On the hedge and safe haven properties of Bitcoin: Is it really more than a diversifier?

Forthcoming in Finance Research Letters

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Abstract

This paper uses a dynamic conditional correlation model to examine whether Bitcoin can act as a hedge and safe haven for major world stock indices, bonds, oil, gold, the general commodity index and the US dollar index. Daily and weekly data span from July 2011 to December 2015. Overall, the empirical results indicate that Bitcoin is a poor hedge and is suitable for diversification purposes only. However, Bitcoin can only serve as a strong safe haven against weekly extreme down movements in Asian stocks. We also show that Bitcoin hedging and safe haven properties vary between horizons.

Keywords: Bitcoin, cryptocurrency, diversifier, hedge; safe haven, DCC.

JEL codes: G11, G15, Q02.

1. Introduction

Bitcoin is a digital currency and payment system first introduced by Nakamoto (2008. It is fully decentralized and depends on a sophisticated protocol. In this sense, the most unique feature of Bitcoin is that there is no central authority guaranteeing it or having control over it, as central banks are for conventional currencies. Another unique feature is the fact that the supply of Bitcoin is limited by the design of the protocol. The principles of Bitcoin are explained by Dwyer (2015) and at bitcoin.org.

Since its introduction in 2009, the value of Bitcoin grew rapidly to more than US$6 billion at the end of 2015 (coinmarketcap.com). In parallel, there has been a growing interest in research addressing the economics and finance of Bitcoin. Rogojanu and Badea (2014) compare Bitcoin to alternative monetary systems. Brandvold et al. (2015) and Ciaian et al. (2016) focus on price discovery in the Bitcoin market. Bouri et al. (2016) concentrate on the role of trading volume in explaining Bitcoin return and volatility. Balcilar et al. (2016) model the persistence in the volatility of Bitcoin returns. Yermack (2013) argues that Bitcoin appears to behave more like a speculative investment than a currency because its market capitalization is high compared to the economic transactions it facilitates. Although Bitcoin is highly volatile (Molnár et al., 2015), its inclusion into a diversified portfolio is highly profitable (see, among others, Halaburda and Gandal, 2014; Eisl et al., 2015). Bitcoin is an alternative to mainstream currencies and is often even considered as a part of an alternative economy. If some investors lose trust to mainstream currencies or to the entire economy, they might resort to Bitcoin. This is one of the reasons why Bitcoin has sometimes been called digital gold (Popper, 2015). Interestingly, Dyhrberg (2015a) situates the hedging capability of Bitcoin somewhere between gold and the US dollar, later arguing (2015b) that Bitcoin is a

hedge against UK equities and the US dollar. However, prior research has so far ignored the potential role of Bitcoin as a safe haven and has failed to differentiate among its diversification, hedging and safe haven properties. This paper addresses this literature gap by assessing to what extent Bitcoin can act as a diversifier, hedge and safe haven against movements in the prices of various assets (stock indices, bonds, oil, gold, the general commodity index and the US dollar index).

An asset might be suitable for investment from a risk perspective. If the asset is negatively correlated with another asset, putting them together decreases risk significantly. However, we follow Baur and Lucey (2010) and Ratner and Chiu (2013) and differentiate between a diversifier, a hedge and a safe haven. A diversifier is an asset that has a weak positive correlation with another asset on average. A weak (strong) hedge is an asset that is uncorrelated (negatively correlated) with another asset *on average*. A weak (strong) safe haven is an asset that is uncorrelated (negatively correlated) with another asset on average during times of stress. As gold has been traditionally considered a hedge and a safe haven, these concepts have previously been applied mostly to gold (Baur and Lucey, 2010). Also, they were recently applied to credit default swaps (Ratner and Chiu, 2013).

