Does Bitcoin add value to global industry portfolios?

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Highlights

- This paper explores the dynamic interdependence between Bitcoin and the ten global industry sectors classified.
- Empirical results indicate, in accordance with previous literature, that Bitcoin is relatively isolated from traditional industries and hence offers some diversification benefits to investors.
- However, these benefits are counterbalanced by the volatility of the asset.

Does Bitcoin add value to global industry portfolios?_CRC2019

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Revised version

December 17, 2019

Abstract

Bitcoin has been increasingly viewed as a new form of investment, yet its role as an asset in a diversified industry portfolio is not well understood. In this paper, we explore the dynamic interdependence between Bitcoin and the ten global industry sectors classified by the Global Industry Classification Standard. We find, in accordance with previous literature, that Bitcoin is relatively isolated from traditional industries. While the near-zero correlation with traditional financial assets offers some diversification benefits to investors, these benefits are counterbalanced by the volatility of the asset. Bitcoin's optimal presence in a minimum variance portfolio is only about 1 percent – a weight that is robust to various methods for estimating the return covariance matrix. Bitcoin's optimal weight in portfolios maximizing Sharpe and Sortino ratios are on the magnitude of 10 to 20 percent. Hence, the value of Bitcoin as an asset in a diversified portfolio critically depends on investors' views about the future of Blockchain technology.

JEL classification: C32, G11, G15

Keywords: Bitcoin, Global industry sectors, Return spillovers, Portfolio diversification

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1. Introduction

The recent ebbs and flows in the cryptocurrency market have garnered substantial media coverage and captivated the attention of market analysts, academics, investors, and other market players. While the market has witnessed the arrival of a multitude of new cryptocurrencies,[1] the large swings in the market capitalization of the sector were primarily driven by the volatility of its largest constituent: Bitcoin. It traded at levels below $1000 until the end of 2016, reached almost $20,000 by the end of 2017 only to drop below $4000 by the end of 2018. Since its inception, Bitcoin has increasingly been viewed as a new asset category that has the ability to generate spectacular returns. Yet, the bubbles of 2013 and 2017 have marred this picture and called into question the potential of Bitcoin to keep delivering superior returns or offering diversification benefits to investors holding other assets.

In this paper, we derive the dynamic conditional correlation between Bitcoin and the ten global industry sectors classified by Global Industry Classification Standard and examine whether Bitcoin could be part of a hedging or diversification portfolio strategy for investors. Following the literature developed for the classification of other non-income producing assets (see, e.g. Baur and Lucey, 2010) we examine whether Bitcoin is a hedge, a safe haven, or merely a diversifier for each of the ten industry sectors. A 'hedge' of a portfolio is an asset that is uncorrelated or negatively correlated with the portfolio on average, while a 'safe haven' is an asset that is uncorrelated or negatively correlated with the portfolio in periods in which the portfolio sustains severe losses. If an asset is positively but not perfectly correlated with the portfolio, this asset is classified as a 'diversifier.' Studies of earlier time periods find that Bitcoin can serve as a hedge or safe haven for investments in some industries (see, e.g. Klabbers, 2017, Bouri, Jalkh, Molnar, and Roubaud, 2017). Analyzing daily returns covering almost the entire existence of Bitcoin, we find that it is merely a diversifier for each of the ten industries considered.

We also find that Bitcoin is of limited use to investors interested in minimizing the variance of their portfolios' returns. Bitcoin exhibits low correlations with traditional assets which suggests that it might offer diversification benefits. Yet, these benefits are swamped by the high volatility of Bitcoin. The optimal weight of Bitcoin in a minimum variance portfolio consisting of investments in the ten sectors is

[1] As of March 2019 there were more than 2100 individual cryptocurrencies in existence (www.coinmarketcap.com).

merely 1 percent, a result that is robust to various model specifications. Bitcoin, however, enters with a much higher weight into portfolios that maximize Sharpe or Sortino ratios. If expected future returns correspond to historical returns since inception, Bitcoin's optimal weight would exceed 10 percent in a global market portfolio thus dominating several global sectors such as the energy, the industrial and the financial sectors.

