



*Sociology & Cultural Research Review (SCRR)*  
 Available Online: <https://scrrjournal.com>  
 Print ISSN: [3007-3103](https://doi.org/10.3007/3103) Online ISSN: [3007-3111](https://doi.org/10.3007/3111)  
 Platform & Workflow by: [Open Journal Systems](https://www.openjournal.org/)



## Bitcoin Hedge, Diversifier or Safe Haven? A comparison with Gold

Sarah Nawazish

Assistant Professor, Imperial College of Business Studies. Lahore. Pakistan

[sarahkamran21@gmail.com](mailto:sarahkamran21@gmail.com)

### ABSTRACT

*This study investigates whether Bitcoin acts as a hedge, diversifier or safe-haven to extreme price movements of Crude oil (measured by WTI) especially during COVID-19. The data of spot prices have been obtained from 2014-2021 from St. Louis FRED DataStream. This study employs the Dynamic Conditional Correlation (DCC) GARCH model and forecasts the future trend by applying VAR and ARIMA models. The models forecast, within and out of sample, then the findings have been compared to find more accurate results. Mirroring the role of Bitcoin, hedge, diversifier or a safe haven, is worthwhile for the investors to hedge the risk during financial uncertainties. The results reveal that Bitcoin acts as a diversifier and not as a safe haven. These findings are helpful for the investors, government, and regulators of financial markets. This paper contributes to an existing debate on the useful inclusion of Bitcoin in a portfolio and diversifies the risk.*

**Keywords:** Hedge, Safe-haven, Diversifier, DCC-GARCH, VAR, ARIMA.

### Introduction

Risk and return phenomenon is much in debate since the beginning to stock market investments (Holzmeister et al. 2020; Kanamura 2020). The investors seek for the safe assets to hedge risk at given returns. This idea has been thrived with the occurrence of uncertainties, consequently, a sharp decline in stock prices (Nkoro and Uko 2016). A large number of investors suffered losses due to the abrupt decrease in prices during these events (Nkoro and Uko 2016). Global financial crisis is an important event in this regard with contagion effect that influence the global financial markets and a sharp decline has been observed in stock returns (Ahmed 2021). After GFC, the investors began to look for safe assets to invest in. Since then, many asset classes have been discussed as a safe haven for the investors. Gold, in literature, plays as a safest haven during financial crisis, while with the growth of cryptocurrency, Bitcoin, Ethereum, Litecoin and Binance Coin also become an important part of this debate. Concerning to the crisis, global financial markets face an enormous risk during the COVID -19 pandemic. The epidemic effect of the pandemic has encircled the whole financial and economic system of the world (Qiu et al. 2021). The pandemic provided a widespread bearish trend in the financial market and a slump in the prices in the commodity market which push the investors to switch for a safe investment. Since then the investors are seeking a hedge, diversifier or safe haven. During the pandemic, crude oil prices, among other internationally traded commodities, showed a volatile behavior and sharp decline as the prices plunged to lower than USD 20 per barrel<sup>1</sup>. The most astonishing fact was observed on April 20, 2020, when the closing price of crude oil, measured by the US oil benchmark, West Texas Intermediate (WTI) crashed up to -\$37.63<sup>2</sup> per barrel

<sup>1</sup> Crude Oil Prices- Yahoo fiancé. [finance.yahoo.com](https://finance.yahoo.com)

<sup>2</sup> <https://www.thomsonreuters.com/en/search-results.html?q=crude+oil+prices+historical+data>

(Dutta et al. 2020). The negative price level has left the investors with a financial shock, consequently, there found a sudden switch of investments to other commodities (Zhang, Hu, and Ji 2020)

The pandemic, COVID-19, unlike the global financial crisis, influences the financial market differently. Some sectors of financial markets, such as the pharmaceutical and chemical industry show a positive association with COVID-19, while the commodity market experiences a slump. The outbreak of COVID -19 has a contagion effect and is considered a “once-in-a-century” event (Gates 2020). Moreover, the recent literature discusses this pandemic as resembled influenza, SARS, and Ebola virus disease and found that the global financial and economic system has been influenced by the disease (Gates 2020). So the financial markets expect to face high-risk factors due to the overall uncertainty and troubles which are required for further investigation (Zhang et al. 2020).

The investors, in this financial turbulence, look through a safe-haven asset to switch. Hedge or safe haven assets has been widely discussed in the literature for a long. However, these assets have been resurfaced by the researchers and practitioners during the pandemic. The assets, Gold (Baur and Lucey 2010a; Baur and McDermott 2010a), bitcoin (Bouri, Gupta, et al. 2017), and foreign exchange (Forex) is considered as safe -haven during the financial and economic crisis (Tronzano 2020). Therefore, this study evaluates the role of Bitcoin, whether a safe haven or a diversifier during the COVID-19 Pandemic, still a grey area in literature. Among many safe assets, as discussed in prior literature, gold and bitcoin have been selected against the extreme price movement of WTI due to some evidence found in favor of both assets (Ji, Zhang, and Zhao 2020a). Gold has been discussed as the safest asset and is used as a safe haven for a long even when it was not named safe-haven (Baur and Lucey 2010b). While bitcoin has been catching much attention since the last decade but still the role of Bitcoin as a hedge, diversifier, or a safe haven remains unclear. Bitcoin was introduced in 2008, after the global financial crisis, and gradually found to be an attraction of the investors (Www 2020). The prices of Bitcoin reduced dramatically in 2018 and influenced the financial markets of developed countries (T. Klein, Pham Thu, and Walther 2018).

During January- February 2018, a sharp decline in the price of Bitcoin, about 65%<sup>3</sup>, was observed. Till September 2018, Digital Assets 10 Index recorded a loss of 80%<sup>4</sup> value which was considered to be a greater loss than Dot-com bubble burst in 2002. The total market capitalization of Bitcoin recorded to fall below \$100<sup>5</sup> billion in November 2018 (Vardar and Aydogan 2019).

The transactions of bitcoin are recorded on a digital ledger “Blockchain”. Besides this, bitcoin is criticized for its volatile nature and restricted tractions, especially in developing countries. Still, the recent research discusses much bitcoin as a hedge or a diversifier (Othman, Alhabshi, and Haron 2019), while, the dynamic role of bitcoin, whether a hedge or a diversifier during the COVID-19 pandemic is still unanswered, as per my best knowledge.

To answer the question, whether gold or bitcoin can protect against price shocks of WTI or plays only as a diversifier during the current crisis, this study employs more sophisticated

<sup>3</sup> St. Thomas Reuter website. Historical data of Bitcoin

<sup>4</sup> St. Thomas Reuter website. Historical data of Bitcoin

<sup>5</sup> [cnbc.com/2021/03/17/bitcoin-morgan-stanley-is-the-first-big-us-bank-to-offer-wealthy-clients-access-to-bitcoin-funds.html](https://www.cnbc.com/2021/03/17/bitcoin-morgan-stanley-is-the-first-big-us-bank-to-offer-wealthy-clients-access-to-bitcoin-funds.html)

techniques. The definition of a safe haven or diversifier is controversial due to the lack of a theoretical framework (Guesmi et al. 2019). However, this issue has been discussed under the domain of portfolio diversification in modern portfolio theory that supports the inclusion of safe assets in a portfolio to reduce the risk (Markowitz 1952). According to this theory, investors are inherently risk-averse and seek safe assets for investment. So in a portfolio, negatively or uncorrelated assets are favorable in risk reduction (Conlon and McGee 2020). Therefore, in the normal economic situation, the strategy of portfolio diversification works, however, during uncertain financial circumstances different assets are explored to be a safe haven (Baur and Lucey 2010a). This discussion leads to a search for the safe-haven asset. Although in normal economic circumstances, the assets act as safe-haven such as flats, agriculture futures and precious metals (Hillier, Draper, and Faff 2006; Li and Lucey 2017; Adediran, Yinusa, and Lakhani 2021b) yet during COVID-19, a new debate has been opened with the inclusion of cryptocurrencies along with the safest asset gold to diversify the risk of crude oil price crash (Guesmi et al. 2019). Gold has been considered as a store of value for centuries and plays a role as a safe haven for investors for decades (Herbst 1983). However, the safe-haven properties of gold have been changed due to an increasing trend in gold investment for hedging or speculative purposes (Baur and Glover 2016).

Conversely, bitcoin with volatile behavior has been criticized to be less liquid. Moreover, the restricted transactions of bitcoin in developing countries further reduce the trust of investors to use it as a safe haven (Conlon and McGee 2020). However, the safe haven and hedging properties are found in gold and bitcoin and both the assets are positively correlated in developed countries. Therefore, the association of product immaturity and built-in risk of bitcoin (Klein et al. 2018). Despite this, Bitcoin is yet an important asset to be included in a portfolio for diversifying the risk, however, the true role of bitcoin, whether a hedge or only a diversifier is still a grey area, while gold plays a role of a hedge with all its safe-haven properties (Ahmed 2021). Finally, the hedging capability of Bitcoin against uncertain economic or financial conditions has been examined and found to be a significant hedge during short-term investment (E Bouri 2017; Bouri, Molnár, et al. 2017). This study focuses on investigating the role of bitcoin and gold prices, whether a safe haven or a diversifier against downward price movement (Stavroyiannis 2018; Conlon and McGee 2020) of crude oil prices before and during COVID-19. The current situation and role of assets for a safe haven are the main motivations for this study. Furthermore, it contributes in several ways such as filling a knowledge gap with a unique and comprehensive methodology and techniques to the existing literature. Along with this, by forecasting the future trend of spot prices, employing two sophisticated techniques (VAR & ARIMA) then compare the findings for accuracy of results. In previous empirical literature, there employed many techniques for forecasting such as Smoothing, EWMA, VAR and ARIMA (Yaziz, Zakaria, and Suhartono 2019; Fan et al. 2021; Lertthairakul, Khumsawat, and Manirochana 2021; Ma, Shang, and Zhang 2021; Muhammad et al. 2021; Ouhome, Hadi, and Ullah 2021) modeling yet the combination of two techniques for comparison of results are still inconclusive. It is found that the forecasting results of VAR models are somewhat overestimated, while the results of ARIMA and EWMA models are observed to be more reliable (Lertthairakul et al. 2021). In addition to this, forecasting with VAR model often considered to be for short-term (Ma et al. 2021), while the forecasting with ARIMA modeling is examined as a tool of prediction for long-term (Jiang and Subramanian

2019; Munim, Shakil, and Alon 2019; Fangping, Yanqing, and Chenxi 2021; Muhammad et al. 2021;). To extend the existing literature for applying forecasting techniques, this study combines VAR and ARIMA models and compare the accuracy of results. The sample split enables us to investigate a deep insight into the role of Bitcoin and gold during episodes of global uncertainty and strengthens the study by predicting the future trend of spot prices.

