A review of the literature reveals a gap in studies examining the COVID-19 period in relation to crisis events, highlighting the originality of this research. The subsequent sections will provide a literature review, outline the methodology and dataset used, present findings, and offer conclusions and recommendations.

Literature review

Research on the Adaptive Markets Hypothesis (AMH), which emerged as a counterpoint to the Efficient Market Hypothesis (EMH) and behavioral finance, began after 2004. Many studies have examined multiple countries, utilizing various methods such as the Automatic Portmanteau Test, Variance Ratio Test, BDS test, Unit Root Tests, and the Jarque-Bera normality test. For instance, Todea et al. (2009) investigated the validity of AMH in Asia-Pacific countries and concluded that it holds true. Similarly, Dyakova and Smith (2013) found Bulgarian equity markets compatible with AMH. Popović et al. (2013) assessed the Montenegrin stock market and concluded that AMH is valid there. Lim et al. (2014) studied the compatibility of the DJIA, S&P 500, and New York Stock Exchange with AMH, determining that all three markets align with the hypothesis. Ghazani and Araghi (2014) also found the Tehran Stock Exchange compatible with AMH. Arendas and Chovancová (2015) concluded that BRIC countries' equity markets demonstrated consistent behavior with AMH. Urquhart and McGroarty (2016) found AMH valid across the S&P 500, FTSE 100, NIKKEI 225, and EURO STOXX 50 exchanges. Noda (2016) reported similar findings for the TOPIX and TSE2 stock exchanges in Japan. Rahman et al. (2017) examined the equity markets of Bangladesh, India, Pakistan, and Sri Lanka, concluding that AMH is supported in these markets. Zhu (2017) and Shi et al. (2017) confirmed the validity of AMH in Chinese stock markets. Ndubuisi and Okere (2018) also found AMH valid in the Nigerian stock market, while Phan Tran Trung and Pham Quang (2019) concluded the same for Vietnamese stock markets. Kołatka (2020) found the Polish stock market compatible with AMH, and Akhter and Yong (2021) supported its presence in the Bangladesh stock market. Munir et al. (2022) partially supported AMH in South Asia's emerging equity markets. In contrast, Aytekin and Doğan (2023) confirmed the validity of AMH in certain sectors of Borsa Istanbul, while Kılıç (2020) found that AMH does not hold in Borsa Istanbul. Additionally, Himremath and Kumari (2014) concluded that the Indian stock market does not fully comply with AMH. Overall, the literature indicates that AMH is generally valid in most studies. While this study looks at different crisis periods, it also looks at the COVID-19 period as a general crisis period, which other studies have not looked at, but which led to a global crisis. In this respect, this study differs from other studies in the literature.

Methodology

The aim of this study is to examine the compatibility of the equity markets in BRIC-T countries with the Adaptive Markets Hypothesis (AMH) using daily data from 1.01.2000 to 31.12.2023, including various crisis

periods. Table 1 presents the stock market index data for the countries involved in the study, along with details about the crises that occurred during the analysis period.

Table 1: Countries list and crisis

Countries	Stock Exchange	Crises	Periods	Periods of Crisis
Brazil	BOVESPA	Dotcom Crisis	Q1	01.03.2000-31.10.2002
Russia	IMOEX	Mortgage Crisis	Q2	02.06.2007-30.07.2009
India	BSESN	European Debt Crisis	Q3	01.12.2009-31.12.2012
China	SHANGHAI	COVID-19 Crisis	Q4	02.12.2019-31.12.2021
Turkey	BIST100		QAll	01.01.2000-31.12.2023

Source: Authors' own work.

For this research, the stock market index data were analyzed for both the entire period and the specific intervals during identified global crises, as outlined in the studies by Shahid et al. (2020) and Aytekin and Doğan (2023). The data were sourced from investing.com. Return calculations for each country's stock market indices were conducted for both the full dataset and the crisis periods. Returns were computed using the formula $R_t = \ln(P_t / P_{t-1})$ where R_t represents the natural logarithmic return, P_t is the closing value of the index at time t, and P_{t-1} is the closing value in the previous period. The validity of AMH in BRIC-T countries was assessed through the Wild-bootstrap Variance Ratio Test, BDS Test, and Ljung-Box Q Portmanteau Tests.

Wild-bootstrap variance ratio test

The most commonly used method in the literature to test the random walk hypothesis is the Variance Ratio test developed by Lo and MacKinlay (1998). This test argues that the variance of uncorrelated increases in time series such as stock prices is proportional to the sample intervals (Gemici, 2021). Calculating the return of an asset in the Variance Ratio test developed by Lo and MacKinlay (1998):

$$VR(k) = \frac{\sigma_k^2}{k\sigma^2} \quad (1)$$

where: r_t refers to the return of a stock over time, the holding period and $k\sigma^2_k = k$ the variance of the period. In this case, the calculation of the Variance ratio test is:

$$VR(k) = 1 + 2\sum_{j=1}^{k-1}(1 - \frac{j}{k}) p_j \quad (2)$$

In Equation 3, p_j denotes the autocorrelation of r_t at level j. In this context, the main hypothesis of the variance ratio test is "H_0: the series exhibit random walk". According to this hypothesis, all k values of the variance ratio are equal to 1(k = 1), in other words, there is no autocorrelation in the series (Ghazani & Araghi, 2014). If VR(k) > 1, the series are positively autocorrelated; if VR(k) < 1, the series are negatively autocorrelated (Urquhart & McGroarty, 2016). In the variance ratio test, holding periods are generally preferred as 2, 4, 8 and 16 (Eyüboğlu & Eyüboğlu, 2020; Topaloğlu & Yaman, 2021). In addition, according to this test, random walk is valid; failure to reject the H_0 hypothesis indicates that the markets are efficient, while rejection of the H_0 hypothesis indicates that the markets are not efficient.

BDS Test

The BDS test, which is a nonparametric test and used to detect nonlinear dependencies observed in time series, was first proposed by Broock et al. (1987), but was developed by Brock et al. (1996) and contributed to the literature. The calculation method for the BDS test is as follows (Urquhart & McGroarty, 2016):

$$W_{m,n}(\varepsilon) = \sqrt{n}\frac{T_{m,n}(\varepsilon)}{V_{m,n}(\varepsilon)} \quad (3)$$

In Equation 3, $W_{m,n}(\varepsilon)$ is the BDS statistic, is the sample size, is the embedding dimension, and the metric boundary (ε) is the maximum difference between pairs of observations for computing the correlation integral. $T_{m,n}(\varepsilon)$ is the difference in the gaps ($C_{m,n}(\varepsilon)$ - $C_{1,n}(\varepsilon)^m$) resulting from the independent and identical distribution of the observed series and $V^2_m(\varepsilon)$ is the asymptotic normal distribution. Rejecting the main hypothesis of the BDS test "H_0: there are no nonlinearities in the series" implies that markets are not efficient, while failing to reject H_0 implies that markets are efficient.

Ljung and Box Q Portmanteau test

The autocorrelation test is used as a simple and reliable test for the independence of random variables in a series. Detection of autocorrelation in the series implies that returns are not independent. In other words, it can be interpreted as inefficient markets. More precisely; H_0: Failure to reject the "no autocorre-

lation" hypothesis is interpreted as markets are efficient, while rejection of Ho, i.e. autocorrelation, is interpreted as markets are not efficient. In this study, Ljung-Box (1978) Q Portmanteau statistics based on autocorrelation (AC) and partial autocorrelation (PAC) functions are used to determine the efficiency of the markets and the calculation method for this statistic is shown in Equation 4 (Hiremath & Kumari, 2014).

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{p_k^2}{n-1}\right) \quad (4)$$

Results

Descriptive statistics for the closing stock market value of each BRIC-T country for which return calculations are made are presented in Table 2.

Table 2: Descriptive statistics

Variables	LNBrazil	LNRussia	LNIndia	LNChina	LNTurkey
Mean	0.0003	0.0005	0.0004	0.0001	0.0006
Median	0.0007	0.0009	0.0009	0.0005	0.0012
Maximum	0.1368	0.2523	0.1599	0.0940	0.1776
Minimum	-0.1599	-0.4047	-0.1410	-0.0926	-0.1998
Std. Dev.	0.0176	0.0201	0.0141	0.0149	0.0204
Skewness	-0.3610	-1.5389	-0.3896	-0.3779	-0.1806
Kurtosis	9.6563	45.4053	12.6786	8.3876	10.5760
Jarque-Bera	11100.5871	448680.8886	23350.5287	7173.6275	14417.6087
Probability	0.0000	0.0000	0.0000	0.0000	0.0000
Observations	5943.0000	5957.0000	5944.0000	5817.0000	6015.0000

Source: Authors' own work.

As seen in Table 1, the standard deviations of BRIC-T countries are 0.01, 0.02, 0.01, 0.01, 0.01 and 0.02, respectively. Additionally, all variables were skewed to the left. It is observed that the Jarque-Bera probability value of all variables was smaller than 0.05. In this case, the hypothesis "H_0: The series are normally distributed" was rejected since the series in the model did not have a normal distribution.

Test results for Brazilian stock market

The results of the Wild-bootstrap Variance ratio test, BDS test and Ljung and Box Q Portmanteau test for the Brazilian stock market are shown in Table 3, Table 4 and Table 5, respectively.

Table 3: Wild-bootstrap Variance ratio test

Period		Joint Tests	Value	df	Prob.
QAll (01.01.2000-31.12.2023)		Max|z| (at period 2)	13.9884	5942.0000	0.0000
Q1 Dotcom Crisis		Max|z| (at period 2)	9.3712	663.0000	0.0000
Q2 Mortgage Crisis		Max|z| (at period 2)	6.6955	500.0000	0.0000
Q3 European Debt Crisis		Max|z| (at period 2)	8.0484	777.0000	0.0000
Q4 COVID-19 Crisis		Max|z| (at period 2)	3.4980	521.0000	0.0030
Period		**Var. Ratio**	**Std. Error**	**z-Stat.**	**Prob.**
QAll (01.012000-31.12.2023)	2	0.4875	0.0366	-13.9884	0.0000
	4	0.2467	0.0648	-11.6327	0.0000
	8	0.1213	0.0947	-9.2781	0.0000
	16	0.0580	0.1261	-7.4721	0.0000
Q1 Dotcom Crisis	2	0.5325	0.0499	-9.3712	0.0000
	4	0.2519	0.0895	-8.3592	0.0000
	8	0.1310	0.1337	-6.4992	0.0000
	16	0.0587	0.1880	-5.0080	0.0000
Q2 Mortgage Crisis	2	0.5148	0.0725	-6.6956	0.0000
	4	0.2463	0.1297	-5.8106	0.0000
	8	0.1183	0.1935	-4.5555	0.0010
	16	0.0568	0.2838	-3.3239	0.0050

Period		Var. Ratio	Std. Error	z-Stat.	Prob.
Q3 European Debt Crisis	2	0.4972	0.0625	-8.0484	0.0000
	4	0.2531	0.1089	-6.8553	0.0000
	8	0.1209	0.1538	-5.7174	0.0000
	16	0.0633	0.2063	-4.5408	0.0000
Q4 COVID-19 Crisis	2	0.3321	0.1909	-3.4990	0.0000
	4	0.2031	0.3363	-2.3693	0.0250
	8	0.0868	0.4871	-1.8745	0.0350
	16	0.0354	0.6166	-1.5643	0.0060

Source: Authors' own work.

