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Interdependence and volatility transmission among MENA stock markets, gold, and Bitcoin: Evidence from VAR-BEKK approach

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Abstract
Based on hedging asset returns in gold and Bitcoin, this study investigates the interdependence and the spillover effects among these hedging assets and some Middle East and North Africa (MENA) stock market returns namely Jordan, Saudi Arabia, United Arab Emirates, Kuwait, and Morocco**.** VAR models and GARCH-BEKK model under the student t- distribution based on daily data from February 2017 to December 2021 are conducted in this study. The empirical results from VAR model indicated that there is a lower degree of association between all pairs during the covid-19 period thus a weak hedging capacity of gold and Bitcoin against the MENA region. Besides, results from GARCH-BEKK suggest that gold act only as diversifier for MENA stock markets and a safe-haven asset for Morocco and Kuwait market. However, Bitcoin can be regarded as a diversifier for the MENA stock markets especially for Saudi Arabia market. Our findings are useful for financial investors and policymakers needing forecasts of MENA region futures interdependence to optimize investment choices and to benefit from low transaction costs and high level of security.

Keywords: Covid-19, gold, Bitcoin, MENA stock markets, volatility spillovers

Introduction

By the end of 2019, a new Coronavirus was identified as the cause of a disease outbreak in Wuhan city, China. Since then, the disease has spread rapidly and infected more than 2 million persons across 210 countries (WHO, 2020). The outbreak of the novel coronavirus (COVID-19) propagated across the world and continuous waves have been observed in stock markets which caused a continuous increase in financial volatility, a high degree of uncertainty and a huge decrease in the international financial markets.

The World Health Organization proclaimed COVID-19 as an epidemic in March 2020 and has predicted one of the biggest public health crisis or non-economic crises in history that transferred across the world.

Although its effects on global economic activities such as supply, demand and productivity, the COVID-19 crisis quickly turned into a large-scale financial and economic crisis and might further affect other sectors (Italy *et al* (2021); Baldwin and Mauro 2020). The influence of this epidemic on stock markets has been investigated by various researchers (Baek *et al* (2020); Zhang *et al* (2020); Liu *et al* (2020)). Studies showed that international stock markets have been affected in a negative way and this incident has shaken their correlations. In addition, several asset categories have been unfavorably affected by the COVID-19 pandemic (Yousaf & Ali, (2021) [33, 35]; Bouri *et al*., (2020) [23, 33]; Yarovaya *et al*., (2021); Mirza, Rahat, *et al*., (2020)) [21, 22].

During such recession, the prices of risky assets tend to flare up simultaneously under the effect of numerous contagion channels. In case of severe losses on one stock market, equities tend to fall and became extremely volatile due to high levels of interrelationship of financial markets due to globalization. Thus, in these periods, financial investors rush into safe-haven investments, considered safe, such as US Treasury bills, gold or Bitcoin, to improve their portfolio returns and to generate long-term unrelated or negatively correlated returns between assets during downturns.

The fact that gold may be considered as a safe-haven is not new and several research browse whether gold is a safe-haven asset all the turmoil periods. For instance, Baur and Lucey (2010) [3] demonstrate that gold is a blanket and a safe-haven for both American and Britain stock indices but not in Germany. Baur and McDermott (2010) [4] extend the previous analysis by including stock market indices of emerging countries. They confirmed that gold is a hedge and a safe-haven for U.S. and European markets but not for the BRICs, Japan, Australia and Canada. Investigating stock returns from Germany, United States, France, United Kingdom and the G-7, Coudert & Raymond-Feingold (2011) [9] confirm the results of Baur and McDermott (2010) [4].

Even Thought gold is known for its safe-haven property, recent literature divulges varied results regarding its property during the COVID-19 crisis. Another strand of recent literature has studied whether Bitcoin, the most famous electronic money or cryptocurrency in the world which has appeared in 2008, could be better characterized as gold and is considered as another popular candidate for a haven or hedging asset. Several investigators have examined the correlation between Bitcoin and gold; but there is no agreement regarding the similarity's strength. Furthermore, additional investigations through Panagiotidis *et al*. (2018) [24], Bouoiyour *et al.* (2019) [5] and Shahzad *et al*. (2019) [6, 30] similarly approve the existence of a robust connection between Bitcoin and gold. Nevertheless, other studies exhibited weaker connections amid Bitcoin and gold (Dyhrberg (2016a) [12], Wu *et al*. (2019) [34], Kang *et al*. (2019) [1], Gajardo *et al*. (2018) [14], Pal and Mitra (2019) [25], Panagiotidis *et al*. (2019) and Das *et al*. (2020)) [10, 11].