### **Related Literature**

The concept of a safe haven has been discussed for decades, while this was explored post-world war II and gold was found to be the safest hedge against uncertain financial conditions (Elmblad and Palmberg 2020.). Later on, gold, being a hedge was discussed in literature along with other safe assets such as foreign exchange, flats, treasury bonds, treasury bonds, and precious metals ( Herbst 1983; Baur and Lucey 2010b; Dyhrberg 2016; E Bouri 2017; Kliber et al. 2019). Moreover, two potential candidates, commodities and currencies, for safe-haven are widely discussed in the context of the hedge the risk in financial markets. USD, Japanese yen, and Swiss francs are suggested to be a hedge, especially during uncertainties. These currencies are also found to hedge against oil price shocks (Baur and Lucey 2010a; Wang et al. 2019a). However, the commodity indices are weak form of safe- haven for to avoid or diversify risk, while precious metals, particularly gold, are demonstrated as safe-haven in all market conditions (Urquhart and Zhang 2019).

During an uncertain financial condition such as the recent health pandemic “COVID-19” (Gates 2020) and global financial crisis (Riaz, Mehr Ali Shah, and Imran Hunjra 2015), the assets behave differently and the investors seeks for safe-haven assets to avoid losses. Resultantly, the investors, rather than of having many assets, focus on two main candidates, in general, gold and cryptocurrency (Qin, Su, and Tao 2021; Salisu, Sikiru, and Vo 2020). the debate of a safe haven is still inconclusive, the main reason is the safe haven along with its features of the safest assets (Ji, Zhang, and Zhao 2020b). Therefore, gold, being a popular asset, plays the role of a safe haven but not entirely secure. Some important characteristics of a safe haven have been discussed in this regard: the value of a candidate is universally accepted, the effectiveness of the asset, and the change in the fundamental characteristics of a safe haven in depression or market turmoil (Shafiee and Topal 2010). In this sense, gold and bitcoin have been discussed to hedge extreme price movement of crude oil during COVID-19 (Naeem et al. 2020). After GFC, Bitcoin, a digital currency was introduced but it took much time to be accepted due to its volatile nature (Lánský 2017). Bitcoin lacks the hedging features, however, largely traded in developed economies (Tronzano 2020). The bubbles burst in bitcoin prices in 2018 reduced (Wang et al. 2019b) the trust of investors but it regained the attention of the investors especially after the outbreak of the COVID-19, investors tend to add bitcoin to the portfolio to diversify the risk (Dyhrberg 2016; Qiu et al. 2021; Scharnowski 2021). Since then, the inclusion of Bitcoin, for hedging, in the portfolio has been discussed (Kliber et al. 2019). The recent literature explores that bitcoin and gold have simultaneously been discussed as hedge, diversifier or a safe-haven (Ji et al. 2020b). By including both the assets in a portfolio makes it diversified but this diversification is not always favorable (Reinholtz, Fernbach, and de Langhe 2021). Besides, the search for safe-haven assets are more purposeful during uncertain financial or economic conditions (Baur and Lucey 2010a; Baur and McDermott 2010b, 2016).

The features of a safe haven are slightly different than a diversifier or hedge (Reinholtz et al. 2021). To qualify the standard of a safe -haven asset, an asset is required to increase or retain the value during the market crash (Ahmed 2021). Statistically, the MPT (Modern Portfolio Theory) states that the returns of a safe -haven asset must be negatively or uncorrelated with the returns (Elmblad and Palmberg 2020.) of other candidates in the portfolio particularly during a financial crisis (Baur and Glover 2016). Under such a notion, gold with its features is considered to be the safe -haven (Naeem et al. 2020) due to the feature “store of value”. Extensive literature discusses gold as a safe haven among other precious metals ( Solt and Swanson 1981; Adediran, Yinusa, and Lakhani 2021a, 2021b).

Subsequently, cryptocurrency is also discussed as a popular candidate to hedge the risk (Conlon, Corbet, and McGee 2020). Bitcoin is stated to be the most popular cryptocurrency among all, was introduced in 2008 after the global financial crisis and was traded as a decentralized digital currency. Its unique nature and features make bitcoin independent of central banks ( Naeem et al. 2020; Dwita Mariana, Ekaputra, and Husodo 2021). The statistical analysis found bitcoin as uncorrelated to other currencies and commodities particularly crude oil and gold (Conlon et al. 2020). Therefore, cryptocurrencies are found to be used as a hedge or a diversifier against downside money and equity market risk (Bouri, Lucey, and Roubaud 2020). This property of bitcoin has been examined during normal market conditions and crisis periods to draw a comprehensive analysis about a consistent behavior of bitcoin (Bouri, Hagfors, and Molnár 2017). Conversely, Bitcoin, with its statistical features among other assets, are a diversifier rather than a safe haven (Bouri, Shahzad, et al. 2020). In a portfolio, bitcoin is unable to hedge the downside risk (Li et al. 2021) even in developed economies (Akhtaruzzaman, Boubaker, and Sensoy 2021).

Similarly, Bitcoin is not discussed as a potential safe haven , while, gold is stated to be an “indisputable” safe -haven asset over that of Bitcoin (Bouri et al. 2021). Therefore, despite the general reference for Bitcoin as a bar of digital gold, the role of Bitcoin that acts as a hedge, only a diversifier or a safe haven is relatively scarce. However, Bitcoin has been used as gold due to many similarities, in terms of its potential as a diversifier and hedging capabilities (Lánský 2017). This study contributes to the existing literature by exploring the role of Bitcoin as compared to gold before and during COVID-19. Based on these arguments, this study empirically analyzes the role of Bitcoin, whether a safe haven, hedge or diversifies the risk by employing more sophisticated econometric tools.

### **Methodology**

The sample of this study consists of 1,631 daily observations from December 1<sup>st</sup> , 2014, to March 22<sup>nd</sup>, 2021 from St. Louis FRED DataStream. The spot price data of gold and WTI is available five days a week while the spot price data of Bitcoin for seven days. The data has been cleaned and managed to five days a week. Being internationally traded commodities, there was no need to scrutinize the study to the specific country. The data then split into two windows, first for the whole sample and second for the “COVID” period from January, 1<sup>st</sup> 2020 to March, 22<sup>nd</sup> 2021. To examine the distribution of WTI prices, quantile regression at 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup>, quantile has been employed. DCC GARCH model has been applied to test the volatility of the distribution, Based on AIC and BIC criterion, the DCC(1,1)-GARCH(1,1) model proposed by Engle (2002), has been estimated with t-distribution considering as best fitted to our sample (Kumar and Anandarao 2019; Ng, Chin, and Chong 2020). The

aforementioned macro-econometric model has been employed to measure the time-varying correlation to understand the time-varying relationship between WTI price, Bitcoin price, and gold price by using a DCC (dynamic conditional correlation) multivariate (GARCH) generalized autoregressive conditional heteroscedasticity) model. The model captures the fat-tailed behavior of the spot price distributions. Moreover, Vector auto regression and ARIMA (1, 1, 1) have been applied for forecasting.

### Data Analysis

The data of this study has been collected from St. Louis FRED database from 1<sup>st</sup> December 2014 to 22<sup>nd</sup> March 2021. The starting point of this data has been restricted due to the availability of Bitcoin data. Therefore, the data is split into two panels to understand the dynamic relationship between WTI price, Bitcoin price, and Gold price before COVID-19 and during the COVID-19 period. For this purpose, a dummy has been created "COVID" from 1<sup>st</sup> January 2020 to 22<sup>nd</sup> March 2021. Then a regression analysis has been employed after testing the assumptions of OLS regression, i.e. normality, autocorrelation, multicollinearity, and heteroscedasticity. The price data of Bitcoin is stationary at level, while the price data of WTI and gold is stationary at 1<sup>st</sup> difference.

**Table 1.Descriptive Statistics (ADF) –Full Sample**

Variables	Obs.	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
WTI Price	1669	51.1740	10.8250	-37.6300	76.4100	-0.6690	5.9280
Gold Price	1669	1421.6010	206.5920	1070.8000	2069.4000	1.2060	3.5920
BTC Price	1810	10705.7800	15822.6500	120	61130.220	1.8850	5.4080

**Descriptive Statistics- COVID-19 Period**

Variables	Obs.	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
WTI Price	323	42.9557	12.6293	-37.6300	66.0900	0.9871	4.8765
Gold Price	323	1790.1540	125.6906	1487.100	1487.100	1.7854	3.0023
BTC Price	323	29720.4700	19072.7100	3359	61130.2200	1.2543	4.2536

Table 1, exhibits the results of ADF test (descriptive statistics) and found that Bitcoin price fluctuation is higher as compared to WTI and gold price, which is not in favor of a hedge. The data of gold and Bitcoin price is positive while WTI price data is negatively skewed. The price data of WTI and Bitcoin have high kurtosis (thin tail)

**Table 2.Phillips-Perron and ADF test for Unit Root**

Variables	Full Sample		COVID Period	
	ADF	PP	ADF	PP
	Level	level	Level	level
WTI Price	0.4010	0.4010	-0.0260	0.0430
Gold Price	-3.1440	-41.2250	0.6540	0.0234
BTC Price	-3.1500	-2.8600	0.2330	-0.8750

Notes: "PP" indicates Phillips–Parron, significant at a "level" as the significance level of 1% \*\*\*.

