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Analysis of the performance of Islamic gold-backed cryptocurrencies during the bear market of 2020

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ABSTRACT

This study examines the performance of Islamic gold-backed cryptocurrencies during the bear market of 2020. Price data is collected for three Islamic gold-backed cryptocurrencies, OneGram, HelloGold and X8X, as well as the conventional gold-backed cryptocurrency, PaxGold, and the conventional fiat-backed cryptocurrency, Bitcoin, from December 2019 to November 2020. Analysis via ARMA-EGARCH models show that returns on all cryptocurrencies are lower during the bear market but the decrease is only significant for the Islamic gold-backed cryptocurrencies. Volatility is found to be higher for all five cryptocurrencies but the effect of the bear market on the volatility is only significant for the conventional cryptocurrencies.

1. Introduction

The Covid-19 pandemic has had a significant impact on global financial markets. As the number of confirmed Covid-19 cases increased, stock market returns decreased (Ashraf, 2020). Between February 19 and March 23, 2020, the S&P 500 index experienced a decline of 34% (Jason, 2020). The decline is attributed to the expectation of future Covid-19 cases, as well as the economic and population effects of Covid-19 (Mamaysky, 2020). Following the pandemic's uncertainty and global economic catastrophe, investors sought to invest in safe-haven instruments such as gold and cryptocurrency. However, Covid-19 affected the gold supply chain as well. Due to great demand but insufficient supply, gold futures rose US$70 above the spot price at the start of the pandemic (LePan, 2020), reaching an all-time high of US$1902/toz on July 24, 2020. The cryptocurrency market saw a 47.4% surge in new investors in conventional fiat-backed cryptocurrencies during the first quarter of 2020. Analysis of the level of efficiency of conventional fiat-backed cryptocurrencies before and after the pandemic by Mnif et al. (2020) shows that the cryptocurrencies became more efficient as a result of the pandemic. However, it was also observed that these cryptocurrencies had become very volatile during the pandemic. In the first quarter of 2020, the volatility of Bitcoin's hash rate was almost 30%.[1] However, in March 2020, the market and Bitcoin's hash rate crashed after Covid-19 was declared a pandemic. Lahmiri and Bekiros (2020) confirm through their analysis that cryptocurrencies had become far more unstable and volatile than the stock market, and are therefore considered riskier than equities, hence they should not be used as a hedge.

Academic interest in gold and conventional fiat-backed cryptocurrencies grew due to the pandemic, however, very few research has been conducted on gold-backed cryptocurrencies. Although both conventional and gold-backed cryptocurrencies are built and used on

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[1] Cryptocurrency Mining Experiences High Volatility Amid COVID-19 (thecryptoassociate.com)

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block chain technology, gold-backed cryptocurrencies are influenced and backed by gold, whilst conventional fiat-backed cryptocurrencies rely on the computing power (hash rate) and network (number of users). As gold-backed cryptocurrencies are backed by gold, which is stable in value, they are expected to be less volatile than conventional fiat-backed cryptocurrencies (Jalan et al., 2021). A new form of gold-backed cryptocurrency that has emerged is the Islamic gold-backed cryptocurrency. In general, in Islamic finance, the industry and products offered are *Shariah*-compliant. Islamic gold-backed cryptocurrencies are backed by gold and are compliant to the *Shariah* law, enabling Muslim investors to invest in new digital currency investment opportunities that are *halal*. The nature of *Shariah* prohibits interests, speculation and high risk asset classes hence Islamic financial instruments are purported to be more stable than conventional ones (Aloui et al., 2021).

Studies investigating the stability of Islamic banks and financial markets during the global financial crisis of 2009 concluded that the crisis had very minimal impact. Cerovic et al. (2017) observe that Islamic banks have greater stability and efficiency as compared to conventional banks before and at the time of crisis, as the business is based on religious principles, commissions and fees, and has less risk. Aloui et al. (2021) find that Islamic gold-backed cryptocurrencies are positively correlated to gold, whereas their conventional counterparts are negatively correlated. Taking into consideration that Islamic financial institutions and markets have been found to be more stable compared to their conventional counterparts due to their nature and that Islamic gold-backed cryptocurrencies are positively correlated with gold, this digital currency is expected to be more stable than conventional fiat-backed cryptocurrencies or conventional gold-backed cryptocurrencies.

This study is therefore aimed at analyzing the safe-haven properties of Islamic gold-backed cryptocurrencies. The performance of Islamic gold-backed cryptocurrencies is analyzed with respect to how these digital assets were affected by the bear market of 2020 which occurred during the Covid-19 pandemic. Analysis is conducted on price data collected for three different forms of cryptocurrencies (conventional fiat-backed, conventional gold-backed and Islamic gold-backed). The impact of the bear market, which occurred between February 13 to March 12, 2020, on the returns and volatilities of these digital assets is studied. The daily returns of Onegram. HelloGold, X8X, PaxGold and Bitcoin dated from December 1, 2019 to November 30, 2020 are used for analysis using the ARMA – EGARCH family of models. Comparison of the results of each cryptocurrency shows that during the bear market of Covid-19, the Islamic gold-backed cryptocurrencies (OneGram, HelloGold and X8X) and the conventional fiat-backed cryptocurrency (Bitcoin) experienced decreasing returns although the decrease is insignificant for the Bitcoin but weakly significant at the 10% level for the Islamic gold-backed cryptocurrencies. On the other hand, the PaxGold is found to experience increased, but insignificant, returns during the bear market. It is also found that the volatility of all the cryptocurrencies have increased during the period. However, the increase is found to be significant for both conventional cryptocurrencies (PaxGold and Bitcoin), while the bear market has had no significant impact on the volatility of the Islamic gold-backed cryptocurrencies.

This study adds to the growing body of knowledge about the hedging and safe-haven properties of cryptocurrencies during market downturns. The Covid-19 pandemic has created uncertainty in financial markets worldwide, and the pandemic period provides opportunity to study the properties of different types of cryptocurrencies. While assessing the financial effects of the Covid-19 pandemic is important and has added to the knowledge and understanding of the nature and features of cryptocurrencies, the focus of this study on the bear market provides further insight into the behavior of cryptocurrencies during extreme market fluctuations. Although there is substantial amount of research on the Covid-19 crisis, to the authors' knowledge, no study so far has specifically investigated the effects of extreme market downturns, i.e. the bear market, during the pandemic period. As Islamic gold-backed cryptocurrencies differ in characteristics from those of conventional cryptocurrencies in terms of certainty, transparency and stability due to the requirement of *Shariah*-compliance, this study contributes to the body of knowledge on the returns and volatility of different types of digital currencies, as well as their speculative nature. The study also adds to the limited amount of literature on gold-backed cryptocurrencies, especially Islamic gold-backed crypto assets. This study provides evidence of the safe-haven and hedging properties of Islamic gold-backed cryptocurrencies, but not of the conventional counterparts. Despite the lack of evidence of the safe-haven property of conventional gold-backed cryptocurrencies, this study provides evidence of the diversification benefits that can be achieved through the formation of portfolios that consist of both conventional and Islamic gold-backed crypto assets.

The rest of the study is structured as follows. The literature relevant to this investigation is discussed next, followed by the formation of the study's hypotheses. The research methodology is then described, followed by an analysis of the study's findings. The final section concludes this study.

2. Literature review

The efficient market hypothesis posits that markets are efficient, i.e., securities are fairly priced. However, studies have shown the markets are not always efficient, especially in times of crisis. Anagnostidis et al. (2016), for example, conduct the Generalized Hurst Exponent analysis to show that Eurozone stock markets were inefficient during the global financial crisis of 2008. Since the outbreak of the Covid-19 pandemic, numerous studies have sought to determine the impact of the pandemic on various financial markets such as the stock markets, commodity markets and cryptocurrency markets. In the case of stock markets, most studies find that the pandemic has had a negative impact on stock market returns (Al-Awadhi et al., 2020; Ashraf, 2020; Erdem, 2020). Erdem (2020) and Baek et al. (2020) find that most stock markets have become more volatile during the pandemic, while Topcu and Gulal (2020) find that the impact of the pandemic on emerging stock markets returns varies. Since this study is aimed at investigating gold-backed cryptocurrencies, a review of literature on the performance of the cryptocurrency and gold markets during the pandemic is first carried out.

