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Dynamics of the sheltering role of Bitcoin against crude oil market crash with varying severity of the COVID-19: A comparison with gold

Xiaohang Ren \textsuperscript{a}, Rui Wang \textsuperscript{b}, Kun Duan \textsuperscript{c},* , Jinyu Chen \textsuperscript{a}

\textsuperscript{a} School of Business, Central South University, Changsha 410083, China
\textsuperscript{b} Xi’an Aerospace Propulsion Testing Technology Research Institute, Xi’an, Shaanxi 710025, China
\textsuperscript{c} School of Economics, Huazhong University of Science and Technology, Wuhan, Hubei 430074, China

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\textbf{ABSTRACT}

This paper studies evolution of the asymmetric sheltering role of Bitcoin compared to gold against oil-related uncertainties with varying severity of the COVID-19 pandemic. Using a varying-coefficient quantile approach, we find a safe haven role of Bitcoin, and it becomes gradually stronger when the pandemic intensifies. The relationship between gold and oil markets is shown to vary with changing severity of the pandemic. We find that gold acts as an increasingly weakened diversifier as the pandemic intensifies until a level, above which its diversification gains would dissipate then. In normal market conditions, both Bitcoin and gold perform as weak hedges for oil portfolios. Our findings demonstrate that interpretation of the sheltering role of Bitcoin and gold against oil market downturns would be biased unless the role dynamics in different market conditions and pandemic severity are considered. Additional analyses reassure robustness of our findings.

1. Introduction

The raging and escalating COVID-19 pandemic has not only induced tremendous cost in lives, but also demonstrated how fragile the world is in the face of exceptional uncertainties and risks. In the face of significant financial turmoil associated with the ongoing pandemic, the global crude oil market has witnessed a widespread downturn characterized as a substantial fall in oil prices along with a high volatility (Dutta et al., 2020). Such the downturn would lead to serious losses especially in oil-related investments, further giving rise to adjustments in optimal portfolio selections and prompting investors to seek shelter against the downside risk in the market (Berkelaar et al., 2004; Li et al., 2021; Wen et al., 2019, 2020). Thus, exposure to great risks of losses in the ongoing COVID-19 pandemic has led to a profusion of attentions for hedging and safe-haven assets to both academicians and practitioners alike. \textsuperscript{1}

Gold is traditionally known as an investment shelter against adverse fluctuations of traditional financial assets, while, being

\* Corresponding author.
E-mail addresses: domxhr@outlook.com (X. Ren), rui.wang17@outlook.com (R. Wang), kduan15@outlook.com (K. Duan), cjy2014@csu.edu.cn (J. Chen).

\textsuperscript{1} According to Baur and Lucey (2010); Bouri et al. (2017a), an asset that is positively (but not perfectly) correlated with another asset on average is defined as a diversifier; an asset that has no/negative correlation with another asset on average is defined as a weak/strong hedge; an asset that has no/negative correlation with another asset during downside periods is defined as a weak/strong safe haven.

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recognized as ‘digital gold’, the resilience of Bitcoin during severe bust periods has recently demonstrated its potential hedging and save haven roles against global market stress (Das et al., 2020; Wen et al., 2022). Bitcoin is featured as an investment shelter due to its weak dependence with traditional assets, its function as value storage, and its independence with policy interventions of Sovereign nations (Huang et al., 2021). Although severe financial turbulence led by the COVID-19 pandemic provides a critical test-bed for the sheltering role of Bitcoin (Conlon and McGee, 2020), extant relevant literature is nevertheless sparse; more so, far little concerns its role against the downside risk in the oil market. At the same time, existing literature reveals the asymmetry of the market relationship of Bitcoin/gold with traditional assets and commodities in the data distribution (Beneke et al., 2019; Zeinedini et al., 2022). Such the asymmetric relationship supports the rationale behind the research of the underlying sheltering role of Bitcoin/gold for traditional financial goods at market downturns (i.e., extreme low data quantiles). More importantly, it also provides rich information than traditional mean-based methods for enhancement of risk mitigation and policy effectiveness on financial stability. Moreover, it is argued that intensification of the pandemic leads to a heightening uncertainty level worldwide, which might alter the hedging and save haven ability of Bitcoin in the oil market (Dutta et al., 2020; Gozgor et al., 2019; Selmi et al., 2018; Ren et al., 2022). However, there is still a lack of research that examines the above argument by measuring the dynamics of the sheltering role of Bitcoin as the pandemic intensifies.