Table 2, shows the results of ADF and PP tests to test the stationarity of the data. As the stationary is required in a time series (Ali et al. 2020).

### Correlation Analysis

The positive, negative or no correlation has been found by employing the widely used correlation matrix proposed by Pearson 2001, (Buvanendra, Sridharan, and Thiagarajan 2017)

**Table 3. Correlation Matrix- Full Sample COVID Period**

Variables	-1	-2	-3	-1	-2	-3
(1) WTI Price	1.0000			1.0000		
(2) Gold Price	-0.2240	1.0000		-0.8500	1.0000	
(3) BTC Price	-0.0110	0.7610	1.0000	0.7240	-0.7940	1.0000

*Note: Correlation Matrix for whole sample and "COVID" period*

The above table shows the correlation, during full sample period and COVID period, between Crude oil (WTI) price, Bitcoin price and Gold price during the whole sample period and found that WTI price is negatively correlated (-0.224) with the gold price. On the other hand, gold price is positively correlated (0.761) with Bitcoin price. On the other hand, WTI price is also negatively correlated with Bitcoin price but with a weak magnitude (-0.011). The tables shed light on the correlation during the whole period. When the price of WTI decreases, the gold price increases, due to this negative correlation, effect with the magnitude of 22% but this negative effect is 1.1% in the price of Bitcoin.

The above table also explored the correlation during the "COVID" period and found a significant negative (-0.850) relation between WTI price and Gold price during the "Covid" period. The investors switch to the gold market, considering a gold as a safe haven in this pandemic. Gold can also be used to hedge the risk of WTI price movement. On the other hand, BTC price has a positive correlation with the crude oil price, which reveals that BTC is not suitable to hedge the oil price shocks during "COVID" uncertainty. Moreover. The prices of gold and BTC are negatively correlated (-0.794).

**Table 4. Ordinary Least Square and Quantile Regression**

Variables	Coef-OLS	Q0.25		Q0.50		Q0.75		Q0.90	
		Coef	p-value	Coef	p-value	Coef	p-value	Coef	p-value
WTI Price	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	-0.0400	0.0000
BTC Price	-0.0320	-0.0270	0.0000	-0.0320	0.0000	-0.0320	0.0000	0.0000	0.0000
Gold Price	102.0110	86.3780	0.0000	102.0110	0.0000	102.0110	0.0000	125.5360	0.0000

\*\*\*  $p < .01$ , \*\*  $p < .05$ , \*  $p < .1$

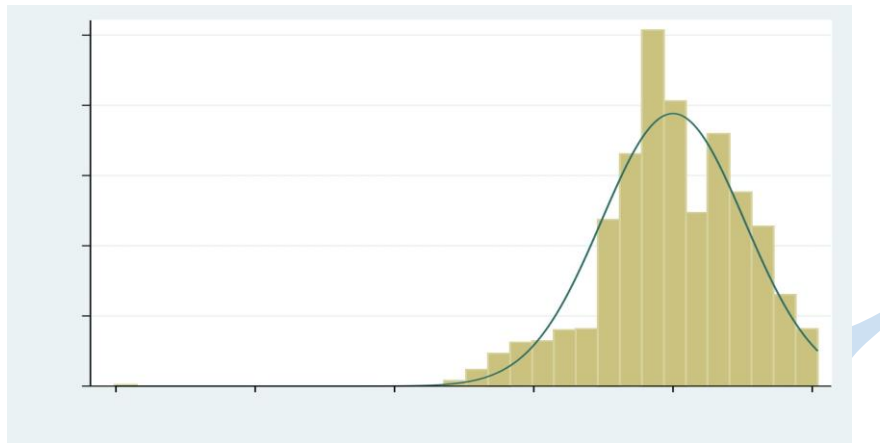
To find the relationship between WTI prices, gold price, and Bitcoin price OLS regression has been employed with the given model:

$$WTI_t = \alpha + \beta_1 Gold_t + \beta_2 BTC_t + \varepsilon_t$$

**Figure1.**

The regression assumption including normality has been tested. Figure 1, shows the results of the normality test.

In the regression equation,  $WTI_t$ , represents the price of WTI in-sample period,  $\alpha$  is the constant,  $\beta_1$  is the coefficient of Gold during the sample.  $\beta_2$  is the coefficient of BTC (Bitcoin) during the period and  $\varepsilon_t$  represents the error term in the regression model. The results of regression analysis in Table 2, reveals that the decrease in the price of WTI leads to a 2.7 percent rise in the price of gold while there is no effect on Bitcoin price due to WTI price change as per the results of the Beta coefficient, while the p-value is significant yet the goodness of fit "F statistics" has strong value. The regression analysis has been employed



during the "COVID" period and found that (Table 4) the gold price is significantly negatively (-.056) associated with WTI prices. Therefore, no relationship has been found between WTI price and BTC price. Moreover, the subsequent p-value  $> 0.05$  i.e. 0.249, shows an insignificant relationship with WTI price.

Due to similarities between linear regression and Pearson correlation, the researchers, sometimes, are uncertain about taking a decision, which techniques should be used. There found a close mathematical relationship between these techniques, while the assumptions and purpose of employing these tests are different. The regression line does not reveal the strength of the relationship between IV and DV (Ngoo, Tan, and Tey 2021). However, correlation does not fit a line like regression as well and does not allow this type of estimations, but it explores the strength of a relationship between IV and DV. Therefore, the application of any technique depends upon the research question but sometimes, the test for correlation coefficient has been criticized for having no formal intrinsic interpretation. However, the "coefficient of determination" i.e.  $R^2$  can be interpreted easily (Schober and Schwarte 2018)

### Quantile Regression Results

Quantile regression was first introduced in Koenker and Bassett (1978). The initial model can be expressed as :

$$y_{i,t} = x'_{i,t}\beta_{\theta} + \varepsilon_{\theta i,t} \text{ with } \text{Quant}_{\theta}(y_{it} | x_{it}) = x'_{i,t}\beta_{\theta}$$

Where  $y_{it}$  expresses the dependent variable, while,  $x$  is the vector of the independent variable,  $\beta$  is an estimated vector of parameters, and  $\varepsilon$  represents a vector of the error term.  $Q_{\theta}(y_{it}|x_{it})$  expresses the  $\theta^{\text{th}}$  conditional quantile of  $y_{it}$  (dependent variable) given  $x_{it}$  (independent variable). The  $\theta^{\text{th}}$  regression quantile ranges from  $0 < \theta < 1$ . (Bassett and Koenker 1978) .

It can be found by solving the following:

$$\min_{\beta \in R^k} [\sum \theta |y_i - x_i' \beta| + \sum (1 - \theta) |y_i - x_i' \beta| \quad i \in \{i: y_i\}$$

Therefore, this study has proposed the quantile regression model at 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup> and 90<sup>th</sup> as:

$$WTI_{i,t} = \alpha + \beta_1 \text{GoldPrice}_{i,t-1} + \beta_2 \text{WTI}_{i,t-1} + \beta_3 \text{BTC}_{i,t-1} + \delta_t + \varepsilon_{i,t}$$

The results of quantile regression analysis reveal that there is a negative relationship i.e. -.021 between WTI price and gold price in the 25<sup>th</sup> quantile with standard deviation in WTI price 10.895. However, there found no/insignificant relationship between WTI price and BTC price, while the p-value is significant. The results of robust standard errors for quantile regression at 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> quantile by bootstrapping repetitions have been reported to find heteroscedasticity-robust estimates.

Table 4 also shows the results of quantile regression analysis and found that there is a negative relationship between WTI price and gold price on 50<sup>th</sup> quantile to OLS regression. However, there found an insignificant relationship between WTI price and BTC price, while the p-value is significant with the same SD as on q 50<sup>th</sup> quantile. The results of quantile regression analysis reveal a negative relationship i.e. -.032 between WTI price and gold price on 75<sup>th</sup>, which is higher as compare to 25 quantiles and 50<sup>th</sup>. It can be expressed that on the 75<sup>th</sup> quantile, gold is considered to be a stronger hedge than in 25<sup>th</sup> and 50<sup>th</sup> quantile. However, there exist an insignificant relationship between WTI price and BTC price, while the p-value is significant with the same SD as in q 0.25 and q 0.50. therefore, on 90<sup>th</sup> quantile, Bitcoin coefficient has changed the sign and converted into a negative relationship. This reveals a diverse behavior on the 90<sup>th</sup> quantile (Ali et al. 2020). we find empirical pieces of evidence regarding testing of distribution by applying quantile regression and found significant results, that gold acts as a safe haven, however, Bitcoin plays a role of diversifier at many quantiles (E Bouri 2017).