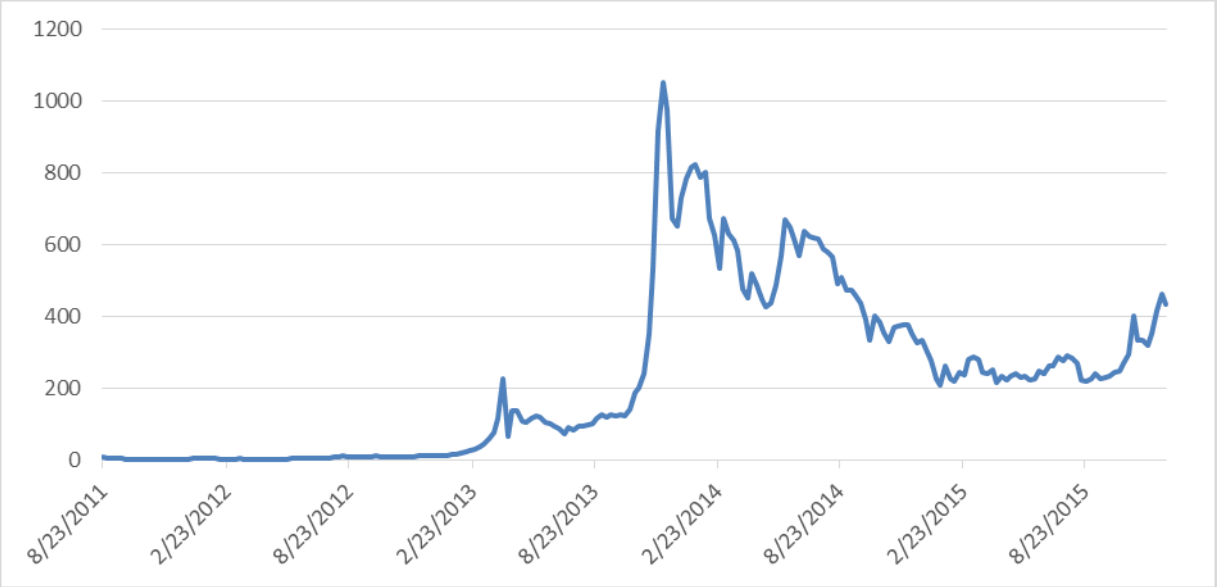
With a more explicit modeling technique, which is based on the dynamic conditional correlation (DCC) model of Engle (2002), our findings are complementary to those presented by Dyhrberg (2015a, 2015b). Particularly, we provide evidence that Bitcoin is an effective diversifier against movements in all the assets under study, whereas it is a safe haven in just few cases. These interesting findings would be helpful for policy makers, investors and Bitcoin users.

The rest of the paper is organized as follows. Section 2 describes the data, section 3 explains the method, section 4 presents the results and section 5 concludes.

2. Data and preliminary analysis

The dataset we investigate consists of price index values for Bitcoin and several financial assets, which include stocks, bonds, currencies and commodities from 18th July 2011 to 22nd December 2015. The timespan is constrained by the availability of Bitcoin prices. We use daily and weekly prices obtained from Thomson Reuters DataStream. For each time series, we have 1,133 daily observations and 226 weekly observations. The proxy for Bitcoin prices is the exchange rate of Bitcoin to US dollars from the Bitstamp marketplace (Brandvold et al., 2015). Bitstamp, which represents one of the largest Bitcoin exchanges, is based in the UK and is considered to be a rather safe exchange by market participants around the world. The historical Bitcoin price is plotted in Figure 1.

Figure 1. Evolution of the Bitcoin price in US dollars



The stock market indices for the US, the UK, Germany, Japan and China respectively are the S&P 500, FTSE 100, DAX 30, Nikkei 225 and Shanghai A-share. As a proxy for world, European and Asia Pacific stocks, we use three regional and international benchmarks from Morgan Stanley Capital International (MSCI) indices. The US dollar index, which tracks the performance of the US dollar against a basket of major foreign currencies, is used as a proxy for the currency market. The proxies for the commodity market and the overall bond market respectively are Standard & Poor's Goldman Sachs (SPGS) Commodity Index and the Pimco Investment Grade Corporate Bond Index Exchange-Traded Fund (ETF). We also consider Brent Crude oil and gold spot prices. For each price index, we calculate return as the first difference of the logarithm of closing prices. Table 1 shows summary statistics of the return series for the examined variables. As shown in Panel A of Table 1, Bitcoin has by far the highest levels of daily mean and volatility. All the return series are found to be leptokurtic and have a negative skewness. As for the summary statistics of weekly returns, Panel B of Table 1 shows that the kurtosis of some assets (bond, ETF and gold) is significantly decreased but the kurtosis of Bitcoin remains high.

