The Volatility and Risk-Return Trade-Off of Malaysian Islamic and Conventional Indexes During the Global Financial Crisis and COVID-19 Pandemic

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ABSTRACT

Manuscript type: Research paper
Research aims: This study aims to investigate the volatility characteristics and risk-return trade-off of Islamic and conventional indexes in the Malaysian market.
Design/Methodology/Approach: The research covers the daily data of the period from August 2007 to December 2022, divided into four distinct periods: the full sample, the period during and after the 2007-08 financial crisis, and the period during the COVID-19 pandemic. The research employs a hybrid model that combines ARIMA with GARCH family models.
Research findings: In this research, both Islamic and conventional indexes in the Malaysian market demonstrate a memory effect, emphasising the persistence of market volatility through the influence of past volatility. Additionally, historical data, represented by lagged values, significantly shape volatility, while negative shocks have an immediate

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https://doi.org/10.22452/ajba.vol16no2.1

and pronounced impact compared to positive shocks, providing valuable insights for investors and risk management. Lastly, during the COVID-19 crisis, the conventional index showed no leverage effect, and the Islamic index lacked safe haven characteristics, making this crisis unique in the Malaysian financial context.
Theoretical contribution/Originality: This research contributes to the understanding of market volatility dynamics in the Malaysian context by utilising a hybrid ARIMA-GARCH model. The identification of memory effects, asymmetric responses, and the unique characteristics observed during the COVID-19 crisis adds to the body of knowledge on financial market behaviour.
Practitioner/Policy implication: The findings of this study have practical implications for investors and supervisory entities operating in the Malaysian market. Understanding the persistence of volatility and the differential impact of positive and negative shocks can help investors make more informed decisions, while regulators can use this information to quantify and manage market volatility effectively.
Research limitation/Implications: The limitation of the present study is that the results may be influenced by the selection of the sample period, potentially yielding different outcomes depending on market conditions, such as the presence of bull or bear markets, periods of high or low volatility, or other contextual factors.

Keywords: Islamic Index, GARCH Family Models, Risk-Return Trade-Off, Asymmetric Volatility, Market Efficiency
JEL Classification: G01

1. Introduction

The conventional and Islamic financial markets have experienced an unprecedented Coronavirus pandemic (COVID-19), which causes real economic shrinkage, alters peoples' livelihoods, increases global co-movements, and escalates market disturbances. It was reported that the US market's circuit-breakers were triggered four times in March 2020, and the global markets experienced heightened volatility during the predicament periods (Contessi & De Pace, 2021). Although COVID-19 began as a health crisis, it quickly developed into a financial and economic calamity comparable to the global financial crisis (GFC) in 2008 (Goodell, 2020). In response, countries implemented urgent monetary and fiscal stimulus packages, including mandatory lockdowns and social isolation policies (Baig et al., 2021). The importance of the Islamic index as a safe haven gained attention during the crisis and thus it requires a complete understanding of volatility characteristics and risk-return trade-off of Islamic and conventional indexes.

Interestingly, assets in Islamic finance have grown significantly during the past few decades. The Islamic Finance Development Report in 2022 reported that the total value of assets related to Islamic finance reached US$4.00 trillion in 2021 and is projected to achieve US$5.90 trillion at the end of 2026 (Islamic Financial Services Board, 2022). It is worth mentioning that Islamic finance has gained popularity among non-Muslim investors and has become a key instrument for portfolio diversification. Instruments of Islamic finance adhere to Islamic law or Shariah, which has a set of moral and monetary restraints because these instruments are founded on the mechanism of Shariah screening, including profit and loss sharing. Shariah laws govern Islamic assets, which forbid pursuits of gambling, interest-bearing, and risky business dealings including speculation, short-selling, and arbitration (Alahouel & Loukil, 2021; Bhutto et al., 2021; Kamaludin & Zakaria, 2019; Sundarasen et al., 2022). For the reason that interest is prohibited, non-existence of risk transfer, and the notion of profit and risk sharing in which the Shariah assets were constructed, it is predicted that Islamic financial products could, in theory, withstand financial crises better (Hasan, et al., 2021).

The present study finds that the results of the previous studies are largely inconclusive about the dynamics of Islamic and conventional indexes. On the one hand, more recent empirical investigations corroborate the decoupling hypothesis, concluding that Shariah instruments could act as a safe haven in times of crisis (Alahouel & Loukil, 2021; Alqaralleh & Abuhowmmous, 2021; Haroon et al., 2021; Mandaci & Cagli, 2021; Shahzad & Naifar, 2022). On the other hand, other studies contradict the decoupling hypothesis, showing evidence that Shariah assets were unable to possess the characteristics of safe havens during times of distress (Anas et al., 2020; Bugan et al., 2022; Hassan et al., 2020). The urgent desire for assets that display safe haven properties has augmented due to COVID-19's widespread effects, and it is comparable to the GFC (Goodell, 2020). The investors suffered huge losses simply because of a lack of adequate understanding of the behaviour of safe haven assets (Yarovaya et al., 2020). Recent studies, including those by Hasan et al. (2021) and Yarovaya et al. (2021), evaluate the resilience of various assets with safe haven properties. The authors reveal that traditional instruments are unable to serve as safe havens during the COVID-19 pandemic. In contrast, these assets are known to be effective throughout the GFC period. Their results support the claim that economic contagion originating from the COVID-19 pandemic is distinctive from those brought on by either the Great Depression, GFC, or any other previous infectious pandemics (Contessi & De Pace, 2021). The equity markets' responses to safe havens may differ as a result of the fact that the fundamental causes of the previous crises and the COVID-19 pandemic are dissimilar (Disli et al., 2021). To the best of our knowledge, the GFC was essentially a financial catastrophe brought on by elements such as irresponsible lending practices, over-leveraging of subprime mortgage instruments, derivatives, inadequate risk management, and accounting fraud. The COVID-19 pandemic, however, started as a health crisis and swiftly developed into a significant economic disaster because of lockdowns, supply chain disruptions, and a decrease in consumer activities. The discrepancies in results could also be due to investors' behaviours, such as emotion, sentiment, and expectations, including market conditions and government policy that may have held during one crisis but may not hold in another. Islamic finance was less affected by the GFC because many practices are not permitted under Shariah laws (Hassan et al., 2020). Hence, the COVID-19 pandemic is presumed to have less impact on Islamic assets, which may provide investors with some protection during the crisis. Nevertheless, the dramatic economic alterations caused by the COVID-19 pandemic have prompted concerns about the sustainability of Shariah assets. In another note, the choice of approaches, models, and data sources may differ from one study to another, hence influencing the results and conclusions drawn from the existing findings in the literature. As a result, assessing the financial market's reaction to this unique COVID-19 exogenous crisis and comparing it to the GFC is crucial.

In this context, this study seeks to investigate and compare the volatility behaviours, risk-return trade-offs, asymmetric volatility, and market efficiency of the Islamic equity index and its conventional counterpart during the GFC, post-GFC, and during the COVID-19 pandemic by using symmetrical and asymmetrical Generalised Autoregressive Conditional Heteroskedasticity (GARCH) models. To examine the influence of GFC and COVID-19, the entire sample is classified into three subperiods. First, the traditional methodologies are employed to determine the appropriate AutoRegressive Integrated Moving Average (ARIMA), and thence the ARIMA-GARCH family models for each subperiod. Second, every ARIMA-GARCH family model is analysed to capture the conventional equity market's volatility behaviours versus the Islamic equity market for every subperiods. Third, the best ARIMA-GARCH family model is documented for the respective conventional and Islamic equity indexes. The analysis provides evidence of both the GFC and COVID-19 pandemic impacting inversely the returns of both conventional and Islamic equities. As expected, during the GFC and post-GFC periods, the Islamic index performs better than its conventional peers, despite a lower coefficient of variation value. On the contrary, the conventional equity index performed better than its Islamic counterpart during COVID-19. This implies that the Islamic index reacts differently to the COVID-19 pandemic compared to the GFC, making the COVID-19 pandemic a unique circumstance. The authors find that the Islamic equity index is closely connected to the conventional equity index, implying that the Islamic index may not be able to provide safe haven properties during the pandemic. It is further supported by the fact that the Islamic index has a higher volatility persistency, hence making it riskier compared to its conventional counterpart during the COVID-19 period.

We also found that both the Islamic and conventional indexes in Malaysia demonstrate weak-form efficient market behaviour with positive risk-return associations in the conventional equity index and Islamic equity index in the full sample period, including the Islamic equity index in the post-GFC period. The leverage effect shows that negative news causes the volatility of both indexes' returns to escalate more. Given that volatility is a risk signal, it is implied that investors did not view the Islamic index as a safe haven or a mature asset. Interestingly, the KLCI conventional index is perceived as a safe haven during the COVID-19 period, hence expanding the extant evidence in this field of research. To the best of the authors' knowledge, the present study provides comprehensive results by investigating the volatility, market efficiency, and risk-return trade-offs of Islamic vs. conventional equity markets during COVID-19, including comparing them to the preceding GFC era. Notably, the findings assist government regulators, investors, and policymakers in protecting their interests and determining the best strategy in reaction to crises. The structure of the study is as follows: Section two addresses the works of literature in the field of study, followed by the presentation of data and methodology. Section four covers the analysis of findings, while section five presents the concluding remarks.

