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Borsa İstanbul Review

Borsa İstanbul Review 22-S1 (2022) S47–S59

http://www.elsevier.com/journals/borsa-istanbul-review/2214-8450

Covid-19 pandemic, asset prices, risks, and their convergence: A survey of Islamic and G7 stock market, and alternative assets

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Received 5 August 2022; revised 16 November 2022; accepted 16 November 2022

Available online 21 November 2022

Abstract

The coronavirus (Covid-19) pandemic created a shock not only for the health-care industry but also the global economy and finances. The pandemic also caused an increase in the risk of investing in various financial assets worldwide. To investigate this phenomenon empirically, this study analyzes the behavior of financial assets through risk and return in the time of the Covid-19 outbreak, using the GARCH (Generalized Auto Regressive Conditional Heteroskedasticity) family methods. This study conducts a group analysis asset price performance, based on stock markets in Muslim-majority countries and the Group of Seven (G7) and alternative financial assets. This asset group is selected to represent the characteristics of the global financial market with possibly varied behavior. The results of the study show, first, that the severity of the pandemic had a negative effect on the price performance of some assets, such as Indonesia (Jakarta Islamic Index), the UK (United Kingdom100 Index, ESG (Environmental, Social, and Governance), commodities, 10-year US bonds, and Bitcoin, but the price performance of other assets went in the opposite direction, for example, Malaysia (FBMHS Index), the US (S&P 500 Index), and gold. Second, during the pandemic, most assets became more risky. Third, prices on G7 and Islamic stocks and alternative asset groups had different price and risk convergence patterns. The pandemic contributed to price differentials but not much changed in the risk patterns of the assets. Stock prices in the markets of Muslim-majority countries moved randomly—that is, they did not tend to converge in the pre-crisis period. However, before and during the pandemic, asset risk converged in the markets of Muslim-majority countries, which means that the risk of investing in assets there has long-term risk following the same pattern (i.e., if it increases in one country, assets in the other countries will follow). This pattern makes it easier for investors to observe and make risk decisions on investment in Islamic assets in Muslim-majority countries, so this investment in these assets is sustainable. This study suggests that investment managers diversify financial portfolios based on the type of assets and the severity of the pandemic and the policy response in the relevant country.
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JEL classification: G01; G15; G17

Keywords: Financial asset risks; GARCH family; Financial crisis; Convergence

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Peer review under responsibility of Borsa İstanbul Anonim Şirketi.

https://doi.org/10.1016/j.bir.2022.11.011

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1. Introduction

The spike in cases of coronavirus (Covid-19) globally triggered unprecedented risk for people and uncertainty in the global economy. As of June 21, 2022, the pandemic had spread to 230 countries, infected more than 545 million people, and resulted in the death of 6.3 million people. The rampant spread of the virus has caused many governments to implement policy responses, such as strict health protocols, curfews, and lockdowns. Both the spread of the virus and the lockdowns in response have had far-reaching impacts on all segments of the economy, including financial markets. In 2020, the global economy contracted by 3.4 percent, the most severe recession since World War II. In addition, the Organization for Economic Cooperation and Development (OECD; 2020) reported that when the pandemic began, the global stock market fell more than 30 percent. Further analyses confirm the negative impacts of Covid-19 on stock market performance in many major equity markets (Albulescu, 2021; Heyden & Heyden, 2021; Setiawan, Ben Abdallah, et al., 2021; Singh et al., 2020; Yilmazkuday, 2021). The precipitous decline in response to the global health crisis imperiled the portfolios of stockholders globally.

In times of high uncertainty and financial market fluctuation, investors search for safe-haven instruments. However, the crisis exacerbated volatility across financial asset classes (Le et al., 2021). Gold, for instance, is often considered a safe haven but failed to protect investment in this instance (O'Donnell et al., 2021). In addition, Conlon et al. (2020) and Disli et al. (2021) reveal that, in general, cryptocurrencies, perceived as providing a cushion against crisis, did not offer hedging benefits during the financial downturn. However, Mariana et al. (2021) show that Bitcoin and Ethereum were safe havens during the Covid-19 turmoil. Wang and Wang (2021) state that the Bitcoin market was more efficient and more resilient than the stock market, the US dollar index, and gold during the bear market due to the Covid-19 pandemic.

Several studies about portfolio diversification through the inclusion of multiple assets—such as Islamic, conventional, and environmental, social, and governance (ESG) stock indices, commodities, and bonds—during financial crises have received considerable attention. They conclude that Islamic equity indexes are more efficient than their conventional counterparts (Abbes & Trichilli, 2015; Ali et al., 2018; Karim & Rahman, 2020; Saleem et al., 2021; Yarovaya et al., 2021). However, Aarif et al. (2021) find no significant difference in risk-adjusted returns for sharia-compliant and conventional stocks. Chiadmi and Ghaiti (2014) show that the global financial crisis affected both Islamic and conventional equity markets, but Islamic stocks were less volatile than their conventional counterparts. Furthermore, Abu-Alkheil et al. (2017) find that Islamic stocks are preferable for risk-averse investors, and conventional indexes are attractive for those with a preference for risk.

The interest in the ESG index has inspired policy makers and investors who seek financial benefits and social contributions. According to the Global Sustainable Investment Alliance (2020), the assets under management (AUM) of sustainable investment reached USD 35.3 trillion in 2020 compared with USD 30.7 trillion in 2018, a growth rate of 15 percent over two. Canada is the leader in terms of growth of ESG assets at 62 percent, followed by Europe and Australia at 42 percent and 38 percent, respectively. The phenomenal growth of ESG investment around the world motivates us to incorporate an ESG index into our analyses. Further, we examine the response of various financial assets to unprecedented events not only to help investors in managing their financial portfolios but also, from a macroeconomic perspective, to confirm that financial development is positively associated with economic growth (Setiawan, Saleem, et al., 2021).

