

Cryptocurrencies, Correlations, and COVID-19: Diversifiers, Hedge, or Safe Haven?

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ABSTRACT

The objective of this study is to examine whether Bitcoin and the aggregate cryptocurrency market acts as a diversifier, hedge, or safe haven to U.S. stocks, bonds, the U.S. Dollar, commodities, real estate, and gold. Using daily price data over the period January 2015 to July 2020, including the COVID-19 market crash, we estimate the Dynamic Conditional Correlation (DCC) to model time-varying, dynamic relationships across the asset return series. We find that Bitcoin acts primarily as a diversifier to other assets, a strong hedge to the aggregate cryptocurrency market, and is neither a strong nor weak safe haven. We also find that the cryptocurrency market is primarily a strong hedge to other assets. The findings of this study provide investors empirical results regarding the relationships between Bitcoin and the cryptocurrency market with that of other assets and their potential role within a portfolio. These findings have important implications for investors making asset allocation decisions.

Keywords: Bitcoin; Cryptocurrency; Diversifier; Hedge.

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1. INTRODUCTION

When Baur and Lucey (2010) investigated whether gold may serve as a hedge or safe haven for stocks and bonds in average and extreme market conditions, Bitcoin was just a few years introduced to financial markets (Bouri *et al.*, 2017; Nakamoto, 2008). Since that time Bitcoin and cryptocurrencies have gained increasing attention. At the end of 2015, Bitcoin's market capitalization exceeded \$6 billion USD. As of May 2021, Bitcoin's value exceeds \$1 trillion USD and cryptocurrencies are worth a collective \$2.44 trillion USD (coinmarketcap.com). Cryptocurrencies' dramatic volatility and impressive growth rates have gained scholarly interest from the perspectives of finance and economics (Bouri *et al.*, 2017).

A growing number of scholars have focused their attention on investigating the diversifier, hedge, and safe haven properties of Bitcoin and cryptocurrencies (Bouri *et al.*, 2017; Dyhrberg, 2019; Feng *et al.*, 2018; Kliber *et al.*, 2019; Pengfei *et al.*, 2019; Smales, 2019). Researchers suggest that Bitcoin's weak correlation with more traditional assets makes it an effective tool for portfolio diversification (Baur *et al.*, 2018; Brière *et al.*, 2015; Dyhrberg, 2016; Shahzad *et al.*, 2020). However, little is known about the dynamic

correlations between Bitcoin or the aggregate cryptocurrency market with that of other traditional assets as cryptocurrencies are still in their infancy.

This paper extends Baur and Lucey's (2010) seminal econometric framework by exploring the diversification, hedging, and safe haven properties of Bitcoin and the aggregate cryptocurrency market with commonly held assets in investor portfolios. This paper makes several contributions to the literature. Our results show that Bitcoin serves primarily as a diversifier for investment portfolios and surprisingly is a strong hedge for the aggregate cryptocurrency market, as well as with commodities. Our findings also indicate that the aggregate cryptocurrency market does not qualify as a safe haven in times of extreme volatility, however, can serve as a strong hedge for investors.

The remainder of this paper is organized as follows: Section 2 presents the data and preliminary analysis. Section 3 presents the econometric methodology. Section 4 presents the empirical results. Section 5 provides conclusions, implications, and suggestions for future research.

2. DATA AND PRELIMINARY ANALYSIS

The dataset for this analysis consists of daily price values for Bitcoin, the aggregate cryptocurrency market, U.S. stocks, bonds, the U.S. dollar, commodities, real estate, and gold from January 2, 2015 to July 31, 2020. The time series is constrained to only the dates all asset prices are available, totaling 1,405 observations. When appropriate we use the adjusted closing price. As this study takes the perspective of U.S. investors, the data are expressed in U.S. dollars. Bitcoin data was obtained from CoinMarketCap.com, which aggregates Bitcoin prices across various crypto exchanges. Several studies have drawn their cryptocurrency data from this source as it is considered reliable (Bouri *et al.*, 2017; Feng *et al.*, 2018; Hayes, 2017; Segendorf, 2014). As a proxy for the aggregate cryptocurrency market, we use the "CCi30 Index," an exponentially weighted moving average index designed to track the 30 largest cryptocurrencies by market capitalization, including Bitcoin and excluding stable coins. The CCi30 index statistically represents the aggregate cryptocurrency market at a confidence level of 99% and with a margin of error value of just 1%. The CCi30 is designed to objectively measure the overall growth and movement of the blockchain sector and serves as a passive industry benchmark index for investment managers.

