The Basel 2.5 capital regulatory framework and the COVID-19 crisis: evidence from the ethical investment market

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Abstract

Purpose – This research aims to evaluate the accuracy of several Value-at-Risk (VaR) approaches for determining the Minimum Capital Requirement (MCR) for Islamic stock markets during the pandemic health crisis.

Design/methodology/approach – This research evaluates the performance of numerous VaR models for computing the MCR for market risk in compliance with the Basel II and Basel II.5 guidelines for ten Islamic indices. Five models were applied—namely the RiskMetrics, Generalized Autoregressive Conditional Heteroskedasticity, denoted (GARCH), fractional integrated GARCH, denoted (FIGARCH), and SPLINE-GARCH approaches—under three innovations (normal (N), Student (St) and skewed-Student (Sk-t) and the extreme value theory (EVT).

Findings – The main findings of this empirical study reveal that (1) extreme value theory performs better for most indices during the market crisis and (2) VaR models under a normal distribution provide quite poor performance than models with fat-tailed innovations in terms of risk estimation.

Research limitations/implications – Since the world is now undergoing the third wave of the COVID-19 pandemic, this study will not be able to assess performance of VaR models during the fourth wave of COVID-19.

Practical implications – The results suggest that the Islamic Financial Services Board (IFSB) should enhance market discipline mechanisms, while central banks and national authorities should harmonize their regulatory frameworks in line with Basel/IFSB reform agenda.

Originality/value – Previous studies focused on evaluating market risk models using non-Islamic indexes. However, this research uses the Islamic indexes to analyze the VaR forecasting models. Besides, they tested the accuracy of VaR models based on traditional GARCH models, whereas the authors introduce the Spline GARCH developed by Engle and Rangel (2008). Finally, most studies have focus on the period of 2007–2008 financial crisis, while the authors investigate the issue of market risk quantification for several Islamic market equity during the sanitary crisis of COVID-19.

Keywords Basel 2.5, Capital requirements, Extreme value theory, Islamic indices, GARCH family, Stressed value-at-risk

Paper type Research paper

Introduction

The Basel Banking Supervisory Committee (BCBS) has announced a new prudential strategy to strengthen the current market risk management regulatory framework in the aftermath of the sub-prime crises 2007–2008. During this period, the trading book has been a significant

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source of losses. The circumstance that some important risks are not covered by the current capital framework for market risk was a major factor of this distress. As a result, The Committee has added to the current value-at-risk-based trading book methodology an incremental risk capital charge for unsecuritized credit products that includes default risk as well as migration risk. With a small exception for certain so-called correlation trading activities, the capital charges of the banking book will apply to securitized products. Under the new Basel II.5 regulatory framework, the BCBS presented new approaches to capture changes in market risk during the stress periods (BCBS, 2009b). These guidelines will decrease the incentives for regulatory arbitrage between the banking and trading books. The Basel committee requires financial institutions to compute a stressed value-at-risk based on a one-year observation period relating to large losses, in addition to the value-at-risk based on the most recent one-year observation period. The added stressed value-at-risk requirement will also help to decrease the procyclicality of the market risk minimum capital requirements. Thus, an added risk capital charge will be assessed on a bank that has acquired approval to model specific risk. The Basel II.5 Framework's additions to internal value-at-risk models require financial institutions to justify any price factors excluded from value-at-risk computation. They will also be required to use hypothetical backtesting for validation and to update market data monthly. Later in 2010, Basel III was established to reduce the risk of transmission to the wider national economy (Ben Maatoug *et al.*, 2019). In January 2019, the Committee amended its MCR for market risk (BCBS, 2016; BCBS, 2019).

From a regulatory viewpoint, financial institutions may choose between the internal model's approach, denoted (IMA) and the standardized approach, denoted (SA), to determine the MCR based on estimations provided by their VaR models. They should also adopt a strict system for market risk management to make certain that daily disclosures are not excessive and thus satisfy the MCR. Several techniques have been proposed in the previous literature (McNeil and Frey, 2000; Ané, 2006; Mabrouk and Saadi, 2012; Orhan and Köksal, 2012). However, the multiple crises over recent decades have revealed the VaR method to be unsatisfactory. According to FSA (2009), most of the VaR estimation models are unable to capture the fail-tail risks during the global financial crisis, although national authorities have authorized backtesting to analyze the estimates and forecasting performance.

In 2020, the global financial system experienced one of its most severe crises as the novel coronavirus exerted a harmful economic impact on our tightly integrated world (Ashraf, 2020; Zaremba *et al.*, 2020; Zhang *et al.*, 2020) and put the global financial systems under strain (Padhan and Prabheesh, 2021; Batten *et al.*, 2022). Most global financial markets saw sharp falls because of the COVID-19 global pandemic, and there was a collapse in oil prices (Ali *et al.*, 2020; Abuzayed and Al-Fayoumi, 2021; Gharib *et al.*, 2021). According to Salisu and Akanni (2020), the increase in confirmed cases and deaths triggered fear among market players, prompting investors to divest their assets over a very short period. This led to extreme volatility in international equity markets and an escalation in geopolitical conflicts, and oil prices declined as demand weakened (Batten *et al.*, 2022). All this created a disconnect between the economic forecasts and the markets. Due to these global events, the Islamic capital market also experienced market turbulence. Consistent with the IFSB (2020), these market dislocations were similar to other major events of past decades. Thus far, market volatility and massive sell-offs are the most significant indications of tensions in the market that have been caused by the pandemic, and these have led to a sharp drop in all the ethical investment stock indices in addition to other global indices.

Numerous empirical papers have tried to quantify risk during periods of stress using different VaR forecasting models (Gençay and Selçuk, 2004; Angelidis *et al.*, 2007; Dimitrakopoulos *et al.*, 2010; Slim *et al.*, 2017; Su *et al.*, 2021). Another area of the literature has analyzed the impact of new market risk measures on the occurrence of VaR models in the conventional market during the previous financial crisis (Rossignolo *et al.*, 2012, 2013; Burchi, 2013; Prorokowski and Prorokowski, 2014; Drenovak *et al.*, 2017) but their findings have generally been inconclusive. Pengelly (2011) and EBA (2012) support the idea that stressed VaR (sVaR) provides a comprehensive outlook for market risk, but Pengelly (2012) and Gibart (2012) note that sVaR was inefficient for linear portfolios.

Despite the huge human and economic costs of the COVID epidemic, research have inevitably been carried out on equities indices. The Coronavirus offers a good opportunity to examine various market trend, such as market fear (Lahmiri and Bekiros, 2020; Lyócsa *et al.*, 2020; Lyócsa and Molnár, 2020) safe haven assets (Goodell and Goutte, 2021; Hassan *et al.*, 2022, 2022; Kinateder *et al.*, 2021; Mariana *et al.*, 2021; Choudhury *et al.*, 2022) and contagion effects (Okorie and Lin, 2020; Akhtaruzzaman *et al.*, 2021; Mazur *et al.*, 2021).

While the acceptance of Basel II.5 is considered a challenge for the whole world's economies, countries that are characterized by a dual-banking system experience bank capital procyclicality (FSI, 2015). As far as we know, only one study assessing the performance of VaR models has concentrated on the estimation of the tail risk of the non-ethical investment markets during the coronavirus period (Omari *et al.*, 2020). Besides, Earlier studies have shown that herd behavior also influenced ethical investment indices (Abdullahi, 2021). Finally, for global economic stability, market risk quantification for equity markets appears crucial. For this reason, it seems relevant to explore the subject of market risk computation for the ethical investment equity markets.

This article is structured as follows. The literature review will be provided in the next part, followed by the methodology and data. Section 4 then outlines the major findings before Section 5 wraps up the study.

Literature review

Empirical literature on VaR forecasting models

In the last few decades, the growing recognition of VaR models has inspired various studies of their validity during periods of stress, especially after the publication of the new Basel reform. Several studies have compared the performance of different approaches, namely, parametric, semi parametric and non-parametric models for computing the MCR (Abad *et al.*, 2014).

The success of various non-parametric methods (Historical Simulation and the non-parametric density estimation technique) has been discussed in the previous work of Beder (1995), Hendricks (1996), Down (2002), Alemany *et al.* (2013), Pritsker (1997), Gu *et al.* (2021). However, other studies have reported that VaR estimates obtained using the non-parametric techniques are inaccurate for a large sample size (Pritsker, 2006; Abad and Benito, 2013).