From the above-mentioned reports, it can be renowned that although there are wide studies on Bitcoin and gold, the

ones which focused on their relationship with the stock markets are still limited and no previous studies combine gold and Bitcoin to test empirically the safe-haven and hedging attributes of these assets for MENA countries thru the current COVID-19 epidemic. More specifically, some regions were completely overlooked by the current studies such as the Middle East and more specifically the Gulf countries. The existent research studies on the Middle East and North Africa (MENA) region are mainly concerned with the determinants of the stock market, ignoring any potential for these hedging assets to offer diversification opportunities in the context of MENA region. In this study, we try to fill this gap by examining both the interdependence and transmission between gold, Bitcoin and some selecting MENA stock markets. This will be held by analyzing the effects of crisis or shocks on these returns and volatilities to show whether gold and Bitcoin may offer any diversification profits and profitable speculations.

The present research methodology is based on employing VAR-BEKK-GARCH approach under student-t distribution to survey the relationship among asset returns then volatilities at dissimilar frequencies from January 2017 to December 2021. This model permits the transmission effects between conditional fluctuations and returns to study both conditional volatility specific to each market and conditional cross-market fluctuation transmission amongst some selected MENA stock markets and gold as well as Bitcoin.

The current study preceded the previous research studies in four significant points: Primarily, the existence of shock transmissions in the recent background of globalization and growing interaction of stock markets reinforce the interconnectedness between stock markets, it also reduce gain from international diversification, the above mentioned observation conduct investment managers to choose safe and hedging asset to improve their portfolio returns and to benefit from low transaction costs with high level of security. Thus, the introduction of the hedging assets in the MENA region is expected to have a significant impact on the economy and financial system. Secondly, despite that current literature investigates the linkage only between digital currency and gold and reveals different conclusions about the nexus of Bitcoin and gold, we explore, in this paper, dynamic trilateral integration and volatility spillover among financial markets, Bitcoin and gold throughout both the pre and during the COVID-19 pandemic in MENA countries. Hence, this study furnishes substantial perception within this region. For instance, from North Africa, we identify Morocco, in particular, which despite the ban by the authorities to use the Bitcoin, is gaining more and more followers and many Moroccans no longer hesitate to invest in cryptocurrencies and buy bitcoins. Furthermore, according to the American media specializing in cryptocurrencies CoinDesk, the OTC exchange site Local Bitcoins recorded a 30% increase in Moroccan user's registrations between 2019 and 2020, with more than 700 new accounts created. Considering the Middle East region, we select Saudi Arabia with the highest growth in its cryptocurrency transaction volumes, followed by United Arab Emirates, Jordan, Kuwait countries that are at the forefront of Bitcoin usage in the Middle East as well as gold occupies a vital part of life in MENA countries since it is a part of their cultures. Thirdly, we evaluate the time-varying relationship intending to offer appropriate discerning for investment managers about both the pre-COVID-19 and COVID-19 pandemic periods. Fourthly, we explore the hedge and safe-haven properties of Bitcoin and gold for the MENA stock markets during the COVID-19 epidemic, which will be helpful for financial investors in detecting blankets and safe havens for the MENA markets throughout traumatic periods.

The rest of the paper is framed in such a way that, in Section 2, we present the revue of literature, section 3 presents the methodology employed. Section 4 summarizes our results, and Section 5 a conclusion.

Literature review

Middle East and North Africa region remains a diverse region. MENA countries are classified as the top trading economies in oil in the world and widely investigated by academic, financial, and international organizations due to the recently liberalized investment policies, trade, and capital flow barriers. Although that these emerging markets are influenced by economic and political revolutions, they attempt to have considerable economic growth. Thus, one important advantage of the concentration on MENA is that these emerging markets are attractive for stockholders around the word. As a part of their culture, gold dominates a vital part of life in MENA region. Gold is one of the most relevant commodities in the global economy and is considerate as a hedging asset and offers important opportunities for investors to diversify their portfolio and have profitable speculations. Throughout this decades, the invention of new financial tools that maximize the investors' return with acceptable amounts of risk remains the eventual target for policymakers. Hence, the appearance of cryptocurrency market offered safe virtual low transaction costs and higher level of security. The impressive expansion of the hedging assets over the last years has led to several studies providing a comprehensive background on its role in the stock markets by using various techniques.

Using copula functions, Reboredo (2013) [26] investigates the safe-haven or hedge properties of gold against the US dollar from 2000 to 2012. They conclude a positive and substantial dependence among gold and USD devaluation against diverse currencies, suggesting that gold can blanket against USD movements. Liu (2018) [19] employ the extremal quantile regression model for 16 international markets to investigate the gold's role as a safe-haven over the past 20 years. They inveterate the safe-haven feature of gold for the advanced economies, during market turmoil. Selmi *et al*. (2018) [27] employed quantile-on-quantile regression model to explore even if Bitcoin and gold can be considered as a hedge against crude oil. Their empirical results confirm that both Bitcoin and gold are safe havens assets against the crude oil, particularly throughout turbulent periods. In their study, Guesmi *et al*. (2019) [15] employ the multivariate GARCH approach to examine volatility spillover between Bitcoin and other financial markets. They conclude that Bitcoin can hedge against gold, oil and emerging stock markets. Al-Yahyaee *et al*. (2019) [1] use the conditional dynamic correlation GARCH model to investigate whether Bitcoin and gold markets are Safe Haven assets contrary to the crude oil and global commodities exchange. Their results show that mutually gold and Bitcoin can expand the risk of crude oil and numerous commodity markets. In the same context, Jin *et al*. (2019) [16] study the volatility