In this paper, we explore several main questions. How did various assets behave in response to the Covid-19 outbreak in Islamic, conventional, and ESG indices compared to safe havens, commodities, and cryptocurrency? Do they have different pattern from safe-haven and other assets? How different are they from conventional assets, that is, those in G7 countries? We examine the alternatives to understand the collective behavior of individual stock movements. We measure the risk and return of stocks before and during the pandemic and assess the differences in their volatility. In addition, we use convergence analysis and the club clustering by Phillips and Sul (2007) to pinpoint asset convergence (comovement). For example, Islamic stocks in Indonesia may have a pattern of comovement with ESG stocks, unlike the Pakistan stock index in which both are categorized as part of an Islamic index. We then add safe-haven assets and cryptocurrency, and our objects of study involve cryptocurrency and select countries with the largest Muslim populations in the world, and the G7 countries for comparison. We select this asset group to represent the characteristics of global financial assets that might have different behavior. The existing studies on price convergence or returns in the stock market have shortcomings in that they look only at returns or prices but not risk patterns, whereas looking at patterns in both is important because they are two sides of the same coin and show that conditions increase the risk of investment in financial markets. Moreover, existing studies do not provide a comparison with alternative assets whereas in this study these two shortcomings are addressed.

Looking at asset movement patterns in return and risk, we provide an overview of the various choices of asset groups, whether the type of investment or the country as well as alternative financial assets, such as commodities. Islamic financial assets are motivated by a search for profit from trade but also have a religious motivation in transactions to encourage people to get economic benefits without faith barrier. Here, we look at the general pattern of Islamic financial assets from various countries and compare them to other financial assets and commodities to give an overview about how Islamic financial assets are reflected in the convergence pattern of returns and risks in the long term. The long-term pattern of convergence demonstrates the sustainability of Islamic financial assets in national and global financial markets. In addition, the development of Islamic finance is based on the cultivation of comprehensive human development through

business activities that comply with the Quran, which prohibits interest, excessive speculation, and so on, in line with Islamic sustainable finance principles. Islamic financial assets are becoming an attractive investment instrument in developing countries and gaining traction in developed countries. Therefore, comparison of the behavior of Islamic financial assets to that of conventional financial assets and other alternative assets is needed to understand the performance of each asset in normal and crisis periods, which can be used as information for investment decision-making. Islamic financial assets also promote financial inclusion by removing the religious barrier to conventional financial services, which is aligned with the United Nations' sustainable development goals (UN SDGs) of equitable access to finance and the development of sustainable Islamic finance.

The rest of the paper is organized as follows. Section 2 presents a critical review of previous literature related to the impact of Covid-19 on Islamic indexes and other assets. Section 3 explains the data and methodologies employed, and Section 4 gives our empirical results and discussion based on statistical analysis and its interpretation. Section 5 is the conclusion, with limitations and suggestions for future research.

2. Literature review

The Covid-19 pandemic is a massive event that has shocked the world since it began to spread at the end of 2019, affecting many countries, which consequently closed their borders for a time. The literature related to this study is divided into two streams: the impact of the Covid-19 pandemic on the risk of both conventional and Islamic assets, and asset price movement or convergence. Many studies show that the Covid-19 pandemic has had a contractionary effect on the return or risk of assets, including Baker et al. (2020), Baek et al. (2020), Aggarwal et al. (2021), Albulescu (2021), Baig et al. (2021), and Caporale et al. (2022). However, two things in many existing studies need to be noted, including heterogeneity over time and between asset groups or regional groups. The heterogeneity over time relates to the fact that the effect of the Covid-19 pandemic will last longer than the pandemic itself, and where the effect is smaller, recovery is faster, as revealed by Singh et al. (2020) and Tan et al. (2022). The heterogeneity between asset groups or regions in terms of the effects of Covid-19 is discussed by Klose and Tillmann (2022), who show heterogeneity in the effects of the pandemic, and Farooq et al. (2022), who reveal differences in abnormal returns between developed and developing countries. Dharani et al. (2022) and Narayan et al. (2022) demonstrate heterogeneity in assets, finding that various sectors experienced negative and positive effects during the Covid-19 pandemic. The effects of the Covid-19 pandemic are also heterogeneous between conventional and Islamic stock markets. Nomran and Haron (2021) discuss this difference in effects, in particular between Islamic and conventional stock markets that have been negatively affected by Covid-19. However, the negative effect was smaller on Islamic stock markets than conventional markets. This is contrary to what was found by Jawadi et al. (2021), who show that, in the face of Covid-19, Islamic stock markets are no more resilient than conventional stock markets. Even studies of Islamic stock markets show heterogeneity among regions, including Asia, North America, and Europe, as shown by Adekoya et al. (2022), who state that Islamic stocks in Europe experienced an upward trend during the pandemic.

This heterogeneity problem makes it difficult for decision-making to reflect the effects of Covid-19 on stock markets, especially if investors are playing in international markets. One way to detect the general pattern and market trends is by looking at the relationship between asset prices in the market. If trends or assets have the same pattern or move in the same direction, it is highly likely that their risks or returns will also have the same pattern. The literature on trends in, for example, stock markets focuses on several technical concepts, including integration, comovement, and convergence. These three concepts concern the movement of two or more data series in a certain pattern over a certain period. Barro and Sala-i-Martin (1992) introduced the concept of convergence in a practical economic framework, in which they looked at whether growth is faster in developing countries than developed countries. In the context of the stock market, the issue is whether the value of the stock price or volume moves in the same direction over a certain period. Caporale et al. (2019) and Clark and Qiao (2022), among others, look at the integration of Asian stock markets with the convergence concept developed by Barro and Sala-i-Martin (1992), which looks at α and β convergence. Boako and Alagidede (2016) demonstrate partial deterministic convergence among African countries, and, like the other emerging and frontier markets, the African equities markets have not yet achieved the level of global integration necessary to be considered a unified group of assets with global equivalents. Heimonen (2002) uses several definitions of convergence, so the results are mixed and show that most stock markets are segmented and integrated. Several studies also analyze the convergence of stock markets during the Covid-19 pandemic, in conventional stock markets, such as Raifu et al. (2021), and in Islamic stock markets, such as Alexakis et al. (2021). In this study, we enrich the literature related to the behavior of stock markets and how their behavior differs during the Covid-19 pandemic.