#### Dynamic conditional correlation MGARCH model

To address the research question of this study, we have applied the DCC-GARCH approach, a widely used and sophisticated technique (Engle 2002) This technique has gained much attention in the existing literature to test the time-varying correlation among commodities and stocks traded in the financial markets (Malladi and Dheeriya 2021). In line with existing empirical literature, we have framed the model as follows:

$$r_t = L + \tau r_{t-1} + \varepsilon_t \quad (1)$$

$$\varepsilon_t = H^{1/2}_t \eta_t \quad (2)$$

In eq. 1,  $r_t$  is a log difference matrix of price indexes of the variables.  $L$  is the fixed-parameter matrix and  $\tau$  is a coefficient matrix of the cross mean transmission on its lag value. While  $\eta_t$  is the iid innovation matrix and  $\varepsilon_t$  is the residual. In eq. 2.  $H^{1/2}_t$  is the matrix of conditional volatility at time  $t$ , while the covariance matrix is expressed as:

$$H_t = D_t R_t D_t \quad (3)$$

Where  $D_t = \text{diag}(v h^X_t \quad v h^Y_t)$  is the time-varying standard deviation's diagonal matrix with  $h^X_t$  and  $h^Y_t$  as the conditional volatilities of both the assets, asset X and asset Y. Moreover,  $R_t$  expresses the conditional correlation matrix of standardized returns of the error term,  $\varepsilon_t$ , as:

$$R_t = \text{diag}(Q_t)^{-1/2} Q_t \text{diag}(Q_t)^{-1/2} \quad (4)$$

Where  $Q_t$  expresses a time-varying conditional correlation of error term given by:

$$Q_t = (1 - \theta_1 - \theta_2)Q + \theta_1\xi_{t-1}\xi'_{t-1} + \theta_2Q_{t-1} \tag{5}$$

In above equation,  $\theta_1$  and  $\theta_2$  expressed as non-negative scalar parameters range  $\theta_1 + \theta_2 < 1$ , while  $Q$  is considered as an unconditional correlation matrix for the  $\xi_t$ , standardized residuals.

In regression model- 2, make two penal. Penal A WTI and Gold while Penal B, WTI, and Bitcoin to examine the dynamics of the conditional correlations for both penal.

$$\hat{\rho}_{xyt} = \alpha_0 + \delta_1\text{COVID}_t + \delta_2\text{Uncertainty}_t + \varepsilon_t \tag{6}$$

In eq. 6,  $\hat{\rho}_{xyt}$  expresses the conditional correlation between WTI, gold/ and Bitcoin at time  $t$  that has been derived from applying the DCC-GARCH process. "COVID" is a dummy variable for the Covid-19 period from January, 1<sup>st</sup> 2020 to March, 22<sup>nd</sup> 2021. Moreover, the whole period is taken as Uncertainty, binary variable that controls the influence of turmoil.

**Table 5. Penal A (WTI and Gold) - Penal B (WTI-Bitcoin)  
Dynamic conditional correlation MGARCH model**

D.WTIPrice Gold Price	Coef.	p-value	D.WTIPrice BTC Price	Coef.	p-value
L.D.WTI Price	-0.100	0.005	L.D. WTI Price	0.741	0.000
L. Gold Price	0.002	0.000	BTC Price	0.243	0.000
Constant	-2.133	0.000	Constant	-0.056	0.000
lambda1	0.087	0.160	lambda1	0.409	21.85
lambda2	0.123	0.668	lambda2	0.582	30.300

\*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . Notes: This table reports the estimates as:  $\hat{\rho}_{xyt} = \alpha_0 + \delta_1\text{Covid}_t + \delta_2\text{Uncertainty}_t + \varepsilon_t$ . \*\*\*, \*\* and \* indicate statistical significance at 1%, 5% and 10% levels respectively

Table 5 exhibits the results of DCC-GARCH for the two penal, WTI- Gold and WTI-Bitcoin. During the pandemic period, there is a significant negative correlation between WTI and Gold, while there found a stronger negative correlation during COVID period. However, with many price swings, in penal B, the combination of WTI and Bitcoin has a positive and somewhere, very weak inverse relationship. Therefore, these commodities, most of the time, have a positive relationship even during the pandemic period. The estimates of  $\delta_1$  and  $\delta_2$  indicate a weak but positive relationship between WTI and gold during the whole period while in Table 10,  $\delta_1$  and  $\delta_2$  reveal a significant positive relationship between WTI and Bitcoin.

**Forecasting- Vector Autoregression Model**

This study has employed vector auto regression model for forecasting the vector (30 steps) of time series. It consists of one equation for each variable in the study i-e prices of WTI, Gold and BTC. The system. The right hand side of given equation have a constant with lag values of all variables. To avoid the complexity of model and as per 5th lag selection criteria, maximum 2 lags (Bouri et al. 2021; Ijiri and Jinushi 2021; Lin and Bai 2021) has been taken in the model as:

$$\begin{aligned} Y_{1,t} &= C_1 + \phi_{11,1}Y_{1,t-1} + \phi_{12,1}Y_{2,t-1} + e_{1,t} \\ Y_{2,t} &= C_2 + \phi_{21,1}Y_{1,t-1} + \phi_{22,1}Y_{2,t-1} + e_{2,t} \\ Y_{3,t} &= C_3 + \phi_{31,1}Y_{1,t-1} + \phi_{33,1}Y_{3,t-1} + e_{3,t} \end{aligned}$$

Where  $e_{1,t}$ ,  $e_{2,t}$ , and  $e_{3,t}$  is white noise processes and may be correlated. The coefficient  $\phi_{ii}$ ,  $\phi_{ij}$  influences of the  $\ell^{\text{th}}$  lag of variable  $y_i$  (dependent variable) on its lag value, while the coefficient  $\phi_{ij}$ ,  $\phi_{ij}$  influences of the  $\ell^{\text{th}}$  lag of variable  $y_j$  on  $y_i$ .

Forecasting with VAR has been generated from a VAR model in the recursive manner. The VAR predicts for *each* variable. The forecasting process is estimated as:

$$y_{1,T+1|T} = \hat{c}_1 + \hat{\phi}_{11,1} y_{1,T} + \hat{\phi}_{12,1} y_{2,T}$$

$$y_{2,T+1|T} = \hat{c}_2 + \hat{\phi}_{21,1} y_{1,T} + \hat{\phi}_{22,1} y_{2,T}$$

$$y_{3,T+1|T} = \hat{c}_3 + \hat{\phi}_{31,1} y_{1,T} + \hat{\phi}_{33,1} y_{3,T}$$

This is the same equation as above except a change of the error term has been set to zero and the parameters are used in place of estimates. For  $h=2$ , the forecasts are given as:

$$y_{1,T+2|T} = \hat{c}_1 + \hat{\phi}_{11,1} \hat{y}_{1,T+1} + \hat{\phi}_{12,1} \hat{y}_{2,T+1}$$

$$y_{2,T+2|T} = \hat{c}_2 + \hat{\phi}_{21,1} \hat{y}_{1,T+1} + \hat{\phi}_{22,1} \hat{y}_{2,T+1}$$

$$y_{3,T+2|T} = \hat{c}_3 + \hat{\phi}_{31,1} \hat{y}_{1,T+1} + \hat{\phi}_{33,1} \hat{y}_{3,T+1}$$

Again, the above equation is the same except a change of the error term has been set to zero and the parameters are used in place of estimates with the unknown values of  $y_1$ ,  $y_2$  and  $y_3$  have been replaced with the predicted values (Bassett and Koenker 1978; Kanamura 2020; Neri 2021). The process has been iterated for future  $i=30$  days. By employing Vector Autoregression model, the forecasting of prices of WTI, Gold, and Bitcoin has been conducted, the following graphs show the results:

**Figure2.**

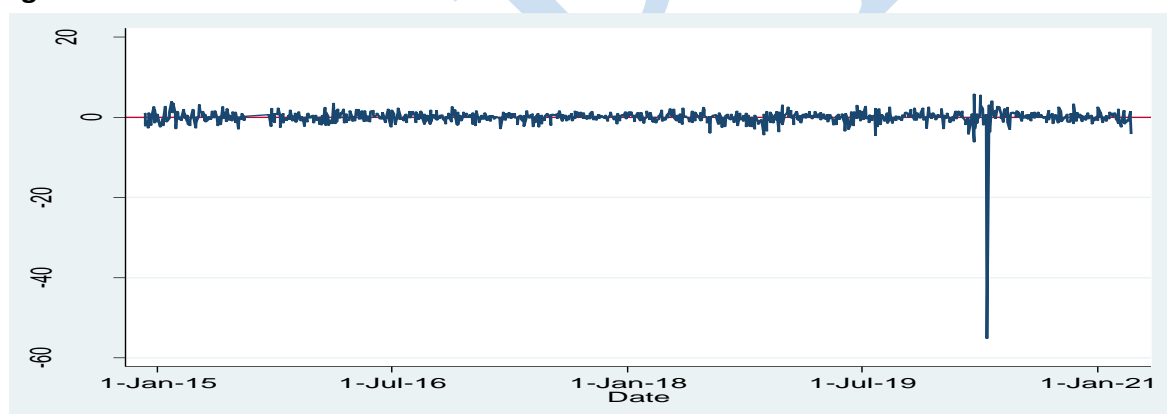


Figure2 shows a sharp decline in prices of WTI during March 2020, and a sudden rise after this shock. The investors switched during this period (COVID-19) and searched for a safe-have asset for their investments.