According to Table 3, the probability value calculated for periods 2-16 is below the critical value of 0.05 both in the crisis periods and in the whole period and the null hypothesis of random walk is rejected. Therefore, it can be said that the market for Brazilian stock returns is not efficient in terms of periods. This shows that both EMH and AMH are not valid in the Brazilian stock market.

Table 4: BDS test results

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
QAll (01.01.2000-31.12.2023)	2	0.0110	0.0011	10.4932	0.0000
	3	0.0237	0.0017	14.2341	0.0000
	4	0.0338	0.0020	17.1381	0.0000
	5	0.0397	0.0021	19.3715	0.0000
	6	0.0423	0.0020	21.4631	0.0000
Q1 Dotcom Crisis	2	0.0003	0.0026	0.1192	0.9051
	3	0.0037	0.0042	0.8851	0.3761
	4	0.0089	0.0049	1.7994	0.0719
	5	0.0148	0.0051	2.8777	0.0040
	6	0.0166	0.0049	3.3794	0.0007
Q2 Mortgage Crisis	2	0.0143	0.0040	3.5728	0.0004
	3	0.0326	0.0064	5.1256	0.0000
	4	0.0434	0.0076	5.7120	0.0000
	5	0.0487	0.0079	6.1401	0.0000
	6	0.0519	0.0077	6.7711	0.0000
Q3 European Debt Crisis	2	0.0043	0.0027	1.6152	0.1063
	3	0.0159	0.0042	3.7464	0.0002
	4	0.0245	0.0050	4.8554	0.0000
	5	0.0290	0.0052	5.5500	0.0000
	6	0.0311	0.0050	6.1775	0.0000
Q4 COVID-19 Crisis	2	0.0381	0.0038	9.9861	0.0000
	3	0.0628	0.0061	10.3311	0.0000
	4	0.0770	0.0072	10.6370	0.0000
	5	0.0822	0.0076	10.8897	0.0000
	6	0.0809	0.0073	11.1045	0.0000

Source: Authors' own work.

As the results in Table 4 are analyzed, it is found that the probability value calculated for periods 2, 3 and 4 of the Dotcom crisis and period 2 of the European debt crisis is above the critical value, but the probability value calculated for other periods is below the critical value. This shows that EMH is valid in the 2nd, 3rd and 4th dimension of the Dotcom crisis and in the 2nd dimension of the European debt crisis, while AMH is valid in other periods.

Table 5: Ljung and Box Q Portmanteau test results

Period	Length	AC	PAC	Q-Stat	Prob
QAll (01.01.2000-31.12.2023)	1	-0.0304	-0.0304	5.3944	0.0202
	5	0.0060	0.0046	12.3284	0.0306
	10	0.0278	0.0269	27.0359	0.0026
	15	0.0059	0.0078	30.8033	0.0093
	20	0.0181	0.0198	51.8980	0.0001
	25	-0.0082	-0.0098	58.4340	0.0002
	30	-0.0025	-0.0015	62.5393	0.0004
	35	-0.0079	-0.0053	69.4011	0.0005
Q1 Dotcom Crisis	1	0.0155	0.0155	0.1599	0.6893
	5	-0.0650	-0.0649	4.2869	0.5089
	10	0.0252	0.0199	7.3362	0.6934
	15	0.0244	0.0216	19.6284	0.1867
	20	-0.0205	-0.0133	32.1238	0.0420
	25	-0.0061	-0.0169	39.6024	0.0320
	30	0.0115	-0.0044	43.0269	0.0583
	35	-0.0241	-0.0146	47.5406	0.0767
Q2 Mortgage Crisis	1	-0.0097	-0.0097	0.0473	0.8279
	5	-0.0093	-0.0229	7.1272	0.2114
	10	0.0153	0.0095	10.1497	0.4275
	15	-0.0151	-0.0058	11.6023	0.7088
	20	0.0863	0.0882	26.3253	0.1553
	25	0.0557	0.0452	28.7412	0.2749
	30	0.0257	0.0373	30.4692	0.4418
	35	-0.0420	-0.0240	34.0280	0.5149
Q3 European Debt Crisis	1	0.0011	0.0011	0.0009	0.9764
	5	-0.0261	-0.0255	1.8092	0.8749
	10	0.0405	0.0380	9.4918	0.4862
	15	0.0194	0.0196	16.2985	0.3625
	20	0.0438	0.0309	23.7662	0.2528
	25	0.0056	0.0090	29.7681	0.2331
	30	-0.0121	-0.0080	31.6236	0.3852
	35	0.0026	0.0009	36.6694	0.3913
Q4 COVID-19 Crisis	1	-0.2505	-0.2505	32.9485	0.0000
	5	0.1427	0.0999	61.7038	0.0000
	10	0.0006	-0.0380	94.8877	0.0000
	15	-0.1139	-0.0710	109.6584	0.0000
	20	-0.0450	0.0024	112.9300	0.0000
	25	-0.0542	-0.0594	115.5675	0.0000
	30	-0.0371	0.0034	127.1015	0.0000
	35	-0.0258	0.0196	131.8747	0.0000

Source: Authors' own work.

According to the results in Table 5, it is determined that there is no autocorrelation problem for the 1-15 lag lengths of the Dotcom crisis, the Mortgage Crisis and the European Debt Crisis, since the Q probability value calculated for all lag lengths is above the calculated value. In this case, it is understood that the market is efficient in the periods when there is no autocorrelation problem and the market is inefficient in the periods when there is an autocorrelation problem. In this context, it can be said that AMH is valid in the Brazilian stock market in the analyzed periods.

Test results for the Russian stock market

The results of the Wild-bootstrap Variance ratio test, BDS test and Ljung and Box Q Portmanteau test for the Russian stock market are shown in Table 6, Table 7 and Table 8, respectively.

Table 6: Wild-bootstrap Variance ratio test

Period		Joint Tests	Value	df	Probability
QAll (01.01.2000-31.12.2023)		Max|z| (at period 2)	7.732600	5956.0000	0.0000
Q1 Dotcom Crisis		Max|z| (at period 2)	8.018700	663.0000	0.0000
Q2 Mortgage Crisis		Max|z| (at period 2)	5.447448	500.0000	0.0010
Q3 European Debt Crisis		Max|z| (at period 4)	8.668342	777.0000	0.0000
Q4 COVID-19 Crisis		Max|z| (at period 2)	1.840940	521.0000	0.0590
Period		**Var. Ratio**	**Std. Error**	**z-Statistic**	**Probability**
QAll (01.01.2000-31.12.2023)	2	0.5085	0.063600	-7.7326	0.0000
	4	0.2533	0.102200	-7.3074	0.0000
	8	0.1289	0.131900	-6.6059	0.0000
	16	0.0630	0.160100	-5.8527	0.0000
Q1 Dotcom Crisis	2	0.5888	0.051300	-8.0187	0.0000
	4	0.2884	0.090400	-7.8711	0.0000
	8	0.1370	0.134600	-6.4113	0.0000
	16	0.0758	0.192700	-4.7971	0.0000
Q2 Mortgage Crisis	2	0.5185	0.088400	-5.4474	0.0000
	4	0.2763	0.156300	-4.6313	0.0000
	8	0.1407	0.235000	-3.6566	0.0030
	16	0.0641	0.326900	-2.8627	0.0120
Q3 European Debt Crisis	2	0.6005	0.046400	-8.6071	0.0000
	4	0.2798	0.083100	-8.6683	0.0000
	8	0.1403	0.125300	-6.8640	0.0000
	16	0.0758	0.181300	-5.0969	0.0000
Q4 COVID-19 Crisis	2	0.3876	0.332700	-1.8409	0.0060
	4	0.1966	0.519700	-1.5458	0.0700
	8	0.1041	0.630600	-1.4208	0.0940
	16	0.0389	0.699700	-1.3736	0.0070

Source: Authors' own work.

According to Table 6, it is understood that the probability value calculated for periods 2-16 is below the critical value of 0.05 both in the crisis periods and in the whole period and the null hypothesis of random walk is rejected. However, it is determined that the probability value calculated in periods 4 and 8 during the COVID-19 crisis period is above the critical value. Therefore, it can be said that the market is not efficient for Russia stock returns in terms of periods. This shows that both EMH and AMH are not valid in Russia's stock market.

Table 7: BDS test results

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
QAll (01.01.2000-31.12.2023)	2	0.0258	0.0013	20.0914	0.0000
	3	0.0560	0.0020	27.4693	0.0000
	4	0.0788	0.0024	32.4584	0.0000
	5	0.0927	0.0025	36.6723	0.0000
	6	0.1002	0.0024	41.0750	0.0000
Q1 Dotcom Crisis	2	0.0087	0.0031	2.8544	0.0043
	3	0.0200	0.0049	4.1294	0.0000
	4	0.0267	0.0058	4.6090	0.0000
	5	0.0290	0.0060	4.8061	0.0000
	6	0.0291	0.0058	4.9927	0.0000
Q2 Mortgage Crisis	2	0.0153	0.0046	3.3628	0.0008
	3	0.0417	0.0073	5.7460	0.0000

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
Q2 Mortgage Crisis	4	0.0683	0.0087	7.8832	0.0000
	5	0.0816	0.0091	9.0042	0.0000
	6	0.0908	0.0088	10.3555	0.0000
Q3 European Debt Crisis	2	0.0128	0.0030	4.3024	0.0000
	3	0.0265	0.0047	5.6296	0.0000
	4	0.0364	0.0056	6.5132	0.0000
	5	0.0411	0.0058	7.0736	0.0000
	6	0.0426	0.0056	7.6131	0.0000
Q4 COVID-19 Crisis	2	0.0000	0.0002	-0.0442	0.9647
	3	0.0000	0.0004	-0.0596	0.9525
	4	0.0000	0.0006	-0.0715	0.9430
	5	-0.0001	0.0009	-0.0817	0.9349
	6	-0.0001	0.0012	-0.0909	0.9276

Source: Authors' own work.

When the results in Table 7 are analyzed, it is found that the probability value calculated for the COVID-19 crisis period is above the critical value, but the probability value calculated for other periods is the critical value. This shows that EMH is valid in the COVID-19 crisis period, while AMH is valid in other periods.