Our proxy for U.S. stocks was the S&P 500 while bonds were represented by the Vanguard Total Bond Market Index Fund (BND), which tracks a benchmark of U.S. government, corporate and other U.S. dollar-denominated fixed income securities. The U.S. dollar index (DXY), which tracks the strength or weakness of the dollar against a basket of foreign currencies, was used as a proxy for domestic currency. Commodities were proxied through the S&P Goldman Sachs Commodity Index (SPGSCI), which benchmarks the performance of the aggregate commodities market including oil and energy, industrial materials, and agricultural commodities. The real estate market was proxied via the Vanguard Real Estate Index Fund (VNQ), which tracks a benchmark of publicly traded U.S. REITs. Finally, the proxy for gold was the U.S. dollar gold spot price. The non-crypto datasets were gathered from a combination of Nasdaq.com, Investing.com, and Yahoo! Finance.

For each asset in our study, we calculate the logarithm daily returns by taking the natural

log of the current period's price divided by the previous period's price. Table 1 presents descriptive statistics for the asset returns under investigation. "Total Return" represents the total holding period return from January 2, 2015 to July 31, 2020. Bitcoin and the aggregate cryptocurrency market produce impressive returns compared to the other assets investigated.

Cryptocurrencies likewise possess the highest daily mean and volatility. Only gold possesses a positive skew while only the U.S. dollar index is leptokurtic during the period studied.

Table 1
Descriptive Statistics

Measure	Bitcoin	CC130	S&P 500	Bond Index	U.S. Dollar Index	Commodity Index	Real Estate	Gold
Total Return	3,526%	4,476%	59%	26%	3%	-18%	24%	66%
Mean %	0.002	0.002	0.0003	0.0001	0.00001	-0.0001	0.0001	0.00003
Std. Dev. %	0.043	0.043	0.012	0.003	0.004	0.271	0.014	0.008
Skewness	-1.118	-1.398	-1.057	-2.986	-0.007	-0.006	-2.368	0.131
Kurtosis	14.356	14.778	21.892	107.385	1.903	697.323	36.096	2.925
Min. %	-0.465	-0.484	-0.128	-0.056	-0.024	-7.166	-0.195	-0.036
Max. %	0.225	0.17	0.09	0.041	0.02	7.164	0.086	0.047

Table 2 presents pairwise correlations for the assets under investigation during the holding period January 2, 2015 to July 31, 2020. Bitcoin shares several significant relationships with other assets such as stocks, bonds, real estate, and gold. Surprisingly, the aggregate cryptocurrency market has no significant relationship with other assets.

3. ECONOMETRIC METHODOLOGY

The study of dynamic correlations between Bitcoin and the aggregate cryptocurrency market with that of traditional assets is still in its infancy and therefore is the focus of this study. Engle's (2002) Dynamic Conditional Correlation (DCC) is the preferred method for modeling the time-varying and dynamic relationships across asset return series as it affords analysis of source-target pairs, allowing each pair's parameters to vary and be shaped by the data (Cho and Parhizgari, 2009). In this study we use Engle's (2002) DCC method to estimate the diversifying, hedge, or safe haven properties of Bitcoin and the aggregate cryptocurrency market in relation to commonly held portfolio asset classes.

Following previous scholars (Baur and Lucey, 2010; Bouri *et al.*, 2017), we distinguish a safe haven, hedge, and diversifying asset with these definitions:

Diversifier – An asset that has a weak positive correlation with another asset *on average*.

Hedge – A weak (strong) hedge is an asset that is uncorrelated (negatively correlated) with another asset *on average*.

Safe Haven – A weak (strong) safe haven is an asset that is uncorrelated (negatively correlated) with another asset on average during times of stress.

To evaluate Bitcoin and the aggregate cryptocurrency markets' safe haven, hedge, or diversifying properties we first split our data into a train and test set consisting of 1,355 train observations and 50 test observations. This strengthens our models by being trained and tested with observations occurring during and after the COVID-19 market event.