**Figure3.**

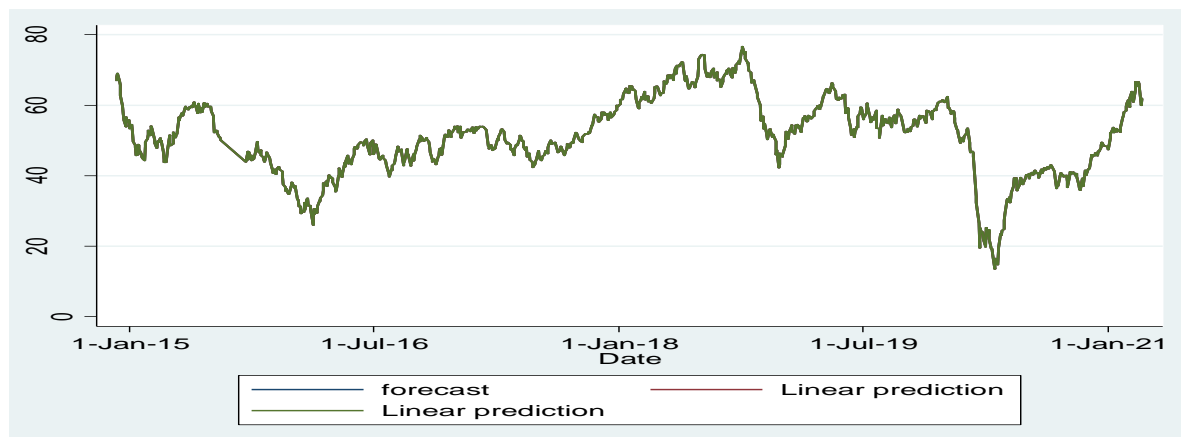
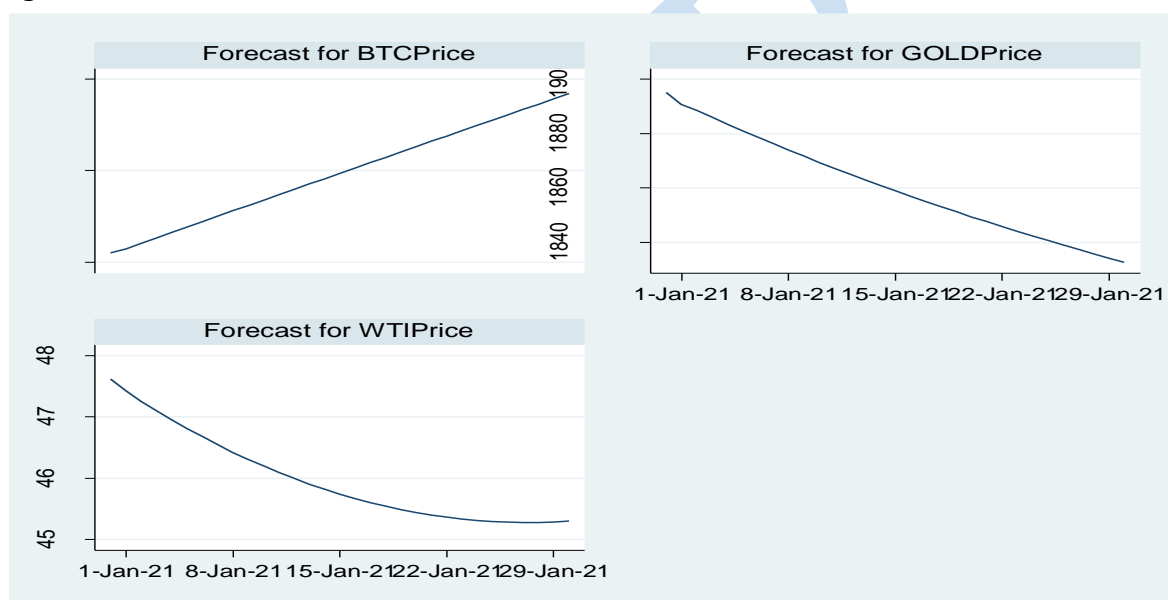


Figure2, reveals that the relationship between WTI price, with continuous shocks, gold and Bitcoin will exist during the next one month, as this study conducts forecasting of 30 steps.

**Figure4.**



The above figure 3, exhibits comprehensive results for the next one month, as the gold and WTI prices have the same trend during the next period, while Bitcoin has an inverse relationship. It can be said as Bitcoin can be used as a hedge in the future against the volatile behavior of WTI prices despite gold. However, Bitcoin might fulfill the features of a hedge and gain more trust from the investors. The existing literature also observes that the investors, searching for a hedge, diversifier or a safe-haven are interested in investing in Bitcoin due to an increasing trend in Bitcoin price and for getting more returns (Li 2021; Yang and Lee 2021).

**Forecasting With ARIMA Model**

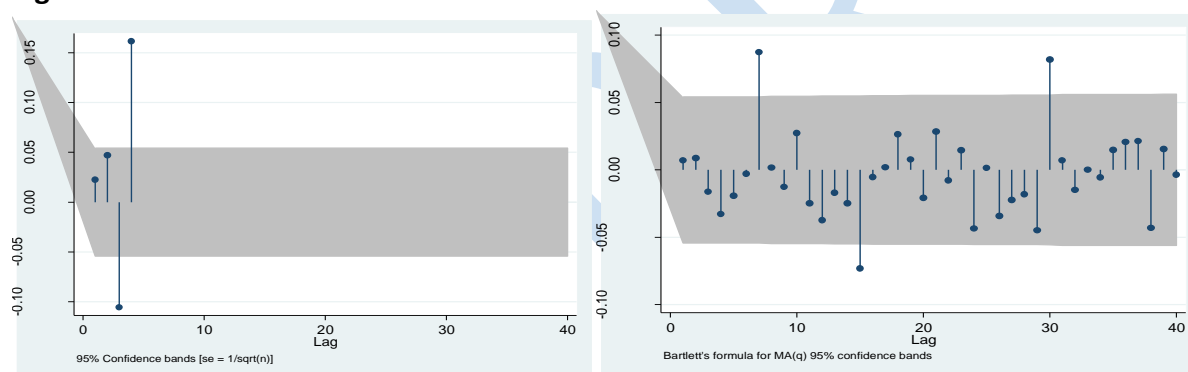
ARIMA model, among many, is a powerful approach that has been widely used to forecast a time series data. The relative predictive properties of ARIMA, VAR, and ECM models have been examined in a shred of evidence from Nigeria that predicts inflation and exchange rate volatility, measured by GARCH, in the country. The study concludes that these models can forecast a time series with different periods.

However, ARIMA is considered to be a benchmark model for forecasting, while ECM is a suitable approach for long-run forecasting and the VAR model has been applied for short-

term forecasting (Nkoro and Uko 2016). Furthermore, in another study, some other approaches for forecasting were also reviewed such as Hidden Markov Model (Bolar, Tesfamariam, and Sadiq 2017), Naive Bayes Classifier, Nonlinear Regression Analysis, Artificial Neural Networks, Support Vector Machines, Decision Trees Classifier, Random Forest Method, WB-CNN (Word Embedding’s Input, PCA (Principal Component Analysis), and Convolutional Neural Network prediction model) and CNN (Convolutional Neural Network). The study concludes that neural network exhibits significant results as compared to the other forecasting techniques (Das Sharma, Chatterjee, and Rakshit 2018)

Subsequently, the ARIMA model has been revealed to be a better forecasting approach and it can deal with the time series data quite well and is considered to be a suitable measure for forecasting the future index (Das Sharma et al. 2018). ARIMA model has also been applied to forecast the gold price in Malaysia with symmetric GARCH-type models in presence of heteroscedasticity (Yaziz et al. 2019). This study has employed the ARIMA model to forecast the trend of crude oil and compare the results with VAR forecasting. The ARIMA forecasting has been applied within and out of the sample to focus on the accuracy of forecasting results.

**Figure 5 Partial & Auto Correlation**



The above Figure 5, revealed the partial and autocorrelation till lag 40. It is observed that the residuals are partially correlated on third and fourth lag, while auto correlated on 7<sup>th</sup>, 15<sup>th</sup>, and 31<sup>st</sup> lag.

**Table 6. ARIMA Forecasting Model**

ARIMA (1,1,1)	Volatility (SIGMASQ)	P> z
ar lag1	0.06665	0.0000
ma lag1	-0.02473	0.0000
Sigma b_cons	-135.2891	0.0000

Table 6 shows the results of the ARIMA (1, 1, 1) forecasting model and found that there would be a declining trend in the WTI price data during the next period.