Table 8: Ljung and Box Q Portmanteau test results

Period		AC	PAC	Q-Stat	Prob
QAll (01.01.2000-31.12.2023)	1	0.0069	0.0069	0.2775	0.5983
	5	0.0202	0.0197	6.6777	0.2457
	10	-0.0146	-0.0147	18.1958	0.0517
	15	0.0082	0.0080	36.2112	0.0016
	20	-0.0268	-0.0263	57.2790	0.0000
	25	-0.0494	-0.0428	87.0975	0.0000
	30	-0.0261	-0.0193	119.0002	0.0000
	35	-0.0161	-0.0126	129.4625	0.0000
Q1 Dotcom Crisis	1	0.1272	0.1272	10.7986	0.0010
	5	-0.0355	-0.0384	13.2453	0.0212
	10	0.0347	0.0301	18.5385	0.0465
	15	0.0081	-0.0075	24.2999	0.0602
	20	0.0108	0.0072	28.1344	0.1063
	25	-0.0429	-0.0396	32.4277	0.1460
	30	-0.0148	-0.0081	33.4922	0.3016
	35	0.0161	0.0172	41.2160	0.2172
Q2 Mortgage Crisis	1	0.0254	0.0254	0.3262	0.5679
	5	0.0562	0.0575	6.4081	0.2685
	10	-0.0421	-0.0462	15.1874	0.1254
	15	0.0315	0.0334	34.7343	0.0027
	20	-0.0920	-0.0722	50.3537	0.0002
	25	-0.0630	-0.0001	56.4945	0.0003
	30	0.0362	0.0752	75.8334	0.0000
	35	-0.0351	-0.0302	82.3181	0.0000
Q3 European Debt Crisis	1	0.1334	0.1334	13.8957	0.0002
	5	-0.0022	-0.0165	17.7105	0.0033
	10	0.0305	0.0162	24.8599	0.0056
	15	0.0028	0.0009	32.2214	0.0060

Period		AC	PAC	Q-Stat	Prob
Q3 European Debt Crisis	20	0.0298	0.0221	38.5834	0.0075
	25	-0.0453	-0.0384	42.5248	0.0158
	30	-0.0372	-0.0388	44.1273	0.0464
	35	0.0025	0.0078	53.5864	0.0230
Q4 COVID-19 Crisis	1	-0.1940	-0.1940	19.7603	0.0000
	5	0.0195	0.0433	24.5397	0.0002
	10	-0.0643	-0.0932	30.0371	0.0008
	15	-0.0111	-0.0061	30.8841	0.0091
	20	0.0045	0.0058	33.4744	0.0299
	25	-0.0208	-0.0508	38.1539	0.0447
	30	-0.0445	-0.0323	49.0892	0.0154
	35	-0.0295	-0.0275	49.9355	0.0487

Source: Authors' own work.

According to the results in Table 8, it is determined that there is no autocorrelation problem for the period January 1, 2000-December 31, 2023 since the Q probability value calculated for lag lengths of 1-10 for the period January 1, 2000-December 31, 2023, 15-35 for the Dotcom Crisis and 1-10 for the Mortgage Crisis is above the calculated value. In this case, it is understood that the market is efficient in the periods when there is no autocorrelation problem and the market is ineffi-problem. In this context, it can be said that AMH is valid in the Russian stock market in the periods analyzed.

Test results for India's stock market

The results of the Wild-bootstrap Variance ratio test, BDS test, and Ljung and Box Q Portmanteau test for the investigation of market efficiency for India stock market are shown in Table 9, Table 10 and Table 11, respectively.

Table 9: Wild-bootstrap Variance ratio test

Period	Joint Tests	Value	df	Probability
QAll (01.01.2000-31.12.2023)	Max|z| (at period 2)	14.4409	5943.0000	0.0000
Q1 Dotcom Crisis	Max|z| (at period 2)	6.6985	663.0000	0.0000
Q2 Mortgage Crisis	Max|z| (at period 2)	6.5605	500.0000	0.0000
Q3 European Debt Crisis	Max|z| (at period 2)	7.6334	777.0000	0.0000
Q4 COVID-19 Crisis	Max|z| (at period 2)	6.7009	521.0000	0.0000

Period		Var. Ratio	Std. Error	z-Statistic	Probability
QAll (01.01.2000-31.12.2023)	2	0.5398	0.0319	-14.4409	0.0000
	4	0.2624	0.0545	-13.5470	0.0000
	8	0.1278	0.0786	-11.1019	0.0000
	16	0.0666	0.1103	-8.4623	0.0000
Q1 Dotcom Crisis	2	0.5821	0.0624	-6.6985	0.0000
	4	0.2766	0.1110	-6.5169	0.0000
	8	0.1392	0.1641	-5.2447	0.0000
	16	0.0701	0.2257	-4.1209	0.0020
Q2 Mortgage Crisis	2	0.5647	0.0664	-6.5605	0.0000
	4	0.2882	0.1155	-6.1605	0.0000
	8	0.1236	0.1699	-5.1586	0.0000
	16	0.0676	0.2414	-3.8630	0.0020
Q3 European Debt Crisis	2	0.5325	0.0612	-7.6334	0.0000
	4	0.2580	0.1086	-6.8356	0.0000
	8	0.1341	0.1608	-5.3853	0.0000
	16	0.0661	0.2196	-4.2526	0.0000
Q4 COVID-19 Crisis	2	0.5360	0.0692	-6.7009	0.0000
	4	0.2662	0.1230	-5.9684	0.0000
	8	0.1381	0.1827	-4.7178	0.0000
	16	0.0669	0.2502	-3.7296	0.0020

Source: Authors' own work.

According to Table 9, it is understood that the probability value calculated for periods 2-16 is below the critical value of 0.05 both in crisis periods and in the whole period and the null hypothesis that random walk is valid is rejected. Therefore, it can be said that the market is not efficient for India's stock returns over the periods. This shows that both EMH and AMH are not valid in the Indian stock market.

Table 10: BDS test results

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
QAll (01.01.2000-31.12.2023)	2	0.0285	0.0012	23.0895	0.0000
	3	0.0569	0.0020	29.0245	0.0000
	4	0.0767	0.0023	32.8379	0.0000
	5	0.0883	0.0024	36.2637	0.0000
	6	0.0932	0.0023	39.6829	0.0000
Q1 Dotcom Crisis	2	0.0320	0.0035	9.2142	0.0000
	3	0.0608	0.0055	11.0044	0.0000
	4	0.0793	0.0066	12.0675	0.0000
	5	0.0873	0.0069	12.7438	0.0000
	6	0.0890	0.0066	13.4670	0.0000
Q2 Mortgage Crisis	2	0.0073	0.0036	2.0521	0.0402
	3	0.0194	0.0057	3.4133	0.0006
	4	0.0307	0.0068	4.5417	0.0000
	5	0.0396	0.0070	5.6326	0.0000
	6	0.0432	0.0068	6.3655	0.0000
Q3 European Debt Crisis	2	0.0330	0.0032	10.2668	0.0000
	3	0.0638	0.0051	12.4827	0.0000
	4	0.0841	0.0061	13.8327	0.0000
	5	0.0933	0.0063	14.7141	0.0000
	6	0.0960	0.0061	15.7039	0.0000
Q4 COVID-19 Crisis	2	0.0303	0.0037	8.2651	0.0000
	3	0.0566	0.0058	9.7314	0.0000
	4	0.0749	0.0069	10.8573	0.0000
	5	0.0826	0.0072	11.5120	0.0000
	6	0.0847	0.0069	12.2878	0.0000

Source: Authors' own work.

When the results in Table 10 are analyzed, it is found that the probability value calculated both in crisis periods and in the whole period is below the critical value. This indicates that EMH is valid in the Indian stock market.

Table 11: Ljung and Box Q Portmanteau test results

Period		AC	PAC	Q-Stat	Prob
QAll (01.01.2000-31.12.2023)	1	0.0477	0.0477	13.2368	0.0003
	5	-0.0020	-0.0029	17.5008	0.0036
	10	0.0223	0.0224	49.9762	0.0000
	15	0.0015	-0.0001	62.0815	0.0000
	20	-0.0361	-0.0295	91.7623	0.0000
	25	0.0299	0.0286	98.6622	0.0000
	30	-0.0084	-0.0048	105.9205	0.0000
	35	-0.0125	-0.0169	109.2027	0.0000
Q1 Dotcom Crisis	1	0.1112	0.1112	8.2414	0.0041
	5	-0.0245	-0.0309	10.8196	0.0551
	10	-0.0142	-0.0274	14.5834	0.1480
	15	0.0405	0.0296	22.6393	0.0921
	20	-0.1240	-0.0975	40.5243	0.0043

Period		AC	PAC	Q-Stat	Prob
Q1 Dotcom Crisis	25	0.0034	-0.0164	47.7803	0.0040
	30	-0.0285	-0.0372	56.8030	0.0022
	35	-0.0085	0.0184	64.6643	0.0017
Q2 Mortgage Crisis	1	0.0728	0.0728	2.6675	0.1024
	5	-0.0683	-0.0598	8.1514	0.1481
	10	0.0035	0.0014	16.9271	0.0760
	15	-0.0128	-0.0233	19.9853	0.1725
	20	-0.0587	-0.0446	26.9543	0.1366
	25	0.0620	0.0383	29.7454	0.2340
	30	-0.0189	0.0007	34.0053	0.2806
	35	-0.0780	-0.1024	40.1612	0.2521
Q3 European Debt Crisis	1	0.0656	0.0656	3.3583	0.0669
	5	-0.0362	-0.0424	7.2694	0.2014
	10	-0.0021	-0.0073	12.0783	0.2799
	15	0.0054	0.0055	17.2163	0.3061
	20	-0.0976	-0.0772	34.1856	0.0249
	25	0.0046	-0.0219	44.3004	0.0100
	30	-0.0020	0.0007	58.3582	0.0014
	35	-0.0382	-0.0123	63.3218	0.0023
Q4 COVID-19 Crisis	1	0.0742	0.0742	2.8869	0.0893
	5	-0.0402	-0.0431	5.4306	0.3656
	10	0.0211	0.0142	8.9449	0.5373
	15	0.0135	0.0153	12.1869	0.6648
	20	-0.1138	-0.0921	26.1370	0.1613
	25	-0.0037	-0.0374	35.4119	0.0810
	30	-0.0049	-0.0042	49.5025	0.0140
	35	-0.0255	0.0081	51.9565	0.0324

Source: Authors' own work.

According to the results in Table 11, since the Q probability value calculated for lag lengths of 5-15 for the Dotcom Crisis, 1-35 for the Mortgage Crisis, 1-15 for the European Debt Crisis, and 1-25 for the COVID-19 Crisis is above the calculated value, it is determined that there is no autocorrelation problem and there is an autocorrelation problem for the other periods. In this case, it is understood that the market is efficient in the periods when there is no autocorrelation problem and the market is inefficient in the periods when there is an autocorrelation problem. In this context, it can be said that AMH is valid in the Indian stock market in the periods analyzed.

Test results for China's stock exchange

The results of the Wild-bootstrap Variance ratio test, BDS test and Ljung and Box Q Portmanteau test for the investigation of market efficiency for China's stock market are shown in Table 12, Table 13 and Table 14, respectively.

Table 12: Wild-bootstrap Variance ratio test

Period		Joint Tests	Value	df	Probability
QAll (01.01.2000-31.12.2023)		Max |z| (at period 2)	19.4689	5816.0000	0.0000
Q1 Dotcom Crisis		Max |z| (at period 2)	6.5359	663.0000	0.0010
Q2 Mortgage Crisis		Max |z| (at period 2)	7.9952	500.0000	0.0000
Q3 European Debt Crisis		Max |z| (at period 2)	7.4506	777.0000	0.0000
Q4 COVID-19 Crisis		Max |z| (at period 2)	8.1582	521.0000	0.0000
Period		**Var. Ratio**	**Std. Error**	**z-Statistic**	**Probability**
QAll (01.01.2000-31.12.2023)	2	0.5196	0.0247	-19.4689	0.0000
	4	0.2446	0.0429	-17.6216	0.0000
	8	0.1265	0.0626	-13.9537	0.0000
	16	0.0635	0.0876	-10.6935	0.0000

Period		Var. Ratio	Std. Error	z-Statistic	Probability
Q1 Dotcom Crisis	2	0.5248	0.0727	-6.5359	0.0000
	4	0.2457	0.1267	-5.9553	0.0000
	8	0.1360	0.1843	-4.6872	0.0010
	16	0.0663	0.2531	-3.6890	0.0020
Q2 Mortgage Crisis	2	0.5084	0.0615	-7.9952	0.0000
	4	0.2351	0.1070	-7.1518	0.0000
	8	0.1294	0.1573	-5.5348	0.0000
	16	0.0665	0.2253	-4.1443	0.0000
Q3 European Debt Crisis	2	0.5199	0.0644	-7.4506	0.0000
	4	0.2514	0.1126	-6.6493	0.0000
	8	0.1323	0.1646	-5.2706	0.0000
	16	0.0638	0.2273	-4.1179	0.0000
Q4 COVID-19 Crisis	2	0.4854	0.0631	-8.1582	0.0000
	4	0.2507	0.1115	-6.7224	0.0000
	8	0.1239	0.1605	-5.4571	0.0000
	16	0.0636	0.2207	-4.2434	0.0010

Source: Authors' own work.