A number of studies have considered various aspects of the cryptocurrency market during the Covid-19 pandemic. In particular, studies have focused on the conventional fiat-backed cryptocurrency. Mnif et al. (2020) find that fiat-backed cryptocurrencies vary in terms of efficiency before and after the outbreak, but efficiency of the 5 cryptocurrencies they studied improved after the pandemic.

Corbet et al. (2020) focus on conventional fiat-backed cryptocurrencies with market values of more than $500 million that are listed in the Binance exchange and use the GARCH methodology to find that, although the negative views of Covid-19 affected returns, both returns and trading volume increased in general. Corbet et al. (2022) find evidence of substantial flows of investments into the cryptocurrency markets during the Covid-19 period and the use of cryptocurrencies as a store of value to protect from financial losses during the pandemic period. Yousaf and Ali (2020) and Wasiuzzaman and Rahman (2021) both confirm an increase in the returns of fiat-backed cryptocurrencies during the Covid-19 crisis. Al-Awadhi et al. (2020), Ashraf (2020), Erdem (2020) and Baek et al. (2020) reason that the negative impact of Covid-19 on stock market returns may have benefited the cryptocurrency market. Yousaf and Ali (2020) find evidence of return and volatility spillover effects between stock markets and cryptocurrency markets during the Covid-19 pandemic. Corbet et al. (2020) find that the pandemic has significant time-varying price-volatility effects on cryptocurrencies, indicating that conventional fiat-backed cryptocurrencies are found to be able to act as a safe-haven for investors. Caferra and Vidal-Tomás (2021) find that during market downturns, both the stock and cryptocurrency markets experienced price declines however, while stock markets were trapped in the bear phase, cryptocurrencies rebounded. On the other hand, Conlon and McGee (2020) find that, compared to the S&P500, the Bitcoin experienced greater declines in value during the bear market. This is supported by Ftiti et al. (2021), who find that investors in fiat-backed cryptocurrencies become particularly anxious during periods of market upheaval and overreact to unfavorable news. Mariana et al. (2020) find that during the Covid-19 crisis, conventional fiat-backed cryptocurrencies were more volatile than gold and the S&P500 index. This is in line with Lahmiri and Bekiros' (2020) finding that Covid-19 has caused significant fluctuations in the values of cryptocurrencies. They find that cryptocurrencies are riskier than equity markets as the cryptocurrency market becomes more unstable and erratic during the pandemic. Jeribi et al. (2020) conclude that fiat-backed cryptocurrencies cannot act as hedging instruments in most markets before and during the pandemic but they can be used as diversifiers in investors' portfolios. Investor panic due to Covid-19 outbreak caused volatility in cryptocurrency markets to increase (Umar and Gubareva, 2020). However, both Yarovaya et al. (2021) and Yousaf et al. (2021) find no indication of herding behavior being prevalent or amplified despite the increase in volatility observed during the Covid-19 pandemic.

In the case of gold, Rajput et al. (2021) observe that the price of gold had been increasing since January 2020, although some fluctuations in the price were observed in March 2020. Baranova et al. (2020) find a decreasing trend in the price of gold and an increase in the volatility of the price of gold as a result of an increase in the total number of confirmed cases. Similarly, Mensi et al. (2020) find that the volatility of gold had increased as a result of the Covid-19 pandemic but they also find that the gold market had been more efficient during the upward trend. Salisu et al. (2020) confirm significant negative volatility effects in the price of gold, but they also find that gold can be used as a hedge against oil price risks during the pandemic. Ji et al.'s (2020) study to re-evaluate the safe-haven property of assets such as gold, commodities, cryptocurrency and foreign exchange during the Covid-19 pandemic finds that only gold and soybean commodity futures had positive Sharpe ratios. They confirm that gold and soybean commodities can be safe-haven investments for investors during the pandemic. However, when analyzing the daily returns of the gold market before and during the Covid-19 pandemic, Jeribi et al. (2020) find negative average daily returns for gold before Covid-19 but positive returns during Covid-19, indicating a positive relationship between gold and stock market indices. As a result, they conclude that gold cannot act as a hedge but it can be an effective diversifier for investors during the pandemic.

As both fiat-backed cryptocurrencies and gold are purported to be able to act as hedging instruments or diversifiers, it is expected that gold-backed cryptocurrencies should also be able to act as a safe-haven investment. Mariana et al. (2020) find an increase in the correlation between gold and cryptocurrencies during the Covid-19 crisis. However, there is a limited number of studies carried out on gold-backed cryptocurrencies, particularly with respect to Covid-19. Wasiuzzaman and Rahman (2021) compare the returns and volatility of fiat-backed cryptocurrencies, gold and gold-backed cryptocurrencies during the bear market of 2020 which occurred within the Covid-19 pandemic period. They find that gold-backed cryptocurrencies (Paxgold, in this case) experienced higher returns and volatility during the bear market of 2020 but the results are found to be insignificant. They conclude that during periods of crisis, gold-backed cryptocurrencies can act as safe-haven investments. Jalan et al. (2021) analyze the performance of gold-backed cryptocurrencies during the Covid-19 pandemic and find that the cryptocurrencies were vulnerable to the volatility in the gold market and that the cryptocurrencies remained comparable to the Bitcoin. They also find a lack of safe-haven potential of the gold-backed cryptocurrencies compared to gold.

Aside from conventional gold-backed cryptocurrencies, there are also Islamic gold-backed cryptocurrencies. Islamic gold-backed cryptocurrencies are purported to be fully *Shariah*-compliant, which restricts Muslim investors from speculation (Yousaf and Yarovaya, 2022). The firms issuing these cryptocurrencies have obtained *Shariah* certifications from relevant Islamic scholars. For cryptocurrencies to be fully *Shariah* compliant, they must conform with the *Maqasid al-Shariah* (protection of wealth) concept, therefore the cryptocurrencies should be regulated by an authority and backed by an asset (Aliyu et al., 2020). Islamic gold-backed cryptocurrencies are pegged to gold, which is a permissible medium of exchange and its value is stable. The ability to trade the cryptocurrencies for certain quantities of physical gold gives cryptocurrencies an intrinsic value (Yousaf and Yarovaya, 2022). The gold that backs these cryptocurrencies are stored in vaults and the Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) provides the rules guiding the cryptocurrencies (Aliyu et al., 2020). Islamic finance dictates that transactions must be certain and do not carry excessive risk. An evaluation of various Islamic cryptocurrencies by Aliyu et al. (2020) finds that the Islamic gold-backed cryptocurrencies employ the Know Your Customer (KYC) concept so that there is transparency about the investors and their activities. Thus, Islamic gold-backed cryptocurrencies have intrinsic value and address the issues of uncertainty, speculation and volatility of non-*Shariah* compliant cryptocurrencies.

