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Abstract

We assess 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 overtime and assess the adaptive market hypothesis over different market conditions. We find that the null is rejected in a number of 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 over different market conditions including financial crisis of 2007-08 and 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 of 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) and 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 as postulated in the efficient market hypothesis (EMH). TheEMH 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 the empirical findings is as Ali et al. (2018) outline is that Islamic capital markets are more efficient than conventional markets due to better governance, shari'ah 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) in Islamic and conventional stock markets simultaneously[2].

Given the poor empirical support for EMH,Lo (2004) proposed the adaptive market hypothesis (AMH) as an alternative explanation to EMH which postulates that market efficiency (return predictability) varies overtime with shifts in market conditions. Though, the AMH has been subjected to extensive empirical analysis in conventional markets, empirical evidence on the validity of 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 stock markets which builds a case for empirical evidence in the global context.

Fair pricing of assets is a key input in optimal portfolio allocation and investment performance. Lack of empirical evidence on the degree of informational efficiency (postulated in the AMH theory) hinders designing optimal investment strategies by investors, fund managers and investment analysts. Therefore, it is important to thoroughly evaluate informational efficiency of Islamic stock markets and assess if their pricing is fair overtime. Informational inefficiency presents opportunities to earn abnormal returns by market players that can be detected and exploited using technical analysis. On the contrary, informational efficiency in any market renders active investment management in search of under or overpriced assets futile and therefore, make 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)). Therefore, including Islamic stocks in a portfolio of conventional stock may offer diversification benefits that mitigate risk (Mensi et al., 2015). Therefore, we empirically test the return predictability of both conventional and Islamic stock markets overtime and across different market conditions

[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).

to assess the relative resilience of Islamic stocks.

We contribute to the scarce extant literature on time-varying robust empirical tests of AMH i.e. degree of informational efficiency of international Islamic stock markets relative to their conventional counterparts. In the first place, our study is unique as we use the automatic variance (AVR) test of Kim (2009), 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. We evaluate both the linear and non-linear autocorrelation structures of international Islamic stock indices and their conventional counterparts using 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 overtime using two years rolling window measures of each test statistic over an extended sample period. Doing this we are able to observe time-varying return predictability of Islamic and conventional stock returns simultaneously and find if there are any trends in return predictability overtime. Finally, the study brings more novelty by directly testing the AMH for both the Islamic and conventional stock indices and by accounting for shifts in market conditions through dummy variable regressions. Our empirical inquiry, therefore, enables us to evaluate return predictability overtime across different market conditions.

The results from our empirical tests suggest no obvious differences in the degree of information efficiency i.e. return predictability between Islamic and conventional stocks. Our findings support the implications of the AMH as MDH is rejected in several periods across Islamic and conventional stock markets. We find that episodes of return predictability occur in response to changing market conditions especially the COVID-19 breakout and the U.S. 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 markets 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 procedures and provide results and discussions of the findings in Section 4. 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 observed during 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 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 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 are unable to take advantage of past information to generate a return above the level commensurate with the risk assumed (Fama, 1970). 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 have even believed that EMH is one of the reasons having caused the global financial crisis (GFC) in 2007-08 (Fox and Sklar, 2009).

Consensus among researchers on the empirical validity of EMH is, however, rare. Critics, especially from behavioral aspects, point towards anomalies when refuting EMH. Barber and Odean (2001) suggest investors overreact and process information in specific ways in particular instances. Since their collective behavior has a design in certain circumstances (such as bubbles and crisis), therefore, returns are predictable under those conditions which contradict the inferences of 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).

Mediating between the proponents and skeptics of 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 EMH or inefficiency as propagated by champions of behavioral 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 informationally efficient or inefficient. Rather, market efficiency is time-variant and subject to varying market conditions. Several researchers have empirically tested the implications of AMH and found the substantiating evidence. Most of the studies have used conventional financial assets and indices (see, e.g., Urquhart and McGroarty (2016); Noda (2016)). Some have even investigated 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 market efficiency of Islamic stock markets relative to conventional stock markets is mixed. For example, Rejeb and Arfaoui (2019) and Ali et al. (2018) found that Islamic stock markets are more efficient than conventional stock markets. Charles et al. (2017) reported 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) observed from their multifractal detrended fluctuation analysis (MF-DFA) that the Islamic sectoral stock indices exhibited time-varying market efficiency with reduced efficiency after GFC. In addition, Al-Khazali et al. (2014) analyzed the nine Dow Jones Islamic Market indices and their counterparts and reported mixed findings on the efficiency of Islamic stock indices. On the contrary, Uddin et al. (2018) provided evidence indicating that Islamic stocks were more efficient only in the medium term. Similarly, Jawadi et al. (2015) concluded that Islamic stocks were inefficient in both short and long run relative to conventional stocks. Sensoy et al. (2015) also reported that Islamic stock indices were relatively inefficient compared to conventional stock indices.

