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Is Bitcoin an alternative investment?

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Abstract

Bitcoin is arguably the most prominent invention in fintech of the late 2000s. Originally designed as a digital currency for peer to peer exchange, it has grown into an investment tool due to its large gains and losses and a high degree of volatility. Although there are thousands of digital currencies Bitcoin controls the cryptocurrency market with its high unit price and a dominant market share. This paper looks at Bitcoin as an alternative class of investment and shows that it has remarkably low correlation with stocks, bonds, oil, gold, private equity, real estate and top traded hard currency pairs. Extensive tests prove that Bitcoin has a non-normal distribution of returns which is a peculiar property of alternative investments. Returns are predictable to a certain extent, but only through using lagged variable of the same. Although dark side of the coin is not ignorable, but an increased interest from institutional as well as individual investing has given a considerable exposure to this new line of investing and a lucrative risk-adjusted return offered by it can be a fine addition to a portfolio.

Contents

1. Introduction

"Cryptocurrency is any form of currency that only exists digitally, that usually has no central issuing or regulating authority but instead uses a decentralized system to record transactions and manage the issuance of new units, and that relies on cryptography to prevent counterfeiting and fraudulent transactions"

Merriam-Webster (2008)

There are 4,937 different digital currencies[1] in circulation with a total market capitalisation of nearly $193.5 billion. Bitcoin, being the oldest and the most famous, holds the lion's share of the pie with 66.5% of the total market.[2] Table 1 below summarises the key statistics of five largest digital currencies. It is evident that Bitcoin is by far the chosen one. Updated graphical comparison is available in Appendix A.

Name	Market Cap. (Bill. USD)	Price (USD)	Volume (24h) (Bill. USD)	Supply (Mill. Units)
Bitcoin	130.1	7,184	20.8	18.1 BTC
Ethereum	14	128	7.7	109 ETH
XRP	8.4	0.2	1.5	43,319 XRP
Tether	4.1	1	25.2	4,108 USDT
Bitcoin Cash	3.4	187.9	1.3	18.2 BCH

Table 1: Summary Statistics
(Coinmarketcap 2019)

Back in 2008 bitcoin's invention by Satoshi Nakamoto[3] marked a new era, but it was not until 2013 when a price rally grasped attention of the Wall Street. In the

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[1] Terms digital currency and cryptocurrency maybe used interchangeably
[2] As of December 16, 2019
[3] It is not known whether Satoshi Nakamoto is a person, a group or an organization

last quarter of 2013, its value increased ten-fold. And as recently as in the last quarter of 2017 its value jumped by 400%. But it has had its fair share of nose dives: following the start of 2008 the value fell from $17,527 to $8,621 per unit in a matter of five weeks (Yahoo Finance 2009). Hence, unexpectedly, volatility became one of its defining features.

Bitcoin is based on Blockchain technology which is, in simple terms, is a distributed ledger. The blockchain is a documentation of exchanges and ownership that is distributed among users. There is no centralized ledger of transactions (Twesige 2015). It is the system that oversees the exchange of value of digital currencies.

Bitcoin's market is highly inefficient, but it is expected as the degree of acceptance increases and as smaller individual investors join in, the market will naturally move towards efficiency (Buchholz, et al. 2012). On the other hand the distributed ledger slows down transaction speed and serves as a restriction on the number of transactions that can be performed per unit of time.

Bitcoin prices are volatile. The Graph 1 below draws the comparison of percentage changes in price index of Bitcoin and S&P500, Nasdaq and US Treasury 10-year bond over the period 2015 - 2019. Based on the diagram below, it is difficult to say if Bitcoin is correlated with any of the given indices.
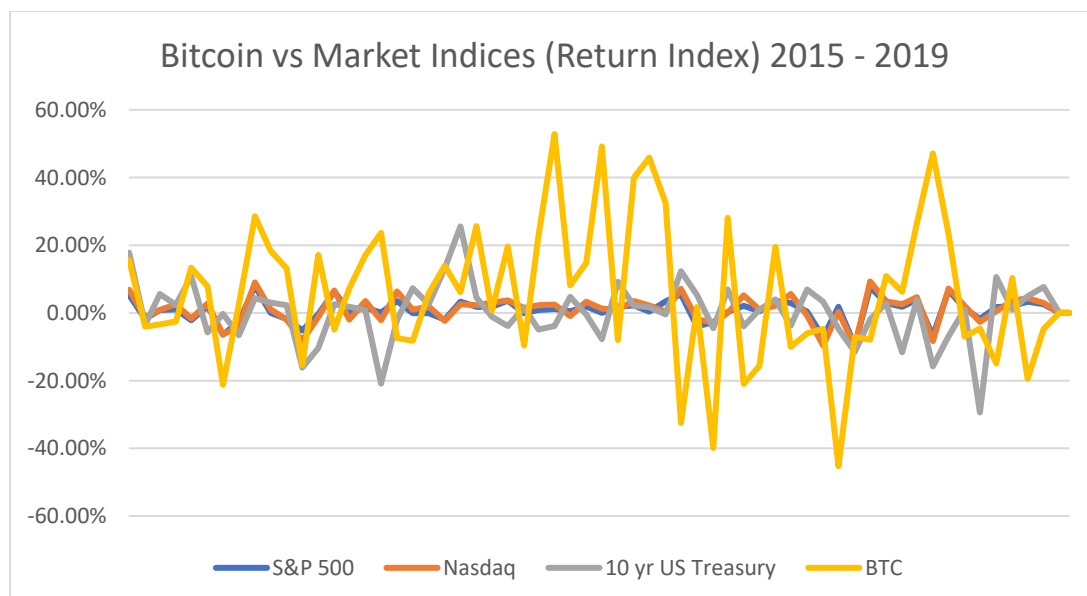
Graph 1 – Bitcoin plotted with major market indices, showing return index from Jan 2015 – December 2019

2. Background and Motivation

Barter — Start of Human Race → Precious Metal Coins — 500 BC → Paper Money — 7th Century China → Gold Standard — 17th Century England → Plastic Money — 1960s USA → Bitcoin — 2008 Unknown

Exhibit 2 – Timeline of medium of exchange

Exhibit 2 summarises different points in history of medium of exchange. We are, arguably, at a turning point. (www.pbs.org 1996)

Now the question arises how much of recognition this 'new payment system' is receiving against the established means. According to Joint Economic Report 2018 of Congress of the U.S.A, the blockchain technology (on which the bitcoin is based) can offer innovative solutions and has so far been resistant to hacking (which might not be the case as discussed later in literature review). It has been recommended that the policy makers and the public should get acquainted with this new technology and the digital currency. (Joint Economic Committe 2018)

Let's consider factors that have helped bitcoin stay in spotlight. First, the media: both the conventional as well as social media have hardly missed an opportunity to mention possibility of hacking, legalisation issue or the market volatility – one way or the other digital currencies have been in commerce & trade news. Second, the celebrity: when people like Bill Gates (Microsoft), Richard Branson (Virgin Group), Elon Musk (Tesla) and Travis Kalanick (Uber) talk about digital currency, endorse the technology behind and even buy it (Crypto Cuurency News 2017), that would act as a catalyst for acceptance by general public.

It is worth noting that bitcoin can be considered a hybrid money system, featuring the properties of both fiat money and commodity money (Selgin 2015). In case of the former, it is being used as a medium of exchange: second only to fiat money. Secondly, it has no intrinsic value like fiat money. In case of latter, its value is

determined by supply and demand and the supply is limited as with any tradeable commodity. Secondly, the decentralization: Bitcoin is not backed by a central system.

The purpose of this research is to investigate if bitcoin is an alternative class[4] of investment. Though there is a considerable research available on this, this paper takes a slightly new direction by comparing related statistics in boom times (2015 – 2019) and bust times (first half of 2020, economic halt due to Covid-19), and in addition to comparing bitcoin as an investment class to other investment classes of stocks, bonds and private equity, I also take in to account the top three most traded international currency pairs.