In addition to the convergence technique and model developed by Barro and Sala-i-Martin (1992), several different approaches are also used to identify the general pattern in the stock market, such as by looking at movement at the technical level, using an approach that differs from the one previously discussed. Other studies use the common factors approach (Gospodinov, 2017), dynamic cointegration (Hassan et al., 2019), multistep and structural equation approaches (Ehrmann and Jansen, 2022), or indexation and single equations that directly estimate comovement patterns (Höchstötter et al., 2014). The concept of comovement used in existing studies provides an alternative approach and innovation in viewing general patterns in the stock market.

3. Methodology

3.1. Data

To perform the data analysis for this study, we used daily prices and indexes accessed from https://www.investing.com and Covid-19 data obtained from https://github.com/owid/Covid-19-data/tree/master/public/data/, as described in Table 1. The data are collected from November 11, 2013, to March 31, 2021. We end the observation in March 2021 because most countries were still struggling to control the Covid-19 pandemic and vaccination was not affordable for most of the population; hence, it is a valid period during which the impact of the pandemic is still being felt. The data has some gaps, which we handle by selecting observations reported for the same dates for all assets; consequently, we have 1.132 daily time observations. The sharia index was selected based on various considerations. First, we use sharia indexes, such as the Jakarta Islamic Index (Indonesia) and the Karachi Stock Exchange Meezan Islamic Index (Pakistan), reflecting the behavior of Islamic financial assets based on religious guidance, as well as regulating the company's interest-based debt, which is frequently a dilemma for companies during economic and financial crises. Second, the Muslim-majority countries in this study are developing economies, where the stock market generates higher average returns and volatility than developed countries and has a low correlation with financial assets in developed countries (Bekaert & Harvey, 1997).

Our sample selection of the seven countries with the largest Muslim population is as follows. First, although the seven largest Muslim-majority countries comprise more than 50 percent of the global Muslim population (World Population Review, 2022), their participation in the stock market is relatively low. Second, stock market development, proxied by market capitalization as a percentage of the gross domestic product GDP (size indicator) and the ratio of total value as a variable for liquidity, is lower in the sample of Muslim-majority countries than in countries in the Middle East and North Africa (MENA) and the world (WDI, 2022). So, this study can provide information for potential Muslim investors without facing obstacles to their faith. Finally, Islamic stocks are a type of financial asset that has the potential to complement asset preferences through risk diversification and the optimization of long-term investment growth (Azmi et al., 2019).

Table 1 displays the descriptive statistics for financial assets. Our samples for analysis consists of Islamic stock indexes in the countries with the largest Muslim population (Indonesia, India, Bangladesh, Egypt, Malaysia, Pakistan, and Nigeria), G7 countries (UK, US, France, Germany, Italy, Japan, and Canada), and alternative assets (commodities, oil, rubber, natural gas, gold, silver, 10-year US bonds, Chinese stock market, ESC, FTSE Good, Sparinvest, and Bitcoin).

Table 1
Descriptive statistics for the full sample.

Variable	Proxy	Obs.	Min.	Max.	Mean	Std. Dev.
MSCI World Index	MSCI World Index	1132	1491.70	2826.70	1933.50	3264
MSCI Syariah Index	MSCI Syariah Index	1132	950.90	1603.40	1226.50	1321.90
Indonesia	Jakarta Islamic Index	1132	393.80	758.10	654.60	6423.20
India	Nifty50 Shariah Index	1132	1369.10	3612.30	2139.00	4994.20
Pakistan	Karachi Stock Exchange Meezan Islamic Index	1132	39,915.20	90,677.50	60,386.00	11,576.50
Bangladesh	S&P Bangladesh BMI Total Return Index	1132	636.10	1222.50	858.40	1284.50
Nigeria	NSE Lotus Islamic Index	1132	1234.30	2947.10	2097.40	3946.30
Egypt	Egyptian Exchange EGX 30 Price Index	1132	5713.30	15,247.80	10,276.70	2590.50
Malaysia	FBMHS Index	1132	9120.40	13,646.60	12,475.70	6592.80
US	S&P 500 Index	1132	1774.20	3974.50	2484.00	594.40
Germany	GDAXI Jerman Index	1132	8441.70	15,008.60	11,303.90	1451.70
Japan	Nikkei 225 Index	1132	13,910.10	30,236.00	19,610.10	3517.30
UK	United Kingdom100 (Invuk100) Index	1132	799.50	1234.50	1086.90	81.00
France	CAC 40 Paris Index	1132	3754.80	6111.20	4893.40	5385.70
Italy	Italy40 Index	1132	1460.00	2491.70	2001.00	2112.70
Canada	S&P/TSX Composite	1132	11,228.40	18,983.10	15,216.30	1375.20
China	SZSE Composite Index	1132	1007.20	3140.60	1808.50	4061.40
ESC	Dow Jones Sustainability World Index	1132	1278.90	3056.80	1841.20	5007.90
FTSE Good	FTSE4Good Global 100 Index	1132	4768.70	10,910.70	6896.30	1413.40
Sparinvest	Sparinvest DJSI World Index	1132	93.50	182.70	132.70	23.60
Commodity	S&P GSCI Commodity	1132	1249.20	5185.10	2757.70	9.969.0
Oil	Crude Oil WTI	1132	−37.60	145.20	105.80	2031.10
Rubber	Rubber Future (JRUc1)	1132	129.00	352.50	208.70	4555.20
Natural Gas	Natural Gas Future	1132	1552.00	6149.00	2863.30	0.81
Gold	Gold Future	1132	1108.10	2103.20	1429.10	2211.90
Silver	Silver Future	1132	6.69	48,584.00	2194.80	1000.60
Bond 10 Years	US 10-Year Bond	1132	0.51	3002.00	1925.00	0.60
Bitcoin	Bitcoin Index Price	1132	111.60	58,913.50	5628.20	10,201.30

