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Adaptive Market Hypothesis: Evidence from Sharia Stocks in Asian Countries

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ABSTRACT

Research Originality: The adaptive market hypothesis, which is a new way to test capital market performance that reconciles the efficient market hypothesis (EMH) with behavioral finance, is the focus of our research. Our study's novelty lies in testing the efficiency of the Islamic capital market in six Asian countries: Bangladesh, India, Indonesia, Malaysia, Pakistan, and Thailand, over different periods: before, during, and after the COVID-19 pandemic.

Research Objectives: We aim to delve into its application in the Islamic capital market, which has seen significant growth in recent years.

Research Methods: We employed the variance ratio test, the ARIMA model, and the Elman neural network to test efficiency.

Empirical Result: Our findings revealed that the efficiency of sharia indices in these countries was not constant over the three periods, thereby supporting the existence of the adaptive market hypothesis.

Implications: The results of this study are not only important for academic discourse but also offer practical applications for investors to refine their investment strategies, engaging the audience in a discussion on Islamic capital market efficiency.

Keywords:
adaptive market hypothesis; sharia stocks; Asian countries

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INTRODUCTION

According to the efficient market hypothesis (EMH), first introduced by Fama (1965), if a market is efficient, all market information is reflected in stock prices instantly, and prices adjust to new information. Stock prices move randomly following the information circulating. It is highly unlikely to take abnormal returns from predicting price movements. Investors can only beat the market for some time, which is also random. There are two assumptions underlying the EMH, called the perfect market assumption, and investors are rational humans who behave rationally and always look for profit opportunities that lead to market efficiency. This second assumption has received much criticism from proponents of behavioral finance (Fakhoury, 2020; Yildirim, 2017). They argue that humans are normal creatures who are sometimes irrational, and this contradicts the basic assumptions of the EMH.

Another critique of EMH theory is that there needs to be a clear definition of the rate at which a market can absorb information. The market speed varies in adjusting to new information. For some time, the market might behave according to the definition of EMH, and for another period, it shows anomalies (Woo et al., 2020). Researchers have also identified numerous market anomalies in the capital market, each with varying degrees of prevalence across different countries (Khan & Rabbani, 2019; Obalade & Muzindutsi, 2019; Shahid & Sattar, 2017). Among the most extensively studied are calendar anomalies, size anomalies, and anomalies during crises.

Calendar anomalies manifest when stock prices exhibit a trend or pattern at specific times, such as the January effect, holiday effect, and Monday and Friday (Khan & Rabbani, 2019; Obalade & Muzindutsi, 2019; Shahid & Sattar, 2017). Rossi (2015) argued that calendar anomalies are a compelling counterpoint to the EMH theory. Banz's (1981) study demonstrated that company size is a crucial determinant of investor returns, with smaller companies outperforming larger ones. This size effect has significant implications for investment strategies, as further substantiated by studies conducted by Pan et al. (2021) and Xiao (2023).

The anomalies observed in the market also contradict the EMH model, thus encouraging the presence of behavioral finance. Unlike EMH, which is based on rational decision-making, behavioral finance introduces a component of irrationality, leading to the emergence of a new paradigm (Seth & Chowdary, 2017; Kumar & Chandel, 2018). However, according to Lo (2005), behavioralists face a fundamental theoretical problem: a solid theory that can answer questions about anomalies in EMH. He initiated the idea of the adaptive market hypothesis (AMH), which is considered to be able to reconcile EMH with behavioral finance. Several studies, such as those conducted by Akhter and Yong (2019), Akhter and Yong (2021), Sing and Singh (2019), Tripathi et al. (2020), and Urquhartand McGroarty (2016) support AMH.

Studies regarding the existence of AMH in the Islamic capital market are academically important because the Islamic capital market has experienced significant growth over the past few years (Paltrinieri et al., 2018; Saleem & Ashfaque, 2020). A

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study on the existence of AMH in the Islamic capital market is also necessary because it can provide crucial input for investors when making investment decisions, underscoring the practical relevance of our research. Investors can set the best investment strategy in different economic conditions, including determining the extent to which the Islamic capital market faces extreme conditions, such as pandemic situations.

