Adaptive Market Hypothesis: A Comparison of Islamic and Conventional Stock Indices

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Abstract

We assess the informational efficiency of nine Dow Jones Islamic market indices and their counterpart conventional Morgan Stanley indices using data from 1996 to 2020. We test the martingale difference hypothesis of no return predictability over time and assess the adaptive market hypothesis over different market conditions. We find that the null is rejected in several periods in line with the adaptive market hypothesis for both Islamic and conventional stock indices. However, we do not observe any significant differences in return predictability between Islamic and conventional stocks in different market conditions, including the financial crisis of 2007-08 and the COVID-19 pandemic.

1 Introduction

Since the global financial crisis (GFC) of 2007-08, Islamic finance in general and Islamic capital markets, in particular, have received increasing attention from researchers (e.g., Al-Khazali et al. (2016); El Khamlichi et al. (2014); Azmat et al. (2014); Albaity and Mudor (2012); Hassan and Girard (2011); Hayat and Kraeussl (2011); Merdad et al. (2010))[1]. Researchers have studied Islamic capital markets from multiple perspectives, one of which is market efficiency, i.e., the degree of return predictability of Islamic stocks (stocks that meet the Islamic Shariah screening criteria) as postulated in the efficient market hypothesis (EMH). The EMH implies that market prices are fair and reflect all available information fully and instantaneously (Fama, 1965). Some of the recent studies on the market efficiency of Islamic stock markets include Rejeb and Arfaoui (2019), Uddin et al. (2018), Charles et al. (2017), and Al-Khazali et al. (2016). Predominantly the argument based on empirical findings, as Ali et al. (2018) outline, is that the markets for Islamic stocks are more efficient than conventional markets due to better governance, Shariah compliance, and improved disclosure mechanisms. However, the empirical evidence on the validity of the EMH is mixed and fewer studies have used time-varying tests to evaluate return predictability, i.e., the martingale difference hypothesis (MDH) of Islamic stocks and conventional stocks simultaneously[2].

Given the poor empirical support for the EMH, Lo (2004) proposed the adaptive market hypothesis (AMH) as an alternative explanation to the EMH, which postulates that market efficiency (return predictability) varies over time with shifts in market conditions. Though the AMH has been subjected to extensive empirical analysis in conventional markets, empirical evidence on the validity of the AMH in Islamic stock markets is still deficient and demands attention. In addition, the MDH has been recently put to newer robust empirical tests across different financial markets (e.g., Charles et al. (2017); Charles et al. (2015); Kim et al. (2011)) except for Islamic stocks, which builds a case for empirical evidence in the global context.

Fair pricing of assets is a crucial input in optimal portfolio allocation and investment performance. Lack of empirical evidence on the degree of informational efficiency (as postulated in the AMH theory) hinders designing optimal investment strategies by investors, fund managers and investment analysts. Therefore, it is cardinal to thoroughly evaluate the informational efficiency of Islamic stocks and assess if their pricing is fair over time. This is especially true since investment in Islamic stocks constitutes a separate systematic and undiversifiable risk (Merdad et al., 2015). Consequently, the risk-return relation of Islamic stocks, and hence their pricing as well, is considerably different from that of conventional equities (Hasnie et al., 2022)[3]. The informational inefficiency presents opportunities to earn abnormal returns by market players that can be detected and exploited using technical analysis. On the contrary, the informational efficiency in any market renders active investment management in search of under or overpriced assets futile and, therefore, makes

[1] Though still significantly smaller than conventional finance, Islamic finance has registered splendid growth since the 1990s; reported \$2.4 trillion worth of assets in 2017 with the highest share contributed by Islamic banking (Reuters, 2018). At present, it comprises of almost 1,400 financial institutions operating in 80 countries. Although hindered by COVID-19 pandemic induced adverse environment, financial technology, inclusive standardization, and environmental, social, and governance opportunities are likely to keep driving the growth of Islamic finance (Ratings, 2020).

[2] E.g., Sensoy et al. (2015), Al-Khazali et al. (2016), Charles et al. (2017) and Rejeb and Arfaoui (2019).

[3] To read more along these lines, see Hippler et al. (2021) and Chkili and Hamdi (2021).

technical analysis ineffective. Furthermore, Islamic investments (as well as financial institutions) have been argued to be more resilient in adverse market conditions when their conventional counterparts perform poorly (Al-Khazali et al. (2014); Farooq and Zaheer (2015)). Islamic stocks are less vulnerable to uncertainty and exhibit relatively better performance than conventional stocks during Covid-19 (Salisu and Shaik, 2022). The literature offers several plausible explanations for the superior performance and resilience of Islamic stocks. The smaller leverage effect (Hasan et al. (2021); Dewandaru et al. (2014)) due to the omission of interest-based financing makes Islamic stocks less susceptible to bankruptcy risk (Krichene, 2012). Shariah compliance requires profit and loss sharing and excludes firms with low working capital, involved in risky financial assets like derivatives, gambling, selling alcohol and pork, and less connected with the real economy (Ibrahim (2015); Ibrahim and Alam (2018)). Consequently, Islamic indices experience lower volatility and demonstrate better performance than conventional indices (Hassan et al., 2020), especially when the financial markets are struggling. Moreover, Islamic stocks function as a hedge during financial crises against conventional international capital markets and provide a platform for risk diversification (Azad et al., 2018). Hence, including Islamic stocks in a portfolio of conventional stocks may offer diversification benefits that mitigate risk (Mensi et al., 2015). For these reasons, it is imperative to empirically test the return predictability of both conventional and Islamic stocks over time and across different market conditions to assess the relative resilience of Islamic stocks. Furthermore, improving on the extant literature, we analyse the nine regional Dow Jones Islamic Market Indices (DJIMIs) and compare them against their conventional counterparts, Morgan Stanley Capital International (MSCI) indices. The MSCI indices are considered benchmark stock indices for conventional investments and are widely used for a better comparison against the DJIMIs, the benchmark Islamic stock indices (Rejeb and Arfaoui, 2019).

We contribute to the scarce extant literature on time-varying robust empirical tests of the AMH, i.e., degree of informational efficiency of international Islamic stock markets relative to their conventional counterparts. Firstly, our study is unique as we use the automatic variance (AVR) test of Kim (2009), the automatic portmanteau (AQ) test of Escanciano and Lobato (2009), and the generalized spectral (GS) test of Escanciano and Velasco (2006) to evaluate return predictability in line with the AMH proposition. The extant literature provides evidence mainly on linear autocorrelations. We examine the linear and non-linear autocorrelation structures of international Islamic stock indices and their conventional counterparts using the GS test for the first time. These tests are robust and do not suffer from the undesirable small sample properties (Charles et al., 2015). Secondly, we assess return predictability over time using two years rolling window measures of each test statistic for an extended sample period. Doing so, we are able to observe time-varying return predictability of Islamic and conventional stocks simultaneously and find if there are any trends in return predictability over time. Finally, the study brings more novelty by directly testing the AMH for both the Islamic and conventional stock indices by accounting for shifts in market conditions through dummy variable regressions. Thus, our empirical inquiry enables us to evaluate return predictability over time and across different market conditions. In particular, we provide empirical evidence on the influence of adverse events, such as the recent COVID-19 pandemic outbreak, on return predictability across both Islamic and conventional stock indices from our rolling estimates of the three different tests and dummy variable regressions.

The results from our empirical tests suggest no apparent differences in the degree of information efficiency, i.e., return predictability between Islamic and conventional stocks. Our findings reject the MDH in several episodes across Islamic and conventional stock indices and hence support the validity of the AMH. We find that periods of return predictability occur in response to changing market conditions, especially the COVID-19 breakout and the US sub-prime mortgage crisis, across both Islamic and conventional stock indices. These findings lead us to believe that diversification benefits of investing in related Islamic and conventional stocks are unlikely to be significant except when investment is spread across different regional markets, i.e., geographical diversification is valuable.

In the next section, we provide a brief review of the theoretical and empirical literature on the topic. In section 3, we describe the empirical methods and section 4 provides the results and discussions of the findings. Finally, conclusions are provided in section 5.

2 Brief Literature Review

Kendall and Hill (1953) proposed the theory of Random Walk for stock prices when they failed to observe any systematic pattern in time series of price changes. The so-called random 'animal spirits' of investors noticed during the trading of stocks provided foundations for rationality and the efficient market hypothesis (EMH). This hypothesis, in its weak-form, argues that past prices and returns are public knowledge and are already reflected in current prices (Fama, 1970). The weak-form of EMH has been extensively investigated using tests of the martingale difference hypothesis (MDH), which postulates that a current price is the best estimate of future price (i.e., asset prices are martingale) as asset returns have no systematic autocorrelation and, therefore, are unpredictable (Escanciano and Velasco, 2006). Consequently, market participants cannot take advantage of past information to generate a return above the level commensurate with risk (Fama, 1970). The EMH has tangible implications for firms, investors, policymakers, and other stakeholders. Seeking underpriced securities, for instance, is a fruitless and costly exercise in efficient markets where securities are traded at their intrinsic values. At a far extreme, some even believe that the EMH is one of the reasons having caused the global financial crisis (GFC) in 2007-08 (Fox and Sklar, 2009).

The consensus among researchers on the empirical validity of the EMH is, however, rare. Critics, especially from behavioural aspects, point towards anomalies when refuting the EMH. Barber and Odean (2001) suggest investors overreact and process information in specific ways in particular instances. Since their collective behaviour has a design in certain circumstances (such as bubbles and crises), therefore, returns are predictable under those conditions, which contradicts the inferences of the EMH. Similarly, investment strategies such as momentum or contrarian advocate the presence of an exploitable pattern in stock prices to generate an abnormal return (Jegadeesh and Titman, 1993). The empirical evidence endorses the presence of anomalies in Islamic financial markets. Such anomalies arise from religious sentiments (Hassan et al. (2020); Shohruh (2022)), significant differences in investors' preferences and tastes (Shafron, 2019), and social connectedness of Muslim investors and correlated trading of Islamic stocks (Alhomaidi et al. (2018); Çıkıryel et al. (2021)). Consequently, several studies have reported anomalies in the Islamic capital markets across a range of countries. For instance, Hasan et al. (2021) support the presence of calendar anomalies in the Islamic stock market of Bangladesh and their role in generating abnormal returns for investors. Likewise, the momentum and contrarian strategies are rewarding in the Islamic equity markets of Saudi Arabia, Indonesia, Qatar, the United Arab Emirates, and Turkey (Özkan and Çakar, 2021).

Mediating between the proponents and sceptics of the EMH, Lo (2004) developed a framework combining the evolution principle with bounded rationality known as the adaptive market hypothesis (AMH). Contrary to perfect efficiency, as advocated by supporters of the EMH, or inefficiency, as propagated by champions of behavioural finance, the AMH takes a balanced approach and predicts departures from the market efficiency depending on prevailing market conditions. In other words, markets are not static and are not always informationally efficient or inefficient. Instead, market efficiency is time-variant and subject to varying market conditions. Several researchers have empirically tested the implications of the AMH and found substantiating evidence. Most of the studies have used conventional financial assets and indices (see, e.g., Urquhart and McGroarty (2016); Noda (2016)). Some studies have investigated the AMH in the precious metal markets (see, e.g., Charles et al. (2015); Urquhart (2016)), the cryptocurrency market (see, e.g., Chu et al. (2019); Khuntia and Pattanayak (2018)), and the crude oil market (see, e.g., Ghazani and Ebrahimi (2019)).