2. Related literature

This paper relates to the nascent but rapidly growing literature which explores the characteristics of Bitcoin as an investment asset and its potential role in portfolio management for institutional and individual investors. Most of this literature has focused on specific sectors.

The relationship between Bitcoin and energy commodities has been analyzed by Bouri, Jalkh, Molnar, and Roubaud (2017) who find that Bitcoin was able to serve as a hedge only prior to 2013, yet, for the period after 2013 it could only be a diversifier, i.e. its correlation with a portfolio of commodities is no longer negative. Corbet, Meegan, Larkin, Lucey, and Yarovalya (2018) find that Bitcoin is disconnected from traditional investment assets (e.g. gold, bonds, and stocks) in that its return spillovers (Diebold and Yilmaz, 2012) and unconditional connectedness (Barunik and Krehlik, 2015) to these assets are quite low. They thus suggest that Bitcoin may confer diversification benefits to investors.

Klein, Thu, and Walther (2018) compare the time-series properties of Bitcoin and gold and establish that Bitcoin does not share the flight-to-quality characteristics of gold. In particular, Bitcoin is not a hedge to equity investments. Considering a conditional Value-at-Risk framework, Eisl, Gasser, and Weinmayer (2015) find that the optimal portfolio weight of Bitcoin is in the range between 2 percent to 8 percent. A similar analysis is performed by Klabbers (2017) in a dynamic mean-variance framework who finds that Bitcoin's optimal weight fluctuates between 0 percent and 5 percent.

In this paper, we contribute to this literature by exploring the role of Bitcoin in optimal portfolios constructed for a comprehensive set of industry sectors. We analyze the diversification benefits of Bitcoin to each individual sector, as well as the role of Bitcoin in a diversified portfolio including all sectors.

3. Data and methodology

The data used in this study consists of the daily closing price indices for the ten global industry sectors and Bitcoin's price over the period from July 19, 2010, to December 31, 2018. The sectorial price indices are obtained from Datastream and cover the performance of companies in the following sectors: Energy (EN), Materials (MA), Industrials (IN), Consumer Discretionary (CD), Consumer Staples (CS), Health Care (HC), Financials (FI), Information Technology (IT), Telecommunication Services (TC), and Utilities (UT). The Bitcoin price index is collected from CoinDesk (www.coindesk.com) which serves as a reference index for industry participants and accounting professionals by providing estimates of Bitcoin price based on the average price of global Bitcoin exchanges.

Our empirical analysis consists of two stages. In the first stage, we select the best fit for our data from 12 model specifications of Dynamic Conditional Correlations (DCC) and Asymmetric Dynamic Conditional Correlations (ADCC) between Bitcoin and the ten global sector indices. In addition to the standard DCC-GARCH specification, we include the ADCC-GARCH model of Cappiello, Engle and Sheppard (2006) which improves on the DCC-GARCH model of Engle (2002) by accounting for possible asymmetric response of correlation to positive and negative shocks. We also include the GARCH(1,1) model, the GJRGARCH(1,1) model by Glosten et al (1993) which allows for asymmetry in returns, and the EGARCH(1,1) model of Nelson (1991) which accounts for possible asymmetry in volatility clustering. Further, we include an AR(1) term in the mean equation for all models to ensure a white noise error term. According to all four model selection criteria considered (Akaike Information Criteria (AIC), log-likelihood (LL), the Bayesian Information Criterion (BIC) and the Hannan-Quinn Criterion (HQC)), the best model is the AR(1)-ADCC-GARCH model specification which we use in our analysis. In the second stage, we examine the risk transitions and volatility connectedness between Bitcoin and the global sector indices by applying the Spillover approach recently developed by Diebold and Yilmaz (2012, 2016). Using these results, we then explore whether Bitcoin is a hedge, a safe haven, or a diversifier for each of the ten industries. Furthermore, we derive optimal portfolio weights for long positions in all assets.