So far to the authors' knowledge only a limited number of studies have investigated the properties of these cryptocurrencies. Mnif and Jarboui (2020) investigate the Islamic gold-backed cryptocurrencies X8X, HelloGold and OneGram, whereby X8X is an Islamic cryptocurrency that is backed by both fiat currency and gold while HelloGold and OneGram are Islamic cryptocurrencies that are

backed by gold. The study focuses on the effect of Covid-19's confirmed cases and fatality cases on Islamic cryptocurrencies' market returns using Ordinary Least Squares (OLS) regression with Newey-West standard errors. They find that an increase in confirmed and death cases of Covid-19 has a significant negative effect on the returns of Islamic cryptocurrencies. Aloui et al. (2021) considered the differential effect of geopolitical risk on both Islamic and conventional gold-backed cryptocurrencies and find strong positive correlations between the five Islamic gold-backed cryptocurrencies they studied and the gold market, but weak and negative correlations between conventional gold-backed cryptocurrencies and the gold market. They also find greater impact of geopolitical risk on the conventional gold-backed cryptocurrencies rather than on the Islamic counterparts. They believe that Islamic gold-backed cryptocurrencies are more stable than conventional fiat-backed and gold-backed cryptocurrencies, as the pegging of the Islamic gold-backed cryptocurrency to gold and its compliance to *Sharia* rules reduces its sensitivity to global geopolitical risk. Yousaf and Yarovaya (2022) examine spillover effects between Islamic gold-backed cryptocurrencies and global Islamic equity sectors during the pre-Covid and Covid-19 periods. They find evidence of increased spillover effects between the selected Islamic assets due to the Covid-19 crisis. In addition, they find increased hedging costs for all pairs of Islamic assets during the crisis period compared to the pre-pandemic period. They therefore suggest that the inclusion of Islamic gold-backed cryptocurrencies can reduce the risk of the equity sector portfolios.

As there is no known study to date that has investigated the volatility or stability of Islamic gold-backed cryptocurrencies during market downturns such as the bear market during the Covid-19 pandemic, studies on Islamic financial markets and institutions are also referred to in order to understand how the Islamic finance industry behaves during times of crisis. In the case of Islamic finance in general, there are studies that find that the Islamic finance industry is more stable compared to the conventional finance industry (Akram, and Rahman, K.u., 2018; Wasiuzzaman and Gunasegavan, 2013; Mohammad et al., 2012). Islamic banks are found to be more efficient and stable compared to conventional banks before and during times of crisis, mainly due to the nature of the business of Islamic banks, i.e., the business is based on risk aversion, commissions and fees, not on interest as practiced by conventional banks (Cerovic et al., 2017). Dridi and Hasan (2010) find that, on average, Islamic banks were more resilient during the global financial crisis but they suffered larger losses compared to their conventional counterparts when the global financial crisis hit the real economy. Apart from the banking industry, a number of studies such as those by Shahzad et al. (2017), Hkiri et al. (2017) and Saiti et al. (2019) have sought to understand Islamic stock indices and how they behave during crisis periods. The study by Shahzad et al. (2017) examines whether investors can use Islamic stock indices as a hedge during a financial crisis. Using a VAR-based spillover index, they compare the returns and volatilities of the Dow Jones Islamic Market and the VIX index in the United States. They find that Islamic stocks are not immune to negative shocks during financial crises, particularly during the financial crisis of 2007, when an increase in the spillover effects in the return and volatility of Islamic stocks was observed. Therefore, they conclude that Islamic stock indices cannot be used as a hedge for investors during financial crises. Similarly, Hkiri et al. (2017) compare nine regional Islamic stock indices with nine other conventional stock indices in the Asia Pacific region, Eurozone, Canada, UK and the United States. They find evidence of volatility spillovers between Islamic and conventional stock indices, indicating the presence of a correlation between the two types of stock indices. However, over time, Islamic stock indices are found to move against conventional stock indices during periods that affected the Eurozone and the United States. As a result, according to Shahzad et al. (2017) and Hkiri et al. (2017), increase in the correlation between the Islamic and conventional finance industry is observed during times of crises. Using multivariate GARCH dynamic conditional correlations, Saiti et al. (2019) compare three different Islamic stock indices in China with ten other conventional sectoral indices on the Shanghai Stock Exchange and find that all Islamic stock indices are less volatile than their conventional counterparts.

Based on the literature above, there is a limited number of literature on gold-backed cryptocurrencies. In addition, so far, aside from the study by Aloui et al. (2021) and Yousaf and Yarovaya (2022), who investigate the issue of geopolitical risks and spillover effects, respectively, to the authors' knowledge, no study has been conducted to assess the possible safe haven properties of Islamic gold-backed cryptocurrencies during times of market downturns, thus this study attempts to fill this gap. For an asset to be qualified as a safe haven, it should be able to retain or increase in value during market downturns, i.e. its returns should be uncorrelated or negatively correlated with those of other assets during a crisis period (Ji et al., 2020). Studies on conventional cryptocurrencies (both fiat and gold-backed) and also on gold so far have provided mixed results, thus the safe-haven property of gold-backed cryptocurrencies is uncertain. This study is an attempt to add to the understanding of the properties of cryptocurrencies, particularly Islamic gold-backed cryptocurrencies, especially during times of crisis.

It may be argued that Islamic gold-backed cryptocurrencies can be good safe haven investment vehicles for investors during crisis periods. This argument is based on the empirical evidence that show that gold-backed cryptocurrencies are more stable than fiat-backed cryptocurrencies as gold-backed cryptocurrencies are backed by gold. Since gold and cryptocurrencies have been found in a number of studies to be effective hedging instruments or diversifiers, gold-backed cryptocurrencies are expected to be less affected by financial crises compared to fiat-backed cryptocurrencies due to their compliance to Shariah requirements of ensuring stability, certainty and transparency and limiting speculation. In addition, Islamic financial markets and institutions are found to be more stable (and less volatile) during crisis periods compared to their conventional counterparts, mainly due to the nature of the business. Hence, it is expected that the return and volatility of Islamic gold-backed cryptocurrencies will not be significantly affected by the Covid-19 crisis or the bear market that occurred during the Covid-19 crisis.

3. Data and methodology

As this study is focused on investigating the performance of Islamic gold-backed cryptocurrency, three currencies are considered – OneGram, the X8X token and the HelloGold Token.[2] The OneGram cryptocurrency was first launched on May 26, 2017.[3] It is a Dubai-based digital currency that is issued by One Gram, a start-up in Dubai that acquired the ruling from Al Maali Consulting that the OneGram cryptocurrency complies with *Shariah* principles. Each OneGram unit is backed by physical gold stored in a vault, limiting speculation, and the currency is paired for trading against the Bitcoin (Torchia and Vizcaino, 2018). The X8X token is an Ethereum-based cryptocurrency that is fully backed by a basket of eight fiat currencies and gold. It is issued by X8 AG, a Swiss financial technology firm that has obtained certification from Islamic scholars for its digital currency (Vizcaino, 2018). The HelloGold token is a cryptocurrency that is backed by gold held in a vault in Singapore (King, 2018). It is a product of HelloGold, a Malaysian Fintech savings platform, that has obtained *Shariah* certification from the Shariah Supervisory Board of Amanie Advisors (Wong, 2018).

The performance of both conventional fiat-backed and conventional gold-backed cryptocurrencies is also considered to gain a better understanding of the performance of the Islamic gold-backed cryptocurrency. Bitcoin is the traditional fiat-backed cryptocurrency used in this study because Bitcoin can influence the price of other traditional fiat-backed cryptocurrencies such as Ethereum and Litecoin. PAX Gold is used to analyze the performance of traditional gold-backed cryptocurrencies, as investors use this as a hedge against the volatility of cryptocurrency. Closing price data for all cryptocurrencies is collected from December 1, 2019 to November 30, 2020 and extracted from coincodex.com. The dates were chosen because they coincide with the Covid-19 pandemic and the bear market (a period of extended price declines) that occurred between February 13 to March 12, 2020 (Conlon and McGee, 2020). The daily returns are calculated using the daily closing values of each cryptocurrency.

Prior research on the returns and volatility of market variables has shown that the Ordinary Least Squares (OLS) regression method is not suitable for analysis of market variables as the data does not meet the requirements of the OLS regression method. Instead, the ARMA-GARCH family of models is used to examine the returns and volatilities of market variables. To analyze the impact of the bear market on the returns of the selected cryptocurrencies, the ARMA(m,n) model is as follows:

$$R_t = c + \sum_{i=1}^{m} \varnothing_i R_{t-i} + \sum_{j=1}^{n} \theta_j \varepsilon_{t-j} + \lambda D_{Bear} \tag{1}$$

The EGARCH(p,q) model is used to analyze the impact of the bear market on the volatility of the selected cryptocurrencies as the model allows for the testing of asymmetries. The EGARCH model is as follows:

$$log\left(\sigma_t^2\right) = \omega + \sum_{j=1}^{p} \beta_j log\left(\sigma_{t-j}^2\right) + \sum_{i=1}^{q} \alpha_i \left[\left|\frac{\varepsilon_{t-i}}{\sigma_{t-i}}\right| - E(|\varepsilon_t|)\right] + r\frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \gamma D_{Bear} \tag{2}$$

where $\varepsilon_t = \sigma_t z_t$ and $E(|\varepsilon_t|) = \sqrt{(2/\pi)}$.

