Efficiency of Asean-5 Markets: An Detrended Fluctuation Analysis

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Abstract: This study intends to analyse efficiency, in its weak form, in the financial markets of Indonesia, Malaysia, Philippines, Singapore, Thailand (Asean-5), and China, during the global pandemic (Covid-19). Different approaches have been undertaken to carry out this analysis in order to determine whether: Asean -5 financial markets and China are efficient, in their weak form, during the analysis period? The results indicate that the random walk hypothesis is rejected in all markets. The values of the variance ratios are, in all cases, lower than the unit, which implies that the returns are autocorrelated over time and, there is a reversion to the average, in all indices. In corroboration, the exponents Detrended Fluctuation Analysis (DFA), indicate significant long memories with a larger incidence in the Philippines and Singapore markets, however the Chinese market evidences anti persistence. These results demonstrate that stock prices do not completely reflect the available information and that stock prices movements are not i.i.d. This has implications for investors, as some returns can be expected, creating opportunities for arbitrage and abnormal returns, contrary to the assumptions of random walk and information efficiency. These conclusions also allow market regulators to implement measures to ensure better information in these regional markets.

Keywords: Covid-19; Asean-5; long memories; arbitrage; portfolio diversification.
JEL classification: C58, G10, G11, G12, G14, G15, F3

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Učinkovitost trgov Asean-5: analiza nihanj z odstranitvijo trenda

Povzetek: Namen te raziskave je preučiti učinkovitost finančnih trgov v njihovi šibki obliki v Indoneziji, Maleziji, Singapurju, na Filipinih, Tajskem (Asean-5) in Kitajskem v času svetovne pandemije (Covid-19). Z različnimi pristopi smo s to analizo želeli ugotoviti, ali so finančni trgi držav Asean-5 in Kitajske v preučevanem obdobju učinkoviti v svoji šibki obliki. Rezultati kažejo, da je hipoteza naključnega gibanja ovržena za vse trge. Vrednosti razmerij varianc so v vseh primerih nižje od enote, kar kaže, da so donosi skozi čas avtokorelirani in da se vsi kazalniki vračajo k srednji vrednosti. To potrjuje eksponent analize nihanj z odstranitvijo trenda (DFA), ki kaže na občutne dolgotrajne spomine z večjo pojavnostjo na filipinskem in singapurskem trgu, pri čemer pa se na kitajskem trgu kaže odmik od vztrajnosti. Rezultati kažejo, da cene delnic v celoti ne odražajo razpoložljivih informacij in da gibanje teh cen ni neodvisno in enakomerno porazdeljeno. To ima posledice za investitorje, saj je mogoče pričakovati določen donos, kar ustvarja priložnosti za arbitražo in neobičajne donose, kar je v nasprotju s predpostavkama o naključnem gibanju in učinkovitosti informacij. Ti zaključki regulatorjem trga omogočajo izvajanje ukrepov za

1. Introduction

The Covid-19 pandemic negatively affects global trade as well as, social and cultural life, including tourism, commodity trade, industrial production, aviation, and others. Rating agencies such as Moody's and Standard & Poor's have therefore a reduction in forecast for China GDP growth in 2020. Aligned with all these negative effects, it seems inevitable that stock markets, economic growth and exchange rates have also been affected equally. (Liu, Manzoor, Wang, Zhang and Manzoor, 2020).

Several studies have analysed the question of market efficiency, examining the assumption of predictability of returns by analysing the average reversal in financial market prices (Fama and French, 1988). When the assumptions of *random walk* and information efficiency are rejected, they cause extreme comovements in stock prices. The occurrence of these events, may eventually, reduce the implementation of efficient portfolio diversification strategies (Sadat and Hasan, 2019).

This research will test the hypothesis of efficiency, in its weak form, in the financial markets of Indonesia, Malaysia, Philippines, Singapore, Thailand (ASEAN-5), and China, during the pandemic outbreak (Covid-19). The results suggest that the *random walk* hypothesis is rejected in all markets. In corroboration, the exponents *Detrended Fluctuation Analysis (DFA),* indicate significant long memories with a larger incidence in the Philippines and Singapore markets, but the China market evidences anti persistence.

This research adds contributions to the literature, namely the survey on market efficiency in its weak form, in the stock market indices of Indonesia, Malaysia, Philippines, Singapore, Thailand (ASEAN-5), and China, during the pandemic outbreak (Covid-19). According to our information, this study is the first to analyse these financial markets in a separate way. However, there are recent research that examined the impact of the global 2020 pandemic on financial markets, namely the authors' studies Morales and Andreosso-O´Callaghan (2020), Şenol and Zeren (2020). Although the approach was rather different from that followed in this study.