transmission and connections amongst gold, Bitcoin, and crude oil returns by applying the DCC-GARCH model. They show the evidence of important volatility transmission between the three assets. Shahzad *et al* (2020) [6, 30] worked on the safe-haven and hedging properties of gold and Bitcoin for the G7 stock markets. They reported that these hedging asset under the study have distinct safe-haven and hedging characteristics. Moreover, gold offer additional benefits in the G7 than those of Bitcoin. Bagheri *et. al* (2021) [2] focused on the connectedness among MENA stock markets, crude oil Brent and gold by employing the Generalized forecast error variance approach and causality test. Their results showed that these markets are extremely speculative in the short term and that offers more chance of portfolio diversification. Moreover, considering the MENA markets, the gold is the more adequate choice for managers in diversifying their portfolios. Ourir *et al* (2021) [23] introduced a DCC GARCH technique to investigate the dynamic correlation among MENA stock markets and gold. They revealed that gold and stocks depend on the spectral density of each market. Using a DCC-FIGARCH model, Chkili et al (2021) [8] tried to examine the save haven propriety of Bitcoin and gold around the COVID-19 pandemic for six Dow Jones Islamic market indices. Their empirical results indicated that, during turbulent periods, Bitcoin serves as a safe-haven and thus leads to low portfolio risks. Bouri et al (2021) [23, 33] employed a TVP-VAR technique to explore the connectedness through currencies, crude oil, bonds, and world equities over the COVID-19 pandemic. They reported a remarkable change in their return correlations' structure. Yousaf et al (2021) [33, 35] examined the safe-haven and hedging proprieties against thirteen Asian stock markets when the COVID-19 occurs, using DCC-GARCH model. They reported that, for the majority of Asian stock markets, gold is considered as a strong hedge. Kumar *et al* (2022) [18] combined 10 major cryptocurrencies to study their returns and volatilities spillovers before and during the COVID-19 outbreak. They investigated their association structure in time, and they argued that the connectedness strengthens during the COVID-19 period.

Methodology

1. Data Description

Our data consists of price series of gold, Bitcoin and MENA stock markets. The series run from 2017 (1 February) to 2021 (27 December). This period is substantial since it covers the recent COVID-19 crisis and price fluctuations for Bitcoin. For the MENA stock markets, we select Kuwait (BKA), Morocco (MASI), Jordan (AMGNRLX), Saudi Arabia (TASI) and United Arab Emirates (ADX). Daily frequency is used because it allows capturing the intensity of the dynamics of the relationship between variables.

The data series consists of 1019 daily stock market observations (excluding weekends and holidays) and was initially converted into incessantly combined returns,

$$ri.\ t = Ln\ (Pi.t\ Pi.t{-}1) * 100,$$

where $Pi.\ t$ represents the index price i at time t.

To notice any vicissitudes such as spillovers ensuing the current COVID-19 pandemic crisis, we divide the sample period into two sub-periods: (i) the period before COVID-19 outbreak from 2017 to 2020; and ii) the post- crisis period from 2020 to 2021.

Data on gold and Bitcoin prices are extracted from the Coindesk.com database. While the closing value of the BKA, MASI, AMGNRLX, ADX General and TASI index prices, are obtained from the Investing.com database.

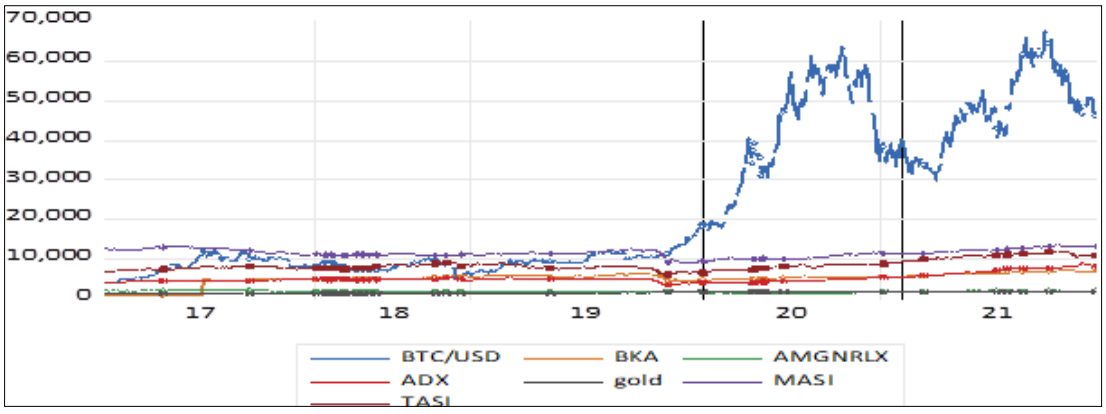

Fig 1: Dynamics of Jordan, Saudi Arabia, Maroc, United Arab Emirates, Kuwait, gold, and Bitcoin over the period February 2017 to December 2021