2. Related Literature Review

There are two main theoretical arguments regarding volatility and risk-return trade-off between Islamic and conventional stock markets namely decoupling and contagion theories. Both theories assist the researchers in addressing the following questions: (1) Are Islamic financial markets "safe havens" for investors? and (2) Do Islamic instruments provide diversification benefits to conventional investors? These arguments are predominant against the backdrop of several periodic crises in the global financial markets due to financial shocks, most recently, COVID-19. The notions of decoupling and contagion are crucial to the relevance of these arguments in tandem with the main research questions of this study. Both theories assist the researchers in understanding the global financial market's volatility behaviour, risk and return trade-off, and asymmetric volatility, including market efficiency. On one hand, analysing the decoupling theory helps assess whether the Islamic equity indices behave differently from their conventional counterparts during the crisis periods. On the other hand, contagion theory hypothetically claims that financial crises can cause adverse shocks to spread to previously protected markets and asset classes. It is possible to ascertain whether contagion effects existed during the crises period by considering the two notions. Incorporating both into the analysis allows the researchers to gain a more comprehensive picture of how Islamic and conventional equities markets react to major changes in the world economy. It also clarifies if these markets behave in a way that is compatible with theoretical predictions or displays certain traits at different times of crisis.

2.1 Evidence for Decoupling theory

Evidence has shown that recent research has emphasised the influence of the COVID-19 pandemic on volatility and risk-return trade-off in equity markets (Aloui et al., 2022; Balli et al., 2022; Hasan et al., 2021; Hasan et al., 2022; Mzoughi et al., 2022). Extant evidence in the strand of literature supports the decoupling theory, which hypothetically views Islamic financial instruments can providing risk-hedging benefits for investors in the conventional financial market. A more recent study by Shahzad and Naifar (2022), revealed that Islamic stocks may satisfy investors' risk tolerance during financial crises, indicating the significance of these stocks as alternative investment vehicles to conventional ones. This implies that Shariah-compliant stocks are gaining considerable proportions in international portfolio diversification, hedging and 'safe haven' benefits (Bossman, 2021; Bossman et al., 2022; Ng et al., 2020) owing to investors shying away from conventional markets during turbulent periods. These findings thus provide evidence that decoupling exists between Islamic and conventional financial markets. Likewise, a study by Adekoya et al. (2022) indicates a strong integration and a high spillover status between the Islamic index and conventional index from January 1 2020 to 30 November 2020 in nine different sectors in the US, China, Nigeria, and Saudi Arabia. They also discovered that Islamic indexes generally are more immune to shocks, stable, and have less exposure to risks compared to conventional indexes. Karim et al. (2022) discovered that the returns for Islamic instruments are less vulnerable to market panic than their counterparts in conventional instruments. This might be attributed to the unique screening that provides the Islamic index being more decoupled than the conventional index. In contrast, Bugan et al. (2022) argue that the Islamic index provides limited diversification benefits during the COVID-19 period, thus limiting the safe haven benefits during turbulent periods. Similarly, studies by Hassan et al. (2020), Hasan et al. (2021) and Jawadi et al. (2021) suggested that Islamic markets and conventional counterparts comove strongly; and the movements are strongly associated during the COVID-19 period. The findings are inconsistent with the notion of the decoupling hypothesis, implying that Shariah screening procedures are inadequate to provide a safe haven characteristic to Islamic assets during the turbulent period.

2.2 Evidence for Contagion Theory

The fundamental understanding of the contagion hypothesis assists the financial communities in evaluating the diversification benefits by including Islamic financial assets in their portfolios. Balli et al. (2019) found rising interactions in returns and volatility spillovers across 15 Islamic equities between 2007 and 2017, concluding that the magnitude of spillovers is asymmetric between the Islamic and conventional markets. Furthermore, in times of crisis, the cumulative spillovers across Islamic markets become more concentrated. Haddad et al. (2020) employ permanent-transitory (P-T) decompositions to investigate the importance of permanent versus transitory shocks to explain the nature of fluctuations in the business cycle of the Dow Jones Islamic stock market (DJIM), namely the US, UK, Canada, Europe, Asia-Pacific, Japan and GCC during the period spanning from April 2003 until November 2018. The authors found that the DJIM US, UK, Europe and GCC indices are more sensitive to both domestic and international shocks; while the DJIM Canada, Asia-Pacific and Japan are more inclined to domestic shocks. During the crisis periods, the spillover volatility is mostly transmitted by the DJIM US and received by the DJIM GCC. In another study, Haroon et al. (2021) concluded that Islamic equities have lower systematic risks during the COVID-19 period, which could provide diversification benefits. One of the possible reasons for lower systematic risk could be the Shariah screening procedures that emphasise a lower level of debt. Similarly, Owusu Junior & Owusu (2022) contends that based on the competitive markets' hypothesis, spillovers and information flow between assets/or asset classes increased during crises, such as the Covid-19 pandemic partly because of the relentless search by rational and irrational market participants to minimise the risks and maximise the returns. These efforts resulted in the unruly trading of assets, causing unexpected non-fundamental connectedness between the assets or asset classes (Bossman, 2021; Bossman et al., 2022).

2.3 Evidence Using GARCH Family Models

Extant studies in the strand of literature employed the Generalized Auto-Regressive Conditionally Heteroscedastic (GARCH) and its family models to construct a volatility framework in finance and economics. The GARCH and family models proved their effectiveness in capturing volatility clustering, persistence, and asymmetric effects (see Abduh, 2020; Hossain et al. 2021; Yong et al. 2021; Akinlaso et al., 2021; Danila et al., 2021; Arashi & Rounghi, 2022; and Kaur & Singla, 2022). Abduh (2020) compared the volatility of Islamic and conventional equity indexes using the GARCH (1,1) model in Malaysia between 2008 to 2014. The results demonstrate that the Islamic index is less volatile than its counterpart during the GFC due to a higher weightage of defensive stocks and a lack of conventional financial institution stocks. In Tunisia, Akinlaso et al. (2021) found a negative but significant risk-return trade-off relationship in the conventional index. Nevertheless, they could not find a similar relationship in the Islamic index using symmetric and asymmetric GARCH models. The authors claimed that there is a positive leverage effect in the Islamic index, while a negative leverage effect in the conventional index. Hossain et al. (2021) employed various GARCH family models for pre-, during- and post-GFC using Bangladesh stock indexes. The results show that the EGARCH model is the best construct in the three periods using information criteria, while GARCH-M in the during- and post-crisis using minimum error. The findings also reveal the existence of volatility persistence and leverage effect on returns. In a similar vein, Yong et al. (2021) supported the presence of the leverage effect in the equity markets of Singapore and Malaysia, however, the authors found that the risk-return trade-off is not available in both countries. Using GJR-GARCH, Danila et al. (2021) extended the sample into other ASEAN countries, and they found the presence of volatility clustering in ASEAN countries. The authors further found that leveraged effects exist in Malaysia, Singapore, and Thailand. In the Indian market alone, Kaur & Singla (2022) employed GARCH, EGARCH, and TGARCH for the country's equity market and concluded that the ARIMA-EGARCH model is the best in forecasting volatility. The authors also claimed that the persistency and leverage effects are both present in Indian markets. In another study, Arashi & Rounaghi (2022) investigated the market efficiency of the NASDAQ stock exchange using the ARMA-GARCH model, and they contended that NASDAQ is an efficient market and hence consistent with the strong form market efficiency.

3. Data and Methodology

To meet the objectives of this study, data for both Islamic and conventional equity indexes were gathered from Bursa Malaysia. One of the grounds for selecting Malaysia is the country's initiative to establish an Islamic financial system in the global market, with Malaysia ranked top in the overall ranking of the Islamic Finance Development Indicator (IFDI) for the tenth consecutive year (ICD-Refinitiv, 2022). Furthermore, in Malaysia, a conventional system coexists alongside an Islamic system, allowing researchers to further compare. The conventional FTSE Bursa Malaysia KLCI Index (KLCI) and the Islamic FTSE Bursa Malaysia Hijrah Shariah Index (HJS) were employed in this study. The daily data was obtained from Thomson Reuters DataStream between August 1, 2007, and December 30, 2022. To provide comprehensive results, the data is further subdivided into three subperiods. To begin, the entire sample is examined to determine the overall risk for both indexes as well as to obtain insight into market reactions across the entire period. Then, a subsample for the during-GFC period is selected, which spanned August 1, 2007, to July 31, 2009. The sub-sample period from August 1, 2009, to February 21, 2020, is then analysed for the study of the post-GFC. Finally, the period of during-COVID-19 is defined as February 22, 2020, to December 30, 2022, to capture pandemic shocks.