Empirical evidence on the market efficiency of Islamic stocks relative to conventional stocks is mixed. For example, Rejeb and Arfaoui (2019) and Ali et al. (2018) find that Islamic stock markets are more efficient than conventional ones. Charles et al. (2017) report similar findings for size and sectoral indices of Islamic and conventional stocks of Dow Jones Islamic markets and Dow Jones global. Mensi et al. (2017) observe from their multifractal detrended fluctuation analysis (MF-DFA) that the Islamic sectoral stock indices exhibit time-varying market efficiency with reduced efficiency after GFC. In addition, Al-Khazali et al. (2014) report mixed findings on the efficiency of Dow Jones Islamic stock indices. On the contrary, Uddin et al. (2018) provide evidence indicating that Islamic stocks are more efficient only in the medium term. Similarly, Jawadi et al. (2015) conclude that Islamic stocks are inefficient in both the short and long-run relative to conventional equities. Sensoy et al. (2015) also report that Islamic stock indices are relatively inefficient compared to conventional stock indices.

Though the market efficiency of Islamic stocks has received significant attention from researchers since GFC, most have not used time-varying tests. In addition, the AMH has not been tested robustly for Islamic stocks[4]. For example, Al-Khazali et al. (2016) examine the validity of the AMH in Islamic and conventional stock markets. However, they use only sub-samples for their empirical evaluation of the AMH. In addition, Al-Khazali et al. (2016) do not directly test return predictability in both Islamic and conventional stock markets using regression analysis. Their study also do not account for the non-linear autocorrelation. In addition to regression analysis, our study employs the generalized spectral (GS) test of Escanciano and Velasco (2006) to account for linear and non-linear dependencies in asset returns. We also use a monthly rolling sample window of two years to

[4]There are few studies that have investigated adaptive market hypothesis for the Islamic stocks relative to conventional stocks such as Al-Khazali and Mirzaei (2017).

provide robust evidence on the MDH and the AMH for Islamic stock indices and their conventional counterparts. Charles et al. (2017) have used a similar approach for size and sectoral indices of Islamic (Dow Jones Islamic Market) and conventional (Dow Jones Global) indices. However, their study falls short of considering non-linear autocorrelation structures in stock returns. We use an enlarged data set of nine Islamic and nine conventional stock indices, spread over continents (Europe and Asia Pacific), countries (Japan, UK, US, and Canada), global (World) and economic status (Developed and Emerging). Using this data set, we empirically examine the MDH for linear as well as non-linear autocorrelations.

3 Empirical Methods and Procedures

3.1 Data

Our sample comprises nine Dow Jones Islamic Market Indices (DJIMIs) and their nine conventional counterpart stock indices, i.e., Morgan Stanley Capital International (MSCI) indices. Following Uddin et al. (2018), we compare the DJ Islamic indices against conventional MSCI indices as these are the most investable, known, and visible to global investors for Islamic and conventional stocks, respectively (Rejeb and Arfaoui (2019); Ali et al. (2018); El Khamlichi et al. (2014)). The indices cover the World (Global), Asia Pacific, Developed, Emerging, European, Canadian, US, Japanese, and UK markets. These indices represent different regions/continents, types of economies, and individual countries. Both the DJ Islamic and MSCI conventional stock indices are market value-weighted indices. The DJIMIs are managed by Shariah Supervisory Boards and include stocks that are compatible with Islamic principles evaluated through Shariah screening criteria. The Shariah screens are of two types; sector-based (e.g., not more than 5% of the revenue can come from impure sources such as alcohol) and accounting-based (such as debt to trailing 24 months market capitalization of less than 33%)[5].

For each of the DJIM and MSCI index, daily prices (index values) are obtained from January 1996 to June 2020 from Datastream. There are 6392 total daily observations for each index of the 18 indices over the sample period. Contrary to Al-Khazali et al. (2016), we construct a rolling window of two years (approximately 520 days observations) to obtain time-varying estimates of AQ, AVR, and GS tests over our sample period from January 1996 to June 2020. This approach is consistent with Charles et al. (2015), Kim et al. (2011) and Charles et al. (2011) and it allows accounting for changing market conditions (as well as particular occurrences such as bubbles, crises, and disease outbreaks). In addition, it ensures the desired size and power properties for the empirical tests of our study and also overcomes data snooping bias (Hsu and Kuan, 2005), while enabling return predictability over time (Charles et al., 2015). The two years rolling window starts from January 1996 to December 1997 and then moves by an increment of one month so that the second window is from February 1996 to January 1998. It continues until the end of our sample period, where the last two years window is from July 2018 to June 2020. Over the entire sample period, the process provides 271 monthly estimates of AQ, AVR, and GS tests statistics (measures used to assess return predictability) from January 1996 to June 2020. For each return predictability measure, we plot the respective monthly estimates (test statistics for AVR and

[5]https://www.spglobal.com/spdji/en/documents/methodologies/methodology-dj-islamic-market-indices.pdf.

AQ tests and p-values for GS test) for the sample period for both Islamic and conventional stock indices.

Following Al-Khazali et al. (2016) and Salisu and Shaik (2022), we also employ the daily natural log returns for our empirical analysis and calculate them as:

$$R_{i,t} = ln(P_{i,t}/P_{i,t-1}) \tag{1}$$

where $R_{i,t}$ is the day t return, while $P_{i,t}$ and $P_{i,t-1}$ are the index values on day t and day t-1, respectively, for the index (Islamic/conventional) i. Figure 1 and Figure 2 provide the graphs of the daily index values and log returns for the nine Islamic and nine conventional stock indices, respectively. Both the figures reveal qualitatively similar trends in prices and returns for both types of indices. The price and return patterns for the Islamic and conventional stock indices, in most cases, coincide with the dotcom bubble bust (1998-2000), the US housing bubble (2005-07), the sub-prime mortgage crisis (2007-2009), and the COVID-19 outbreak (2020). These price and return trends for Islamic (DJIM), and conventional (MSCI) stocks indices indicate variability in market efficiency over time that we explore directly through robust empirical tests and procedures outlined next.

3.2 Automatic Variance Ratio Test

Lo and MacKinlay (1988) developed the variance ratio (VR) test, which has been widely employed as a test of the weak-form of market efficiency. It is used to test that a given time series (e.g., stock returns) is a martingale difference sequence (MDS) and hence unpredictable. The underlying proposition of the VR test is that if returns are random, then the variance of n-period returns is proportionate to one-period returns (Kim, 2009). Therefore, the underlying null hypothesis is that $VR(k) = 1$, or equally, $\rho_i = 0$, where the VR test statistic is the weighted sum of autocorrelation of asset returns as:

$$VR(k) = \frac{var(R_t - R_{t-k})/k}{var(R_t - R_{t-1})} = 1 + 2\sum_{i=1}^{k-1}(1 - \frac{i}{k})\rho_i, \tag{2}$$

where R_t is asset return at time t, ρ_i is the autocorrelation of order i of asset returns with linearly declining weights, while k denotes the holding period. The empirical estimate of the VR test statistic is given as:

$$VR(k) = 1 + 2\sum_{i=1}^{k-1}(1 - \frac{i}{k})\hat{\rho}_i \tag{3}$$

where $\hat{\rho}_i$ is an estimator (sample autocorrelation) of the population parameter, ρ_i. However, it has two limitations; it requires the arbitrary choice of the holding period (k) and has the theoretical limitation of inconsistency, i.e., a compensation between negative and positive autocorrelation. To overcome the first limitation, Choi (1999) proposed the AVR test that uses a data-guided method that automatically determines an optimal holding period (k) under the assumption that the time series has identical and independent distribution. The AVR test statistic is estimated as:

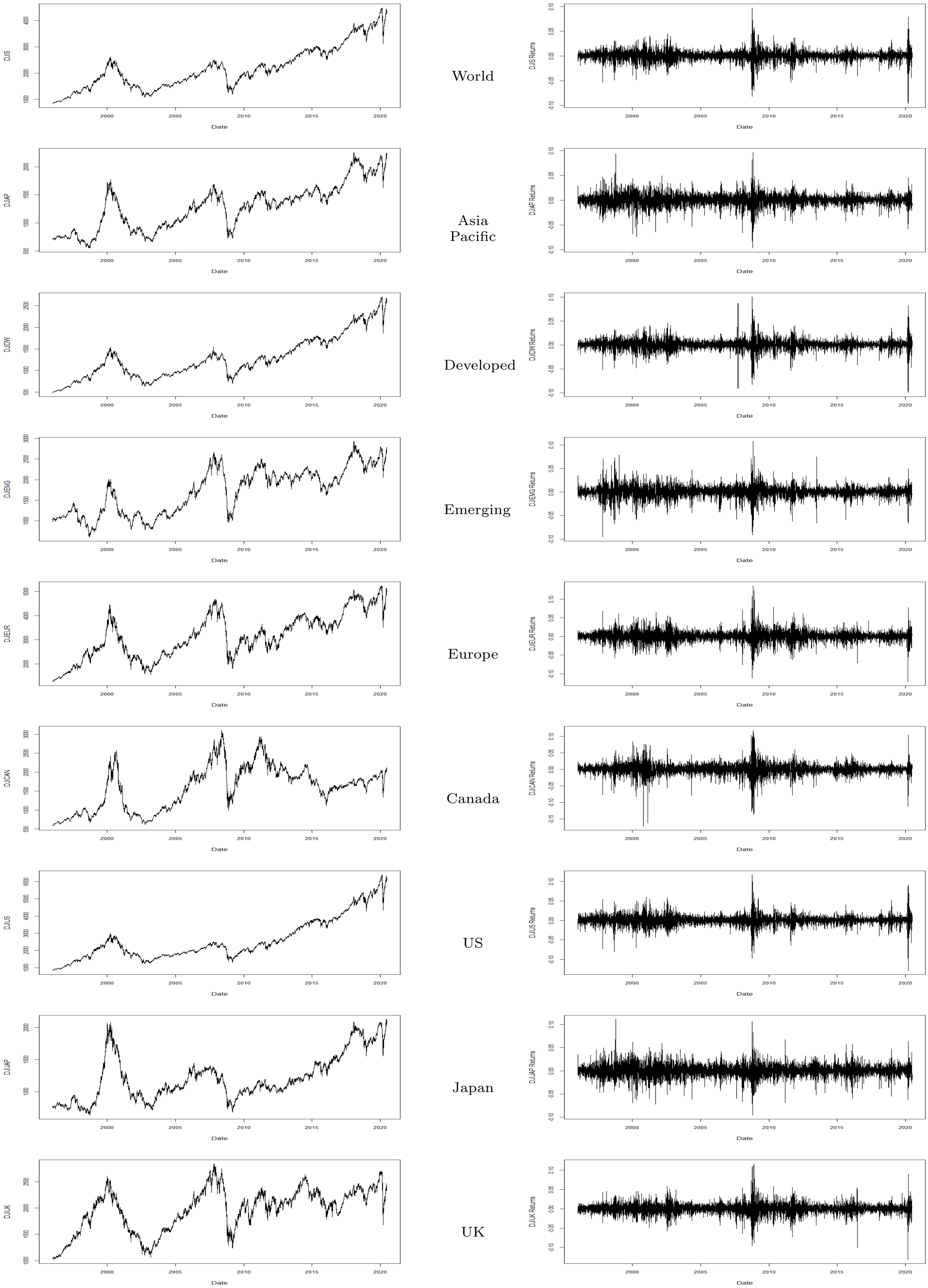


Figure 1: The left-hand column contains the daily index values of the nine Dow Jones Islamic market stock indices, and the right-hand column contains their respective log returns from January 1996 to June 2020.