In terms of structure this paper is organised in 5 sections. Section 1 is represented by the current introduction. Section 2 presents a literature review on articles concerning contagion in financial markets. Section 3 describes the data and methodology. Section 4 contains the results. Finally, Section 5 presents the main conclusions.

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2. Literature review

The subject of the efficient market hypothesis (EMH) has motivated several studies to analyse the implications of the market efficiency hypothesis, according to which the current price of assets reflects all available information, at a given moment, and the price adjusts quickly, as new and unforeseen information reaches the market (Fama and French, 1988).

Nisar and Hanif (2012), Mehla and Goyal (2013), El Khamlichi, Sarkar, Arouri, and Teulon (2014), tested the hypotheses of random walk and, of efficient market, in its weak form, in the Asian markets. Nisar and

Hanif (2012) studied the major stock exchanges in South Asia, including India, Pakistan, Bangladesh and Sri Lanka, and showed market (in)efficiency, in their weak form. Mehla and Goyal (2013) suggested that the Indian market did not show the characteristics of *random walk*, therefore was not efficient, in its weak form. El Khamlichi et al. (2014) evidenced that Islamic indices have the same level of (in) efficiency as the benchmarks, but the MSCI and FTSE indices are less inefficient. Additionally, Islamic indices and their benchmarks are not integrated, which suggests the existence of opportunities for diversification in the long term.

Malhotra, Tandon, and Tandon (2015), Andrianto and Mirza (2016), Hamid et al., (2017), Singh and Kumar (2018) analysed the Asian markets, in a context of efficiency, in their weak form. Malhotra, Tandon, and Tandon (2015) evidenced that the efficient market hypothesis is rejected. The authors argue that these results have important implications for investors who can exploit market inefficiency and obtain anomalous returns while holding a well-diversified portfolio in these emerging markets. Andrianto and Mirza (2016) evidenced that the Indonesian stock market is efficient in its weak form, suggesting that the daily stock price movement is random, and does not have autocorrelation. Singh and Kumar (2018) suggested that the Kuala Lumpur Stock Exchange, Malaysia, is not efficient in its weak form. Hamid et al. (2017) suggested that prices do not follow the *random walk* hypothesis in the countries of the Asia-Pacific region. As a result, investors can benefit from the arbitration process and obtaining anomalous returns without incurring additional risk. Aggarwal (2018), Rehman, Chhapra, Kashif, and Rehan (2018), Karasiński (2020) have studied efficiency in several financial markets. Aggarwal (2018) analysed the market efficiency and persistence of the Korean stock market (KOSPI), and suggests that weekly series that do not follow a *random walk* process. Rehman, Chhapra, Kashif, and Rehan (2018) demonstrate that the stock market indices of Pakistan, India and Bangladesh are not efficient in their weak form. Karasiński (2020) analysed efficiency, in its weak form, in European markets, and evidenced that global efficiency tended to improve after the global financial crisis of 2008.

In summary, this work aims to contribute to providing information to investors and regulators in ASEAN-5 financial markets, and to assess whether these regional markets are efficient, in their weak form, in the context of the global pandemic (COVID-19).

3. Data and methodology

The data used for this study were the daily prices index for the markets of Indonesia, Malaysia, Thailand, Singapore, Philippines, and China, from 02 January 2019 to 06 July 2020. The source of information used was the Thomson Reuters platform, with local currency stock prices being used to mitigate exchange rate distortions.

Table 1: The name of countries and their indices used in this paper

Country / Region name	Index
Indonesia / ASEAN-5	Jakarta Stock Exchange Composite Index
Malaysia / ASEAN-5	FTSE Bursa Malaysia Index
Philippines / ASEAN-5	Philippines Stock Exchange PSEi Index
Singapore / ASEAN-5	Singapore Exchange - SGX
Thailand / ASEAN-5	Stock Exchange of Thailand
China / Asia	Shanghai Stock Exchange Composite Index

Source: Own elaboration

The development of research has taken place in several stages. To test the *random walk* hypothesis we used the non-parametric test developed by Wright (2000), because it is a test more resilient to time series that do not exhibit normality and quite consistent when they show series correlation. The methodology of this author consists of two types of tests, the Position test (Rankings) for homoscedastic series and the