3.1 Data analysis

Following the data-cleaning process, the index price is transformed into a daily logarithmic return as follows:

$$r_t = \ln(\frac{P_t}{P_{t-1}})$$

In this study, log returns were used over raw prices because log returns are normally distributed and may offer a more precise prediction of the variable. Meanwhile, raw prices cannot fall below zero and, as a result, are not represented by a normal distribution. Additionally, log returns can be compounded over time to provide cumulative returns.

3.2 Econometric model

3.2.1 ARIMA model

ARIMA model was proposed in the 1970s by George Box and Gwilym Jenkins (Liu et al., 2011) and is commonly employed to measure the relationship between the previous observational data value (autoregressive (AR) terms) and the previous random error terms (a moving average (MA) terms) linearly. ARIMA analysis requires time series to be stationary with the assumption of homoskedasticity (constant variance). Hence, successive transformation is required to be employed on non-stationary data.

The model of ARIMA(p,d,q)

$$\emptyset_p(W)(1-W)^d(y_t-\vartheta) = \theta_0 + \theta_q(W)a_t$$

where

W = backward shift operator
Y_t = observed value at time t
ϑ = mean
a_t = random error at time t
$\emptyset_p (W) = 1-\sum_{i=1}^{p}\emptyset_i W^i$ = polynomial in terms of W of degree p
$\theta_q (W) = 1-\sum_{j=1}^{q}\theta_j W^j$ = polynomial in terms of W of degree q
$\emptyset_1, \emptyset_2, \ldots, \emptyset_p$ = autoregressive parameters
$\theta_1, \theta_2, \ldots, \theta_q$ = moving average parameters
d = order of differencing

In ARIMA, random errors are presumed to be independent and identically distributed (iid) across time. To establish the right order of the polynomials, the study employs the autocorrelation function (ACF) and partial autocorrelation function (PACF). The competing ARIMA model is chosen based on the lowest AIC (Akaike information criterion), SIC (Schwarz information criterion), and HQC (Hannan-Quinn information criterion). Due to the presence of heteroskedasticity and volatility clustering, most financial time series data do not comply with ARIMA assumptions. Volatility clustering arises when the returns of a financial time series are tremendously volatile during booms and busts, and it can have an impact on the statistical validity of ARIMA. Therefore, to acquire more precise findings in volatility modelling, researchers employed GARCH and its family models in their studies. Not only are GARCH and its family models ideal for rectifying heteroskedasticity issues, but they are excellent for solving volatility clustering problems as well. This is the reason why the study examines and contrasts the ARIMA model, the hybrid ARIMA-Symmetric-GARCH (ARIMA-SGARCH), the ARIMA-Symmetric-GARCH-Mean (ARIMA-SGARCH-M), the ARIMA-Asymmetric-EGARCH (ARIMA-EGARCH), and the ARIMA-Asymmetric-TGARCH (ARIMA-TGARCH).

3.2.2 ARIMA-SGARCH Hybrid Model

ARIMA-SGARCH's hybrid modeling process is separated into two components. The first component addresses the linearity of time series by fitting the ARIMA model for stationary. Following the completion of the previous component, the next component fits the SGARCH model by solving the non-linearity of the residuals. As a result, the SGARCH(r,s) model, with r as GARCH terms' order and s as ARCH terms' order.

The SGARCH (r, s) model's conditional heteroskedasticity equation (Bollerslev, 1986):

$$\Delta^d \sigma_t^2 = \mu_0 + \sum_{i=1} \alpha_i \, \Delta^d \varepsilon_{t-1}^2 + \sum_{j=1} \beta_j \, \Delta^d \sigma_{t-1}^2$$

where $\Delta^d \sigma_t^2$ is the d-order differentiated conditional variance forecast; μ_0 is the constant variance; a_i is the autoregressive coefficient; $\Delta^d \varepsilon_{t-1}^2$ is the d order differentiated previous period forecasting errors; β_j is the first moving average coefficient; $\Delta^d \sigma^2_{t-1}$ is the order differentiated by previous conditional variance forecast.

3.2.3 ARIMA-SGARCH-M Hybrid Model

After fitting the best ARIMA model, the study proceeds with the fitting of the SGARCH-Mean hybrid model (Engle et al., 1987):

$$\mu_{kt} = E(Y_t \mid I_{t-1}) = c + \delta\, \vartheta_t + Y_{kt-1}$$

where μ_{kt} denotes the expected return of k market at time t; δ denotes the slope parameter of conditional variance at t; ϑ_t denoted the conditional variance at t and $Y_{kt\text{-}1}$ is the return of k market at time t-1. The SGARCH-Mean hybrid model incorporates the volatility into the mean, with δ known as a risk-return trade-off or risk premium. When the coefficient of δ is positive and statistically significant, it implies that an increase in risks results in an increase in the mean return.

3.2.4 ARIMA-Asymmetric-EGARCH Hybrid Model

The EGARCH is a model by Nelson (1991), that addresses the non-negativity constraints which exist in the SGARCH model. After the first component of fitting ARIMA, the fitting of Asymmetric EGARCH is as follows:

$$\ln(\vartheta_t) = \omega_0 + \omega_1 \left(\frac{\varepsilon_{t-1}}{\vartheta^{0.5}_{t-1}}\right) + \gamma_1 \left|\frac{\varepsilon_{t-1}}{\vartheta^{0.5}_{t-1}}\right| + \omega_2 \ln(\mu_{t-1})$$

The natural logarithm is employed in the EGARCH model to address the non-negativity constraint. ω_0, ω_1, ω_2 and γ_1 are constant parameters. When γ parameter is negative and significant, the leverage effect exists, whereby a negative shock will cause greater volatility than a positive shock of the same size.

3.2.5 ARIMA-Asymmetric-TGARCH Hybrid Model

Zakoian's (1994) threshold of GARCH or TGARCH model incorporates asymmetry by allowing conditional variance to respond dissimilarly to the positive and negative innovations. After completing the first component above, the fitting of Asymmetric-TGARCH is as follows:

$$\Delta^d \sigma_t^2 = \mu_0 + \sum_{i=1}^{r} \alpha_i \, \Delta^d \varepsilon_{t-i}^2 + \sum_{j=1}^{s} \beta_j \, \Delta^d \sigma_{t-i}^2 + \sum_{k=1}^{r} \gamma_k \, \varepsilon_{t-k}^2 v_{t-k}$$

α_i, β_j and γ_k are constant parameters. When γ parameter is positive and significant, the leverage effect exists, whereby negative news could cause greater volatility than positive news of the same size. The TGARCH is a version of the GJR-GARCH model by Glosten et al. (1993).

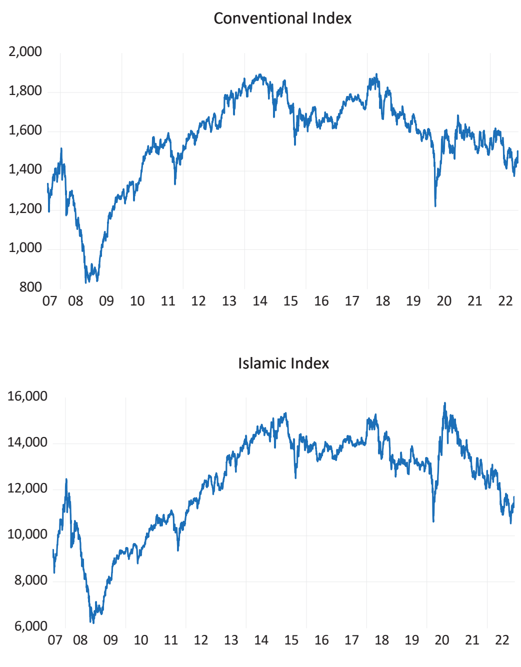
4. Results and Discussion

4.1 Descriptive statistics

From August 1st, 2007 to December 30th, 2022, there were 4,001 daily observations of the Islamic index and conventional index respectively. Negative mean returns were observed during the GFC and COVID-19 periods, indicating investors experienced more losses than gains during these two periods. On the contrary, the conventional and Islamic indexes' mean returns are positive in the post-GFC period. The standard deviation depicts the daily return swings for both indexes, with the Islamic index consistently producing larger values than its counterpart. When comparing the periods of during-GFC and during-COVID-19 to the entire period and the post-GFC period, the mean returns of both indexes are negative with significant departure from mean returns. It demonstrates the wildness of equity market returns volatility amid the GFC and the viral pandemic. In addition, an extreme kurtosis value is detected in both samples, which exceeds the normal value of 3. The excess kurtosis suggests a significant likelihood of extreme points occurring for both conventional and Islamic indexes, which also indicating that both indexes are fat-tailed (leptokurtic).