Figure 1 illustrates the dynamics of the price series of gold, Bitcoin and MENA region. From the graph, we can see how these markets are interrelated over the period 2017-2021. Indeed, MENA and gold market indices commove together during all the periods. Also, the COVID-19 outbreak from December 2019 until December 2021 was accompanied by decreases both in these markets. Nevertheless, when MENA stock returns and gold began to shut down because of the occurrence of COVID-19 outbreak in the end of 2019, the Bitcoin's returns weren't dropping alongside stock returns and continue to rise.

2. VAR model

Our methodology is based, primarily, on the modelling of daily returns through vector autoregression (VAR) introduced by Sims (1980) [31]. We obtain series of returns between these markets, and we study their dynamics interrelationships. Secondly, multivariate GARCH approach is used to provide the robust measures of the time-varying covariances and variances.

The VAR (1) model used in this paper is given by:

$$R_t = \omega + \delta R_{t-1} + \mu_t \quad (1)$$

Where:
$R_t = (r_t^{HA}, r_t^s)$ with r_t^{HA} and r_t^s being the returns on hedging Assets (gold and Bitcoin) and the stock markets under the study, at time t;
δ *is a* $(2x2)$ matrix of coefficients of the form $\delta = \begin{pmatrix} \delta_{11} & \delta_{12} \\ \delta_{21} & \delta_{22} \end{pmatrix}$;
ω is a (2x1) vector of constant terms of the form.
$\mu_t = (\mu_t^{HA}, \mu_t^s)$ with μ_t^{HA} and μ_t^s being the error terms of from the mean equations of the markets, HA and s (Hedging Assets and stock market returns), respectively.
The coefficients δ_{11} and δ_{22} measure own-mean spillovers, whereas the coefficients δ_{12} and δ_{21} provide the measures of the cross-mean spillovers.
VAR models assume that series are stationary. In general, the macroeconomic and financial series are non-stationary. To differentiate them sufficiently allows the stationary riser. This operation, however, has limitations especially if the variables share one or more stable long-term relationships. In this case, a particular class of models is used: vector models with error correction (VECM). After estimating the VAR(p) model, we collected the residuals to model BEKK-GARCH.
Based on VAR (1) model, the residuals $\mu_{1,t}$ and $\mu_{2,t}$ of the mean equation are derived and the conditional variance-covariance matrix (H_t) of the residuals are represented as follows:

$$\mu_t = z_t\sqrt{H_t},\ z_t \sim \mathrm{N}(0, H_t) \qquad (2)$$

Where $z_t = (z_t^{HA}, z_t^s)$ refers to (2x1) vector of independently and identically distributed errors.

3 BEKK-GARCH model
The study of volatility relationship between gold, Bitcoin and some selected MENA stock markets is carried out by using BEKK-GARCH model proposed by Engle and Kroner (1995).

BEKK (p,p,k) model is defined as:

$$H_t = C^{*\prime}C^* + \sum_{k=1}^{K} C_{1k}^{*\prime} x_t x_t' C_{1k}^* + \sum_{k=1}^{k}\sum_{i=1}^{q} A_{1k}^{*\prime} \mu_{t-1}\mu_{t-1}' A_{1k}^* + \sum_{k=1}^{k}\sum_{i=1}^{q} G_{1k}^{*\prime} H_{t-1} G_{1k}^* \qquad (3)$$

where $C^*, A_{1k}^* \text{ and } G_{1k}^*$ are (N × N) matrices of parameters. C^* triangular. C_{1k}^* is (J x N) matrix parameters. The K element refers to the generality of the model and a higher K implies a more general process.
However, most of the practical applications of the BEKK (1,1, K) model set K = 1, which makes the process represented by:

$$H_t = C^{*\prime}C^* + A_{11}^{*\prime}\mu_{t-1}\mu_{t-1}^{'}A_{11}^* + G_{11}^{*\prime}H_{t-1}G_{11}^* \qquad (4)$$

Moreover, the model describes a direct multivariate generalization of the univariate GARCH model. If N = 1 and K = 1, the equation (3) reduces to the GARCH equation.

Results and discussion
1. Descriptive statistics
The summary statistics for daily returns are exposed in Table 1 below. The Descriptive statistics indicate that all data series are negatively skewed suggesting that these distributions are skewed to the left expect for Kuwait which have long right tails. Moreover, the Kurtosis value of all returns is greater than three times of Normal distribution value. This signifies that relatively to the normal distribution all the financial returns have peaks. Wherefore, these financial returns indicate the properties of tail dependence, leptokurtosis, and asymmetry; by meaning that the normality assumption has been differently abled. And we use the test of goodness of fit presented by Jarque-Bera statistics. The Jarque-Bera statistics confirm the assumption of normality is nonrealistic and highly significant for all return series. Volatility is measured by the standard deviation and including the highest value recorded on the Kuwaiti stock market (2.3707) however, the Morocco market seems to be the least volatile.
Results from Augmented Dickey-Fuller (ADF) and Phillips Perron tests show that all return series are stationary, i.e. I (0), at significance levels.