According to Table 12, it is understood that the probability value calculated for periods 2-16 is below the critical value of 0.05 both in crisis periods and in the whole period and the null hypothesis that random walk is valid is rejected. Therefore, it can be said that the market is not efficient for China's stock returns in terms of periods. This shows that both EMH and AMH are not valid in China's stock market.

Table 13: BDS test results

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
QAll (01.01.2000-31.12.2023)	2	0.0170	0.0013	13.3007	0.0000
	3	0.0385	0.0020	18.9698	0.0000
	4	0.0547	0.0024	22.6417	0.0000
	5	0.0642	0.0025	25.5487	0.0000
	6	0.0688	0.0024	28.4112	0.0000
Q1 Dotcom Crisis	2	0.0161	0.0037	4.3494	0.0000
	3	0.0376	0.0059	6.3812	0.0000
	4	0.0567	0.0070	8.0847	0.0000
	5	0.0648	0.0073	8.8621	0.0000
	6	0.0670	0.0070	9.5066	0.0000
Q2 Mortgage Crisis	2	0.0013	0.0036	0.3501	0.7262
	3	0.0021	0.0057	0.3642	0.7157
	4	0.0090	0.0068	1.3262	0.1848
	5	0.0163	0.0071	2.3013	0.0214
	6	0.0203	0.0068	2.9755	0.0029
Q3 European Debt Crisis	2	0.0151	0.0035	4.3322	0.0000
	3	0.0381	0.0056	6.8620	0.0000
	4	0.0572	0.0066	8.6511	0.0000
	5	0.0668	0.0069	9.6977	0.0000
	6	0.0703	0.0066	10.5862	0.0000
Q4 COVID-19 Crisis	2	0.0062	0.0034	1.8257	0.0679
	3	0.0181	0.0054	3.3378	0.0008
	4	0.0203	0.0064	3.1458	0.0017
	5	0.0190	0.0067	2.8347	0.0046
	6	0.0163	0.0064	2.5285	0.0115

Source: Authors' own work.

When the results in Table 13 are analyzed, it is found that the probability value calculated for the 2,3,4 dimensions of the Mortgage Crisis period and the 2 dimensions of the COVID-19 Crisis period is above the critical value, but the probability value calculated for other periods is below the critical value. This shows that EMH is valid in the 2,3,4 dimensions of the Mortgage Crisis period and 2 dimensions of the COVID-19 Crisis period, while AMH is valid in other periods.

Table 14: Ljung and Box Q Portmanteau test results

Period		AC	PAC	Q-Stat	Prob
QAll (01.01.2000-31.12.2023)	1	0.020300	0.020300	2.400400	0.1213
	5	-0.006800	-0.007600	17.888100	0.0031
	10	0.000200	0.002900	37.045800	0.0001
	15	0.034700	0.035600	60.204000	0.0000
	20	0.021200	0.017800	68.407300	0.0000
	25	0.004800	-0.000200	73.777500	0.0000
	30	-0.010300	-0.008200	83.699800	0.0000
	35	0.032500	0.030000	101.246500	0.0000
Q1 Dotcom Crisis	1	0.013500	0.013500	0.091300	0.7625
	5	0.046500	0.045300	2.793000	0.7319
	10	-0.041200	-0.052600	12.140100	0.2758
	15	0.019400	0.053600	19.491100	0.1923
	20	0.074400	0.053500	22.516100	0.3132
	25	-0.064400	-0.074400	31.446700	0.1747
	30	-0.019680	0.006520	40.268820	0.0997
	35	0.087029	0.043218	50.646150	0.0423
Q2 Mortgage Crisis	1	-0.007500	-0.007500	0.028600	0.8657
	5	-0.009200	-0.008300	1.295400	0.9354
	10	0.008800	0.012200	3.047300	0.9803
	15	0.052800	0.047200	7.677500	0.9361
	20	-0.056900	-0.054400	10.239900	0.9636
	25	0.004500	-0.003900	12.911000	0.9776
	30	-0.019900	-0.016100	15.156700	0.9888
	35	0.061700	0.055100	28.456000	0.7752
Q3 European Debt Crisis	1	0.034300	0.034300	0.917200	0.3382
	5	-0.011800	-0.014400	2.884200	0.7178
	10	0.009600	0.012900	4.753100	0.9070
	15	0.020700	0.028900	7.611300	0.9384
	20	0.074300	0.079000	14.885500	0.7829
	28	0.011100	0.028200	33.829900	0.2065
	25	-0.036400	-0.022100	28.785400	0.2730
	35	0.067413	0.065279	44.412480	0.1322
Q4 COVID-19 Crisis	1	-0.015900	-0.015900	0.132500	0.7158
	5	-0.060000	-0.058600	6.095700	0.2970
	10	0.024821	0.016668	7.016532	0.7238
	15	0.011900	0.014400	8.709000	0.8922
	20	-0.017710	-0.015510	10.297610	0.9624
	25	0.017321	0.015336	10.929600	0.9932
	30	0.049160	0.054690	19.725660	0.9234
	35	-0.042220	-0.043100	21.443040	0.9650

Source: Authors' own work.

According to the results in Table 14, it is determined that there is no autocorrelation problem for the period January 1, 2000-December 31, 2023, 1-30 for the Dotcom Crisis, Mortgage Crisis, European Debt Crisis and Covid-19 Crisis, since the Q probability value calculated for all lag lengths is above the calculated value, and there is an autocorrelation problem for the other periods. In this case, it is understood that the market is efficient in periods when there is no autocorrelation problem and inefficient in periods when there is an autocorrelation problem. In this context, it can be said that AMH is valid in the Chinese stock market in the periods analyzed.

Test results for Turkey's stock exchange

The results of the Wild-bootstrap Variance ratio test, BDS test and Ljung and Box Q Portmanteau test for the market efficiency of Turkey's stock market are shown in Table 15, Table 16 and Table 17, respectively.

Table 15: Wild-bootstrap Variance ratio test

Period		Joint Tests	Value	df	Probability
QAll (01.01.2000-31.12.2023)		Max|z| (at period 2)	17.6502	6014.0000	0.0000
Q1 Dotcom Crisis		Max|z| (at period 2)	7.4341	663.0000	0.0000
Q2 Mortgage Crisis		Max|z| (at period 2)	7.4466	500.0000	0.0000
Q3 European Debt Crisis		Max|z| (at period 2)	8.3684	777.0000	0.0000
Q4 COVID-19 Crisis		Max|z| (at period 2)	6.9262	521.0000	0.0000
Period		**Var. Ratio**	**Std. Error**	**z-Statistic**	**Probability**
QAll (01.01.2000-31.12.2023)	2	0.4907	0.0289	-17.6502	0.0000
	4	0.2479	0.0515	-14.6057	0.0000
	8	0.1241	0.0741	-11.8199	0.0000
	16	0.0615	0.0993	-9.4544	0.0000
Q1 Dotcom Crisis	2	0.4836	0.0695	-7.4341	0.0000
	4	0.2383	0.1293	-5.8904	0.0000
	8	0.1186	0.1888	-4.6684	0.0000
	16	0.0605	0.2507	-3.7473	0.0040
Q2 Mortgage Crisis	2	0.5421	0.0615	-7.4466	0.0000
	4	0.2587	0.1077	-6.8820	0.0000
	8	0.1395	0.1618	-5.3191	0.0000
	16	0.0700	0.2311	-4.0248	0.0000
Q3 European Debt Crisis	2	0.4888	0.0611	-8.3684	0.0000
	4	0.2473	0.1135	-6.6303	0.0000
	8	0.1197	0.1662	-5.2953	0.0000
	16	0.0617	0.2221	-4.2242	0.0010
Q4 COVID-19 Crisis	2	0.4881	0.0739	-6.9262	0.0000
	4	0.2448	0.1378	-5.4808	0.0000
	8	0.1192	0.2014	-4.3739	0.0000
	16	0.0624	0.2675	-3.5046	0.0050

Source: Authors' own work.

According to Table 15, the probability value calculated for periods 2-16 is below the critical value of 0.05 both in the crisis periods and in the whole period and the null hypothesis of random walk is rejected. Therefore, it can be said that the market is not efficient for Turkey's stock returns over the periods. This indicates that both EMH and AMH are not valid in Turkey's stock market.

Table 16: BDS test results

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
QAll (01.012000-31.12.2023)	2	0.0201	0.0012	16.9782	0.0000
	3	0.0445	0.0019	23.6603	0.0000
	4	0.0627	0.0022	28.0672	0.0000
	5	0.0737	0.0023	31.6932	0.0000
	6	0.0777	0.0022	34.7529	0.0000

Period	Dimension	BDS Statistic	Std. Error	z-Statistic	Prob.
Q1 Dotcom Crisis	2	0.0116	0.0032	3.6890	0.0002
	3	0.0240	0.0050	4.8094	0.0000
	4	0.0308	0.0059	5.1954	0.0000
	5	0.0349	0.0062	5.6486	0.0000
	6	0.0358	0.0059	6.0363	0.0000
Q2 Mortgage Crisis	2	0.0066	0.0037	1.8048	0.0711
	3	0.0203	0.0058	3.5023	0.0005
	4	0.0332	0.0069	4.8121	0.0000
	5	0.0409	0.0072	5.6956	0.0000
	6	0.0436	0.0069	6.3139	0.0000
Q3 European Debt Crisis	2	0.0120	0.0028	4.2506	0.0000
	3	0.0258	0.0045	5.7806	0.0000
	4	0.0343	0.0053	6.4474	0.0000
	5	0.0392	0.0056	7.0657	0.0000
	6	0.0407	0.0054	7.6049	0.0000
Q4 COVID-19 Crisis	2	0.0135	0.0034	3.9157	0.0001
	3	0.0260	0.0055	4.7486	0.0000
	4	0.0325	0.0065	4.9855	0.0000
	5	0.0359	0.0068	5.2829	0.0000
	6	0.0377	0.0065	5.7510	0.0000

Source: Authors' own work.

According to Table 16, the probability value calculated for the 2 dimensions of the Mortgage Crisis period is above the critical value, but the probability value calculated for other periods is below the critical value. This indicates that EMH is valid in 2 dimensions of the Mortgage Crisis period, while AMH is valid in the other periods.