Both Islamic and conventional indexes have skewness coefficients that are different from 0. The result highlights that asymmetry is present, which is possibly a sign of nonlinearity. According to the analysis, it is found that only the Islamic index showed a positively skewed value during the COVID-19 period. The study suggests that investors can expect to make significant returns that could compensate for their small losses. In contrast, for other periods, investors may only expect minor returns, however, might face the possibility of significant losses. The statistical significance of the Jarque-Bera statistic for all indexes is observed, which is a normal characteristic of financial series, suggesting that the distributions of logarithmic returns of Islamic and conventional indexes do not follow a normal distribution. Henceforth, the results of descriptive statistics summarised that the KLCI conventional index and the HJS Islamic index follow an asymmetric distribution. The present study observes the volatility clustering phenomenon, in which strong variations are typically followed by strong variations, and small variations are typically followed by little variations (see Figure 2 for the daily returns of both indexes). This phenomenon exists due to the correlations between financial data. The present work notices ARCH test results demonstrate a higher moment of return distribution, continuing to exhibit temporal dependencies in every situation. According to the descriptive statistics for the four different periods, the time series data are leptokurtic, extremely volatile, fat-tailed, and erratically distributed. The outcomes, thus, justify the use of the GARCH family models to analyse both equity indexes' volatility at different points in time: during the GFC, post-GFC, and during the COVID-19 period.

Figure 1: The Market Trends of the KLCI and HJS



Source: Authors' calculation

Table 1: Descriptive Statistics Comparing the Various Time Periods

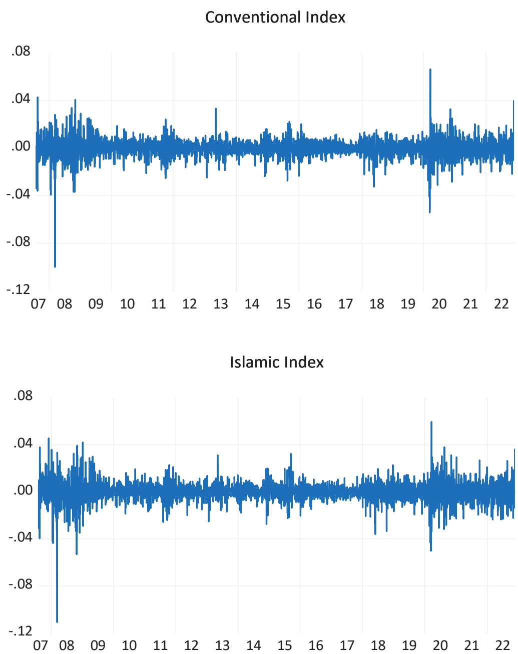
	Full Sample Period		During the GFC		Post-GFC		During COVID-19	
Statistics	**Conventional**	**Islamic**	**Conventional**	**Islamic**	**Conventional**	**Islamic**	**Conventional**	**Islamic**
Mean	0.0026	0.0055	-0.0251	-0.0120	0.0096	0.0138	-0.0039	-0.0137
Median	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Standard deviation	0.0074	0.0081	0.0119	0.0133	0.0055	0.0058	0.0092	0.0103
Skewness	-0.7688	-0.7536	-1.1339	-1.1361	-0.3779	-0.2574	-0.0326	0.0288
Kurtosis	17.0881	16.6729	12.9473	12.8768	5.9636	6.4124	10.0831	6.3479
Maximum	0.0663	0.0594	0.0426	0.0454	0.0332	0.0323	0.0663	0.0594
Minimum	-0.0998	-0.1109	-0.0998	-0.1109	-0.0324	-0.0360	-0.0540	-0.0502
CV	2.7947	1.4813	-0.4732	-1.1113	0.5704	0.4185	-2.3765	-0.7493
Jarque-Bera	33473.24 **	31536.62 **	2263.97 **	2234.04 **	1073.80 **	1367.09 **	1511.51 **	337.76 **
ADF statistics	-59.6475 **	-59.6843 **	-20.7417 **	-20.6203 **	-48.2194 **	-48.4906 **	-27.4033 **	-27.3899 **
PP statistics	-59.8457 **	59.7028 **	-20.8363 **	-20.6356 **	48.1328 **	-48.4346 **	-27.4940 **	-27.3068 **
ARCH-LM (Chi^3)	203.1145 **	154.5323 **	14.9391 **	12.1636 **	159.4419 **	114.8015 **	58.5469 **	23.4427 **
ARCH effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4000	4000	522	522	2755	2755	723	723

Notes: Author's calculation. **, * indicates significance at 1%, 5% respectively. Mean represents mean returns in %. ADF statistics represent the Augmented Dickey and Fuller test for stationarity. PP statistics represent the Phillips and Perron test of stationarity. ARCH effect represents the ARCH test for the presence of heteroskedasticity and autocorrelation in data series. The full sample period is from 1 August 2007 to 30 December 2022. The GFC period is from 1 August 2007 to 31 July 2009. Post-GFC refers to the time period from 1 August 2009 to 21 February 2020. The COVID-19 period is from 22 February 2020 to 30 December 2022.

4.2 *Selection of an appropriate model for the full period*

The trend of both equity indexes for the full sample is shown in Figure 1. The Islamic equity index has been found to move in a quite similar manner to its conventional equivalent. The ACF plot is discovered to be linearly tailing off exceptionally slowly, showing a trend and non-stationarity in the series. Hence, a differencing method using a logarithmic function is required to solve this situation.

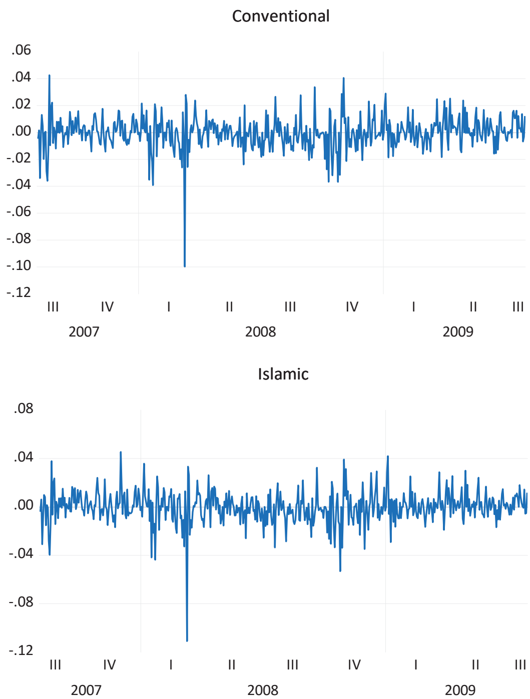
Figure 2: Logarithmic Returns: Full Sample Period



Source: Authors' calculations

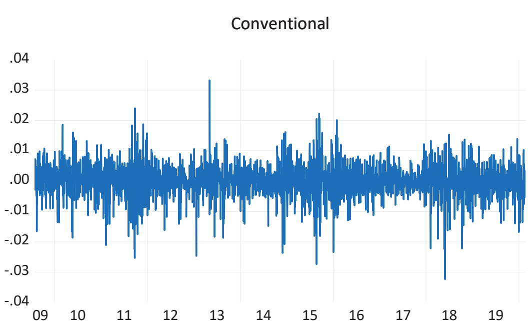
Daily logarithmic returns appear to be stable in Figure 2 around a constant, with oscillations around the mean taking on both positive and negative values. The GFC and the COVID-19 pandemic produce enormous effects on Islamic and conventional indexes (as shown in closing price progression and daily returns), indicating significant volatility in both periods. In the opening two months of COVID-19 and during the GFC, both equity indexes exhibited significant falls.

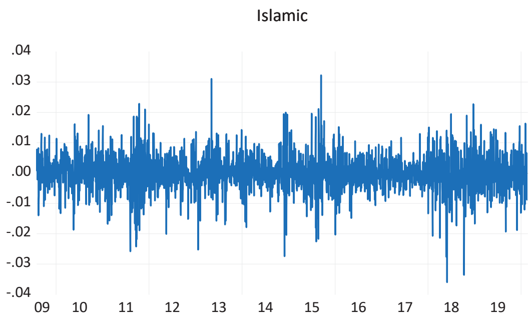
Figure 3: Logarithmic Returns: During the GFC



Source: Authors' calculations

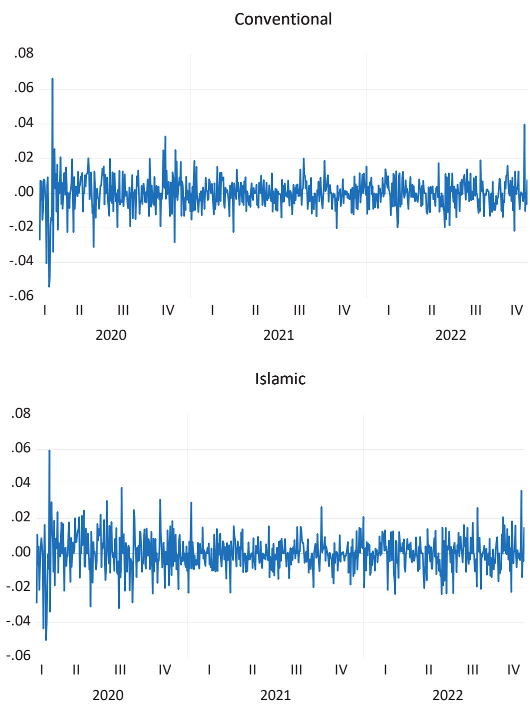
Figure 4: Logarithmic Returns: Post-GFC





Source: Authors' calculations

Figure 5: Logarithmic Returns: During the COVID-19 Period



Source: Authors' calculations

The volatility clustering for both indexes is identified in Figures 3 and 5. All equity indexes have a propensity for high and low volatility to congregate. Moreover, high and low returns fluctuate and tend to cluster more sharply during crisis years. Nevertheless, both equity indexes for the post-GFC period show a consistent and mean-reverting variance. Stationarity tests are performed using the Augmented Dicky Fuller (ADF) and Phillips Perrons (PP) unit root tests. The data in Table 1 demonstrates that the return series is stationary during all sample periods, contradicting the random-walk hypothesis. As a result, both ADF and PP tests of the Malaysian indexes demonstrate weak-form inefficiency, suggesting that the returns can be predicted using historical data.