To this end, this paper assesses to what extent Bitcoin can act as a diversifier, hedge, and/or safe haven against adverse changes in oil prices, and the dynamics of its role with variations in market conditions and the pandemic intensity, in comparison to that of gold. The potential non-linearity and asymmetry of the price relationship between Bitcoin and oil, as well as that between gold and oil, over the whole data distribution with varying intensity of the pandemic is studied through a non-parametric varying-coefficient quantile regression approach.

Our paper is closely related to at least two strands of literature. That is, studies on the sheltering role of gold and Bitcoin against adverse movements of financial and commodity assets (in particular, oil); and performance of the two potential shelters in the financial turmoil (in particular, oil-related downturns). Gold is traditionally recognized as an investment shelter in market turmoil mainly due to the fact that it is among the firsts form of money and is known as a hedge against inflation (Baur and Lucey, 2010). Gold has been earlier recognized as a safe haven against global uncertainty given weak or negative correlations between this precious metal and other assets (e.g., Chua et al., 1990; Ciner et al., 2013; Hillier et al., 2006; Kaul and Sapp, 2006; Baur and Lucey, 2010; Dutta et al., 2020; Reboredo, 2013). However, the hedging and safe haven properties of Gold appears to be inconstant and varying against different asset types and market conditions (e.g., Baur and Lucey, 2010; Ciner et al., 2013; Bampinas and Panagiotidis, 2015; Reboredo, 2013; Duan et al., 2021b; Ren et al., 2022a; Ciner et al. (2013)) examine if and to what extent each of the five assets, i.e., stock, bond, crude oil, gold, and US dollar can act as a hedge and/or safe haven for each other. They find an evident safe haven role of Gold against target assets except for the crude oil. Reboredo (2013b) points out that gold is not a valid hedge against oil price changes but an effective safe haven against extremely adverse movements in oil prices.

While gold is traditionally known to offer an investment shelter particularly in a downturn period when diversification opportunities are diminishing (Baur and Lucey, 2010; Conlon et al., 2018), its hedging and safe haven properties appear to be unstable (Klein, 2017). The effectiveness of such properties of gold has recently suffered widespread criticism, especially in the aftermath of the global financial crisis when facing the zero-bound interest rate and the intensified financialization of gold (commodity) investment worldwide (Shahzad et al., 2019). In contrast, recently, a nascent but growing literature focuses on hedging and safe haven roles of Bitcoin due mainly to its exemption from political and economic interventions, its function as value preservation, and its weak/reverse relationship with major assets (Conlon and McGee, 2020; Shahzad et al., 2019; Selmi et al., 2018; Huang et al., 2021; Duan et al., 2021a). Employing a dataset covering the Global Financial Crisis, Peng et al. (2021) observe a significant negative relationship between crude oil and the US dollar, implying a safe haven potential for both assets with each other. He et al. (2022) find the important role of oil-related uncertainties in altering risk-return relationships in the stock market, indicating close linkages between oil and traditional financial assets. This demonstrates the necessity of seeking a shelter for risk mitigation of oil-related investments.