Though market efficiency in Islamic stock markets has received significant attention from researchers since GFC, most have not used time-varying tests. In addition, AMH has not been tested robustly in Islamic financial markets[3]. For example, Al-Khazali et al. (2016) investigated AMH for Islamic stocks as well as the conventional stocks. However, they used only sub-samples to empirically test the AMH. In addition, Al-Khazali et al. (2016) were unable to directly test return predictability in both Islamic and conventional stock markets using regression analysis. Their study also missed on testing 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 as well as non-linear dependencies in asset returns. We also use a monthly rolling sample window of two years to provide robust evidence on MDH and AMH for Islamic stock indices and their conventional counterparts. Charles et al. (2017) have used similar approach for size and sectoral indices of Islamic (Dow Jones Islamic Market) and conventional (Dow Jones Global) indices. However, their study is found limited in testing the nonlinear autocorrelation structures in stock returns. We use an extended data set of nine Islamic stock indices across different continents (Europe, Asia Pacific), economic status (Developed, Emerging), countries (Japan, UK, US, Canada) as well as global (World) and empirically tests MDH for both linear and non-linear dependencies (autocorrelations).

3 Empirical Methods and Procedures

3.1 Data

Our sample comprises of nine Dow Jones Islamic Market Indices (DJIMIs) and nine conventional stock indices i.e. Morgan Stanley Capital International (MSCI) indices. The indices cover World (Global), Asia Pacific, Developed, Emerging, European, Canadian, U.S., Japanese and UK markets. These indices represent different regions/continents, types of economies as well as 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 Screens. The Shariah screens are of two types; sector-based (e.g. not more than 5% of the revenue cannot come from impure sources such as alcohol) and accounting-based (such as debt to trailing 24 months market capitalization of less than 33%)[4].

For each of the DJMIs (Islamic stock indices) and MSCI indices (conventional stock indices), daily prices (index values) are obtained over January 1996 to June 2020 from Datastream. There are 6392 total daily observations (index values) 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) as well as Charles et al. (2011) and allows accounting for changing market conditions (as well as particular occurrences such as bubbles, crisis and disease outbreaks). In addition, it also 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

[3]There are few studies that have investigated Adaptive market hypothesis in Islamic stock markets relative to conventional markets such as Al-Khazali and Mirzaei (2017).

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

overtime 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 full sample period, the process provides 271 monthly estimates of AQ, AVR and GS tests statistics (measures used to assess return predictability) from December 1997 to June 2020. For each return predictability measure, we plot the respective monthly estimates (test statistics for AVR and AQ tests and p-values for GS test) over the sample period for both Islamic and conventional stock indices.

For empirical analysis of market efficiency in Islamic and conventional stock markets, we calculate the daily natural log returns 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 for 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 Figure 1 and Figure 2 reveal qualitatively similar trends in prices and returns for the Islamic and conventional stock indices respectively. The price and return patterns for the Islamic and conventional stock indices in most cases coincide with the Dotcom bubble bust (1998-2000), the U.S. housing bubble (2005-07), sub-prime mortgage crisis (2007-2009) and the COVID-19 outbreak (2020). These price and return trends for Islamic and conventional stock markets are indicative of variability in market efficiency overtime 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 used 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 is not predictable. 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 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:

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

where $\hat{\rho_i}$ is an estimator (sample autocorrelation) of the population parameter, ρ_i. However, it has two basic