3.2. Techniques

We use models in the GARCH family to measure conditional variance as our measure of the risk of stock price volatility. In studies that use conditional heteroskedasticity models, stationarity tests are commonly used to determine the performance of the dataset, as suggested by most studies: Jensen and Rahbek (2004), Francq and Zakoïan (2012), and Pedersen and Rahbek (2015) employ nonstationary (asymmetric) GARCH quasi maximum likelihood estimation. Because of data gaps, however, we cannot perform stationarity tests.

First, we estimate an uncertainty model to measure of risk, using Autoregressive Heteroskedasticity (ARCH) and Generalized Autoregressive Heteroskedasticity (GARCH) family models, as well as exponential ARCH (EARCH/EGARCH) and Threshold ARCH (TARCH), and we use Bayesian information criteria (BIC) to identify the model with the best fit. BIC is very popular, as the general approach in the model selection process prefers models with fewer features over models with more features (Bauldry, 2015). Moreover, we use a categorically different measure of BIC proposed by Raftery (1999) to select the most preferred model. The estimated mean model is based on an autoregressive moving average (ARMA), which can be stated as follows:

$$y_t = \theta_0 + \pi TC_t + \sum_{i=1}^{p} \theta_i y_{t-i} + \sum_{i=0}^{q} \delta_i \varepsilon_{t-i} \quad (1)$$

where θ_0 is a constant, TC is the total number of cases of Covid-19 in the location of a stock index, θ_i is the AR (P) process, and δ_i denotes MA (q) process. After the preferred mean models are identified using Equation (1), we estimate the standard GARCH (1,1) developed by Engle and Bollerslev (1986), which is presented as Equation (2):

$$\sigma_t^2 = \omega + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2 \quad (2)$$

We also use additional GARCH models, exponential GARCH, proposed by Nelson (1991), and threshold GARCH, developed independently by Zakoian (1994) and Glosten et al. (1993), as follows:

$$log(\sigma_t^2) = \omega + \sum_{j=1}^{q} \beta_j log\left(\sigma_{t-j}^2\right) + \sum_{i=1}^{p} \alpha_i \left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{\sigma_{t-k}} \quad (3)$$

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{k=1}^{r} \gamma_k \varepsilon_{t-k}^2 \tau_{t-k} \quad (4)$$

where ω is the constant, ε_{t-1}^2 is the ARCH term, measured as the lag of the squared error disturbance from the mean equation, and σ_{t-1}^2 denotes GARCH term. Equation (3) is an EGARCH model in which the logarithm of conditional variance is on the left-hand side. This indicates that the leverage effect is exponential, rather than quadratic; hence, conditional variance forecasts are assumed to be nonnegative. The existence of a leverage effect can be represented as $\gamma = 0$. If $\gamma \neq 0$, the impact is asymmetric. Equation (4) represents a TARCH/TGARCH model where $\tau_t = 1$ if $\varepsilon_t < 0$ and otherwise.

Second, we conduct various tests to determine whether the risks and returns before and during the pandemic are statistically different. The pandemic began when the first case of Covid-19 was identified, and we use a simple measure of risk by dividing stock prices or assets by one lag and multiply it by a number that will enable them to retain their original form—meaning that if the original value is one digit, the revised value will be one digit. We employ two sample *t*-tests, assuming that the variance is equal.

Third, we examine the convergence among assets in order to detect any convergence patterns in an asset group. The convergence approach used was originally designed by Barro and Sala-i-Martin (1992) to determine convergence in economic growth and by Clark and Qiao (2022) to find convergence in stock market efficiency in 35 countries; the latter model was used by Degl'Innocenti et al. (2017) to detect convergence in bank productivity. The equation is as follows:

$$ln\left(\frac{E_{j,t}}{E_{j,t-1}}\right) = \alpha + \beta\, ln\left(E_{j,t-1}\right) + \mu_{j,t} \quad (5)$$

where $E_{j,t}$ and $E_{j,t-1}$ is the price of assets and risks for asset j at times t and t-1. A negative β shows the existence of β-convergence, meaning that the asset price and risks with relatively low initial values move to a higher value of returns and risks. Equation (5) is estimated by generalized least squares (GLS) for observations of both returns and risks because the GLS estimator minimizes the generalized sum of the squares (Greene, 2013).

4. Results and discussion

Table 2 (A, B, and C) presents the results of the estimation of the mean model and the variance equations. According to the Table, the mean models for all asset samples are significant at the 0.001 level. The total Covid-19 cases are included in the mean equation as a control variable. If the index or prices of assets are for the world or more than one country, we use the total number of cases of Covid-19 as the control in the mean equation. Based on the mean equation, Indonesia, the UK, ESC, FTSE Good, commodity, oil, natural gas, silver, US 10-year bonds, and Bitcoin are negatively affected by the total number of cases of Covid-19, meaning that when the number of cases is higher, the prices are lower. In addition, ARMA variables are selected based on the model performance indicated by BIC, after including the maximum number of ARMA variables. Pakistan, Malaysia, Germany, Bangladesh, and US 10-year bonds perform at AR (1), and the rest reach their best performance at AR (2) until AR (4) and MA (1) until MA (4). At the same time, the variance equation shows that, for most assets, EGARCH and TARCH are the best models.

