The new digital gold? Exploring the future potential of Bitcoin as a hedge against traditional financial assets

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Abstract

This paper explores the future potential of Bitcoin as a financial hedging asset for purposes of risk management in traditional portfolios holding equities and other major asset classes. Using a data period of 1st January 2014 - 30th November 2017 and a combination of a DCC mGARCH model and OLS regressions, this paper has found that Bitcoin acts as a diversifier and a weak safe haven for most asset classes considered. However, it suffers from increased correlation and a 'contagion of losses' during market uncertainty in some Asian markets and there is no evidence of Bitcoin providing strong safe haven abilities during fiat currency crises. Given this limited diversification potential as well as the practical limitations of buying and holding Bitcoin, this paper finds little support for Bitcoin's future use as a hedge, especially when compared to the performance of the classic market hedge - gold.

Contents

1 Introduction

In Bitcoin's short but turbulent history as an asset class, it has produced one of the greatest bull market rallies in financial history,[1] which preceded the early 2018 crash in which prices fell over 70%.[2] These financial gains, coupled with frequent hacking attempts and connections to the 'dark web' has resulted in rampant media coverage of 'cryptocurrencies' in the past few years. Despite this, little focus by academic researchers has been committed to this new technology beyond the widespread and rational criticisms of Bitcoin's inability to be a feasible currency.[3] This paper has sought to add to this literature by exploring any remaining use cases for the technology - in particular, its potential as a financial hedging asset.

Having analysed the correlation of Bitcoin to a range of traditional assets, this paper has found Bitcoin has diversification and close to weak safe haven abilities against most assets considered in the study. However, the Hang Seng and KOSPI indexes suffer from increased correlation to Bitcoin during poor market performance. The academic view that Bitcoin is best viewed as a combination gold and fiat currencies,[4] has been supported by strong correlations to USD and gold. Furthermore, this paper has found no evidence to support the idea that Bitcoin is an effective hedge in times of extreme currency crisis, but the exact opposite when the currency crisis of Brexit is considered.

1.1 Background to Cryptocurrencies

Cryptocurrencies is a wide-ranging term used to describe the substantial new market of blockchain-based 'e-coins', each of which have substantially different aims; from revolutionising third-world healthcare to transforming the global financial system through a new decentralised currency. To distinguish these aims, the paper will separate cryptocurrencies into 3 main categories. The focus of this paper is on the first category; those that offer an alternative currency to traditional fiat money e.g. Bitcoin and Litecoin. The remaining two types; coins that exist to serve a particular non-monetary use case, including payment processing tokens such as Ripple, and tokens for use on their own blockchain network, e.g. Ethereum, are not a focus of this paper.

The leading cryptocurrency by market price, volume, market capitalisation and media attention, and thus the primary focus of this paper, is Bitcoin. Created in 2008 it was released under the anonymous alias of Satoshi Nakamoto (Nakamoto (2008)) and founded upon the libertarian views of the devolution of money from government and the Austrian school view that currency must have an underlying value and cannot be printed at will.[5] Bitcoins are produced by solving increasingly complex computer algorithms until a 'hard-cap' of 21 million has been produced. However, given the ease at which Bitcoin can be lost through non-recoverable e-wallets, typographical errors in transactions and hacking suggest that this limited supply will shrink over time.[6]

1.2 Literature Review

Despite the nascent academic literature surrounding Bitcoin, a wide consensus has been reached of Bitcoin's limited potential as a functioning currency (Glaser et al. (2014)). This is due to its inability to meet the three main characteristics of a currency; unit of account, store of value and a medium of exchange. The lack of any legal goods priced in Bitcoin,[7] and readability issues of goods priced in decimals as a result of each Bitcoin being split into 100,000,000 'satoshis' mean Bitcoin cannot be considered a viable unit of account. Furthermore, its large price volatility, (Katsiampa (2017)), raise huge concerns for the asset's store of value capabilities. Finally, its now-outdated technological design compared to other new 'alt-coins'[8] means transactions can be prohibitively expensive, delayed for up to an hour and are confirmed at a rate of just 10 transactions per second, thus limiting any use as a medium of exchange.[9][10][11]

Academic research has also focused on Bitcoin's close similarity to gold(Dyhrberg (2016*a*)), primarily based on their shared decentralised nature from any country or person, a useful feature of a hedging asset (Capie et al.