At the same time, similar to gold, empirical evidence regarding hedging and safe haven abilities of Bitcoin are not consistent. Bouri et al. (2017) find Bitcoin behaving as an effective hedge instrument against the global uncertainty represented by the option implied volatility indexes in both emerging and developed economies. Similar findings regarding the hedging property of Bitcoin are drawn with the global uncertainty proxyed by the economic policy uncertainty index (Demir et al., 2018; Wu et al., 2019. Kliber et al. (2019) suggest a weak hedge of Bitcoin in traditional financial markets worldwide; and it acts as a valid safe haven in Venezuela. Urquhart and Zhang (2019) point out a hedging role of Bitcoin against fiat currencies. Much of the extant literature argues in favor of hedging and safe haven roles of Bitcoin against various assets; however, there also exist many contradictory findings. Smales (2019) finds that the risk mitigation ability of Bitcoin tends to be relatively weaker in contrast to gold, given its higher volatility, lower liquidity, and greater transaction costs. Bouri et al. (2017c) report that hedging and safe haven roles of Bitcoin were no longer held after its price crash in December 2013; and Bitcoin only shew weak diversification benefits against the non-energy commodity indexes thereafter. Das et al. (2020) find that Bitcoin possesses only weak hedging ability for oil-related uncertainties; and the ability of potential hedge assets is conditional upon the uncertainty level in the market.

How does the COVID-19 pandemic impact hedging and safe haven capabilities of Bitcoin and gold? Using a cross-quantilogram approach, Ji et al. (2020) find that the capabilities of the most considered assets including Bitcoin are weakened, while gold still remains as an effective safe haven during the pandemic. Dutta et al. (2020) report that during the pandemic gold behaves as a safe haven asset for crude oil, while Bitcoin only acts as a diversifier instead. Corbet et al. (2020) point out that Bitcoin has no safe haven ability against stock markets. Conlon et al. (2020) suggest the safe haven role of Bitcoin only for downside risks of the Chinese CSI 300 stock index. Wen et al. (2022) indicate that Bitcoin has no safe haven ability against oil and stock markets during this pandemic.

Our paper contributes to the existing research in the following ways. First, our employed varying-coefficient quantile method...
comprehensively considers the potential nonlinearity and asymmetry over the entire data distribution of target variables. Through this, the impact coefficient of the explanatory variable is allowed to not only vary in different market conditions, but also be governed conditionally upon a dynamic smoothing factor, i.e., severity of the COVID-19 pandemic in our case, in comparison to linear and mean-based methods. Second, we are among the first to uncover the dynamically asymmetric relationship between oil and Bitcoin prices, as well as that between oil and gold prices, over price distributions, potentially varying with changes in the severity of the COVID-19 pandemic. Through this, we are able to uncover how the potentially sheltering role of Bitcoin and gold against oil-related uncertainties evolves with different market conditions and varying pandemic intensity, respectively.

Using a daily dataset over a period of 23 January to 19 August 2020 and a varying-coefficient quantile approach, our main findings are summarized as follows. During downside periods of the WTI crude oil market represented as 5%, 10%, and 25% quantiles of oil prices, the price impact of Bitcoin on oil prices experiences a gradual decline an increase in the pandemic severity represented as the growth rate of infected cases. The coefficient of Bitcoin prices is shown to be insignificant when the pandemic intensity is low, while it turns to be increasingly significant and negative when the pandemic becomes more severe with high growth rates of infected cases. This provides empirical evidence that Bitcoin can act as a safe haven asset against adverse movements of oil asset prices and its safe haven ability becomes much stronger when the pandemic intensifies. In addition, the impact coefficient of Bitcoin prices on oil prices under normal market conditions is insignificant, suggesting the hedging ability of Bitcoin in normal periods.

In comparison, the sheltering role of gold is different. In the face of downside risk in the WTI crude oil market, the impact coefficient of gold is insignificant when infected cases of the COVID-19 pandemic are at low levels, indicating a weak diversification role. The coefficient then becomes increasingly significant and positive when the pandemic intensifies. This indicates that diversification gains earned by gold tends to gradual diminish with increases in the pandemic intensity until approaching to a level, above which the impact coefficient of gold is significantly greater than one. Specifically, an above-one impact coefficient indicates that gold no longer provides diversification benefit and risk mitigation but amplifies risk levels of the oil-related portfolio. It is also worth noting that price impacts of gold on oil prices are shown to be insignificant on average in normal market periods, indicating a weak hedging role of gold. Our conclusions survive a series of robustness checks such as replacement of the oil market and alternative estimation strategy. Overall, Bitcoin is found to play a safe haven role for oil-related portfolios, while gold could only provide weak diversification gains instead. Our findings demonstrate that the sheltering role of Bitcoin and gold against adverse fluctuations of the oil asset can vary with changes in the pandemic severity and market conditions, and should be of interest to various stakeholders.