**Figure 6 Dynamic Forecasting**

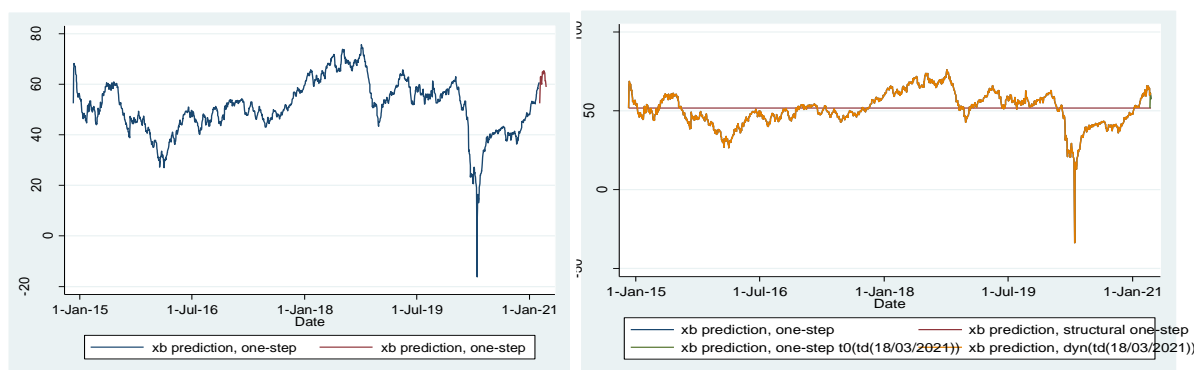
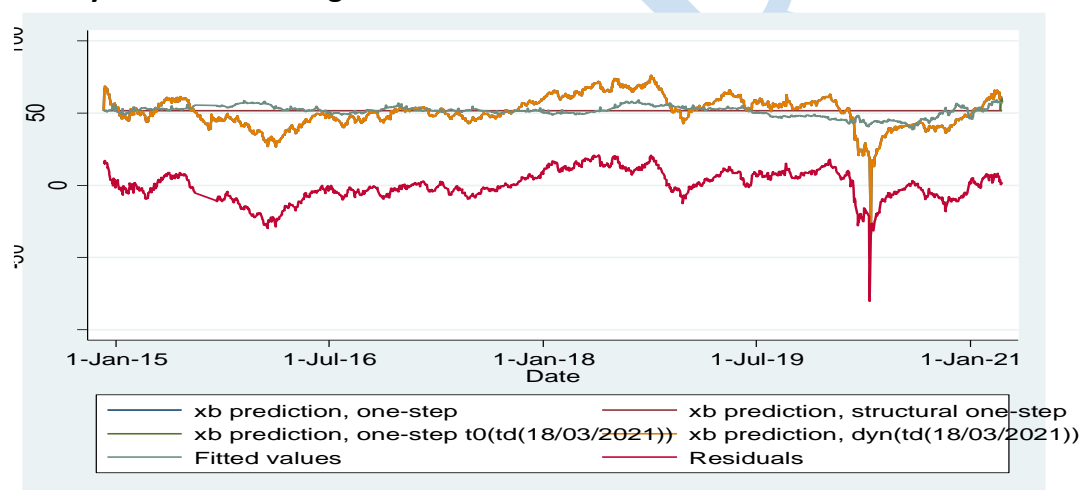


Figure 6 reveals within and out of sample forecasting and found a decreasing trend in the prices of WTI. To forecast WTI prices within the sample, the data split from March, 18<sup>th</sup> 2021 to March 22<sup>nd</sup>, 2021 (full sample period). There found a downward trend as also exhibit in Table 6 (-135.2891).

**Figure 7. Dynamic Forecasting with Residuals**



The above Figure7 exhibits the predicted results of structural, one step, and dynamic along with residuals and found a sharp decline in the prices of WTI during the “COVID” period and also a declining trend in the prices of WTI in the next period.

**Comparison of Forecasting**

This study has employed two widely used approaches for forecasting the VAR model (Bouri et al. 2021; El Hedi Aroui, Lahiani, and Nguyen 2015; Malladi and Dheeriya 2021; Okorie and Lin 2020) and the ARIMA model ( E, Bao, and Ye 2017; Alameer et al. 2019; Jiang and Subramanian 2019; Munim, Shakil, and Alon 2019; Faghih Mohammadi Jalali and Heidari 2020; Malladi and Dheeriya 2021). Almost similar results have been found about a declining trend in WTI price in the next period, while ARIMA (1,1,1) also reveal more precise results as provided the results of the model in figures (Table 6) and provide an insight about the decreasing trend (-135.2891) in WTI prices for the next period.

**Conclusion**

This paper investigates and contributes to existing literature regarding the role of Bitcoin to be a hedge, diversifier or a safe haven especially during financial uncertainties. Furthermore, this study also contributes to forecast the future trend by two techniques and compare the accuracy of results. The findings of this study explore that descriptive statistics found that

Bitcoin prices have highly volatile behavior that is against the features of a hedge. The spot price of gold is negative while the WTI spot price is positively correlated to Bitcoin price. However, gold and Bitcoin prices are positively correlated. Regarding modern portfolio theory, the assets are required to be uncorrelated or negatively correlated to diversify risk (Markowitz 1952). However, during the pandemic period, gold prices are significantly negatively correlated with WTI prices, while Bitcoin price is also negatively correlated but at a weak magnitude. Furthermore, there found a negative relationship between WTI price and gold price. The quantile regression results provide a deep insight about the distribution on four quantiles, on 25<sup>th</sup>, 50<sup>th</sup> and 75<sup>th</sup> quantile there found a negative relationship between WTI price and Bitcoin price, however, on the 90<sup>th</sup> quantile, the relationship has been changed. Furthermore, during the pandemic period, there is a significant negative correlation between WTI and Gold, which have the same behavior during the whole sample period, while during the stress period, there found a stronger negative correlation. However, with many price swings, in panel B, the combination of WTI and Bitcoin has a positive and somewhere, very weak inverse relationship by employing DCC GARCH. The COVID-10 period is considered as sub-periods for assessing the time-varying relationship between WTI price, gold price, and Bitcoin price.

This study explores a decreasing trend in the process of WTI during the next 30 days. To check the accuracy of results of forecasting, we have employed ARIMA (1,1,1) within and out of the sample then compare the results. The forecasting has been conducted within the sample by including 1627 observations initially then 1631(total) observations. The results of this study explore that gold is a safe haven even in uncertain financial condition, while Bitcoin can be used as a diversifier and not acts as a hedge or a safe haven due to volatile nature and lack of liquidity. The results of this study are consistent with previous literature (Conlon, Corbet, and McGee 2020; Conlon and McGee 2020; Ng et al. 2020; Meher et al. 2021; Qin, Su, and Tao 2021; Salisu, Sikiru, and Vo 2020; Sharma 2021), that consider gold as a safe haven, while Bitcoin can be used as a diversifier. The results of ARIMA modeling are found to be more accurate as the analysis has been conducted within and out of sample. These findings are consistent with previous literature ( Yaziz et al. 2019; Fan et al. 2021; Lertthairakul et al. 2021).

### **Discussion**

As for as, the capabilities of safe haven are concerned, these assets are widely traded and trusted by investors even in uncertain market conditions. Gold, for long, is considered to act as the safest asset to be traded. However, with time, there found many other assets which can be used to hedge an investment. These assets include commodities, exchange rates, flats, equity investments, and derivatives. However, the literature reveals some contradictions about the capabilities of a safe haven. Gold is found to act as a safe haven (Hood and Malik 2013; Hussain Shahzad et al. 2020) while in developed countries, USD, Yen, and franks ( Hammoudeh, and Soytaş 2010; Cheong 2018; Sari, Shah, Ahmad, and Mahmood 2018) are also considered as a hedge. These assets have been used to hedge the risk for a long. In 2008, after GFC, a digital currency “Bitcoin” was introduced (Www 2020). Gradually, this currency grabbed the attention of investors and being included in the trade. In 2018, the price bubble burst, and a sharp decline in the price of Bitcoin was observed. Right after that, Bitcoin prices caught a rising trend (Wu et al. 2019) and the investors started including Bitcoin in the

portfolio as a diversifier. By gaining much popularity, a debate has been opened on Bitcoin, being a hedge, diversifier or a safe haven (Bouri, Molnár, et al. 2017; Bouri, Shahzad, et al. 2020). The findings are different in developing and developed countries, while this study, by considering WTI, gold, and Bitcoin as internationally traded commodities, does not focus on country boundaries. Overall, the findings of this study have implications for international investors' perspective, who seek protection against the downside risk (Conlon and McGee 2020) of price movements in WTI prices. These investors can have an edge of position in Bitcoin at the time of recession but gold is the safest investment in all circumstances. Furthermore, the results could be beneficial for regulators of financial markets and governments to examine the role of Bitcoin, hedge or diversifier, in financial markets.

### Limitations

The excess and data availability of Bitcoin are limited. The data on authenticated databases is available since the end of 2014. While in developing countries the data availability is a hazard particularly if the Bitcoin trade is required to be observed in the derivative market.

### Future Research

This study has been conducted on two assets, being safe haven or a diversifier, gold and Bitcoin. However other metals can also be used as a hedge against oil price shocks. Secondly, the futures and forwards (derivatives) of the same stocks can also be used in analysis while this study has conducted with the spot prices of the stocks, however, the volatile behavior and lack of liquidity of Bitcoin would be considered.

### References

- Adediran, Idris A., Olalekan D. Yinusa, and Kanwal Hammad Lakhani. 2021a. "Where Lies the Silver Lining When Uncertainty Hang Dark Clouds over the Global Financial Markets?" *Resources Policy* 70(September):101932.
- Adediran, Idris A., Olalekan D. Yinusa, and Kanwal Hammad Lakhani. 2021b. "Where Lies the Silver Lining When Uncertainty Hang Dark Clouds over the Global Financial Markets?" *Resources Policy* 70.
- Ahmed, Walid M. A. 2021. "Stock Market Reactions to Upside and Downside Volatility of Bitcoin: A Quantile Analysis." *North American Journal of Economics and Finance* 57.
- Akhtaruzzaman, Md, Sabri Boubaker, and Ahmet Sensoy. 2021. "Financial Contagion during COVID-19 Crisis." *Finance Research Letters* 38.
- Alameer, Zakaria, Mohamed Abd Elaziz, Ahmed A. Ewees, Haiwang Ye, and Zhang Jianhua. 2019. "Forecasting Gold Price Fluctuations Using Improved Multilayer Perceptron Neural Network and Whale Optimization Algorithm." *Resources Policy* 61:250-60.
- Ali, Rizwan, Inayat Ullah Mangla, Ramiz Ur Rehman, Wuzhao Xue, Muhammad Akram Naseem, and Muhammad Ishfaq Ahmad. 2020. "Exchange Rate, Gold Price, and Stock Market Nexus: A Quantile Regression Approach." *Risks* 8(3):1-16.
- Anon. n.d. "Forecasting Stock Market Prices Using Mixed ARIMA Model: A Case Study of Indian Pharmaceutical Companies."
- Bassett, Gilbert, and Roger Koenker. 1978. "Asymptotic Theory of Least Absolute Error Regression." *Journal of the American Statistical Association* 73(363):618-22.
- Baur, Dirk G., and Kristoffer J. Glover. 2016. "The Destruction of a Safe Haven Asset?" *Applied Finance Letters* 1(1):8.