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[4] An investment whose return and risk are uncorrelated with conventional investments of stocks & bonds. For example real estate, commodities and private equity.

3. Literature Review

In the beginning the literature available on digital currencies was scarce but as the acquaintance and acceptance level have' increased, this new phenomenon has become more ingrained in academic literature. As a financial asset, bitcoin is not only wanted by speculators, but it is also sought after as a diversifier by the investors. Academics are mainly concerned about its effects as a diversifier on portfolio rather than as a currency on monetary system. (Chuen, Guo and Wang 2018)

Generally research on Bitcoin tends to focus on pricing inefficiencies and predictability (Inan, Are Cryptocurrency Price Changes Predictable? 2018), while others focus on value determinants by using time series analysis (Kavvadias 2017). Projecting the prices, determining the make-or-break value factors are important issues, but these do not essentially reduce the importance of the subject as a unique asset. This research takes a slight turn from usual and looks at bitcoin not as a currency but as a financial asset from the perspective of uncorrelated risk and return in both the boom and bust times

People are not buying bitcoins, or any other digital currencies, as a transacting medium. Currency needs to have a stable or a predictable value as one of the criteria to be a medium of exchange. No rational mind would sell home, car or a gadget for that matter for something whose value is susceptible to a sudden drop the next day or would pay for something with an asset whose value can potentially double in a matter of weeks. Putman and Norland of Chicago Mercantile Exchange is of the same opinion: "Wouldn't you have regretted paying 20 Bitcoins for a $40,000 car in June 2017 only to see the same 20 Bitcoins valued at nearly $100,000 by October of the same year". Greater fool theory explains why people are investing in bitcoin. They expect to sell it at a higher price. (Buttonwood 2017)

An attractive investment should be safe, has good return and above all optimal. Interestingly there is a belief that Bitcoin provides diversification benefits. That belief is based on research through mean-variance analysis. (Eisl, Gassery and Weinmayerz 2015). Now there are two issues here. First mean-variance analysis

requires normal distribution, but alternative investments have non-normal return distribution (Abdullah and Hongtao 2010). Second, mean-variance framework considers only two variables: mean and variance, but investment decision making is way more than that, namely behavioural biases and liquidity-needs among others (Chuen, Guo and Wang 2018).

Considering the high risk as well as high returns, bitcoin fulfils the criteria of a speculative asset. But it is the very low correlation with other major assets classes that has earned it the honour of diversifier. In crises, a fall in Bitcoin's value might be an isolated event if the correlation is low to zero with other ingredients of the portfolio. (G.Bau, KiHoonHong and D.Lee 2018).

Like individual investors, institutional investors are showing an increased appetite towards digital currency as an investment. A survey conducted 2020 by Fidelity Digital Assets, an arm of Fidelity Investments LLC with a total customer assets value of $1.3 trillion, shows 36% of the institutional investors in USA and Europe surveyed owned one or more type of digital currencies. More than 25% of the respondents owned Bitcoin. (Greenwich Associates 2020). Grayscale Investments, a global leader in cryptocurrency asset management, has $607.7 million in digital AUM[5] (Grayscale Investments 2019) which is more than the cumulative figure between 2013 and 2018.

<div align="center">Dark Side of the Coin</div>

We should pay heed to loopholes and pitfalls that come with a novelty, especially when we are dealing with technology. One of the few economists credited with predicting the 2008 global financial crises, Nouriel Roubini, calls cryptocurrency the "mother of all bubbles" which is favoured by "charlatans and swindlers" and predicts the value of the currency crashing "all the way down to zero". It is impossible to find an investment class which has experienced such a rapid boom and a sudden bust and that includes thousands of crypto-assets (Roubini 2018).

Price manipulation is an issue as well, and in my opinion that should not be unexpected in an unregulated environment. Tether[6] has been methodically used at

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[5] Assets Under Management
[6] A digital currency claimed to be pegged 1:1 to US dollar

market downturns to inflate the value of bitcoin in 2017, and Bitfinex, the force behind Tether, has persistently avoided proper audit (Griffin and Shams 2019).

Decentralization is a myth, according to a study conducted by Princeton University and Florida International University. Top four miners controlling 75% of the total mining is based in authoritarian regimes like China, which is posing a serious threat to stability and viability of Bitcoin (Kaiser, Jurado and Ledger 2018).

An ICO advisory firm, Statis Group, says around 80% of ICOs in 2017 were scam (Statis Group 2018). Unlike an IPO[7], an ICO[8] is not backed by concrete business plans, proforma financial statements, KYC[9] and AML[10] measures.

Bitcoin Mining is an energy catastrophe. Annual consumption figure sits at 45.8TWh which is more than that of Switzerland, producing carbon dioxide emission between 22 to 22.9 $MtCO_2$ which is more than that of Sri Lanka and Jordan whereas bitcoin's market capitalization is quarter of Switzerland's annual GDP (Christian, Lena and Ulrich 2019).

Safety and security lapses give a feel of the Wild West in this modern day. Mt. Gox, once a dominant bitcoin exchange based in Tokyo, lost around $300 million worth of bitcoins in first quarter of 2014 (Rachel and Nathaniel 2014). That essentially became the first incident of such sort. Carbon Black, a firm specializing in cybersecurity, reported in 2018 of heists of cryptocurrency amounting to roughly $1.1 billion in first half of the year and unfortunately it was not difficult to do so using services based on The Dark Web[11] (McElroy 2018).

Investment Characteristics

In terms of transaction costs, bitcoin markets have nearly 2% narrower bid-ask spread than retail foreign exchange spreads. On top of that there is a cost advantage of up to 10% when other currencies are converted into US dollar via

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[7] Initial Public Offering: When a stock is offered for sale to general public for the first time
[8] Initial Coin Offering
[9] Know Your Customer
[10] Anti-Money Laundering
[11] Part of the internet that is used for illegal activities and is only accessible using a special set of software packages

Bitcoin compared to a direct conversion. This considerable cost advantage is attributable, in large part, to simple structure of bitcoin market system compared to complex infrastructures needed to arrange trade of currencies and other financial assets (Kim 2017). So, it will not be an over-stretch if estimates of transaction costs of investing in bitcoin turns out to be one of the lowest compared to investing in other financial assets.

Laws and regulations overseeing digital currencies vary greatly across jurisdictions. Since it is a step in an uncharted territory, the most common among regulators is the issuance of 'warning' against the novelty of crypto-markets. On one hand we have countries like Spain and Luxemburg developing crypto-friendly regulatory regime in order to encourage investment in underlying technology among other reasons. On the other hand, countries like Pakistan and Vietnam ban all activities linked to cryptocurrencies. One of the important issues that arise when investments are discussed is the taxation. Similar to the regulation framework, taxation differs among different territories. For the said purpose, digital currencies can take the form of financial asset (capital gains tax), ordinary income, foreign currency and an ordinary asset depending on jurisdiction (The Law Library of Congress 2018).

The level of liquidity differs across different exchanges and currency pairs for Bitcoin. Mean quoted spread of 1.950% in Pound Sterling on Kraken Exchange is one of the highest, and the lowest is 0.011% in Chinese Yuan on Okcoin Exchange. The average quoted spread on Bitcoin-exchanges is 0.3% compared to 1.7% for global stocks and 1.3% for bonds (Marshall, Nguyen and Visaltanachoti 2019). Four factors make the driving force behind Bitcoin liquidity: The Bitcoin network, gold price volatility, state of the US economy and Bitcoin prices. Higher volatility gives lower liquidity (Scharnowski 2020).

4. Data & Hypotheses

Is Bitcoin an alternative class of investment?