The *t*-test shows significant difference in asset risk before and during the pandemic. Conditional heteroskedasticity as the measure of risks comes from the best fit model of the variance equation. The results show that most assets have higher risk

Table 2
GARCH test results.

A. Islamic Indexes

	MSCI Sharia Index	Indonesia	India	Pakistan		Bangladesh	Nigeria	Egypt	Malaysia
	Coefficients	Coefficients	Coefficients	Coefficients		Coefficients	Coefficients	Coefficients	Coefficients
	Standard error	Standard error	Standard error	Standard error		Standard error	Standard error	Standard error	Standard error
Mean of total cases of COVID-19					Mean of total cases of COVID-19				
World	0.00000***				Bangladesh	0.00037***			
	0					−0.00001			
Indonesia		−0.00005***			Nigeria		0.00448***		
		−0.00001					−0.00013		
India			0.00014***		Egypt			0.01685***	
			0					−0.00077	
Pakistan				0.02208***	Malaysia				0.00424***
				−0.00301					−0.00056
Constant	1194.44671***	657.58655***	1657.90132***	59,786.61044***	constant	975.45061***	1817.46975***	7050.98235***	12,124.74482***
	−120.159	−0,93759	−1.051.970	−13.483.074		−221.404	−383.994	−5.491.411	−3.697.459
ARMA					ARMA				
AR	0.14102***	0.11964***	0.99683***	0.99369***	AR	1.00428***	0.24234***	0.98399***	1.00385***
	−0.02633	−0.02339	−0.00630	−0.00390		−0.00957	−0.00879	−0.00161	−0.01804
MA	0.86804***	0.88616***	−0.01445**	0.02378	MA	−0.00870	0.62936***	−0.01571***	−0.07228
	−0.02903	−0.03181	−0.00653	−0.02878		−0.00938	−0.01165	−0.00213	−0.07670
MA(2)	0.82966***	0.81688***	−0.02523***	0.01719	MA(2)	−0.00490	0.66787***	−0.00312	
	−0.02788	−0.02856	−0.00640	−0.01939		−0.00963	−0.00952	−0.00201	
MA(3)	0.77636***	0.75220***	−0.01649***	0.00310	MA(3)	−0.00227	0.63615***		
	−0.02543	−0.02410	−0.00604	−0.00847		−0.00901	−0.00901		
MA(4)	0.77098***	0.75565***			MA(4)	−0.00364	0.51458***		
	−0.02291	−0.02116				−0.00718	−0.00970		
Variance Equation					Variance Equation				
EARCH	0.00184	−0.04167***	−6.09094***	0.04092***	EARCH	−0.19861***	−3.45085***	−7.37120***	−0.03900
	−0.00978	−0.01026	−0.09284	−0.01183		−0.03182	−0.11345	−0.09576	−0.04211
EARCH_A	0.02047	−0.04096**	6.20073***	−0.08059***	EARCH_A	0.42186***	7.09392***	7.82918***	−0.15563*
	−0.01402	−0.01714	−0.11111	−0.01196		−0.04036	−0.04556	−0.11564	−0.08606
EGARCH	1.57549***	1.48639***	0.16722***	1.46034***	TARCH	0.00072***	−0.00001***	0	
	−0.03251	−0.03560	−0.01352	−0.01973		−0.00001	0	0	
					EGARCH				1.40928***
									−0.07765
constant	−4.66405***	−3.65065***	10.20620***	−8.48832***	constant	3.20085***	12.26827***	16.29981***	−5.48662***
	−0.23712	−0.23416	−0.15768	−0.33177		−0.03396	−0.03813	−0.06794	−0.94834
BIC	11,304.2	10,555.8	13,346.4	22,017.3	BIC	9658.3	13,969.2	17,535.0	3424.1

B. G7 Stock Markets

	MSCI World Index	US	Germany	Japan	Equation	UK	France	Italy	Canada
	Coefficients	Coefficients	Coefficients	Coefficients		Coefficients	Coefficients	Coefficients	Coefficients
	Standard error	Standard error	Standard error	Standard error		Standard error	Standard error	Standard error	Standard error
Mean equation for total cases of COVID-19					Mean equation for total cases of COVID-19				
World	0.00001***				UK	−0.00001***			
	0					0			
US		0.00006***			France		0.00025***		
		0					−0.00002		