Table 2
Pearson's Correlations

Asset/Market/Class	Asset/Market/Class Correlation Tested	<i>r</i>	<i>p</i>
Bitcoin	– CCI30	-0.041	0.124
Bitcoin	– S&P 500	0.152 ***	< .001
Bitcoin	– Bond Index	0.167 ***	< .001
Bitcoin	– US Dollar Index	-0.012	0.654
Bitcoin	– Commodity Index	0.022	0.406
Bitcoin	– Real Estate	0.115 ***	< .001
Bitcoin	– Gold	0.099 ***	< .001
CCI30	– S&P 500	-0.030	0.266
CCI30	– Bond Index	-0.017	0.533
CCI30	– US Dollar Index	0.012	0.665
CCI30	– Commodity Index	0.022	0.420
CCI30	– Real Estate	-0.032	0.232
CCI30	– Gold	0.002	0.949
S&P 500	– Bond Index	0.030	0.257
S&P 500	– US Dollar Index	0.039	0.145
S&P 500	– Commodity Index	-0.006	0.813
S&P 500	– Real Estate	0.760 ***	< .001
S&P 500	– Gold	-0.059 *	0.026
Bond Index	– US Dollar Index	-0.181 ***	< .001
Bond Index	– Commodity Index	0.021	0.428
Bond Index	– Real Estate	0.219 ***	< .001
Bond Index	– Gold	0.358 ***	< .001
US Dollar Index	– Commodity Index	-0.014	0.607
US Dollar Index	– Real Estate	-0.035	0.194
US Dollar Index	– Gold	-0.409 ***	< .001
Commodity Index	– Real Estate	0.007	0.804
Commodity Index	– Gold	0.013	0.624
Real Estate	– Gold	0.078 **	0.003

* $p < .05$, ** $p < .01$, *** $p < .001$

Second, we built a univariate GARCH 1, 1 model for each of the assets of the study. On the basis of our models, we calculate the mean equation as:

$$r_t = u_t + \omega r_{t-1} + \varepsilon_t \quad (1)$$

where r_t represents the price return of a given asset, u_t represents the conditional mean of r_t and ε_t represents the residuals. Additionally, we calculate the dispersion predictions for each asset using the following variance equation:

$$h_t = c + \alpha \varepsilon_{t-1}^2 + b h_{t-1} \quad (2)$$

where h_t represents the conditional variance, c represents the GARCH constant, α represents the parameter that captures the short-run persistence of the ARCH effect, and b represents the long-run persistence of the GARCH effect.

The DCC (1, 1) equation is calculated as:

$$Q_t = (1 - \alpha - \beta) \underline{Q} + \alpha \varepsilon_{t-1} \varepsilon_{t-1}' + \beta Q_{t-1} \quad (3)$$

where Q_t represents the time-varying unconditional correlation matrix of the standardized residuals from the GARCH 1, 1 process, denoted as ε_t , α represents the parameters of the effects of previous shocks, and β represents previous dynamic conditional correlations on the current DCC. When calculating our dynamic correlation matrices, we use a rolling 200-observation period that accounts for the COVID-19 market event.

The pairwise DCC between asset i and asset j is calculated as:

$$\rho_{i,j,t} = \frac{q_{i,j,t}}{\sqrt{q_{i,j,t} q_{j,j,t}}} \quad (4)$$

These pairwise dynamic conditional correlations calculated in equation 4 are then extracted into a separate time series and regressed on dummy variables (D) representing extreme downward movements in the lower 10th, 5th, and 1st percentile of a Gaussian return distribution. This procedure is performed to determine our cryptocurrencies' potential safe haven, hedge, and diversifying properties. This regression model is specified as:

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

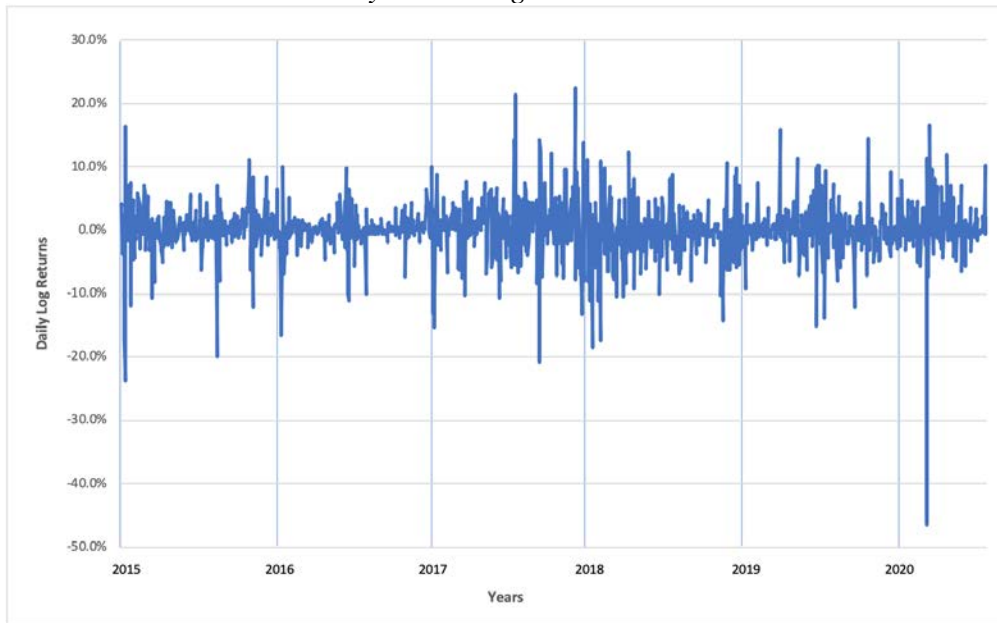
where DCC represents the pairwise conditional correlation between Bitcoin or the CCI30 Index with that of another asset, $r_{other\ asset}$ represents the return of each other asset, and v_t is the error term.