Table 1: Summary Statistics for daily returns

Panel A: Descriptive statistics							
	RDTS_TASI	**RDTS_MASI**	**RDTS_BKA**	**RDTS_GOLD**	**RDTS ADX**	**RDTS_BTC**	**RDTS_ AMGNRLX**
Mean	0.020053	1.80E-05	0.079594	0.009395	0.028735	0.103518	-0.000530
Median	0.042492	1.76E-05	0.032820	0.019494	0.035706	0.082510	-0.005380
Maximum	2.966867	0.023041	74.58963	3.102846	3.507439	7.760181	1.178068
Minimum	-3.771666	-0.040093	-4.172210	-3.374452	-3.650794	-20.88540	-1.992017
Std. Dev.	0.451811	0.003306	2.370783	0.557706	0.483037	1.769382	0.224296
	-1.538826	-2.560042	30.49170	-0.227567	-0.486884	-1.540213	-0.386365
	17.83323	38.44168	959.3652	11.68211	19.75490	23.51221	12.38087
	9744.040***	54445.49 ***	38991752 ***	3209.263 ***	11959.45 ***	18267.27 ***	3761.718 ***
Panel B: ADF and PP stationary tests							
	RDTS_TASI	RDTS_MASI	RDTS_BKA	RDTS_GOLD	RDTS ADX	RDTS_BTC	RDTS_ AMGNRLX
ADF test	-17.65***	-15.27***	-17.34***	-16.96***	-18.30***	-15.77***	-19.96***
PP test	-163.23***	-282.10***	-640.85***	-341.02***	-113.11***	-341.50***	-334.57***

Given that correlations are the most familiar measures of relationship in finance and tell us about average diversification opportunities over the entire distribution, we examine, as a preliminary analysis, linear and rank correlation between the hedging assets and the MENA stock market returns. We get series of correlation coefficients between these returns, and we study their dynamics changes. The following table summarize the empirical results.

Table 2: Correlation matrix between gold, Bitcoin and MENA region before and during Covid-19 outbreak

Pearson Correlation							
PANEL A: Pre-Covid-19 crisis							
	BTC	Saudi Arabia	Morocco	Kuwait	United Arab Emirates	Jordan	gold
BTC	1	0.0238	0.0126	-0.1378	-0.0186	-0.0051	-0.0144
GOLD	-0.0144	-0.0116	0.0028	-0.0068	-0.0203	-0.0246	1
PANEL B: During Covid-19 crisis							
	BTC	Saudi Arabia	Morocco	Kuwait	United Arab Emirates	Jordan	gold
BTC	1	0.0422	-0.051	0.0077	-0.0827	0.07873	-0.0154
GOLD	-0.0154	0.0973	0.1156	0.1200	0.0802	-0.0633	1
Spearman's Rho							
PANEL A: Pre-Covid-19 crisis							
	BTC	Saudi Arabia	Morocco	Kuwait	United Arab Emirates	Jordan	gold
BTC	1	0.0139	0.0103	-0.0196	-0.0063	0.0059	-0.0080
GOLD	-0.0080	0.0081	-0.0342	0.0622	0.0089	-0.033	1
PANEL B: During Covid-19 crisis							
	BTC	Saudi Arabia	Morocco	Kuwait	United Arab Emirates	Jordan	gold
BTC	1	0.0060	-0.0771	0.0135	-0.0439	0.0220	0.0004
GOLD	0.0004	0.0426	0.0779	0.1184	0.0754	-0.043	1
Kendall's tau Correlation							
PANEL A: Pre-Covid-19 crisis							
	BTC	Saudi Arabia	Morocco	Kuwait	United Arab Emirates	Jordan	gold
BTC	1	0.0092	0.0076	-0.0134	-0.0037	0.0041	-0.0062
GOLD	-0.0062	0.0046	-0.0246	0.0417	0.0051	-0.008	1
PANEL B: During Covid-19 crisis							
	BTC	Saudi Arabia	Morocco	Kuwait	United Arab Emirates	Jordan	gold
BTC	1	0.0037	-0.0540	0.0098	-0.0293	0.0131	0.0004
GOLD	0.0004	0.0302	0.0513	0.0781	0.0508	-0.0287	1

Table 2. shows the linear correlations, the Kendall's tau and the Spearman's rho rank correlations among gold, Bitcoin and MENA returns before and during Covid-19 crisis.