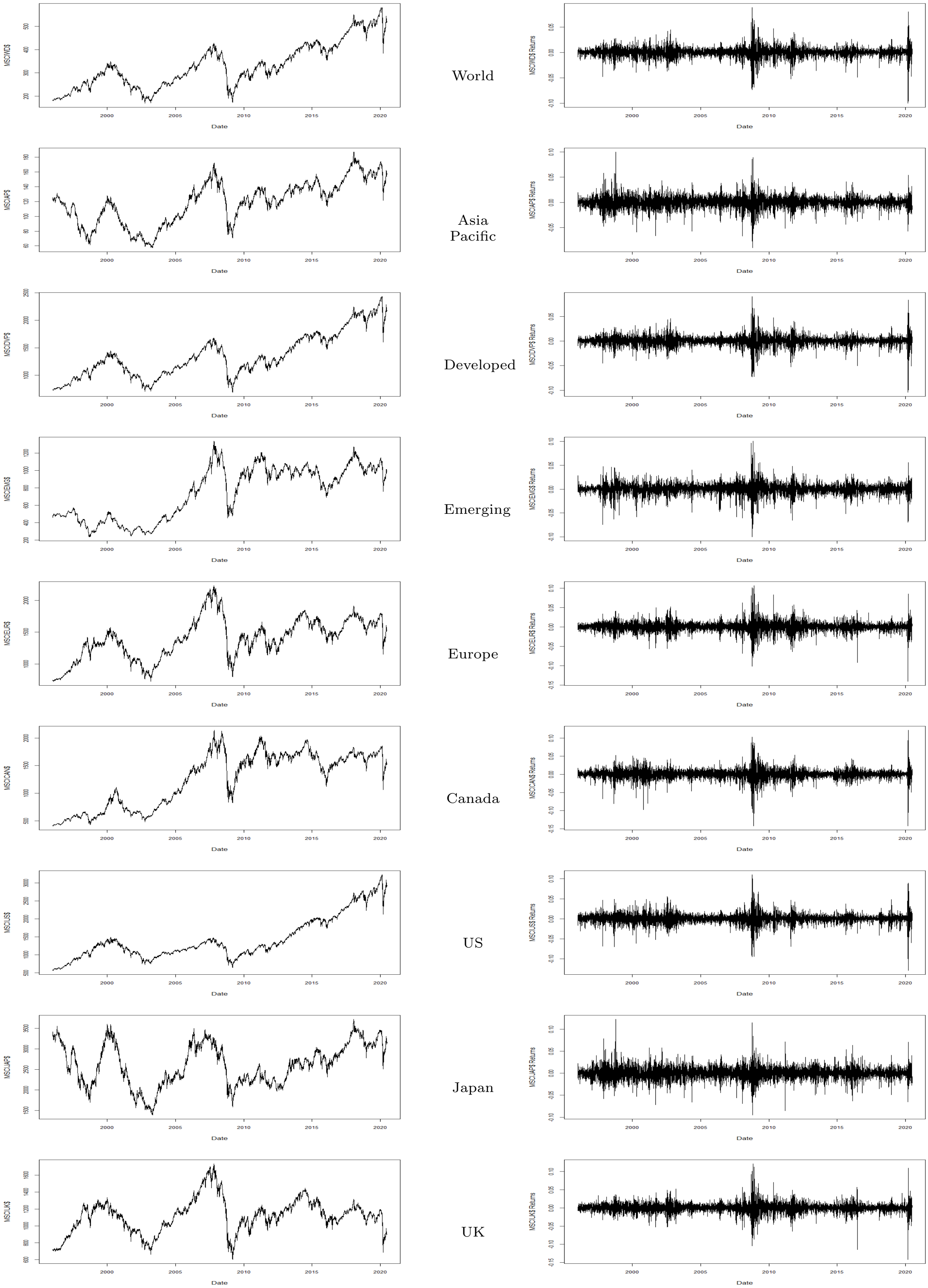


Figure 2: The left-hand column contains the daily index values of the nine Morgan Stanley Capital International stock indices, and the right-hand column contains their respective log returns from January 1996 to June 2020.

$$AVR(\hat{k}) = \sqrt{T/\hat{k}}[VR(\hat{k}) - 1]/\sqrt{2}^d \rightarrow N(0,1) \quad (4)$$

One of the main limitations of the AVR test in equation 3 is that it may produce invalid inferences, especially when used in small samples that are subject to conditional heteroscedasticity of the unknown form (Kim, 2009). To yield accurate inferences in the presence of conditional heteroscedasticity and non-normality in small samples, Kim (2006, 2009) proposed the wild bootstrapping procedure. Kim et al. (2011) authenticated the desirable small sample properties of the wild bootstrapping procedure of Kim (2006, 2009) from their Monte Carlo experiment. We obtain all the AVR test statistics and their associated confidence bands using the same bootstrapping procedure to test the MDH and AMH over time for our sample. The underlying null hypothesis in the AVR test is that asset (stock) returns are uncorrelated and, therefore, unpredictable (MDH).

3.3 Automatic Portmanteau Test

The positive and negative correlations may offset each other in the AVR test, which leads to a biased AVR test statistic. The automatic portmanteau (AQ) test overcomes this limitation, of the AVR test, as an asymptotic test using the squared correlation coefficients (Kim et al., 2011). Box and Pierce (1970) designed the original portmanteau test (Box-Pierce portmanteau test) given in equation 5 as[6]:

$$Q_p = T \sum_{i=1}^{p} \rho_i^2 \quad (5)$$

where Q_p is the portmanteau test statistic and ρ_i is the autocorrelation of asset return R_t for $t = 1, 2, \ldots, T$. The sample portmanteau test is given as:

$$Q_p = T \sum_{i=1}^{p} \hat{\rho}_i^2 \quad (6)$$

where $\hat{\rho}_i$ is the sample autocorrelation of asset return of order i. However, the portmanteau test does not perform well in small samples in the presence of conditional heteroscedasticity. Alternatively, Lobato et al. (2001) introduced a more robust version of the test that accounts for conditional heteroscedasticity as:

$$Q_p^* = T \sum_{i=1}^{p} \tilde{\rho}_i^2 \quad (7)$$

where $\tilde{\rho}_i^2$ is the ratio of sample auto-covariance of stock return R_t of order i and sample auto-covariance of R_t^2 of order i. The arbitrary choice of the lag length (p) in equation 7 exacerbates the test's small sample properties, particularly in the presence of conditional heteroscedasticity. Escanciano and Lobato (2009) proposed the automatic portmanteau test (AQ) that selects the optimal lag length (p) based on all available data. The AQ test is robust to conditional heteroscedasticity and is given as:

[6]The Box-Pierce portmanteau test is mostly implemented using the Ljung-Box test (Ljung and Box, 1978).

$$AQ = Q^*_{\tilde{p}} = T \sum_{i=1}^{\tilde{p}} \tilde{\rho}_i^2 \tag{8}$$

where $\tilde{\rho}$ denotes the optimal lag order[7]. The AQ test is asymptotic and follows a chi-squared distribution with one degree of freedom. The null hypothesis of no return predictability (MDH) is rejected at a 5 percent level of significance if the estimated AQ test statistic is larger than the corresponding critical value of 3.84. We then evaluate the AMH using the AQ test statistics estimated over the two years rolling window for our sample period.

3.4 Generalized Spectral Test

Both AVR and AQ tests are confined in the sense that they do not detect and account for non-linear autocorrelation (dependency) in asset returns that has been well documented in the literature (e.g., De Gooijer (1989); Antoniou et al. (1997); Harrison et al. (1999); McPherson and Palardy (2007)). The GS test proposed by Escanciano and Velasco (2006) builds on the generalized spectral density function of Hong (1999) that considers both linear and non-linear dependencies in asset returns. We, therefore, use the GS test to capture non-linear dependencies in returns of both Islamic and conventional stock indices. If Y_t is a MDS, then the null hypothesis is stated as $H_0^* : E(Y_t|Y_{t-1}, Y_{t-2}, ...) = \mu$ where μ is a real number. To test the MDS, Y_t, for general non-linear conditional mean dependence Escanciano and Velasco (2006) modified the null hypothesis into a form of pairwise regression function that uses all available sample data avoiding high dimensional integration. Specifically, they stated the null hypothesis as $H_0 : m_j(r) = 0$ where $E(Y_t - \mu|Y_{t-j}) = r$ and the alternative hypothesis as $H_1 : Pm - j(r) \neq 0 > 0$ for some $j \geq 1$[8]. The modified null is equivalent to testing for general non-linear conditional mean dependence $\gamma_j(x) = E[(Y - \mu)e^{ixY_{t-j}}] = 0$, where $\gamma_j(x)$ is a measure of autocovariance in a non-linear time series, and x denotes any real number. For empirical tests, Escanciano and Velasco (2006) suggest generalized spectral distribution function of the following form:

$$H(\lambda, x) = \gamma_0(x)\lambda + 2\sum_{j=1}^{\infty} \gamma_j(x) \frac{sin(j\pi\lambda)}{j\pi} \tag{9}$$

where λ is a real number between 0 and 1. The sample estimate of the function in equation (9) is given as:

$$\hat{H}(\lambda, x) = \hat{\gamma}_0(x)\lambda + 2\sum_{j=1}^{\infty} (1 - \frac{j}{T})\hat{\gamma}_j(x) \frac{sin(j\pi\lambda)}{j\pi} \tag{10}$$

In equation 9, $\hat{\gamma}_0(x) = (T - J)^{-1} \sum_{t=1+j}^{T} (Y - \bar{Y}_{T-j})e^{ixY_{t-j}}$ and $\bar{Y}_{T-j} = (T - j)^{-1} \sum_{t=1+j}^{T} Y_t$. Therefore, the null hypothesis for the generalized spectral distribution function is $H_0(\lambda, x) = \hat{H}(\lambda, x) = \hat{\gamma}_0(x)\lambda$ where the test statistics is:

$$S_T(\lambda, x) = (0.5T)^{\frac{1}{2}} \{\hat{H}(\lambda, x) - H_0(\lambda, x)\} \tag{11}$$

[7]The optimal lag order in the AQ test is determined based on a compromise between the Akaik and Bayesian information criteria.

[8]This implies that the previous values of r are not useful in predicting future values of r, i.e., expected value of r remains fixed.