Data is distributed in two timeframes: Weekly returns from January 2015 to December 2019 (This period will be addressed as 'Period 1' in the rest of the paper), and daily returns from January 2020 to June 2020 (this period will be addressed as 'Period 2' in the rest of the paper). The purpose of two-tiered data distribution is to capture the boom (bullish trend in stock markets in late 2010s) and bust (covid-19 crash in world economy starting 2020) and see how correlation between Bitcoin and other instruments plays out at two different extremes. Data resource is Thomson Reuters Eikon.

Hypothesis

H_1: Bitcoin has non-normal distribution of returns

H_2: Bitcoin has insignificant correlation with traditional/conventional investments of stocks & bonds

H_3: Bitcoin has insignificant correlation with other alternative investments namely, Crude Oil, Gold, Real Estate and Private Equity

H_4: Bitcoin has insignificant correlation with three most traded currency pairs: EUR/USD, GBP/USD and JPY/USD

The following table 4.1 shows the variables and their description (secondary data)

Name	Description	Asset Class
MSCI Emerging Markets Index	Stock market index of Emerging Market Economies	Equity

S&P 500	Stock market index of largest 500 listed companies in USA	Equity
Dow Jones US Corporate Bond Index	Equal Weighted US Corporate Bonds Index	Fixed Income
SSE Corporate Bond Index	Index of Corporate Bonds Issued by Companies listed on Shanghai Stock Exchange	Fixed Income
Crude Oil	Brent Crude Index	Commodity
Gold	Price of Gold per Ounce	Commodity
Global Listed Private Equity Index	Leading publicly listed companies that are active in private equity	Alternative Investment
Dow Jones Select REIT Index	Index of mature USA real estate market designed to show performance of REITs and exclude companies whose revenues are driven by factors other than real estate.	Real Estate
BTC	Bitcoin Price in US Dollars	Digital Currency
EUR/USD	Price of EURO in United States Dollar	Currency
GBP/USD	Price of Pound Sterling in United States Dollar	Currency
USD/JBP	Price of United States Dollar in Japanese Yen	Currency

Table 4.1: Variables with description

Figure below shows price of Bitcoin when put against the stock prices of American technology behemoths (2012 – 2020). Apple ($1.9T), Google's parent company Alphabet ($1T), Facebook ($0.72T), Amazon ($1.57T) and Microsoft ($1.61T) have a

combined worth of nearly $7 trillion USDs[12] which is almost 7 times the Norway's oil fund[13]. In terms of price level bitcoin is in a league of its own as presented in Graph 4.1.
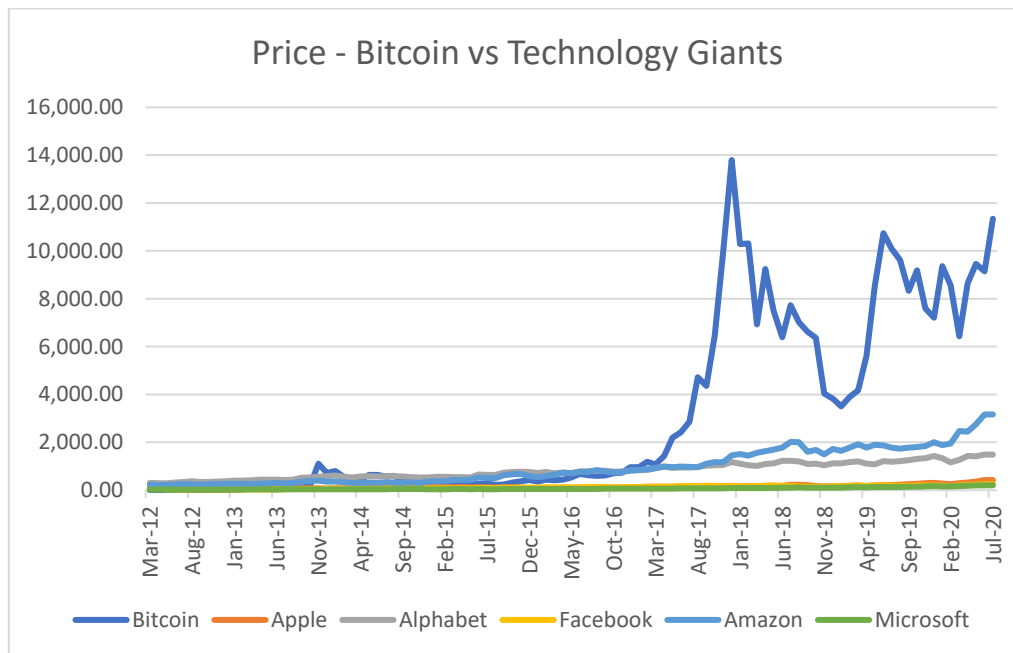
Graph 4.1: Price of 1 unit of BTC and Technology Companies Shares
Data Source: Thomson Reuters Eikon

Against other digital currencies, the story is more of the same. The closest competitor in terms of price is Ethereum, which trades[14] at $400 compared to Bitcoin at $11,320.

5. Methodology

Tests for Normality

To determine the normality/non-normality of return distribution, I am employing Jarque-Bera test and Shapiro-Wilk test. As mentioned before, one of the properties

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[12] Yahoo Finance
[13] www.nbim.no
[14] As of August 03, 2020

that sets alternative investments apart from conventional investing is their non-normal distribution of return.

Jarque-Bera test is the analysis of skewness and kurtosis, which in turn are basically measure of the asymmetry of the probability distribution around the mean. Former informs about the thickness of the tails and the latter is about the height of the 'bump'.

$$JB = \frac{n}{6}(skew^2 + \frac{kurtosis^2}{4}) \qquad (1)$$

We reject null hypothesis if the calculated value from the Equation (1) is more than the critical value of chi-square with 2 degrees of freedom, x^2; which is 5.99 at 5% significance level.

Shapiro-Wilk test is given by the following process:

$$SS = \sum_{i=1} n\ (x_i - \bar{x}) \qquad (2)$$

$$b = \sum_{i=1} m\ a_i(x_{n+1-i} - x_i) \qquad (3)$$

$\frac{b^2}{SS}$ gives the test statistic.

In addition to the two tests above, I am also using Lilliefors test and Anderson-Darling test which are, again, about the distribution of the data around its mean. Further tests can only help strengthen the authenticity of results.

With the help of Pearson Correlation, this paper will find if financial, commodity and currency markets are related to Bitcoin. It will be interesting to see if alternative investments are correlated with Bitcoin because alternative investments namely Commodity Trading Advisors (CTA) and hedge funds have a very low correlation between them (Liang 2004).

Multiple regression analysis can be an important part of any financial research paper; hence Bitcoin prices will be regressed on stocks and bonds indices,

alternative investment returns, and currency pairs and subsequent results will be discussed in the next section.

6. Results

In Period 1, Bitcoin has an average weekly return of 1.8% compared to 0.15% of 60/40 developed markets portfolio (60% equity in S&P 500 and 40% bonds in Dow Jones US Corporate Bonds Index, addressed as Portfolio 1), and 0.09% of 60/40 emerging markets portfolio (60% equity in MSCI Emerging Markets Index and 40% in Shanghai Stock Exchange Bond Index, addressed as Portfolio 2). In terms of reward-risk ratio, the annualized Sharpe Ratio, supposing annual risk-free rate of 1%, is 1.1 compared to 0.86 of Portfolio 1 and 0.43 of Portfolio 2. Skewness and Kurtosis are 0.58 and 1.42 which theoretically points towards non-normal distribution, generally values of more than +1 and less than -1 signal skewed distribution and likewise value greater than +1 of kurtosis signals excessive peak and value less than -1 signals excessive flatness of distribution (Joe, et al. 2016).

In period 2, Bitcoin has an average daily return of 0.24% with a standard deviation of 4.7% compared to 0.02% daily return and 1.9% daily standard deviation of Portfolio 1 and -0-03% and 1.1% respectively of Portfolio 2. The annual Sharpe Ratio, supposing risk-free rate of 0% in bust times, for the three entities is 0.83, 0.13 and -0.43. Skewness and kurtosis for BTC are -2.6 and 24.6 respectively. This signals non-normal distribution.