Table 17: Ljung and Box Q Portmanteau test results

Period		AC	PAC	Q-Stat	Prob
QAll (01.01.2000-31.12.2023)	1	0.0056	0.0056	0.1795	0.6718
	5	-0.0114	-0.0105	7.5245	0.1845
	10	0.0509	0.0507	40.3396	0.0000
	15	0.0256	0.0287	51.9179	0.0000
	20	-0.0094	-0.0087	56.1946	0.0000
	25	0.0105	0.0083	64.7640	0.0000
	30	-0.0212	-0.0178	72.4834	0.0000
	35	-0.0115	-0.0131	91.6682	0.0000
Q1 Dotcom Crisis	1	-0.0280	-0.0280	0.5235	0.4693
	5	-0.0286	-0.0262	3.4935	0.6244
	10	0.0370	0.0422	10.8536	0.3690
	15	0.0616	0.0740	15.3088	0.4294
	20	-0.0005	-0.0019	17.6288	0.6118
	25	0.0359	0.0189	27.2314	0.3444
	30	-0.0324	-0.0273	29.1044	0.5121
	35	-0.0226	-0.0363	37.3668	0.3609
Q2 Mortgage Crisis	1	0.0535	0.0535	1.4435	0.2296
	5	0.0050	-0.0027	4.2242	0.5176
	10	0.0770	0.0683	15.7920	0.1057
	15	-0.0434	-0.0373	19.9709	0.1731
	20	-0.0402	-0.0358	24.2971	0.2297
	25	0.0223	0.0345	25.2556	0.4481
	30	-0.0293	-0.0175	31.8242	0.3757
	35	0.0018	-0.0014	39.9118	0.2609

Period		AC	PAC	Q-Stat	Prob
Q3 European Debt Crisis	1	-0.0026	-0.0026	0.0053	0.9420
	5	-0.0332	-0.0311	3.5850	0.6106
	10	0.0482	0.0481	12.1407	0.2758
	15	0.0635	0.0727	17.5449	0.2873
	20	-0.0089	-0.0027	19.7351	0.4746
	25	0.0258	0.0066	27.4593	0.3333
	30	-0.0140	-0.0058	31.8070	0.3766
	35	-0.0231	-0.0302	38.9168	0.2978
Q4 COVID-19 Crisis	1	0.0057	0.0057	0.0168	0.8968
	5	-0.0566	-0.0543	4.0509	0.5421
	10	0.0507	0.0500	10.1086	0.4310
	15	0.0843	0.0957	16.5775	0.3447
	20	-0.0201	-0.0098	19.1483	0.5122
	25	0.0289	0.0099	24.9358	0.4660
	30	-0.0077	0.0008	27.6021	0.5915
	35	0.0015	-0.0096	34.1310	0.5099

Source: Authors' own work.

According to the results in Table 17, it is determined that there is no autocorrelation problem for the period January 01, 2000-December 31, 2023 since the Q probability value calculated for the period 1-5, Dotcom Crisis 1-30, Mortgage Crisis, European Debt Crisis, COVID-19 Crisis for all lag lengths is above the calculated value, and there is an autocorrelation problem for the other periods. In this case, it is understood that the market is efficient in the periods when there is no autocorrelation problem and the market is inefficient in the periods when there is an autocorrelation problem. In this context, it can be said that AMH is valid in the Turkish stock market in the analyzed periods.

Conclusions

AMH, which brings EMH and Behavioral Finance together, forms the basis of this study. The aim of this study is to test the validity of AMH in the equity markets of BRIC-T countries, also known as the rapidly developing country group. Accordingly, daily index return series of each country were constructed and analyzed with the help of Wild-bootstrap Variance ratio test, BDS test and Ljung and Box Q Portmanteau tests. According to the results of the analysis, it can be said that both EMH and AMH are not valid according to the Wild-bootstrap Variance ratio test; according to the BDS test results, AMH is valid and according to the Ljung and Box Q Portmanteau test results, AMH is valid in the equity market of BRIC-T countries. This is in line with the studies in the literature such as Todea et al. (2009); Popović et al. (2013); Dyakova and Smith (2013); Lim et al. (2014); Ghazani and Araghi (2014); Arendas and Chovancová (2015); Urquhart and Mc Groarty (2016); Noda (2016); Rahman et al, (2017); Zhu (2017); Shi et al. (2017); Ndubuisi and Okere (2018); Phan et al. (2019); Kołatka (2020); Akhter and Yong (2021); Munir et al. (2022); Aytekin and Doğan (2023); while it differs from Himremath and Kumari (2014) and Kılıç (2020). When the results of the study are evaluated within the theoretical framework, it can be said that international investors and portfolio managers will occasionally generate above-normal returns in the equity markets of BRIC-T countries. This may be an opportunity especially for investors who want to diversify their portfolios to spread risk. In fact, it can be said that investors do not act rationally when changes in the markets occur, and that they can earn higher returns than other investors by taking into account the strategic mistakes they made in the past and using new analysis methods. In short, it is concluded that AMH is more successful than EMH in explaining the equity markets of BRIC-T countries. In fact, according to AMH, what is important is that investors have the ability to adapt more quickly to new conditions, new situations, shocks or crises. As a matter of fact, after each crisis and global pandemic, the markets sooner or later adapted to the changes and shocks and the transition to the new situation began. The important point here is the decisions to be taken by governments, especially after such crises and pandemics. Since the economy is like an interconnected neural network and interactions are faster and more effective than expected, policymakers should make and implement more cautious and conservative decisions during these periods. Researchers interested in studying this topic in the future can examine different country groups using different methods or make comparisons of country groups.

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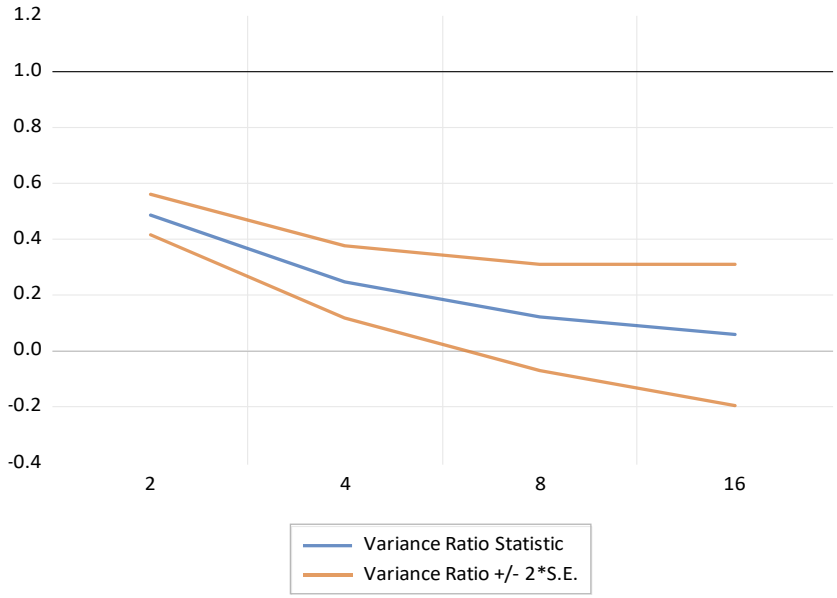
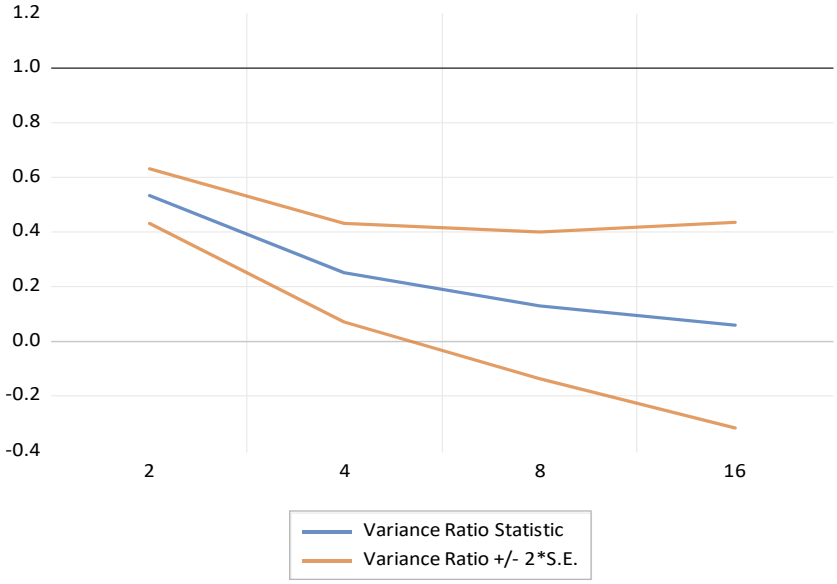
Appendix

Appendix 1: Variance Ratio Statistic for LNB with Robust +/- 2*S.E. Bands (Graph for Table 3)



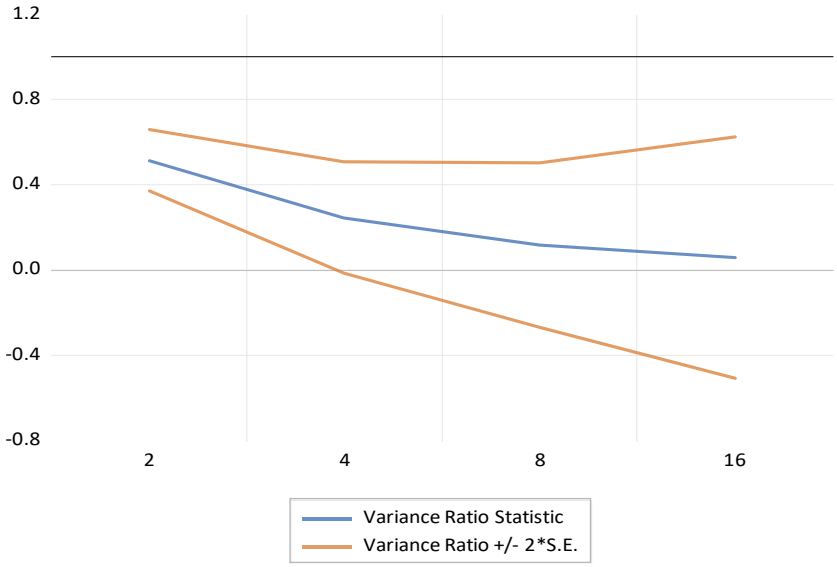
Source: Authors' own work.

Appendix 2: Variance Ratio Statistic for LNBQ1 with Robust +/- 2*S.E. Bands (Graph for Table 3)



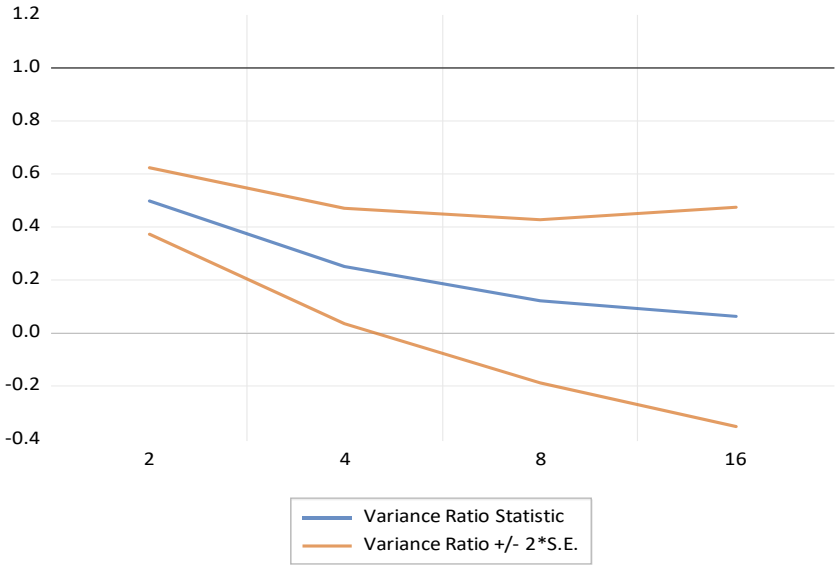
Source: Authors' own work.