Germany			0.00153***		Italy			0.00008***	
			−0.00005					−0.00001	
Japan				0.02956***	Canada				0.00409***
				−0.00083					−0.00019
constant	1858.39256***	2393.82378***	11,029.31195***	20,879.80167***	constant	1083.72148***	4813.48639***	1981.09741***	16,227.89115***
	−285.981	−520.856	−1490.777	−6056.954		−102.384	−655.587	−273.183	−2847.665
ARMA					ARMA				
AR	0.13269***	0.12563***	0.99377***	0.15726***	AR	0.99559***	1.00355***	0.09663***	0.97974***
	−0.02776	−0.02573	−0.00308	−0.00865		−0.00478	−0.00488	−0.0312	−0.00417
MA	0.85565***	0.83003***	−0.00264	0.74915***	MA	0.01617	0.01311	0.87742***	−0.06240***
	−0.02913	−0.02917	−0.01970	−0.01411		−0.02607	−0.03511	−0.03670	−0.00619
MA(2)	0.82898***	0.80331***		0.74818***	MA(2)	0.01186	0.00104	0.84445***	−0.02663***
	−0.02730	−0.02544		−0.01142		−0.01802	−0.02106	−0.03328	−0.00458
MA(3)	0.80274***	0.79975***		0.70881***	MA(3)	0.01212	−0.00806	0.77706***	
	−0.02620	−0.02483		−0.01076		−0.01198	−0.01230	−0.03192	
MA(4)	0.80046***	0.79568***		0.68526***	MA(4)			0.77049***	
	−0.02450	−0.02365		−0.01255				−0.02896	
Variance Equation					Variance Equation				
EARCH	0.03508***	0.10540***	−0.02601**	3.98139***	EARCH	−0.14204***	−0.00950	−0.01056	5.22084***
	−0.00984	−0.01251	−0.01132	−0.09824		−0.01776	−0.01066	−0.00883	−0.08604
EARCH_A	−0.01794	−0.12913***	−0.30148***	4.69744***	EARCH_A	−0.12755***	−0.08892***	−0.04520**	6.23987***
	−0.01580	−0.01697	−0.02473	−0.11106		−0.02046	−0.02547	−0.01758	−0.09435
EGARCH	1.57426***	1.56161***	1.34712***	0.31781***	EGARCH	1.36597***	1.44133***	1.50992***	0.13715***
	−0.03164	−0.03078	−0.02339	−0.02871		−0.02616	−0.02862	−0.03697	−0.01711
constant	−5.70976***	−6.37854***	−4.90352***	11.03898***	constant	−3.15109***	−5.28444***	−4.95540***	12.86850***
	−0.28313	−0.31619	−0.29282	−0.42223		−0.18633	−0.30749	−0.32878	−0.22633
BIC	13,044.0	14,447.2	17,236.7	18,691.6	BIC	11,207.7	15,257.6	13,221.8	16,803.1

C. Alternative Assets

	China	ESC	FTSEGood	Sparinvest		Commodity	Oil	Rubber	Natural Gas
	Coefficients	Coefficients	Coefficients	Coefficients		Coefficients	Coefficients	Coefficients	Coefficients
	Standard error	Standard error	Standard error	Standard error		Standard error	Standard error	Standard error	Standard error
Mean equation for total cases of COVID-19					Mean equation for total cases of COVID-19				
China	0.00478***				World	−0.00001***	−0.00000	0.00000***	−0.00000**
	(0.00020)					(0.00000)	(0.00000)	(0.00000)	(0.00000)
World		−0.00001***	−0.00002***	0.00000***					
		(0.00000)	(0.00000)	(0.00000)					
constant	1735.82186***	2384.60049***	7013.97215***	146.42150***	Constant	1921.41136***	37.18762***	156.90690***	2.91754***
	−452.635	−648.710	−1661.465	(0.37893)		−1395.334	(0.51219)	(0.89923)	(0.01093)
ARMA					ARMA				
AR	0.07380***	0.17752***	0.16807***	0.97765***	AR	1.00071***	0.97451***	0.97486***	0.11604***
	(0.01522)	(0.00549)	(0.01431)	(0.00102)		(0.00556)	(0.00183)	(0.00281)	(0.02830)
MA	0.92763***	0.81812***	0.83482***	−0.01535***	MA	−0.03743***	−0.04068***	−0.09990***	0.87298***
	(0.02553)	(0.00764)	(0.01963)	(0.00357)		(0.00568)	(0.00568)	(0.00789)	(0.03215)
MA(2)	0.87205***	0.81682***	0.80452***		MA(2)	−0.01632***			0.84168***
	(0.02336)	(0.00700)	(0.01865)			(0.00566)			(0.03069)
MA(3)	0.84386***	0.79504***	0.77220***		MA(3)	−0.01824***			0.80146***
	(0.02075)	(0.00636)	(0.01452)			(0.00525)			(0.02854)
MA(4)	0.85539***	0.76814***	0.76546***		MA(4)				0.79636***
	(0.01910)	(0.00534)	(0.01447)						(0.02706)

(*continued on next page*)

Table 2 (*continued*)

C. Alternative Assets

Variance Equation					Variance Equation				
EARCH	0.08056***	0.59266***	0.01226	5.89737***	EARCH	−7.71520***	−6.06754***	−4.44678***	0.08807***
	(0.00978)	(0.05489)	(0.01102)	(0.10225)		(0.10371)	(0.11991)	(0.06973)	(0.01134)
EARCH_A	0.00937	0.40734***	0.03998***	6.13507***	EARCH_A	8.36849***	6.95944***	5.82378***	−0.02933**
	(0.01093)	(0.05218)	(0.00951)	(0.10525)		(0.09907)	(0.11394)	(0.10236)	(0.01217)
EGARCH	1.58340***		1.56838***	0.16987***	TARCH	0.00000			
	(0.02276)		(0.02043)	(0.01802)		(0.00000)			
TARCH		0.00004***			EGARCH		0.13990***	0.31014***	1.48745***
		(0.00000)					(0.01789)	(0.02090)	(0.03065)
constant	−6.44497***	8.13014***	−7.76631***	5.49629***	constant	14.20133***	5.77966***	5.77686***	0.56609***
	(0.22878)	(0.04005)	(0.25417)	(0.11589)		(0.05784)	(0.11059)	(0.14344)	(0.06899)
BIC	14,266.7	14,162.4	17,065.4	7179.3	BIC	14,900.8	6969.0	9295.4	529.4