Then to evaluate S_T for all possible pairs of λ and x, Escanciano and Velasco (2006) use the Cramer-von Mises norm to obtain the test statistics as:

$$D_T^2 = \sum_{j=1}^{T-1} \frac{(T-j)}{(j\pi)^2} \int R|\hat{\gamma}_j x|^2 W(dx) \tag{12}$$

where W() is a weighting function. Escanciano and Velasco (2006) derive the GS test statistics using the standard normal distribution as a weighting function[9]:

$$D_T^2 = \sum_{j=1}^{T-1} \frac{(T-j)}{(j\pi)^2} \sum_{t=j+1}^{T} \sum_{s=j+1}^{T} exp(-0.5(Y_{t-j} - Y_{s-j})^2) \tag{13}$$

Given that the standard distribution of GS test statistics is not asymptotic, we use the wild bootstrapping procedure, as suggested by Escanciano and Velasco (2006), to implement the test in our finite samples of Islamic and conventional stock indices. We obtain the p-values of GS test statistics in all cases and provide their plots for each index over our estimation period. The GS test is helpful, especially when interpreted in light of results obtained from the AVR and AQ tests. For instance, a failure to reject the null hypothesis under the AVR and AQ tests, but rejection of the null under the GS test will suggest evidence of non-linear autocorrelations that can be exploited by market participants to generate superior returns. Overall, the AVR, AQ, and GS tests described in this section exhibit desirable properties of size and power for samples that are smaller, non-normal, and heteroscedastic (Charles et al., 2011).

3.5 Return Predictability Regressions

Following Kim et al. (2011) and Charles et al. (2015), we also use regression analysis to examine the magnitude (size) of the degree of return predictability in line with the implications of AMH in different market conditions (events). During the sample period, we recognize six significant events (including three infectious diseases), representing a shift in market conditions over time. These include the dotcom bust (1998:01 - 2000:12), US housing bubble (2005:01 - 2007: 06), sub-prime crisis (2007:12 - 2009:06), SARS outbreak (2002:11 - 2004:05), Ebola outbreak (2013:12 - 2016:06) and COVID-19 outbreak (2020:01 - 2020:06). Other studies have also used various time periods as an indication of market conditions to gauge market efficiency. Al-Khazali et al. (2016) are closer in approach to us. They have also subjected market efficiency to five bullish and bearish periods from 1997 to 2012. We have included the Ebola outbreak and COVID-19 since they occurred post-2012. They have also used the AVR and AQ tests. We include the GS test as well to account for linear and non-linear dependencies. We measure each event as a dummy variable and use absolute AVR statistics as the dependent variable in the regressions for our sample of Islamic and conventional stocks indices. The advantage of the AVR test statistics over the AQ statistics is that it is not only a measure of return predictability but also its direction, i.e., $AVR > 1$ and $AVR < 1$ suggest positive and negative autocorrelation, respectively. Therefore, informed investors can use the sign of the overall autocorrelation in AVR test statistics to devise strategies such

[9]In fact, Escanciano and Velasco (2006) suggest that both standard normal and exponential weighting functions can be used.

as momentum or contrarian to earn arbitrage profits (Charles et al., 2015). The use of the absolute values of AVR in the predictability regression is justified given that efficient pricing should result in lower autocorrelation in both negative and positive directions (Kim et al., 2011).

4 Empirical Results and Discussions

4.1 Descriptive Analysis

Table 1 provides the descriptive statistics for daily returns of both Islamic and conventional stock indices in panel A and panel B, respectively. Descriptive statistics reveal that the Islamic stock indices have higher mean returns than the conventional stock indices, except for Canada, which has the same average returns for both types of markets. However, the Islamic stock indices also have higher standard deviation than the conventional stock indices, except for Japan. It may partly be explained by the lower diversification (due to fewer stocks) of the Islamic stock indices relative to conventional stock indices (Rejeb and Arfaoui, 2019). In all cases except Japan, daily returns of both the Islamic and conventional stock indices exhibit statistically significant negative skewness, indicating longer left tails. The daily returns of the Japanese Islamic and conventional stock indices do not show statistically significant skewness and are symmetrical. We also observe that the time series of daily returns of the Islamic and conventional stocks exhibit statistically significant excess kurtosis, suggesting leptokurtic empirical distributions, i.e., significant fatter tails than a normal distribution. We also report the Jarque-Bera (JB) statistic for all the indices, which are statistically significant at 1% in all cases, demonstrating that daily returns of the Islamic and conventional stock indices are non normally distributed. In addition, we also conduct LM test for ARCH effects, and the results provide evidence of conditional heteroscedasticity in daily returns of both the Islamic and conventional stock indices (Table 1).

Table 1: Panel A and panel B present descriptive statistics of daily log returns of nine Dow Jones Islamic stock indices and daily log returns of their conventional counterparts, Morgan Stanley Capital International stock indices, respectively, for the period January 1996 to June 2020.

Panel A	Dow Jones Islamic Stock Indices								
	World	Asia Pacific	Developed	Emerging	Europe	Canada	US	Japan	UK
Mean	0.026	0.018	0.026	0.016	0.022	0.021	0.031	0.016	0.013
Std.Dev	1.021	1.176	1.062	1.255	1.457	1.659	1.248	1.376	1.338
Skewness	-0.523*	-0.275*	-0.497*	-0.401*	-0.102*	-0.844*	-0.290*	-0.056	-0.290*
Kurtosis	9.411*	5.504*	11.661*	6.347*	6.863*	11.332*	9.294*	3.997*	8.265*
JB p-value	23878*	8147*	36472*	10897*	12552*	34952*	23090*	4258*	18279*
ARCH(10)	1815*	1240*	1483*	1287*	1217*	1194*	1672*	1233*	943*
Obs.	6391	6391	6391	6391	6391	6391	6391	6391	6391
Panel B	MSCI Conventional Stock Indices								
	World	Asia Pacific	Developed	Emerging	Europe	Canada	US	Japan	UK
Mean	0.017	0.004	0.017	0.012	0.012	0.021	0.026	-0.001	0.004
Std.Dev	0.984	1.159	0.999	1.176	1.287	1.370	1.213	1.378	1.307
Skewness	-0.635*	-0.195*	-0.626*	-0.585*	-0.389*	-0.905*	-0.430*	0.029	-0.388*
Kurtosis	11.054*	5.610*	11.436*	7.756*	9.353*	13.251*	11.026*	4.763*	11.469*
JB p-value	32966*	8421*	35246*	16382*	23458*	47628*	32570*	6042*	35190*
ARCH(10)	1810*	1282*	1827*	1676*	1128*	1536*	1762*	822*	1195*
Obs.	6391	6391	6391	6391	6391	6391	6391	6391	6391

*, ** and *** indicate statistical significance at 1%, 5% and 10% respectively.

4.2 Empirical Tests - Return Predictability

Figure 3 shows 18 graphs of the monthly estimates of AVR test statistics from January 1996 to June 2020 for both Islamic and conventional stock indices. The first column provides nine graphs of AVR test statistics for Islamic stock indices (DJIMs), while the second column contains the graphs of AVR test statistics of their corresponding conventional stock indices (MSCI conventional indices). We use the wild bootstrapping approach, suggested by Kim (2009), to compute the AVR test statistic and the 95% confidence interval in all cases. AVR statistic falling outside its 95% confidence band implies the rejection of the null MDH at a 5% significance indicating return predictability in the given time window.

From Figure 3, we observe that the Islamic stock indices reveal a qualitatively similar pattern in the computed AVR test statistics relative to their respective conventional counterparts. Therefore, there are no significant distinct trends in the predictability of returns of Islamic stock indices against conventional stock indices. The graphs in Figure 3 suggest that the return predictability of both Islamic and conventional stock indices vary over time in line with the AMH proposition of Lo (2004). The European, UK and the US Islamic and conventional stock indices exhibit mostly insignificant AVR test statistics over time, failing to reject the MDH. In these three markets, returns of Islamic and conventional stock indices have relatively insignificant autocorrelation and hence are unpredictable in most of the estimation windows over the sample period. From the Emerging market perspective, Islamic and conventional indices appear to be the most inefficient, followed by the World indices, as suggested by their respective graphs in Figure 3. Al-Khazali et al. (2016) report similar findings for Islamic and conventional stock indices. Our empirical evidence is,however, robust based on the two years rolling window estimates of AVR test statistics. Further, we use bootstrapping to compute AVR test statistics and the 95% confidence interval consistent with Kim (2009) that allows overcoming serial correlation while replicating the heteroscedastic structure of returns at the same time (Charles et al., 2015).

Figure 3 also indicates that return predictability over time relates to prevailing market conditions in most markets as advocated by the AMH. The graphs of the US and Japanese Islamic and conventional stock indices, for example, depict that the AVR test statistics are falling below their lower confidence limits during the sub-prime crisis from the end of 2007 to the mid of 2009. Returns are predictable during the dotcom bust over three years from 1998 to 2000 for the Developed and Emerging Islamic and conventional stock indices. Similarly, the Asia Pacific Islamic and conventional stock indices are inefficient during COVID-19. Charles et al. (2017) also report that Islamic and conventional sectoral stock indices are predictable during different events, hence supporting the AMH. Similar findings have been reported by Charles et al. (2015) and Kim et al. (2011) for precious metals and stock market returns, respectively.

The graphs for individual markets in Figure 3 also reveal a noticeable pattern. Except for the Asia Pacific and the World indices, all other Islamic indices closely resemble their counterparts in the predictability of returns. The US Islamic and conventional stock indices have 19% and 18% of their AVR test statistics, respectively, falling outside their confidence limits over the estimation period. The same is 7.3% and 7.7% for conventional and Islamic stock indices, respectively, in the UK. Similarly, for the other five Islamic indices, the return