Concerning pre-covid-19, we observe that Bitcoin has a weak negative correlation with all the variables except for the Maroc and Saudi Arabia. Furthermore, there is a weak negative correlation with gold and all stock returns expect for Morocco. The correlation matrix demonstrate that the rise (decline) of Bitcoin and gold markets is associated with the decline (rise) of the other markets. The higher correlation is between the Saudi Arabia and Bitcoin returns but it remains weak (below 0.1). The lowest correlation is between the Kuwaiti market and Bitcoin returns. During the Coronavirus pandemic, the correlation increases between the Bitcoin and the following returns: Saudi Arabi, Kuwait, and Jordan. However, we observe that there is a decrease in the interdependence between gold and all the returns expect for Jordan. Most correlation are below 0.1 and -0.1 implying several weak positive and negative correlations and relationships between stock markets and hedging asset under study. This result inspires us to investigate the role that gold and Bitcoin can play as diversifiers of MENA stock markets. Similar results of low correlations between gold, Bitcoin and traditional and alternative assets were found in previous studies (Letho *et al* (2021), Yousaf *et al* (2021) [33, 35], Chkili *et al* (2021)) [8].

2. VAR model

Firstly, our returns are modeled by a multivariate VAR between Bitcoin and stock market returns then between gold and stock market returns. Considering Bitcoin, the return transmissions are analyzed using a VAR (2) model before COVID-19 outbreak and VAR (1) during the pandemic crisis. However, for Gold, the return transmissions are analyzed using a VAR (1) model before and during COVID-19 outbreak. We notice that the lag length is selected by Hannan Quinn information criterion (HQ). Secondly, VAR-BEKK-GARCH model has been used to estimate the dynamic conditional covariance matrix and to conclude about the volatility's dynamics.

Table 3: Multivariate VAR model (BTC- stock markets)

Pre-COVID-19 period						
	btc	**jordan**	**unitedarabemirates**	**kuwait**	**morocco**	**saudi arabia**
BTC (-1)	-0.1102 (0.04114) [-2.68046]	0.002792 (0.00458) [0.61022]	0.008530 (0.01321) [0.64574]	0.166174 (0.07225) [2.29986]	**-** E-072.77- (E-058.0) [0.00346]	0.020983 (0.01212) [1.73126]
BTC (-2)	0.052293 (0.04115) [1.27077]	0.001166- (0.00458) [-0.25464]	0.003206 (0.01321) [0.24259]	0.125699 (0.07228) [1.73914]	5.49E-06 (8.0E-05) [0.06867]	0.018882 (0.01212) [1.55740
during covid -19 crisis						
	btc	jordan	united arabemirates	kuwait	morocco	saudi arabia
BTC (-1)	-0.036712 (0.05045) [-0.72773]	0.000977 (0.00686) [0.14239]	-0.007517 (0.00866) [-0.86756]	-0.006697 (0.00782) [0.85603]	3.14E-05 (6.8E-05) [0.46231]	0.001038 (0.00901) [0.11514]

Table 4: Multivariate VAR model (gold- stock markets)

pre-covid-19 period						
	gold	**jordan**	**united arabemirates**	**kuwait**	**morocco**	**saudi arabia**
gold (-1)	-0.156366 (0.03930) [-3.9782]	-0.002149 (0.01257) [0.17095]	0.023476 (0.03660) [0.64146]	0.934840 (0.19663) [4.75423]	0.000272- (0.00024) [-1.14996]	0.004076- (0.03359) [-0.12136]
during covid -19 crisis						
	gold	jordan	united arab emirates	kuwait	morocco	saudi arabia
gold (-1)	0.047372- (0.05081) [-0.93242]	0.004034- (0.02829) [-0.14261]	0.019717- (0.03573) [-0.55180]	-0.016825 (0.03227) [-0.52144]	-0.000312 (0.00028) [-1.11622]	-078401 (0.03695) [-2.12195]

Considering pre-covid outbreak, we found out that even gold and Bitcoin have a substantial impact on the countries in our data sample which depend significantly on past profitability of gold and bitcoin past returns. This dependence may testify to the existence of long memory in the series of stock market returns. This is in contradiction with the weak efficiency hypothesis developed by Fama (1965) which stipulates that the series of returns are characterized by an absence of memory and that the price instantly and completely reflects all the information available on the market. Accordingly, we can predict volatility of future returns of these markets from gold and bitcoin past returns.

In addition, we detected dependence between stock market returns and fluctuations in past returns of Bitcoin and gold. Therefore, we can conclude that the lagged changes in gold and Bitcoin have an impact on the MENA stock market returns. Thus, a shock to the gold or Bitcoin exert pressure on the variation of stock market returns of these countries.

In order to test the impact of covid-19 pandemic on the interdependence between the stock market return and bitcoin and gold, we attempt to examine this dynamic relationship during the crisis. Mostly, return spillovers from gold and bitcoin to the MENA countries decrease during the Covid-19 crisis. Specifically, there is a lower degree of association between all pairs, and we observe that the stock return linkage between markets seems to be less strong during the crisis period which explain the hedging capacity of gold and Bitcoin against the MENA region. However, it is particularly important to understand and model the volatility of a series. Indeed, investment decisions depend heavily, not only on the assessment of future returns, but also on the risks associated with the various stocks that make up the portfolios. Thus, own volatility and shock dependence, cross-market volatility and shock spillover for the Bitcoin and other stock markets and for Gold and MENA stock markets are tested by the dynamic conditional BEKK-GARCH (1,1) model both for the pre-COVID-19 and the during COVID-19 outbreak.