Several researchers have studied capital market efficiency during the COVID-19 pandemic with different results (Ammy-Driss & Garcin, 2023; Evangelos, 2021; Gu, 2023; Saleem et al., 2023; Vasileiou, 2021). Their studies show that the impact of the pandemic on capital markets varies by country, as demonstrated in the study conducted by Rodoni et al. (2022), which examined the efficiency of Islamic capital markets in Southeast Asian countries. Their study results show that Thailand's Sharia capital market was more efficient during the pandemic than in the preceding period. In contrast, the Sharia capital market in Malaysia showed the opposite condition. The results of this study highlight the adaptability of the capital market, which is efficient in certain conditions and inefficient in others, providing a reason for optimism.

However, the AMH theory is not exempt from criticism, such as that articulated by Li et al. (2021). They stated that, unlike EMH, which has become the standard use in academia and industry, AMH is a qualitative theory without a solid test method. In addition, a study conducted by Munir et al. (2022) shows that only part of the presence of AMH can be proven. The weakness of AMH has also been acknowledged by its initiator. However, Lo stated that although the AMH theory is qualitative, the implications of this theory can be used by investors and consultants to manage better investment strategies. The analysis in this study is limited to the Islamic stock index in six countries: Bangladesh, India, Malaysia, Pakistan, and Thailand, using the variance ratio test, ARIMA model, and Elman neural network..

Therefore, the novelty from this study lies in testing the efficiency of the Islamic capital market in six Asian countries: Bangladesh, India, Indonesia, Malaysia, Pakistan, and Thailand, over different periods: before, during, and after the COVID-19 pandemic. The purpose of this study is to delve into its application in the Islamic capital market, which has seen significant growth in recent years.

METHODS

Variance ratio tests are established on the principle that if stock returns exhibit a random walk, then the variance of q-differences in an uncorrelated series is q-times the variance of its first differences (Lo & MacKinlay, 1988). If there are n+1 observations, p_0 , p_1, p_2 . . ., p_n are obtained at an equal interval, 1/q of the variance P_t, P_{t-q}, is expected to be equal to the variance p_t - p_{t-1}, for a time series characterized by a random walk. To put it more simply, the variance ratio VR(q) is defined as:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)}$$

If a time series data is random, then the variance of the q-difference is q times the variance of the first difference:

$$Var(p_t - p_{t-q}) = qVar(p_t - p_{t-1})$$

The variance ratio test requires a large number of data. To fulfill this requirement, the daily data was used in this study. Confidence interval for the variance ratio test in this study was 95%. If the variance ratio test score is > 5%, then the data is random and follows a random walk pattern.

ARIMA is a forecasting method. The formation of its model is based on the influence of time by using past and present data as interrelated variables. The ARIMA model consists of three parts: autoregressive (AR), moving average (MA), and integrated (I) part. The general equation of the ARIMA model is as follows:

$$Y_t = Y_{t-1} + \varphi_0 + \varphi_1(Y_{t-1} - Y_{t-2}) + \cdots + \varphi_p(Y_{t-p} - Y_{t-p-1}) - \omega_1, \varepsilon_{t-1} - \cdots - \omega_q, \varepsilon_{t-q} + \varepsilon_t$$

Where

Y_t : dependent variable at time t
ω_0 : intercept
ω_{t-p} : MA component coefficient
ε_{t-p} : previous residual value (lag)
ε_t : residual at time t

A common way to measure the stock market efficiency is by using a forecasting method. The predictability of stock prices or returns based on past data is considered an effective method to test weak-form efficiency (Lim & Brooks, 2011). One of the most popular methods to forecast time series data is recurrent neural network (RNN). A typical RNN architecture consists of input, hidden, and output layers, and has at least one context layer that has a function as a memory of the network (see Figure 1). The output of the previous cell or context layer, sometimes also called the recurrent layer, is connected back and entered as input on the hidden layer, thus resembling a chain (Dautel et al., 2020).