R_t from Eq. (1) represents the return that is dependent on its past values, R_{t-i}, and past shocks, ε_{t-i}. ε_t is the error term and c represents the constant term. The bear market period during the Covid-19 crisis is represented by the dummy variable, D_{Bear}, which is assigned a value of 1 if the date falls within the bear market period and 0 otherwise. The log of the variance series (σ_t^2) on the left-hand side of Eq. (2) makes the leverage effect exponential. The constant α denotes ARCH effects, r denotes asymmetric effects and β denotes GARCH effects.

4. Data analysis

Before carrying out any analysis, unit root tests in level (by intercept; and trend and intercept) are performed on all cryptocurrency data using the Augmented Dickey-Fuller (ADF) test statistics to ensure that the data are stationary. Table 1 shows that the returns data have no unit root, indicating that the data are stationary.

The Wald-Wolfowitz Runs test (Wald and Wolfowitz, 1940) is carried out to test whether the prices of the cryptocurrencies follow a random walk. The results, presented in Table 2, show that the null hypothesis of a random walk is rejected at the 1% level for all cryptocurrencies, indicating that their prices are predictable and not random.

Table 3 presents the descriptive statistics for the five cryptocurrencies (OneGram, X8X, HelloGold, PaxGold and Bitcoin), which are first computed using each currency's daily returns from December 1, 2019 to November 30, 2020, for a total of 364 observations. Table 3 also reports the Q-statistic values of the correlogram for the residuals (Q(20)), which are used to check for autocorrelation issues in the returns, as well as the ARCH-LM test for heteroscedasticity. These tests were carried out on an empty model with the returns being the dependent variable.

Table 3 shows that all cryptocurrencies have positive mean returns over time, with Bitcoin having the highest (0.002725) and the X8X token having the lowest (0.000459). Among the Islamic gold-backed cryptocurrencies, the HelloGold token has the highest mean return over the period (0.002006). A comparison of the Islamic and conventional gold-backed cryptocurrencies shows that, with the exception of HelloGold, which appears to perform almost as well as the Bitcoin, Islamic gold-backed cryptocurrencies have lower

[2] It should be noted that Aloui et al. (2021) classify the HelloGold token as a conventional gold-backed cryptocurrency.
[3] https://icoholder.com/en/onegram#about

Table 1
Unit Root test.

	OneGram		X8X		HelloGold		PaxGold		Bitcoin	
	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*	t-Statistic	Prob.*
ADF Test statistic (level)	−17.355	0	−26.489	0	−14.509	0	−22.616	0	−22.843	0
ADF Test statistic (trend and intercept)	−17.33	0	−26.454	0	−14.49	0	−22.641	0	−22.884	0

Table 2
Runs test.

Cryptocurrency	Positive Returns	Negative Returns	Total no of Runs	Expected Runs	*Z*-value
Onegram	214	150	205	177.37	2.993
X8X	193	171	202	182.34	2.072
HelloGold	190	174	181	182.65	−0.173
PaxGold	200	164	197	181.22	1.673
X8X	199	166	217	181.41	3.769

Table 3
Descriptive Statistics.

	OneGram	X8X	HelloGold	PaxGold	Bitcoin
Mean	0.000506	0.000459	0.002006	0.000596	0.002725
Median	0.000000	0.000000	0.000000	0.000951	0.002394
Maximum	0.169500	1.055893	0.412398	0.055295	0.155394
Minimum	−0.25173	−1.25329	−0.53747	−0.07402	−0.51808
Stdev.	0.040412	0.170006	0.099459	0.013461	0.041870
Mean/Stdev.	0.012521	0.0027	0.020169	0.044276	0.065082
Skewness	−1.19488	−0.87335	0.133816	−0.57921	−4.98614
Kurtosis	13.05296	21.58658	7.813919	7.990194	68.35991
Jarque-Bera	1619.391	5285.766	352.5560	398.0335	66,299.01
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Test of autocorrelation					
Q(20)	69.61	61.396	45.617	25.79	43.978
Prob.	0	0	0.001	0.173	0.002
Test of heteroscedasticity					
F-statistic	13.628	54.038	33.613	14.2	2.046
Prob. Chi-Square	0.0003	0	0	0.0002	0.1535
Number of Observations	364				

average returns than the conventional cryptocurrency, PaxGold. The standard deviations in Table 3 are used to compare the volatility of the assets. Of the five cryptocurrencies, PaxGold has the lowest volatility (0.013461), while the X8X token has the highest risk (0.170006). The HelloGold token has the second highest risk (0.099459), whereas the risk levels for the OneGram and the Bitcoin are similar. The reward-to-risk ratio of the cryptocurrencies, which is calculated by dividing the mean value by the standard deviation, shows that the conventional cryptocurrencies outperform Islamic cryptocurrencies, with the ratio for Bitcoin being 0.065082 while that of PaxGold being 0.044276. The risk-to-reward ratios of Islamic gold-backed cryptocurrencies are found to be lower compared to both the PaxGold and Bitcoin, with the X8X token having the greatest risk. Autocorrelation analysis shows that, with the exception of PaxGold, the returns of all the other cryptocurrencies are correlated with their past returns. In addition, with the exception of Bitcoin,

Table 4
Test of mean difference (Mann-Whitney test).

	OneGram		X8X		HelloGold		PaxGold		Bitcoin	
	$D_{Bear} = 0$	$D_{Bear} = 1$	$D_{Bear} = 0$	$D_{Bear} = 1$	$D_{Bear} = 0$	$D_{Bear} = 1$	$D_{Bear} = 0$	$D_{Bear} = 1$	$D_{Bear} = 0$	$D_{Bear} = 1$
Mean returns	0.0007	−0.0021	0.0029	−0.0273	0.0037	−0.0171	0.0008	−0.0016	0.0048	−0.0213
Diff in mean (*p*-value)	0.569		0.056		0.332		0.938		0.036	
Std. Dev. of returns	0.0374	0.0672	0.1726	0.13581	0.09487	0.14307	0.01205	0.0247	0.03052	0.10474
Mean sent.	2.467	3.278	0.00138	0.0007	0.00009	0.00011	44.472	78.918	386.505	533.919
Diff in mean (p-value)	0.155		0.035		0.015		0.001		0.08	

the returns data for all cryptocurrencies suggest that heteroscedasticity is not a concern.

The means and standard deviations, as well as the significance in the difference in the means, are calculated for the subsamples ($D_{Bear} = 0$ and $D_{Bear} = 1$) and presented in Table 4.

The mean values for all cryptocurrencies are positive during normal market conditions, but they become negative during the bear market of 2020. Bitcoin appears to have been the most affected during the bear market, since its mean returns are the highest during normal market conditions but the second lowest during the bear market (lowest mean return during the bear market is observed for X8X). Analysis of the significance in the difference in mean returns shows that the differences are significant only for the Bitcoin (at 5% level) and the X8X token (at 10% level). The standard deviation of returns for the overall period and the bear market period shows that, with the exception of X8X, all other cryptocurrencies had higher standard deviations during the bear market of 2020, indicating that the cryptocurrencies had higher overall risk during this period. Interestingly, the standard deviation of the X8X token is found to have decreased during the bear market. The change in risk of the gold-backed cryptocurrencies is less compared to that of the fiat-backed cryptocurrency (the Bitcoin), with the PaxGold having the lowest risk during the bear market period. However, the significance in the difference in the standard deviation is not assessed.