Table 1. Summary statistics

	Mean (%)	Maximum	Minimum	Std. Dev. (%)	Skewness	Kurtosis
Panel A: Daily returns						
Bitcoin	0.35	0.48	-0.66	6.80	-1.14	23.06
S&P 500	0.05	0.04	-0.04	0.90	-0.18	5.43
FTSE 100	0.02	0.04	-0.05	0.90	-0.16	5.59
DAX 30	0.06	0.05	-0.05	1.30	-0.03	4.84
Nikkei 225	0.07	0.07	-0.08	1.30	-0.32	5.94
Shanghai A-share	0.03	0.06	-0.09	1.50	-0.91	9.28
MSCI World	0.03	0.04	-0.04	0.80	-0.26	6.64
MSCI Europe	0.02	0.06	-0.06	1.20	-0.11	6.28
MSCI Pacific	0.01	0.05	-0.05	1.00	-0.28	4.83
Bond index	0.00	0.01	-0.04	0.30	-1.87	23.18
US dollar index	0.02	0.02	-0.02	0.50	-0.04	4.93
Commodity index	-0.08	0.05	-0.07	1.10	-0.16	6.39
Oil	-0.10	0.10	-0.09	1.60	0.17	7.37
Gold	-0.05	0.05	-0.10	1.10	-1.04	11.90
Panel B: Weekly returns						
Bitcoin	2.41	0.70	-1.21	16.00	-1.20	21.20
S&P 500	0.23	0.05	-0.12	1.90	-1.26	9.16
FTSE 100	0.05	0.07	-0.07	2.00	-0.16	3.99
DAX 30	0.27	0.08	-0.07	2.60	-0.26	3.32
Nikkei 225	0.37	0.10	-0.14	3.00	-0.58	5.68
Shanghai A-share	0.18	0.10	-0.17	3.40	-1.06	7.80
MSCI World	0.15	0.06	-0.10	1.90	-0.81	6.00
MSCI Europe	0.08	0.07	-0.07	2.40	-0.04	3.68
MSCI Pacific	0.07	0.07	-0.10	2.10	-0.70	5.26
Bond index	-0.01	0.02	-0.04	0.70	-1.11	7.61
US dollar index	0.11	0.03	-0.03	1.00	0.11	3.54
Commodity index	-0.41	0.08	-0.07	2.50	-0.07	4.22
Oil	-0.53	0.16	-0.11	3.80	0.16	5.85
Gold	-0.23	0.06	-0.13	2.20	-1.02	7.78

Notes: Bitcoin prices are represented by the exchange rate of Bitcoin to US dollar from the Bitstamp marketplace, US stocks are represented by the S&P 500 Index, UK stocks are represented by the FTSE 100 Index, German stocks are represented by the DAX 30 Index, Japanese stocks are represented by the Nikkei 225 Average, Chinese stocks are represented by the Shanghai A-share Index, international stocks are represented by the MSCI World Index, European stocks are represented by the MSCI Europe Index, Asia Pacific stocks are represented by the MSCI Pacific Index, bonds are represented by the Pimco Investment Grade Corporate Bond Exchange-Traded Fund Index, the performance of the US currency is represented by the dollar index, commodities are represented by the SPGS Commodity Index, the oil market is represented by Brent Crude oil spot prices, and the gold market is represented by the gold spot price per ounce.

3. Method

This section describes the econometric modeling procedure we use to assess the hedge and safe haven properties of Bitcoin. First, we provide the bivariate DCC model of Engle (2002), which we use to estimate the correlation between the return series. Then, we present the regression that we employ to assess the hedge and safe haven properties of Bitcoin against stocks, bonds, currency and commodities.

3.1 DCCs

Unlike other multivariate GARCH models, such as the BEKK (Baba-Engle-Kraft-Kroner) and constant conditional correlation (CCC) models, which may experience convergence problems and unreasonable parameter estimates, the DCC model of Engle (2002) has the ability to capture the time-varying and dynamic relationships across return series with fewer computational complications (Parhizgari and Cho, 2008). In this sense, the DCC model is used to parameterize the conditional correlation directly and has the flexibility of a univariate GARCH model (Engle, 2002). For the purpose of this study and given the large number of return series, the DCC model is estimated for pairs of return series separately and not for all the return series simultaneously. In doing so, a small possibility of getting biased estimates of parameters in higher dimensions will be prevented (Hafner and Reznikova, 2012).