- Baur, Dirk G., and Brian M. Lucey. 2010a. "Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold." *Financial Review* 45(2):217–29.
- Baur, Dirk G., and Brian M. Lucey. 2010b. "Is Gold a Hedge or a Safe Haven? An Analysis of Stocks, Bonds and Gold." *Financial Review* 45(2):217–29.
- Baur, Dirk G., and Thomas K. McDermott. 2010a. "Is Gold a Safe Haven? International Evidence." *Journal of Banking and Finance* 34(8):1886–98.
- Baur, Dirk G., and Thomas K. McDermott. 2010b. "Is Gold a Safe Haven? International Evidence." *Journal of Banking and Finance* 34(8):1886–98.
- Baur, Dirk G., and Thomas K. J. McDermott. 2016. "Why Is Gold a Safe Haven?" *Journal of Behavioral and Experimental Finance* 10:63–71.
- Bolar, Aman A., Solomon Tesfamariam, and Rehan Sadiq. 2017. "Framework for Prioritizing Infrastructure User Expectations Using Quality Function Deployment (QFD)." *International Journal of Sustainable Built Environment* 6(1):16–29.
- Bouri, Elie, Rangan Gupta, Aviral Kumar Tiwari, and David Roubaud. 2017. "Does Bitcoin Hedge Global Uncertainty? Evidence from Wavelet-Based Quantile-in-Quantile Regressions." *Finance Research Letters* 23:87–95.
- Bouri, Elie, Lars Ivar Hagfors, and Peter Molnár. n.d. *On the Hedge and Safe Haven Properties of Bitcoin: Is It Really More than a Diversifier?*
- Bouri, Elie, Xiaojie Lei, Naji Jalkh, Yahua Xu, and Hongwei Zhang. 2021. "Spillovers in Higher Moments and Jumps across US Stock and Strategic Commodity Markets." *Resources Policy* 72:102060.
- Bouri, Elie, Brian Lucey, and David Roubaud. 2020. "Cryptocurrencies and the Downside Risk in Equity Investments." *Finance Research Letters* 33.
- Bouri, Elie, Peter Molnár, Georges Azzi, David Roubaud, and Lars Ivar Hagfors. 2017. "On the Hedge and Safe Haven Properties of Bitcoin: Is It Really More than a Diversifier?" *Finance Research Letters* 20:192–98.
- Bouri, Elie, Syed Jawad Hussain Shahzad, David Roubaud, Ladislav Kristoufek, and Brian Lucey. 2020. "Bitcoin, Gold, and Commodities as Safe Havens for Stocks: New Insight through Wavelet Analysis." *Quarterly Review of Economics and Finance* 77:156–64.
- Buvanendra, S., P. Sridharan, and S. Thiyagarajan. 2017. "Firm Characteristics, Corporate Governance and Capital Structure Adjustments: A Comparative Study of Listed Firms in Sri Lanka and India." *IIMB Management Review* 29(4):245–58.
- Cheong, Calvin W. H. 2018. "The Islamic Gold Dinar: A Hedge against Exchange Rate Volatility." *Managerial Finance* 44(6):722–38.
- Conlon, Thomas, Shaen Corbet, and Richard J. McGee. 2020. "Are Cryptocurrencies a Safe Haven for Equity Markets? An International Perspective from the COVID-19 Pandemic." *Research in International Business and Finance* 54(June):101248.
- Conlon, Thomas, and Richard McGee. 2020. "Safe Haven or Risky Hazard? Bitcoin during the Covid-19 Bear Market." *Finance Research Letters* 35.
- Dutta, Anupam, Debojyoti Das, R. K. Jana, and Xuan Vinh Vo. 2020. "COVID-19 and Oil Market Crash: Revisiting the Safe Haven Property of Gold and Bitcoin." *Resources Policy* 69.
- Dwita Mariana, Christy, Irwan Adi Ekaputra, and Zaäfri Ananto Husodo. 2021. "Are Bitcoin and Ethereum Safe-Havens for Stocks during the COVID-19 Pandemic?" *Finance Research Letters* 38(May).

- Dyhrberg, Anne Haubo. 2016. "Hedging Capabilities of Bitcoin. Is It the Virtual Gold?" *Finance Research Letters* 16:139–44.
- E Bouri, N. Jalkh, P. Molnar, D. Roubaud. 2017. "Bitcoin for Energy Commodities before and after the December 2013 Crash: Diversifier, Hedge or Safe Haven?" *Appl Econ* 49(50):5063–73.
- E, Jianwei, Yanling Bao, and Jimin Ye. 2017. "Crude Oil Price Analysis and Forecasting Based on Variational Mode Decomposition and Independent Component Analysis." *Physica A: Statistical Mechanics and Its Applications* 484:412–27.
- Elmblad, Daniel, and Johanna Palmberg. n.d. *GOLD-A "SAFE HAVEN" A QUANTITATIVE RESEARCH OF GOLD AND ITS ROLE AS A "SAFE HAVEN" IN SWEDEN*.
- Engle, Robert. 2002. "Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models." *Journal of Business and Economic Statistics* 20(3):339–50.
- Faghieh Mohammadi Jalali, Mahboubeh, and Hanif Heidari. 2020. "Predicting Changes in Bitcoin Price Using Grey System Theory." *Financial Innovation* 6(1):13.
- Fan, Dongyan, Hai Sun, Jun Yao, Kai Zhang, Xia Yan, and Zhixue Sun. 2021. "Well Production Forecasting Based on ARIMA-LSTM Model Considering Manual Operations." *Energy* 220:119708.
- Fangping, Yu, Liu Yanqing, and Zhang Chenxi. 2021. "To Cite This Article: Fangping Yu et Al 2021." *J. Phys* 12048.
- Gates, Bill. 2020. "Responding to Covid-19 — A Once-in-a-Century Pandemic?" *New England Journal of Medicine* 382(18):1677–79.
- Guesmi, Khaled, Samir Saadi, Ilyes Abid, and Zied Ftiti. 2019. "Portfolio Diversification with Virtual Currency: Evidence from Bitcoin." *International Review of Financial Analysis* 63:431–37.
- El Hedi Arouri, Mohamed, Amine Lahiani, and Duc Khuong Nguyen. 2015. "World Gold Prices and Stock Returns in China: Insights for Hedging and Diversification Strategies." *Economic Modelling* 44:273–82.
- Herbst, Anthony F. 1983. "Gold versus U.S. Common Stocks: Some Evidence on Inflation Hedge Performance and Cyclical Behavior." *Financial Analysts Journal* 39(1):66–74.
- Hillier, David, Paul Draper, and Robert Faff. 2006. "Do Precious Metals Shine? An Investment Perspective." *Financial Analysts Journal* 62(2):98–106.
- Holzmeister, Felix, Jürgen Huber, Michael Kirchler, Florian Lindner, Utz Weitzel, and Stefan Zeisberger. 2020. "What Drives Risk Perception? A Global Survey with Financial Professionals and Laypeople." *Management Science* 66(9):3977–4002.
- Hood, Matthew, and Farooq Malik. 2013. "Is Gold the Best Hedge and a Safe Haven under Changing Stock Market Volatility?" *Review of Financial Economics* 22(2):47–52.
- Hussain Shahzad, Syed Jawad, Elie Bouri, David Roubaud, and Ladislav Kristoufek. 2020. "Safe Haven, Hedge and Diversification for G7 Stock Markets: Gold versus Bitcoin." *Economic Modelling* 87:212–24.
- Ijiri, Hiroyuki, and Toshiki Jinushi. 2021. "International Spillover Effects of Quantitative Easing Policy: A Case Study on the U.S. and Japan." *Applied Economics Letters*.
- Ji, Qiang, Dayong Zhang, and Yuqian Zhao. 2020a. "Searching for Safe-Haven Assets during the COVID-19 Pandemic." *International Review of Financial Analysis* 71:101526.