Elman network is one of the RNN types that is used to forecast time series data with high accuracy and better results than other traditional methods (Krichene et al., 2017; Wutsqa et al., 2014; You, 2022). A typical model of Elman network with m neurons in input layer, n neurons in hidden layer and one output is shown in Figure 2. The relationship between the input and output is given by following equation:

$$y_{t+1}(k) = \sigma\left(\sum_{j=1}^{m} v_j z_{jt}(k)\right)$$

Where z_{jt} is a set of output vector of hidden layer at time t and v_j are the weights that connect the node j in the hidden layer to the output. The output of hidden layer at time can be written as follow

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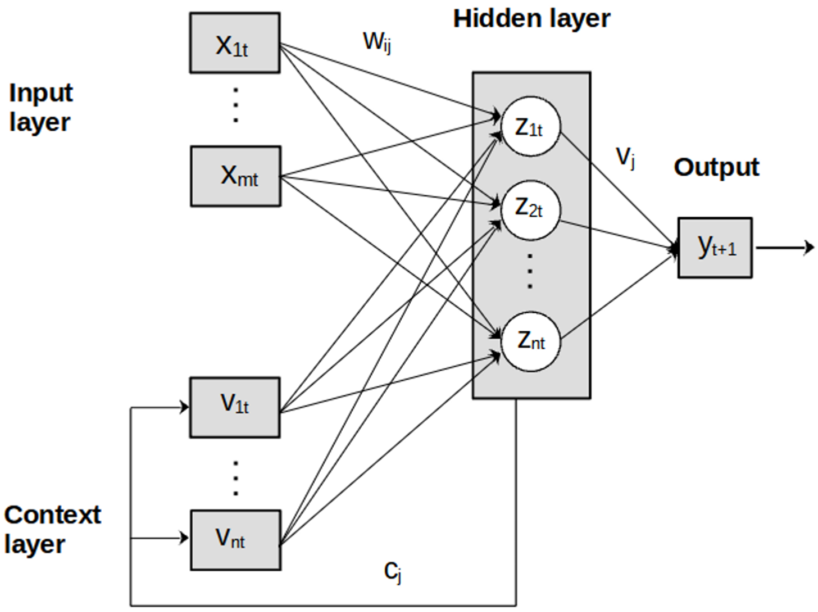
$$z_{jt}(k) = \sigma\left(\sum_{j=1}^{n} w_{ij}x_{it}(k) + \sum_{j=1}^{m} c_j z_{jt}(k-1)\right)$$

Where x_{it} is a set of input vector at time t, w_{ij} are the weights that connect the node i in the input layer to the node j in the hidden layer while c_j are the weights that connect the node j in the hidden layer to the node in context layer, and σ is a sigmoid function.

Figure 2. A typical structure of Elman Network



This study employed the Wilcoxon test to determine the significance of the stock index forecasting results obtained through the ARIMA model and Elman neural network statistical test. It is a non parametric test method to measure the significance of the difference between two groups of paired data that are not normally distributed. The confidence interval used is 95%. If the p-value is > 5%, then there is no significant difference between the stock prices predicted using the ARIMA and Elman neural network model and actual prices.