The second group of studies has focused on parametric approaches such as Riskmetrics (Morgan, 1996) and volatility models (Merton, 1980; Taylor, 1982; Bollerslev, 1986; Baillie *et al.*, 1996). The comparison of the various models reveals the following results: First, Riskmetrics perform well in forecasting VaR during the calm period (González-Rivera *et al.*, 2004; McMillan and Kambouroudis, 2009; Degiannakis *et al.*, 2012; Ben Ayed *et al.*, 2020). However, the GARCH extension models outperform all models during crisis periods (Bali and Theodossiou, 2007; Orhan and Köksal, 2012; Chau *et al.*, 2014; Zhang *et al.*, 2018). Studies such as Aloui and Mabrouk (2010), Mokni and Mansouri (2011) and Mabrouk and Saadi (2012) found that the mixture of asymmetric approaches with fractional integrated techniques offers the best results. Besides, they show that the performance depends on the innovation relating to return distribution. In this context, Castillo *et al.*, (2021), Chen *et al.* (2021), Omari *et al.* (2020) show that the fat-tail and asymmetric distributions improve the results significantly during the pandemic crisis. Their results highlighted the relevance of tail risk while analyzing spillover effects across financial markets. They underline the need for modeling severe events with sophisticated techniques to correctly reflect the volatility clustering.

The third group of studies attempts to combine the non-parametric and parametric approaches. In the literature, several proofs for semi-parametric methods have been developed as the approach based on EVT, filtered historical simulation and the CaViaR method. The empirical evidence indicates that it produces better estimation than other approaches (Hull and White, 1998; Bekiros and Georgoutsos, 2005; Giannopoulos and Tunaru, 2005; Angelidis *et al.*, 2007; Assaf, 2009; Mwamba *et al.*, 2017). However, other authors show that performance depends on backtesting tests, the extreme return distribution innovation and the dataset (Engle and Manganelli, 2004; Abad and Benito, 2013; Abad *et al.*, 2014).

To sum up, previous research has been inconclusive. It seems that the performance of such models depends on various factors such as the period of study (tranquil and stress periods), the trading positions (short and long positions) and the dataset (developed, frontier and emerging markets). Alternatively, the market risk measuring technique for Islamic indexes appears to be understudied. Only one paper has attempted to examine the impact of the sanitary disease on Islamic indexes using the multivariate GARCH model (Abdullahi, 2021).

Empirical literature on VaR models under the market risk regulation

Several studies examined how financial institutions are dealing with the sVaR proposed by Basel II.5 (Berner, 2010; Rossignolo *et al.*, 2012, 2013; Burchi, 2013; Prorokowski and Prorokowski, 2014). They consider that the MCR under the new Basel regulations provides adequate coverage for larger losses during periods of financial turmoil. Besides, it raises the market capital requirement and reduces the incentive to use techniques with higher predictive ability (Berner, 2010). Finally, it gives a comprehensive assessment of market risk (Burchi, 2013; Prorokowski and Prorokowski, 2014). Other researchers are concerned about the suitability of VaR models under the Basel II.5, especially when they evaluate several approaches in the context of different conventional stock markets. Rossignolo *et al.* (2012) used the VaR-based Internal Models Approach to calculate the MCR for conventional stock markets. They tested the accuracy of the semi-parametric methods (EVT) and the parametric methods (GARCH and EGARCH). The results reveal that the implementation of heavy-tailed methods such as EVT gives a wide coverage, reduce the need for additional capital buffers and allow financial institutions to match massive future losses without paying heavy development costs (Rossignolo *et al.*, 2013). However, Pengelly (2012) and Gibart (2012) identified several shortcomings in sVaR implementation. They show that the new measure fails to make bank's capital contracyclical. Also, in times of financial crisis, the sVaR fails to correct several weaknesses in the traditional VaR. Lastly, the sVaR does not give a full view of market risk. The main problem is related to the lack of regulatory directives and poor-quality market data.

Empirical literature on COVID-19 and financial markets

The COVID-19 pandemic offers a good opportunity to examine various market trend. Choudhury *et al.* (2022) investigate the effectiveness of safe havens during various sanitary crisis using the DCC-GARCH model. The authors examine the conditional correlations between daily returns of several Emerging Markets Index, gold and major sovereign bonds. The findings reveal that the US treasuries are the best safe haven for stock market investors followed by Japanese sovereign bonds. Kinateder *et al.* (2021) examine whether the traditional safe haven assets are still operating as a good choice during the crises. The results suggest that the gold and, in particular, US sovereign bonds remains a safe alternative within their asset class.

Conlon *et al.* (2020) assess the role of Bitcoin, Ethereum and Tether as a safe haven. The authors used the modified VaR Techniques to capture the impact of significant higher order moments. The results reveal that Bitcoin and Ethereum are not safe havens for almost all of the indices during the COVID-19 market turmoil. Conlon and McGee (2020) confirms these findings. Their results show a doubt on the ability of Bitcoin to protect investors from market turbulence (Naeem *et al.*, 2021). However, Mariana *et al.* (2021) found that the cryptocurrencies are suitable as short-term safe havens during the extreme stock market drops. Also, they show that Ethereum could be a safer than Bitcoin during the pandemic.

The accelerate contagion of COVID-19 has had harmful economic impacts in a strongly integrated world (He *et al.*, 2020). It may be a source of systematic risk (Sharif *et al.*, 2020). In this context, Batten *et al.* (2022) investigate the volatility transmission between the VIX and European GSIBs during the global financial crisis and the COVID-19 period. The findings show a negative time-varying link amongst European banks. Furthermore, in comparison to the GFC, this association was more visible during COVID-19. Abuzayed *et al.* (2021) assess the systemic distress risk spillover between the global stock market and individual stock markets. According to their results, markets in North America and Europe have received more marginal severe risk from the global market than other markets. They also demonstrated a high degree of integration in the stock market system's significant hazard risk.

From their part, Lahmiri and Bekiros (2020) investigated the impact of the COVID-19 pandemic on investor expectations. Their results showed that the portfolios composed of Gas and Silver, Gold and Silver, Brent and Silver, Bitcoin and Gas could be less risky than those composed of Bitcoin and other markets. Also, they showed that the VIX which represents the investor fear index demonstrated the lowest point of information disorder during the COVID-19 pandemic. The authors conclude that information identified by investors has not affected their level of fear. Lyócsa *et al.* (2020) used Google search volume activity (as a measure of investors' fear) to model stock price variation of ten stock market indices. They show that investors' attention has a significant predictive power for uncertainty of stock market. Besides, Google searches could predict variance in the future of market in the sample. Il may be a reliable tool in assessing the market risk. Lyócsa and Molnár (2020) used a nonlinear autoregressive model to evaluate the Stock market movements during the crisis period. They found that the high level of fear and market uncertainty increase the negative correlation of market returns.

In line with these research studies, some studies have focus on Islamic stock markets. Hassan *et al.* (2022) compare the safe-haven attributes of various assets to the major Gulf Cooperation Council (GCC) stock indexes during two periods of financial instability, namely the COVID-19 pandemic and the 2008 Global Financial Crisis, using a bivariate dynamic conditional correlation (DCC-GARCH). The results show that the sovereign bonds provided the best hedging benefits during the crises. Also, they Find that gold and silver, which were quite productive prior to the GFC, have been a poor option during the sanitary crisis. Finally, for investors holding GCC stock indices, the Japanese yen has emerged as a particularly secure alternative. During each crisis, both sector and stock indexes failed to protect investors most of the time. These results confirm the result of Hassan *et al.* (2022) who find that GCC equities market returns are sensitive to volatility and risk in global financial markets. Abdullahi (2021) investigates how Islamic indices responds to the pandemic crisis using the multivariate GARCH model (MGARCH). The results reveal that Islamic index are influenced by the crisis and their response are not different from the conventional counterpart. In other words, it follows the same herd behavior. The authors conclude that the transmission can easily spread from one Islamic index to another index. Haroon *et al.* (2021) analyze the nature of time-varying systematic risk for both conventional and non-conventional sectoral indices. They found that conventional equities indices demonstrate high risk that Islamic indices. However, both two indices illustrate a similar behavioral change. Based on these results, the authors conclude that investing in Islamic equities can offer to managers portfolio diversification opportunities due to the lower level of systematic risk (Umar and Gubareva, 2021).