In Period 1, Bitcoin does not have a normal distribution of returns. Jarque-Bera calculated value is 34.69 which is more than critical value of 5.99 at 95% confidence intervals. Shapiro-Wilk test has given the same conclusion where p-value is lower than the significance level of 0.05.
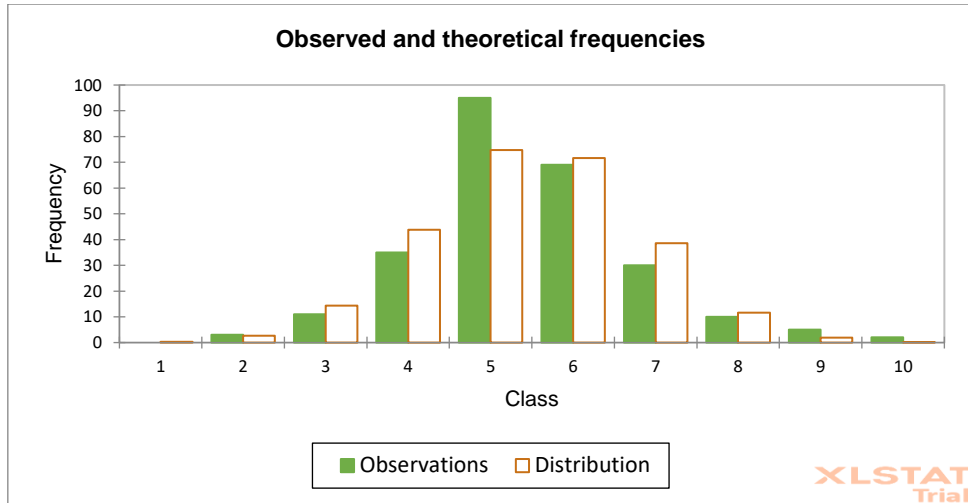
Exhibit 6.1: Frequency Distribution of Expected and Observed Return of Bitcoin in Period 1 – January 2015-December 2019

In Exhibit 6.1 above we can clearly see that the theoretical normal distribution (white bars) are clearly different from observed distribution (green bars).

Exhibit 6.2: Probability Plot of BTC returns in Period 1

In probability plot above – exhibit 6.2, it is evident that the data is systematically following a path but not the 45° straight line, which endorses the non-normality of the return distribution in period 1.

Likewise, in Period 2, Jarque-Bera and Shapiro-Wilk suggest the non-normal distribution of returns. p-values are less than alpha of 0.05. In this period the

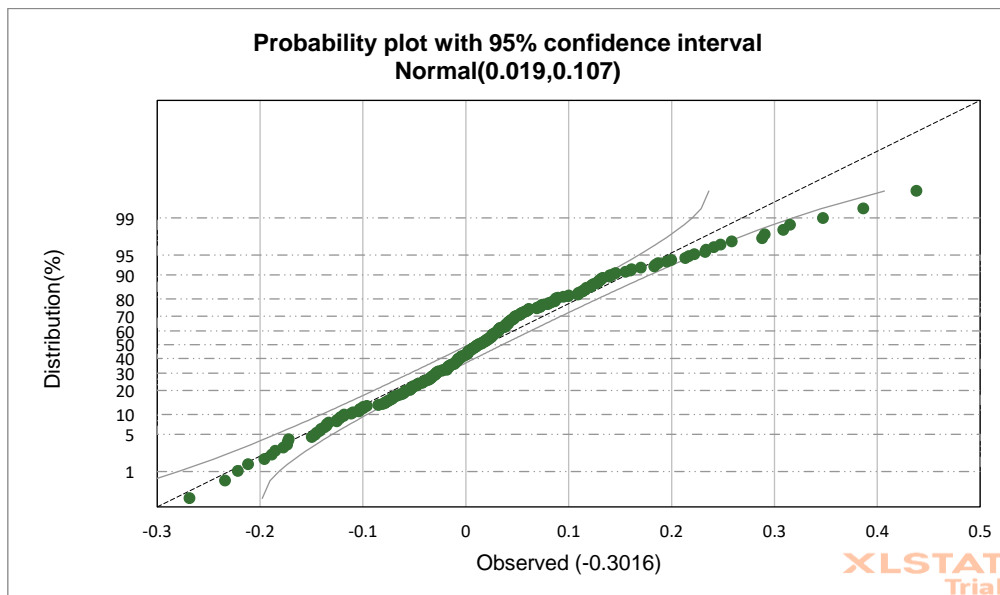degree of non-normality is greater than in Period 1, that might be, in part, high frequency of data as daily data has been used compared to weekly in previous period and, in part, investors tend to look at unconventional investing in downturns since stocks and bonds do not produce attractive returns in such times.

In Exhibit below, red line represents normal distribution and BTC returns in first half of 2020 are clearly off the mark.
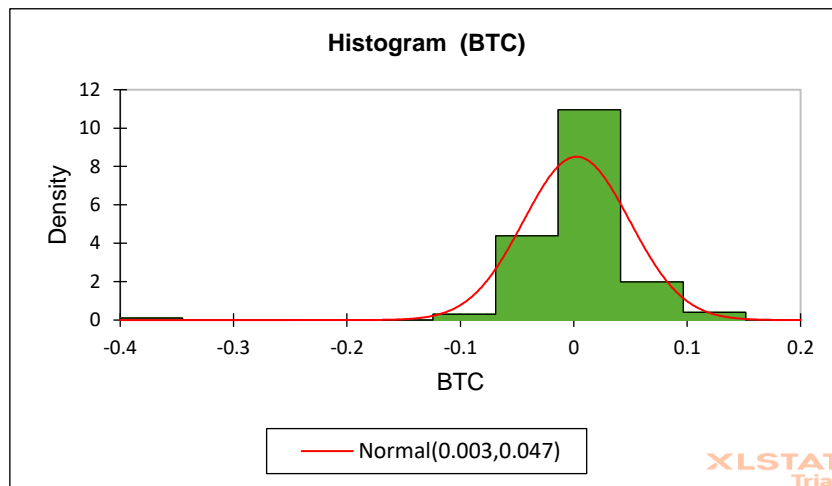

Exhibit 6.3: Histogram with Normal Distribution Curve of BTC returns in Period 2 – January 2020 – June 2020

In probability distribution plot – exhibit 6.4, data follows a systematic path which is clearly not on a straight line in Exhibit.
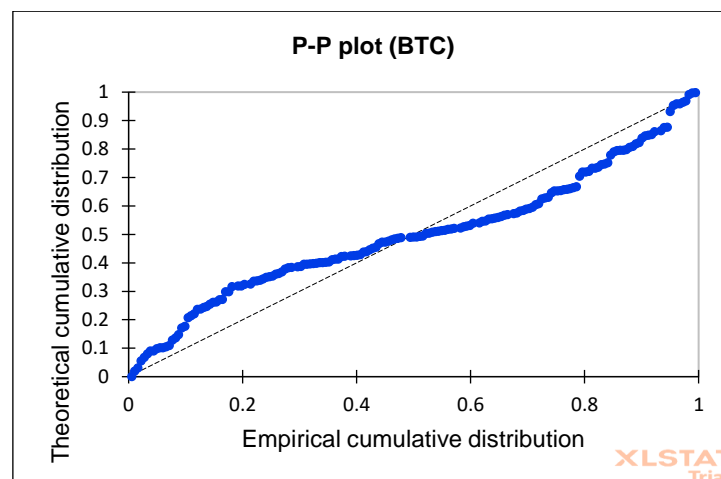

Exhibit 6.4: Probability Distribution Plot of BTC Returns in Period 2

Detailed test statistics for period 2 are available in Appendix B.