4. Empirical results

We first examine the univariate characteristics of all price indices. Results indicate that all return series are stationary at levels.

Table 1. Estimation results of the AR(1)-ADCC-GARCH model[2]

Panel A: Univariate GARCH (1,1) Models (Step 1)

	Mean equations		Variance equations		
	μ	φ	ω	α_i	β_i
EN	0.0004**	0.0736***	0.0121**	0.0736***	0.9198***
MA	0.0003	0.1888***	0.0045*	0.0438***	0.9524***
IN	0.0005***	0.1594***	1.4696*	0.092***	0.889***
CD	0.0006***	0.1538***	1.3756**	0.106***	0.8782***
CS	0.0005***	0.0674***	2.4454**	0.1095***	0.836***
HC	0.0007***	0.0609***	1.988***	0.0983***	0.8709***
FI	0.0005***	0.1454***	2.1194**	0.1028***	0.8764***
IT	0.0009***	0.0606**	4.0508***	0.1111***	0.8467***
TC	0.0002*	0.0868***	2.9743**	0.0793***	0.8718***
UT	0.0003**	0.0647***	0.9713	0.0513***	0.9315***
BT	0.0022**	0.0593**	0.9314	0.1799**	0.8166***

Panel B: Estimates of the ADCC model (Step 2)

	EN	MA	IN	CD	CS	HC	FI	IT	TC	UT
MA	0.755***									
IN	0.741***	0.837***								
CD	0.661***	0.730***	0.867***							
CS	0.607***	0.641***	0.728***	0.730***						
HC	0.631***	0.631***	0.74***	0.747***	0.757***					
FI	0.721***	0.774***	0.866***	0.802***	0.688***	0.712***				
IT	0.599***	0.585***	0.731***	0.792***	0.587***	0.681***	0.672***			
TC	0.586***	0.63***	0.704***	0.675***	0.717***	0.659***	0.713***	0.523***		
UT	0.552***	0.552***	0.618***	0.595***	0.716***	0.612***	0.618***	0.441***	0.682***	
BT	-0.042	-0.03	-0.04	-0.039	-0.013	-0.006	-0.032	-0.041	-0.052	-0.019
θ_1	0.013***									
θ_2	0.978***									
γ	0.005**									

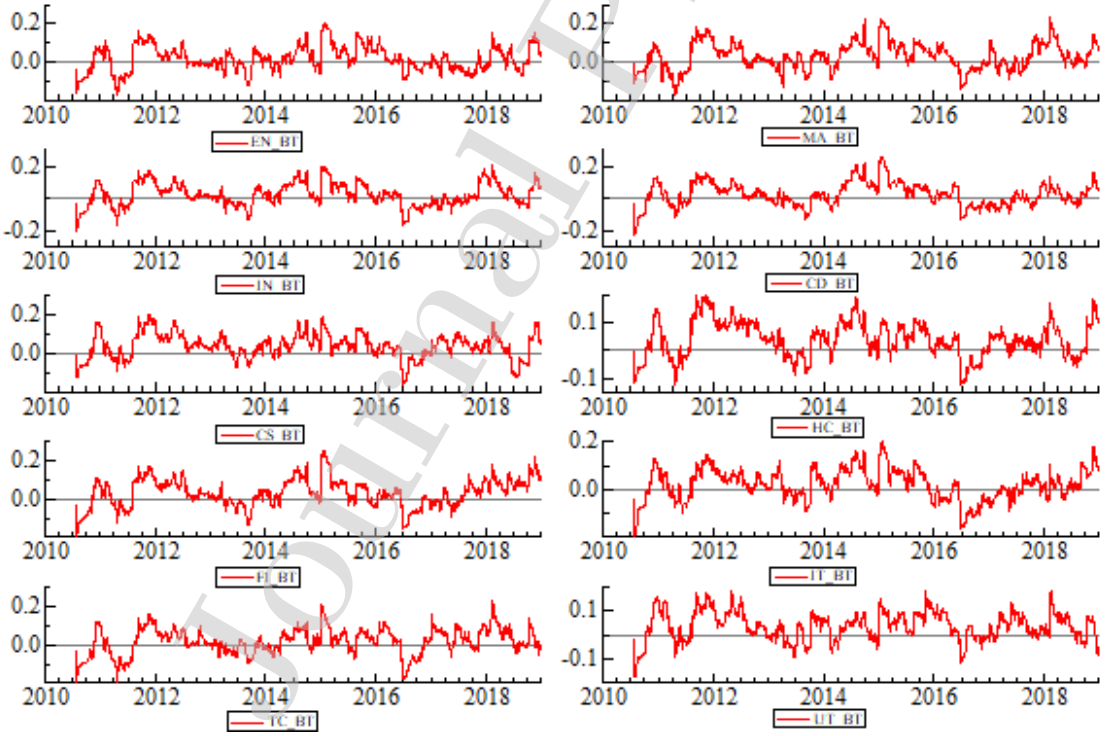
Notes: EN, MA, IN, CD, CS, HC, FI, IT, TC, UT, BT indicate Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Telecommunication Services, Utilities sectors, and Bitcoin respectively. The significance levels are indicated as follows: '***' p<0.01, '**' p<0.05, '*' p<0.1.