[1] Domm (2017)
[2] *Bitcoin Price Information* (2018)
[3] *Bitcoin Criticisms* (2018)
[4] See section 1.2.
[5] Whilst having no intrinsic value, Bitcoin has a fixed finite supply.
[6] Sulleyman (2017)
[7] The most widespread use of Bitcoin as an actual currency was on dark web marketplaces such as The Silk Road (Raeesi (2015)).
[8] Any cryptocurrency other than Bitcoin.
[9] Fees have averaged $28 during high demand periods - Browne (2017).
[10] Bohme et al. (2015)
[11] *Bitcoin transactions per second* (2017)

(2005)). Also, they both have rising marginal costs of production,[12] and a fixed global supply in the long term which protects against inflation concerns in a way fiat currencies cannot.

Crucially however, unlike gold, Bitcoin lacks any intrinsic value. Whilst much of gold's price is a result of speculative demand, its use in electronics and jewellery provide a price floor to the asset which can reassure investors. This lack of intrinsic value is a shared characteristic with fiat currencies, and as such literature has placed Bitcoin between gold and fiat money in both its store of value and medium of exchange capabilities (Dyhrberg (2016*a*)).

Based upon this loose definition of Bitcoin, research has then focused on its behaviour as a financial asset. Anecdotal evidence has suggested that Bitcoin's technical similarities to gold mean it has been a 'digital gold' during fiat currency crises such as the Cypriot banking crisis (2012-2013) where Bitcoin has provided an 'exit ramp' [13] for investors from troubled currencies with capital controls, and as such Bitcoin demand and prices rose as a result (Bouri (2017)). Other examples have included geopolitical shocks such as the recent political uncertainty in Zimbabwe which led to Bitcoin trading at double the global market price on local exchanges.[14]

However, academic papers have demonstrated limited support for these circumstantial events. Dyhrberg (2016*b*) finds Bitcoin to be uncorrelated, and thus a weak hedge to equity indexes and the US dollar - and therefore a less effective hedge than gold (Capie et al. (2005)). A further paper, Bouri (2016), uses a DCC-mGARCH model and finds non-significant coefficients with the exception of Chinese stocks which had a significantly negative correlation. However in her later work Bouri (2017) used a respecified model to study Bitcoin's correlation to numerous VIX volatility indicators and found a significant negative correlation in the short run.

In conclusion, whilst current research has categorised Bitcoin relative to its peers, there is no firm consensus as to the hedging potential of Bitcoin, thus highlighting the importance of the further research undertaken by this paper.

1.3 Contributions and Aims of this Paper

This paper seeks to build on this existing literature in terms of increasing the range of traditional assets considered, as well as explicitly studying Bitcoin's hedging ability against fiat currency crises. Furthermore, given the rapid development of the technology, a more updated time period is likely to be a useful contribution to the aforementioned literature.

Bitcoin's relatively informal adoption as a speculative asset, fuelled by 'Bitcoin millionaires' and media coverage, has attracted primarily amateur and retail investors to the market to date.[15] However, as the market begins to mature, an increasing minority of institutional investors are focusing on the market with the launch of futures, ETFs and 'crypto-funds'.[16] These developments have the potential to greatly expand both the opportunites and systemic risks of cryptocurrencies. For instance, the introduction of gold ETFs in 2004 hugely simplified the ownership process, a huge current barrier to entry for Bitcoin, and led to far more widespread gold ownership.[17] As such, there is a vital need for more analysis into how Bitcoin function as an asset in relation to the global financial markets, both in terms of potential wider systemic risk and its use in investment portfolios.