Table 1. The Data Based on Period

	Data Period	Purpose
Period 1	January, 4 2016 - November, 30 2019	Training
	December,1 2019 - December, 30 2019	Test
Period 2	Januari, 4 2020 - October, 30 2021	Training
	November, 1 2021 - November, 30 2021	Test
	Januari, 4 2022 - November, 30 2023	Training
Period 3	December,1 2023 - December, 30 2023	Test

The data for this study comprised sharia indices in six Asian countries, namely DSEX Shariah Bangladesh (DSES), Jakarta Islamic Index Indonesia (JKII), FTSE Bursa Malaysia Hijrah Shariah (FTFBMHS), Karachi Meezan 30 Pakistan (KMI30), Nifty 50 Shariah India (NI50SH), and FTSE SET Shariah Thailand (FTFSTSH). The data spanned from January 4, 2016 to December 30, 2023 and was sourced from the website www.investing.com. The data was divided into three parts, and each period was divided into two: data for training and the model for testing and validation of the ARIMA model and Elman neural network (Table 1).

RESULTS AND DISCUSSION

Table 2 shows the characteristics of the indices in the observed countries in the form of descriptive statistics. The DSES, JKII, and NI50SH indices were positively skewed during the pandemic, which indicates that the investors may expect frequent small losses and a few significant gains from the investment. Meanwhile, the FTFBMS, FTFSTSH, and KMI30 indices showed the opposite. The index NI50SH from India exhibited the highest expected return but also the most volatile index during the pandemic.

Table 2. Descriptive Statistics of Sharia Indices in six Asian Countries

Index	Period	N	Mean	Std.Dev	Max	Min	Skewness
DSES	Period 1	968	-0,00009	0,00590	0,02577	-0,02048	0,17207
	Period 2	427	0,00085	0,01211	0,10142	-0,06986	0,99725
	Period 3	414	-0,00012	0,00555	0,02972	-0,02559	-0,06283
FTFBMS	Period 1	974	-0,00002	0,00560	0,01896	-0,03365	-0,43042
	Period 2	470	0,00007	0,01031	0,05961	-0,05195	-0,31290
	Period 3	486	-0,00008	0,00758	0,03678	-0,02336	0,02648
FTFSTSH	Period 1	975	0,00025	0,00819	0,04610	-0,03779	-0,05742
	Period 2	464	0,00013	0,01576	0,10185	-0,10508	-0,97439
	Period 3	484	-0,00020	0,00723	0,02362	-0,03010	-0,04157
JKISSI	Period 1	968	0,00032	0,00823	0,02673	-0,04254	-0,29841
	Period 2	465	0,00009	0,01349	0,09073	-0,06347	0,17004
	Period 3	485	0,00030	0,00710	0,01990	-0,02840	-0,43660
KMI30	Period 1	987	0,00025	0,01253	0,05027	-0,04982	0,01287
	Period 2	473	0,00024	0,01508	0,06389	-0,07532	-0,49525
	Period 3	493	0,00079	0,01190	0,06678	-0,04610	-0,14005
NI50SH	Period 1	978	0,00048	0,01733	0,19527	-0,16076	2,00489
	Period 2	472	0,00122	0,01671	0,14218	-0,12364	0,21216
	Period 3	493	0,00015	0,00964	0,02906	-0,04362	-0,41345

Most of the indices, except for NI50SH, indicated lower expected returns during the pandemic compared to the time before and after the pandemic. This finding is in line with those of the study by M. N. Khan et al., (2024), Naseem et al. (2021), and Chundakkadan

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and Nedumparambil (2022). They found that investors' sentiment during the COVID-19 pandemic suppressed the returns of stock markets. All indices, with the exception of NI50SH, were also riskier during the pandemic than other periods. This finding is not unexpected as other studies have shown that stock markets tend to be more volatile during a crisis.

Table 3 shows the results of return's randomness test using variance ratio test. The return is said to be random if the p-value is > 0.05, and vice versa. FTFBMS and FTFSTSH were found to be efficient in all periods. Meanwhile the indices DSES, NI50SH, and KMI30, were not random in period 1. Interestingly, these indices improved in period 2, which indicates that the prices move randomly during and after the pandemic. In terms of weak-form efficiency, their performance during and after the pandemic was better than that in the previous period. Only JKII lost its randomness after the pandemic.