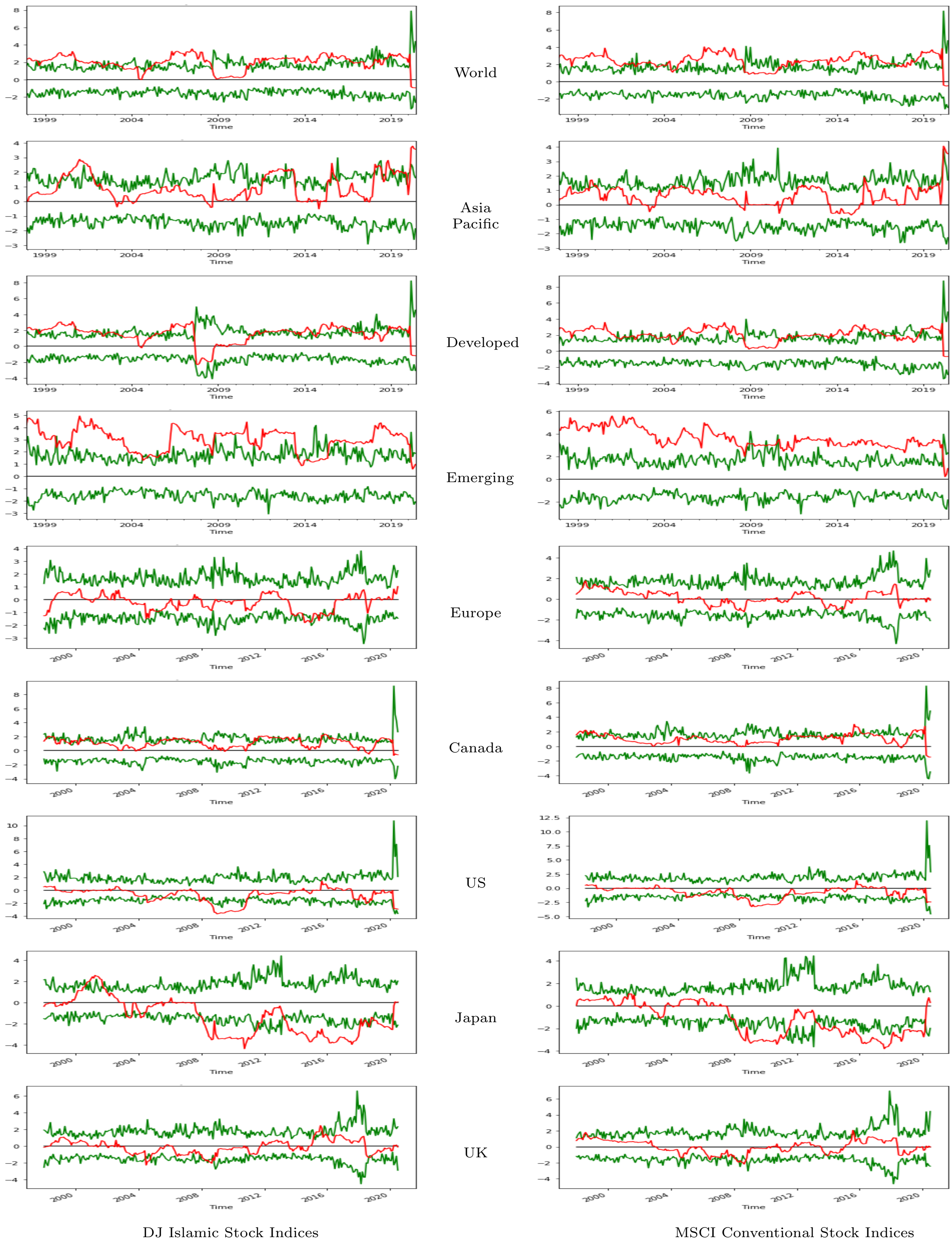


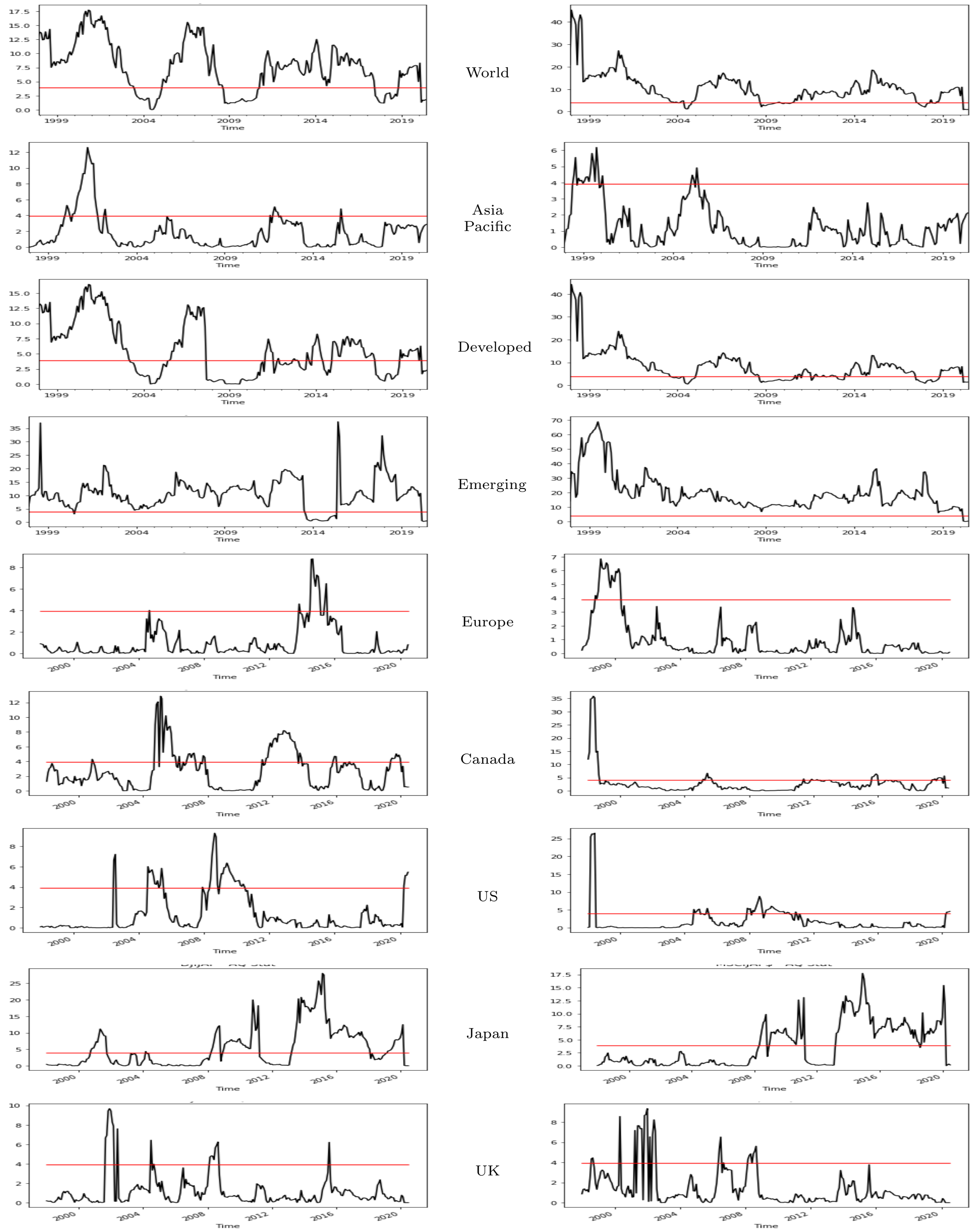
Figure 3: The red lines show monthly automatic variance (AVR) test statistics, and the green lines represent their associated 95% confidence bands, computed using Kim (2009) wild bootstrapping method, from January 1996 to June 2020 for nine Dow Jones Islamic stock indices in the left-hand column and their nine conventional counterparts, Morgan Stanley stock indices, in the right-hand column.

predictability closely resembles that of their conventional counterparts. It suggests that the status (Islamic or conventional) does not drive the similarities or differences in return predictability of Islamic and conventional stock indices. There are, however, geographical drivers of return predictability.

As positive and negative correlations may offset in the estimation of the AVR test statistic, we estimate the AQ test statistics for all the Islamic and conventional stock indices in our sample to assess the robustness of our findings in Figure 3. Figure 4 presents the graphs of monthly estimates of AQ test statistics from the two years rolling window for Islamic and conventional stock indices. The horizontal line in each graph is the 5% critical value (3.84) of the AQ test statistic. If the computed AQ test statistics exceed 3.84, the null of no autocorrelation in returns (MDH) is rejected, and hence the market is declared inefficient in that particular time window. Figure 4 suggests that except; for the Asia Pacific, Europe and Japan, Islamic stock indices are more efficient than conventional ones, as indicated by the range of computed AQ test statistics.Charles et al. (2017) report similar findings for Islamic stock indices from their AQ tests of sectoral Islamic and conventional stock indices. In addition, we observe that the AQ statistics show an apparent increase or decrease for most of the Islamic and conventional stock indices. For example, the Japanese Islamic and conventional stock indices exhibit an increase in AQ test statistics from 1996 to 2020, indicating increasing return predictability, i.e., reduced market efficiency. On the other hand, the Asia Pacific and UK Islamic and conventional indices show a decrease in AQ statistics, indicating increasing market efficiency over time.

Figure 4 suggests time-varying return predictability for both Islamic and conventional stock indices that change with changing market conditions, hence lending support to the AMH. For example, all the conventional (except the Japanese) stock indices and the World, Developed and Emerging Islamic stock indices exhibit return predictability, i.e., are inefficient during the dotcom bust. The US market has statistically significant return predictability, corresponding to the 2007-2009 sub-prime crisis, similar to what we observed from the AVR test statistics in Figure 3. The European Islamic and conventional stock indices are still the most efficient (the least predictable). The Emerging markets are the least efficient (most predictable) relative to the other seven indices. These findings are consistent with Al-Khazali et al. (2016), who find the European markets to be the most efficient and the Emerging the least efficient. In addition, El Khamlichi et al. (2014) also report similar findings for conventional and Islamic stock indices, using variance ratio and unit root tests and co-integration analysis. Recently, Buğan et al. (2021) report finding that support the AMH in a high volatility regime for both the World and Developed Islamic stock indices using the Markov-Switching ADF test.

Overall, the empirical findings from the AVR and AQ test statistics in Figure 3 and Figure 4, respectively, suggest no clear pattern of the Islamic markets becoming increasingly efficient or otherwise except in the case of Japan, the UK and the Asia Pacific. We also note qualitatively similar behaviour of both Islamic and conventional stock indices across the sub-prime mortgage crisis (GFC). Hence, Islamic stocks do not offer opportunities as a safe haven, contrary to Al-Khazali et al. (2014), who report otherwise based on stochastic dominance analysis. These findings are consistent with Bugan et al. (2021), who find a positive and significant correlation between Islamic and conventional stock returns, negating Islamic markets as safe havens. Subsequently, investors can exploit inefficiencies (attributable to market conditions and/or geographical influences) in



DJ Islamic Stock Indices

MSCI Conventional Stock Indices

Figure 4: The red lines show monthly automatic portmanteau (AQ) test statistics, computed using Escanciano and Lobato (2009), and the black lines represent the critical value of 3.84 at a 5% level of significance for the period January 1996 to June 2020 for nine Dow Jones Islamic stock indices in the left-hand column and their nine conventional counterparts, Morgan Stanley stock indices, in the right-hand column.

stock pricing across Islamic and conventional stocks subject to transaction costs. However, given that the AQ test and AVR test only consider linear autocorrelation, we check the robustness of these two tests by employing the GS test, which accounts for both linear and non-linear autocorrelations.

The estimated p-values of GS test statistics are shown in the graphs depicted in Figure 5. The horizontal black line in each graph in Figure 5 represents the p-value at a 5 percent level of statistical significance. Actual p-values are portrayed in red, where p-values below the black line (.05) indicate rejection of the MDH, i.e., the null of no autocorrelation (linear and non-linear). We observe from Figure 5 that p-values fall below the threshold of 0.05 several times across both Islamic and conventional stock indices. Although, there is some variation in return predictability across the two different sets of indices. Similar to AVR and AQ test results, we observe that return predictability is the highest in the Emerging market, followed by the World and Developed Islamic and conventional indices, while it is the lowest in Europe, the US, and the UK. However, the GS test statistics in Figure 5 do not reveal any discernible trend, unlike the AQ test statistics in Figure 4, and suggest the presence of significant non-linear dependencies.

The p-value graphs in Figure 5 suggest patterns of significance in all markets that relate to prevailing market conditions, such as the dotcom bubble, the US housing bubble, the sub-prime mortgage crisis, and infectious diseases, i.e., COVID-19 in the case of the US market. Relative to AVR and AQ tests statistics reported in Figure 3 and Figure 4, respectively, the results from the GS test suggest that markets have been predominantly efficient (i.e., fail to reject the MDH). These results also indicate the presence of substantial non-linear autocorrelation in returns of both Islamic and conventional stock indices. Therefore, both linear and non-linear dependencies must be considered in the appraisal of market efficiency over time for both Islamic and conventional stocks. Kim et al. (2011) and Phan and Pham (2019) report similar findings for the US and Vietnamese conventional stocks, respectively. Overall, our results from the AVR, AQ and GS test statistics do not suggest any noticeable trend of an increasing or decreasing market efficiency in the Islamic stock indices over time. In addition, the results propose that Islamic and conventional stock indices have similar trends in return predictability that vary over time for each market, as the AMH postulates.