The remainder of the paper proceeds as follows. Section 2 reviews related key literature; Section 3 describes employed estimation techniques and our empirical dataset. Section 4 reports estimation results and discusses corresponding theoretical explanations. Section 5 concludes the paper with discussions of policy implications.

2. Methodology and data

2.1. Methodology

2.1.1. The varying-coefficient quantile regression

In this section, we will consider the varying-coefficient quantile regression approach (Cai and Xu, 2008) to investigate whether Bitcoin is a hedge, a diversifier or a safe haven for crude oil futures. Different from the traditional linear quantile regression (Koenker and Bassett, 1978), the varying-coefficient quantile method uses the nonparametric estimation to empirically investigate how the impact of independent variable on dependent variable can be adjusted by the smoothing variable under different quantile levels. The strengths of our employed method on a statistical perspective are summarized as follows.

First, the varying-coefficient quantile method provides a powerful tool for estimating heterogeneity in price distributions of dependent variable, compared with conventional mean-based methods. It therefore provides a more comprehensive and precise understanding of the relationship between the variables under different market conditions. Moreover, this method relaxes the conventionally assumed linear model setting, and captures the potentially-existing non-linearity between explanatory and dependent variables. Through this, the coefficient of explanatory variable is allowed to vary conditionally upon a smoothing variable, i.e. the

Table 1
Descriptive statistics.

|       | Mean  | Stdev | Skewness | Kurtosis | ADF   | JB    |
|-------|-------|-------|----------|----------|-------|-------|
| WTI   | 0.0017| 0.0816| -0.6146  | 7.6073   | -4.5461*** | 372.6813*** |
| Brent | -0.0006| 0.0567| -0.2438  | 5.5286   | -4.3814*** | 194.1605*** |
| Bitcoin | 0.0019| 0.0202| -1.7824  | 14.8129  | -5.2173*** | 1448.8643*** |
| Covid | 0.0215| 0.0336| 4.4391   | 25.7168  | -4.7625*** | 4607.2042*** |
| Gold  | 0.0017| 0.0154| 0.0258   | 2.7105   | -6.4673*** | 47.0486***  |

Note: (i) This table summarizes descriptive statistics of the returns of WTI crude oil price, Bitcoin price, Gold price and Covid-19 no. (ii) The sample period is from Jan 23, 2020 to Aug 19, 2020. (iii) The Jarque-Bera (JB) statistics test for the null hypothesis of non-normality of target series. The Augmented Dickey-Fuller (ADF) test reports unit root test results with the null hypothesis of non-stationarity. (iv) * denotes the 10% significance level; ** denotes the 5% significance level; *** denotes the 1% significance level.

2 Detailed descriptions about the varying-coefficient quantile method are discussed in Section 2.

3
Fig. 1. Density plots of the daily return of WTI crude oil futures prices, Bitcoin prices, Gold prices and Covid-19 numbers from 23 January 2020–19 August 2020. Note: In each subfigure, the kernel density estimate (solid curve) is superimposed with Gaussian density estimate of same mean and variance (dashed curve).
(a) $\tau = 0.05$

(b) $\tau = 0.1$

(c) $\tau = 0.25$

(d) $\tau = 0.5$
intensity of COVID-19 pandemic in our case. Thus, the varying-coefficient quantile method enables us to uncover the real linkages between Bitcoin prices and crude oil futures prices during COVID-19 period, and can provide more meaningful information in contrast to both OLS and traditional quantile regression.