Appendix 3: Variance Ratio Statistic for LNBQ2 with Robust +/- 2*S.E. Bands (Graph for Table 3)



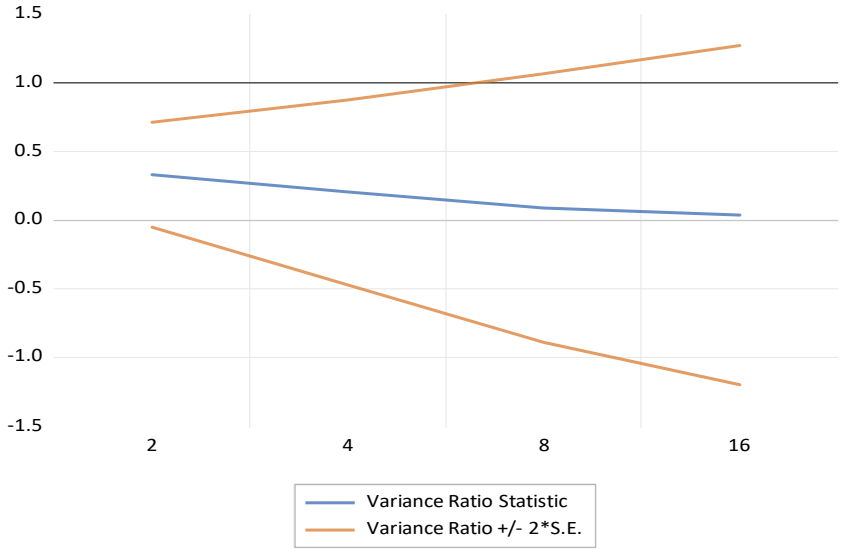
Source: Authors' own work.

Appendix 4: Variance Ratio Statistic for LNBQ3 with Robust +/- 2*S.E. Bands (Graph for Table 3)



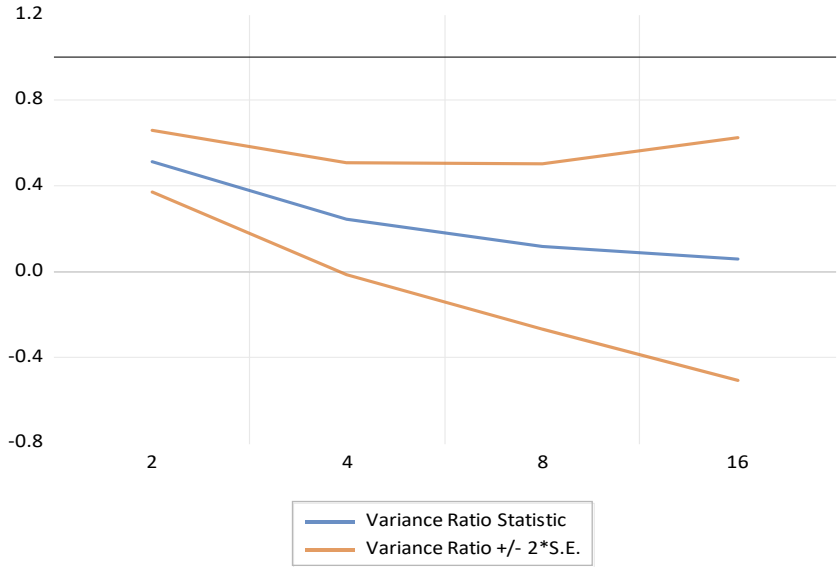
Source: Authors' own work.

Appendix 5: Variance Ratio Statistic for LNBQ4 with Robust +/- 2*S.E. Bands (Graph for Table 3)



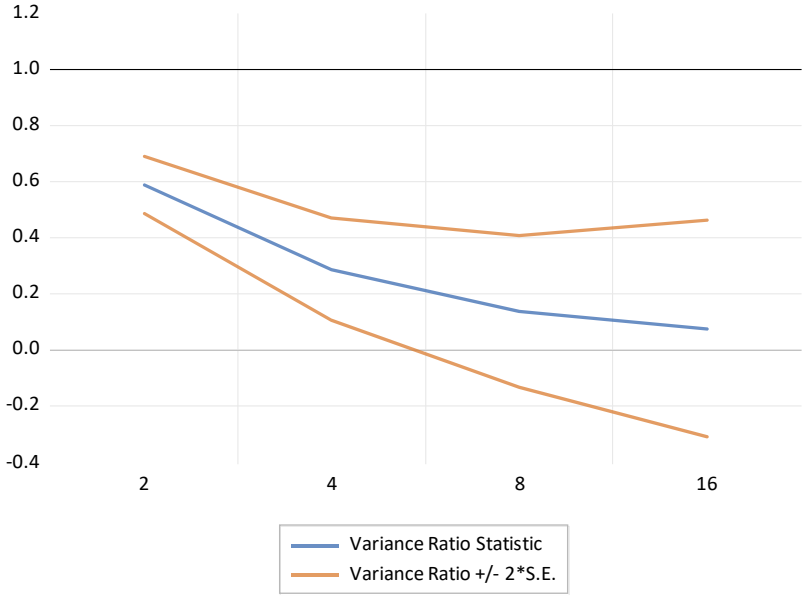
Source: Authors' own work.

Appendix 6: Variance Ratio Statistic for LNBQ2 with Robust +/- 2*S.E. Bands (Graph for Table 6)



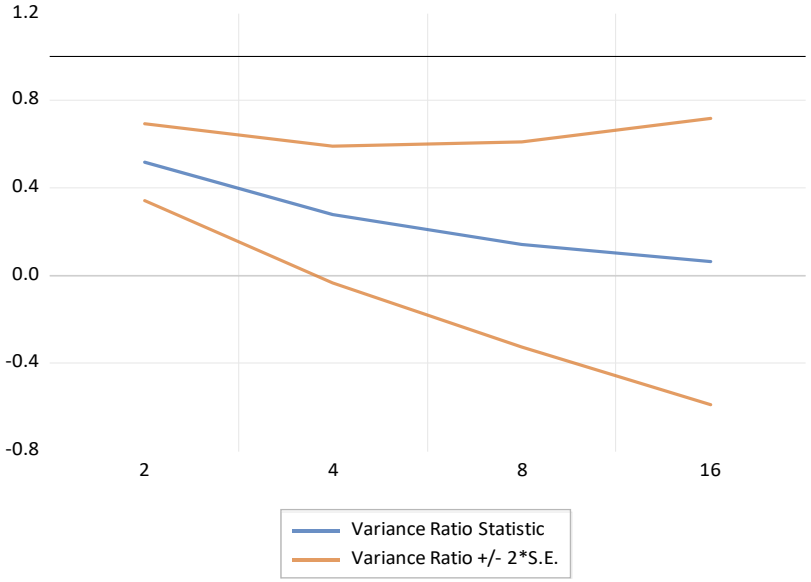
Source: Authors' own work.

Appendix 7: Variance Ratio Statistic for LNRQ1 with Robust +/- 2*S.E. Bands (Graph for Table 6)



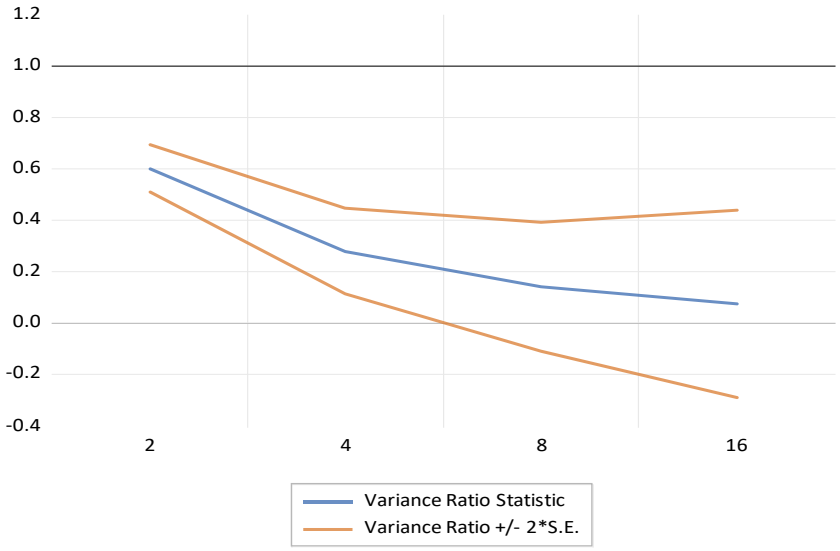
Source: Authors' own work.

Appendix 8: Variance Ratio Statistic for LNRQ2 with Robust +/- 2*S.E. Bands (Graph for Table 6)



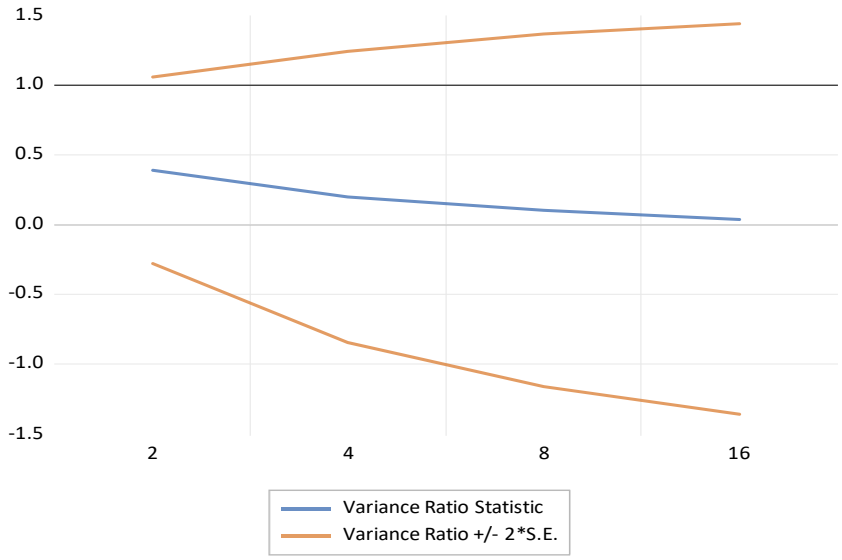
Source: Authors' own work.

Appendix 9: Variance Ratio Statistic for LNRQ3 with Robust +/- 2*S.E. Bands (Graph for Table 6)



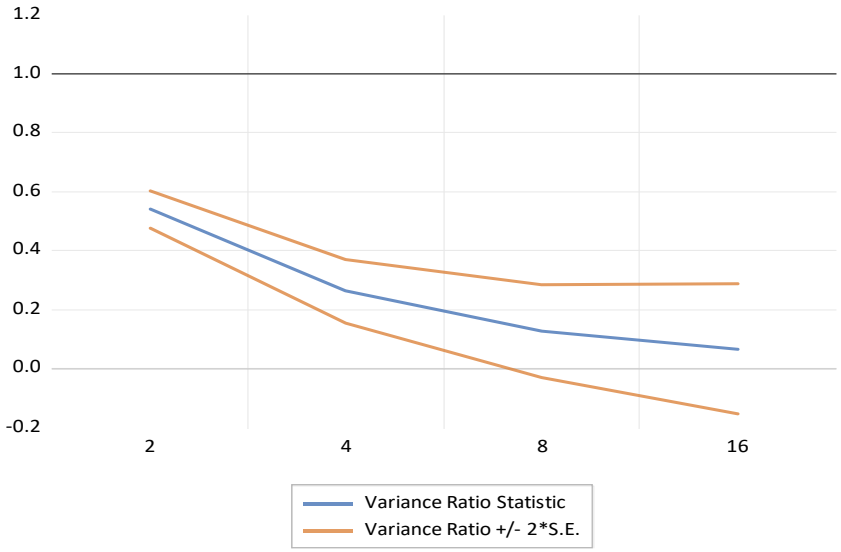
Source: Authors' own work.