4.3 Return Predictability Regressions

We regress the absolute values of estimated AVR test statistics against six prominent events as proxies of shifts in market conditions (measured as dummy variables) over the sample period for each Islamic and conventional stock index. These events include the dotcom bust, the US housing bubble, the sub-prime crisis, the SARS outbreak, the Ebola outbreak, and the COVID-19 outbreak. The results from dummy regressions of the absolute AVR statistics and these events are presented in Table 2.

The results in Table 2 offer valuable insights from multiple perspectives. First, as observed earlier from the AVR test results in Figure 3, the European, UK and Canadian markets are relatively efficient. In other cases, both Islamic and conventional stock indices exhibit return predictability over events used as proxies of different market conditions. Gutiérrez and Philippon (2018) explain that the European markets have become

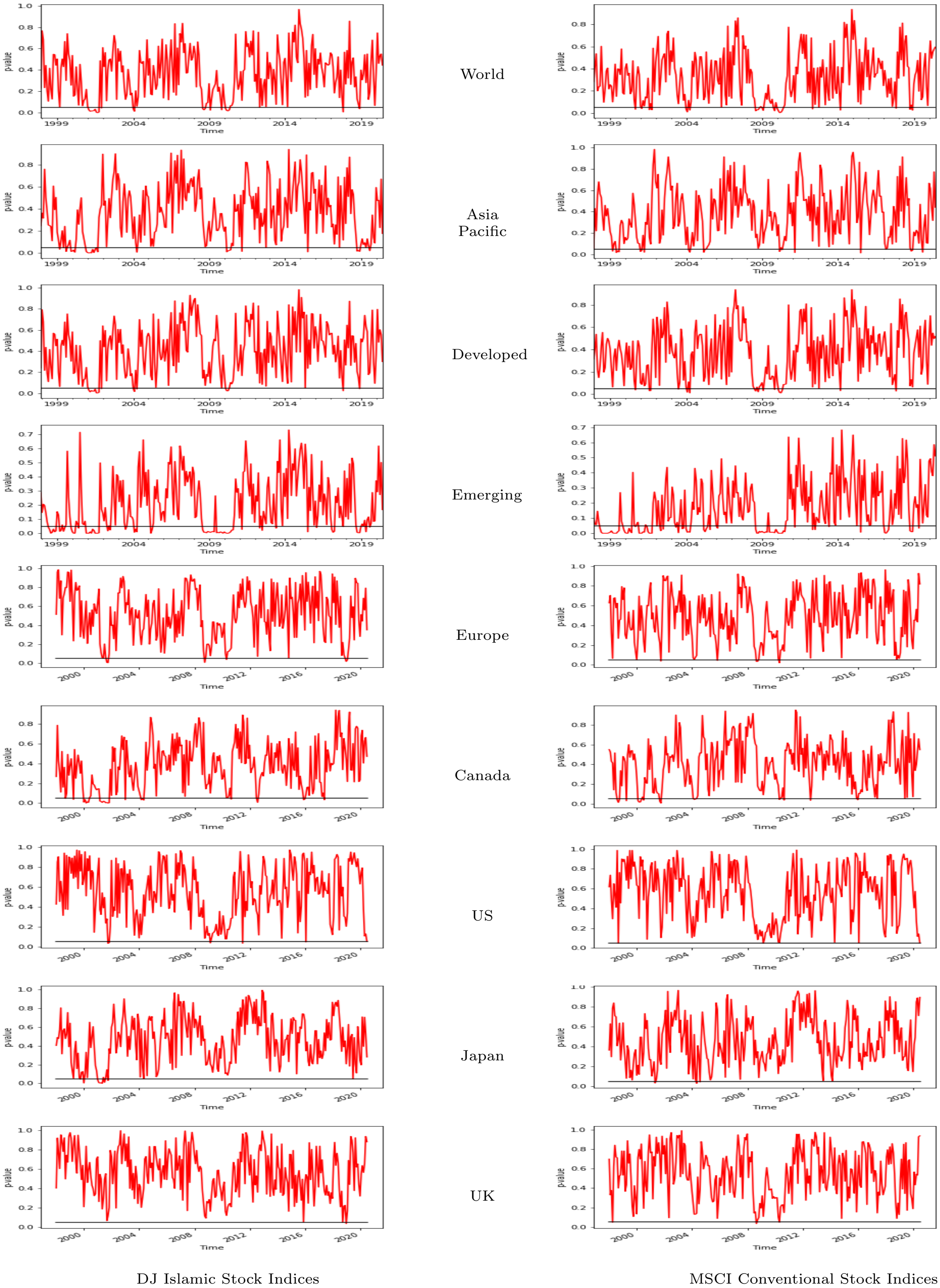


Figure 5: The red lines show the p-values of monthly generalized spectral test statistics, computed using Escanciano and Velasco (2006) procedure, from January 1996 to June 2020, and the black lines represent a 5% significance level for nine Dow Jones Islamic stock indices in the left-hand column and their nine conventional Morgan Stanley counterparts in the right-hand column.

more competitive with a lower concentration, lower excess profits and lower regulatory barriers to entry due to political support for a common regulator. Despite geographical, economic and financial proximities, the US and Canadian equity markets have remained fragmented (King and Segal, 2003), while the Canadian economy is becoming increasingly more competitive[10]. Moreover, the Asia Pacific Islamic and conventional stock market returns are only predictable over the COVID-19 crisis period. Return predictability is significantly high and consistent across developed Islamic and conventional stock markets (except for the SARS outbreak). It is inconsistent with the EMH theory as technological innovations, enhanced regulations, large trading volumes, and stable macroeconomic indicators characterize developed markets as efficient (Borges, 2010).

Second, we also observe that stock returns are mostly predictable over the sub-prime crisis in the World, Developed, US and Japanese Islamic and conventional markets (Table 2). However, we find that returns are predictable over the dot-com bubble bust in the Developed, Emerging, and European conventional markets and the Developed Islamic markets only. The US accounts for a significant share of the Developed Islamic and conventional indices and may explain their significance over the dotcom bubble bust. These findings suggest that Islamic stocks are not immune (safe haven) against financial crises such as the sub-prime mortgage and only offer protection in certain regions such as Europe, Emerging and Asia Pacific (Rejeb and Arfaoui, 2019). As suggested by the AMH, these findings provide empirical evidence, indicating departures from market efficiency in response to changing market conditions for our sample of Islamic and conventional stock indices except the UK. Though Al-Khazali et al. (2016) did not test return predictability directly using regression analysis, their sub-sample analysis representing different market conditions also suggests varying levels of return predictability in line with the AMH.

Third, we note that among all the events, the COVID-19 outbreak has the highest implications for return predictability across Islamic and conventional stock indices, with mostly the highest coefficients of all the events (Table 2). The coefficient on the COVID-19 dummy is statistically significant at 5% in 11 (five Islamic and six conventional) out of the 18 stock indices in our sample. Return predictability during the Ebola outbreak is relatively confined mostly to international than country Islamic and conventional stock indices, while the SARS outbreak is insignificant in all cases. Return predictability in COVID-19 has been documented in emerging literature on COVID and financial markets (e.g., Ashraf (2020); Mazur et al. (2020); Phan and Narayan (2020); Topcu and Gulal (2020)). Both the COVID-19 outbreak (relative to SARS and Ebola outbreaks) and the sub-prime mortgage crises are global events and hence have influenced markets worldwide.

Finally, table 2 suggests geographical variations in return predictability but not across the index, i.e., Islamic and conventional. For example, the sub-prime crisis dummy carries similar size coefficients of 0.249 and 0.238 for Islamic and conventional US markets, respectively. The spillover effect is pivotal and depends on the integration between markets. Given the size of the Japanese economy, which is closely integrated with the US economy (Floros, 2005), the Japanese Islamic and conventional indices have a high degree of return predictability during the sub-prime crisis. At the same time, the World and Developed markets also exhibit relatively higher return

[10]https://www.freshdaily.ca/news/2020/06/canada-more-competitive-economy-us/.

predictability as the US stocks account for a significant share of their Islamic and conventional indices[11].

[11] https://www.msci.com/documents/10199/178e6643-6ae6-47b9-82be-e1fc565ededb.

Table 2: Panel A presents the regression results of nine Dow Jones Islamic stock indices, and panel B the regression results of their conventional counterparts, Morgan Stanley Capital International stock indices. We use the monthly AVR statistics as a dependent variable and their lag values and six dummy variables as independent variables, representing a downward shift in market conditions.

Panel A	DJ Islamic Stock Indices								
	World	Asia Pacific	Developed	Emerging	Europe	Canada	US	Japan	UK
	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$
Intercept	0.206*	0.117*	0.266*	0.255*	0.098*	0.141*	0.078**	0.094*	0.104*
AR	0.892*	0.902*	0.824*	0.912*	0.711*	0.874*	0.905*	0.941*	0.827*
Dotcom bust(1998:01-2000:12)	0.059	0.057	0.149**	0.052	0.012	0.048	-0.069	-0.009	-0.028
US housing bubble(2005:01-2007:06)	0.121**	-0.047	0.158**	0.057	0.020	0.063	-0.073	-0.096	-0.007
Sub-prime crisis(2007:12-2009:06)	-0.163**	-0.103	-0.188**	0.037	0.007	-0.123***	0.249*	0.182**	0.070
SARS outbreak(2002:11-2004:05)	-0.071	-0.131	-0.054	-0.105	-0.020	-0.074	0.003	0.022	0.052
Ebola outbreak(2013:12-2016:06)	0.088	-0.050	0.141**	-0.021	0.277*	0.014	-0.059	0.129***	0.033
COVID-19 outbreak(2020:01-2020:06)	-0.274**	0.422*	-0.126	-0.452*	0.149	-0.184***	0.520*	-0.406*	-0.072
Adjusted R^2	0.87	0.87	0.80	0.86	0.73	0.83	0.91	0.95	0.71
Panel B	MSCI Conventional Stock Indices								
	World	Asia Pacific	Developed	Emerging	Europe	Canada	US	Japan	UK
	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$	$\|AVR\|$
Intercept	0.375*	0.171*	0.298*	0.545*	0.074*	0.160*	0.104*	0.113*	0.103*
AR	0.830*	0.753*	0.834*	0.841*	0.816*	0.840*	0.882*	0.936*	0.832**
Dotcom bust(1998:01-2000:12)	0.108	0.064	0.136**	0.224*	0.122*	0.079	-0.089	-0.067	0.054
US housing bubble(2005:01-2007:06)	0.192***	0.037	0.198**	0.103	-0.010	-0.028	-0.059	-0.111***	0.01
Sub-prime crisis(2007:12-2009:06)	-0.141***	-0.137	-0.155**	-0.076	0.024	-0.114	0.238*	0.148**	0.039
SARS outbreak(2002:11-2004:05)	-0.034	-0.047	0.007	-0.015	0.043	-0.030	-0.023	-0.101	-0.037
Ebola outbreak(2013:12-2016:06)	0.145**	-0.039	0.156**	-0.036	-0.023	0.114***	-0.083	0.084	-0.008
COVID-19 outbreak(2020:01-2020:06)	-0.511*	0.791*	-0.339*	-0.648*	-0.037	-0.008	0.444*	-0.361*	-0.070
Adjusted R^2	0.81	0.72	0.83	0.86	0.78	0.80	0.88	0.95	0.72

*, ** and *** indicate statistical significance at 1%, 5% and 10% respectively.