[2] The mean equation is defined as an AR(1) process: $r_t = \mu + \varphi r_{t-1} + \varepsilon_t$, where r_t is a vector of the returns of Bitcoin and global sectorial indices, μ_t is the conditional mean vector of r_t, φ refers to the AR(1) term in the mean equation and ε_t is a vector of residuals. The variance equation is specified as $h_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1}$, where $h_{i,t}$ is the conditional variance, ω_i is the constant, α_i denotes the ARCH term and β_i refers to the GARCH term. In the second stage, the conditional covariance matrix is defined as: $Q_t = (1 - \theta_1 - \theta_2)\bar{Q} - \gamma\bar{N} + \theta_1 \varepsilon_{t-1}\acute{\varepsilon}_{t-1} + \theta_2 Q_{t-1} + \gamma n_{t-1}\acute{n}_{t-1}$. Finally, the pairwise dynamic conditional correlation between variables i and j is calculated as: $\rho_{i,j,t} = \frac{q_{i,j,t}}{\sqrt{q_{i,i,t} q_{j,j,t}}}$.

However, they exhibit autocorrelation, non-normality and volatility clustering.[3] Consequently, all GARCH models are estimated with an AR(1) term in the mean equation which follows a multivariate Student t distribution.

In Table 1, Panel A, we report the estimated coefficients of the mean equation (AR(1)) which are positive and statistically significant for all series. Furthermore, volatility is persistent for all indices as the sum of the GARCH parameters is very close to unity. The correlation estimates from the AR(1)-ADCC-GARCH model are presented in Panel B. We observe that the correlation coefficients among industry sectors are positive and statistically significant at the 1 percent level, while the conditional correlations between Bitcoin and the industry sectors are negative but not statistically significant. This suggests that the Bitcoin market is isolated from traditional financial markets. We further examine the dynamic trajectory of the conditional correlations between the returns on Bitcoin and each individual industry sector. The graphs presented in Figure 1 show that the dynamic conditional correlations are generally low and fluctuate between +0.25 and -0.25 over the entire sample period.

Figure 1. Time-varying conditional correlation between Bitcoin and global sector indices



Notes: EN, MA, IN, CD, CS, HC, FI, IT, TC, UT, BT indicate Energy, Materials, Industrials, Consumer Discretionary, Consumer Staples, Health Care, Financials, Information Technology, Telecommunication Services, Utilities sectors, and Bitcoin respectively. The dynamic conditional correlations have been estimated based on the AR(1)-ADCC-GARCH model.

[3] Descriptive statistics and univariate tests for all time series are available upon request.