Table 4 also presents the findings of the mean sentiment analysis for the overall period and the bear market periods. Due to large variations in the volume data and, in some cases, lack of volume data for the Islamic cryptocurrencies, sentiment is measured as the difference in the daily high and low prices (Abbes and Abdelhedi-Zouch, 2015). Abbes and Abdelhedi-Zouch (2015) used this measurement as an indicator of investor sentiment to reflect emotions such as greed and fear towards financial market conditions. A large spread between the highest and lowest trading price denotes a bearish mood, while a small spread denotes a bullish mood. Sentiment analysis results in Table 4 show that, with the exception of X8X, the spreads are higher during the bear market for all other cryptocurrencies, indicating that the investors in these markets are bearish. However, the X8X token has a smaller spread during the bear market.

Correlation analysis is carried out next to gauge the extent to which the returns of the three cryptocurrencies influence each other. The correlations provided in Table 5 are calculated for the full sample and the subsamples ($D_{Bear} = 0$ and $D_{Bear} = 1$).

Table 5 shows positive correlations between the cryptocurrencies for the full sample and the subsamples, with the exception of the X8X token. The Islamic gold-backed cryptocurrencies, OneGram and HelloGold, show moderate to strong correlations with Bitcoin in the full sample (OneGram = 0.602; HelloGold = 0.382) and the correlation strengthen during the bear market (OneGram = 0.825; HelloGold = 0.785). In both the full sample and the subsamples, the correlations between OneGram and HelloGold with the Bitcoin are highly significant at the 1% level. This may be because OneGram is paired for trading with the Bitcoin while HelloGold's highest volume trading pair is the Bitcoin. The correlation between the OneGram and PaxGold is weak, with correlation coefficients being less than 2, and although the correlation coefficients are larger in value during the bear market, the correlations become insignificant. The correlation between HelloGold and PaxGold is also weak and insignificant during the bear market. Interestingly, the X8X token has negative correlations with all the cryptocurrencies. Its relationship strengthens during the bear market, particularly with the other Islamic cryptocurrencies – OneGram and HelloGold, with the relationships becoming significant during the bear market period. Its relationship with the Bitcoin is strengthened during the bear market but the relationship is only weakly significant. The strengthening of the correlations between most of the crypto assets during crisis periods (i.e. during the bear market) confirms the finding of Yousaf and Yarovaya (2022) that there is greater connectedness between assets during crisis periods. On the other hand, its relationship with PaxGold is insignificant for all the samples, and it weakens during the bear market. The negative correlation of the X8X token with the

Table 5
Correlations Analysis.

Full Sample						
	OneGram	X8X	HelloGold	PaxGold	Bitcoin	N
OneGram	1.000	−0.090*	0.183**	0.169**	0.602***	
X8X		1	−0.038	−0.038	−0.092*	
Hello Gold			1	0.087*	0.382***	364
PaxGold				1.000	0.288***	
Bitcoin					1.000	
$D_{Bear} = 0$						
OneGram	1.000	−0.039	0.036	0.148***	0.538***	
X8X		1	−0.007	−0.044	−0.066	
HelloGold			1	0.062	0.242***	335
PaxGold				1.000	0.274***	
Bitcoin					1.000	
$D_{Bear} = 1$						
OneGram	1.000	−0.562***	0.823***	0.235	0.825***	
X8X		1	−0.39**	−0.029	−0.359*	
HelloGold			1	0.175	0.785***	29
PaxGold				1.000	0.326	
Bitcoin					1.000	

***, **, * denote significance at 1%, 5% and 10% levels, respectively.

rest of the crypto assets is expected given that sentiment analysis in Table 4 showed smaller spreads for this token and larger for all others.

The ARMA(m,n)-EGARCH(p, q) model is used to examine the impact of the bear market on cryptocurrency returns and volatility, the results of which are provided in Table 6. Also provided in Table 6 are the results of the post-analysis tests of autocorrelation (Q-statistic values of the correlogram for the residuals, Q(20)) and heteroscedasticity (ARCH-LM test). Selection of lags for the EGARCH(p, q) models for each cryptocurrency is determined via the Akaike Information Criterion (AIC) and the Schwarz criterion (SIC). The AIC and SIC values are provided in Table 6. Based on the Q-statistics and the chi-squared values of the ARCH LM test, and also the values of the AIC and SIC, it is determined that the ARMA(1,1)-EGARCH(2,1) model is suitable to be used for Onegram and PaxGold while the ARMA(1,1)-EGARCH(1,1) model is suitable for Hellogold, ARMA(0,1)-EGARCH(2,1) is suitable for X8X and the ARMA(1,0)-EGARCH (2,1) is suitable for the Bitcoin.

Analysis of the impact of the bear market on the returns and volatility of the five cryptocurrencies yields varying results. First, the bear market has a negative influence on the returns of all the Islamic gold-backed cryptocurrencies and also the Bitcoin but the influence is positive on the returns of PaxGold, implying that the conventional gold-backed cryptocurrency experienced higher returns during the bear market. Next, in terms of the size of the coefficient, the bear market is found to have the greatest effect on the Islamic tokens – the X8X token (−0.024122) and the HelloGold token (−0.021465), implying that these crypto assets are more sensitive to market movements than the other crypto assets. However, the influence is found to be weakly significant for the Islamic cryptocurrencies and insignificant for the PaxGold and Bitcoin. Thus, the bear market is found to have weak to no significant influence on the returns of any of the cryptocurrencies.

The influence of the bear market on the volatility of the cryptocurrencies is found to be positive for all the cryptocurrencies, except for the X8X token, where the impact is negative. The impact is greatest on the volatility of the HelloGold token (0.202089), followed by Bitcoin (0.189057) and the least on the volatility of PaxGold (0.143179). The increase in volatility is found to be highly significant only for PaxGold and Bitcoin, implying that the conventional cryptocurrencies (whether it is fiat-backed or gold-backed) are more susceptible to financial market downturns than the Islamic cryptocurrencies. In addition, the coefficient of r is found to be positive for all the cryptocurrencies, with the exception of X8X, implying that good news (positive shocks) generates greater volatility than bad news (negative shocks), whereas for the X8X token, bad news generates greater volatility. The impact of news on the cryptocurrencies is highly significant for HelloGold, PaxGold and Bitcoin, but insignificant for OneGram and X8X.

The ARMA-EGARCH-M model is used to perform a robustness test to confirm that the change in returns during a bear market is not due to the sentiment surrounding the period but a result of the market's conditional risk. The ARMA-EGARCH-M model incorporates the conditional market risk, σ_t with the coefficient being ρ. The results are presented in Table 7.

In terms of the effect of the bear market on the returns and volatility of the cryptocurrencies, the results in Table 7 confirm those in Table 6. The inclusion of the conditional market risk factor in the equation confirms that the bear market has no significant impact on the returns of all the cryptocurrencies and that the decrease in returns is due to the conditional market risk. The effect of the bear market on the volatility of returns of the cryptocurrencies remains the same as what was reported in Table 6, with the difference that the impact on the X8X token is now positive, though still insignificant. Table 7 further shows that the conditional market risk is highly

Table 6
Estimations of ARMA(1,1)-EGARCH(p, q) models for cryptocurrencies.