Overall, a comparison of the Islamic and conventional indices reveals no substantial differences in return predictability over the six events used as measures of a shift in market conditions. For instance, none of the coefficient estimates of the six events is statistically significant at 5 percent for the UK and Canadian Islamic and conventional markets (Table 2). Similarly, the Asia Pacific Islamic and conventional markets reveal significant return predictability during the COVID-19 event only. Likewise, both the Emerging markets exhibit considerable return predictability in COVID-19. The reported coefficients of the different event dummies for the World, Developed, US and Japan show almost a similar pattern of statistical significance across Islamic and conventional stock indices during each event. Thus, the sensitivity of return predictability to a particular circumstance does not appear to be a function of the type of index, i.e., Islamic or conventional but varies across geographical regions. Our result of both conventional and Islamic stock indices displaying market inefficiency (i.e., similar behavior) during financial plight is explained by the growing convergence between the two types of markets. The convergence is guided by financial integration, the geographical spread of financial institutions, and product imitation because of competition for investors and depositors (Alexakis et al., 2021). The convergence is mainly profound in the banking system. Despite the theoretical differences, the operations of the Islamic banking system resemble those of the conventional banking system. As a result, Islamic banking has emerged as a substitute rather than a complement to traditional banking (Hunjra et al., 2022). Also, the Dow Jones Islamic firms are not less risky or more socially responsible than their conventional counterparts (Elnahas et al., 2021). In addition, the S&P 500 Islamic firms do not enjoy better corporate governance than their non-Islamic compeers (Hayat and Hassan, 2017).

We also present plausible reasons for our finding of the Islamic capital markets losing their informational efficiency during adverse market conditions. Farooqi et al. (2015) and Narayan and Phan (2017) underscore the market inefficiency of the Dow Jones Islamic Index as they find the momentum strategy effective in the Islamic capital market. Tee et al. (2019) report the presence of momentum anomaly in the Malaysian Islamic and conventional capital markets. The momentum and contrarian strategies also pay off in the Islamic equity markets of Saudi Arabia, Indonesia, Qatar, the United Arab Emirates, and Turkey (Özkan and Çakar, 2021). The return predictability in the Islamic capital markets arises due to social and religious norms. The EMH emphasizes stock prices are influenced only by the fundamentals such as discount rate and projected cash flows (Hassan et al., 2020). Departure from market efficiency, however, happens when stock prices reflect non-fundamentals like social or religious norms. Muslim investors, strictly following their communal and religious values, derive utility from investments in Shariah-compliant equities and, therefore, pay a premium for such stocks. Else, they demand discounts to invest in stocks that contradict their belief. In either case, stock prices deviate from their true values, and the distortion is not arbitraged away if arbitrageurs too carry the same religious sentiment (Shohruh, 2022). In line with this argument, Shafron (2019) reveals a lower yield of Islamic bonds (Sukuk) against conventional bonds. The author further accentuates that the differential is caused by the differences in investors' preferences and tastes and not by an inherent risk differential in both the bonds. Thus, it confirms the influential role religious sentiments play in the pricing of assets. In addition, Islamic investors experience a high level of social connectedness through religious events and obligations. It facilitates information sharing and correlated trading of Islamic stocks based on non-fundamental factors causing return co-movements and thereby arising return predictability (Alhomaidi et al., 2018). Crucially, the high correlation is not limited to stocks traded in a single Islamic stock market. The evidence is international since it exists between the Islamic stock market of the United Kingdom and those of Canada, the United States of America, Malaysia, and India (Çıkıryel et al., 2021). Given these detailed arguments, we infer no benefits of investing in Islamic stocks relative to conventional stocks based on the type of market. On the contrary, Islamic and conventional indices across different regions may offer more value for investing due to geographical segmentation.

5 Conclusions

Islamic finance has received increasing attention and experienced significant growth over the last two decades. Investment in stocks that conform to Shariah principles, i.e., Islamic stocks, have been on the rise across global financial markets for their diversification value as safe havens (Al-Khazali et al. (2014); Mensi et al. (2015); Hkiri et al. (2017)). Researchers have shown mounting and a keen interest in investigating Islamic stocks. However, the market efficiency of Islamic equity markets is one area where extant literature is inadequate. Specifically, the degree of informational efficiency of Islamic equities over time has not been put to rigorous empirical tests, which account for linear and non-linear dependencies in returns across different international markets.

We provide robust empirical evidence on return predictability tests of the martingale difference hypothesis (MDH) and the adaptive market hypothesis (AMH) over time for nine DJ Islamic stock indices relative to conventional MSCI stock indices. Using an extended sample from January 1996 to June 2020, we evaluate the degree of informational efficiency over time using a two years monthly rolling window. We use the automatic variance ratio (AVR) test of Kim (2009), the automatic portmanteau (AQ) test of Escanciano and Lobato (2009), and the generalized spectral (GS) test of Escanciano and Velasco (2006) for the empirical testing of the MDH. These tests have the desired small sample properties and account for linear and non-linear autocorrelation. Moreover, we also conduct a regression analysis to evaluate the return predictability of Islamic and conventional stocks during six different events, i.e., the dot-com bust, US housing bubble, sub-prime mortgage crisis, SARS outbreak, Ebola outbreak, and the COVID-19 outbreak, representing varying market conditions.

The results from our extensive empirical analysis provide strong evidence of return predictability (rejection of the MDH) over different periods for both Islamic and conventional stock indices. We observe no significant and distinct differences in return predictability between the respective Islamic and conventional stock indices. Furthermore, our results suggest no pattern of decreasing return predictability over time (increasing market efficiency), or otherwise, for both Islamic and conventional stock indices after accounting for non-linear dependencies. We note that return predictability is more prevalent across regional markets in different periods coinciding with the events, representing shifts in market conditions. In particular, return predictability across various Islamic and conventional stock indices is higher during the sub-prime mortgage crisis and the COVID-19 outbreak. Relatively, return predictability is lower in the European, UK, and Canadian Islamic and conventional markets and higher in the World, Developed, and Emerging markets. Based on our empirical results, we conclude that type of stock,i.e., Islamic or conventional, is inconsequential in determining return predictability. However, return predictability relates to geographic segmentation that provides opportunities to strategise investment in markets geographically. Our evidence suggests the existence of opportunities for above-average returns in different periods across Islamic and conventional stock markets in line with AMH.

As we find no discernible differences in the behaviour of returns of Islamic and conventional stocks across our sample markets during extreme market conditions, such as the sub-prime mortgage crisis, we suggest that investors, fund managers, and stock analysts take caution in considering Islamic stocks as safe havens. For investors, it is more valuable in terms of diversification to spread their investments in equities across different geographical regions. In addition, investors may be able to exploit inefficiencies around significant market events over time in line with the AMH. Hence investors may find it rewarding to monitor markets over time and follow tactical allocation strategies during unique and/or extreme market events such as the global financial crisis or the COVID-19 pandemic. Market regulators should devise regulations and policies that foster the protection of all investors (particularly small investors) and mitigate the likelihood of financial crisis and contagion. Improving timely availability and access to material information are pre-requisites for efficient markets that offer level-playing field to all participants. Market regulators should foster collaborations across regions, leading to convenience, speed, and reduce transaction costs for investors diversifying geographically across different stock markets.

References

Al-Khazali, O., Lean, H. H., and Samet, A. (2014). Do islamic stock indexes outperform conventional stock indexes? a stochastic dominance approach. *Pacific-Basin Finance Journal*, 28:29–46.

Al-Khazali, O. and Mirzaei, A. (2017). Stock market anomalies, market efficiency and the adaptive market hypothesis: Evidence from islamic stock indices. *Journal of International Financial Markets, Institutions and Money*, 51:190–208.

Al-Khazali, O. M., Leduc, G., and Alsayed, M. S. (2016). A market efficiency comparison of islamic and non-islamic stock indices. *Emerging Markets Finance and Trade*, 52(7):1587–1605.

Albaity, M. S. and Mudor, H. (2012). Return performance, cointegration and short run dynamics of islamic and non-islamic indices: evidence from the us and malaysia during the subprime crisis. *Atlantic Review of Economics*, 1.

Alexakis, C., Kenourgios, D., Pappas, V., and Petropoulou, A. (2021). From dotcom to Covid-19: A convergence analysis of Islamic investments. *Journal of International Financial Markets, Institutions and Money*, 75:101423.

Ali, S., Shahzad, S. J. H., Raza, N., and Al-Yahyaee, K. H. (2018). Stock market efficiency: A comparative analysis of islamic and conventional stock markets. *Physica A: Statistical Mechanics and Its Applications*, 503:139–153.

Alhomaidi, A., Hassan, M. K., Zirek, D., and Alhassan, A. (2018). Does an Islamic label cause stock price comovements and commonality in liquidity?. *Applied Economics*, 50(59):6444–6457.

Antoniou, A., Ergul, N., and Holmes, P. (1997). Market efficiency, thin trading and non-linear behaviour: evidence from an emerging market. *European Financial Management*, 3(2):175–190.

Ashraf, B. N. (2020). Stock markets' reaction to covid-19: cases or fatalities? *Research in International Business and Finance*, page 101249.

Azad, A. S., Azmat, S., Chazi, A., and Ahsan, A. (2018). Sailing with the non-conventional stocks when there is no place to hide. *Journal of International Financial Markets, Institutions and Money*, 57:1–16.

Azmat, S., Skully, M., and Brown, K. (2014). The shariah compliance challenge in islamic bond markets. *Pacific-Basin Finance Journal*, 28:47–57.

Barber, B. M. and Odean, T. (2001). Boys will be boys: Gender, overconfidence, and common stock investment. *The quarterly journal of economics*, 116(1):261–292.

Borges, M. R. (2010). Efficient market hypothesis in european stock markets. *The European Journal of Finance*, 16(7):711–726.

Box, G. E. and Pierce, D. A. (1970). Distribution of residual autocorrelations in autoregressive-integrated moving average time series models. *Journal of the American statistical Association*, 65(332):1509–1526.

Bugan, M. F., Cevik, E. I., and Dibooglu, S. (2021). Emerging market portfolios and Islamic financial markets: diversification benefits and safe havens. *Borsa Istanbul Review*

Buğan, M. F., Çevik, E. İ., Çevik, N. K., and Yildirim, D. Ç. (2021). Testing adaptive market hypothesis in global islamic stock markets: evidence from markov-switching adf test. *Bilimname*, 2021(44):425-449

Charles, A., Darné, O., and Kim, J. H. (2011). Small sample properties of alternative tests for martingale difference hypothesis. *Economics Letters*, 110(2):151–154.

Charles, A., Darné, O., and Kim, J. H. (2015). Will precious metals shine? a market efficiency perspective. *International Review of Financial Analysis*, 41:284–291.

Charles, A., Darné, O., and Kim, J. H. (2017). Adaptive markets hypothesis for islamic stock indices: Evidence from dow jones size and sector-indices. *International economics*, 151:100–112.

Chkili, W., and Hamdi, M. (2021). An artificial neural network augmented GARCH model for Islamic stock market volatility: Do asymmetry and long memory matter?. *International Journal of Islamic and Middle Eastern Finance and Management.*

Choi, I. (1999). Testing the random walk hypothesis for real exchange rates. *Journal of Applied Econometrics*, 14(3):293–308.

Chu, J., Zhang, Y., and Chan, S. (2019). The adaptive market hypothesis in the high frequency cryptocurrency market. *International Review of Financial Analysis*, 64:221–231.