The test result using the Elman neural network and ARIMA model is presented in Table 4. The Wilcoxon test was the statistical method used to measure the significance of the difference between actual and predicted data using the Elman neural network and ARIMA model. This test is used as a statistical method to analyze significant differences between two groups of data that are not normally distributed. If the p-value is > 5%, then the actual stock price index is not significantly different from the stock price predicted using the Elman neural network and ARIMA model, suggesting that the market is inefficient. The prediction using the Elman network showed that DSES was the only index that proved to be efficient in all periods, while JKII was the only index that was found to be efficient in all periods according to the ARIMA model. The other indices showed different results.

Table 3. Test result using Variance Ratio Test

Index	Period	Stat	p-value
	Period 1	31,6357	0,0000
DSES	Period 2	1,3828	0,2396
	Period 3	2,3528	0,1250
	Period 1	1,7716	0,1830
FTFBMS	Period 2	0,0406	0,8400
	Period 3	1,3999	0,2360
	Period 1	0,1197	0,7290
FTFSTSH	Period 2	1,9753	0,1598
	Period 3	1,54535	0,2138
	Period 1	0,0192	0,8890
JKISSI	Period 2	0,0803	0,7760
	Period 3	4,9048	0,0267
	Period 1	16,3747	0,0000
KMI30	Period 2	1,7326	0,1880
	Period 3	1,8499	0,1730
	Period 1	4,2777	0,0386
NI50SH	Period 2	2,2210	0,1360
	Period 3	1,0407	0,3076

Table 5 provides a comprehensive overview of the test results on six Islamic indices in Asia, using three methods, with positive signs indicating efficiency and negative signs pointing to inefficiency. The use of different methods in testing the indices led to a variety of results. This diversity in outcomes was not unexpected, given the established fact that tests conducted using different methods can yield divergent results. The presence of random walk patterns and the level of stock market efficiency are notably influenced by the chosen methodology, underscoring the importance of the research process.

The results also showed that all indices exhibited different efficiency in all periods. Sharia stocks in these countries showed different degrees of efficiency following global and local events. This finding strongly supports the adaptive market hypothesis. These results align with the results of previous studies which show that there are changes in efficiency in capital markets, both in developed and emerging markets, in the short and long terms (Akhter & Yong, 2021; Boya, 2019; Cruz-Hernández & Mora-Valencia, 2024; Dos Santos et al., 2024; Munir et al., 2022; Noreen et al., 2022). Capital market efficiency always appears to coexist with market anomalies, resulting in a constant switch between efficient and inefficient conditions. Capital market inefficiency conditions are generally related to major macroeconomic factors (Boya, 2019), institutional factors (Dos Santos et al., 2024), and are conditioned to the state of the market (Tripathi et al., 2020).

Table 4. Test Result using Elman Neural Network and ARIMA Model

Index	Period	p-value	
		Elman	ARIMA
DSES	Period 1	0,6554	0,0000
	Period 2	0,0000	0,0000
	Period 3	0,0020	0,0000
FTFBMS	Period 1	0,0000	0,0000
	Period 2	0,0000	0,0000
	Period 3	0,1909	0,2024
FTFSTSH	Period 1	0,2449	0,0042
	Period 2	0,0000	0,1231
	Period 3	0,0234	0,5217
JKISSI	Period 1	0,0000	0,0000
	Period 2	0,0000	0,0000
	Period 3	0,0000	0,1850
KMI30	Period 1	0,0000	0,0000
	Period 2	0,0000	0,0000
	Period 3	0,3184	0,0532
NI50SH	Period 1	0,2894	0,9563
	Period 2	0,0000	0.9563
	Period 3	0,9193	0,0000

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Three important aspects emerge from this study. First, four indices, namely DSES, FTFBMS, JKII and KMI30, showed a good level of efficiency during the pandemic compared to the other two indices. All testing methods showed consistent results indicating that the four were efficient in weak form. Meanwhile, FTFSTSH and NI50SH were declared inefficient based on testing using the ARIMA model. Both indices also showed higher risks, represented by higher standard deviations during the pandemic compared to other indices. This indicates that investors can beat the market during the pandemic consistently. These results are in line with those of Pillai et al. (2021) and Bhatia (2022) which showed that the capital market in India was inefficient during the pandemic. The increasing expected returns in the Indian capital market during the pandemic as shown in this study was also reported by Rao et al. (2021). According to the results of their study, there was an abnormal return that occurred during the lockdown.