Variable	OneGram	X8X	HelloGold	PaxGold	Bitcoin
C	0.001106**	0.010580***	0.002509	0.000491**	0.004780***
	(0.000237)	(0.00245)	(0.002452)	(0.000236)	(0.001258)
D_{Bear}	−0.004955*	−0.024121*	−0.021465*	0.000182	−0.014347
	(0.002777)	(0.012309)	(0.011860)	(0.004799)	(0.015220)
ϕ_1	0.531279***		0.488786***	−0.213736	−0.153557**
	(0.057067)		(0.112836)	(0.146356)	(0.061126)
θ_1	−0.891331***	−0.484449***	−0.756727***	−0.013837	
	(0.027604)	(0.054171)	(0.078640)	(0.161745)	
Variance Equation					
ω	−0.793704***	−2.61062***	−1.732599***	−0.305133***	−0.338671***
	(0.221435)	(0.466645)	(0.417325)	(0.041828)	(0.050391)
α_1	1.014348***	0.392473***	0.198583***	0.238515**	0.356729***
	(0.071446)	(0.065929)	(0.056997)	(0.113482)	(0.086904)
α_2	−0.510484***	0.333225***		−0.381203***	−0.362282***
	(0.092442)	(0.079584)		(0.113482)	(0.080895)
r	0.020249	−0.087348	0.155575***	0.118870***	0.070881***
	(0.038040)	(0.056983)	(0.046661)	(0.019738)	(0.020626)
β_1	0.939485***	0.431016***	0.672033***	0.955673***	0.952635***
	(0.024703)	(0.104884)	(0.081717)	(0.005284)	(0.007443)
D_{Bear}	0.178588	−0.094091	0.202089*	0.143179***	0.189057***
	(0.113426)	(0.102269)	(0.119960)	(0.025973)	(0.030530)
Q(20)	28.692	22.991	22.857	24.839	14.415
ARCH LM F-statistic	0.142528	0.140447	0.399359	$9.02e^{-6}$	0.059458
Akaike info criterion	−4.082242	−0.978805	−1.930696	−6.155367	−4.087892
Schwarz criterion	−3.974958	−0.882447	−1.834140	−6.048083	−3.991336

Table 7
Estimations of ARMA(1,1)-EGARCH(p, q)-M models for cryptocurrencies.

Variable	OneGram	X8X	HelloGold	PaxGold	Bitcoin
C	0.007246**	0.088694***	0.059941**	−0.000391	−0.004759
	(0.002732)	(0.025740)	(0.028461)	(0.000339)	(0.005021)
ρ	−0.182650**	−0.559753***	−0.614158*	0.117297**	0.384997**
	(0.079703)	(0.194091)	(0.322150)	(0.049353)	(0.184370)
D_{Bear}	−0.003010	−0.023380	−0.003211	−0.000571	−0.019327
	(0.003219)	(0.018496)	(0.024420)	(0.004630)	(0.015055)
ϕ_1	0.502422***		−0.232003***	−0.348249**	−0.153506**
	(0.068367)		(0.054392)	(0.142581)	(0.062642)
θ_1	−0.889758***	−0.360388***		−0.126818	
	(0.030961)	(0.079600)		(0.164745)	
Variance Equation					
ω	−0.864734***	−1.977701***	−1.469624***	−0.240439***	−0.228966***
	(0.273228)	(0.270307)	(0.343369)	(0.010744)	(0.056293)
α_1	0.939028***	0.401946***	0.095906*	0.212344***	0.3575999***
	(0.067827)	(0.075756)	(0.056228)	($3.30e^{-8}$)	(0.085520)
α_2	−0.478058***	0.296984***		−0.349989***	−0.410263***
	(0.095640)	(0.073901)		(0.009596)	(0.079571)
r	−0.002181	−0.093250	0.207879***	0.105484***	0.081511***
	(0.035044)	(0.068386)	(0.042104)	(0.016358)	(0.021183)
β_1	0.926042***	0.598548***	0.710510***	0.936158***	0.964567***
	(0.032365)	(0.065333)	(0.066678)	(0.000285)	(0.007770)
D_{Bear}	0.196462*	0.048600	0.193299*	0.130053***	0.169630***
	(0.111506)	(0.085686)	(0.102712)	(0.019737)	(0.026976)
Q(20)	29.024	23.295	24.030	19.981	15.299
ARCH LM F-statistic	3.855487	0.310441	0.681634	2.015507	0.052816
Akaike info criterion	−4.086943	−0.991332	−1.916573	−6.150680	−4.089585
Schwarz criterion	−3.968930	−0.884264	−1.820017	−6.032668	−3.982302

significant (at 1% level) for all the cryptocurrencies, with the exception of HelloGold, where the significance is only at the 10% level. The conditional market risk coefficient is negative for the Islamic gold-backed cryptocurrencies, thus the returns of the Islamic cryptocurrencies is negatively related to their volatility, i.e. when volatility increases, mean returns decrease. On the other hand, the conditional market risk coefficient is positive for both PaxGold and Bitcoin, implying that an increase in the volatility of the conventional cryptocurrencies results in an increase in mean returns.

5. Discussion of results

Impact of the bear market on the Islamic gold-backed cryptocurrencies - OneGram, HelloGold and X8X - is investigated via a number of analysis, including descriptive statistics, the Mann-Whitney independent test of mean difference and the ARMA-EGARCH family of models. Descriptive statistics show that the mean returns of the Islamic gold-backed cryptocurrencies are positive but generally lower than those of PaxGold and Bitcoin, with the exception of HelloGold which has mean returns greater than the PaxGold. On the other hand, the volatility of the Islamic gold-backed cryptocurrencies are higher than that of PaxGold, implying that the conventional gold-backed cryptocurrency appears to do better in terms of risk-return characteristics. This is further supported by the higher reward-to-risk ratio of PaxGold when compared to the Islamic gold-backed cryptocurrencies. Of the five cryptocurrencies analyzed, the Bitcoin has the highest reward-to-risk ratio. The lower reward-to-risk ratio of the Islamic gold-backed cryptocurrencies contradict the findings of Aliyu et al. (2020), which claim that Islamic gold-backed cryptocurrencies are more stable than conventional fiat-backed and conventional gold-backed cryptocurrencies.

The mean returns and volatility of the five cryptocurrencies are further examined in two different market conditions: when the market is suffering downturns (bear market) and when it is not. The results show that the Bitcoin does very well in normal market conditions but it suffers substantially during the bear market in the form of decreased returns. This is consistent with the findings of Conlon and McGee (2020), which show that the decrease in Bitcoin's returns during the bear market was higher than that of the S&P500. The OneGram has the lowest returns during normal market conditions and while its returns are negative during the bear market, the reduction in returns is much less compared to that of the Bitcoin. When compared to the conventional gold-backed cryptocurrency, the PaxGold, the OneGram does not fare as well in both market conditions. The PaxGold has superior mean returns in both market conditions compared to the OneGram. On the other hand, HelloGold and X8X outperform PaxGold in normal market conditions but underperform during the bear market. In terms of risk, the standard deviations in both market conditions show that all three Islamic gold-backed cryptocurrencies always have greater risk compared to the PaxGold. Therefore, this again contradicts the claim by Aliyu et al. (2020) that Islamic gold-backed cryptocurrencies are more stable than conventional gold-backed cryptocurrencies. An examination of investor sentiment for all five cryptocurrencies produces similar outcomes, i.e. sentiments are higher during the bear market. Interestingly however, both the volatility and investor sentiment of the X8X token decrease during the bear market. A probable explanation is that the X8X token is backed by a portfolio of fiat currencies and gold, instead of a single asset as is

the case for the other cryptocurrencies.

The ARMA-EGARCH model is used to evaluate the impact of the bear market on the returns and volatility of the five cryptocurrencies. The results show that while the returns of the Islamic gold-backed cryptocurrencies and Bitcoin are negatively affected by the bear market, the effect is weakly significant (at 10% level) for the Islamic gold-backed cryptocurrencies. PaxGold is positively affected by the bear market, although the effect is insignificant. The significant negative impact of the bear market on the returns of Islamic gold-backed cryptocurrencies is consistent with the findings of Shahzad et al. (2017) for Islamic stocks, which show that Islamic stocks are not immune to negative shocks during financial crises. This study finds that the Islamic cryptocurrency is not immune to negative shocks of the bear market.