Çıkıryel, B., Aslan, H., and Özdemir, M. (2021). Impact of Brexit on Islamic stock markets: employing MGARCH-DCC and wavelet correlation analysis. *International Journal of Islamic and Middle Eastern Finance and Management.*

De Gooijer, J. G. (1989). Testing non-linearities in world stock market prices. *Economics Letters*, 31(1):31–35.

Dewandaru, G., Rizvi, S. A. R., Masih, R., Masih, M., and Alhabshi, S. O. (2014). Stock market co-movements: Islamic versus conventional equity indices with multi-timescales analysis. *Economic Systems*, 38(4):553–571.

Elnahas, A., Ismail, G., El-Khatib, R., and Hassan, M. K. (2021). Islamic labeled firms: Revisiting Dow Jones measure of compliance. *Journal of Business Finance & Accounting*, 48(5-6):988–1021.

El Khamlichi, A., Sannajust, A., Sarkar, H. K., et al. (2014). Islamic equity indices: insight and comparison with conventional counterparts. *Bankers, Markets & Investors*, (130):69–80.

Escanciano, J. C. and Lobato, I. N. (2009). An automatic portmanteau test for serial correlation. *Journal of Econometrics*, 151(2):140–149.

Escanciano, J. C. and Velasco, C. (2006). Generalized spectral tests for the martingale difference hypothesis. *Journal of Econometrics*, 134(1):151–185.

Fama, E. F. (1965). The behavior of stock-market prices. *The journal of Business*, 38(1):34–105.

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The journal of Finance*, 25(2):383–417.

Farooq, M. and Zaheer, S. (2015). Are islamic banks more resilient during financial panics? *Pacific Economic Review*, 20(1):101–124.

Farooqi, J., Ngo, T., Huerta-Sanchez, D., and Chen, H. (2015). Momentum Strategies in Shari'ah-Compliant Stocks: The Role of Debt. *The Journal of Investing*, 24(2):90–111.

Floros, C. (2005). Price linkages between the us, japan and uk stock markets. *Financial Markets and Portfolio Management*, 19(2):169–178.

Fox, J. and Sklar, A. (2009). *The myth of the rational market: A history of risk, reward, and delusion on Wall Street*. Harper Business New York.

Ghazani, M. M. and Ebrahimi, S. B. (2019). Testing the adaptive market hypothesis as an evolutionary perspective on market efficiency: Evidence from the crude oil prices. *Finance Research Letters*, 30:60–68.

Gutiérrez, G. and Philippon, T. (2018). How eu markets became more competitive than us markets: A study of institutional drift. Technical report, National Bureau of Economic Research.

Harrison, R. G., Yu, D., Oxley, L., Lu, W., and George, D. (1999). Non-linear noise reduction and detecting chaos: some evidence from the s&p composite price index. *Mathematics and Computers in Simulation*, 48(4-6):497–502.

Hasan, M. B., Hassan, M. K., Rashid, M. M., Ali, M. S., and Hossain, M. N. (2021). Calendar anomalies in the stock markets: conventional vs Islamic stock indices. *Managerial Finance.*

Hasnie, S. S. A., Collazzo, P., and Hassan, M. K. (2022). Risk assessment of equity-based conventional and Islamic stock portfolios. *The Quarterly Review of Economics and Finance.*

Hassan, M. K., Aliyu, S., Saiti, B., and Halim, Z. A. (2020). A review of Islamic stock market, growth and real-estate finance literature. *International Journal of Emerging Markets.*

Hassan, M. K. and Girard, E. (2011). Faith-based ethical investing: the case of Dow Jones Islamic indexes. *Networks Financial Institute Working Paper*, (2011-WP):06.

Hayat, R., and Hassan, M. K. (2017). Does an Islamic label indicate good corporate governance?. *Journal of Corporate Finance*, 43:159–174.

Hayat, R. and Kraeussl, R. (2011). Risk and return characteristics of islamic equity funds. *Emerging markets review*, 12(2):189–203.

Hippler, W. J., Hassan, M. K., and Pezzo, L. (2021). Partial adjustment towards performance-based mutual fund returns: Evidence from US-based equity funds. *International Journal of Finance & Economics*, 26(4):5864–5883.

Hkiri, B., Hammoudeh, S., Aloui, C., and Yarovaya, L. (2017). Are islamic indexes a safe haven for investors? an analysis of total, directional and net volatility spillovers between conventional and islamic indexes and importance of crisis periods. *Pacific-Basin Finance Journal*, 43:124–150.

Hong, Y. (1999). Hypothesis testing in time series via the empirical characteristic function: a generalized spectral density approach. *Journal of the American Statistical Association*, 94(448):1201–1220.

Hsu, P. H. and Kuan, C. M. (2005). Reexamining the profitability of technical analysis with data snooping checks. *Journal of Financial Econometrics*, 3(4):606–628.

Hunjra, A. I., Islam, F., Verhoeven, P., and Hassan, M. K. (2022). The impact of a dual banking system on macroeconomic efficiency. *Research in International Business and Finance*, 61:101647.

Ibrahim, M. H. (2015). Issues in Islamic banking and finance: Islamic banks, Shari'ah-compliant investment and sukuk. *Pacific-Basin Finance Journal*, 34:185–191.

Ibrahim, M. H., and Alam, N. (2018). Islamic economics and Islamic finance in the world economy. *The World Economy*, 41(3):668–673.

Jawadi, F., Jawadi, N., and Cheffou, A. I. (2015). Are islamic stock markets efficient? a time-series analysis. *Applied Economics*, 47(16):1686–1697.

Jegadeesh, N. and Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of finance*, 48(1):65–91.

Kendall, M. G. and Hill, A. B. (1953). The analysis of economic time-series-part i: Prices. *Journal of the Royal Statistical Society. Series A (General)*, 116(1):11–34.

Khuntia, S. and Pattanayak, J. (2018). Adaptive market hypothesis and evolving predictability of bitcoin. *Economics Letters*, 167:26–28.

Kim, J. H. (2006). Wild bootstrapping variance ratio tests. *Economics letters*, 92(1):38–43.

Kim, J. H. (2009). Automatic variance ratio test under conditional heteroskedasticity. *Finance Research Letters*, 6(3):179–185.

Kim, J. H., Shamsuddin, A., and Lim, K. P. (2011). Stock return predictability and the adaptive markets hypothesis: Evidence from century-long us data. *Journal of Empirical Finance*, 18(5):868–879.

King, M. R. and Segal, D. (2003). Valuation of canadian-versus us-listed equities: Is there a discount? *Financial*, page 81.

Krichene, N. (2012). *Islamic capital markets: Theory and practice.* John Wiley & Sons.

Ljung, G. M. and Box, G. E. (1978). On a measure of lack of fit in time series models. *Biometrika*, 65(2):297–303.

Lo, A. W. (2004). The adaptive markets hypothesis. *The Journal of Portfolio Management*, 30(5):15–29.

Lo, A. W. and MacKinlay, A. C. (1988). Stock market prices do not follow random walks: Evidence from a simple specification test. *The review of financial studies*, 1(1):41–66.

Lobato, I., Nankervis, J. C., and Savin, N. E. (2001). Testing for autocorrelation using a modified box-pierce q test. *International Economic Review*, 42(1):187–205.

Mazur, M., Dang, M., and Vega, M. (2020). Covid-19 and the march 2020 stock market crash. evidence from s&p1500. *Finance Research Letters*, page 101690.

McPherson, M. Q. and Palardy, J. (2007). Are international stock returns predictable?: An examination of linear and non-linear predictability using generalized spectral tests. *Journal of International Financial Markets, Institutions and Money*, 17(5):452–464.

Mensi, W., Hammoudeh, S., Reboredo, J. C., and Nguyen, D. K. (2015). Are sharia stocks, gold and us treasury hedges and/or safe havens for the oil-based gcc markets? *Emerging Markets Review*, 24:101–121.

Mensi, W., Tiwari, A. K., and Yoon, S. M. (2017). Global financial crisis and weak-form efficiency of Islamic sectoral stock markets: An mf-dfa analysis. *Physica A: Statistical Mechanics and its Applications*, 471:135–146.

Merdad, H., Hassan, M. K., and Alhenawi, Y. (2010). Islamic versus conventional mutual funds performance in Saudi Arabia: A case study. *Journal of King Abdulaziz University: Islamic Economics*, 23(2):157-193.

Merdad, H. J., Hassan, M. K., and Hippler III, W. J. (2015). The Islamic risk factor in expected stock returns: an empirical study in Saudi Arabia. *Pacific-Basin Finance Journal*, 34:293–314.

Narayan, P. K., and Phan, D. H. B. (2017). Momentum strategies for Islamic stocks. *Pacific-Basin Finance Journal*, 42:96–112.

Noda, A. (2016). A test of the adaptive market hypothesis using a time-varying ar model in japan. *Finance Research Letters*, 17:66–71.

Özkan, O., and Çakar, R. (2021). Momentum and Contrarian Anomalies in Islamic Equity Markets: Evidence from Qismut Countries. *Research & Reviews in Social, Human and Administrative Sciences*, 199.

Phan, D. H. B. and Narayan, P. K. (2020). Country responses and the reaction of the stock market to covid-19—a preliminary exposition. *Emerging Markets Finance and Trade*, 56(10):2138–2150.

Phan Tran Trung, D. and Pham Quang, H. (2019). Adaptive market hypothesis: Evidence from the Vietnamese stock market. *Journal of Risk and Financial Management*, 12(2):81.

Ratings, S. G. (2020). Economic research: Covid-19 deals a larger, longer hit to global gdp. *Comments published on April*, 16:2020.

Rejeb, A. B. and Arfaoui, M. (2019). Do islamic stock indexes outperform conventional stock indexes? a state space modeling approach. *European Journal of Management and Business Economics.*

Reuters, T. (2018). Islamic finance development report 2018: Building momentum. *ICD-Thomson Reuters.*

Salisu, A. A., and Shaik, M. (2022). Islamic Stock indices and COVID-19 pandemic. *International Review of Economics and Finance*, 80:282–293.

Sensoy, A., Aras, G., and Hacihasanoglu, E. (2015). Predictability dynamics of islamic and conventional equity markets. *The North American Journal of Economics and Finance*, 31:222–248.

Shafron, E. (2019). Investor tastes: Implications for asset pricing in the public debt market. *Journal of Corporate Finance*, 55:6–27.

Shohruh, N. (2022). Islamic corporate finance, financial markets,and institutions. *Academic Research*, 1(1):170–183.

Tee, L. T., Kew, S. R., and Low, S. W. (2019). Do momentum strategies perform better for Islâmic stocks than for conventional stocks across market states?. *Economic Annals*, 64(221):107–129.

Topcu, M. and Gulal, O. S. (2020). The impact of covid-19 on emerging stock markets. *Finance Research Letters*, 36:101691.

Uddin, G. S., Hernandez, J. A., Shahzad, S. J. H., and Yoon, S. M. (2018). Time-varying evidence of efficiency, decoupling, and diversification of conventional and islamic stocks. *International Review of Financial Analysis*, 56:167–180.

Urquhart, A. (2016). The inefficiency of bitcoin. *Economics Letters*, 148:80–82.

Urquhart, A. and McGroarty, F. (2016). Are stock markets really efficient? evidence of the adaptive market hypothesis. *International Review of Financial Analysis*, 47:39–49.