Appendix 10: Variance Ratio Statistic for LNRQ2 with Robust +/- 2*S.E. Bands (Graph for Table 6)



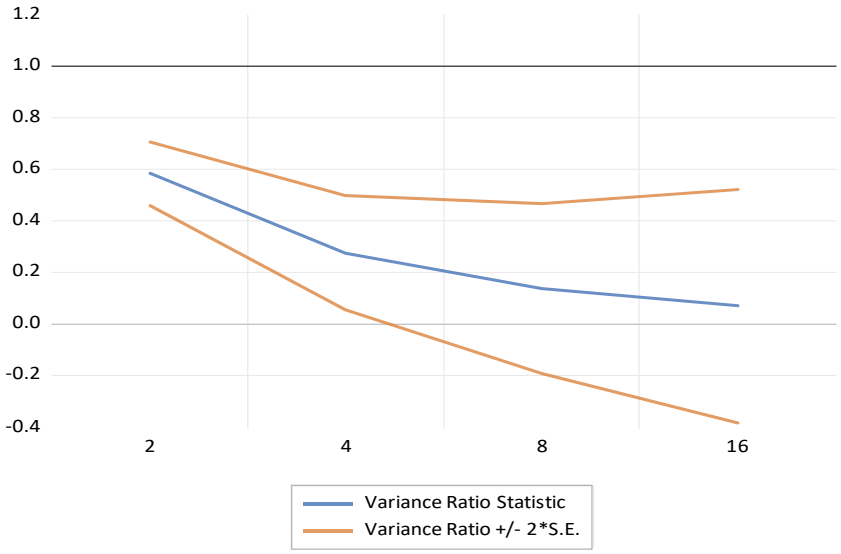
Source: Authors' own work.

Appendix 11: Variance Ratio Statistic for LNI with Robust +/- 2*S.E. Bands (Graph for Table 9)



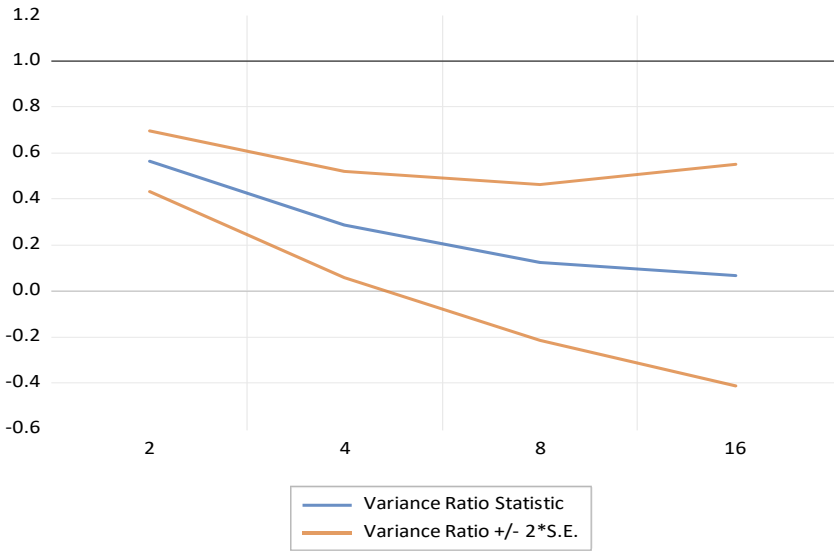
Source: Authors' own work.

Appendix 12: Variance Ratio Statistic for LNIQ1 with Robust +/- 2*S.E. Bands (Graph for Table 9)



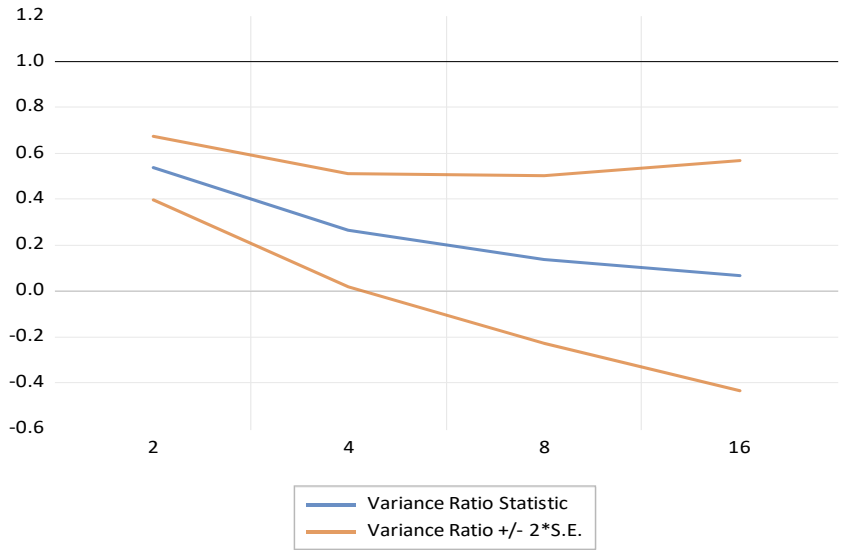
Source: Authors' own work.

Appendix 13: Variance Ratio Statistic for LNIQ2 with Robust +/- 2*S.E. Bands (Graph for Table 9)



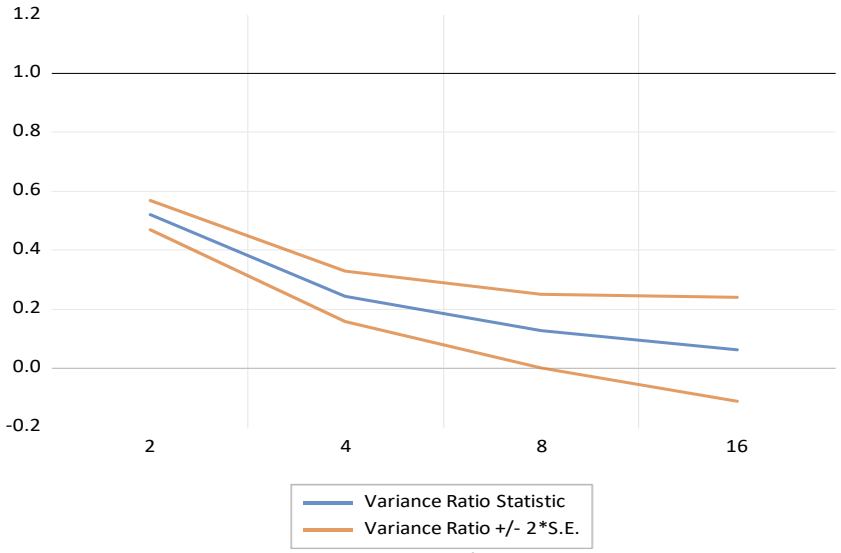
Source: Authors' own work.

Appendix 14: Variance Ratio Statistic for LNIQ4 with Robust +/- 2*S.E. Bands (Graph for Table 9)



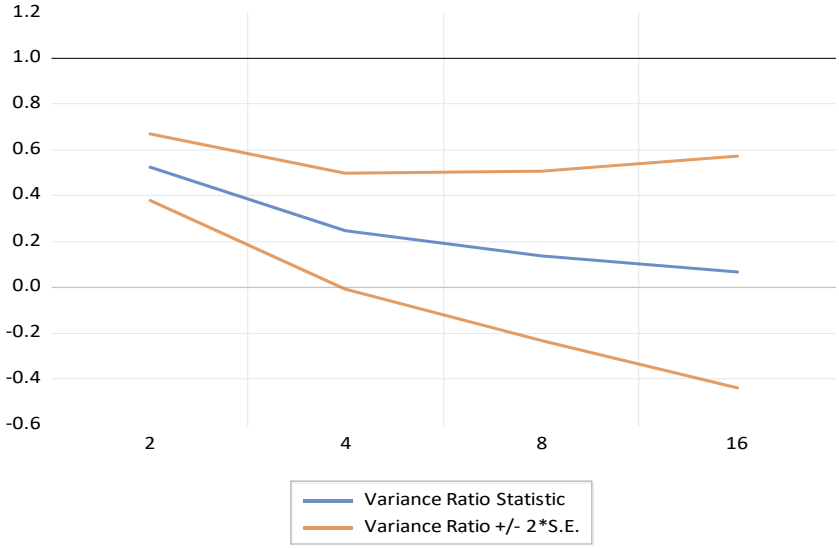
Source: Authors' own work.

Appendix 15: Variance Ratio Statistic for LNC with Robust +/- 2*S.E. Bands (Graph for Table 12)



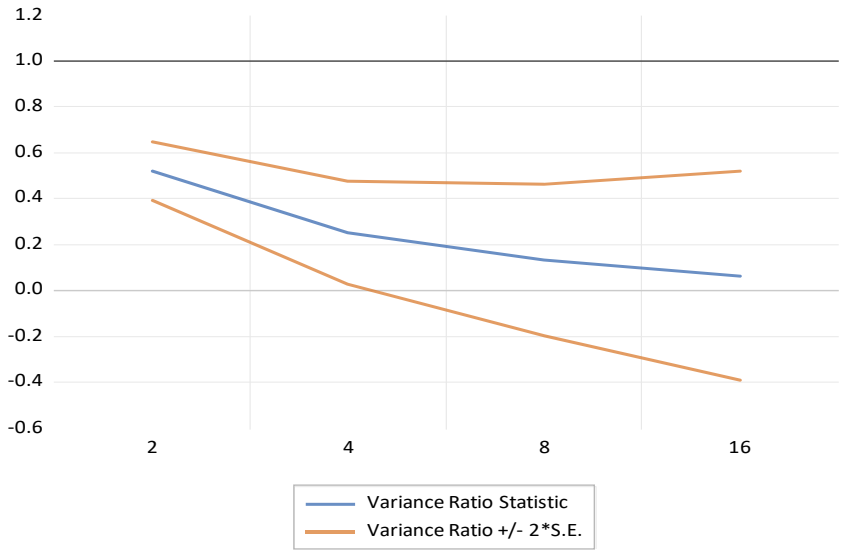
Source: Authors' own work.

Appendix 16: Variance Ratio Statistic for LNCQ1 with Robust +/- 2*S.E. Bands (Graph for Table 12)



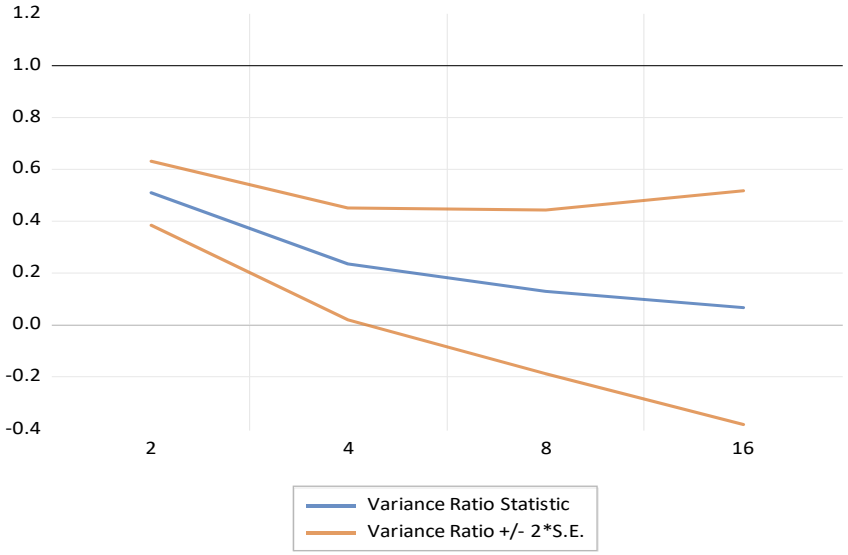
Source: Authors' own work.