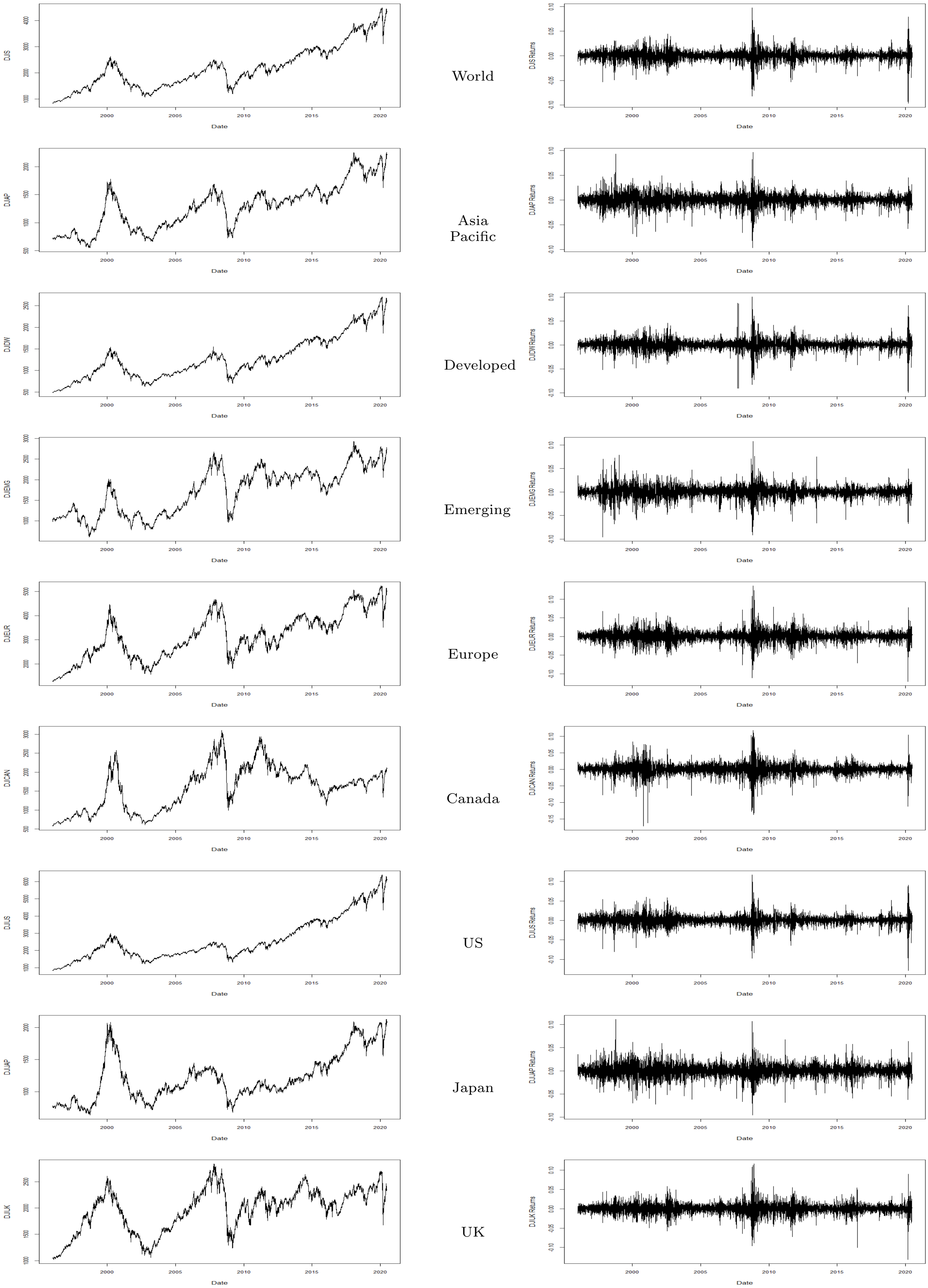


Figure 1: Time plots of the Islamic indices and their log returns.

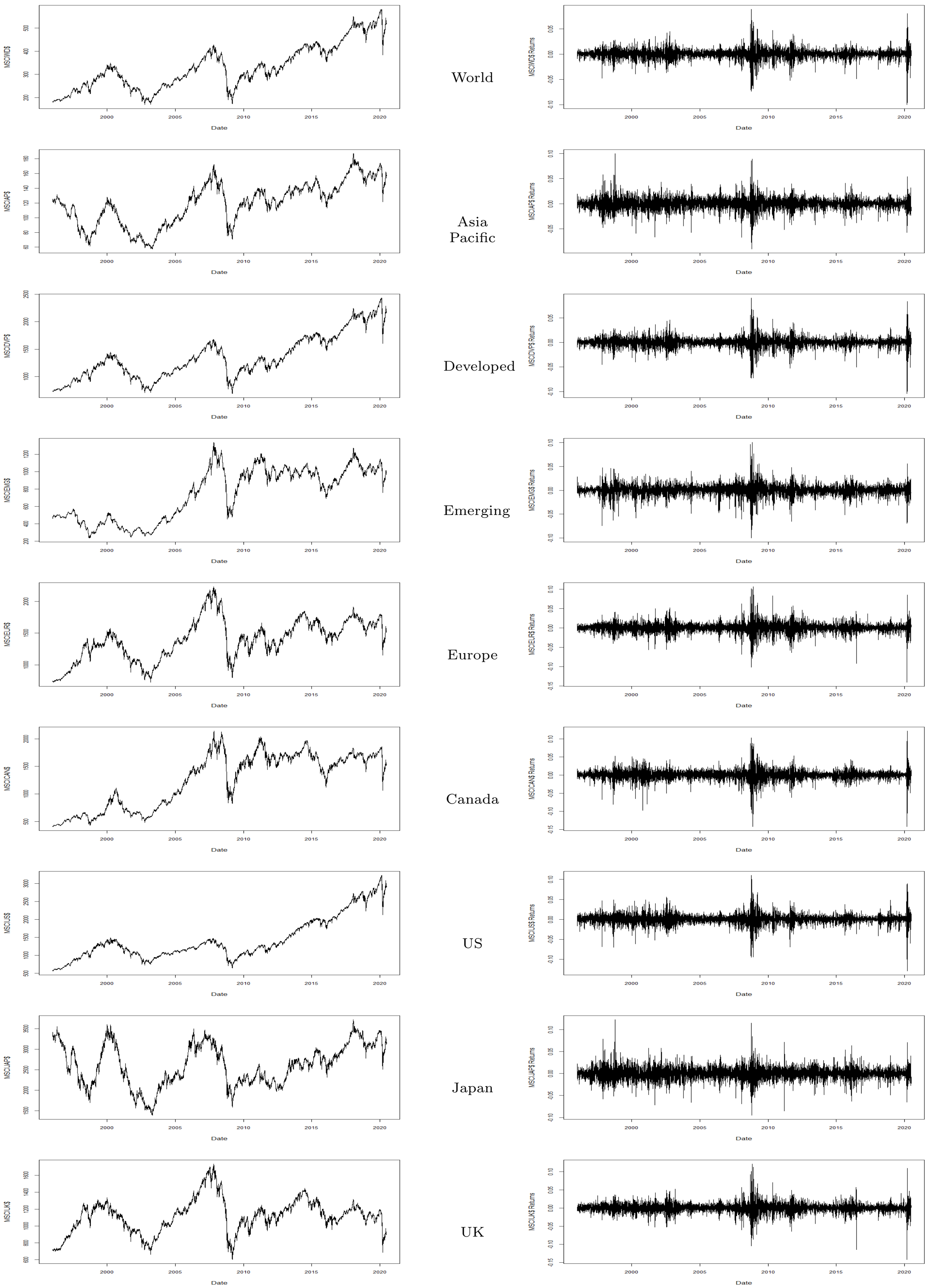


Figure 2: Time plots of the conventional indices and their log returns.

limitations; it requires arbitrary choice of holding period (k) and the serious 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 statistics is estimated as:

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

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 MDH and the AMH overtime. The underlying null hypothesis in the AVR test is that asset (stock) returns are uncorrelated and, therefore, unpredictable (MDH).