Signals test for heteroscedastic series. The ratio of variances is given by the relation between the variance of q periods and of a single period, being the same equal to 1: thus, in the variance ratio test, under the null hypothesis $VR(q) = 1$, the series follows a *random walk* type process. When the hypothesis of randomness is rejected and $VR(q) > 1$, the series indicates the existence of positive correlation. When the null hypothesis is rejected and $VR(q) < 1$, the series exhibits negative series correlation. In order to validate the outcome, the *Detrended Fluctuation Analysis (DFA)* will be used. The *DFA* is a method of analysis that examines the time dependency in non-stationary data series. This technique by assuming that time series are non-stationary avoids spurious results when the analysis focuses on the relationships of data series in the long term. This methodology was developed by Peng et al. (1994), and in its origin, has the study of the behaviour of *DNA*. Later this method was used to examine the behaviour of financial series. DFA has the following interpretation:$0 < \alpha < 0,5$: anti-persistent series; $\alpha = 0,5$ series contains *random walk;* $0,5 < \alpha < 1$ persistent series.

4. Results

The sample comprises the time horizon from July 2, 2019 to July 6, 2020, which is a very complex period due to the global pandemic outbreak (Covid-19). The financial market indices analysed clearly reveal the volatility experienced in these markets in January, February, and March 2020.
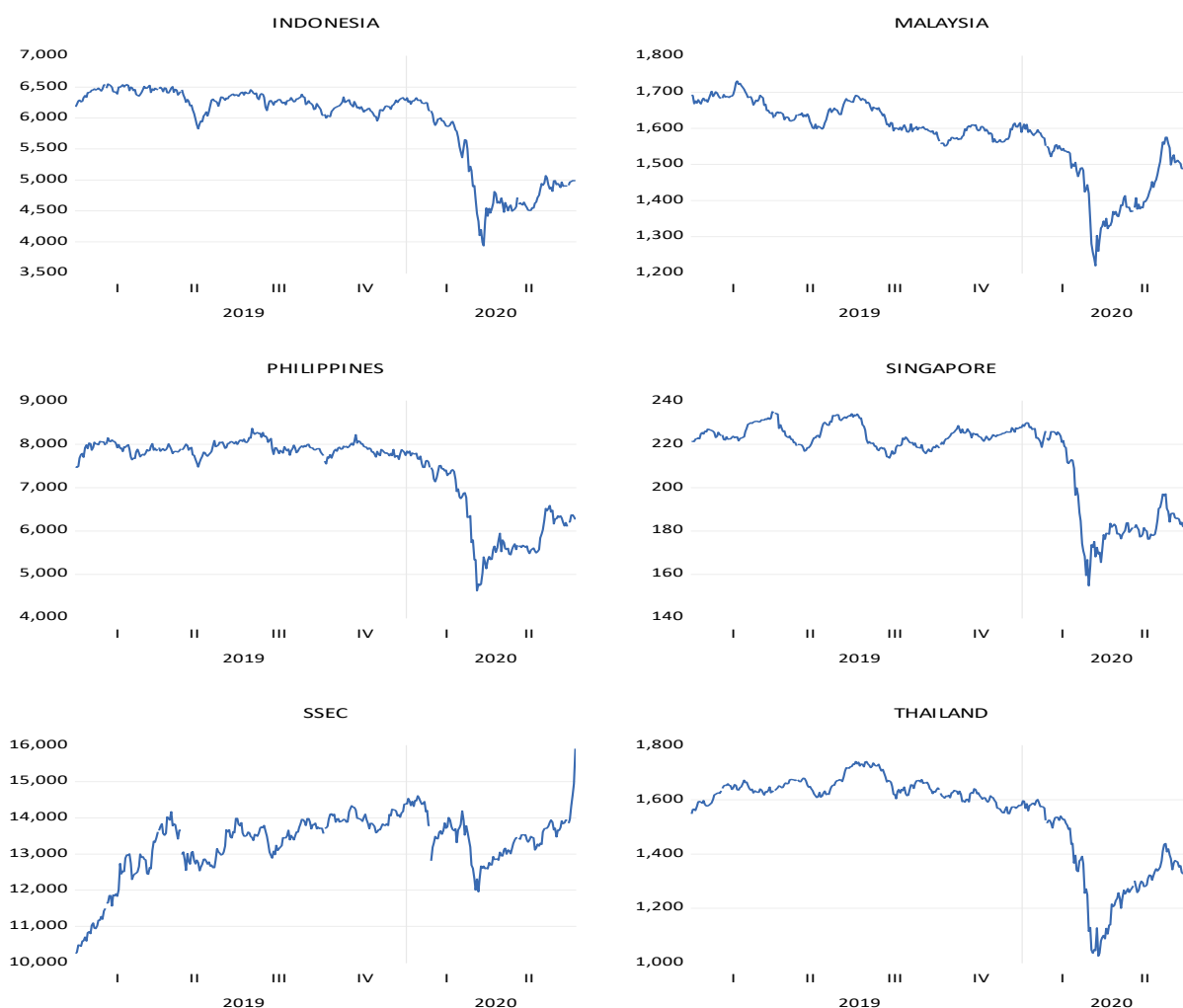