Appendix 17: Variance Ratio Statistic for LNCQ2 with Robust +/- 2*S.E. Bands (Graph for Table 12)



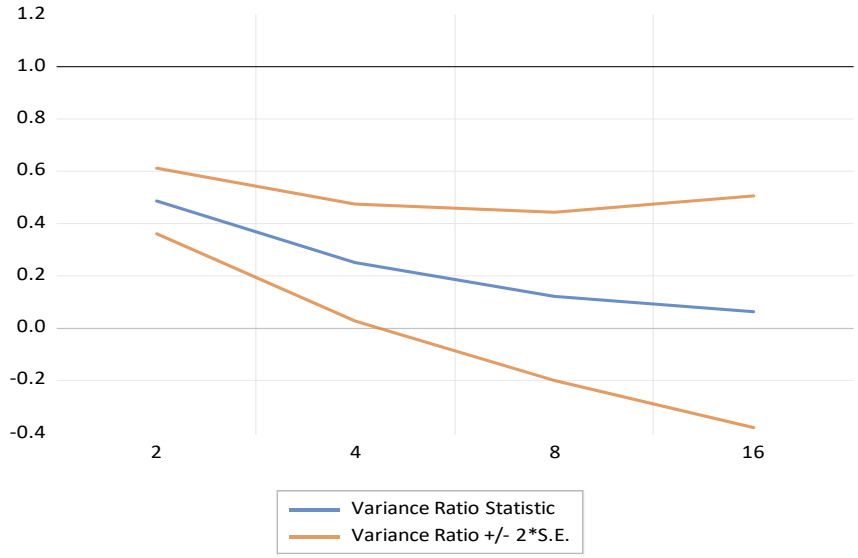
Source: Authors' own work.

Appendix 18: Variance Ratio Statistic for LNCQ3 with Robust +/- 2*S.E. Bands (Graph for Table 12)



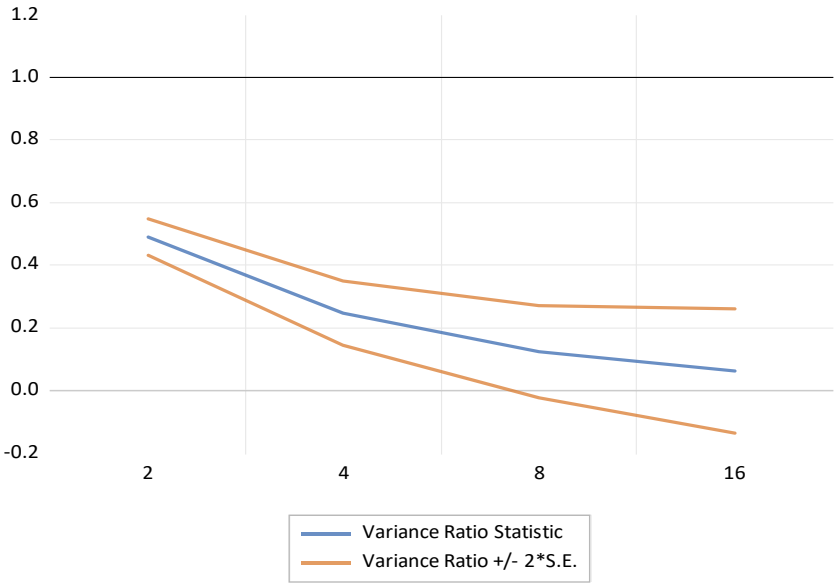
Source: Authors' own work.

Appendix 19: Variance Ratio Statistic for LNCQ4 with Robust +/- 2*S.E. Bands (Graph for Table 12)



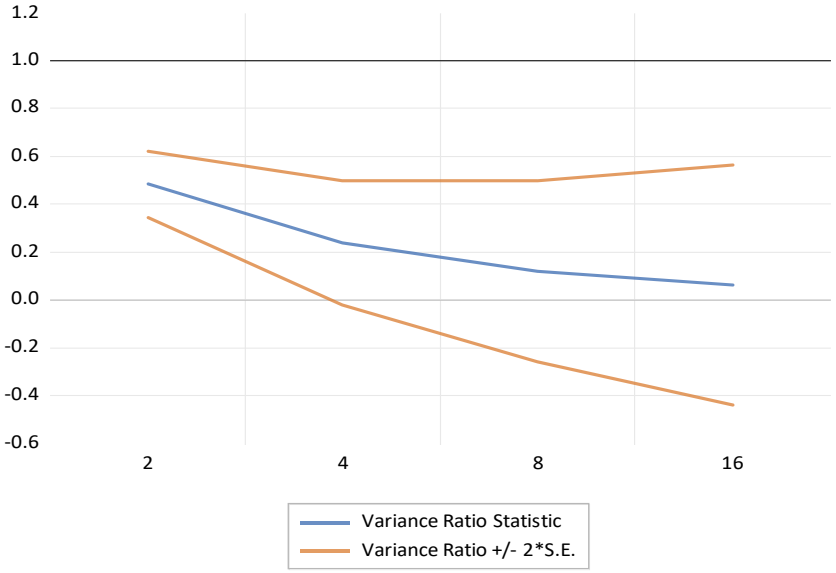
Source: Authors' own work.

Appendix 20: Variance Ratio Statistic for LNT with Robust +/- 2*S.E. Bands (Graph for Table 15)



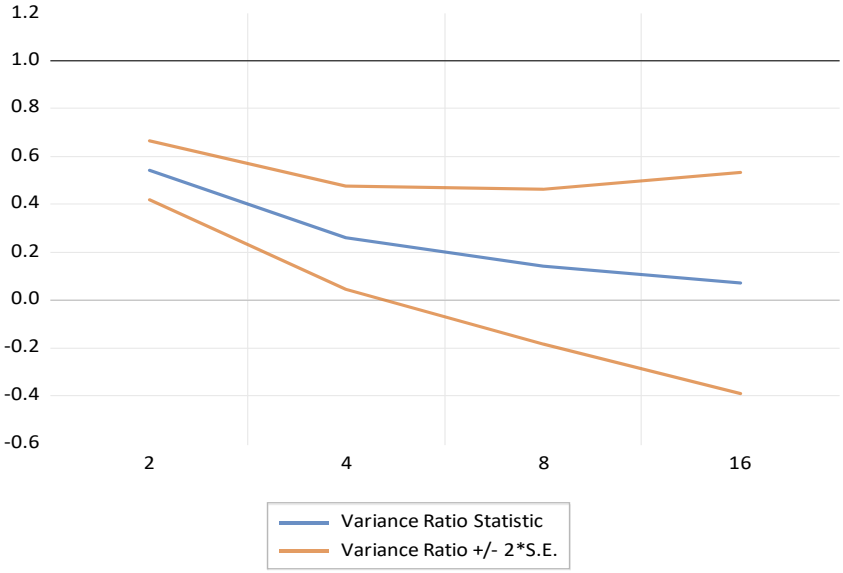
Source: Authors' own work.

Appendix 21: Variance Ratio Statistic for LNTQ1 with Robust +/- 2*S.E. Bands (Graph for Table 15)



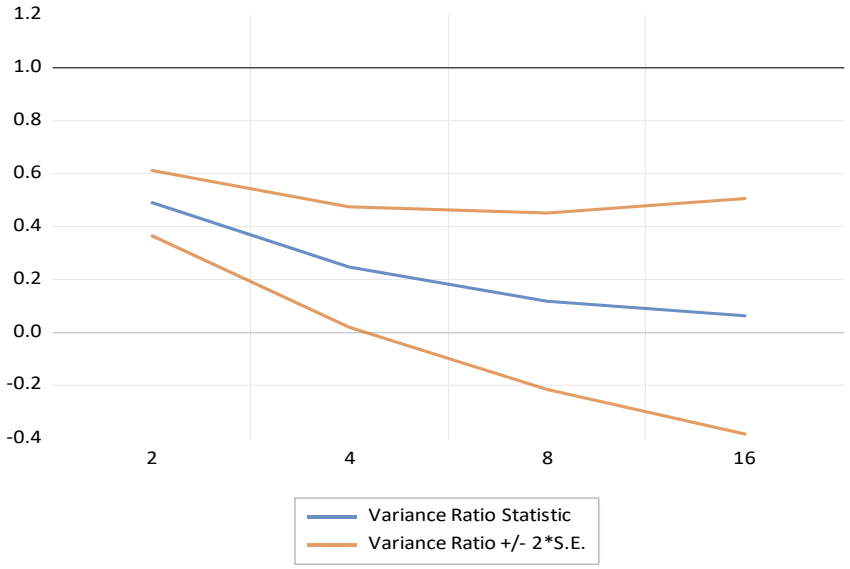
Source: Authors' own work.

Appendix 22: Variance Ratio Statistic for LNTQ2 with Robust +/- 2*S.E. Bands (Graph for Table 15)



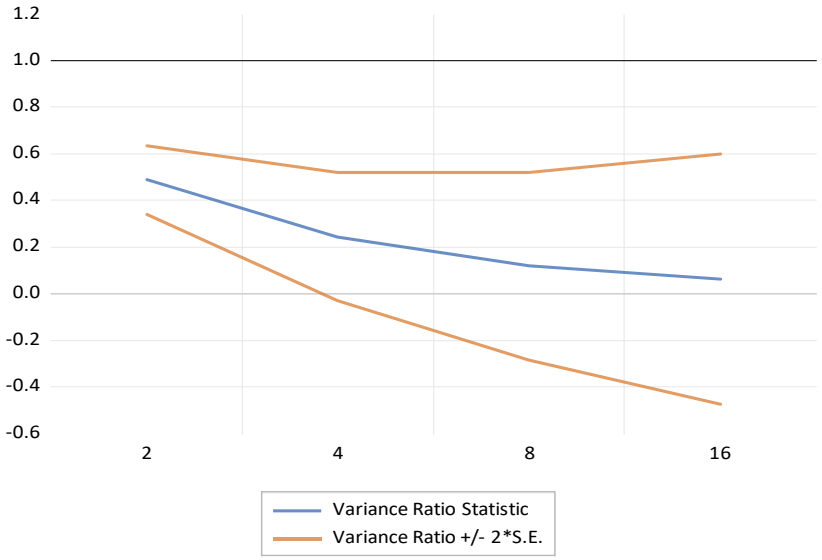
Source: Authors' own work.

Appendix 23: Variance Ratio Statistic for LNTQ3 with Robust +/- 2*S.E. Bands (Graph for Table 15)



Source: Authors' own work.

Appendix 24: Variance Ratio Statistic for LNTQ4 with Robust +/- 2*S.E. Bands (Graph for Table 15)



Source: Authors' own work.