3.3 Automatic Portmanteau Test

One of the main limitations of the AVR test is that positive and negative correlations may offset each other and hence result in biased AVR test statistic. The automatic portmanteau test overcomes this limitation 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[5]:

$$Q_p = T\sum_{i=1}^{p}\rho_i^2 \tag{5}$$

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:

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

where $\hat{\rho}_i$ is the sample autocorrelation 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:

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

where $\tilde{\rho}_i^2$ is the ratio of sample auto-covariance of stock return R_t of order i and sample auto-covariance

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

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 that selects the optimal lag length (p) based on all available data. The AQ test is robust to conditional heteroscedasticity and is given as:

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

where $\tilde{\rho}$ denotes the optimal lag order[6]. The AQ test is asymptotic and follows chi-squared distribution with one degree of freedom. The null hypothesis of no return predictability (MDH) is rejected at 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 GS test to capture non-linear dependencies in returns of both Islamic and conventional stock indices.

If Y_t is an 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 alterative hypothesis as $H_1 : Pm - j(r) \neq 0 > 0$ for some $j \geq 1$[7]. 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 autocovariance in a nonlinear time series and x denoting 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,

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

[7] 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.

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:

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

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:

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

where W() is a weighting function. Escanciano and Velasco (2006) derive the GS test statistics using the standard normal distribution as a weighting function[8]:

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

Given that the standard distribution of GS test statistic is not asymptotic, we use wild bootstrapping procedure as suggested by Escanciano and Velasco (2006) to implement the test in our finite samples of Islamic and conventional stock indices (markets). We obtain the p-values of GS test statistics in all cases and provide plots of the same for each market 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 nonlinear autocorrelations that can be exploited by market participants to generate superior returns.

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 over different market conditions (events). Over the sample period, we recognize significant six events (including three infectious diseases) to represent shift in market conditions over time. These include the Dotcom bust (1998:01 - 2000:12), the U.S. 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). We measure each event as dummy variable and use absolute AVR statistics as dependent variable in the regressions for each market in our sample of Islamic and conventional stocks. The advantage of the AVR test statistics over the AQ statistics is that not only it is 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 a 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

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

et al., 2011).

4 Empirical Results and Discussions

4.1 Descriptive Analysis

Table 1 provides the descriptive statistics for daily returns on both Islamic and conventional stock indices in Panel A and Panel B respectively. Descriptive statistics reveal that Islamic stock indices have higher mean returns than the conventional stock indices in all cases except for Canada that has the same average returns. However, Islamic stock indices also have higher standard deviation than 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 for both Islamic and conventional stock indices exhibit statistically significant negative skewness indicating longer left tails. The daily returns of both Islamic and conventional stock indices for Japan do not exhibit statistically significant skewness and hence are symmetrical. We also observe that the time series of daily returns of Islamic and conventional stocks exhibit statistically significant excess skewness that suggest leptokurtic empirical distributions i.e. significant fatter tails than a normal distribution.

We also report the Jarque-Bera (JB) statistic for all the indices that are statistically significant at 1% in all cases and suggest that the daily returns of 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 the presence of strong conditional heteroscedasticity in daily returns of both Islamic and conventional stock indices (Table 1). Our empirical tests described earlier in the methodology section exhibit desirable properties of size and power for samples that are smaller, non-normal and heteroscedastic (Charles et al., 2011).

Table 1: Descriptive Statistics for Daily Returns on Islamic and Conventional Stock Indices

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

4.2 Empirical Results-Return Predictability

Figure 3 shows 18 graphs of the monthly estimates of AVR test statistics over December 1997 to June 2020 for both Islamic and conventional stock indices. The first column provides nine graphs of AVR test statistics for Islamic stock indices (DJ Islamic indices) while the second column contain graphs of their corresponding conventional stock indices (MSCI stock indices). We use the wild bootstrapping approach suggested by Kim (2009) to compute AVR test statistic and the 95% confidence interval in all cases. AVR statistic falling outside its 95% confidence band implies 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 qualitatively reveal similar pattern in the computed AVR test statistics relative to their respective conventional counterparts. Therefore, there are no significant distinct trends in predictability of returns of Islamic stock indices relative to conventional stock indices. The graphs in Figure 3 suggest that return predictability of both Islamic and conventional stock indices vary overtime 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 over 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 depicted in Figure 3. Al-Khazali et al. (2016) reported similar findings for Islamic and conventional stocks indices; however, our empirical evidence is robust from the two years rolling window estimates of AVR test statistics. 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 overtime relates to prevailing market conditions in most of the markets as propagated in the AMH. The graphs of the U.S. 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 in the Developed and Emerging Islamic and conventional stock markets. Similarly, the Asia Pacific Islamic and conventional stock indices are inefficient during COVID-19. Charles et al. (2017) have also reported that both Islamic and conventional sectoral stock indices were predictable in periods over different events and hence supported the AMH. Similar findings were 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 reveal a noticeable pattern. Except for the Asia Pacific and the World indices, all other Islamic indices closely resemble their counterparts in predictability of returns. The U.S. 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 are 7.3% and 7.7% for conventional and Islamic stock indices respectively in the UK. Similarly, for the other five Islamic indices, return predictability closely