Figure 1: Evolution, in levels, of the 6 financial markets, from 02/01/2019 to 06/07/2020
Source: Own elaboration
Note: Thomson Reuters: 2 January 2019, 372 spot data

Table 2 illustrates the main descriptive statistics of the six indices for the entire sample period. The average is negative in most stock market indices, except in China. The Philippines market presents the sharpest standard deviation. The results obtained demonstrate that the yield series suggest deviations from the hypothesis of normality. Additionally, the asymmetry and kurtosis coefficients are statistically different from those of a normal distribution, being the same leptokurtic and asymmetric.

Table 2: Descriptive statistics, in returns, of the 6 financial markets in the full period

	Indonesia	Malaysia	Philippines	Singapore	Ssec	Thailand
Mean	-0.000576	-0.000189	-0.000476	-0.000441	0.001182	-0.000325
Std. Dev.	0.013235	0.009198	0.017319	0.012043	0.013445	0.014708
Skewness	0.259166	-0.359190	-2.275348	-0.921184	-0.137445	-2.284142
Kurtosis	14.59784	16.07913	20.94910	14.05632	7.673842	23.68051
Jarque-Bera	2089.069***	2659.486***	5314.625***	1947.365***	339.7656***	6952.568***
Sum	-0.214300	-0.070492	-0.177227	-0.163961	0.439684	-0.120736
S. Sq. Dev.	0.064985	0.031385	0.111281	0.053807	0.067069	0.080256
Observations	372	372	372	372	372	372

Source: Own elaboration

The non-parametric methodology Wright (2000), which includes the Rankings and Signals Variance tests, in the period from January 2019 to July 2020, were estimated for the lags of 2, 4, 8 and 16 days. Considering the results of Wright's (2000) Rankings variance test, the random walk hypothesis is rejected in all indices. In turn, the Sign Test also corroborates the rejection of the random walk hypothesis in all data series. The values of the variance ratios are, in all cases, lower than the unit, which implies that the yields are autocorrelated over time and, there is a reversion to the mean, in all indices. The results obtained suggest that the random walk hypothesis and the informational efficiency hypothesis of financial markets are rejected, and are consistent with those obtained in other studies, namely by the authors Hamid, Suleman, Ali Shah and Imdad Akash (2017), Aggarwal (2018), Sadat and Hasan (2019).

Table 3: Wright's (2000) Rankings and Signs Ratio Tests for the ASEAN-5 and China markets in the Full Period

	Wright											
	q=2			q=4			q=8			q=16		
	R1	R2	S1	R1	R2	S1	R1	R2	S1	R1	R2	S1
Indonesia	-19.24***	-19.84***	-13.87***	-16.34***	-17.06***	-11.45***	-12.15***	-12.85***	-8.32***	-8.71***	-9.22***	-5.80***
	0.56	0.55	0.68	0.30	0.27	0.51	0.18	0.14	0.44	0.13	0.08	0.42
Malaysia	-19.80***	-20.30***	-15.24***	-16.61***	-17.36***	-11.92***	-12.20***	-12.75***	-8.94***	-8.84***	-9.20***	-6.36***
	0.55	0.54	0.65	0.29	0.26	0.50	0.18	0.14	0.40	0.12	0.08	0.36
Philippines	-22.30***	-23.05***	-16.33***	-17.01***	-17.70***	-12.14***	-12.38***	-12.87***	-8.84***	-8.97***	-9.27***	-6.03***
	0.49	0.48	0.63	0.27	0.25	0.48	0.16	0.14	0.41	0.10	0.07	0.40
Singapore	-18.71***	-19.50	-13.05***	-15.78***	-16.61***	-10.84***	-11.90***	-12.50***	-8.04***	-8.67***	-9.08***	-5.50***
	0.57	0.56	0.70	0.33	0.30	0.54	0.20	0.16	0.46	0.13	0.09	0.45
Thailand	-21.61***	-22.12***	-15.96***	-17.04***	-17.77***	-12.05***	-12.38***	-12.82***	-8.59***	-8.93***	-9.19***	-6.28***
	0.50	0.50	0.64	0.28	0.24	0.49	0.17	0.14	0.42	0.11	0.08	0.37
SSEC	-20.86***	-21.94***	-15.74***	-16.64***	-17.32***	-12.00***	-12.17***	-12.69***	-8.91***	-8.62***	-8.95***	-6.37***
	0.53	0.50	0.64	0.29	0.26	0.49	0.18	0.15	0.40	0.14	0.10	0.36