Overall, previous studies have been inconclusive. There is no reliable technique to compute it, despite various efforts to discover an acceptable mechanism.

Methodology and data

Internal model approach: stressed VaR (sVaR)

Through VaR estimate methodologies, the IMA is utilized to determine the market risk MCR. ($MCR_{Bâle\,II}$). Five models were applied —namely the RiskMetrics, GARCH, FYGARCH and SPLINE-GARCH (developed by Engle and Rangel (2008)) approaches—under three innovations (normal, Student and skewed-Student) and the extreme value theory, denoted (EVT). In order to test the reliability of the models in assessing the VaR of each market, the BCBS's mandates is followed, namely day-to-day time horizons and one-tailed calculations performed at a 99% confidence level (BCBS, 1996; BCBS, 2004).Then, backtesting is employed before applying a traffic light method in which the internal models were allocated among three groups (red, yellow and green). In the next step, the sVaR is calculated based on the recommendations of the BCBS (BCBS, 2009a; BCBS, 2009b) to increase the $MCR_{Bâle\,II}$. Table 1 presents the stressed periods for the indices. Finally, the $MCR_{Bâle\,2.5}$ is computed according to the BCBS's mandates.

	N	Estimation period	Forecasting period	Stress period
Bahrain	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	28/05/2018–13/05/2019 250 observations
FM ex GCC	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	04/01/2018–19/12/2018 250 observations
Kuwait	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	23/11/2016–07/11/2017 250 observations
Morocco	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	11/06/2018–24/05/2019 250 observations
Oman	967	15/09/2016–14/06/2019 717 observations	15/06/2019–14/09/2020 250 observations	24/02/2017–08/02/2018 250 observations
Qatar	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	28/03/2017–12/03/2018 250 observations
Saudi Arabia	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	29/05/2018–13/05/2019 250 observations
Turkey	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	28/08/2017–10/08/2018 250 observations
UAE	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	30/05/2018–14/05/2019 250 observations
WORLD	1,043	15/09/2016–30/09/2019 793 observations	1/10/2019–14/09/2020 250 observations	21/02/2017–05/02/2018 250 observations

Note(s): N represents the number of observations. The whole sample is divided in two sub-sample: the estimation sample (in-sample) and the forecasting sample (out of sample)
Source(s): Table created by authors

Table 1.
The number of observations and the sample periods

Data

Daily observations were selected for ten Islamic stock market indices: Bahrain, Frontier Markets (FM) ex GCC, Kuwait, Morocco, Oman, Qatar, Saudi Arabia, Turkey, the world and the United Arab Emirates (UAE). Table 1 shows the sample period and the number of observations. To obtain the daily returns, the differences between the logs of the daily prices are computed. The data were obtained from the MSCI database.

To evaluate one-day-ahead VaR predictions, the procedure of Hansen and Lunde (2005) are applied. The entire sample is divided into two sub-samples, estimation and forecasting, before performing a forecasting evaluation for the previous year (about 250 trading days). This period was characterized by a high degree of financial volatility due to the COVID-19 pandemic. Both periods complied with BCBS standards and were consistent with current risk-measurement standards.

Results

Stylized facts about the data

Table 2 provides the descriptive statistics. On average, the daily returns are not different from zero, indicating that the Islamic equities markets were stable during the entire period. During the forecasting period, however, all the ethical stock market index returns were negative, with the exceptions of Kuwait and Saudi Arabia, thus confirming the impact of the pandemic health crisis on the performance of the indices (Li *et al.*, 2022).

Table 3 presents the summary statistics it reveals that all the indices were negatively skewed. In addition, the higher values for the Jarque and Bera tests indicate a non-normal distribution. The values of the kurtosis statistics range from 7,191 for Turkey to 101,830 for Kuwait. In addition, the significant values confirm a fat-tail distribution. The Q-statistic of Ljung and Box (1978) related to the 5th, 10 th and 20 th lags can be used to identify a strong serial correlation, and tests for the series of the squared returns, as well as the ARCH tests, on 5th, 10th and 20th lags indicate the presence of ARCH properties for all series (Engle, 1982). Finally, The findings of Dickey and Fuller's (1981) augmented Dickey–Fuller (ADF) unit root tests demonstrate the stationarity of the returns series.

Basel II framework

Backtesting techniques and regulatory capital

Table 4 displays the violations number for each VaR model and their proportion in the forecasting period. According to BCBS (1996), the model that offers the fewest violations is the most efficient. We found that the RiskMetrics model underestimates VaR for almost the entire sample, with Kuwait being the exception because it is a less-volatile market. The application of the GARCH family of models under different distributions delivers slightly more accurate forecasts than the RiskMetrics one. On the other hand, though, it needs a more detailed consideration because the findings fluctuate in function of the exposure.

Looking at the red zone, all models give very poor forecasts for FM ex GCC, Morocco, Oman, the UAE and the World Islamic index. However, the SPLINE-GARCH gives marginally improved forecasts for Bahrain, Kuwait, Oman, Qatar and Saudi Arabia, but it cannot avoid the yellow zone for Turkey's Islamic index. When analyzing the individual models, we found that the models under a normal distribution (i.e., RiskMetrics, GARCH, FYGARCH) are shown to be inadequate. However, the Student and skewed-Student models relieve the load on shareholders as they run off, meaning extra capital in Bahrain, Kuwait, Oman, Qatar, —and Saudi Arabia (Spline, GARCH), as well as Turkey (GARCH—,

Table 2.
Descriptive statistics

	Full sample		Estimation sample				Forecasting sample			
	Mean	SD	M	SD	Max	Min	M	SD	Max	Min
Bahrain	−0.044	1,489	−0.046	1,47	14,29	−8,709	−0.039	1,547	6,284	−13,094
FM ex GCC	−0.008	0.695	0.002	0.543	2,554	−2,058	−0.039	1,037	3,811	−5,759
Kuwait	0.053	1,369	0.067	0.99	4,754	−6,222	0.007	2,17	5,525	−23,828
Morocco	0.001	1,088	0.006	0.872	3,496	−4,427	−0.012	1,591	7,034	−10,114
Oman	−0.06	1,267	−0.058	1,097	7,44	−6,643	−0.066	1,66	4,653	−15,181
Qatar	0.005	1,103	0.008	1,05	5,642	−8,358	−0.004	1,255	4,333	−12,111
Saudi Arabia	0.027	1,148	0.035	0.935	5,258	−5,559	0.004	1,651	8,033	−15,978
Turkey	0.002	2,022	0.007	2,031	8,666	−17,399	−0.012	1,995	7,229	−8,733
UAE	−0.041	1,357	−0.026	0.985	5,418	−4,151	−0.089	2,145	9,291	−18,163
World	0.02	0.968	0.021	0.609	2,455	−2,861	0.019	1,654	8,263	−10,189

Note(s): M, SD, Max and Min represents the arithmetic mean, standard deviation, the maximum and the minimum
Source(s): Authors' own work