4.3 Estimating the model parameters

The analysis began by utilising the most fundamental models, AR (1), MA (1), and ARIMA (1,1,1), because the authors found that the PACF declines after the first lag whereas the ACF remains large at all lags. At this stage, the trial-and-error method has been utilised to accomplish the least information criteria and significant coefficients. Different models of the full sample period are described in Table 2 along with their diagnoses, and it is evident that ARMA (1,1,1) has the least information criterion of AIC, SIC, and HQC and significant coefficients.

Table 2: Comparison of Selection Criteria for ARIMA Models

Model	Coefficients*	AIC	SIC	HQC
Full period				
ARIMA (1,1,0)	Significant	-6.9837	-6.9822	-6.9832
ARIMA (0,1,1)	Significant	-6.9836	-6.9821	-6.9831
ARIMA (1,1,1)	Significant	-6.9854	-6.9823	-6.9843
ARIMA (2,1,0)	Significant	-6.9841	-6.9810	-6.9830
ARIMA (0,1,2)	Significant	-6.9843	-6.9812	-6.9832
ARIMA (2,1,1)	Significant	-6.9849	-6.9802	-6.9832
ARIMA (1,1,2)	Insignificant	-6.9850	-6.9802	-6.9833
ARIMA (2,1,2)	Significant	-6.9852	-6.9789	-6.9830
ARIMA (3,1,0)	Insignificant	-6.9890	-6.9843	-6.9874
ARIMA (0,1,3)	Insignificant	-6.9842	-6.9795	-6.9825
ARIMA (3,1,1)	Insignificant	-6.9885	-6.9822	-6.9863
ARIMA (1,1,3)	Insignificant	-6.9846	-6.9783	-6.9823

Source: Authors' calculations

The ARCH-LM test is used to validate the heteroscedasticity in the variance before fitting the GARCH (1,1), GARCH-M (1,1), EGARCH (1,1), and TGARCH (1,1,1) into the ARIMA (1,1,1) model. The results provided in Table 1 show the presence of ARCH effects which further proves that volatility clustering exists. Models from the ARCH family, such as symmetric GARCH, symmetric GARCH-Mean, asymmetric EGARCH, and Asymmetric TGARCH, can therefore be used in both symmetrical and asymmetrical applications. The above model estimation processes are repeated for both series during-GFC, post-GFC, and during COVID-19 periods to determine the significant models, and the results are shown in Table 3.

Table 3: Significant Models for Different Sample Periods

Indexes	Model	Coefficients*	AIC	SIC	HQC
Full period					
Conventional	ARMA (1,1)	Significant	-6.9854	-6.9823	-6.9843
Islamic	MA (1)	Significant	-6.8043	-6.8028	-6.8038
During-GFC					
Conventional	MA (1)	Significant	-6.0350	-6.0268	-6.0318
Islamic	MA (1)	Significant	-5.8049	-5.7968	-5.8017
Post-GFC					
Conventional	MA (2)	Significant	-7.5819	-7.5776	-7.5803
Islamic	MA (2)	Significant	-7.4779	-7.4736	-7.4763
During-COVID-19					
Conventional	AR (2)	Significant	-6.5378	-6.5250	-6.5328
Islamic	ARMA (1,1)	Significant	-6.3248	-6.3121	-6.3199

Source: Authors' calculations; * Significant coefficient at 5% level.

4.4 ARIMA-GARCH family models results

Tables 4 until 7 illustrate the results of the hybrid of ARIMA with SGARCH (1, 1), SGARCH-Mean (1,1), EGARCH (1,1), and TGARCH (1,1) model for the full sample period (1 August 2007 to 30 December 2022), during GFC period (1 August 2007 to 31 July 2009), post-GFC (1 August 2009 to 21 February 2020), and during the COVID-19 period (22 February 2020 to 30 December 2022), respectively. The ARIMA-GARCH family models are validated by performing Ljung-Box (LB) statistics for twenty-four lags (Q24) and the ARCH-LM test. The results of both tests conclude that there is no serial correlation and absence of the ARCH effect in every ARIMA-GARCH family model, implying reliable and robust results are yielded in this study.

4.4.1 ARIMA-GARCH family models results – Full Sample

The estimates for the ARIMA (1,1,1)-GARCH, GARCH-M, EGARCH, and TGARCH models of the full period are shown in Table 4. For the full sample period, the values of various coefficients and information criteria under various versions are compared to select the best model out of the many GARCH family models. The ARIMA (1,1,1)-EGARCH (1,1) model has significant coefficients and the lowest values for AIC, SIC, and HQC, making it the best model for the conventional index, and ARIMA (0,1,1)-EGARCH (1,1) for Islamic index. These values are also lower than those predicted by the ARIMA (1,1,1) and ARIMA (0,1,1) models.

4.4.2 ARIMA-GARCH family models results – During GFC

The estimates for the ARIMA (0,1,1)-GARCH, GARCH-M, EGARCH, and TGARCH models of during the GFC are shown in Table 5. During the GFC period, the ARIMA (0,1,1)-TGARCH (1,1) model has significant coefficients and the lowest values for AIC, SIC, and HQC, making it the best model for the conventional index, and ARIMA (0,1,1)-EGARCH (1,1) for Islamic index. These values are also lower than those predicted by the ARIMA (0,1,1) model.

4.4.3 ARIMA-GARCH family models results – Post-GFC

The estimates for the ARIMA (1,1,1)-GARCH, GARCH-M, EGARCH, and TGARCH models of the post-GFC period are shown in Table 6. The ARIMA (0,1,2)-EGARCH (1,1) model has significant coefficients and the lowest values for AIC, SIC, and HQC, making it the best model for both the conventional index and Islamic index. These values are also lower than those predicted by the ARIMA (0,1,2) model.

4.4.4 ARIMA-GARCH family models results – During the COVID-19 pandemic

The estimates for the ARIMA (2,1,0)-GARCH, GARCH-M, EGARCH, and TGARCH models during the COVID-19 period for conventional index with ARIMA (1,1,1) for Islamic index are shown in Table 7.

During-COVID-19 period, the ARIMA (2,1,0)-GARCH (1,1) model has the lowest values for AIC, SIC, and HQC, making it the best model for the conventional index, while ARIMA (1,1,1)-TGARCH (1,1) for Islamic index. These values are also lower than those predicted by the ARIMA (2,1,0) and ARIMA (1,1,1) models.

Table 4: GARCH Family Models Results - Full Sample

	GARCH (1,1)				GARCH-M (1,1)			
	Conventional index		**Islamic index**		**Conventional index**		**Islamic index**	
Mean equation								
Lagged Index Return	0.4133 *	(0.1686)			0.4088 *	(0.1711)		
MA(1)	-0.3345	(0.1749)	0.0675 **	(0.0164)	-0.3300	(0.1773)	0.0669**	(0.0165)
Risk Premium					0.0406 *	(0.0187)	0.0425*	(0.0173)
Variance equation								
Constant	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000**	(0.0000)
ARCH effect	0.0871 **	(0.0050)	0.0755 **	(0.0048)	0.0884 **	(0.0051)	0.0774**	(0.0049)
GARCH effect	0.9047 **	(0.0055)	0.9197 **	(0.0050)	0.9033 **	(0.0056)	0.9178**	(0.0051)
Persistence effect	0.9918		0.9952		0.9917		0.9952	
Half-life	84		146		83		145	
Observations	4,000		4,000		4,000		4,000	
Log likelihood	14587.6		14275.7		14590.2		14278.9	
AIC	-7.3004		-7.1430		-7.3012		-7.1441	
SC	-7.2925		-7.1367		-7.2917		-7.1362	
HQC	-7.2976		-7.1407		-7.2978		-7.1413	
Iteration	38		44		45		45	
ARCH-LM	1.4341	{0.2311}	5.5167	{0.4794}	1.3430	{0.2465}	5.5011	{0.4813}
Q24	26.3590	{0.2370}	28.8680	{0.1850}	26.2160	{0.2430}	28.6470	{0.1920}