Source: Own elaboration

Note: The variance tests by Rankings and are based on the assumption of homoscedasticity. The Signs Test is based on the presence of heteroscedasticity. In both cases, the statistics were calculated for lags of 2, 4, 8 and 16 days. The values immediately below indicate the estimates of the variance ratio. ***. **. *. represent significance at 1%. 5% and 10%, respectively.

Table 4 and figure 2 illustrates the results of the DFA exponents, and we can verify that the markets indicate long memories, with a stronger incidence in the Philippines and Singapore markets, however the China market shows anti- persistence. These results indicate that prices do not fully reflect the available information and that price changes are not i.i.d. This has implications for investors, as some returns can be expected, creating opportunities for arbitrage and abnormal returns, contrary to the assumptions of *random walk* and information efficiency. These results are consistent with the evidence suggested by the authors Aggarwal (2018), Rehman, Chhapra, Kashif, and Rehan (2018) which demonstrate (in) efficiency, in its weak form, and that portfolio diversification may be questioned.

Table 4: DFA results. The hypotheses are H_0: α = 0.5 and H_1: α ≠ 0.5

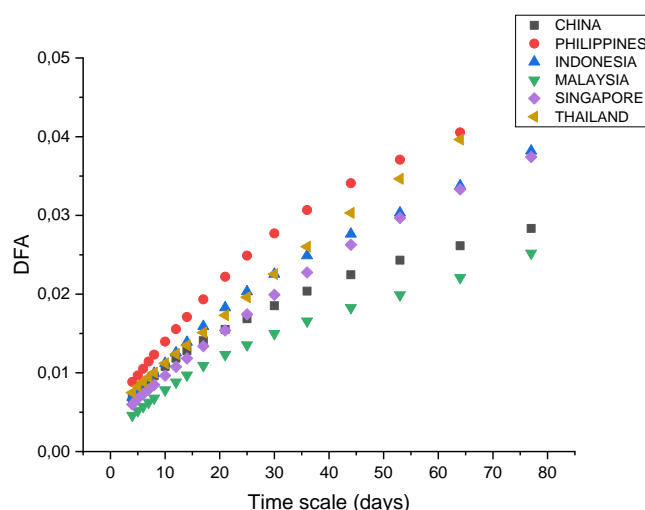| Stock market	DFA exponent (Covid period)
Indonesia	0.58 ≅ 0.0001
Malaysia	0.57 ≅ 0.0012
Philippines	0.57 ≅ 0.0017
Singapore	0.64 ≅ 0.0034
Thailand	0.62 ≅ 0.0011
China	0.49 ≅ 0.0007

Source: Own elaboration

Figure 2: DFA exponent for return. The values of the linear adjustments for α DFA always had R^2>0.99
Source: Own elaboration

5. Conclusion

The general conclusion to be retained and sustained in the results obtained, through the tests performed with mathematical models, is that the *random walk* hypothesis is rejected in all indices. The values of the variance ratios are, in all cases, lower than the unit, which indicates that the yields are autocorrelated in time and, there is reversion to the mean, in all indices. In corroboration, through the DFA model, we have observed that these regional markets show signs of market (in)efficiency, in its weak form. The results obtained may have implications for investors, since some returns may be expected, creating opportunities for arbitrage and abnormal returns, contrary to the assumptions of *random walk* and information efficiency. These conclusions also provide an opportunity for market regulators to introduce measures to ensure better information between these regional and international markets.

References

1. Aggarwal, D. (2018). Random walk model and asymmetric effect in Korean composite stock price index. *Afro-Asian Journal of Finance and Accounting*, doi:10.1504/aajfa.2018.10009906.