Bitcoin and the CCI30 Index are a diversifier against movements in the other asset if m_0 is significant and positive. Bitcoin and the CCI30 Index are a weak hedge against movements in the other asset if m_0 is zero, or a strong hedge if m_0 is negative. Bitcoin and the CCI30 Index are a weak safe haven against movements in the other asset if m_1 , m_2 , and m_3 are not significantly different from zero, or a strong safe haven if these coefficients are negative.

4. EMPIRICAL RESULTS

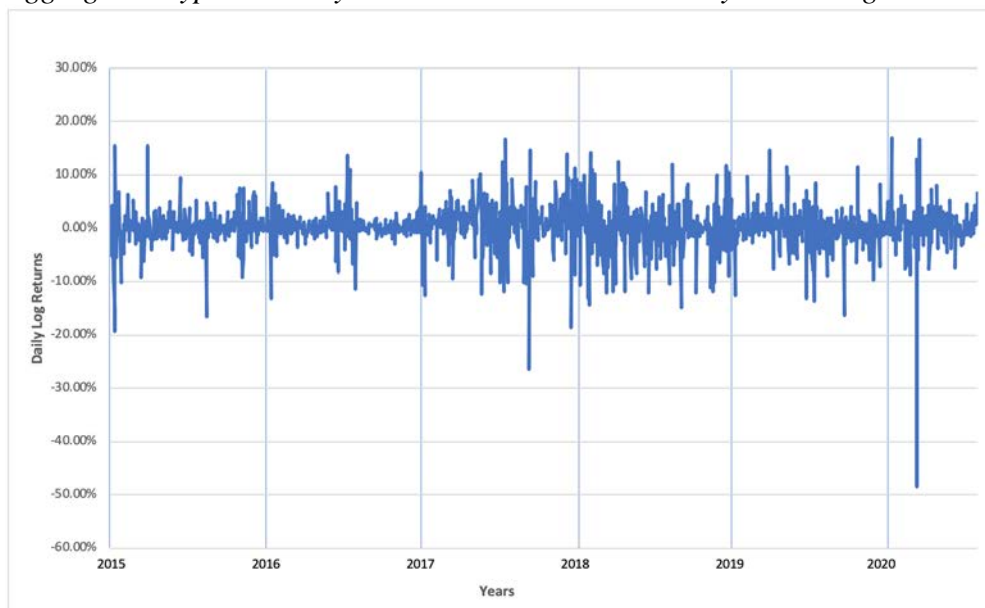
The purpose of our Dynamic Conditional Correlation modeling is to extract the pairwise DCC between Bitcoin and the CCI30 Index with that of other assets in order to assess their hedge, safe haven, and diversifying properties. As a result, we do not report the GARCH or DCC results. However, we do provide a diagnostic summary that supports our DCC models.

Figure 1
Bitcoin Time Series Volatility Clustering



Note. This figure demonstrates bitcoin's volatility clustering using its daily log returns during the time series examined. The left axis represents daily log returns while the bottom axis represents years.

Figure 2
Aggregate Cryptocurrency Market Time Series Volatility Clustering



Note. This figure demonstrates CCI30 cryptocurrency volatility clustering using daily log returns during the time series examined. The left axis represents daily log returns while the bottom axis represents years.

4.1 Diagnostic Summary

Figure 1 graphs the trend of the Bitcoin time series, demonstrating volatility clustering, while Figure 2 graphs the trend of the aggregate cryptocurrency market proxy (CCi30 Index) time series, similarly demonstrating volatility clustering. The graphs provide

evidence that time-varying models are appropriate. The largest one-day drop for Bitcoin (-46%) occurs during the COVID-19 market decline. The largest one-day drop for the aggregate cryptocurrency market was -48.4%, which occurred during the same period.