With respect to the volatility, it is found that the volatility of the cryptocurrencies is positively affected by the bear market, with the exception of X8X, where the effect on the volatility is negative. In general, the results confirm the findings from the studies of Lahmiri and Bekiros (2020), Mariana et al. (2020) and Umar and Gubareva (2020). Lahmiri and Bekiros (2020) found that, when compared to the equity market, cryptocurrencies are riskier as the market becomes more unstable and irregular during the pandemic. Similarly, Umar and Gubareva (2020) found that investor panic due to Covid-19 increased the volatility of the cryptocurrency market. This again supports the findings of Shahzad et al. (2017) that the Islamic markets are not immune to negative shocks. However, the increase in the volatility of the Islamic gold-backed cryptocurrencies are insignificant while those of the Bitcoin and the PaxGold are significant at the 1% level. The significant increase in the volatility of the Bitcoin and the PaxGold supports the conclusion by Conlon and McGee (2020) that the Bitcoin is not a safe hedge but rather it increases risk. With respect to the Islamic gold-backed cryptocurrencies, it can be concluded that market downturns do not have any significant impact on the volatility of this type of cryptocurrency hence it may be able to act as a safe-haven during market downturns such as the bear market of 2020. When the effects of the bear market on the returns and volatility of the Islamic gold-backed cryptocurrencies are viewed together, it can be concluded that similar to the study on Islamic banks by Dridi and Hasan (2010), the Islamic gold-backed cryptocurrency is more resilient during financial market downturns but it suffers greater losses compared to its conventional counterpart.

Interestingly, both the OneGram and HelloGold show strong positive correlations with the Bitcoin, compared to its correlations with PaxGold, their conventional counterpart; and the correlations become stronger during the bear market. The X8X token is found to have negative but insignificant correlations with all the other crypto assets. According to Ji et al. (2020), for an asset to statistically qualify as a safe-haven, its returns should be uncorrelated or negatively correlated with the return of other assets. Considering the negative impact of the bear market on the returns of Islamic gold-backed cryptocurrencies and Bitcoin, but positive impact on PaxGold; and the positive impact of the bear market on the volatility of the cryptocurrencies (although insignificant for the Islamic gold-backed cryptocurrencies and negative for X8X), it can be concluded that a portfolio consisting of Islamic gold-backed cryptocurrencies and conventional gold-backed cryptocurrencies may offer portfolio diversification benefits hence the Islamic gold-backed cryptocurrency may be utilized as a hedge against conventional gold-backed cryptocurrencies. However, a portfolio consisting of Islamic gold-backed cryptocurrencies and conventional fiat-backed cryptocurrencies does not offer portfolio diversification benefits.

6. Conclusion

The aim of this study is to evaluate the impact of the bear market on the returns and volatility of Islamic gold-backed cryptocurrencies. To do this, price data is collected from 1 December 2019 to 30 November 2020 for five cryptocurrencies – the OneGram, HelloGold and X8X (Islamic gold-backed cryptocurrencies), the PaxGold (conventional gold-backed cryptocurrency) and the Bitcoin (conventional fiat-backed cryptocurrency). Analysis is conducted via the ARMA-EGARCH model and the results show that returns are lower during the bear market for all the cryptocurrencies but are weakly significant only for the Islamic gold-backed cryptocurrencies. Although the volatility of both conventional and Islamic gold-backed cryptocurrencies is substantially higher, the effect of the bear market is not significant only for the Islamic cryptocurrencies. As a result, according to the findings, Islamic gold-backed cryptocurrencies can be used as a hedge against conventional cryptocurrencies. However, correlations between the assets show that in general, the Islamic gold-backed cryptocurrencies have very strong correlations with the conventional fiat-backed cryptocurrency, hence it is not advisable for portfolio managers to include both these assets in their portfolio. Instead, the correlations between the Islamic and conventional gold-backed cryptocurrencies are weak even during the bear market, thus diversification benefits may be achieved through the inclusion of these two types of assets in a portfolio. An additional observation in this study is the negative effect of the bear market on the volatility and the sentiments of the investors of the X8X token, which may be because the X8X token is backed by a portfolio of assets, rather than just gold.

The study has several implications for academics, investors and portfolio managers. First, it does not just provide insights into the risk-return characteristics of Islamic gold-backed cryptocurrencies per se, it also compares these characteristics with other well-known and well-researched crypto assets. Second, it shows how various forms of cryptocurrencies are affected by various market conditions, especially during crisis periods. It therefore provides an understanding of the safe-haven property of these assets, particularly that of the Islamic gold-backed cryptocurrency. Third, it emphasizes the benefits of including gold-backed cryptocurrencies (whether Islamic or conventional) as hedging tools in portfolios to mitigate the negative impacts of downturns.

This study is limited in terms of the choice of methodology, the sample period and the number of cryptocurrencies used in the analysis. This study only uses the ARMA-GARCH models (in this case, the EGARCH model) where in fact there are other possibly more efficient models such as the wavelet analysis which have been used in previous studies. This study considers the period of December 2019 to December 2020, not the entire Covid-19 pandemic period due to its focus on the bear market and to avoid the effect of the new virus strains on the results. In addition, the conclusions of this study are limited to the five cryptocurrencies examined. Thus, future researchers could improve this analysis by incorporating more cryptocurrencies, longer study periods and use alternative econometric

techniques. An avenue for further research may be the analysis of cryptocurrencies backed by portfolios of assets, such as the X8X token. In addition, as there are differences in the characteristics of coins and tokens, future studies could delve further into how these distinctions may affect the performance of these assets. Finally, while this study examines the correlations between various crypto assets it does not examine the possibility of spillover effects between the assets; as a result, future research can focus on this topic, particularly in relations to tokens and Islamic gold-backed cryptocurrencies.

CRediT authorship contribution statement

Shaista Wasiuzzaman: Conceptualization, Data curation, Methodology, Software, Writing – original draft, Investigation, Supervision. **Ayu Nadhirah Muhd Azwan:** Data curation, Investigation, Writing – original draft. **Aina Nazurah Hj Nordin:** Investigation, Writing – review & editing.

References

Abbes, M.B., Abdelhedi-Zouch, M., 2015. Does hajj pilgrimage affect the Islamic investor sentiment? Res. Int. Bus. Financ. 35, 138–152.

Akram, H., Rahman, K.u., 2018. Credit risk management: a comparative study of Islamic banks and conventional banks in Pakistan. ISRA Int. J. Islamic Fin. 10 (2), 185–205.

Al-Awadhi, A., Alsaifi, K., Al-Awadhi, A., Alhammadi, S., 2020. Death and contagious infectious diseases: impact of the COVID-19 virus on stock market returns. J. Behav. Exp. Financ. 27 (101615).

Aliyu, A., Abu Bakar, K., Matsuda, G., Darwish, T.S.J., Abdullah, A.H., Ismail, A.S., Raja Mohd Radzi, R.Z., Yusof, A.F., Mohamad, M.M., Idris, M.Y., Ismail, Z., Che Yaacob, A., Herman, 2020. Review of some existing Shariah-compliant cryptocurrency. J. Contemp. Islamic Stud. 6 (1), 23–43.

Aloui, C., Ben Hamida, H., Yarovaya, L., 2021. Are Islamic gold-backed cryptocurrencies different? Financ. Res. Lett. 39, 1–9.

Anagnostidis, P., Varsakelis, C., Emmanouilides, C., 2016. Has the 2008 financial crisis affected stock market efficiency? The case of Eurozone. Phys. A: Stat. Mech. Appl. 447, 116–128.

Ashraf, B., 2020. Stock markets' reaction to COVID-19: cases or fatalities? Res. Int. Bus. Financ. 54, 1–7.

Baek, S., Mohanty, S., Glambosky, M., 2020. COVID-19 and stock market volatility: an industry level analysis. Financ. Res. Lett. 37, 1–10.

Baranova, V., Sergienko, O., Stepurina, S., Lyashenko, V., 2020. Price environment for gold and silver in the context of the development of COVID-19. J. Asian Multicult. Res. Econ. Manag. Study 1 (2), 25–32.

Caferra, R., Vidal-Tomás, D., 2021. Who raised from the abyss? A comparison between cryptocurrency and stock market dynamics during the COVID-19 pandemic. Financ. Res. Lett. 43, 101954.