Second, two indices, JKII and KMI30, experienced an increase in expected returns after the pandemic ended. Interestingly, both indices experienced a decrease in the level of market efficiency. Based on testing using the variance ratio test and ARIMA model, the JKII index was declared inefficient after the pandemic. Meanwhile, the KMI30 index was declared inefficient according to the results of testing using the ARIMA model and Elman network.

Table 5. Summary of the Results

Index	Period	Variance Ratio	ARIMA	Elman Network
DSES	Period 1	-	+	-
	Period 2	+	+	+
	Period 3	+	+	+
FTFBMS	Period 1	+	+	+
	Period 2	+	+	+
	Period 3	+	-	-
FTFSTSH	Period 1	+	+	-
	Period 2	+	-	+
	Period 3	+	-	+
JKISSI	Period 1	+	+	+
	Period 2	+	+	+
	Period 3	-	-	+
KMI30	Period 1	-	+	+
	Period 2	+	+	+
	Period 3	+	-	-
NI50SH	Period 1	-	-	-
	Period 2	+	-	+
	Period 3	+	+	-

Third, a different situation occured in the DSES index. Before the pandemic, the index did not align with the random walk hypothesis. This finding is inline with the study from Raquib & Alom (2015) which state that the stock market from Bangladesh didn't inline with EMH and not followed the Random walk model. However, from the pandemic until its end, DSES was the only one declared efficient according to the three test methods. Compared to the other five capital markets, the size of Bangladesh stock market was smaller. These results indicate that market size is not correlated with efficiency. At certain times, small capital markets can be more efficient than larger ones. This finding is in line with a study conducted by Rönkkö et al. (2024), which shows that small capital markets can be more efficient than large capital markets for a fairly long period of time.

The changes in the level of market efficiency in three different periods show that AMH can provide a better explanation than EMH. It is not only caused by market anomalies at certain times but also by the interaction between rational and irrational investors. EMH cannot explain whether rational investors cause market efficiency during a crisis. It could be rational or irrational investors who force these conditions. Fama (1965) mentioned that rational investors would eliminate the effects caused by irrational investors. Which investor type is more dominant, the rational or irrational investors, remains questionable.

The results of this study showed that the Islamic indices exhibited efficiency at certain times, while at other times, they did not follow the random walk. This finding supports the adaptive market hyptothesis. While our study provides valuable insights, it is not without limitations. One limitation is that we only tested the efficiency of Islamic indices in six Asian countries. In future research, adding more countries, not only in Asia, is suggested to see how the market efficiency evolves. This could provide a more comprehensive understanding of market efficiency in Sharia stock markets.

CONCLUSION

This study aims to analyze the existence of adaptive market hypothesis in sharia indices in six Asian countries. The results showed that all indices exhibited different degree of efficiencies. The market efficiencies were not constant, following some economic and non-economic events. As shown in previous studies, capital market efficiency is changing over time. In adjusting to new information, the market speed differs from one country to another. This study raises questions regarding the efficient market test. For example, if a capital market is said to be random during a pandemic, it could be rational or irrational

The adaptive market hypothesis (AMH) offers a new economic theory that combines principles of efficient market hypothesis and behavioral finance, and may address this issue. However, even though it is not possibleto prove the AMH's reliability with a substantial degree of certainty, it may still be employed as an early indicator whether a competition in a stock market is fair, given that no individual can constantly beat the market. The regulator can use the information to evaluate the performance of the market. Investors can enhance their investment strategies by using the information about market efficiency.

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