The estimation results for the models are reported in Table 5 for return and volatility spillovers between Bitcoin and other markets, namely, Jordan, United Arab Emirates, Kuwait, Morocco and Saudi Arabia obtained from dynamic conditional BEKK-GARCH model, while Table 6 reported the estimated results between Gold and stock market returns.

Table 5: Parameter estimates of Diagonal BEKK-GARCH model (BTC/ Stock market pairs)

Panel A: BTC/ Stock markets before the Corona disease						
	gold	**Jordan**	**United Arab Emirates**	**Kuwait**	**Morocco**	**Saudi Arabia**
Conditional Means						
C (1)	0.0720*	-0.0108**	0.0880*	0.0985**	0.0820*	0.106**
C (2)	0.0079	0.0720	0.0215*	0.0055	-4.77E-05	0.0229**
Conditional Variance						
M (1.1)	0.1623	0.0061***	0.0778***	0.086**	0.0718***	0.090***
M (1.2)	-0.0141	-0.0005	0.0002	-0.0122	2.00E-06	0.0007
M (2.2)	0.2301**	0.0784***	0.0211***	0.0372***	8.08E-07***	0.0100**
A1 (1.1)	0.3035***	0.5467***	0.1863***	0.1905***	0.2009***	0.1877***
A1 (2.2)	0.7767***	0.1781***	0.6156***	1.021***	0.3918***	0.3460***
B1 (1.1)	0.9682***	0.8003***	0.9673***	0.9720***	0.9632***	0.9630***
B1 (2.2)	0.5728***	0.9673***	0.7964***	0.5467***	0.8811***	0.9308***
T-DIS.	2.3565***	3.6455***	3.6052***	2.8983***	4.0572***	3.6767***
Panel B: BTC/ Stock markets during the Corona disease						
	gold	Jordan	United Arab Emirates	Kuwait	Morocco	Saudi Arabia
Conditional Means						
C (1)	0.0753	0.083	0.105	0.052	0.089	0.1123
C (2)	0.0234	0.019**	0.063***	0.0480***	0.0002**	0.0645***
Conditional Variance						
M (1.1)	0.1399	0.1562	0.1461	0.2030	0.1545	0.1804
M (1.2)	0.00148	-0.0013	-0.0011	-0.00034	-1.44E-05	0.0019
M (2.2)	0.0260	0.0014*	0.0147	0.0012*	2.52E-07	0.0098**
A1 (1.1)	0.1853***	0.183***	0.145**	0.1390**	0.1812***	-0.1755**
A1 (2.2)	0.1286	0.297***	0.260***	0.2917***	0.1110**	0.2988***
B1 (1.1)	0.9650***	0.96***	0.967***	0.9619***	0.9626***	0.9588***
B1 (2.2)	0.9199***	0.939***	0.876***	0.9462***	0.9644***	0.8938***
T-DIS.	4.8255***	6.10***	6.656***	5.338***	5.047***	5.4991***

Notes: c (1) and c (2) are constant term of the mean equation. M (1.1), M (1.2) and M (2.2) are constant term of variance equation. A1(1.1), A1(2.2) represent the ARCH effect. B1(1.1) and B1(2.2) indicate the GARCH terms and measure the volatility of each series.

*, **, *** present Statistical significance at the 10,5 and 1 percent levels, respectively.

Table 6: Parameter estimates of Diagonal BEKK-GARCH model (Gold/ Stock market pairs)