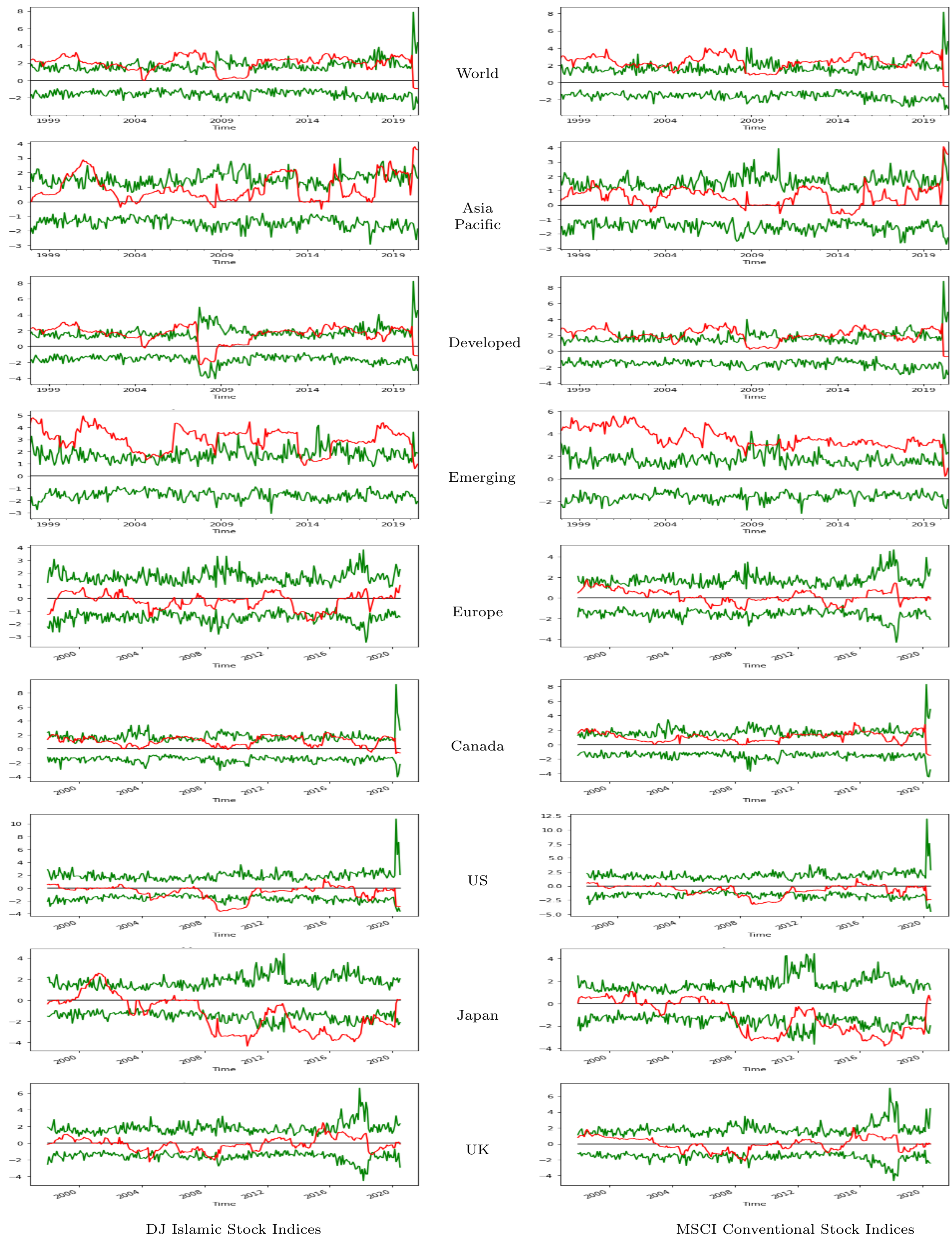


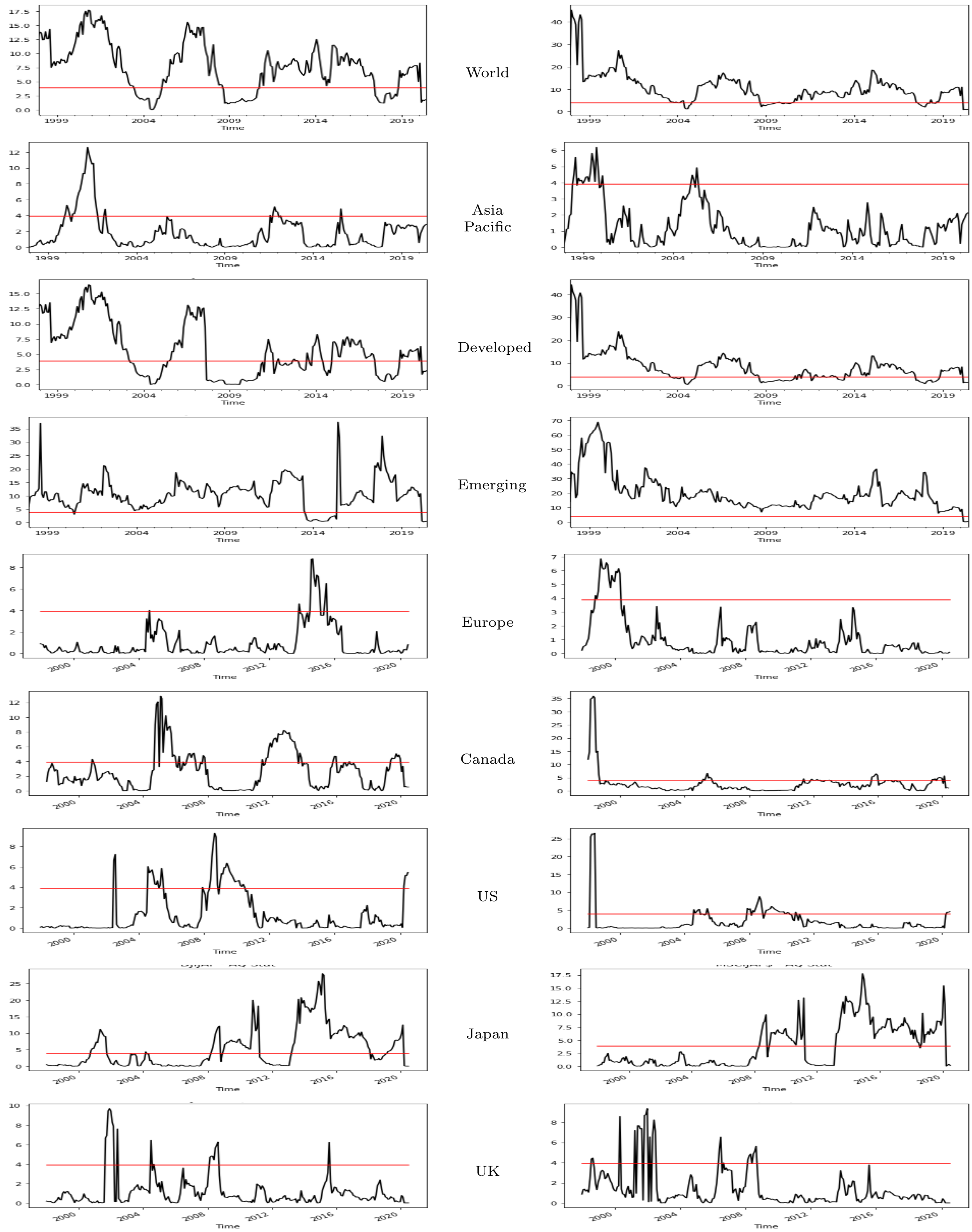
Figure 3: The red lines show AVR (automatic variance ratio) statistics and the green lines represent their associated 95% confidence intervals.

resembles with 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; however, there are 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 is greater than 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 Asia Pacific, Europe and Japan, Islamic stock indices are more efficient than conventional as indicated by the range of the computed AQ test statistics. Charles et al. (2017) reported 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 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 overtime.

Figure 4 suggests time-varying return predictability for both Islamic and conventional stock indices that also relate to changing market conditions consistent with the AMH. For example, all the conventional (except Japanese) stock indices and the World, Developed and Emerging Islamic stock indices exhibit return predictability i.e. are inefficient during the Dotcom bust. The U.S. 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 markets are still the most efficient (least predictable) while the Emerging are the least efficient (most predictable) relative to the other seven markets. These findings are consistent with Al-Khazali et al. (2016) who found the European markets to be the most efficient and the Emerging the least efficient. In addition, El Khamlichi et al. (2014) also reported similar findings for conventional and Islamic stock indices using variance ratio tests as well as unit root tests and co-integration analysis.

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, UK and Asia Pacific. We also note qualitatively similar behavior 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 reported otherwise based on stochastic dominance analysis. Subsequently investors can exploit inefficiencies (attributable to market conditions and/or geographical influences) in stock pricing across Islamic and conventional stocks subject to transaction costs. However, given that the AQ test as well as the AVR test only consider linear autocorrelation, we check the robustness of the AQ and AVR tests using the GS test which accounts for both linear and non-linear autocorrelations.



DJ Islamic Stock Indices

MSCI Conventional Stock Indices

Figure 4: The red lines show AQ (automatic portmanteau) statistics and the black lines represent the critical value of 3.84 at 5% level of significance.