Table 6.1 below shows correlation matrix in Period 1. Bitcoin has a very low correlation with other entities. In fact, the highest positive and negative correlation is with EUR/USD pair of +0.07 and -0.11 with USD/JPY pair respectively. Not only Bitcoin has very low correlation with mainstream investments, it also has nearly similar low levels of correlation with alternative investments namely gold, oil, private equity and real estate.

Variables	BTC	S&P 500	Dow Jones US Bond	MSCI Emerging	SSE Corporate	Gold	Brent Oil	Dow Jones REIT	Global PE	EUR - USD	GBP - USD	USD - JPY
BTC	1	0.019	0.017	-0.011	-0.070	0.037	-0.069	-0.065	-0.049	0.070	-0.065	-0.109
S&P 500	0.019	1	-0.021	0.639	-0.006	-0.166	0.318	0.515	0.757	-0.058	0.161	0.340
Dow Jones US Bond	0.017	-0.021	1	0.128	0.017	0.399	-0.005	0.383	-0.082	0.125	0.020	-0.400
MSCI Emerging	-0.011	0.639	0.128	1	-0.053	0.122	0.353	0.336	0.624	0.118	0.262	0.102
SSE Corporate	-0.070	-0.006	0.017	-0.053	1	0.085	0.025	0.106	-0.028	-0.020	-0.091	-0.017
Gold	0.037	-0.166	0.399	0.122	0.085	1	0.024	0.154	-0.311	0.395	0.232	-0.616
Brent Oil	-0.069	0.318	-0.005	0.353	0.025	0.024	1	0.064	0.296	0.079	0.182	0.105
Dow Jones REIT	-0.065	0.515	0.383	0.336	0.106	0.154	0.064	1	0.325	0.010	0.109	-0.006
Global PE	-0.049	0.757	-0.082	0.624	-0.028	-0.311	0.296	0.325	1	-0.426	0.012	0.510
EUR - USD	0.070	-0.058	0.125	0.118	-0.020	0.395	0.079	0.010	-0.426	1	0.544	-0.436
GBP - USD	-0.065	0.161	0.020	0.262	-0.091	0.232	0.182	0.109	0.012	0.544	1	-0.111
USD - JPY	-0.109	0.340	-0.400	0.102	-0.017	-0.616	0.105	-0.006	0.510	-0.436	-0.111	1

Table 6.1: Correlation Matrix in Period 1

Pearson's Phi underscores the correlation results above as none of the variables have statistically significant correlation with BTC demonstrated by the table 6.2. All p-values are higher than alpha of 0.05 so corresponding correlation coefficients are not statistically significant.

Variable labels	Correlation coefficient	p-values
S&P 500	0.019	0.764
Dow Jones US Bond	0.017	0.785
MSCI Emerging	-0.011	0.858
SSE Corporate	-0.070	0.263
Gold	0.037	0.553
Brent Oil	-0.069	0.269
Dow Jones REIT	-0.065	0.292
Global PE	-0.049	0.434
EUR - USD	0.070	0.261
GBP - USD	-0.065	0.296
USD - JPY	-0.109	0.079

Table 6.2: BTC correlation coefficient and p-values

Exhibit 6.5 shows visual analysis of the correlation using scatter plots. Red is very low correlation and blue is relatively high correlation.
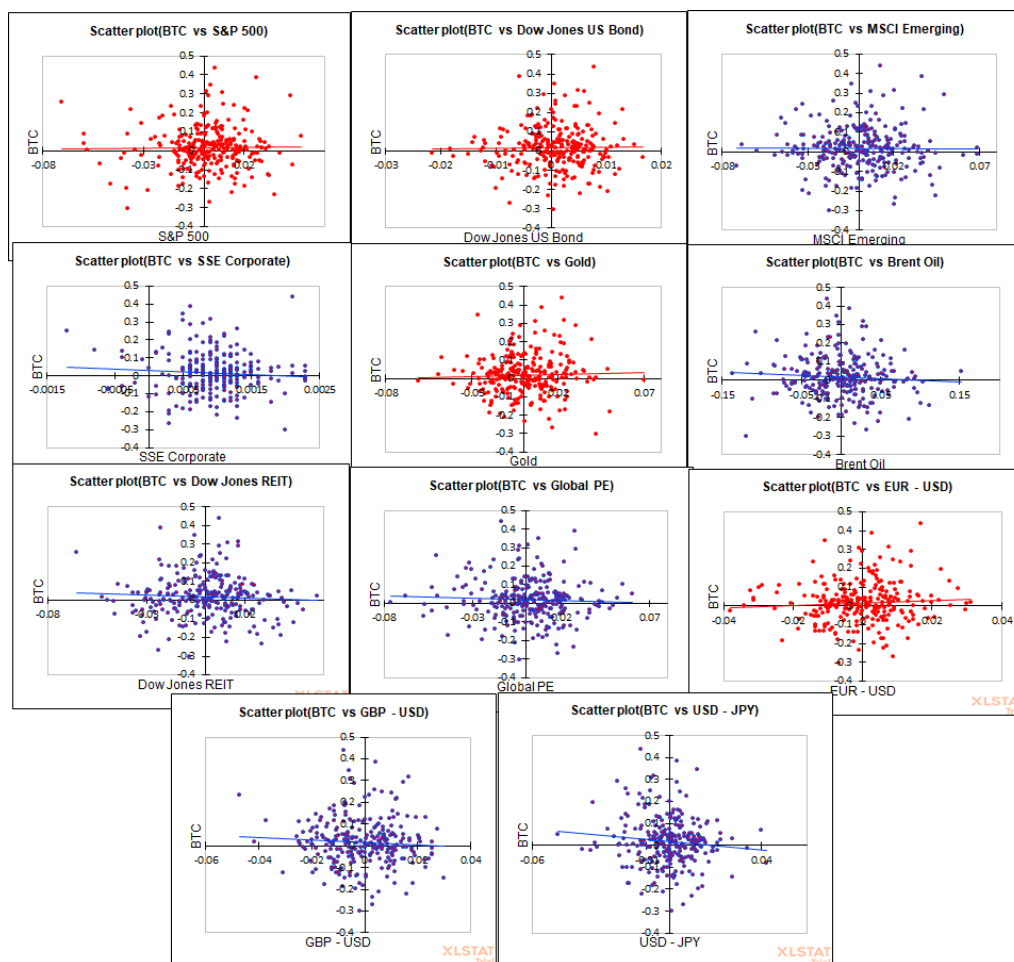

Exhibit 6.5: Scatter plot of BTC against every independent variable mentioned in Data

In Period 2, as shown in Table 6.3, we see the same story. In fact, we have even lower level of correlation between Bitcoin and other assets in downturns when compared to economic boom.

Variables	BTC	MSCI Emergin	SSE Corporate	S&P500	DowJones US Corp	Brent Oil	Gold	Dow Jones REIT	Global Listed PE	EUR - USD	GBP - USD	USD - JPY
BTC	1	0.094	-0.024	0.032	0.004	0.102	-0.029	-0.029	0.058	-0.067	-0.001	0.016
MSCI Emerging	0.094	1	0.110	0.093	-0.007	0.257	0.008	0.103	0.788	0.132	0.427	0.241
SSE Corporate	-0.024	0.110	1	-0.019	-0.051	-0.139	-0.188	-0.061	0.058	-0.142	-0.113	0.122
S&P500	0.032	0.093	-0.019	1	0.195	-0.092	-0.120	0.888	0.279	-0.169	0.235	0.112
DowJones US Corp	0.004	-0.007	-0.051	0.195	1	0.077	-0.110	0.234	-0.103	-0.038	0.138	-0.209
Brent Oil	0.102	0.257	-0.139	-0.092	0.077	1	0.071	-0.114	0.169	0.203	0.297	-0.176
Gold	-0.029	0.008	-0.188	-0.120	-0.110	0.071	1	-0.177	-0.090	0.070	0.078	-0.043
Dow Jones REIT	-0.029	0.103	-0.061	0.888	0.234	-0.114	-0.177	1	0.282	-0.083	0.318	0.034
Global Listed PE	0.058	0.788	0.058	0.279	-0.103	0.169	-0.090	0.282	1	-0.031	0.353	0.339
EUR - USD	-0.067	0.132	-0.142	-0.169	-0.038	0.203	0.070	-0.083	-0.031	1	0.606	-0.595
GBP - USD	-0.001	0.427	-0.113	0.235	0.138	0.297	0.078	0.318	0.353	0.606	1	-0.466
USD - JPY	0.016	0.241	0.122	0.112	-0.209	-0.176	-0.043	0.034	0.339	-0.595	-0.466	1