As markets tend to be more correlated during stress episodes without any change in the interconnection between them (Forbes and Rigobon 2002), the correlation estimates could be biased as they generally depend on market volatility. Therefore, we investigate risk transmission and interdependence among Bitcoin and the global industry indices using the spillover approach developed by Diebold and Yilmaz (2012, 2016). This approach is based on the decomposition of forecast error variance from a generalized vector autoregressive model which is independent of conditional volatilities and hence more accurate (Maghyereh et al., 2015).

Table 2. Volatility spillovers analysis

Panel A: Returns Spillovers												
	EN	MA	IN	CD	CS	HC	FI	IT	TC	UT	BT	FROM
EN	19.19	12.18	11.48	9.60	7.30	7.74	10.71	7.96	7.63	6.17	0.04	80.81
MA	10.76	16.40	12.94	10.74	7.82	7.73	11.36	8.01	8.02	6.16	0.07	83.60
IN	8.81	11.28	14.43	11.98	8.59	9.06	11.63	9.39	8.29	6.52	0.03	85.57
CD	7.64	9.70	12.49	15.13	8.93	9.80	10.95	11.17	8.16	5.99	0.03	84.87
CS	6.67	8.25	10.37	10.28	17.28	10.02	8.96	7.53	10.32	10.29	0.04	82.72
HC	7.06	8.07	10.91	11.28	10.06	17.44	10.05	10.10	8.29	6.67	0.07	82.57
FI	8.89	10.78	12.66	11.42	8.04	9.05	15.49	8.56	8.75	6.33	0.04	84.51
IT	7.62	8.57	11.80	13.48	7.97	10.60	9.92	18.36	6.81	4.86	0.03	81.64
TC	7.37	8.91	10.46	9.81	10.76	8.66	10.15	6.78	17.76	9.31	0.03	82.24
UT	6.92	7.97	9.61	8.46	12.60	8.12	8.63	5.60	10.95	21.10	0.04	78.90
BT	0.13	0.21	0.14	0.17	0.20	0.26	0.19	0.12	0.06	0.19	98.33	1.67
TO others	71.87	85.92	102.87	97.23	82.27	81.02	92.53	75.22	77.27	62.48	0.41	**TSI = 75.37%**
Net spillovers	-8.94	2.32	17.30	12.36	-0.45	-1.54	8.02	-6.42	-4.97	-16.42	-1.27	
Panel B: Volatility Spillovers												
	EN	MA	IN	CD	CS	HC	FI	IT	TC	UT	BT	FROM
EN	20.57	10.72	11.07	10.71	7.67	8.85	9.06	7.24	7.34	6.59	0.20	79.43
MA	9.90	17.99	13.14	11.01	8.01	7.24	11.37	5.51	8.64	6.76	0.44	82.01
IN	8.05	10.78	15.48	13.74	7.85	9.03	11.97	8.40	8.16	6.19	0.38	84.53
CD	7.53	8.80	13.56	16.32	7.66	10.14	10.59	11.29	8.13	5.69	0.31	83.68
CS	6.92	8.16	10.75	10.79	16.45	11.75	9.20	6.66	9.34	9.80	0.18	83.55
HC	7.63	7.12	11.46	12.79	9.99	17.56	8.86	10.39	7.40	6.70	0.12	82.44
FI	7.63	10.75	14.16	12.96	7.79	8.38	16.13	6.88	8.57	6.52	0.23	83.87
IT	7.41	6.89	12.19	15.30	6.76	11.71	8.30	20.22	6.95	4.06	0.22	79.78
TC	7.16	8.82	11.22	11.76	10.09	9.52	10.05	7.83	15.54	7.85	0.18	84.46
UT	7.40	7.99	10.55	9.86	11.27	10.68	9.71	5.48	8.54	18.25	0.28	81.75
BT	0.16	0.38	0.54	0.37	0.20	0.10	0.20	0.19	0.11	0.60	97.16	2.84
TO others	69.78	80.41	108.63	109.27	77.27	87.38	89.31	69.86	73.18	60.75	2.53	**TSI = 75.30%**
Net spillovers	-9.65	-1.61	24.11	25.59	-6.28	4.94	5.44	-9.93	-11.29	-21.00	-0.31	

Note: The underlying forecast error variance decomposition is estimated based on a daily VAR model of order 1 with 10-step ahead forecast.