Table 3. Descriptive statistics of the daily logarithmic stock indexes returns

	Skewness	Excess kurtosis	Jarque-bera	ARCH [5]-test	ARCH [10]-test	Q (5)	Q (10)	Q (20)	$Q^2(5)$	$Q^2(10)$	$Q^2(20)$	ADF
Bahrain	−0.449 [0.000] **	19,280 [0.000] **	15,010 [0.000] **	9,288 [0.000] **	5,194 [0.000] **	19,016 [0.001] **	31,125 [0.000] **	37,098 [0.011]*	52,360 [0000]**	62,057 [0000]**	65,671 [0000]**	−16,113
FM ex GCC	−1,172 [0.000] **	10,919 [0.000]**	5,420 [0.000]**	56,542 [0.000]**	51,765 [0.000]**	60,039 [0.000] **	90,989 [0.000] **	111,866 [0.000] **	352,888 [0.000] **	747,472 [0.000] **	890,554 [0.000]**	−15,439
Kuwait	−6,212 [0.000]**	101,830 [0.000]**	457,340 [0.000]**	30,976 [0.000]**	16,977 [0.000]**	68,281 [0.000] **	83,096 [0.000] **	103,689 [0.000] **	137,056 [0.000] **	138,769 [0.000] **	142,774 [0.000]**	−18,661
Morocco	−1,413 [0.000]**	17,326 [0.000]**	12,417 [0.000]**	138,010 [0.000]**	75,041 [0.000]**	21,708 [0.000] **	31,914 [0.000] **	42,160 [0.000] **	659,623 [0.000] **	724,296 [0000]**	732,351 [0000]**	−15,821
Oman	−2,390 [0.000]**	28,779 [0.000]**	34,292 [0.000]**	2,114 [0.061]	2,375 [0.008]**	3,649 [0.000] **	6,463 [0.000] **	17,892 [0.000] **	12,141 [0329*	28,074 [0.001] **	36,817 [0000]**	−17,236
Qatar	−1,618 [0.000]**	19,594 [0.000]**	17,139 [0.000]**	3,970 [0.001]**	3,130 [0.000]**	4,081 [0.000] **	9,057 [0.000] **	15,907 [0.000] **	20,754 [0.000] **	35,907 [0.000] **	59,122 [0.000]**	−18,369
Saudi. Arabia	−2,565 [0.000]**	40,332 [0.000]**	66,601 [0.000]**	14,204 [0.000]**	7,880 [0.000]**	45,139 [0.000] **	61,343 [0.000] **	93,243 [0.000] **	71,501 [0.000] **	80,732 [0000]**	83,428 [0000]**	−16,549
Turkey	−0.709 [0.000]**	7,191 [0.000]**	2,335 [0.000]**	20,739 [0.000]**	10,979 [0.000]**	16,418 [0.000] **	22,590 [0.000] **	32,613 [0.000] **	128,047 [0.000] **	133,530 [0.000] **	143,645 [0.000]**	−20,053
UAE	−2,682 [0.000]**	40,427 [0.000]**	67,009 [0.000]**	25,144 [0.000]**	14,218 [0.000]**	53,899 [0.000] **	56,343 [0.000] **	107,982 [0.000] **	132,361 [0.000] **	141,201 [0.000] **	225,631 [0.000]**	−15,785
World	−1,616 [0.000]**	25,844 [0.000]**	29,479 [0.000]**	74,676 [0.000]**	51,093 [0.000]**	43,679 [0.000] **	156,473 [0.000] **	203,345 [0.000] **	536,027 [0.000] **	928,320 [0.000] **	1,096,110 [0.000]**	−15,864

Note(s): The columns provide the Skewness, J-B is the Jarque and Bera (1980) normality test, the Skewness-Kurtosis test and,Q(i)and $Q(i)^2$are the Ljung and Box (1978) Q-statistics test for *i* lag, respectively, for returns and squared returns, Numbers in square brackets [ ] are *p*-values, ADF (Augmented Dickey Fuller) Test is is used to test the stationary of the series. The end date of the sample for all markets is 14/09/2020. *, ** and *** denote significance at 1, 5 and 10%, respectively
Source(s): Authors' own work

Table 4.
Backtesting-the three-zone approach

	RM	GARCH			FIGARCH			Spline-GARCH			EVT
		Normal	St	Sk-t	Normal	St	Sk-t	Normal	St	Sk-t	
Bahrain	11	6	5	6	6	5	6	6	2	2	1
	Red	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green
	4%	2%	2%	2%	2%	2%	2%	2%	1%	1%	0.4%
FM ex GCC	21	21	19	21	21	19	21	25	24	24	3
	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green
	8%	8%	8%	8%	8%	8%	8%	10%	10%	10%	1.2%
KUWAIT	4	8	8	8	8	8	8	4	4	3	3
	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green	Green
	2%	3%	3%	3%	3%	3%	3%	2%	2%	1%	1.2%
Morocco	29	13	12	12	13	12	12	13	13	13	3
	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green
	12%	5%	5%	5%	5%	5%	5%	5%	5%	5%	1.2%
Oman	11	11	11	11	11	11	11	11	13	3	3
	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green	Green
	4%	4%	4%	4%	4%	4%	4%	4%	5%	1%	1.2%
QATAR	7	6	5	5	5	5	5	6	2	1	1
	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green
	3%	2%	2%	2%	2%	2%	2%	2%	1%	0%	1.2%
Saudi Arabia	11	11	11	8	11	9	8	11	2	4	2
	Red	Red	Red	Yellow	Red	Yellow	Yellow	Red	Green	Green	Green
	4%	4%	4%	3%	4%	4%	3%	4%	1%	2%	0.8%
Turkey	7	5	3	3	5	3	3	7	5	5	4
	Yellow	Yellow	Green	Green	Yellow	Green	Green	Yellow	Yellow	Yellow	Green
	3%	2%	1%	1%	2%	1%	1%	3%	2%	2%	1.6%
UAE	20	14	12	12	14	12	12	12	12	12	3
	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green
	8%	6%	5%	5%	6%	5%	5%	5%	5%	5%	1.2%
World	26	23	22	25	23	22	23	30	30	31	3
	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Green
	10%	9%	9%	10%	9%	9%	9%	12%	12%	12%	1.2%

Note(s): N: normal distribution, St: Student and Sk-t: skewed Student distribution. The green Zone implies that the number of exceptions between 0 and 4. The yellow zone implies that the Number of exceptions between 5 and 9. The red zone implies that the Number of exceptions equal or greater than 10
Source(s): Authors' own work

FYGARCH). Similar findings have been revealed for the MENA Islamic indices during the "Arab Spring" (Assaf, 2015; Ben Ayed *et al.*, 2020). Finally, EVT is clearly a suitable approach to rely upon during stressed periods, such as that of the pandemic crisis. This corroborates the study of Assaf (2009), who found that EVT provides more precise information than other estimation techniques for the MENA equity markets.

The current basel reforms

According to the BCBS (2009a), the best performing models are those that derive higher VaR estimates. Values in bold characters represent models in the Red Zone in backtesting. Underlined values indicate that the model gives a good accurate VaR estimates. Values in italic fonts designates that the model gives the best accurate VaR estimates. The results presented in Table 5 show that VaR models under the normal innovation distributions do the worst job for the markets, with the dominance of the skewed-Student innovation being again confirmed. Unsurprisingly, EVT shows very good forecast performance for all the market indices. Moreover, some approaches that may possibly produce lower capital levels than EVT show fairly good performance, but they are still insufficient in some cases (e.g., Spline-GARCH-St-t/Spline-GARCH-Sk-t for Bahrain, Kuwait, Qatar and Saudi Arabia). In addition, the skewed-Student FIGARCH/GARCH model performs exceptionally well for Turkey, although it falls within the yellow zone, raising doubts about its all-purpose forecasting adequacy.

Basel 2.5 framework

The results for the VaR and MCR levels during the stress period are reported in Table 6. The concept behind the sVaR is identical to that of the basic VaR, with the exception that it should be carried out during a 250-day period of continuous havoc for the institution's financial situation (BCBS, 2009a). The results confirm that the RiskMetrics model is invalid during turbulent periods, such as the COVID-19 pandemic. In addition, the superiority of the models based on the skewed-Student innovation was again confirmed. For EVT, we get a similar result to that reported in Table 5 in that it gives accurate forecasts and outperforms the Student and skewed-Student innovations for most markets, with the exceptions being Kuwait, Oman and Qatar.

Looking at Table 7, It is clear how, except for Kuwait, Oman and Qatar, EVT offers superior predictions than other models based on asymmetric distribution. In these markets, the skewed-Student Spline-GARCH model shows satisfactory performance.

Table 8 describes the sum of the two components in equation (1) for the MCR as mandated by Basel II.5. As with our previous findings, the poor forecasting performance of RiskMetrics is again confirmed. It failed again to beat the GARCH family of models. For most indices, the Spline-GARCH model under the asymmetric distributions (Student and skewed-Student) demonstrates better forecasting performance. Finally, the EVT again performed well for most cases, with the exceptions being Bahrain, Kuwait and Oman.

Table 9 reports the corresponding variations for the MCR, revealing that the new Basel reform provides adequate coverage for losses higher than the current MCR. The results support the efforts of the BCBS in seeking to maintain financial stability. In this context, the implementation of the sVaR achieves this goal. It can therefore help Islamic financial institutions to strengthen their capital base through adding the capital buffers based on the sVaR. On average, the variation ranged from 60% for the world Islamic market to 106% for the Bahrain stock market, and this is in line with previous studies for emerging and frontier stock markets (Rossignolo *et al.*, 2012, 2013).