Cerovic, L., Nikolaj, S.S., Maradin, D., 2017. Comparative analysis of conventional and Islamic banking: importance of market regulation. Ekonomska Misao i Praksa 26, 241–263.

Conlon, T., McGee, R., 2020. Safe haven or risky hazard? Bitcoin during the Covid-19 bear market. Financ. Res. Lett. 35, 1–5.

Corbet, S., Hou, Y., Hu, Y., Larkin, C., Oxley, L., 2020. Any port in a storm: cryptocurrency safe-havens during the COVID-19 pandemic. Econ. Lett. 194, 1–7.

Corbet, S., Hou, Y.G., Hu, Y., Larkin, C., Lucey, B., Oxley, L., 2022. Cryptocurrency liquidity and volatility interrelationships during the COVID-19 pandemic. Financ. Res. Lett. 45, 102137.

Dridi, J., Hasan, M., 2010. The effects of the global crisison islamic and conventional banks: a comparative study. In: Working Paper, International Monetary Fund, 1 September.

Erdem, O., 2020. Freedom and stock market performance during Covid-19 outbreak. Financ. Res. Lett. 36, 1–6.

Ftiti, Z., Louhichi, W., Ameur, H.B., 2021. Cryptocurrency volatility forecasting: what can we learn from the first wave of the COVID-19 outbreak? Ann. Oper. Res. https://doi.org/10.1007/s10479-021-04116-x.

Hkiri, B., Hammoudeh, S., Aloui, C., Yarovaya, L., 2017. Are Islamic indexes a safe haven for investors? An analysis of total, directional and net volatility spillovers between conventional and Islamic indexes and importance of crisis periods. Pac. Basin Financ. J. 43, 124–150.

Jalan, A., Matkovskyy, R., Yarovaya, L., 2021. "Shiny" crypto assets: a systemic look at gold-backed cryptocurrencies during the COVID-19 pandemic. Int. Rev. Financ. Anal. 78 (101958).

Jason, J., 2020. The coronavirus stock market: a market gone wild. Forbes. Available at: https://www.forbes.com/sites/juliejason/2020/04/08/the-coronavirus-stock-market-a-market-gone-wild/?sh=17008510a31f (accessed 21 February 2022).

Jeribi, A., Chamsa, D., Manzli, Y.S., 2020. Emerging stock markets' reaction to COVID-19: can cryptocurrencies be a safe haven? J. Manag. Econ. Stud. 2 (3), 152–165.

Ji, Q., Zhang, D., Zhao, Y., 2020. Searching for safe-haven assets during the COVID-19 pandemic. Int. Rev. Financ. Anal. 71, 1–25.

King, G.F., 2018. There are now gold-backed cryptocurrencies for Muslims that conform with Sharia. In: Quartz. Available at: https://qz.com/1247409/bitcoin-cryptocurrencies-for-muslims-backed-by-gold-are-popping-up/ (accessed 26 February 2022).

Lahmiri, S., Bekiros, S., 2020. The impact of COVID-19 pandemic upon stability and sequential irregularity of equity and cryptocurrency markets. Chaos, Solitons Fractals 138, 1–7.

LePan, N., 2020. The impact of COVID-19 shutdowns on the gold supply chain. Available at: https://www.visualcapitalist.com/impact-of-covid-19-on-the-gold-supply-chain/.

Mamaysky, H., 2020. Financial markets and news about the coronavirus. Available at: https://voxeu.org/article/financial-markets-and-news-about-coronavirus.

Mariana, C.D., Ekaputra, I.A., Husodo, Z.A., 2020. Are bitcoin and Ethereum safe-havens for stocks during the COVID-19 pandemic? Financ. Res. Lett. 38, 1–7.

Mensi, W., Sensoy, A., Vo, X., Kang, S., 2020. Impact of COVID-19 outbreak on asymmetric multifractality of gold and oil prices. Res. Policy 69, 1–11.

Mnif, E., Jarboui, A., 2020. Impact of COVID19 on the Islamic cryptocurrencies. Eur. J. Islamic Fin. 16, 1–6.

Mnif, E., Jarboui, A., Mouakhar, K., 2020. How the cryptocurrency market has performed during COVID 19? A multifractal analysis. Financ. Res. Lett. 36, 1–14.

Mohammad, W.M.W., Nurdin, N., Wasiuzzaman, S., 2012. Bank risk and performance pre and post financial crisis 2008: a comparison of Islamic and conventional banks. J. Islamic Econ. Bank. Fin. 8 (4), 21–32.

Rajput, H., Changotra, R., Rajput, P., Gautam, S., Gollakota, A.R., Arora, A.S., 2021. A shock like no other: coronavirus rattles commodity markets. Environ. Dev. Sustain. 23 (5), 6564–6575.

Saiti, B., Ma, Y., Nagayev, R., Yumusak, İ., 2019. The diversification benefit of Islamic investment to Chinese conventional equity investors. Int. J. Islam. Middle East. Financ. Manag. 13 (1), 1–23.

Salisu, A.A., Vo, X.V., Lawal, A., 2020. Hedging oil price risk with gold during COVID-19 pandemic. Res. Policy 70, 1–25.

Shahzad, S.J.H., Ferrer, R., Ballester, L., Umar, Z., 2017. Risk transmission between Islamic and conventional stock markets: a return and volatility spillover analysis. Int. Rev. Financ. Anal. 52, 9–26.

Topcu, M., Gulal, O., 2020. The impact of COVID-19 on emerging stock markets. Financ. Res. Lett. 36, 1–4.

Torchia, A., Vizcaino, B., 2018. Cryptocurrency traders use old gold in drive to draw Islamic investors. In: Reuters. Available at: https://www.reuters.com/article/us-crypto-currencies-islamic-finance-ins-idUSKBN1HF076 (accessed 21 February 2022).

Umar, Z., Gubareva, M., 2020. A time–frequency analysis of the impact of the Covid-19 induced panic on the volatility of currency and cryptocurrency markets. J. Behav. Exp. Financ. 28, 1–10.

Vizcaino, B., 2018. Swiss cryptocurrency firm X8 obtains Islamic finance certification'. In: Reuters. Available at: https://www.reuters.com/article/islamic-finance-cryptocurrencies-idUSL8N1XN0BG (accessed 23 February 2022).
Wald, A., Wolfowitz, J., 1940. On a test whether two samples are from the same population. Ann. Math. Stat. 11 (2), 147–162.
Wasiuzzaman, S., Gunasegavan, U.N., 2013. Comparative study of the performance of Islamic and conventional banks. Humanomics 29 (1), 43–60.
Wasiuzzaman, S., Rahman, H.S.W.H.A., 2021. Performance of gold-backed cryptocurrencies during the COVID-19 crisis. Financ. Res. Lett., 101958 https://doi.org/10.1016/j.frl.2021.101958.
Wong, K., 2018. HelloGold receives Shariah certification for its new token. In: The Malaysian Reserve. Accessible at: https://themalaysianreserve.com/2018/10/04/hellogold-receives-shariah-certification-for-its-new-token/ (accessed 24 February 2022).
Yarovaya, L., Matkovskyy, R., Jalan, A., 2021. The effects of a "black swan" event (COVID-19) on herding behavior in cryptocurrency markets. J. Int. Financ. Mark. Inst. Money 75, 101321.
Yousaf, I., Ali, S., 2020. The COVID-19 outbreak and high frequency information transmission between major cryptocurrencies: evidence from the VAR-DCC-GARCH approach. Borsa Istanbul Rev. 20, S1–S10.
Yousaf, I., Yarovaya, L., 2022. Spillovers between Islamic gold-backed cryptocurrencies and equity markets during the COVID-19: a sectoral analysis. Pac. Basin Financ. J. 71, 101705.
Yousaf, I., Ali, S., Bouri, E., Dutta, A., 2021. Herding on fundamental/nonfundamental information during the COVID-19 outbreak and cyber-attacks: evidence from the cryptocurrency market. SAGE Open 11 (3), 21582440211029911.