- Ji, Qiang, Dayong Zhang, and Yuqian Zhao. 2020b. "Searching for Safe-Haven Assets during the COVID-19 Pandemic." *International Review of Financial Analysis* 71:101526.
- Jiang, Loh Chi, and Preethi Subramanian. 2019. "Forecasting of Stock Price Using Autoregressive Integrated Moving Average Model." *Journal of Computational and Theoretical Nanoscience* 16(8):3519–24.
- Kanamura, Takashi. 2020. "Risk Mitigation and Return Resilience for High Yield Bond ETFs with ESG Components." *Finance Research Letters*.
- Klein, Eili Y., Thomas P. Van Boeckel, Elena M. Martinez, Suraj Pant, Sumanth Gandra, Simon A. Levin, Herman Goossens, and Ramanan Laxminarayan. 2018. "Global Increase and Geographic Convergence in Antibiotic Consumption between 2000 and 2015." *Proceedings of the National Academy of Sciences of the United States of America* 115(15):E3463–70.
- Klein, Tony, Hien Pham Thu, and Thomas Walther. 2018. "Bitcoin Is Not the New Gold – A Comparison of Volatility, Correlation, and Portfolio Performance." *International Review of Financial Analysis* 59:105–16.
- Kliber, Agata, Paweł Marszałek, Ida Musiałkowska, and Katarzyna Świerczyńska. 2019. "Bitcoin: Safe Haven, Hedge or Diversifier? Perception of Bitcoin in the Context of a Country's Economic Situation — A Stochastic Volatility Approach." *Physica A: Statistical Mechanics and Its Applications* 524:246–57.
- Koenker, Roger, and Gilbert Bassett. 1978. "Regression Quantiles." *Econometrica* 46(1):33.
- Kumar, Anoop S., and S. Anandarao. 2019. "Volatility Spillover in Crypto-Currency Markets: Some Evidences from GARCH and Wavelet Analysis." *Physica A: Statistical Mechanics and Its Applications* 524:448–58.
- Lánský, Jan. 2017. "Bitcoin System." *Acta Informatica Pragensia* 6(1):20–31.
- Lertthaitrakul, Weerawit, Prahatsorn Khumsawat, and Nattapat Manirochana. 2021. *A Comparison Forecast Volume of Outbound Containers in Case of The Bangkok Port Between Exponential Smoothing and ARIMA Model*. Vol. 12.
- Li, Jing. 2021. "Block Bootstrap Prediction Intervals for Parsimonious First-order Vector Autoregression." *Journal of Forecasting* 40(3):512–27.
- Li, Sile, and Brian M. Lucey. 2017. "Reassessing the Role of Precious Metals as Safe Havens—What Colour Is Your Haven and Why?" *Journal of Commodity Markets* 7:1–14.
- Li, Xingjian, Hongrui Feng, Sebastian Zhao, and David A. Carter. 2021. "The Effect of Revenue Diversification on Bank Profitability and Risk during the COVID-19 Pandemic." *Finance Research Letters* 101957.
- Lin, Boqiang, and Rui Bai. 2021. "Oil Prices and Economic Policy Uncertainty: Evidence from Global, Oil Importers, and Exporters' Perspective." *Research in International Business and Finance* 56:101357.
- Ma, Jinghao, Yujie Shang, and Hongyan Zhang. 2021. "Application of Bayesian Vector Autoregressive Model in Regional Economic Forecast."
- Malladi, Rama K., and Prakash L. Dheeriyaa. 2021. "Time Series Analysis of Cryptocurrency Returns and Volatilities." *Journal of Economics and Finance* 45(1):75–94.
- Markowitz, Harry. 1952. *Portfolio Selection*. Vol. 7.
- Meher, Bharat Kumar, Iqbal Thonse Hawaldar, Cristi Spulbar, and Ramona Birau. 2021. "Forecasting Stock Market Prices Using Mixed ARIMA Model: A Case Study of Indian

- Pharmaceutical Companies." *Investment Management and Financial Innovations* 18(1):42–54.
- Muhammad, Asadullah, Uddin Imam, Qayyum Arsalan, Ayubi Sharique, and Sabri Rabia. 2021. "Forecasting Chinese Yuan/USD Via Combination Techniques During COVID-19." *Journal of Asian Finance* 8(5):221–29.
- Munim, Ziaul Haque, Mohammad Hassan Shakil, and Ilan Alon. 2019. "Next-Day Bitcoin Price Forecast." *Journal of Risk and Financial Management* 12(2):103.
- Naeem, Muhammad Abubakr, Mudassar Hasan, Muhammad Arif, and Syed Jawad Hussain Shahzad. 2020. "Can Bitcoin Glitter More Than Gold for Investment Styles?" *SAGE Open* 10(2).
- Neri, Selina. 2021. "Environmental, Social and Governance (ESG) and Integrated Reporting." Pp. 293–302 in *Global Challenges to CSR and Sustainable Development*. Nature Publishing Group.
- Ng, Sew Lai, Wen Cheong Chin, and Lee Lee Chong. 2020. "Realized Volatility Transmission within Islamic Stock Markets: A Multivariate HAR-GARCH-Type with Nearest Neighbor Truncation Estimator." *Borsa Istanbul Review* 20:S26–39.
- Ngoo, Yee Ting, Eu Chye Tan, and Nai Peng Tey. 2021. "Determinants of Life Satisfaction in Asia: A Quantile Regression Approach." *Journal of Happiness Studies* 22(2):907–26.
- Nkoro, Emeka, and Aham Kelvin Uko. 2016. "Exchange Rate and Inflation Volatility and Stock Prices Volatility: Evidence from Nigeria, 1986-2012." *Journal of Applied Finance & Banking* 6(6):1–4.
- Okorie, David Iheke, and Boqiang Lin. 2020. "Crude Oil Price and Cryptocurrencies: Evidence of Volatility Connectedness and Hedging Strategy." *Energy Economics* 87:104703.
- Othman, Anwar Hasan Abdullah, Syed Musa Alhabshi, and Razali Haron. 2019. "The Effect of Symmetric and Asymmetric Information on Volatility Structure of Crypto-Currency Markets: A Case Study of Bitcoin Currency." *Journal of Financial Economic Policy* 11(3):432–50.
- Ouhame, Soukaina, Youssef Hadi, and Arif Ullah. 2021. "An Efficient Forecasting Approach for Resource Utilization in Cloud Data Center Using CNN-LSTM Model." *Neural Computing and Applications* 1–13.
- Qin, Meng, Chi Wei Su, and Ran Tao. 2021. "BitCoin: A New Basket for Eggs?" *Economic Modelling* 94(November 2019):896–907.
- Qiu, Yue, Zongrun Wang, Tian Xie, and Xinyu Zhang. 2021. "Forecasting Bitcoin Realized Volatility by Exploiting Measurement Error under Model Uncertainty." *Journal of Empirical Finance* 62:179–201.
- Reinholtz, Nicholas, Philip M. Fernbach, and Bart de Langhe. 2021. "Do People Understand the Benefit of Diversification?" *Management Science*.
- Riaz, Lubna, Pir Mehr Ali Shah, and Ahmed Imran Hunjra. 2015. *Relationship between Psychological Factors and Investment Decision Making: The Mediating Role of Risk Perception*. Vol. 9.
- Salisu, Afees A., Abdulsalam Abidemi Sikiru, and Xuan Vinh Vo. 2020. "Pandemics and the Emerging Stock Markets." *Borsa Istanbul Review* 20:S40–48.
- Sari, Ramazan, Shawkat Hammoudeh, and Ugur Soytas. 2010. "Dynamics of Oil Price, Precious Metal Prices, and Exchange Rate." *Energy Economics* 32(2):351–62.
- Scharnowski, Stefan. 2021. "Understanding Bitcoin Liquidity." *Finance Research Letters* 38(February):101477.

- Schober, Patrick, and Lothar A. Schwarte. 2018. "Correlation Coefficients: Appropriate Use and Interpretation." *Anesthesia and Analgesia* 126(5):1763–68.
- Shafiee, Shahriar, and Erkan Topal. 2010. "An Overview of Global Gold Market and Gold Price Forecasting." *Resources Policy* 35(3):178–89.
- Shah, Syed Zulfiqar Ali, Maqsood Ahmad, and Faisal Mahmood. 2018. "Heuristic Biases in Investment Decision-Making and Perceived Market Efficiency: A Survey at the Pakistan Stock Exchange." *Qualitative Research in Financial Markets* 10(1):85–110.
- Das Sharma, Kaushik, Amitava Chatterjee, and Anjan Rakshit. 2018. "Some Contemporary Stochastic Optimization Algorithms: A Glimpse." Pp. 23–36 in.
- Sharma, Susan Sunila. 2021. "Westerlund and Narayan Predictability Test: Step-by-Step Approach Using COVID-19 and Oil Price Data." *MethodsX* 8:101201.
- Solt, Michael E., and Paul J. Swanson. 1981. "On the Efficiency of the Markets for Gold and Silver." *The Journal of Business* 54(3):453–78.
- Stavroyiannis, Stavros. 2018. "Value-at-Risk and Related Measures for the Bitcoin." *Journal of Risk Finance* 19(2):127–36.
- Tronzano, Marco. 2020. "Safe-Haven Assets, Financial Crises, and Macroeconomic Variables: Evidence from the Last Two Decades (2000–2018)." *Journal of Risk and Financial Management* 13(3):40.
- Urquhart, Andrew, and Hanxiong Zhang. 2019. "Is Bitcoin a Hedge or Safe Haven for Currencies? An Intraday Analysis." *International Review of Financial Analysis* 63:49–57.
- Vardar, Gulcin, and Berna Aydogan. 2019. "Return and Volatility Spillovers between Bitcoin and Other Asset Classes in Turkey: Evidence from VAR-BEKK-GARCH Approach." *EuroMed Journal of Business* 14(3):209–20.
- Wang, Gangjin, Yanping Tang, Chi Xie, and Shou Chen. 2019a. "Is Bitcoin a Safe Haven or a Hedging Asset? Evidence from China." *Journal of Management Science and Engineering* 4(3):173–88.
- Wang, Gangjin, Yanping Tang, Chi Xie, and Shou Chen. 2019b. "Is Bitcoin a Safe Haven or a Hedging Asset? Evidence from China." *Journal of Management Science and Engineering* 4(3):173–88.
- Wu, Shan, Mu Tong, Zhongyi Yang, and Abdelkader Derbali. 2019. "Does Gold or Bitcoin Hedge Economic Policy Uncertainty?" *Finance Research Letters* 31:171–78.
- Www, Satoshingmxcom. 2020. "S A t o S h i N a k a m O t o A Peer-to-Peer Electronic Cash System."
- Yang, Kai, and Lung fei Lee. 2021. "Estimation of Dynamic Panel Spatial Vector Autoregression: Stability and Spatial Multivariate Cointegration." *Journal of Econometrics* 221(2):337–67.
- Yaziz, Siti Roslindar, Roslinazairimah Zakaria, and Suhartono. 2019. "ARIMA and Symmetric GARCH-Type Models in Forecasting Malaysia Gold Price." in *Journal of Physics: Conference Series*. Vol. 1366. Institute of Physics Publishing.
- Zhang, Dayong, Min Hu, and Qiang Ji. 2020. "Financial Markets under the Global Pandemic of COVID-19." *Finance Research Letters* 36.