Table 5.
MCR(VaR) – current directives

		Bahrain	FM ex GCC	Kuwait	Morocco	Oman	Qatar	Saudi	Turkey	UAE	World
RM	N	*1,83*	*1,546*	3,818	*1,868*	*2,592*	1,991	*2,212*	3,259	*2,677*	*1,614*
GARCH		*3,374*	*1,586*	2,469	*2,358*	*2,542*	2,18	*2,252*	*4,602*	*2,931*	*1,733*
FIGARCH		3,248	*1,576*	2,558	*2,3*	*2,559*	*2,393*	*2,265*	4,72	*2,944*	*1,763*
Spline-G		2,87	*1,402*	*4,051*	*2,242*	*2,273*	2,201	2,286	3,358	*3.189*	*1,492*
GARCH	St	*3,602*	*1,677*	2,638	*2,565*	*2,417*	2,668	*2,252*	5,239	*3,155*	*1,787*
FIGARCH		*3,486*	*1,661*	2,797	*2,495*	*2,427*	2,636	2,406	5,29	*3,164*	*1,82*
Spline-G		*7,523*	*1,435*	*4,142*	*2,33*	*2,033*	*3,707*	6,84	4,743	*3,632*	*1,519*
GARCH	Sk-t	3,447	*1,623*	2,752	*2,512*	*2,248*	2,742	*2,477*	5,205	*3,127*	*1,691*
FIGARCH		3,337	*1,616*	2,851	*2,447*	*2,225*	2,715	2,5	*5,241*	*3,127*	*1,731*
Spline-G		*7,311*	*1,435*	4,28	*2,266*	7,428	3,971	*3,941*	4,738	*3,613*	*1,443*
EVT		6,332	1,121	4,32	2,63	7,522	4,257	7,258	6,235	5,588	2,666

Note(s): Values in italic letters indicate models belonging to the Red Zone in Backtesting. Values in italic underline fonts indicate that the model provides the best accurate VaR estimates. N, St-t and Sk-t are successively the, normal, Student and skewed Student distribution
Source(s): Authors' own work

		Bahrain	FM ex GCC	Kuwait	Morocco	Oman	Qatar	Saudi	Turkey	UAE	World
RM	N	*3,046*	*1,174*	2,228	*1,28*	*1,266*	4,434	*1,917*	6,089	*1,956*	*0,942*
GARCH		2,657	*1,159*	2,186	*1,332*	*2,239*	2,304	*2,163*	5,806	*2,128*	*1,04*
FIGARCH		*2,756*	*1,183*	2,157	*1,355*	*2,192*	3,444	*2,139*	5,707	*2,265*	*0,957*
Spline-G		2,695	*1,223*	*2,446*	*1,158*	*2,541*	*3,793*	2,481	*6,484*	*2,326*	*1,025*
GARCH	St-t	2,812	*1,281*	2,354	*1,691*	*2,144*	3,946	*2,163*	6,245	*2,494*	*1,102*
FIGARCH		2,953	*1,326*	*3,249*	*1,562*	*1,83*	3,924	2,203	6,031	*2,594*	*1,009*
Spline-G		*3,08*	*1,37*	3,004	*1,466*	*3,1*	*4,867*	*2,558*	*6,518*	*2,834*	*1,095*
GARCH	Sk-t	2,656	*1,206*	2,503	*1,644*	*1,863*	4,051	*2,357*	*6,211*	*2,451*	*1,012*
FIGARCH		2,809	*1,26*	2,638	*1,519*	*1,733*	4,026	2,296	5,974	*2,535*	*0,94*
Spline-G		*2,999*	*1,37*	*3,181*	*1,41*	*2,642*	*5,124*	*2,54*	*6,509*	*2,787*	*1,009*
EVT		*2,999*	*2,010*	*3,221*	*1,897*	*2,789*	*5,222*	*2,569*	*6,520*	*2,222*	*2,089*

Note(s): Values in italic letters indicate models belonging to the Red Zone in Backtesting. Values in italic underline fonts indicate that the model provides the best accurate VaR estimates. N, St-t and Sk-t are successively the, normal, Student and skewed Student distribution
Source(s): Table created by authors

Table 6.
250-day average VaR (stressed period)

Table 7.
MCR (stressed period)

Model		Bahrain	FM ex GCC	Kuwait	Morocco	Oman	Qatar	Saudi	Turkey	UAE	World
RM	N	*3,225*	*1,358*	2,536	*1,589*	*1,91*	2,587	*2,096*	4,102	*2,329*	*0,902*
GARCH		3,232	*1,325*	2,425	*1,731*	*2,304*	2,634	*2,157*	4,256	*2,332*	*1,053*
FIGARCH		3,223	*1,341*	2,465	*1,685*	*2,239*	2,585	*2,137*	4,155	*2,3*	*0,996*
Spline-G		*3,563*	*1,374*	*2,656*	*1,604*	*2,385*	*2,738*	*2,402*	*4,564*	*2,345*	*0,992*
GARCH	St-t	3,443	*1,436*	2,643	*2,031*	*2,152*	2,759	*2,157*	4,823	*2,649*	*1,107*
FIGARCH		3,441	*1,457*	2,705	*1,934*	*2,131*	2,768	2,301	4,641	*2,615*	*1,054*
Spline-G		*4,206*	*1,529*	*3,054*	*1,922*	*2,964*	*3,878*	*2,676*	*4,976*	*2,896*	*1,044*
GARCH	Sk-t	3,287	*1,363*	2,776	*1,967*	*1,876*	2,835	2,421	4,79	*2,609*	*1,002*
FIGARCH		3,294	*1,391*	3,054	*1,875*	*1,86*	2,849	2,397	4,597	*2,562*	*0,969*
Spline-G		*4,108*	*1,529*	*3,214*	*1,84*	*2,671*	*4,121*	*2,62*	*4,969*	*2,848*	*0,952*
EVT		*4,215*	*1,5*	2,263	*1,999*	1,899	*3,92*	*2,786*	*4,997*	*2,848*	*1,255*

Note(s): Values in italic letters indicate models belonging to the Red Zone in Backtesting. Values in italic underline fonts indicate that the model provides the best accurate VaR estimates. N, St-t and Sk-t are successively the, normal, Student and skewed Student distribution
Source(s): Authors' own work

Model		Bahrain	FM ex GCC	Kuwait	Morocco	Oman	Qatar	Saudi	Turkey	UAE	World
RM	N	*5,055*	*2,904*	6,354	*3,457*	*4,502*	4,578	*4,308*	7,361	*5,006*	*2,516*
GARCH		6,606	*2,911*	4,894	*4,089*	*4,846*	4,814	*4,409*	8,858	*5,263*	*2,786*
FIGARCH		*6,471*	*2,917*	5,023	*3,985*	*4,798*	*4,978*	*4,402*	*8,875*	*5,244*	*2,759*
Spline-G		6,433	*2,776*	*6,707*	*3,846*	*4,658*	4,939	*4,688*	7,922	*5,534*	*2,484*
GARCH	St-t	7,045	*3,113*	5,281	*4,596*	*4,569*	5,427	*4,409*	*10,062*	*5,804*	*2,894*
FIGARCH		6,927	*3,118*	5,502	*4,429*	*4,558*	5,404	4,707	9,931	*5,779*	*2,874*
Spline-G		*11,729*	*2,964*	*7,196*	*4,252*	*4,997*	*7,585*	*9,516*	9,719	*6,528*	*2,563*
GARCH	Sk-t	6,734	*2,986*	5,528	*4,479*	*4,124*	5,577	*4,898*	*9,995*	*5,736*	*2,693*
FIGARCH		6,631	*3,007*	5,905	*4,322*	*4,085*	5,564	4,897	9,838	*5,689*	*2,7*
Spline-G		*11,419*	*2,964*	*7,494*	*4,106*	10,099	*8,092*	*6,561*	9,707	*6,461*	*2,395*
EVT		*10,547*	*2,621*	*6,583*	*4,629*	*9,421*	*8,177*	*10,044*	*11,232*	*8,436*	*3,921*

Note(s): Values in italic letters indicate models belonging to the Red Zone in Backtesting. Values in italic underline fonts indicate that the model provides the best accurate VaR estimates. N, St-t and Sk-t are successively the, normal, Student and skewed Student distribution
Source(s): Authors' own work