We first consider the following varying-coefficient quantile regression equation for the $\tau$-quantile of crude oil futures price return ($Y$) as a function of the Bitcoin price return ($X$) and the return of number of the infected cases of COVID-19 ($C$) as:

$$Y = \alpha_t(C) + \beta_t(C)X_t + \epsilon_{t,\tau}$$

where $Y$ represents crude oil futures return in following empirical research at time $t$, the residual term $\epsilon_{t,\tau}$ has a zero $\tau$-quantile. Due to the lack of prior information on the relationship, $\alpha_t(C)$ and $\beta_t(C)$ are varying-coefficient functions and assumed to be an unknown function.

To examine the impact of the Bitcoin price return on $\tau$-quantile of crude oil futures return, we apply the local linear method to estimate the unknown function $\alpha_t(C)$ and $\beta_t(C)$ by taking a first order Taylor expansion around $c_0$:

$$\alpha_t(C) \approx \alpha_t(c_0) + \alpha_t(c_0)(C_t - c_0) \equiv a_0(\tau) + a_1(\tau)(C_t - c_0),$$

$$\beta_t(C) \approx \beta_t(c_0) + \beta_t(c_0)(C_t - c_0) \equiv b_0(\tau) + b_1(\tau)(C_t - c_0).$$

By substituting Eq. 2.2 and 2.3 into Eq. 2.1, we can obtain

$$Y = a_0(\tau) + a_1(\tau)(C_t - c_0) + b_0(\tau)X_t + b_1(\tau)(C_t - c_0)X_t + \epsilon_{t,\tau}.$$  

Then, we solve Eq. 2.4 by considering

$$\begin{bmatrix}
\hat{a}_1(\tau) \\
\hat{a}_0(\tau) \\
\hat{b}_1(\tau) \\
\hat{b}_0(\tau)
\end{bmatrix} = \text{argmin}_{a_0, a_1, b_0, b_1} \sum_{t=1}^{T} \rho_\theta(y_t - \hat{a}_0(\tau) - a_1(\tau)(C_t - c_0) - b_0(\tau)X_t - b_1(\tau)(C_t - c_0)X_t)K\left(\frac{C_t - c_0}{h}\right).$$

where $\rho_\theta(y) = y(\theta - I_{y > 0})$ and $I_A$ is the indicator function of set $A$. $K$ is a Gaussian kernel function on $\mathbb{R}$, and $h > 0$ is the bandwidth.

The choice of bandwidth is important for a nonparametric estimation, which is because the bandwidth decides the size of variance and bias in the estimation. Therefore, a suitable bandwidth can provide a balance between the bias and the variance. In this study, we will use the cross-validation method (Stone, 1984; Li and Racine, 2004) to choose the optimal bandwidth in this study, which can derive a more accurate estimate of the model. The leave-one-out cross-validation estimator of Eq. 2.4 is

$$M(h) = \sum_{t=1}^{T} \rho_\theta(y_k - \hat{a}_{0-k}(C_k) - \hat{b}_{0-k}(C_k)X_k),$$

where $\hat{a}_{0-k}$ and $\hat{b}_{0-k}$ are the local linear estimators obtained from Eq. 2.5 after removing $k$th observation. Then the optimal bandwidth parameter is:

$$h_{CV} = \text{argmin}_{h} M(h).$$

2.1.2. Data

Our research uses a daily dataset since the outbreak of the COVID-19 epidemic covering the period from 23 January 2020–19 August 2020. The data of the intensitify degree of the COVID-19 pandemic (measured as a number of the infected cases of COVID-19 worldwide) is obtained from the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University. Following extant literature, we accordingly collect the daily closing/spot price of bitcoin (CoinDesk price index), gold (ounce of gold-LBMA), the WTI crude oil futures price from the U.S Energy Information Agency will be employed in the robust analysis.

Table 1 describes summary statistics for our data presented in a return format. Specifically, it is essential to first test whether the series are non-stationary as non-treatment of the latter characteristics might bias our inference of the causal relationship between

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Footnotes:

3 The Center for Systems Science and Engineering (CSSE) at Johns Hopkins University: https://github.com/CSSEGISandData/COVID-19.