2 The Theoretical Framework

Given its lack of feasible use and a relatively fixed supply in the short term, Bitcoin's price is entirely driven by speculative demand and thus it is difficult to determine a fundamental value. The cause of this speculation is heavily linked to exogenous shocks impacting the confidence in the wider cryptocurrency sector - for instance, Bitcoin's price frequently falls following high profile hacking of exchanges,[18] or news of impending regulation in countries such as China (Neate (2017)).

However, this paper also assumes that Bitcoin's price is determined by the performance of similar assets for two main reasons. Firstly, Bitcoin is a substitute investment good for more traditional assets - a relationship that can have both a positive income and negative substitution effects on Bitcoin demand during strong traditional market performance. For instance, strong equity market performance may make increase investor confidence, and lead to them investing more capital elsewhere i.e. Bitcoin, or conversely it may dampen demand for alternative investment choices due to the success of their current portfolio. Given the current volatility of Bitcoin, these effects

[12] Bitcoin "mining" is a hugely energy-intensive process (O'Dwyer & Malone (2014)).
[13] Kelly (2018)
[14] Brand (2017)
[15] Ross (2017)
[16] Wigglesworth (2017)
[17] Saefong (2013)
[18] A 36% fall in Bitcoin price followed the hack and closure of a major exchange, Mt Gox, in 2014 (Ashton (2016)).

will unfortunately provide unwanted bias to econometric results since the decision making process of investors will be heavily influenced by the current volatility of Bitcoin.

Secondly, many of the underlying determinants of traditional assets' demand are also determinants for Bitcoin, but often in reverse. For instance, a lack of confidence in a collapsing economy will lead to the associated equity markets and currencies depreciating, whilst the decentralised nature of Bitcoin means it is likely to be unaffected or even rise as investors flee from these other markets. This effect is likely to be even more powerful during currency crises because whilst all Bitcoin transactions are recorded publicly on the blockchain, the recipients and senders are anonymous. As a result, Bitcoin can be used by investors to circumvent capital controls in troubled countries, meaning once capital controls are imposed in a nation, Bitcoin's price could be expected to rise, *cetirus paribus*.

Furthermore, given Bitcoin's unbalanced global adoption, it is assumed that Bitcoin's correlation to assets will be uneven across the globe. For instance, Bitcoin is more likely to react to equity markets in high-adoption areas since there are more investors pricing this equity market's embedded information into Bitcoin's price.

The current volatility of Bitcoin is a huge risk to potential investors and undermines, to some extent, the ability of Bitcoin to act as an effective hedging asset. To control for this, this paper is primarily focusing on the *future* hedging ability of Bitcoin and makes the vital, and potentially limiting, assumption that Bitcoin's price volatility is a rational technological bubble seen throughout history in events such as the US railroads, 'canal mania' and the 'dot-com' booms (Perez (2009)). This simplifying assumption supposes that in the medium to long-term price stability will occur in crypto-currency markets, and associated risk will fall, as it did in the post dot-com crash NASDAQ market. However, the fundamental decentralised nature of Bitcoin, or its successor as a result of innovation, which allows for the previously mentioned relationships with traditional assets will continue to persist.

These assumptions lead to the three hypotheses of the paper:

1. Given its technical similarities to gold, Bitcoin should share its hedging ability and act as a safe haven against traditional assets.

2. Bitcoin's hedging ability should vary across geographic markets, given the differing rates of adoption of this technology across regions.

3. Anecdotal evidence of strong Bitcoin performance during fiat currency crises is supported by the more rigorous econometric analysis of this paper.