Table 8.
$MCR_{Basel\,2.5}$

Table 9.
Variation in MCR = $(MCR_{Basel\,2.5}/MCR) - 1$

Model		Bahrain	FM ex GCC	Kuwait	Morocco	Oman	Qatar	Saudi	Turkey	UAE	World
RM	N	*176%*	*88%*	66%	*85%*	*74%*	130%	*95%*	126%	*87%*	*56%*
GARCH		96%	*84%*	98%	*73%*	*91%*	121%	*96%*	92%	*80%*	*61%*
FIGARCH		99%	*85%*	96%	*73%*	*87%*	108%	*94%*	88%	*78%*	*56%*
Spline-G		124%	*98%*	66%	*72%*	*105%*	124%	105%	136%	*74%*	*66%*
GARCH	St-t	96%	*86%*	100%	*79%*	*89%*	103%	*96%*	92%	*84%*	*62%*
FIGARCH		99%	*88%*	97%	*78%*	*88%*	105%	96%	88%	*83%*	*58%*
Spline-G		56%	*107%*	74%	*82%*	*146%*	105%	39%	105%	*80%*	*69%*
GARCH	Sk-t	95%	*84%*	101%	*78%*	*83%*	103%	*98%*	92%	*83%*	*59%*
FIGARCH		99%	*86%*	107%	*77%*	*84%*	105%	96%	88%	*82%*	*56%*
Spline-G		56%	*107%*	75%	*81%*	36%	104%	66%	105%	*79%*	*66%*
EVT		67%	134%	52%	76%	25%	92%	38%	80%	51%	47%

Note(s): Values in italic letters indicate models belonging to the Red Zone in Backtesting. Values in italic underline fonts indicate that the model provides the best accurate VaR estimates. N, St-t and Sk-t are successively the, normal, Student and skewed Student distribution
Source(s): Authors' own work

Conclusion

In 2009, the BCBS introduced the sVaR to ensure the stability of financial institutions by strengthening their capital structure and preparing them for any distress in the financial markets.in this study, we assess the performance during the pandemic of COVID of different VaR models to compute MCR under Basel II and Basel II.5. To this end, we selected ten sharia-compliant market indexes for the period from September 15, 2016 to September 14, 2020. We explore the performance of five techniques, namely RiskMetrics, GARCH, FYPARCH, Spline-GARCH, and EVT. We firstly found that the RiskMetrics modes shows bad forecasting performance compared to the GARCH family of models. However, more sophisticated models, such as the Spline-GARCH model, provide the most accurate VaR forecasts. Moreover, VaR models below the skewed-Student distribution outperforms than those below the normal and Student innovations. Finally, EVT is the most preferred, because it provides the worthiest backtesting results and is strong with respect to the assessment.

In summary, the results suggest that the introduction of the sVaR has accomplished the main objectives of the BCBS, because it will lead to a growth in the MCR for market risk. In addition, we also found that the COVID-19 pandemic had exerted a significant impact on VaR estimates. The empirical findings support that heavy-tailed distributions, particularly EVT, could have helped shield financial institutions from the huge losses caused by the pandemic crisis.

This paper offers some important implications about the pandemic's effects in terms of the precision of VaR models for ethical investment equity indices. Thus, given the specific nature of Islamic financial institutions (IFI), regulatory authorities should take into account the specific risks that could increase their exposure and lead to excessive capital charges. According to the Ben Ayed *et al.* (2020) and IFSB (2017) there are A few non-conventional commercial banks use IMA to estimate their market capital. Hence, The IFSB should strengthen market discipline measures (Pillar 3 of Basel II) and continue to review the significance of IFIs in times of market turbulence.

From our standpoint, this empirical investigation has enhanced our perception of market risk management for IFIs' assets. Given the particularity of countries with dual-banking systems, the adoption of IFRS should improve the disclosure of firms' market positions, generate a more secure environment for investors, and reinforce protections for shareholders. For their part, central banks and national authorities should engage with the Basel/IFSB reform agenda to harmonize their regulations, and they should implement macro-prudential reforms to protect their financial system from volatility in the financial cycle.

Since the publication of the 1996 amendment, the VaR has been considered a reliable tool for measuring market risk. Despite the drawbacks that have arisen, however, the committee decided to stick with it until at least 2022, the expected year for the full adoption of Basel III. Nevertheless, the fact that the BCBS has initiated a call for discussion about replacing the VaR with an alternative measure of market risk, namely the Expected Shortfall, leads us to hope that regulators have finally come to appreciate that market risk cannot be represented by a single number.

References

Abad, P. and Benito, S. (2013), "A detailed comparison of value at risk estimates", *Mathematics and Computers in Simulation*, Vol. 94 No. 8, pp. 258-276.

Abad, P., Benito, S. and López, C. (2014), "A comprehensive review of Value at Risk methodologies", *The Spanish Review of Financial Economics*, Vol. 12 No. 1, pp. 15-32.

Abdullahi, S.I. (2021), "Islamic equities and COVID-19 pandemic: measuring Islamic stock indices correlation and volatility in period of crisis", *Islamic Economic Studies*, available at: https://doi.org/10.1108/IES-09-2020-0037 (accessed 8 June 2021).

Abuzayed, B. and Al-Fayoumi, N. (2021), "Risk spillover from crude oil prices to GCC stock market returns: new evidence during the COVID-19 outbreak", *The North American Journal of Economics and Finance*, Vol. 58 No. 4, 101476.

Abuzayed, B., Bouri, E., Al-Fayoumi, N. and Jalkh, N. (2021), "Systemic risk spillover across global and country stock markets during the COVID-19 pandemic", *Economic Analysis and Policy*, Vol. 71 No. 1, pp. 180-197.

Akhtaruzzaman, M., Boubaker, S. and Sensoy, A. (2021), "Financial contagion during COVID–19 crisis", *Finance Research Letters*, Vol. 38 No. 1, 101604.

Alemany, R., Bolancé, C. and Guillén, M. (2013), "A nonparametric approach to calculating value-at-risk", *Insurance: Mathematics and Economics*, Vol. 52 No. 2, pp. 255-262.

Ali, M., Alam, N. and Rizvi, S.A.R. (2020), "Coronavirus (COVID-19) — an epidemic or pandemic for financial markets", *Journal of Behavioral and Experimental Finance*, Vol. 27 No. 3, 100341.

Aloui, C. and Mabrouk, S. (2010), "Value-at-risk estimations of energy commodities via long-memory, asymmetry and fat-tailed GARCH models", *Energy Policy*, Vol. 38 No. 5, pp. 2326-2339.

Ané, T. (2006), "An analysis of the flexibility of Asymmetric Power GARCH models", *Computational Statistics and Data Analysis*, Vol. 51 No. 2, pp. 1293-1311.

Angelidis, T., Benos, A. and Degiannakis, S. (2007), "A robust VaR model under different time periods and weighting schemes", *Review of Quantitative Finance and Accounting*, Vol. 28 No. 2, pp. 187-201.

Ashraf, B.N. (2020), "Economic impact of government interventions during the COVID-19 pandemic: international evidence from financial markets", *Journal of Behavioral and Experimental Finance*, Vol. 27 No. 3, 100371.

Assaf, A. (2009), "Extreme observations and risk assessment in the equity markets of MENA region: tail measures and Value-at-Risk", *International Review of Financial Analysis*, Vol. 18 No. 3, pp. 109-116.

Assaf, A. (2015), "Value-at-Risk analysis in the MENA equity markets: fat tails and conditional asymmetries in return distributions", *Journal of Multinational Financial Management*, Vol. 29 No. 1, pp. 30-45.

Baillie, R.T., Bollerslev, T. and Mikkelsen, H.O. (1996), "Fractionally integrated generalized autoregressive conditional heteroskedasticity", *Journal of Econometrics*, Vol. 74 No. 1, pp. 3-30.

Bali, T.G. and Theodossiou, P. (2007), "A conditional-SGT-VaR approach with alternative GARCH models", *Annals of Operations Research*, Vol. 151 No. 1, pp. 241-267.

Batten, J.A., Choudhury, T., Kinateder, H. and Wagner, N.F. (2022), "Volatility impacts on the European banking sector: GFC and COVID-19", *Annals of Operations Research*, doi: 10.1007/s10479-022-04523-8.

BCBS (1996), "Amendment to the capital accord to incorporate market risks".

BCBS (2004), International Convergence of Capital Measurement and Capital Standards. Basel Committee on Banking Supervision, Bank for International Settlements, Basel, Switzerland.