Panel C: GOLD/ Stock markets before the Corona disease					
	Jordan	**United Arab Emirates**	**Kuwait**	**Morocco**	**Saudi Arabia**
Conditional Means					
C (1)	0.00315	0.0092	0.01288	0.0072	0.0065
C (2)	-0.016***	0.0157	0.00954	-7.29E-05	0.0201
Conditional Variance					
M (1.1)	0.1474***	0.1496***	0.3093*	0.1328***	0.1492***
M (1.2)	-0.0013	0.0032	0.01293	-1.68E-05***	0.002703
M (2.2)	0.0072**	0.0218**	0.0886*	1.07E-06**	0.0129*
A1(1.1)	0.6060***	0.5869***	0.5389***	0.5498***	0.5663***
A1(2.2)	0.5856***	0.6150***	1.3395***	0.3338***	0.3347***
B1(1.1)	0.5522***	0.5689***	0.5835***	0.6153***	0.5637***
B1(2.2)	0.8438***	0.8656***	0.5860***	0.9222***	0.9513***
T-DIS.	2.7873***	2.7231***	2.3114***	2.7588***	2.7337***
Panel D: GOLD/ Stock markets during the Corona disease					
	Jordan	United Arab Emirates	Kuwait	Morocco	Saudi Arabia
Conditional Means					
C (1)	0.0198	0.0216	0.0271	0.0277	0.0225
C (2)	0.0217**	0.0688***	0.0552***	0.0002***	0.0644***
Conditional Variance					
M (1.1)	0.0209	0.0295	0.02246	0.0104	0.011007
M (1.2)	0.00011	0.0014	0.00193	4.89E-06	0.000235
M(2.2)	0.00135	0.01749	0.00092*	2.69E-07**	0.0115*
A1(1.1)	0.1381*	0.1074	-0.1522*	-0.1472***	0.14214**
A1(2.2)	0.3132***	0.3082***	0.2309***	0.1414***	0.3106***
B1(1.1)	0.9349***	0. 9143***	0.9286***	0.9614***	0.9613***
B1(2.2)	0.9403***	0.8602***	0.9659***	0.9604***	0.8502***
T-DIS.	4.717***	4.8472***	4.8459***	4.445***	4.5337***

Notes: c (1) and c (2) are constant term of the mean equation. M (1.1), M (1.2) and M (2.2) are constant term of variance equation. A1(1.1), A1(2.2) represent the ARCH effect. B1(1.1) and B1(2.2) indicate the GARCH terms and measure the volatility of each series.
*,**,*** present Statistical significance at the 10,5 and 1 percent levels, respectively.

The ARCH effects show that all diagonal elements A (1,1), A (2,2) are statistically significant at 1 percent level for both sub-periods, signifying that each conditional variance depends on its own squared lagged innovations. Moreover, the volatility of Bitcoin and gold are strongly dependent on past its innovations which is in line with the study of Chkili *et al* (2021) [8]. Nevertheless, this level of interrelation becomes less strong during the corona disease with time (ARCH effects) indicating weakly short-run persistence. Besides, we find that gold could act as a safe haven asset both for Kuwait and Morocco markets during this pandemic period since the estimates of A (1.1) ARCH effect become negative and significant in each case. However, Bitcoin seems to be considered as a safe haven asset only for Saudi Arabia.

Regarding the results of GARCH parameters B (1,1) and B (2,2), we showed that the sensitivity to past own conditional volatility and cross-market volatility transmission are significant at the level of 1%, showing that future volatility can be predicted by both the past own conditional volatility in the long run and the cross-market volatility spillover. The empirical results provide strong evidence of bidirectional cross-market volatility transmission between gold and Bitcoin among MENA stock market during the covid-19 epidemic. Hence, it may be concluded that volatility of gold is highly affected by the dynamics of MENA stock market assets.

In summary, the empirical results suggest that gold act only as diversifier for MENA stock markets and a safe-haven asset for Morocco and Kuwait market. However, Bitcoin can be regarded as a diversifier for the MENA stock markets expect for Saudi Arabia market.

Conclusion

The present paper attempt to explore the spillover effects across Bitcoin, gold, and stock markets to verify whether gold and Bitcoin can serve as hedging or safe-havens assets for MENA region. We have used a VAR-BEKK-GARCH approach. The main conclusions gained from the empirical results are as follows:

1. The results of the VAR-BEKK-GARCH provide evidence of spillover effects across gold, bitcoin and MENA stock markets.
2. The spillover effects between gold, bitcoin and MENA markets are quite different. The gold market has stronger impact upon MENA markets than Bitcoin.
3. Based on the two sub-sample periods, it is found that ARCH coefficient estimates decrease during the Covid-19 outbreak indicating weakly short run persistence. Besides the effect of Bitcoin on Saudi Arabia becomes significatively negative suggesting that Bitcoin is a safe haven asset for only the Saudi Arabia. Moving to the interrelation between gold and MENA stock markets, we found that gold could act as a safe haven asset for Kuwait and Morocco.

The above findings may have vital implications in risk management and can be beneficial to investors, financial managers, and analysts detecting hedges and safe havens for MENA markets and opting to minimize their portfolio risks throughout traumatic periods. In effect, the risk management involves better understanding of the type of connections between different assets. Hence, the market conditions influence the optimal portfolio's composition. Overall, during bearish market conditions, investors in Saudi Arabia

Market would invest more in Bitcoin than during normal periods. However, investors in Kuwait and Morocco should invest more in gold to minimize their portfolio risk.

Abbreviations

BKA: Kuwait All Share; MASI: Moroccan All shares' Indices; AMGNRLX: Actions Amman; TASI: Tadawul All Share Index; ADX: Benchmark stock market index; BTC: Bitcoin; ADF: Augmented Dickey Fuller test; PP: Phillips Perron test; VAR: Vector Autoregression model; T-Dis: Degrees of Freedom of Student's t-Distribution

Author contributions

The paper contributed the review of literature, the methodologies, collected data, analyzed the data in Eviews and interpretation and discussion of results.

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