	EGARCH (1,1)				TGARCH (1,1)			
	Conventional index		Islamic index		Conventional index		Islamic index	
Mean equation								
Lagged Index Return	0.5548 **	(0.1067)			0.4268 **	(0.1576)		
MA(1)	-0.4654 **	(0.1137)	0.0732 **	(0.0158)	-0.3443 *	(0.1640)	0.0692 **	(0.0165)
Variance equation								
Constant	-0.2521 **	(0.0197)	-0.2125 **	(0.0177)	0.0000 **	(0.0000)	0.0000 **	(0.0000)
ARCH effect	0.1410 **	(0.0087)	0.1409 **	(0.0085)	0.0473 **	(0.0059)	0.0411 **	(0.0052)
GARCH effect	0.9854 **	(0.0016)	0.9889 **	(0.0014)	0.9066 **	(0.0054)	0.9207 **	(0.0051)
Leverage effect	-0.0714 **	(0.0057)	-0.0592 **	(0.0046)	0.0717 **	(0.0079)	0.0654 **	(0.0063)
Persistence effect	0.9854		0.9889		0.9539		0.9618	
Half-life	47		62		15		18	
Observations	4,000		4,000		4,000		4,000	
Log likelihood	14612.2		14305.5		14606.8		14298.5	
AIC	-7.3122		-7.1574		-7.3095		-7.1539	
SC	-7.3028		-7.1495		-7.3001		-7.1460	
HQC	-7.3089		-7.1546		-7.3062		-7.1511	
Iteration	61		41		42		28	
ARCH-LM	10.5821	{0.1022}	9.2249	{0.1613}	2.7115	{0.8441}	4.4432	{0.6169}
Q24	24.9310	{0.3000}	27.6070	{0.2310}	24.8960	{0.3020}	27.4000	{0.2390}

Source: Authors' calculation.
Note: * and ** indicate significance at the 5 and 1% levels, respectively. Standard errors are in parentheses. P-values are in curly brackets.

Table 5: GARCH Family Models Results – During the GFC

	GARCH (1,1)				GARCH-M (1,1)			
	Conventional index		Islamic index		Conventional index		Islamic index	
Mean equation								
MA(1)	0.2012 **	(0.0534)	0.2090 **	(0.0566)	0.1985 **	(0.0549)	0.2055 **	(0.0577)
Risk Premium					0.0455	(0.0560)	0.0429	(0.0593)
Variance equation								
Constant	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)
ARCH effect	0.1966 **	(0.0386)	0.1629 **	(0.0410)	0.1960 **	(0.0385)	0.1624 **	(0.0408)
GARCH effect	0.7076 **	(0.0673)	0.7137 **	(0.0746)	0.7123 **	(0.0664)	0.7190 **	(0.0741)
Persistence effect	0.9042		0.8767		0.9083		0.8814	
Half-life	7		5		7		5	
Observations	522		522		522		522	
Log likelihood	1612.5		1542.3		1612.9		1542.6	
AIC	-6.1630		-5.8938		-6.1606		-5.8912	
SC	-6.1303		-5.8611		-6.1198		-5.8504	
HQC	-6.1502		-5.8810		-6.1446		-5.8752	
Iteration	17		20		18		23	
ARCH-LM	3.2321	{0.7792}	1.7849	{0.9384}	3.4307	{0.7532}	1.9450	{0.9247}
Q24	14.6610	{0.9060}	16.6870	{0.8240}	14.4640	{0.9130}	16.2590	{0.8440}

	EGARCH (1,1)				TGARCH (1,1)			
	Conventional index		Islamic index		Conventional index		Islamic index	
Mean equation								
MA(1)	0.1743 **	(0.0533)	0.1570 **	(0.0515)	0.1539 **	(0.0562)	0.1704 **	(0.0561)
Variance equation								
Constant	-1.1525 **	(0.2827)	-1.0914 **	(0.3327)	0.0000 **	(0.0000)	0.0000 **	(0.0000)
ARCH effect	0.1875 **	(0.0514)	0.1726 **	(0.0400)	-0.0112	(0.0290)	0.0115	(0.0230)
GARCH effect	0.8885 **	(0.0295)	0.8902 **	(0.0364)	0.7244 **	(0.0569)	0.7363 **	(0.0648)
Leverage effect	-0.1718 **	(0.0391)	-0.1476 **	(0.0390)	0.3203 **	(0.0737)	0.2451 **	(0.0623)
Persistence effect	0.8885		0.8902		0.7131		0.7478	
Half-life	6		6		2		2	
Observations	522		522		522		522	
Log likelihood	1622.1		1552.4		1624.5		1551.7	
AIC	-6.1956		-5.9288		-6.2049		-5.9259	
SC	-6.1549		-5.8881		-6.1641		-5.8851	
HQC	-6.1797		-5.9129		-6.1889		-5.9099	
Iteration	40		45		39		22	
ARCH-LM	4.5847	{0.5981}	1.5113	{0.9587}	3.5324	{0.7397}	1.4810	{0.9607}
Q24	14.3630	{0.9160}	12.0300	{0.9700}	12.8600	{0.9550}	13.0160	{0.9520}

Source: Authors' calculation.
Note: * and ** indicate significance at the 5 and 1% levels, respectively. Standard errors are in parentheses. P-values are in curly brackets.

Table 6: GARCH Family Models Results – Post-GFC

	GARCH (1,1)				GARCH-M (1,1)			
	Conventional index		Islamic index		Conventional index		Islamic index	
Mean equation								
MA(1)	0.0880 **	(0.0195)	0.0763 **	(0.0189)	0.0877 **	(0.0197)	0.0748 **	(0.0191)
MA(2)	0.0514 **	(0.0194)	0.0530 **	(0.0196)	0.0513 **	(0.0196)	0.0518 **	(0.0198)
Risk Premium					0.0424	(0.0225)	0.0539 *	(0.0217)
Variance equation								
Constant	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)
ARCH effect	0.0796 **	(0.0071)	0.0819 **	(0.0072)	0.0812 **	(0.0072)	0.0845 **	(0.0073)
GARCH effect	0.8847 **	(0.0105)	0.8869 **	(0.0091)	0.8824 **	(0.0106)	0.8839 **	(0.0092)
Persistence effect	0.9643		0.9688		0.9636		0.9684	
Half-life	19		22		19		22	
Observations	2,755		2,755		2,755		2,755	
Log likelihood	10610.6		10465.3		10612.5		10468.5	
AIC	-7.6992		-7.5937		-7.6998		-7.5953	
SC	-7.6884		-7.5829		-7.6870		-7.5824	
HQC	-7.6953		-7.5898		-7.6952		-7.5906	
Iteration	43		27		30		27	
ARCH-LM	11.6393	{0.0705}	8.3440	{0.2140}	11.6468	{0.0703}	8.8485	{0.1823}
Q24	16.9730	{0.7650}	18.7020	{0.6640}	17.0710	{0.7590}	18.7680	{0.6600}

	EGARCH (1,1)				TGARCH (1,1)			
	Conventional index		Islamic index		Conventional index		Islamic index	
Mean equation								
MA(1)	0.1015 **	(0.0187)	0.0827 **	(0.0181)	0.0971 **	(0.0196)	0.0804 **	(0.0189)
MA(2)	0.0639 **	(0.0185)	0.0635 **	(0.0185)	0.0551 **	(0.0193)	0.0535 **	(0.0194)
Variance equation								
Constant	-0.4509 **	(0.0491)	-0.3952 **	(0.0419)	0.0000 **	(0.0000)	0.0000 **	(0.0000)
ARCH effect	0.1287 **	(0.0118)	0.1363 **	(0.0122)	0.0286 **	(0.0087)	0.0344 **	(0.0073)
GARCH effect	0.9662 **	(0.0043)	0.9716 **	(0.0037)	0.8893 **	(0.0099)	0.8906 **	(0.0087)
Leverage effect	-0.0809 **	(0.0084)	-0.0778 **	(0.0077)	0.0848 **	(0.0122)	0.0882 **	(0.0109)
Persistence effect	0.9662		0.9716		0.9179		0.9250	
Half-life	20		24		8		9	
Observations	2,755		2,755		2,755		2,755	
Log likelihood	10626.3		10484.9		10625.7		10482.9	
AIC	-7.7098		-7.6072		-7.7094		-7.6057	
SC	-7.6969		-7.5943		-7.6965		-7.5928	
HQC	-7.7051		-7.6025		-7.7047		-7.6010	
Iteration	52		47		28		31	
ARCH-LM	9.4957	{0.1015}	8.3408	{0.1178}	12.1807	{0.0581}	9.7631	{0.1350}
Q24	18.7830	{0.6590}	20.1590	{0.5730}	17.4170	{0.7400}	19.0980	{0.6390}

Source: Authors' calculation.
Note: * and ** indicate significance at the 5 and 1% levels, respectively. Standard errors are in parentheses. P-values are in curly brackets.