The estimation of the bivariate DCC model is carried out in two steps. In the first step, a univariate GARCH (1,1) model is estimated. In the second, a time-varying correlation matrix is computed using the standardized residuals from the first-step estimation.
The mean equation of the DCC model is specified as:

$$r_t = \mu_t + \omega\, r_{t-1} + \varepsilon_t \tag{1}$$

where r_t is the vector of the price return of Bitcoin and that of the other asset (return is computed as the first difference of the logarithm of closing prices); μ_t is the conditional mean vector of r_t; and ε_t is a vector of residuals. The variance equation is specified as:

$$h_t = c + a\, \varepsilon^2_{t-1} + b\, h_{t-1} \tag{2}$$

where h_t is the conditional variance; c is the constant; a is the parameter that captures the short-run persistence or the ARCH effect; and b represents the long-run persistence of volatility or the GARCH effect.

The DCC (1,1) equation is given by Q_t, which is a square positive-definite matrix such as:

$$Q_t = (1 - \alpha - \beta)\overline{Q} + \alpha\, \varepsilon_{t-1}\varepsilon'_{t-1} + \beta\, Q_{t-1} \tag{3}$$

where Q_t is the time-varying unconditional correlation matrix of ε_t; ε_t is a vector of standardized residuals obtained from the first-step estimation of the GARCH (1,1) process; and α and β are parameters that represent, respectively, the effects of previous shocks and previous DCCs on the current DCC[1].
The DCC between assets i and j is calculated by:

$$\rho_{ij,t} = \frac{q_{ij,t}}{\left(\sqrt{q_{ii,t}}\sqrt{q_{jj,t}}\right)} \tag{4}$$

[1] For a detailed explanation of the GARCH DCC model and its estimation, refer to Engle (2002).

To ensure that the selected DCC model is well fitted, diagnostics tests will examine the existence of autocorrelation and heteroscedasticity in the return series. However, we do not intend to elaborate on the DCC modeling and parameter estimates but only to extract the pairwise dynamic conditional correlations, as shown in Equation 4, and this is done in order to use them for assessing the hedge and safe haven properties of Bitcoin (see Equation 5, below).

3.2 Hedge and safe haven

To assess the extent to which Bitcoin can be considered as a diversifier, a hedge or a safe haven against different financial assets, we follow the method used by Ratner and Chiu (2013). First, the dynamic conditional correlations are extracted from the DCC model into separate time series and then regressed on dummy variables (D) representing extreme movements in the lower 10th, 5th or 1st percentile of the return distribution.

$$DCC_t = m_0 + m_1 D(r_{other\ asset}\ q_{10}) + m_2 D(r_{other\ asset}\ q_5) + m_3 D(r_{other\ asset}\ q_1) + v_t \quad (5)$$

where DCC is the pairwise conditional correlation between Bitcoin and each of the other assets under study; $r_{other\ asset}$ is the return of each of the other assets; and v_t is the error term. Bitcoin is a diversifier against movements in the other asset if (m_0) is significantly positive. Bitcoin is a weak hedge against movements in the other asset if (m_0) is zero, or it is a strong hedge if (m_0) is negative. Bitcoin is a weak safe haven against movements in the other asset if the m_1, m_2 and m_3 coefficients are not significantly different from zero, or it is a strong safe haven if these coefficients are negative.

4. Results

4.1 The DCC model

In the DCC model, an autoregressive (AR) specification of the mean Equation 1 is estimated to capture the autocorrelation of the residuals. Specification results based on the Schwarz information criteria indicated that an AR (1) model was sufficient to eliminate the substantial degree of autocorrelation in the returns. As for the optimal number of lags for the estimation of the univariate variance process, the GARCH (1,1) model was found to be the best fit. Following the same logic, a comparison of the likelihood values across alternative lag specifications implies that the DCC (1,1) is the best choice. In all cases, we estimate the DCC model with a generalized error distribution (GED) to capture fat-tail behavior. As indicated in the methodology section, we do not elaborate on the DCC results (which are not presented here but are available from the authors), as the initial purpose of DCC modeling was not to

derive estimates of Equations 1–3 but only to extract the pairwise DCCs that will be used in the below subsection to assess the hedge and safe haven properties of Bitcoin. However, diagnostics tests show that the selected model is well fitted, given that no problem of autocorrelation or heteroscedasticity remained in the return series. For all cases, most of the coefficients in the mean, variance and DCC equations are significant at the 5% significance level. In the variance equation, the sum of the ARCH and GARCH parameters is close to one, suggesting a high degree of persistence in the variance process.