BCBS (2009a), "Revisions to the Basel II market risk framework".

BCBS (2009b), *Strengthening the Resilience of the Banking Sector*, Basel, Switzerland: Basel Committee on Banking Supervision, Bank for International Settlements.

BCBS (2016), "Minimum capital requirements for market risk".

BCBS (2019), *Basel III Monitoring Report*, Basel Committee on Banking Supervision, Bank for International Settlements, Basel, Switzerland.

Beder, T.S. (1995), "VaR: seductive but dangerous", *Financial Analysts Journal*, Vol. 51 No. 5, pp. 12-24.

Bekiros, S.D. and Georgoutsos, D.A. (2005), "Estimation of Value-at-Risk by extreme value and conventional methods: a comparative evaluation of their predictive performance", *Journal of International Financial Markets, Institutions and Money*, Vol. 15 No. 3, pp. 209-228.

Ben Ayed, W., Fatnassi, I. and Maatoug, A.B. (2020), "Selection of value-at-risk models for MENA islamic indices", *Journal of Islamic Accounting and Business Research*, Vol. 11 No. 9, pp. 1689-1708.

Ben Maatoug, A., Ben Ayed, W. and Ftiti, Z. (2019), "Are MENA banks' capital buffers countercyclical? Evidence from the Islamic and conventional banking systems", *The Quarterly Review of Economics and Finance*, Vol. 74 No. 4, pp. 109-118.

Berner, R. (2010), "Stress VaR and systemic risk indicators", in IMF Conference on Operationalizing Systemic, Morgan Stanley Working Paper, New York, NY, 28 May 2010.

Bollerslev, T. (1986), "Generalized autoregressive conditional heteroskedasticity", *Journal of Econometrics*, Vol. 31 No. 3, pp. 307-327.

Burchi, A. (2013), "Capital requirements for market risks", *Journal of Financial Regulation and Compliance*, Vol. 21 No. 3, pp. 284-304.

Castillo, B., León, Á. and Ñíguez, T.-M. (2021), "Backtesting VaR under the COVID-19 sudden changes in volatility", *Finance Research Letters*, Vol. 43, pp. 1-9.

Chau, F., Deesomsak, R. and Wang, J. (2014), "Political uncertainty and stock market volatility in the Middle East and North African (MENA) countries", *Journal of International Financial Markets, Institutions and Money*, Vol. 28 No. 1, pp. 1-19.

Chen, C.W., Watanabe, T. and Lin, E.M. (2021), "Bayesian estimation of realized GARCH-type models with application to financial tail risk management", Econometrics and Statistics, In Press, Corrected Proof, available at: https://doi.org/10.1016/j.ecosta.2021.03.006 (accessed 18 April 2021).

Choudhury, T., Kinateder, H. and Neupane, B. (2022), "Gold, bonds, and epidemics: a safe haven study", *Finance Research Letters*, Vol. 48, 102978.

Conlon, T. and McGee, R. (2020), "Safe haven or risky hazard? Bitcoin during the Covid-19 bear market", *Finance Research Letters*, Vol. 35, 101607.

Conlon, T., Corbet, S. and McGee, R.J. (2020), "Are cryptocurrencies a safe haven for equity markets? An international perspective from the COVID-19 pandemic", *Research in International Business and Finance*, Vol. 54 No. 4, 101248.

Degiannakis, S., Floros, C. and Livada, A. (2012), "Evaluating value-at-risk models before and after the financial crisis of 2008: international evidence", *Managerial Finance*, Vol. 38 No. 4, pp. 436-452.

Dickey, D.A. and Fuller, W.A. (1981), "Likelihood ratio statistics for autoregressive time series with a unit root", *Econometrica*, Vol. 49 No. 4, pp. 1057-1072.

Dimitrakopoulos, D.N., Kavussanos, M.G. and Spyrou, S.I. (2010), "Value at risk models for volatile emerging markets equity portfolios", *The Quarterly Review of Economics and Finance*, Vol. 50 No. 4, pp. 515-526.

Down, K. (2002), *Measuring Market Risk*, John Wiley & Sons, New York, NY.

Drenovak, M., Ranković, V., Ivanović, M., Urošević, B. and Jelic, R. (2017), "Market risk management in a post-Basel II regulatory environment", *European Journal of Operational Research*, Vol. 257 No. 3, pp. 1030-1044.

EBA (2012), "EBA guidelines on stressed value at risk", in Authority, E.B., ed. *European Banking Authority*, Working Paper No. EBA/GL/2012/2, 16 May 2012, London,.

Engle, R.F. (1982), "Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation", *Econometrica: Journal of the Econometric Society*, pp. 987-1007.

Engle, R.F. and Manganelli, S. (2004), "CAViaR: conditional autoregressive value at risk by regression quantiles", *Journal of Business and Economic Statistics*, Vol. 22 No. 4, pp. 367-381.

Engle, R.F. and Rangel, J.G. (2008), "The spline-GARCH model for low-frequency volatility and its global macroeconomic causes", *The Review of Financial Studies*, Vol. 21 No. 3, pp. 1187-1222.

FSA (2009), *The Turner Review: A Regulatory Response to the Global Banking Crisis*, London, available at: http://www.fsa.gov.uk (accessed October 2009).

FSI (2015), *Basel II, 2.5 and III Implementation*, Financial Stability Institute, Bank for International Settlements, Basel.

Gençay, R. and Selçuk, F. (2004), “Extreme value theory and Value-at-Risk: relative performance in emerging markets”, *International Journal of Forecasting*, Vol. 20 No. 2, pp. 287-303.

Gharib, C., Mefteh-Wali, S. and Jabeur, S.B. (2021), “The bubble contagion effect of COVID-19 outbreak: evidence from crude oil and gold markets”, *Finance Research Letters*, Vol. 38 No. 1, 101703.

Giannopoulos, K. and Tunaru, R. (2005), “Coherent risk measures under filtered historical simulation”, *Journal of Banking and Finance*, Vol. 29 No. 4, pp. 979-996.

Gibart, P. (2012), “Stressed VaR”, *European Institute of Financial Regulation Conference Paper, 07 February 2012, in Paris*.

González-Rivera, G., Lee, T.-H. and Mishra, S. (2004), “Forecasting volatility: a reality check based on option pricing, utility function, value-at-risk, and predictive likelihood”, *International Journal of Forecasting*, Vol. 20 No. 4, pp. 629-645.

Goodell, J.W. and Goutte, S. (2021), “Co-movement of COVID-19 and Bitcoin: evidence from wavelet coherence analysis”, *Finance Research Letters*, Vol. 38 No. 1, 101625.

Gu, B., Zhang, T., Meng, H. and Zhang, J. (2021), “Short-term forecasting and uncertainty analysis of wind power based on long short-term memory, cloud model and non-parametric kernel density estimation”, *Renewable Energy*, Vol. 164 No. 2, pp. 687-708.

Hansen, P.R. and Lunde, A. (2005), “A forecast comparison of volatility models: does anything beat a GARCH (1, 1)?”, *Journal of Applied Econometrics*, Vol. 20 No. 7, pp. 873-889.

Haroon, O., Ali, M., Khan, A., Khattak, M.A. and Rizvi, S.A.R. (2021), “Financial market risks during the COVID-19 pandemic”, *Emerging Markets Finance and Trade*, Vol. 57 No. 8, pp. 2407-2414.

Hassan, M.K., Djajadikerta, H.G., Choudhury, T. and Kamran, M. (2022), “Safe havens in Islamic financial markets: COVID-19 versus GFC”, *Global Finance Journal*, Vol. 54 No. 22, 100643.

Hassan, M.K., Kamran, M., Djajadikerta, H.G. and Choudhury, T. (2022), “Search for safe havens and resilience to global financial volatility: response of GCC equity indexes to GFC and Covid-19”, *Pacific-Basin Finance Journal*, Vol. 73, 101768.

He, Q., Liu, J., Wang, S. and Yu, J. (2020), “The impact of COVID-19 on stock markets”, *Economic and Political Studies*, Vol. 8 No. 3, pp. 275-288.

Hendricks, D. (1996), “Evaluation of Value-at-Risk Models Using Historical Data”, Economic Policy Review, Federal Reserve Bank of New York, April, 39-69.

Hull, J. and White, A. (1998), “Incorporating volatility updating into the historical simulation method for value-at-risk”, *Journal of Risk*, Vol. 1 No. 1, pp. 5-19.