3 Data and Descriptive Analysis

3.1 The Data

This paper has focused on market data from January 1st 2014 until November 30th 2017 which resulted in a dataset of 1021 market days after controlling for weekends and differing public holidays across countries. A relatively short time period has been used because Bitcoin transaction volume prior to 2014 is extremely low.[19] This is deemed important because a low transaction volume means few people were trading in reaction to traditional asset movements and these traders' signals could easily be 'drowned out' by noise of irrational investors,[20] and as such Bitcoin would have substantial different hedging abilities in comparison to the current market.

Market prices for Bitcoin were collated from www.coinmarketcap.com, the leading industry source for cryptocurrencies, and are quoted as the average of major exchanges globally.[21] Traditional asset prices were collected from DataStream.[22][23]

Traditional assets considered include a range of equity markets, which are proxied for through equity indexes, as well as gold, major fiat currencies, a world bond index and geographic region indexes. Countries and regions have been selected based upon areas of significant Bitcoin demand,[24] and include USA, UK, Germany, Hong Kong, South Korea, China and Japan.

For purposes of analysis, all market prices are modelled as daily log returns.

[19] *Bitcoin Transaction Volume* (2018)
[20] Given its use in widespread use in the dark web meant early investors were often criminals not rational investors (Foley (2018)).
[21] The average is taken due to the significant 'Kimchi Premiums' in South Korea, (*Kimchi Premium* (2018)).
[22] GBP index from Bank of England was the only exception (*BofE GBP Index* (2018)).
[23] A more thorough background to the data is found in Appendix 8.1.
[24] Given the anonymity of users this has been based on fiat currency-Bitcoin trades and exchange locations (*Bitcoin Adoption Rates* (2018)).

3.2 Descriptive Analysis

The summary statistics of the log returns are displayed in the table below. [25]

Table 1: Summary Statistics of Percentage Daily Log Returns*

Assets	*Mean*	*S.D.*	*Min*	*Max*
Bitcoin	0.2502	4.33	-24.71	22.64
FTSE 100	0.008043	.8740	-4.779	3.514
DAX 30	0.0303	1.162	-7.067	4.852
S&P 500	0.03520	.7557	-4.021	3.829
Nikkei 225	0.03260	1.281	-8.253	7.426
Hang Seng	0.02200	1.027	-6.018	4.021
Shanghai A-Share	0.04403	1.525	-8.873	5.604
KOSPI	0.02037	.6843	-3.143	2.912
MSCI World	0.0219	.6688	-5.029	2.565
MSCI Europe	0.0006625	.9807	-9.178	4.321
MSCI Pacific	0.01426	.9345	-4.489	5.086
Bond Index	-0.0003137	.1982	-1.010	.5790
Gold	0.005616	.8526	-3.224	4.618
USD	0.01454	.4468	-2.088	2.449
EURO	0.0000556	.3661	-2.112	2.254
JPY	0.002882	.5513	-2.494	4.613
GBP	-0.00749	.5211	-7.026	2.217

* To 4 significant figures.

Bitcoin's volatility is far higher than any other asset considered, more than double the most volatile equity index (Shanghai), which highlights the potential issues of bias in results from excess volatility. However, gold also has a significantly higher volatility than many equity indexes, suggesting that the high volatility of Bitcoin may not fully discredit its ability to be a hedging asset.

4 Econometric Analysis

The econometric analysis is based on two different models; first, a DCC mGARCH model is used to study the correlation between Bitcoin and each traditional asset. Once a time series correlation is found, the hedging ability of Bitcoin is studied through an OLS regression.

4.1 DCC mGARCH Model

The dynamic conditional correlation multivariate generalised autoregressive conditional heteroskedasticity (DCC mGARCH) model developed by Engle (2002) is used to produce a time variant correlation variable between Bitcoin and each traditional asset.[26] The DCC model is commonly used in financial economics due to its focus on more than one moment as well as demeaning the log returns in order to find the correlation in the volatility of assets, helping to control for the Bitcoin's rapid price growth in the dataset.