The heteroskedasticity test shows the presence of ARCH effects, statistically significant at the 1% level. Hence, the estimation of an ARCH model was used. In all GARCH models, the coefficients of the conditional variance specification met the stability conditions, clearly establishing the presence of time-varying conditional volatility for the assets of study. These results also indicate the persistence of volatility shocks as represented by the sum of the ARCH and GARCH parameters being close to one. Additional diagnostics determined GARCH 1, 1, and DCC 1,1, models provide the best fit.

In the following two subsections, we discuss the diversifying, hedging, or safe haven properties for Bitcoin and the aggregate cryptocurrency market (CCI30 Index).

4.2 Diversifying, Hedge, and Safe Haven Properties of Bitcoin

Table 3 presents the coefficient estimates from the regression model of Equation 5 for Bitcoin where the DCC between Bitcoin and other assets are regressed on a constant (m_0) and three dummy variables (m_1, m_2, m_3) representing extreme movements in the lower 10th, 5th, and 1st quantiles of the return distribution.

Table 3

Estimation Results for Bitcoin

	10% quantile (m_1)	5% quantile (m_2)	1% quantile (m_3)	Hedge (m_0)	
Cryptocurrency Index (CCI30)	0.0000	0.0060	0.0000	-0.1599	***
S&P 500	0.0065	0.0000	-0.0110	0.4113	***
Bond Index	-0.0107	0.0000	0.0000	0.4829	***
US Dollar Index	-0.0045	-0.0024	0.0000	0.0245	***
Commodity Index	0.0000	0.0000	0.0000	-0.0607	***
Real Estate Index	0.0006	0.0007	-0.0053	0.3506	***
Gold	-0.0043	-0.0101	0.0000	0.2792	***

* $p < .05$, ** $p < .01$, *** $p < .001$

Bitcoin as a diversifier: Applying the specifications for a diversifier, hedge, and safe haven, the results in Table 3 indicate that Bitcoin acts primarily as a diversifier in investor's portfolios. Therefore, a U.S. investor holding stocks, bonds, cash, real estate, and gold would achieve portfolio diversification benefits from holding Bitcoin. In only two assets, aggregate cryptocurrencies and commodities, was Bitcoin anything other than a diversifier.

Bitcoin as a hedge: Surprisingly, Bitcoin is a strong hedge for the aggregate cryptocurrency market. This result is surprising given that Bitcoin represents a large portion of the aggregate cryptocurrency market. Bitcoin was also a strong hedge for commodities, demonstrating its ability to counter commodity risk.

Bitcoin as a safe haven: When considering extreme shocks in the assets under investigation, the regression estimations suggest Bitcoin is neither a weak nor strong safe haven. Investors will need to search for safety elsewhere in times of market turbulence.

4.3 Diversifying, Hedge, and Safe Haven Properties of the Aggregate Cryptocurrency Market

Similarly, Table 4 presents the coefficient estimates from the regression model of Equation 5 for the aggregate cryptocurrency market. Continuing to apply the specifications for a diversifier, hedge, and safe haven, the results show the cryptocurrency market serves primarily as a strong hedge.

Table 4

Estimation Results for Cryptocurrency Index

	10% quantile (m_1)	5% quantile (m_2)	1% quantile (m_3)	Hedge (m_0)	
Bitcoin	0.0103	-0.0053	0.0000	-0.1603	***
S&P 500	0.0010	0.0000	-0.0031	-0.0514	***
Bond Index	0.0040	0.0000	0.0000	-0.0659	***
US Dollar Index	-0.0052	0.0031	0.0000	0.0118	***
Commodity Index	0.0000	0.0000	0.0000	-0.0857	***
Real Estate Index	-0.0004	0.0042	-0.0029	-0.0817	***
Gold	-0.0043	-0.0101	0.0000	-0.0839	***

* $p < .05$, ** $p < .01$, *** $p < .001$

Cryptocurrencies as a diversifier: In only the case of the U.S. dollar does the aggregate cryptocurrency market act as a diversifier.

Cryptocurrencies as a hedge: The m_0 coefficient indicates that the aggregate cryptocurrency market strongly hedges the daily returns of Bitcoin, stocks, bonds, commodities, real estate, and gold. As mentioned, it is surprising that the aggregate cryptocurrency market hedges Bitcoin given that Bitcoin encompasses a large share of the market.