D. Alternative Assets

Equation	Gold	Silver	US 10-Year Bond	Bitcoin
	Coefficients	Coefficients	Coefficients	Coefficients
	Standard error	Standard error	Standard error	Standard error
Mean equation for total cases of COVID-19				
World	0.00001***	−0.00000***	−0.00000***	−0.00000***
	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Constant	1390.77061***	13.06656***	2.45590***	5.47789***
	−258.770	(0.14842)	(0.01524)	(0.18866)
ARMA				
AR	0.17480***	0.97559***	0.99730***	
	(0.02255)	(0.00099)	(0.00419)	
AR(2)				0.47265***
				(0.00462)
MA	0.81761***	−0.01194***	0.00380	0.47190***
	(0.03170)	(0.00159)	(0.00637)	(0.00316)
MA(2)	0.80447***	0.01019***	−0.00009	0.36102***
	(0.02692)	(0.00093)	(0.00646)	(0.00455)
MA(3)	0.76359***			0.49126***
	(0.02596)			(0.00341)
MA(4)	0.75825***			
	(0.02369)			
Variance Equation				
EARCH	0.06414***	−6.92143***	−0.09627*	−4.23292***
	(0.00833)	(0.08721)	(0.05100)	(0.02666)
EARCH_A	−0.04736***	8.05042***	0.14392*	6.84052***
	(0.01374)	(0.10243)	(0.08461)	(0.05937)
EGARCH	1.50123***	0.10622***		0.95657***
	(0.02627)	(0.01321)		(0.00646)
TARCH			34.44335***	
			(0.89534)	
Constant	−4.80737***	4.62529***	−6.15094***	1.24944***
	(0.22151)	(0.07498)	(0.04674)	(0.09980)
BIC	12,619.6	4735.4	−1624.5	16,250.2

Notes: $p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 3
Assets price convergence before and during Covid-19.

	Variables	All Observations	Islam Index	G7 Stock Market	Alternative Assets
		Coefficient	Coefficient	Coefficient	Coefficient
Full period	L.lyprice	−0.01306**	0.00103	−0.03773***	−0.05114***
		(-0.00641)	(-0.01244)	(-0.01087)	(-0.00873)
	trend	0.00000	0.00000	−0.00000	0.00000
		(-0.00000)	(-0.00000)	(-0.00000)	(-0.00000)
	constant	−0.00047	−0.00200	0.00075**	−0.00033
		(-0.00060)	(-0.00188)	(-0.00034)	(-0.00062)
	BIC	−72,949.9	−14,632.0	−35,723.0	−38,560.6
Before pandemic	L.lyprice	−0.01355*	0.00036	−0.02951**	−0.06784***
		−0.00720	−0.01379	−0.01187	−0.01004
	trend	0.00000	0.00000	0.00000	−0.00000
		−0.00000	−0.00000	−0.00000	−0.00000
	constant	−0.00044	−0.00217	0.00049	0.00001
		−0.00072	−0.00229	−0.00033	−0.00067
	BIC	−57,131.5	−10,971.9	−30,505.4	−31,933.7
During pandemic	L.lyprice	−0.01481	0.05382**	−0.08307***	−0.01318
		−0.01240	−0.02292	−0.02745	−0.01841
	trend	0.00001**	0.00000	0.00002***	0.00001
		−0.00000	−0.00000	−0.00000	−0.00001
	constant	−0.01422**	−0.00631	−0.02640***	−0.01223
		−0.00707	−0.00741	−0.00990	−0.01430
	BIC	−17,672.9	−6336.3	−5693.9	−6619.9

Notes: $p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

during the pandemic, and these findings are consistent with the evidence by Elsayed et al. (2022) and Mishra and Mishra (2020), but some of them have lower risk, such as Indonesia, the UK, ESC, FTSE Good, commodity, oil, natural gas, silver, US 10-year bonds, and Bitcoin. These findings are consistent with the mean equation, in which during the pandemic, the total number of cases of Covid-19 negatively affected average prices. This asymmetric effect of the total number of cases of Covid-19 across assets and countries is highly influenced by the government policy response by countries and the perceived reaction by buyers.

Financial distress experienced by a company due to government policies in addressing the pandemic, such as a lockdown, could have a sizable financial impact on the company's finances, especially if it is added to the uncertainty introduced by the government as the pandemic becomes more severe. On a

Table 4
Assets risk convergence before and during Covid-19.

	Variables	All Observations	Islam Index	G7 Stock Market	Alternative Assets
		Coefficient	Coefficient	Coefficient	Coefficient
Full Period	L.yrisks	−0.01304*	−0.45316***	−0.47709***	−0.01530
		−0.00707	−0.00946	−0,00634	−0.01079
	trend	0.00028***	0.00004***	0.00005***	0.00059***
		−0.00007	−0.00000	−0.00000	−0.00018
	constant	1.01934***	1.45998***	1.44292***	1.05362***
		−0.05176	−0.01003	−0.00655	−0.11993
	BIC	118,681.7	−8322.3	−18,562.2	58,696.3
Before Pandemic	L.yrisks	−0.01365*	−0.44663***	−0.47303***	−0.01772
		−0.00781	−0.01051	−0.00672	−0.01193
	trend	0.00071***	0.00011***	0.00008***	0.00154***
		−0.00011	−0.00000	−0.00000	−0.00027
	constant	0.87276***	1.43161***	1.42701***	0.73229***
		−0.06272	−0.01113	−0.00696	−0.14535
	BIC	100,392.1	−6375.6	−15,161.2	49,416.0
During Pandemic	L.yrisks	−0.11701***	−0.52903***	−0.49524***	−0.11788***
		−0.01441	−0.01742	−0.01584	−0.02210
	trend	0.00004	0.00006	0.00012***	−0.00011
		−0.00018	−0.00003	−0.00002	−0.00042
	constant	1.12338***	1.48143***	1.37020***	1.34357***
		−0.18827	−0.04519	−0.02938	−0.43563
	BIC	7993.6	−2546.2	−3825.7	4838.2

Notes: $p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

macro basis, almost every economy in the world contracted during 2020 and 2021, due to the pandemic. This weakened company performance because of the serious impacts on the demand side. The risk of distress for companies is not always positively correlated with crash risk. Hung et al. (2021) shows that stock returns during the pandemic varied, depending on the phase and business type of the companies listed on the stock market.