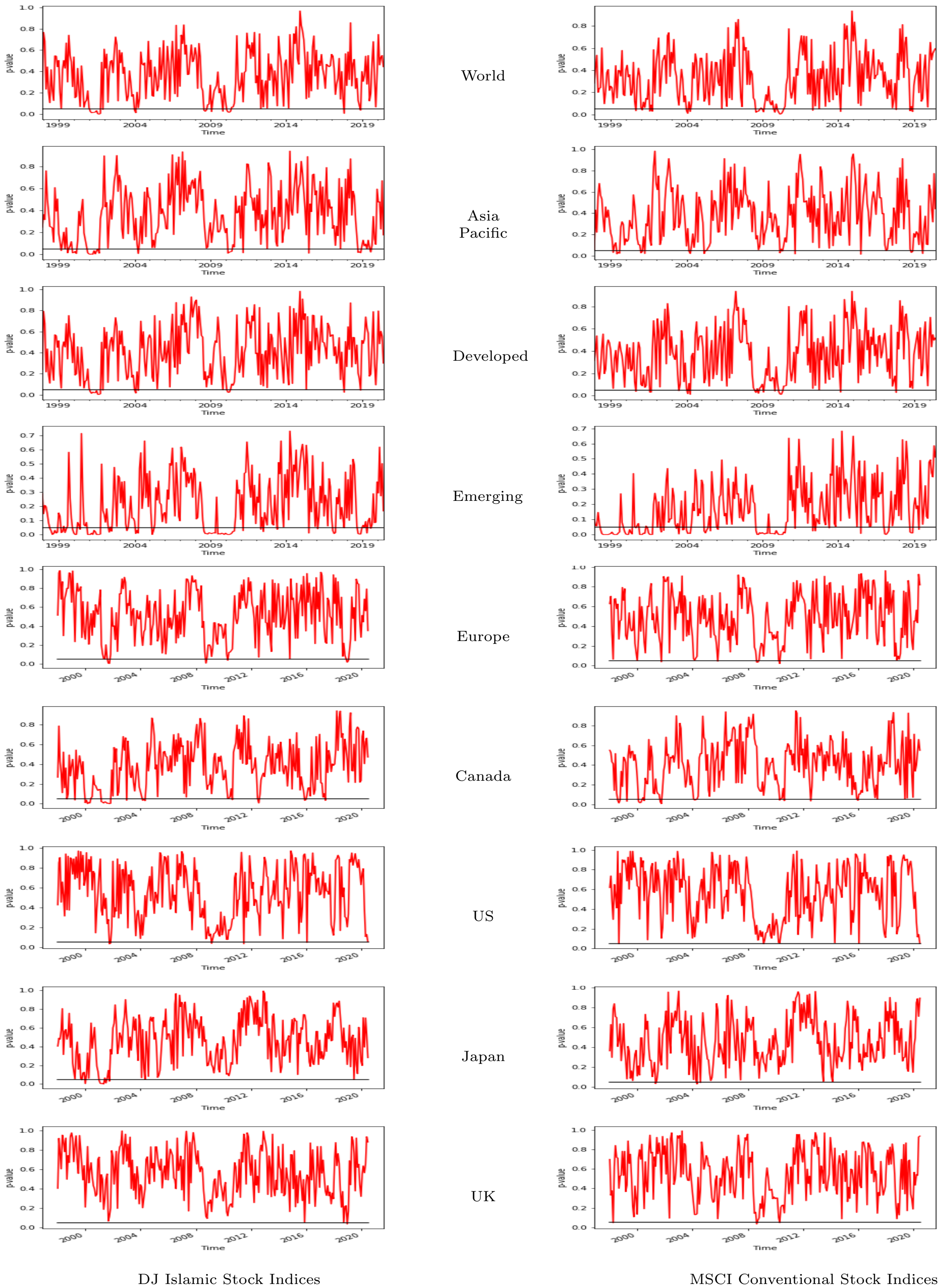


Figure 5: The red lines show P-values (obtained through generalized spectral tests) and the black lines represent 5% level of significance.

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 5 percent level of statistical significance. Actual p-values are depicted in red where p-values below the black line (.05) indicate rejection of 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 a number of times across both Islamic and conventional market indices. There is, however, some variation in return predictability across the different markets. Similar to AVR and AQ test results, we observe that return predictability is the highest in Emerging market followed by the World and Developed Islamic and conventional indices while it is the lowest in Europe, the U.S., 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 suggests that 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 U.S. housing bubble, the sub-prime mortgage crisis as well as infectious diseases i.e. COVID in the case of U.S. market. Relative to AVR and AQ tests statistics reported in Figure 3 and Figure 4 respectively, the results from GS test suggest that markets mostly have been efficient (i.e. failing to reject 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 evaluation of market efficiency overtime. Kim et al. (2011) and Phan Tran Trung and Pham Quang (2019) reported similar findings for the U.S. and Vietnamese conventional stocks respectively. Overall our findings 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 overtime. In addition, the results suggest Islamic and conventional stock indices have similar trends in return predictability that varies overtime 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 U.S. housing bubble, Sub-prime crisis, SARS outbreak, Ebola outbreak, and COVID-19 outbreak. The results from dummy regressions of the absolute AVR statistics and these events are presented in Table 2.

The regression results in Table 2 offer valuable insights from multiple perspectives. First, as observed earlier from AVR test results in Figure 3 Europe, UK and Canadian markets are relatively efficient[9]. In other cases, both Islamic and conventional markets (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 more competitive with 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 U.S.

[9]The coefficients of sub-prime crisis and COVID-19 outbreak dummies are significant at 10 percent for Islamic stocks and the Ebola outbreak for conventional stocks in the Canadian market. The coefficient of Ebola outbreak is significant 10 percent while the Dotcom bubble bust is significant at 5 percent for European Islamic and conventional stock markets respectively.

and Canadian equity markets have remain fragmented (King and Segal, 2003) while the Canadian economy is becoming increasingly more competitive[10]. Further, the Asia Pacific Islamic and conventional stock market returns are predictable over the COVID-19 crisis period only. Return predictability is significantly high and consistent across developed Islamic and conventional stock markets (except for the SARS outbreak). It is not consistent with 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 World, Developed, U.S. and Japanese Islamic and conventional markets (Table 2). However, we find that returns are predicable over the Dotcom bubble bust in Developed, Emerging and European conventional markets and the Developed Islamic markets only. The U.S. accounts for a significant share of the Developed Islamic and conventional indices and this may explain their significance over the Dotcom bubble bust. These findings suggest that Islamic stock markets are not immune (safe haven) against financial crisis such as the sub-prime mortgage and only offer protection in certain regions such as Europe, Emerging and Asia Pacific market (Rejeb and Arfaoui, 2019). As suggested by 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 markets 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 suggest varying levels of return predictability in line with AMH.