Table 6.3: Correlation Matrix in Period 2

We have the highest correlation of 0.11 in absolute term in Period 1, but in Period 2 we have 0.10. So, we can say that Bitcoin becomes an even better alternative investment in economic crises. Evident from the Exhibit 6.6 below, like in Period 1, we have none of the correlations that are statistically significant.
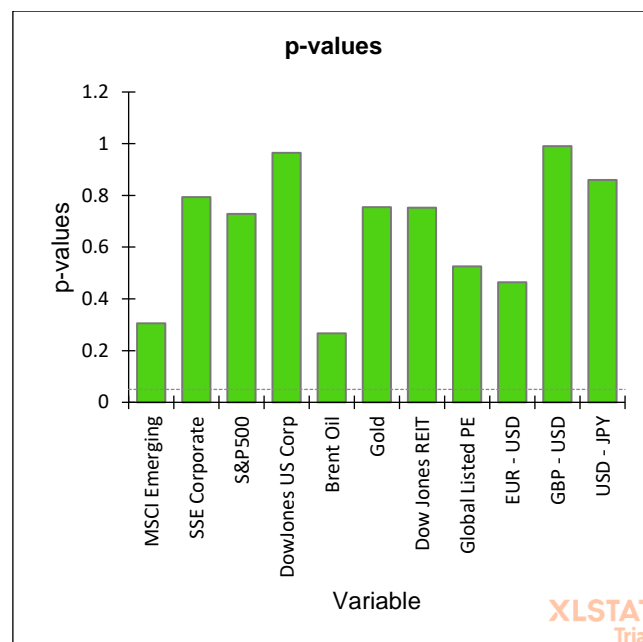

Exhibit 6.6: Histogram of p-values of correlation in Period 2

All values are above the critical value of 0.05 represented by a dotted horizontal line.

In Period 1, I am regressing Bitcoin returns on returns of the mentioned 11 explanatory variables in four steps. First on stocks and bonds indices (Model 1), Second on alternative investments (Model 2), third on currency pairs (Model 3) and Last on all variables combined (Model 4). The aim here is to check which model gives the highest coefficient of determination, R^2, and when *a set of variables* are added does it increase R^2 and simultaneously reduce adjusted-R^2; additional variables are correlated and their inclusion in to the model is of no good, a situation referred to as multicollinearity.

Starting with stocks and bonds indices, exhibit 6.7 below summarizes results when Bitcoin is regressed on MSCI Emerging Market, SSE Corporate Bonds, S&P 500 and Dow Jones US-issued Corporate Bonds indices.

Regression Statistics	
Multiple R	0.083702
R Square	0.007006
Adjusted R Square	-0.00851
Standard Error	0.109621
Observations	261

ANOVA

	df	SS	MS	F	Significance F
Regression	4	0.021704	0.005426	0.451545	0.771228833
Residual	256	3.076266	0.012017		
Total	260	3.097971			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper95%
Intercept	0.031053	0.014183	2.18948	0.029465	0.00312319	0.058984
S&P 500	0.316454	0.502579	0.62966	0.529479	-0.67326176	1.306169
Dow Jones US Bond	0.463719	1.137453	0.407682	0.683848	-1.77623839	2.703677
MSCI Emerging	-0.24774	0.399453	-0.6202	0.535679	-1.03437122	0.538892
SSE Corporate	-15.2694	13.16693	-1.15968	0.247261	-41.1986491	10.65993

Exhibit 6.7: BTC Regressed on Stocks & Bonds Indices

The model explains only 0.7% of the return in Bitcoin. Individually explanatory variables are statistically insignificant since P-value for each is greater than 5% significance level. Model as a whole is also statistically insignificant as F-statistic of 0.77 is greater than 0.05.

Continuing with regression, Bitcoin on the mentioned alternative investment classes of Gold, Brent Oil, Private Equity and Real Estate in Exhibit 6.8.

Regression Statistics

Regression Statistics	
Multiple R	0.104518
R Square	0.010924
Adjusted R Square	-0.00453
Standard Error	0.109404
Observations	261

ANOVA

	df	SS	MS	F	Significance F
Regression	4	0.033842	0.008461	0.70686	0.587887
Residual	256	3.064128	0.011969		
Total	260	3.097971			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.017484	0.006826	2.561258	0.011003	0.004041	0.030927
Gold	0.323437	0.414863	0.779625	0.436332	-0.49354	1.140416
Brent Oil	-0.17207	0.164177	-1.04811	0.295578	-0.49538	0.151234
Dow Jones REIT	-0.40013	0.374732	-1.06777	0.286632	-1.13808	0.337823
Global PE	0.063718	0.386339	0.164928	0.869131	-0.69709	0.824525

Exhibit 6.8: BTC Regressed on Gold, Brent Crude, Real Estate & Private Equity

Variables in the Exhibit above explains Bitcoin returns a little better than the previous model. R^2 is 1.1% but individual independent variables and model as a whole remain statistically insignificant.

Regression of bitcoin on currency pairs gives the following results.

Regression Statistics	
Multiple R	0.15662
R Square	0.02453
Adjusted R Square	0.013143
Standard Error	0.108437
Observations	261

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.075992	0.025331	2.154222	0.093892
Residual	257	3.021978	0.011759		
Total	260	3.097971			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.016861	0.006722	2.508544	0.01274	0.003625	0.030098
EUR - USD	1.038331	0.785804	1.321361	0.187556	-0.5091	2.585765
GBP - USD	-1.12187	0.630435	-1.77951	0.076337	-2.36334	0.119609
USD - JPY	-0.67217	0.612076	-1.09817	0.273156	-1.87749	0.533156

Exhibit 6.9: BTC Regressed on Currency Pairs

Here R^2 is 2.4%, more than that of previous two models combined but t-test and f-test still signal insignificance in the model.

Combining all the variables and regressing Bitcoin on them gives the following statistics.

Regression Statistics	
Multiple R	0.237384
R Square	0.056351
Adjusted R Square	0.014664
Standard Error	0.108354
Observations	261

ANOVA

	df	SS	MS	F	Significance F
Regression	11	0.174575	0.01587	1.3517628	0.1966
Residual	249	2.923396	0.011741		
Total	260	3.097971			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.027999	0.014307	1.957032	0.0514611	-0.00018	0.056176
S&P 500	1.411362	0.737152	1.914615	0.0566875	-0.04049	2.863209
Dow Jones US Bond	0.339987	1.372255	0.247758	0.8045258	-2.36272	3.042694
MSCI Emerging	-0.22585	0.490887	-0.46009	0.6458549	-1.19267	0.740969
SSE Corporate	-14.1503	13.30062	-1.06388	0.2884123	-40.3464	12.04575
Gold	0.098873	0.519266	0.190408	0.8491445	-0.92384	1.121587
Brent Oil	-0.20679	0.1692	-1.22216	0.2228041	-0.54004	0.126457
Dow Jones REIT	-0.82132	0.456572	-1.79889	0.0732476	-1.72056	0.077915
Global PE	-0.02139	0.74065	-0.02888	0.9769806	-1.48013	1.437345
EUR - USD	1.019666	0.989439	1.03055	0.3037519	-0.92907	2.968402
GBP - USD	-1.18763	0.669703	-1.77337	0.0773899	-2.50663	0.131374
USD - JPY	-1.09932	0.80284	-1.36929	0.1721435	-2.68054	0.481905

Exhibit 6.10: BTC Regressed on all eleven independent variables

This model is the best of all, increasing R^2 to 5.6% and adjusted-R^2 to 1.5%. Adding more variables has increased both the R^2 and adjusted-R^2 so this model has no multicollinearity, but insignificance remains there.