4 https://www.coindesk.com/price/bitcoin

5 Historical Futures Prices: Gold Futures, Continuous Contract #1. Non-adjusted price based on spot-month continuous contract calculations. Raw data from CME.

6 Cushing, OK Crude Oil Future Contract 1 (Dollars per Barrel). Raw data from Energy Information Administration.
target variables - dynamically or otherwise. Results of the ADF test indicates that the null hypothesis of a unit root is comfortably rejected at the 1% statistical significance level, showing that all our incorporated series are stationary in returns. The positive kurtosis values indicate that distributions of the series possess heavier tails than the normal distribution, while the Jarque-Bera test also manifests that all series depart from normality. To visualise the distribution pattern of our incorporated series, we provide density plots of the return of WTI crude oil prices, Bitcoin prices, Gold prices and the severity of the COVID-19 pandemic as shown in Fig. 1. Once again, the plots further confirm that our target series in returns are non-normally distributed, providing a strong motivation for the use of the quantile regression approach in our empirical analyses.

3. Empirical results

The descriptive statistics and the distribution of the returns series clearly shows that our series are non-normal, providing motivation of using the quantile framework. In this section, we will present the estimation results from the varying-coefficient quantile depicting how the impact of Bitcoin price return on crude oil futures price return can be governed by the COVID-19 pandemic under different quantile levels. Through this, we are able to uncover whether Bitcoin is a hedge, a diversifier, and/or a safe haven for crude oil futures in different market states and degrees of the pandemic intensity.

3.1. Varying-coefficient quantile estimates

The empirical results from the varying-coefficient quantile estimation show that as the growth rate of infected cases of the COVID-19 pandemic is increasing, there is a decreasing trend for the impact of Bitcoin prices on crude oil prices in market turmoil represented by different quantile levels \( \tau = 0.05, \tau = 0.1, \tau = 0.25, \text{and} \tau = 0.5 \) (Right panels of Fig. 2). Specifically, at low quantiles of oil prices \( \tau = 0.05, \tau = 0.1, \text{and} \tau = 0.25 \), the impact coefficient of Bitcoin prices on oil prices is shown to be increasingly negative and significant with increases in growth rates of infected cases of the pandemic. In particular, the slope of impact coefficient at 5th quantile level is steeper than the slopes at other quantile levels. These indicate a safe haven role of Bitcoin against adverse movements of oil prices, while the role becomes increasingly stronger when the severity of the pandemic intensifies, especially under the oil price crash conditions. Moreover, the coefficient of Bitcoin is shown to be insignificant during normal oil market conditions represented by 50% quantile of oil prices, indicating weak hedging abilities of Bitcoin.

In parallel, the role of gold is shown to be different compared with that of Bitcoin in different market conditions and degrees of


Research in International Business and Finance 62 (2022) 101672

10

Fig. 4. Robust analysis: The estimation results for the impacts of Bitcoin price return on Brent crude oil futures price returns. Note: sub-figures on the right panel show the impact of Bitcoin price return on Brent crude oil price return at 0.05%, 0.1%, 0.25%, and 0.5% quantiles of oil price return. Sub-figures on the left panel show the varying constant at the corresponding quantiles.

severity of the pandemic. As shown in Fig. 3 (Right panels), during the oil market turmoil, i.e. 5%, 10%, and 25% quantiles of oil prices, there is an increasingly positive and significant impact of gold prices on oil prices, leading to differential roles of gold. Moreover, the relation between gold and oil at 5th quantile level is stronger and more significant than at other quantile levels. Specifically, gold provides diversification benefits for the portfolio built with oil assets when the impact coefficient is less than one; then such benefits is dissipating when the severity of the pandemic continuously levels up. When the growth rate of the infected cases is at relatively low levels, the relation between gold and oil is insignificant, indicating a weak safe haven role of gold against oil-related uncertainties. In addition, similar as in the case of Bitcoin, the coefficient of gold is insignificant on average in normal oil market periods. Thus, our findings extend the existing literature by quantifying how intensification of the COVID-19 pandemic alters the role of both Bitcoin and gold against oil-related uncertainties.