2. Andrianto, Y., & Mirza, A. R. (2016). A Testing of Efficient Markets Hypothesis in Indonesia Stock Market. *Procedia - Social and Behavioral Sciences*, doi:10.1016/j.sbspro.2016.04.048.

3. El Khamlichi, A., Sarkar, K., Arouri, M., & Teulon, F. (2014). Are Islamic equity indices more efficient than their conventional counterparts? Evidence from major global index families. *Journal of Applied Business Research*, doi:10.19030/jabr.v30i4.8660.

4. Fama, E. F., & French, K. R. (1988a). Dividend yields and expected stock returns. *Journal of Financial Economics*, doi:10.1016/0304-405X(88)90020-7.

5. Fama, E. F., & French, K. R. (1988b). Dividend yields and expected stock returns. *Journal of Financial Economics*, *22*(1), 3–25, doi:10.1016/0304-405X(88)90020-7.

6. Hamid, K., Suleman, M. T., Ali Shah, S. Z., & Imdad Akash, R. S. (2017a). Testing the Weak Form of Efficient Market Hypothesis: Empirical Evidence from Asia-Pacific Markets. *SSRN Electronic Journal*, doi:10.2139/ssrn.2912908.

7. Hamid, K., Suleman, M. T., Ali Shah, S. Z., & Imdad Akash, R. S. (2017b). Testing the Weak Form of Efficient Market Hypothesis: Empirical Evidence from Asia-Pacific Markets. *SSRN Electronic Journal*, *58*(58), doi:10.2139/ssrn.2912908.

8. Karasiński, J. (2020). The Changing Efficiency of the European Stock Markets. *Annales Universitatis Mariae Curie-Skłodowska, Sectio H − Oeconomia*, doi:10.17951/h.2020.54.1.41-51.

9. Liu, H., Manzoor, A., Wang, C., Zhang, L., & Manzoor, Z. (2020). The COVID-19 outbreak and affected countries stock markets response. *International Journal of Environmental Research and Public Health*, doi:10.3390/ijerph17082800.

10. Malhotra, N., Tandon, K., & Tandon, D. (2015). Testing the empirics of weak form of efficient market hypothesis: Evidence from Asia-Pacific Markets. *IUP Journal of Applied Finance*.

11. Mehla, S., & Goyal, S. K. (2013). Empirical Evidence on Weak Form of Efficiency in Indian Stock Market. *Asia-Pacific Journal of Management Research and Innovation*, doi:10.1177/2319510x1200800107.

12. Morales, L., & Andreosso-O´Callaghan, B. (2020). Covid-19 - Global Stock Markets "Black Swan." *Critical Letters in Economics & Finance*.

13. Nisar, S., & Hanif, M. (2012). Testing weak form of efficient market hypothesis: Empirical evidence from South-Asia. *World Applied Sciences Journal*.

14. Peng, C. K., Buldyrev, S. V., Havlin, S., Simons, M., Stanley, H. E., & Goldberger, A. L. (1994). Mosaic organization of DNA nucleotides. *Physical Review E*, *49*(2), 1685–1689, doi:10.1103/PhysRevE.49.1685.

15. Rehman, S., Chhapra, I. U., Kashif, M., & Rehan, R. (2018). Are Stock Prices a Random Walk? An Empirical Evidence of Asian Stock Markets. *ETIKONOMI*, doi:10.15408/etk.v17i2.7102.

16. Sadat, A. R., & Hasan, M. E. (2019). Testing Weak Form of Market Efficiency of DSE Based on Random Walk Hypothesis Model: A Parametric Test Approach. *International Journal of Accounting and Financial Reporting*, doi:10.5296/ijafr.v9i1.14454.

17. Şenol, Z., & Zeren, F. (2020). Coronavirus (COVID-19) and Stock Markets: The Effects of the Pandemic on the Global Economy. *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi*.

18. Singh, D. S. K., & Kumar, L. (2018). Market Efficiency in Malaysia: An Empirical Study of Random Walk Hypothesis of Kuala Lumpur Stock Market (Composite Index) Bursa Malaysia. *SSRN Electronic Journal*, doi:10.2139/ssrn.3095176.

19. Wright, J. H. (2000). Alternative variance-ratio tests using ranks and signs. *Journal of Business and Economic Statistics*, doi:10.1080/07350015.2000.10524842.