The return and the volatility spillovers between all industries are presented in Table 2 (see Panel A and Panel B, respectively). The spillover estimates are based on a Vector Autoregressive model of order 1, and generalized variance decompositions of 10 day ahead forecast errors. Results show that on average 75% of total spillovers are due to the interlinkages among the ten industry indices. In contrast, Bitcoin has only weak interconnectedness with each of the industry indices.

5. Bitcoin: hedge, safe haven, or diversifier?

We first examine whether Bitcoin is a hedge, safe haven, or merely a diversifier for investments in each of the global sectors using the definitions of Baur and Lucey (2010). For this categorization, the following regression model is estimated by ordinary least squares:

$$CORR(i,\mathrm{BT})_t = \alpha + \gamma_1 D(r_{it}, 1\%) + \gamma_5 D(r_{it}, 5\%) + \gamma_{10} D(r_{it}, 10\%) + \varepsilon_{it}$$

Hereby $\mathrm{CORR}(i,\mathrm{BT})_t$ is the correlation between sector $i \in \{\mathrm{EN}, \mathrm{MA}, \mathrm{IN}, \mathrm{CD}, \mathrm{CS}, \mathrm{HC}, \mathrm{FI}, \mathrm{IT}, \mathrm{TC}, \mathrm{UT}\}$ and Bitcoin (BT) for period t, $D(r_{it}, x\%)$ are dummy variables taking on the value of one when the return r_{it} belongs to the bottom $x\%$ of the sample return distribution for $x = 1, 5 \text{ and } 10$ percent.[4] The regression results are presented in Table 3.

Table 3. Regression results

	EN	MA	IN	CD	CS	HC	FI	IT	TC	UT
γ_1	0.045***	0.008	0.027	0.024	-0.003	0.038**	0.012	0.017	-0.004	-0.004
	(0.015)	(0.016)	(0.017)	(0.017)	(0.015)	(0.015)	(0.017)	(0.015)	(0.016)	(0.014)
γ_5	0.007	0.014	0.007	0.008	0.011	-0.003	0.006	0.006	-0.002	-0.003
	(0.009)	(0.010)	(0.010)	(0.011)	(0.009)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)
γ_{10}	0.018***	0.005	0.010	0.013*	0.008	0.014**	0.008	0.007	0.010	0.011*
	(0.006)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.007)	(0.006)
α	0.015***	0.030***	0.021***	0.023***	0.038***	0.040***	0.031***	0.020***	0.017***	0.037***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)
Num. obs.	2,205	2,205	2,205	2,205	2,205	2,205	2,205	2,205	2,205	2,205
R-squared	0.020	0.005	0.006	0.008	0.004	0.009	0.003	0.004	0.001	0.002

Notes: Dependent variable is the correlation between the returns on Bitcoin and each of the ten industry sectors. Standard errors are in parentheses. Significance levels: *** p<0.01, ** p<0.05, * p<0.1

[4] Bouri, Jalkh, Molnar, and Roubaud (2017) estimate an alternative regression specification in which they include dummy variables for returns in the 90th, 95th, and 100th percentiles. We estimate also this and other alternative models and find that the categorization of Bitcoin presented in Table 3 is robust to alternative specifications.

Bitcoin is a 'hedge' for industry i if the average correlation with this industry is negative and statistically significant (i.e. α is negative and statistically significant at the 1% level) and a 'safe haven' if the correlation with this industry is negative and statistically significant in times when the industry sustains severe losses (i.e. either γ_1, γ_5 or γ_{10} is negative and statistically significant at the 1% level).