4.2 Hedge and safe haven properties of Bitcoin

Following the estimation of the DCC model, the pairwise dynamic conditional correlations are extracted from Equation 4 into separate time series and then used to assess the hedge and safe haven properties of Bitcoin. For example, the series of the DCC between Bitcoin and the S&P 500 is regressed on a constant (m_0) and three dummy variables (m_1, m_2, m_3) representing extreme movements in US stocks in the negative 10th, 5th and 1st quantiles of the return distribution. Panel A of Table 2 presents the coefficient estimates from the regression model specified in Equation 5 for daily data. As for Panel B of Table 2, it presents the same estimates for weekly data. Following the definitions of a diversifier, a hedge and a safe haven, we report the following results of daily and weekly analyses.

4.2.1 Daily analysis

The results from Panel A of Table 2 show that Bitcoin cannot be regarded as a weak or strong safe haven against extreme movements in any of the assets under study; the positive and significant coefficients (m_3) for the case of Asia Pacific stocks and (m_1) for the case of oil only indicate that Bitcoin is no more than an effective diversifier, respectively, in the 1% and 10% quantiles of the return distribution. However, Bitcoin is a strong hedge against movements in Japanese and Asia Pacific stocks. This suggests a preference of Japanese and other Asia Pacific investors for Bitcoin to hedge their equity portfolios. Furthermore, statistical evidence shows that Bitcoin is a strong hedge for the commodity index, suggesting the strong ability of Bitcoin to reduce the risk associated with adverse movements in commodities. It is worth mentioning here that significant and positive coefficients on the constant term (m_0) do not indicate that Bitcoin is a weak hedge. For example, the significantly positive coefficient of 0.0083 indicates that Bitcoin is not a weak hedge against movements in the US stock market, only an effective diversifier. The diversification benefits that emerge from using Bitcoin against all the assets under study can be explained by the results reported by Ciaian et al. (2016), which show that Bitcoin price formation in the long run is unrelated to global macroeconomic and financial developments and that it is only highly sensitive to Bitcoin market forces of supply/demand and to digital-currency-specific factors, such as Bitcoin attractiveness for investors.

Table 2. Estimation results on the hedge and safe haven properties of Bitcoin

	10% quantile (m_1)	5% quantile (m_2)	1% quantile (m_3)	Hedge (m_0)
Panel A: Daily data				
S&P 500	0.0013	-0.0022	-0.0011	0.0083***
FTSE 100	-0.0005	0.0006	0.0007	0.0026***
DAX 30	-0.0024	-0.0001	0.0022	0.0316***
Nikkei 225	-0.0002	0.0008	0.0050	-0.0049***
Shanghai A-share	-0.0065	0.0339	-0.0476	0.0348***
MSCI World	0.0002	0.0031	0.0005	0.0075***
MSCI Europe	0.0002	0.0008	0.0018	0.0101***
MSCI Pacific	0.0006	0.0013	0.0079***	-0.0061***
Bond index	0.0004	0.0000	0.0004	0.0022***
US dollar index	-0.0009	-0.0003	-0.0004	0.0074***
Commodity index	0.0006	-0.0005	0.0003	-0.0242***
Oil	0.0021*	-0.0016	-0.0011	0.0116***
Gold	-0.0018	-0.0031	-0.0014	0.0434***
Panel B: Weekly data				
S&P 500	0.0009	-0.0012	-0.0060	0.0952***
FTSE 100	0.0020*	-0.0013	0.0042	0.0423***
DAX 30	0.0086	-0.0164	0.2860***	0.1092***
Nikkei 225	-0.0346	0.1297	0.1837	-0.0206
Shanghai A-share	0.0145	-0.0424**	0.0544*	-0.0549***
MSCI World	0.0022	-0.0016	-0.0067*	0.0546***
MSCI Europe	0.0219	0.0247	-0.0499	0.0961***
MSCI Pacific	-0.2104***	0.1721	0.4138	0.0069
Bond index	0.0027	0.0009	0.0078	0.0279***
US dollar index	-0.0019	0.0830	-0.0838	0.1016***
Commodity index	0.0206	0.1432	-0.1673	0.1639***
Oil	-0.0493*	0.0752*	0.1407**	0.0992***
Gold	-0.0579	0.0851	0.0173	0.0719***