In period 2 all four aforementioned models produce nearly the same results as obtained in Period 1 which are summarized in the table 6.5 below. Detailed regression statistics for Period 2 are available in Appendix C.

	R^2	ADJUSTED-R^2	T-TEST (INDIVIDUAL INDEPENDENT VARIABLES)	F-TEST
MODEL 1	1.1%	-2.3%	Not Significant	Not Significant
MODEL 2	1.4%	-1.4%	Not Significant	Not Significant
MODEL 3	0.7%	-1.7%	Not Significant	Not Significant
MODEL 4	5.6%	1.4%	Not Significant	Not Significant

Table 6.5: Period 2 Statistics Summary

In this section I will regress bitcoin returns on three lagged variables of its own. That is, the independent variables are BTC_{t-1}, BTC_{t-2} and BTC_{t-3}. Since the relationship and correlation of Bitcoin is not statistically significant with other assets in economic upturn and downturn, it will be interesting to see if past returns are of any use in predicting the future returns. Exhibit 6.11 has the details.

In Period 1 the auto-regressive model gives the following statistics.

Regression Statistics	
Multiple R	0.12719
R Square	0.016177
Adjusted R Square	0.004512
Standard Error	0.109503
Observations	257

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.049885	0.016628	1.386728	0.247304
Residual	253	3.033722	0.011991		
Total	256	3.083606			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.015346	0.007143	2.148389	0.032632	0.001279	0.029414
BTC(t-1)	-0.03111	0.062836	-0.49507	0.620977	-0.15486	0.092639
BTC(t-2)	0.049223	0.062829	0.783454	0.434093	-0.07451	0.172957
BTC(t-3)	0.117069	0.063391	1.846773	0.065948	-0.00777	0.24191

Exhibit 6.11: Period 1 BTC Auto-regressive Model

None of the independent variables are significantly different from zero, as suggested by P-value which are less than 0.05. Same is the case with the whole model. So, we come to a conclusion that past returns are not a good model for predicting future returns.

Period 2 Auto-Regressive Model:

Regression Statistics	
Multiple R	0.272
R Square	0.073984
Adjusted R Square	0.058109
Standard Error	0.046014
Observations	179

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.029603	0.009868	4.660531	0.00369
Residual	175	0.370526	0.002117		
Total	178	0.400129			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	0.003057	0.00346	0.883664	0.37809	-0.00377	0.009886
BTC(t-1)	-0.2	0.075184	-2.66017	0.008536	-0.34839	-0.05162
BTC(t-2)	0.077015	0.07652	1.006474	0.315577	-0.07401	0.228036
BTC(t-3)	-0.10507	0.075476	-1.39212	0.165651	-0.25403	0.043888

Exhibit 6.12: Period 2 BTC Auto-regressive Model

The Exhibit 6.12 above shows that in economic crises Bitcoin returns are predictable using the lagged variables of the same. The variable BTC_{t-1} is statistically significant while other two are not, but the model is also significant. This model explains 7.4% of the return in Bitcoin compared to 1.6% in the Period 1.

7. Conclusion

Bitcoin and other digital currencies are a disruptive innovation to payment systems in general and financial assets in particular. Only time will tell whether this is one of the biggest revolutions in fintech of our generation or yet another bubble in wide array of intangibles assets.

> For now, this research deals with the question whether Bitcoin is an alternative class of investment. The Answer is Yes – It is.

This paper has shown that Bitcoin has non-normal distribution of returns which is one of the striking features of alternative class of investments, a finding supported by Danis Schweiser (Schweizer 2008).

I have found that Bitcoin has very low correlation with traditional and alternative investments, a finding supported by Caveat Emptor (Eisl, Gassery and Weinmayerz 2015) but this study takes on additional variables of currency pairs to investigate whether there is a relationship between Bitcoin and US dollar, Euro, Pound Sterling and Japanese Yen, to which I have found no relationship with. Yet another standout feature of this research is two different timeframes, Boom and Bust times which have been represented by January 2015 – December 2019 and January 2020 – June 2020 respectively. I have also found that none of the financial assets represented by indices in the paper can predict return on Bitcoin in either of the mentioned time periods baring Bitcoin itself. Auto-regressive models suggest that Bitcoin returns are predictable in an economic downturn, a result which contradicts findings by Sinan Inan (Inan, Are Cryptocurrency Price Changes Predictable 2018). It should be noted that timeframes for data selections have been

inclusive for what happened in financial markets in last five years, taking note of the crypto-currency crash of 2018[15] and economic impact of covid-19 pandemic[16].

As mentioned in Results, bitcoin performs better than traditional investments on both absolute and risk-adjusted return basis and in both bullish and bearish times. Given the small size of market capitalization of Bitcoin, or any other digital currency for that matter, compared to market capitalization of stocks and bonds, it should not be perceived as an immediate 'threat' in terms of instability or regime change in financial markets. This naturally leads to low levels of acceptance by investors from behavioral finance perspective. Digital currencies can potentially be a very attractive investment for institutional investors, which in turn can help to ease down the fear faced by individual investors.

Alternative investments have peculiar characteristics, most importantly the unique risk factors. For example, venture capital investment in private equity can have a look-up period of five years and a direct real estate investment can have a high illiquidity and a neighborhood risk, likewise Bitcoin has a very high volatility and safety risk. Although safety issues are being addressed but they remain a threat. So, an investor should consider these unusual risks, his/her investment portfolio ingredients and risk tolerance before making an investment in Bitcoin.

Limitations

Sharpe Ratio is one of the most widely taught concepts in business schools and I have used it to measure the return per unit of risk but in this situation it has two drawbacks. One, it assumes returns are normally distributed and two, it gives equal weights to positive fluctuation (movement above the mean) and negative fluctuation (movement below the mean). It is impossible to find an investor who would see positive and negative fluctuations as having an equal effect on investment.

As mentioned in the paper, I have tried to be comprehensive when it comes to data time period, but Bitcoin returns calculated would have been different if I had not included the Jan-Feb 2018 crash of digital currencies. If such crash where BTC

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[15] https://en.wikipedia.org/wiki/Cryptocurrency_bubble
[16] https://en.wikipedia.org/wiki/Economic_impact_of_the_COVID-19_pandemic

lost 65% of its value does not repeat itself in an investment timeline, the returns calculated here have a downward bias.

Period 2 (January 2020 – June 2020) has data frequency of daily which can signal increased volatility compared to weekly and monthly frequency, but at the time of writing we are in the sixth month of the economic impact of Covid-19 so weekly or month sampling would have produced a very small sample size.