Table 7: GARCH Family Models Results – During the COVID-19 Pandemic

	GARCH (1,1)				GARCH-M (1,1)			
	Conventional index		Islamic index		Conventional index		Islamic index	
Mean equation								
Lagged Index Return	-0.0298	(0.0375)	-0.2053	(0.4983)	-0.0298	(0.0376)	-0.2009	(0.5243)
Lagged 2 Index Return	0.0758	(0.0400)			0.0758	(0.0401)		
MA (1)			0.1710	(0.5016)			0.1660	(0.5279)
Risk Premium					0.0018	(0.0392)	-0.0203	(0.0361)
Variance equation								
Constant	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)	0.0000 **	(0.0000)
ARCH effect	0.0346 **	(0.0097)	0.0110	(0.0066)	0.0346 **	(0.0098)	0.0110	(0.0066)
GARCH effect	0.9403 **	(0.0146)	0.9772 **	(0.0077)	0.9403 **	(0.0147)	0.9773 **	(0.0078)
Persistence effect	0.9749		0.9882		0.9749		0.9883	
Half-life	27		58		27		59	
Observations	723		723		723		723	
Log likelihood	2427.0		2325.8		2427.0		2326.0	
AIC	-6.7372		-6.4557		-6.7344		-6.4533	
SC	-6.7053		-6.4238		-6.6962		-6.4151	
HQC	-6.7249		-6.4434		-6.7197		-6.4386	
Iteration	31		40		36		45	
ARCH-LM	5.7171	{0.4556}	12.4982	{0.0517}	5.7109	{0.4563}	12.3858	{0.0539}
Q24	30.0130	{0.1180}	23.4650	{0.3760}	30.0140	{0.1180}	23.5080	{0.3740}

	EGARCH (1,1)						TGARCH (1,1)					
	Conventional index			Islamic index			Conventional index			Islamic index		
Mean equation												
Lagged Index Return	-0.0242		(0.0350)	0.9281	**	(0.0650)	-0.0255		(0.0379)	-0.0441		(0.4286)
Lagged 2 Index Return	0.0764	*	(0.0384)				0.0784	*	(0.0399)			
MA (1)				-0.9240	**	(0.0684)				0.0013		(0.4219)
Variance equation												
Constant	-0.1361	**	(0.0398)	-0.1094	*	(0.0463)	0.0000	**	(0.0000)	0.0000	**	(0.0000)
ARCH effect	0.0426	**	(0.0164)	0.0408	*	(0.0179)	0.0231		(0.0119)	-0.0318	**	(0.0048)
GARCH effect	0.9894	**	(0.0034)	0.9917	*	(0.0039)	0.9424	**	(0.0139)	1.0055	**	(0.0000)
Leverage effect	-0.0192		(0.0101)	-0.0087		(0.0106)	0.0186		(0.0145)	0.0366	**	(0.0090)
Persistence effect	0.9894			0.9917			0.9655			0.9738		
Half-life	65			83			20			26		
Observations	723			723			723			723		
Log likelihood	2426.1			2323.7			2427.5			2336.8		
AIC	-6.7317			-6.4469			-6.7357			-6.4835		
SC	-6.6935			-6.4087			-6.6975			-6.4453		
HQC	-6.7170			-6.4322			-6.7210			-6.4687		
Iteration	59			65			32			66		
ARCH-LM	7.1150		{0.3103}	9.0725		{0.0619}	3.9907		{0.6779}	7.1449		{0.1088}
Q24	30.3460		{0.1100}	23.5780		{0.3700}	30.5070		{0.1070}	21.3130		{0.5010}

Source: Authors' calculation.
Note: * and ** indicate significance at the 5 and 1% levels, respectively. Standard errors are in parentheses. P-values are in curly brackets

4.5 *Discussion of findings*

The ARCH effect is a sum of squared residuals, illustrating how shocks affect volatility. The value is slightly higher for the conventional index than its counterpart during-GFC and during-Covid-19 periods. Hence, the conventional index was affected by shocks to the GFC and COVID-19 pandemic to a slightly greater extent relative to its Islamic counterpart. The ARCH effect significantly decreased from 0.1966 to 0.0796 then to 0.0346 for the conventional index, and from 0.1629 to 0.0819 then to 0.0110 for the Islamic index from during-GFC to post-GFC period then to during-COVID-19 period. It is also interesting to note that the ARCH effect in the Islamic equity index following COVID-19 is statistically insignificant in GARCH, GARCH-M, and EGARCH models, while showing negative and statistically significant at 5% in the TGARCH model. This implies that both markets are getting less responsive to fresh surprises over time and it is interesting to note that the Islamic index is either not responsive or tends to respond less than what is expected under as standard GARCH model to new surprises during the COVID-19 period.

The GARCH effect corresponds to the sum of recent variances that represent volatility clustering. It is observed that the volatility clustering shows a very high persistency for the Islamic and conventional indexes for all four different sample periods, with the Islamic index demonstrating a slightly greater extent relative to its counterpart. The study noticed that the coefficient of GARCH increased significantly from the GFC period to the post-GFC period, and until the COVID-19 period for both the conventional index (from 0.7076 to 0.8847 then to 0.9403) and Islamic index (from 0.7137 to 0.8824 then to 0.9772). This implies that both indexes have grown increasingly volatile and are reliant on their lagged volatility over time, indicating that the pandemic has pushed the GARCH effect toward unity. As a result, the GARCH effect is more visible during the COVID-19 era, where a period of strong equity returns is followed by a period of poor equity returns in succession. The significant and positive coefficient suggests that past volatility has a lasting impact on the present volatility. The evidence suggests that conventional and Islamic equity markets have a memory that goes beyond a single period and that, their volatility is more responsive to its lag values than it is to fresh shocks in the market. (Hossain et al., 2021)

Concerning the volatility persistency (ARCH term + GARCH term) of GARCH and GARCH-M models, both indexes have a value approaching 1, implying that the shocks could persist in the future (Hossain et al., 2021). Nevertheless, like the trend observed in the GARCH coefficient, the volatility persistent value has also been in an increasing trend from during the GFC, post-GFC, to during the COVID-19 period. Hence, in Malaysia, there would be a price mismatch in the Islamic and conventional equity markets because of the persistent and long-memory volatility characteristics. Consequently, Malaysian investors may have a chance to profit from an arbitrage opportunity. Interestingly, the persistence of the volatility for the Islamic index is always a higher magnitude than the conventional index in every sample period except for during the GFC. Our results are aligned with extant findings in the literature, showing evidence that the Islamic index was less volatile than the conventional index. Hence, the Islamic index exhibited safe haven characteristics during the GFC (Abduh, 2020; Hassan et al., 2022) due to the following reasons: (a) the defensiveness of Shariah screening in stock selection; and (b) the exclusion of conventional financial institutions that are not Shariah compliance.

Remarkably, the Half-Life measure of volatility (Bhar & Nikolova, 2009) for both indexes is 6 days for the during-GFC period. The results also show that the Half-Life measure of the conventional index increased from 20 days in the post-GFC period to 27 days during the COVID-19 period. However, the Islamic index reported a larger increase of 24 days to 58 days during the same period. The findings suggest that the Islamic index has higher volatility persistency, and it takes nearly twice in terms of duration for the volatility to return to its unconditional mean.

The above results are consistent with the study conducted by Bahloul & Khemakhem (2021), who reported that during the COVID-19 period, volatility shocks in Islamic equity indexes persisted for a longer duration, rendering Islamic indexes riskier than conventional indexes.

Furthermore, the authors also found that Islamic indexes remained riskier than conventional indexes even in comparison to the post-GFC era because of Shariah compliance filtering criteria. Other possible reasons could be that Islamic indexes contain less diversified and smaller firm sizes, hence increasing the concentration risk in specific industries, and eventually yielding more volatile returns. HJS Islamic index is driven by investing in smaller firms and these firms are more concentrated in the sectors of Food Beverage and Tobacco, telecommunications, and utilities firms (FTSE Russell, 2022a). The KLCI conventional index, on the other hand, is more concentrated in larger firms in the financial sectors and consumer sectors (FTSE Russell, 2022b). It is further validated by the KLCI conventional index has an average market capitalisation of MYR15,823 million (FTSE Russell, 2022b), while the HJS Islamic index shows only MYR8,506 million (FTSE Russell, 2022a). Therefore, the primary distinguishing characteristics of Islamic indexes are smaller firm size, lower leverage, and less diversity.