3.2. Contextualization of results

How is our research linked to extant relevant literature? While existing research regarding the role of Bitcoin and gold against financial market downturn is ongoing, surprisingly little focuses on the oil market. Empirical findings regarding their roles against oil-related uncertainties in the severe financial turmoil associated with the ongoing COVID-19 pandemic is even more scant, while results drawn by the currently limited ones still remain inconsistent. Specifically, Ciner et al. (2013) suggest an effective safe haven role of gold against traditional financial assets such as stock and bond, while it possesses no risk mitigation for the oil portfolio. In contrast, Reboredo (2013b) point out that gold behaves as a safe haven for oil-related uncertainties, but it demonstrates no hedging abilities in the oil market on average. In terms of Bitcoin, Bouri et al. (2017) study the hedging ability of Bitcoin for the global uncertainty in both emerging and industrialized economies, and this is aligned with the existing literature (Demir et al., 2018; Wu et al., 2019). However, many studies also report empirical evidence that questions the sheltering role of Bitcoin. Bouri et al. (2017c) find that Bitcoin no longer exhibits hedging and safe haven abilities after the price crash on December 2013; instead, it only possesses weak diversification gains against non-energy commodity price movements thereafter.

When comparing the sheltering role between Bitcoin and gold, Klein (2017) show that Bitcoin behaves no safe haven roles against the downward period, while gold plays a significant role instead with an important feature of ‘flight-to-quality’ in the market stress. Selmi et al. (2018) highlight that both Bitcoin and gold can act as hedge, safe haven, and/or diversifier for oil price fluctuations, depending on different oil market conditions. Das et al. (2020) note that Bitcoin has no sheltering abilities like gold and US dollar to hedge against adverse movements in oil market. In the context of the COVID-19 pandemic, Dutta et al. (2020) suggest the safe haven ability of gold for adverse oil price movements, while Bitcoin only demonstrates diversification benefits. Ji et al. (2020) find that, during the pandemic, the safe haven role of Bitcoin is weakened, while such the role of gold still keeps effective.

Overall, we provide empirical evidence that Bitcoin and gold exhibit distant patterns regarding the sheltering role for oil-related assets, both of which dynamics are governed by the intensity degree of the pandemic. Intuitively, it can be seen from Fig. 2 that Bitcoin behaves as a weak hedging role against oil-related assets, and then as a safe haven depicting a significant negative relationship with the oil market dynamics. Its safe haven role becomes increasingly strong when the COVID-19 pandemic intensifies, and this can be demonstrated by a quasi-monotonic decrease in the degree of the relationship with increases in the pandemic intensity. However, gold only contributes to diversification gains for the oil-related portfolio, while the gains dissipate until growth of the pandemic intensity continuously increases to a level, above which the corresponding gold-oil price relationship is significantly greater than one. As a clear illustration as shown in Fig. 3, the market relationship between gold and oil demonstrates a quasi-monotonic increase with increases in the pandemic intensity. Our paper adds to the existing research by examining the dynamic role of Bitcoin and gold as a hedge, safe haven, and/or diversifier against adverse oil price fluctuations with variations in the pandemic intensity. At the same time, the asymmetry and non-linearity of the market relationship between oil and Bitcoin/gold over different oil market conditions can be further uncovered through our employed quantile research framework.

3.3. Robustness checks

3.3.1. Alternative estimation strategy

How sensitive are our results to the model specification? To answer this question, we apply the tradition quantile regression to respectively investigate the impact of Bitcoin and gold prices on crude oil prices under different oil price quantiles. Tables 2 and 3 show the quantile regression estimation for the impacts of Bitcoin and Gold, respectively. The traditional quantile estimates are consistent with the ones obtained using varying-coefficient quantiles estimates, while the traditional method fails to capture potential variations of the impact coefficient of Bitcoin and gold in different intensity degrees of the COVID-19 pandemic.