The coefficient α is positive and statistically significant for all sectors while γ_1, γ_5 and γ_{10} are not significant when they are negative. Hence, Bitcoin is merely a diversifier for all industry sectors.[5]

6. Optimal portfolio weights

Next, we analyze the optimal weight of Bitcoin in diversified portfolios comprising all the global sectors by focusing on minimum variance, maximum Sharpe, and maximum Sortino ratios as portfolio optimization criteria. To assess the contributing role of Bitcoin, in Table 4 we report optimal portfolios that either include or exclude Bitcoin.

Table 4. Optimal portfolio weights

Sector weight	Min Var ADCC Excl. BT	Min Var ADCC Incl. BT	Min Var LW Excl. BT	Min Var LW Incl. BT	Max Sharpe Excl. BT	Max Sharpe Incl. BT	Max Sortino Excl. BT	Max Sortino Incl. BT
BT	0	0.01	0	0.01	0	0.140	0	0.165
EN	0.014	0.014	0.014	0.014	0	0	0	0
MA	0.018	0.018	0.015	0.015	0	0	0	0
IN	0.029	0.029	0.024	0.024	0	0	0	0.001
CD	0.036	0.037	0.034	0.033	0.134	0.146	0.019	0.061
CS	0.445	0.435	0.506	0.507	0.038	0	0.066	0.042
HC	0.1	0.098	0.1	0.102	0.659	0.549	0.763	0.585
FI	0.018	0.018	0.016	0.016	0	0	0	0
IT	0.039	0.04	0.031	0.03	0.169	0.165	0.152	0.144
TC	0.091	0.093	0.07	0.071	0	0	0	0.001
UT	0.21	0.208	0.19	0.178	0	0	0	0.001
Performance	sd=1.637	sd=1.635	sd=1.662	sd=1.660	sr=0.843	sr=1.399	st=1.544	st=2.718

Notes: In the ADCC columns the covariance matrix is calculated by fitting the AR(1)-ADCC-GARCH model. In the LW columns the covariance matrix is calculated using the Ledoit and Wolf (2017) nonlinear shrinkage estimator. The abbreviation 'sd' stands for portfolio standard deviation, 'sr' is the Sharpe ratio, and 'st' is the Sortino ratio. The Sharpe ratio is calculated for an annual risk free return of 2%, and the downside deviation of the Sortino ratio is also calculated for a target of 2%.

[5]Analysis based on a subsample ending in 2017 identifies Bitcoin as a hedge for three of the ten sectors: the energy sector, the industrial sector, and the telecommunication sector. These properties disappear when the data for the past year is included. These finding corroborate the results reported in Bouri et al. (2017) who find that Bitcoin is not a diversifier for energy commodities anymore.

The optimal weight of Bitcoin in a minimum variance portfolio is only 1 percent and including Bitcoin only slightly reduces the standard deviation of the portfolio. Although Bitcoin has the weakest pairwise correlation with all other assets, it enters with the lowest weight into the optimal portfolio due to its high volatility. Because of its high average returns, however, Bitcoin enters maximum Sharpe and Sortino ratio portfolios with a weight exceeding 10 percent, thus dominating the majority of industries.[6]

7. Conclusion

In this paper, we explore whether Bitcoin can add value to diversified portfolios of global industries. Although the relative isolation of Bitcoin from mainstream assets confers some diversification benefits, these benefits are swamped by the volatility of Bitcoin. The optimal weight of Bitcoin in the minimum variance portfolio consisting of the ten industries is merely 1 percent. Due to its high historical returns, however, Bitcoin enters into maximum Sharpe and Sortino ratios with a weight exceeding 10 percent. As the cryptocurrency market matures we find that its properties evolve. In particular, while in earlier periods Bitcoin was a hedge or a safe haven for some financial assets, we find that Bitcoin is merely a diversifier for all industries considered when analyzing the full eight-year sample. We conclude that the attractiveness of Bitcoin is predicated on investors' expectations of high future returns rather than its hedging or diversification potential.

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[6] Bitcoin is dominated only by the healthcare sector and is on par with the IT sector. When Bitcoin is included in portfolios, weight is shifted mostly from the healthcare sector to Bitcoin, which leads to a substantial improvement in the Sharpe and Sortino ratios.

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