The finding also suggests that the Islamic index has a lower risk (standard deviation) per unit of mean return than the conventional index in all periods except during the COVID-19 period. As a result, the Islamic index performs better than the conventional index before the COVID-19 period. However, during-COVID-19 period, the Islamic index performed poorer in its mean returns with a higher risk per unit mean return recorded than its counterpart. The aggregate results of this study imply that the safe haven characteristic of the Islamic index vanishes during the COVID-19 period and this also entails that the Islamic index is reacting differently to the COVID-19 pandemic compared to the GFC, which makes the COVID-19 pandemic unique. Hence, this study concludes that COVID-19 caused the equity market volatility of Malaysian Islamic and conventional indexes to increase significantly, which is consistent with prior research. (Bahloul & Khemakhem, 2021; Bui et al., 2022; Contessi & De Pace, 2021; Goodell, 2020; Kang et al., 2023). This could be due to the COVID-19 pandemic being a unique crisis characterised by sudden and unanticipated shifts in market dynamics. In addition to that, the performance of the Islamic index during the crisis may have been adversely affected by liquidity constraints within the Islamic financial industry. Certain financial instruments and transactions are prohibited by Islamic finance rules, which may make it more difficult to quickly modify portfolios in reaction to market shocks. Also, during crises, investor perceptions of risk and safety and market sentiment may rapidly alter. Investors' perceptions of the security of Islamic assets during this outbreak may have been influenced by factors including news coverage, advancements in public health, and geopolitical events.

In the ARIMA-GARCH-Mean model, the coefficients of conditional variance or risk premium in the mean equation for the conventional equity index are positive and significant in the full sample period and similar evidence is shown for the Islamic equity index in the post-GFC period. It also can be noticed that the risk premium of the Islamic equity index is higher than its conventional counterparts. Empirically, a positive and significant value implies the presence of a risk-return trade-off. Simply put, increased market risk proxied by conditional variance may lead to better returns in the Islamic index during the post-GFC period. In this period, investors are more interested in investing in the Islamic equity index and hence speculating the short-run profit opportunities. The same phenomenon is being observed as well for the Islamic and conventional indexes in the full sample period. Hence, the results of this study contradict the findings of Akinlaso et al. (2021) and Yong et al. (2021), who found little potential for abnormal returns in equity markets. However, such speculation causes the Islamic equity index to be less efficient, to fall in the long term, and eventually harm economic development. This phenomenon is seen in the Islamic index during the COVID-19 period, whereby the mean return of the Islamic index is lower than the conventional for the first time, thus making the COVID-19 crisis unique. For other sub-periods, it is inferred that the coefficient of the risk premium for both indexes is either positive or negative and insignificant, indicating an absence of risk-return trade-off (Yong et al., 2021). Interestingly, insignificant risk premiums are found both during the GFC and during the COVID-19 pandemic, further implying that investors are risk-averse during a crisis. The findings contend that there is no link between volatility and risk premium in both indexes and hence it does not justify the compensation for investors due to the market volatility. The risk-seeking investors tend to be less interested in investing because excessive risk-taking does not generate a commensurate return. Nonetheless, risk-averse investors are more interested in exploiting the investment opportunities.

In terms of market efficiency, the results of the ARIMA-GARCH (1,1) and ARIMA-GARCH-Mean (1,1) models for both Islamic and conventional indexes reveal that the ARCH Term + GARCH term is between 0.8767 and 0.9952. The results indicate that both indexes contradict the random walk hypothesis, confirming that both markets are weak-form inefficient markets in every sample period. The weak-form inefficiency of both markets is further validated by the results of the ADF and PP tests of this study. (Tamilselvan et al., 2022) The weak form of inefficiency suggests that investors may not have sufficient information about the securities in that market to make educated judgments. According to (Rahim & Ahmad, 2016) emerging markets may be inefficient due to the following reasons: (a) securities rules may not induce issuing companies to disclose key information; (b) market research on the equity performance of new firms or new industries may be unavailable; including (c) the buyand-hold investment approach practised by Malaysian stockholders, the inactive secondary market, inadequate supply, and the illiquid market.

Our study finds evidence of an asymmetric effect and a leverage effect (Akinlaso et al., 2021; Danila et al., 2021; Hossain et al., 2021; Kaur & Singla, 2021; Yong et al., 2021). The former can be observed by the negative parameters in EGARCH, and the latter can be identified from the statistically significant positive parameters in TGARCH models. The leverage effect is caused by the fact that losses have a bigger impact on future volatility, and asymmetry refers to the idea that the distribution of losses has a larger tail compared to gains. This denotes that negative news has more effect on the conditional variance, compared to positive news in all sample periods except for one sample period. Interestingly, only the conventional index during-COVID-19 period shows no leverage effect, supported by GARCH, EGARCH, and TGARCH models. The leverage effect exists throughout but increases significantly by about 50% in magnitude during the GFC for both indexes, but no such changes have been seen during the COVID-19 pandemic. Intriguingly, there is also no leverage effect for the conventional index during COVID-19, which could be interpreted as investors perceiving KLCI conventional index as a safe haven asset during that time. The findings of this study conclude that this COVID-19 financial crisis is unique.

4.6 Summaries of findings:

- The return behaviour of Malaysian equity indexes exhibits conditional heteroskedasticity, long memory, and negative leverage effect, and both indexes have also shown an increase in volatility and are more dependent on their lagged volatility, and less responsive to fresh surprise news over time. The Islamic index demonstrates safe haven characteristics during the GFC.
- The Islamic index has higher volatility persistency, and it takes nearly twice as long in terms of duration for the volatility to return to its unconditional mean, compared to its conventional counterpart during the COVID-19 period. Both empirical results imply that the HJS Islamic index is riskier than the KLCI conventional index during the COVID-19 period.
- There are positive risk-return associations in both conventional and Islamic indexes in the full sample period, including the Islamic equity index post-GFC. Generally, the result implies that investors in Malaysia's financial markets are on average

compensated by taking additional risks. Interestingly, insignificant risk premiums are found both during the GFC and the COVID-19 period.

- This study consistently finds that both the Islamic and conventional indexes in Malaysia demonstrate weak-form inefficient market behaviour, further supported by the robustness test of ADF and the PP test of stationarity.
- The existence of leverage effect evidence showed that negative news causes the volatility of returns for both indexes to surge more. Given that volatility is a risk signal, it is implied that investors did not view the Islamic index as a safe haven or a mature asset. Remarkably, the conventional index KLCI is perceived as a safe haven during the COVID-19 period.
- The Islamic index and conventional index are reacting differently to the COVID-19 pandemic compared to the GFC, which makes the COVID-19 pandemic unique.

5. Conclusion and Implications

This study examines the nexus of asset returns and models conditional volatility of HJS Islamic and KLCI conventional indexes in Malaysia by employing symmetrical and asymmetrical GARCH-family models over four sample periods. In addition, the authors also investigate the risk-return trade-off and market efficiency of both indexes.

The authors argue that in terms of volatility, the Islamic index does not provide a respite to investors during the COVID-19 period. Hence, the present work concludes that the COVID-19 crisis is unique, and dissimilar from the GFC as the fundamental causes are distinctive. The safe haven characteristics of the Islamic index were present during the GFC; however, they vanished over time, with the conventional index showing characteristics of a safe haven. Unlike other studies, our findings show that the predicament COVID-19 crisis affects both Islamic and conventional indexes which could have significant ramifications for many market participants. For instance, risk-averse Islamic investors and portfolio managers should incorporate other asset classes in their portfolios to reduce systematic risks. Investors might consider modifying their investment strategy or employing methods to mitigate risks if the study identifies periods of significant volatility. To make informed decisions about asset allocation and investment strategies, investors can compare the performance of Islamic and conventional indexes over various periods. Our findings provide insight for policymakers to design preventive measures against health and economic crises to promote global financial stability and improve market efficiency. The findings can also be used by regulatory bodies to improve market surveillance, particularly by identifying anomalies or trends that can signal market manipulation or fraud.

It has been proposed that Islamic indexes may provide a "safe haven" for conventional indexes during tumultuous times, offering important information for risk management and portfolio diversification techniques. Islamic instruments for stabilising macroeconomic issues could be advantageous to regulatory and policymaking agencies. It is possible to create efficient trading methods to take advantage of the benefits of diversification by studying the volatility transmission patterns between traditional financial markets and Islamic ones.

This study is subject to several limitations. First, the results could be influenced by the sample period selection. Depending on other market variables, such as whether the study includes bull or bear markets, times of high or low volatility, or other factors, the results may differ. Second, model specification bias may be introduced by the choice of GARCH-family models and parameters. Thus, subsequent research is recommended to explore different frameworks for modelling conditional volatilities, such as wavelet-based approaches and multivariate GARCH analysis, to examine the interlinkages of conventional and Islamic equity markets in various regions and countries. Future studies could address the following questions: (1) How do wavelet-based techniques improve our comprehension of the time-varying properties of volatility in both conventional and Islamic equity markets? (2) How can multivariate GARCH models be used to examine the connections and repercussions between the traditional equities markets and the Islamic equity markets?

Acknowledgement

This work was supported by Universiti Putra Malaysia's Geran Putra – IPS [Grant number: GP-IPS/2022/9738100]

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