Notes: This table presents the estimation results from Equation 5; ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

4.2.2 Weekly analysis

The results from Panel B of Table 2 show that Bitcoin is a strong hedge only against movements in Chinese stocks, given that the coefficient of -0.0549 on (m_0) is significantly negative. For market participants, this result indicates that Bitcoin's hedging capabilities are very fruitful in China. Furthermore, significantly positive coefficients on (m_0) only indicate that Bitcoin can act as an effective diversifier against the remaining indices under study, except for the case of Japanese and Asia Pacific stocks. Regarding the safe haven role of Bitcoin, statistical evidence at the 5% level clearly indicates that Bitcoin can be regarded as a strong safe haven against extreme movements in Chinese stocks (in the 5% quantile) and

Asia Pacific stocks (in the 10% quantile)[2]. This finding implies that during times of crisis in the Chinese and other Asia Pacific stock markets, investors seem to put money into Bitcoin. The preference of investors for Bitcoin can be explained by the fact that, unlike conventional currencies, Bitcoin is fully decentralized and independent of any central authorities; if the financial system is not working well or is under threat, investors seek refuge in Bitcoin, which is independent from the financial system and its underlying technology. According to Ciaian et al. (2016), Bitcoin also has an investment attractiveness that is reflected in its increasing acceptance and trust; furthermore, the decreasing transaction costs and uncertainty for investors increase investment demand for Bitcoin.

A simple comparison between daily and weekly results shows that the frequency matters to investors in the Bitcoin market, as the hedging and safe haven properties of Bitcoin differed across time horizons. In fact, the hedging property of Bitcoin against the commodity index, as shown with daily data, vanishes with weekly data. Furthermore, the hedging role of Bitcoin for Japanese stocks in daily data fades when we use weekly data. In contrast, the daily hedging role of Bitcoin for Asia Pacific stocks has progressed to become a safe haven role with weekly data. Similarly, and against weekly changes in Chinese stocks, Bitcoin has gained both hedging and safe haven properties that were not present with daily data. These findings show significant differences in the use of Bitcoin by investors against down movements in Japanese and Chinese stocks between the two data frequencies. Overall, it could be that the daily price fluctuations of Bitcoin and its speculative nature (Yermack, 2013) seem to undermine Bitcoin's *daily* safe haven property to the detriment of its *weekly* safe haven property. Another plausible explanation for why the properties of Bitcoin vary with horizons is in part because hedge and safe haven returns at different horizons are driven by very different factors. This explanation can be drawn from Ciaian et al. (2016), who show that Bitcoin price in the long run is affected by a different set of variables compared to that in the short run.

5. Conclusions

Despite the growing interest in Bitcoin as a digital asset, the current economics and finance literature is still lacking empirical evidence on its diversification, hedging and safe haven properties against other assets, in particular against major world equities, bonds, oil, gold, the general commodity index and the US dollar index. Using daily and weekly data within a DCC model (Engle, 2002), our main overall results show that Bitcoin can serve as an effective diversifier for most of the cases. Furthermore, in just a few cases, Bitcoin has hedge and safe haven properties that differed between horizons.

[2] To control for exchange rate fluctuations and to ensure that our results are not biased, we consider Bitcoin prices denominated in four different currencies (pound-denominated Bitcoin price for the FTSE 100, euro-denominated Bitcoin price for the DAX 30, yuan-denominated Bitcoin price for the Chinese Shanghai A-share and yen-denominated Bitcoin price for the Nikkei 225). Estimation results, which are not reported here but are available from the authors, show that they are qualitatively the same as in the base estimation, in both daily and weekly data.

Despite the importance of our empirical results to market participants, a word of caution is warranted regarding the liquidity of Bitcoin. First, Bitcoin investments are far less liquid than conventional assets, and their accessibility to individual investors can improve a lot with the potential emergence of related funds and financial derivatives. Second, the agitated nature of the sample period under study, during which Bitcoin prices experienced high volatility, may imply that the diversification ability of Bitcoin is not constant over time. This opens the door for further studies on the time-varying nature of the diversifier, hedge and safe haven properties of Bitcoin.

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