3.3.2. Replacement of the oil benchmark

Would our findings be altered by replacing the oil market? To examine this argument, we replace the WTI using the Brent crude oil market and re-estimate the varying-coefficient quantile model. Estimated coefficients of Bitcoin and gold prices on Brent oil prices are presented in Figs. 4 and 5 (Right panels), respectively. Intuitively, during extremely adverse periods of the oil market, the dynamic
pattern of the coefficient of Bitcoin prices on Brent oil prices is highly similar to that on WTI oil prices, i.e. a monotonic decline with intensification of the COVID-19 pandemic. Moreover, the impact coefficient of gold experiences a monotonic rise with increases in growth rates of infected cases of the pandemic in low tails of the Brent oil market, i.e. 1%, 5%, and 25% price quantiles. In addition, in normal oil market periods, the coefficients of both Bitcoin and gold prices on average are insignificant. Overall, above results reassure the robustness of our main findings.

4. Conclusions

The financial turmoil associated with the ongoing COVID-19 pandemic offers a critical test-bed for the sheltering role of Bitcoin against global oil-related uncertainties, while there is still a lack of research in this regard. Moreover, far little attention evaluates if the COVID-19 pandemic governs the relationship between Bitcoin and oil prices; more importantly, to what extent the role of Bitcoin evolves with variations in market conditions and the pandemic intensity degree. This paper extend the literature by examining the asymmetric and nonlinear relationship of Bitcoin and oil prices over the whole data distribution, and studying evolution of the relationship varying with intensification of the pandemic. Through this, dynamics of the sheltering role of Bitcoin and gold against adverse movements of oil prices, conditionally upon different market conditions and the pandemic intensity are respectively investigated.

Our empirical analysis is conducted by using a daily dataset between 23 January to August 2020 through a varying-coefficient quantile method. Overall, Bitcoin is found to play a safe haven role for oil-related portfolios, while gold could only provide weak diversification gains instead. Specifically, we find that the Bitcoin - oil price relationship demonstrates a gradual drop with increases in intensity degrees of the COVID-19 pandemic. It indicates that Bitcoin performs as an increasingly enhanced safe haven role for oil market crash with rises in the pandemic severity. In contrast, gold does not possess risk mitigation abilities during the oil market downturn; instead, its impact coefficient on oil prices behaves as a monotonic rise with increasing intensity of the pandemic. This demonstrates that gold can act as a gradually-weakened diversifier until the pandemic intensity increases to a level, above which the coefficient of gold on oil prices is significantly greater than one. Since then, gold would no longer be a diversifier, and would even amplify the oil portfolio risk if the pandemic intensity keeps increasing. It is worth noting that during normal periods, impacts of Bitcoin and gold prices on oil prices on average remain insignificant, indicating a similar ability of both as a weak hedge for oil-related assets. A battery of additional analysis reassures the robustness of our findings.

Our findings possess practical implications regarding the choice of effective shelter during the oil market stress. We find that the sheltering role of Bitcoin and gold against adverse price changes in the oil asset varies with fluctuations in the pandemic severity and market conditions. This indicates that market investors should exploit such information on the dynamic and asymmetric relationship between potential sheltering assets (i.e., Bitcoin and gold in our case) and traditional financial products for the selection of an effective investment shelter in different conditions. Moreover, our results in favor of a more consistent sheltering role of Bitcoin against that of gold provide the investors with useful insights on hedging against risks of their portfolios. At the same time, the relatively stable sheltering role of Bitcoin in the post-pandemic era would refresh policymakers’ comprehension of the function of Bitcoin in the field of digital finance, contributing to financial stability and healthy operations of the economy.

CRediT authorship contribution statement

Xiaohang Ren: Conceptualization, Methodology, Software, Writing – original draft, Writing – review & editing. Rui Wang: Data curation, Writing – review & editing. Kun Duan: Conceptualization, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. Jinyu Chen: Writing – review & editing.

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