IFSB (2017), *Islamic Financial Services Industry Stability Report 2017*, Bank Negara Malaysia, Islamic Financial Services Board, Kuala Lumpur.

IFSB (2020), *Islamic Financial Services Industry Stability Report 2020*, Bank Negara Malaysia, Islamic Financial Services Board, Kuala Lumpur.

Jarque, C.M. and Bera, A.K. (1980), “Efficient tests for normality, homoscedasticity and serial independence of regression residuals”, *Economics Letters*, Vol. 6 No. 3, pp. 255-259.

Kinateder, H., Campbell, R. and Choudhury, T. (2021), “Safe haven in GFC versus COVID-19: 100 turbulent days in the financial markets”, *Finance Research Letters*, Vol. 43, 101951.

Lahmiri, S. and Bekiros, S. (2020), “Renyi entropy and mutual information measurement of market expectations and investor fear during the COVID-19 pandemic”, *Chaos, Solitons and Fractals*, Vol. 139 No. 10, 110084.

Li, M.C., Lai, C.C. and Xiao, L. (2022), “Did COVID-19 increase equity market risk exposure? Evidence from China, the UK, and the US”, *Applied Economics Letters*, Vol. 29 No. 6, pp. 567-571.

Ljung, G.M. and Box, G.E. (1978), "On a measure of lack of fit in time series models", *Biometrika*, Vol. 65 No. 2, pp. 297-303.

Lyócsa, Š. and Molnár, P. (2020), "Stock market oscillations during the corona crash: the role of fear and uncertainty", *Finance Research Letters*, Vol. 36 No. 5, 101707.

Lyócsa, Š., Baumöhl, E., Výrost, T. and Molnár, P. (2020), "Fear of the coronavirus and the stock markets", *Finance Research Letters*, Vol. 36 No. 5, 101735.

Mabrouk, S. and Saadi, S. (2012), "Parametric Value-at-Risk analysis: evidence from stock indices", *The Quarterly Review of Economics and Finance*, Vol. 52 No. 3, pp. 305-321.

Mariana, C.D., Ekaputra, I.A. and Husodo, Z.A. (2021), "Are Bitcoin and Ethereum safe-havens for stocks during the COVID-19 pandemic?", *Finance Research Letters*, Vol. 38 No. 1, 101798.

Mazur, M., Dang, M. and Vega, M. (2021), "COVID-19 and the march 2020 stock market crash. Evidence from S&P 1500", *Finance Research Letters*, Vol. 38 No. 1, 101690.

McMillan, D.G. and Kambouroudis, D. (2009), "Are RiskMetrics forecasts good enough? Evidence from 31 stock markets", *International Review of Financial Analysis*, Vol. 18 No. 3, pp. 117-124.

McNeil, A.J. and Frey, R. (2000), "Estimation of tail-related risk measures for heteroscedastic financial time series: an extreme value approach", *Journal of Empirical Finance*, Vol. 7 No. 3, pp. 271-300.

Merton, R.C. (1980), "On estimating the expected return on the market: an exploratory investigation", *Journal of Financial Economics*, Vol. 8 No. 4, pp. 323-361.

Mokni, K. and Mansouri, F. (2011), "How long memory in volatility affects market risk estimation", in *The Impact of the Global Financial Crisis on Emerging Financial Markets*, Emerald Group Publishing.

Morgan, J. (1996), *Riskmetrics Technical Document*, 4th ed., J.P. Morgan, New York.

Mwamba, J.W.M., Hammoudeh, S. and Gupta, R. (2017), "Financial tail risks in conventional and Islamic stock markets: a comparative analysis", *Pacific-Basin Finance Journal*, Vol. 42 No. 2, pp. 60-82.

Naeem, M.A., Sehrish, S. and Costa, M.D. (2021), "COVID-19 pandemic and connectedness across financial markets", *Pacific Accounting Review*, Vol. 33 No. 2, pp. 165-178.

Okorie, D.I. and Lin, B. (2020), "Stock markets and the COVID-19 fractal contagion effects", *Finance Research Letters*, Vol. 38 No. 1, 101640.

Omari, C., Mundia, S. and Ngina, I. (2020), "Forecasting value-at-risk of financial markets under the global pandemic of COVID-19 using conditional extreme value theory", *Journal of Mathematical Finance*, Vol. 10 No. 04, p. 569.

Orhan, M. and Köksal, B. (2012), "A comparison of GARCH models for VaR estimation", *Expert Systems with Applications*, Vol. 39 No. 3, pp. 3582-3592.

Padhan, R. and Prabheesh, K. (2021), "The economics of COVID-19 pandemic: a survey", *Economic Analysis and Policy*, Vol. 70 No. 2, pp. 220-237.

Pengelly, M. (2011), "Stressed VAR questioned by risk managers", *Risk Magazine*, February, available at: https://www.risk.net/regulation/basel-committee/2024562/stressed-var-questioned-by-risk-managers (accessed 07 Feb 2011).

Pengelly, M. (2012), "Stressed VAR will hit forex options, dealers warn", FX Week, 31 August 2012, available: https://www.risk.net/foreign-exchange/2201589/stressed-var-will-hit-forex-options-dealers-warn (accessed 30 August 2012).

Pritsker, M. (1997), "Evaluating value at risk methodologies: accuracy versus computational time", *Journal of Financial Services Research*, Vol. 12 No. 2, pp. 201-242.

Pritsker, M. (2006), "The hidden dangers of historical simulation", *Journal of Banking and Finance*, Vol. 30 No. 2, pp. 561-582.

Prorokowski, L. and Prorokowski, H. (2014), "Comprehensive risk measure–current challenges", *Journal of Financial Regulation and Compliance*, Vol. 22 No. 4, pp. 339-348.

Rossignolo, A.F., Fethi, M.D. and Shaban, M. (2012), "Value-at-Risk models and Basel capital charges: evidence from Emerging and Frontier stock markets", *Journal of Financial Stability*, Vol. 8 No. 4, pp. 303-319.

Rossignolo, A.F., Fethi, M.D. and Shaban, M. (2013), "Market crises and Basel capital requirements: could Basel III have been different? Evidence from Portugal, Ireland, Greece and Spain (PIGS)", *Journal of Banking and Finance*, Vol. 37 No. 5, pp. 1323-1339.

Salisu, A.A. and Akanni, L.O. (2020), "Constructing a global fear index for the COVID-19 pandemic", *Emerging Markets Finance and Trade*, Vol. 56 No. 10, pp. 2310-2331.

Sharif, A., Aloui, C. and Yarovaya, L. (2020), "COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: fresh evidence from the wavelet-based approach", *International Review of Financial Analysis*, Vol. 70 No. 4, 101496.

Slim, S., Koubaa, Y. and BenSaïda, A. (2017), "Value-at-Risk under Lévy GARCH models: evidence from global stock markets", *Journal of International Financial Markets, Institutions and Money*, Vol. 46 No. 1, pp. 30-53.

Su, Q., Qin, Z., Peng, L. and Qin, G. (2021), "Efficiently backtesting conditional value-at-risk and conditional expected shortfall", *Journal of the American Statistical Association*, Vol. 116 No. 536, pp. 2041-2052.

Taylor, S.J. (1982), "Financial returns modelled by the product of two stochastic processes-a study of the daily sugar prices 1961-75", *Time Series Analysis: Theory and Practice*, Vol. 1 No. 1, pp. 203-226.

Umar, Z. and Gubareva, M. (2021), "Faith-based investments and the Covid-19 pandemic: analyzing equity volatility and media coverage time-frequency relations", *Pacific-Basin Finance Journal*, Vol. 67 No. 3, 101571.

Zaremba, A., Kizys, R., Aharon, D.Y. and Demir, E. (2020), "Infected markets: novel coronavirus, government interventions, and stock return volatility around the globe", *Finance Research Letters*, Vol. 35 No. 4, 101597.

Zhang, W.-G., Mo, G.-L., Liu, F. and Liu, Y.-J. (2018), "Value-at-risk forecasts by dynamic spatial panel GJR-GARCH model for international stock indices portfolio", *Soft Computing*, Vol. 22 No. 16, pp. 5279-5297.

Zhang, D., Hu, M. and Ji, Q. (2020), "Financial markets under the global pandemic of COVID-19", *Finance Research Letters*, Vol. 36 No. 1, 101528.

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