Third, we note that among all the events, COVID-19 outbreak has the highest implications for return predictability across Islamic and conventional stock markets with mostly the highest coefficients of all the events (Table 2). The coefficient on the COVID-19 dummy is statistically significant at 5 percent in 11 (five Islamic and six conventional) out of the 18 markets in our sample. Return predictability over the Ebola outbreak is relatively confined mostly to international than country Islamic and conventional stock indices while SARS outbreak is insignificant in all cases. Return predictability over 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 COVID-19 outbreak (relative to SARS and Ebola outbreaks) and the sub-prime mortgage crisis are global events hence have influenced markets worldwide.

Finally, the results in Table 2 suggest geographical variations in return predictability but not across type of market i.e. Islamic and conventional. For example, the sub-prime crisis dummy carries the similar size coefficients of 0.249 and 0.238 for Islamic and conventional U.S. markets respectively. The spillover effect is important and depends on the integration between markets. Given the size of the Japanese economy that is closely integrated with the U.S. 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 predictability as the U.S. stocks account for a significant share of their Islamic and conventional indices[11].

[10] https://www.freshdaily.ca/news/2020/06/canada-more-competitive-economy-us/.
[11] https://www.msci.com/documents/10199/178e6643-6ae6-47b9-82be-e1fc565ededb.

Table 2: Return Predictability and Market Conditions Regression Analysis

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, comparison of the Islamic and conventional indices reveal no substantial differences in return predictability over the six events used as measures of shift in market conditions. For instance, none of the coefficient estimates of the six events is statistically significant at 5 percent for UK and Canadian Islamic and conventional markets (Table 2)[12]. The Asia Pacific market reveal significant return predictability related to COVID-19 event only consistent across Islamic and conventional stock indices. Similarly Emerging market exhibit significant return predictability related to COVID-19 in addition to Dotcom bubble bust. The reported coefficients of the different event dummies for World, Developed, U.S. and Japan show similar pattern of statistical significance across Islamic and conventional stock indices in each case. Thus, the sensitivity of return predictability to a particular event does not appear to be a function of the type of market i.e. Islamic or conventional but varies across geographical regions. This finding is compliant with (Ali et al., 2018) who reported similar findings for Islamic stock markets and argued that Shari'ah compliance laws, good governance and disclosure mechanisms make Islamic stock markets more efficient. Given this, we infer no benefits of investing in Islamic stocks relative to conventional stocks based on type of market. On the contrary, Islamic and conventional markets across different regions may offer more value for investing due geographical segmentation.

5 Conclusions

Islamic finance has received increasing attention overtime and has experienced significant growth over the last two decades. Investment in stocks that conform with Shari'ah principles i.e. Islamic stocks has 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 a mounting and keen interest in investigating Islamic stocks; however, market efficiency is one area where extant literature is inadequate. Particularly, the degree of informational efficiency of Islamic stock indices (markets) overtime has not been put to rigorous empirical tests accounting for linear and non-linear dependencies in returns across different international markets.

We provide robust empirical evidence on return predictability tests of martingale difference hypothesis (MDH) and the AMH overtime 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 overtime 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 generalize spectral (GS) test of Escanciano and Velasco (2006) that have the desired small sample properties and also account for linear and nonlinear autocorrelation while testing for MDH. In addition, we also conduct regression analysis evaluating return predictability of Islamic and conventional stocks over six different events i.e. Dotcom bust, U.S. housing bubble, sub-prime mortgage crisis, SARS outbreak, Ebola outbreak and the COVID-19 outbreak representing shifts in market conditions.

The results from our extensive empirical analysis provide strong evidence of return predictability (rejection of MDH) over different periods for both Islamic and conventional stock indices. We observe that there are

[12] Except the coefficient of Dotcom bubble bust for conventional stock index, none of the coefficients is significant in the European markets.

no significant distinct visible patterns in return predictability between the respective Islamic and conventional stock indices. Further, our results suggest no pattern of decreasing return predictability (increasing market efficiency) or otherwise overtime 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 events representing shifts in market conditions. In particular, return predictability across different Islamic and conventional stock markets is higher during the sub-prime mortgage crisis and the COVID-19 outbreak periods. Relatively, return predictability is lower in the European, UK and Canadian Islamic and conventional markets while it is high in World, Developed and Emerging markets. We conclude that type of market i.e. Islamic or conventional is consequential in determining return predictability, however, it relates to geographic segmentation that provides opportunities to strategize investment in stocks. Our findings suggest the existence of opportunities for the above average returns in different periods across Islamic and conventional stock markets in line with AMH.

As we found no discernible differences in the behavior 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 analyst should be vary of considering Islamic stocks as safe havens. Given that Islamic stocks do not exhibit immunity based on their status, policy makers and regulators should devise strategies and policies that foster protection of all investors (especially small investors) and reduce chances of financial crisis and contagion. In addition, diversification across Islamic and conventional stocks from different regions (geographical locations) may be more valuable relative to same market diversification. Improved governance, compliance and detailed disclosures in addition to the technological developments in data sciences are of particular importance with respect to the relative market efficiency of Islamic stocks and conventional stocks.

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.

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.

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.

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.

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.

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.

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

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.

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.

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

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.

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.

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*, 362(3061):1–75.

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

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*.

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.

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.