Cryptocurrencies as a safe haven: When considering extreme shocks (m_1, m_2, m_3), the estimates suggest that the cryptocurrency market does not provide a safe haven in times of extreme volatility for investors.

5. CONCLUSIONS

This study contributes to the literature by providing empirical evidence of the diversification, hedging, and safe haven properties of Bitcoin and the aggregate cryptocurrency market with traditional portfolio assets such as equities, bonds, the U.S. Dollar, commodities, real estate, and gold. The findings of this study provide several implications and areas for future research.

Our overall results indicate that Bitcoin serves primarily as a diversifier to traditional assets. Therefore, the implication to investors is that Bitcoin can play a beneficial role within a diversified investment portfolio. Our findings collaborate with other empirical studies investigating Bitcoin (Baur *et al.*, 2018; Brière *et al.*, 2015; Dyhrberg, 2016; Shahzad *et al.*, 2020). However, the sources of Bitcoin's diversification benefits are currently unclear and provide an opportunity for further research. Ciaian *et al.* (2016) postulate Bitcoin's diversification benefits are a result of its decoupled association from

global macroeconomic and financial developments and its sensitivity to supply and demand forces. While this may have been a possible explanation in Bitcoin's earlier years, as Bitcoin becomes more accepted and integrated into global financial markets its diversification benefits could decline. Future research should explore the degree to which other factors beyond Bitcoin price volatility change its diversification property across time, studying lengthier periods than those examined in this study.

Unexpectedly, our results suggest that Bitcoin is a strong hedge for the aggregate cryptocurrency market. This is surprising given that Bitcoin represents a large portion of the collective cryptocurrency market. It is possible that because the total cryptocurrency market is still relatively small and that investors are primarily retail investors with limited funds, the capital flows between Bitcoin and other cryptocurrencies may be causing this effect as investors buy other cryptocurrencies using Bitcoin as their source of funds, and vice-versa. Further, it is possible that investors fluctuate between a bias for Bitcoin and between a desire to find the next Bitcoin among the small-cap cryptocurrencies. The implication for investors includes the ability to use this relationship between the two assets in risk management practices. Future studies should continue to explore Bitcoin's hedging properties to the overall cryptocurrency market, how investor behaviors factor into this relationship, and whether it is sustainable as the market develops.

Our results also indicate that Bitcoin continues to be a strong hedge for commodities. Similarly, this highlights Bitcoin's ability to counter commodity risk and is an important implication for investors to take away from this study. This finding, previously reported by other scholars (Bouri *et al.*, 2017), demonstrates that Bitcoin's strong hedging property against commodities appears to be resilient.

An additional surprising finding of this study is that cryptocurrencies are only a diversifier for the U.S. dollar rather than a hedge. This is surprising given the motivation of investors to use cryptocurrencies to hedge the risk of fiat currency debasement, inflation, and potential collapse of the traditional financial system. The results may have differed if stable coins, lower-volatility cryptocurrencies whose values are pegged to sovereign currencies (Li and Whinston, 2020), were included in our aggregate cryptocurrency index proxy. Future research should consider whether stable coins provide a hedge or safe haven for the U.S. dollar, other sovereign fiat currencies, and other traditional assets.

This study's results are limited by our proxy of the aggregate cryptocurrency market, the CCI30 Index. Future research should distinguish between the aggregate cryptocurrency market as examined in this study and a separate proxy of the cryptocurrency market which excludes Bitcoin. The use of a cryptocurrency market index that excludes Bitcoin would be informative for investors, however it is beyond the scope of this study as we focus on the cryptocurrency market in its entirety. Future studies may also choose to investigate the characteristics of individual cryptocurrencies beyond Bitcoin, such as Ethereum and Ripple. Such analysis could differentiate between the systematic risk of the aggregate market and the idiosyncratic risk linked to individual cryptocurrencies.

Cryptocurrencies were created out of the 2008 financial crisis as somewhat of a revolt against the traditional financial system. Since then, they have been increasingly adopted by the investor community. COVID-19 presented the cryptocurrency market with its first systemic, multi-asset market crash. This volatile event provided a dynamic environment to test this new asset's portfolio characteristics as they related to more traditional assets. Our

findings provide important implications for investors regarding asset allocation decisions. We show that Bitcoin is primarily a diversifier while the aggregate cryptocurrency market is primarily a strong hedge. Based on our results, these new digital assets demonstrate they can play a beneficial role within investment portfolios but are no better at protecting capital during times of widespread market declines than traditional assets.

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