Furthermore, Farooq et al. (2022) found consistent results in which some countries have a different pattern of effects in responding to the pandemic. <is this also from Farooq?> The other important finding is in the cumulative average abnormal returns (CAAR) in response to the Covid-19 outbreak, travel restrictions, lockdown, stimulus policy packages, and historical decline in oil prices. This implies that as the number of new cases and deaths increases gradually, abnormal returns adjust as well, rendering the effects of these events insignificant when they occur. Andreou et al. (2021) argue that this phenomenon becomes even more complicated when one considers that declines in stock prices have consistently increased since 1950, and in recent decades corporate governance regulation has also increased <is this what you mean?>. To fight managerial opportunism and protect consumers, laws and listing standards must be <changed?> exchanged. Moreover, Ahmad et al. (2021) find that black swan events and different reactions to the outbreak resulted in panic buying and selling.

In the next section, we examine the behavior of groups of assets by looking at convergence, as shown in Table 3, in the price of assets and the conditional volatility of asset prices as a risk indicator. Our analysis is based on all observations and asset groups during the full period and subperiods for before and during the pandemic. Our analysis of total financial assets and the full period show that the Covid-19 pandemic caused a change in the direction of movement in the asset group observed. This is shown by the statistically significant Lyprice variable in Table 3 for all asset prices and all observation periods, meaning convergence exists, but not during the pandemic (Lyprice is not significant), and the same is true of alternative assets. However, the opposite happens for the sharia index, which shows convergence during the pandemic and nonconvergence before the pandemic and throughout the observation period. The G7 shows a consistent pattern, which is convergent throughout the observation period and before and during the pandemic. These findings are in line with Yu et al. (2022), Dash and Maitra (2022), and Heil et al. (2022). More precisely, this shows that the pandemic drove a change in which before the pandemic there was convergence among all financial assets but, during the pandemic, this did not happen. Alexakis et al. (2021) show convergence between conventional and Islamic financial stock markets from 1996 to 2020. Although this study does not differentiate convergence by group and separate periods during and before the pandemic, at least it reveals a common pattern or convergence among financial assets during the period.

On the other hand, different results emerge in the estimation of risk convergence, as shown in Table 4. In terms of risk, the group of Islamic observations experienced convergence in both total observations and subgroups before and during the pandemic, and the same is true of the G7 group, which also shows the same effect in both price and risk convergence. Although the alternative assets show risk convergence only during the pandemic, the observation for the full period and before the pandemic does not show convergence, as shown in Table 4, where Lyrisk is insignificant for alternative assets throughout the observation period and before the pandemic. This asymmetric pattern shows that in the financial market, assets may have different responses and directions to the outbreak between countries, assets, and before and during the pandemic.

5. Conclusion, limitations, and suggestions for future studies

This study examines the behavior of financial and alternative assets during the Covid-19 pandemic using proxies for risk and returns. External factors frequently influence the behavior of financial markets. The market responds to positive news by increasing asset prices and vice versa. However, under certain circumstances, the behavior of movement by assets differs from the theory. The phenomenon of Covid-19, which continues to evolve, provides room for empirical research and complements earlier studies on the movement of financial assets amid crises, from those caused by disease, such as SARS, Ebola, and MERS, to the 2008 global financial crisis.

Specifically, this study analyzes the price movements of Islamic stocks in seven countries with the largest Muslim populations, the capital markets of the G-7 countries, and various alternative assets, such as commodities and cryptocurrency, during the Covid-19 outbreak. Our findings show that the severity of the pandemic had a negative effect on asset price performance, but some assets experienced the opposite. Differences in asset responses to the pandemic are also seen in groups. Price and risk movement patterns differ among the G7, Islamic, and alternative asset groups. The pandemic contributed to price differentials, but with little change in the asset's risk pattern.

Our results reveal that asset behavior responds differently to market information and economic conditions. Gold and Bitcoin, for instance, are less risky during the Covid-19 period than normal. Consequently, one way to deal with this kind of situation is to evaluate investment performance by closely monitoring portfolios and controlling risk by diversifying assets across various instruments, particularly in times of global economic turmoil. Furthermore, domestic investors' participation in the financial industry must increase in order to reduce reliance on foreign investors and control the volatility of financial assets, especially when foreign investors rebalance financial assets during periods of financial or economic distress. Additionally, general knowledge of financial literacy and inclusion must be enhanced, as it not only contributes to the achievement of UN SDG 8, related to optimizing access to formal financial services but also has an impact on mitigating financial risks during an economic crisis.

Even though this study incorporates data on various financial assets, limited data is available for examining a longer period, especially to capture the movement of financial assets during several crisis periods, such as the global financial crisis. Another limitation of this study is that, although knowing information about the behavior of financial assets during a war is essential, it does not observe the behavior of assets amid geopolitical uncertainty due to the Russian invasion of Ukraine.

Subsequent studies could more deeply investigate the behavior of financial assets with lower risk during the Covid-19 crisis. In addition, the capital market can be expanded from G7 countries to G20 economies, which contribute 86 percent of the global economy. Finally, to obtain more comprehensive results, the crisis period should be expanded to include the global financial crisis, the Covid-19 pandemic, and the war in Ukraine.

Compliance with ethical standards

We confirm that we have complied with ethical standards.

Declaration of competing interest

We confirm that we do not have any conflict of interest.

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