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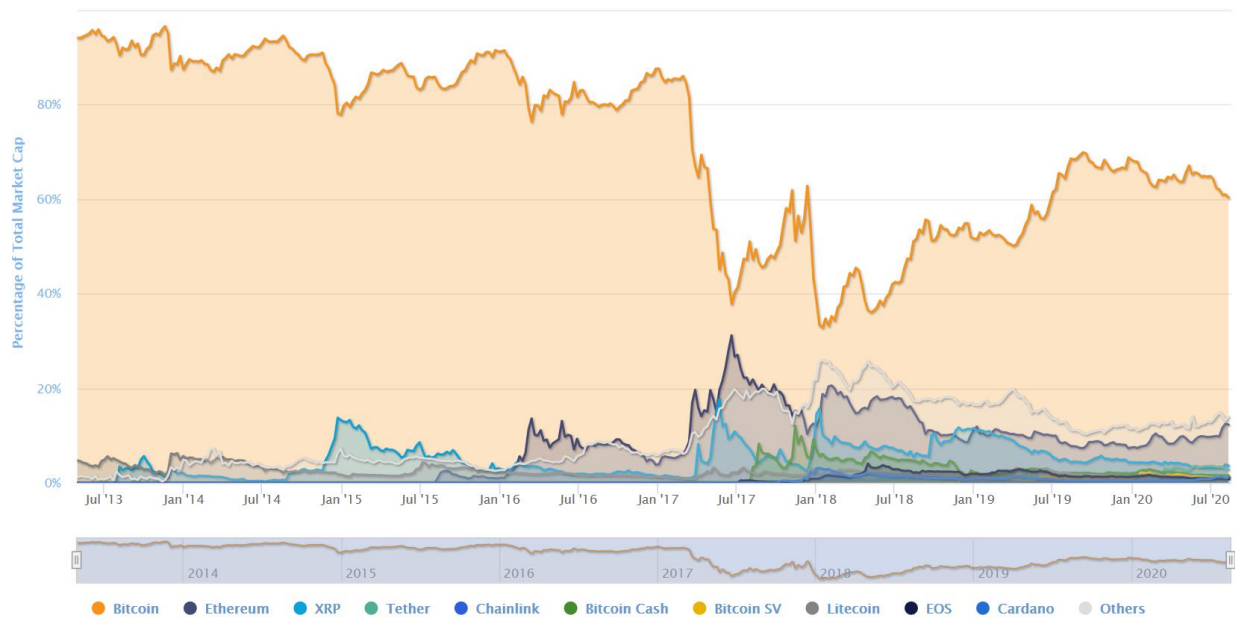
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Appendix

Appendix A: Bitcoin's Lion's share in cryptocurrency market

Source: Coinmarketcap.com

Appendix B:

Statistical test results on non-normality of BTC in Period 1

Shapiro-Wilk test (BTC):

W	0.971
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Anderson-Darling test (BTC):

A²	2.424
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0,

 and accept the alternative hypothesis Ha.

Lilliefors test (BTC):

D	0.091
D (standardized)	1.466
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Jarque-Bera test (BTC):

JB (Observed value)	34.695
JB (Critical value)	5.991
DF	2
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Summary:

Variable\Test	Shapiro-Wilk	Anderson-Darling	Lilliefors	Jarque-Bera
BTC	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**

Statistical test results on non-normality of BTC in Period 2

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
BTC	182	0	182	-0.382	0.142	0.003	0.047

Shapiro-Wilk test (BTC):

W	0.785
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Anderson-Darling test (BTC):

A²	6.151
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Lilliefors test (BTC):

D	0.141
D (standardized)	1.899
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Jarque-Bera test (BTC):

JB (Observed value)	4534.674
JB (Critical value)	5.991
DF	2
p-value (Two-tailed)	< 0.0001
alpha	0.05

Test interpretation:

H0: The variable from which the sample was extracted follows a Normal distribution.

Ha: The variable from which the sample was extracted does not follow a Normal distribution.

As the computed p-value is lower than the significance level alpha=0.05, one should reject the null hypothesis H0, and accept the alternative hypothesis Ha.

Summary:

Variable\Test	Shapiro-Wilk	Anderson-Darling	Lilliefors	Jarque-Bera
BTC	**<0.0001**	**<0.0001**	**<0.0001**	**<0.0001**

Appendix C: Regression of BTC in Period 2

<u>Model 1</u>

Regression Statistics	
Multiple R	0.102158
R Square	0.010436
Adjusted R Square	-0.02339
Standard Error	0.054509
Observations	122

ANOVA

	df	SS	MS	F	Significance F
Regression	4	0.003666	0.000917	0.308482	0.871819
Residual	117	0.347633	0.002971		
Total	121	0.351299			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.00499	0.00868	0.574927	0.566445	-0.0122	0.02218	-0.0122	0.02218
MSCI Emerging	0.266368	0.260136	1.023956	0.307969	-0.24882	0.781554	-0.24882	0.781554
SSE Corporate	-9.94418	27.46196	-0.36211	0.717925	-64.3312	44.44279	-64.3312	44.44279
S&P500	0.041887	0.172721	0.242512	0.808808	-0.30018	0.383951	-0.30018	0.383951
DowJones US Corp	-0.01168	0.642	-0.0182	0.985511	-1.28313	1.259764	-1.28313	1.259764

Model 2

Regression Statistics	
Multiple R	0.121172
R Square	0.014683
Adjusted R Square	-0.01816
Standard Error	0.053757
Observations	125

ANOVA

	df	SS	MS	F	Significance F
Regression	4	0.005167	0.001292	0.447043	0.774368
Residual	120	0.346773	0.00289		
Total	124	0.351941			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.002271	0.004831	0.470022	0.639192	-0.00729	0.011836	-0.00729	0.011836
Brent Oil	0.084348	0.085086	0.991326	0.323521	-0.08412	0.252813	-0.08412	0.252813
Gold	-0.13323	0.323587	-0.41172	0.681276	-0.77391	0.507451	-0.77391	0.507451
Dow Jones REIT	-0.05696	0.13899	-0.40983	0.682663	-0.33215	0.218228	-0.33215	0.218228
Global Listed PE	0.0877	0.169749	0.516649	0.606352	-0.24839	0.423791	-0.24839	0.423791

Model 3

Regression Statistics	
Multiple R	0.083294
R Square	0.006938
Adjusted R Square	-0.01671
Standard Error	0.053166
Observations	130

ANOVA

	df	SS	MS	F	Significance F
Regression	3	0.002488	0.000829	0.293426	0.830086
Residual	126	0.35615	0.002827		
Total	129	0.358639			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.001309	0.004678	0.27973	0.780143	-0.00795	0.010567	-0.00795	0.010567
EUR - USD	-1.09863	1.189508	-0.9236	0.357461	-3.45263	1.255373	-3.45263	1.255373
GBP - USD	0.342677	0.743116	0.461135	0.645497	-1.12793	1.813281	-1.12793	1.813281
USD - JPY	-0.21336	0.813145	-0.26239	0.79345	-1.82255	1.395829	-1.82255	1.395829

Model 4

Regression Statistics	
Multiple R	0.223681
R Square	0.050033
Adjusted R Square	-0.04244
Standard Error	0.054394
Observations	125

ANOVA

	df	SS	MS	F	Significance F
Regression	11	0.017609	0.001601	0.541046	0.871494
Residual	113	0.334332	0.002959		
Total	124	0.351941			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	0.007377	0.008972	0.822185	0.412703	-0.0104	0.025153	-0.0104	0.025153
MSCI Emerging	0.553361	0.481111	1.150173	0.252501	-0.39981	1.506529	-0.39981	1.506529
SSE Corporate	-20.1532	28.66148	-0.70315	0.483411	-76.9368	36.63036	-76.9368	36.63036
S&P500	0.49458	0.376031	1.315264	0.191084	-0.25041	1.239566	-0.25041	1.239566
DowJones US Corp	-0.2492	0.705533	-0.35321	0.724587	-1.64699	1.148584	-1.64699	1.148584
Brent Oil	0.065728	0.093054	0.706341	0.48143	-0.11863	0.250084	-0.11863	0.250084
Gold	-0.23327	0.344447	-0.67724	0.499636	-0.91569	0.449138	-0.91569	0.449138
Dow Jones REIT	-0.38812	0.306004	-1.26835	0.207279	-0.99437	0.218128	-0.99437	0.218128
Global Listed PE	-0.12871	0.303633	-0.42391	0.672439	-0.73026	0.472839	-0.73026	0.472839
EUR - USD	-1.46238	1.354126	-1.07994	0.282466	-4.14515	1.220386	-4.14515	1.220386
GBP - USD	-0.11128	1.093653	-0.10175	0.919134	-2.278	2.055444	-2.278	2.055444
USD - JPY	-0.86809	1.077085	-0.80596	0.421956	-3.00199	1.265808	-3.00199	1.265808