The model is also specified such that Bitcoin is the only dependent variable, since it is assumed that given Bitcoin's comparatively small market capitalisation,[27] the asset does not have the power to influence stock markets.

Alternative modelling methods such as a constant correlation have been consistently rejected for financial assets (Bera & Kim (2002)). Other methods of modelling time variant regressions such as 'rolling regression' and 'exponential smoothing' techniques were deemed unsuitable due to their inability to track abrupt changes in volatility (Martin (1998)); a serious flaw given the volatility of Bitcoin.

[25] Table with the nominal values is shown in appendix 8.3.
[26] A background to this model is found in Appendix 8.2.
[27] Bitcoin market cap remained under $80bn for the majority of the time period considered.

4.2 OLS Regression

The following OLS regression equation was re-specified for each traditional asset (Bouri et al. (2017)) in order to assess the hedging performance of Bitcoin in different market conditions:

$$\rho_{ij,t} = \alpha_0 + \alpha_1(r_{Asset}q_{25}) + \alpha_2(r_{Asset}q_{10}) + \alpha_3(r_{Asset}q_5) + e_t \tag{1}$$

$(r_{Asset}q_i)$ is a multiplicative dummy variable which combines the absolute log return of the traditional asset with an additive dummy variable (q_i), which equals 1 for the worst i percentiles of market days.

This model is used because it allows Bitcoin to be assessed for its applicability to three key characteristics of a hedging asset; *diversifier, hedge* and *safe haven*. In line with the academic literature, (Bouri (2016)), these terms are defined as;

Diversifier

An asset that has a non-perfect positive correlation to another asset on average. Mathematically; when $0 < \alpha_0 < 1$.

Hedge

A strong (weak) hedge is an asset that is negatively correlated (uncorrelated) with another asset on average. Mathematically; when α_0 is negative (zero).

Safe haven

A strong (weak) safe haven is an asset that is negatively correlated (uncorrelated) with another asset in times of extreme negative performance. Mathematically; when α_1, α_2 and α_3 are negative (zero).

Analysing all three of these features is important for the purposes of assessing the hedging potential of Bitcoin. For instance, Bitcoin being a strong hedge would have limited benefit to investors if it has no safe haven abilities and becomes heavily correlated with stocks in crisis periods due to 'herd behaviour' (Calvo & Mendoza (2000)).

The model is then re-specified to study the impact that the currency shock resulting from Brexit had on Bitcoin's correlation to GBP in order to more accurately test the 3^{rd} hypothesis. This was deemed neccessary due to the relative stability of the other currencies considered during this dataset. The equation used to model this is defined below, (Dyhrberg (2016*a*));

$$\rho_{ij,t} = \alpha_0 + \alpha_1(r_{GBP})(Brexit) + e_t \tag{2}$$

The Brexit variable is a dummy variable that equals 1 in the 14 days following the Brexit vote, and 0 otherwise. This lag length was chosen as this was the length of time the pound continued to dramatically react to the news.[28]

[28]See Appendix 8.6.

5 Results

5.1 Model Results

The results from the OLS regressions are shown below:

Table 2: Coefficient results from OLS regressions

Assets	α_0	$\alpha_1(25\%)$	$\alpha_2(10\%)$	$\alpha_3(5\%)$
FTSE 100	0.2438***	0.0100***	-0.0014**	-0.0001**
DAX 30	0.2503***	-0.0161***	0.0024***	0.015**
S&P 500	0.2439***	0.0027***	0.0142 ***	-0.0014
Nikkei 225	0.1925***	0.0191***	-0.0314***	-0.0198**
Hang Seng	0.2048***	0.1697***	-0.0237**	-0.0167**
Shanghai A-Share	0.2425***	0.0131***	-0.0029***	-0.0018***
KOSPI	0.2240***	0.1263***	-0.0201***	-0.0112**
MSCI World	0.2396***	0.0444***	-0.0077***	-0.0048**
MSCI Europe	0.2458***	-0.0001***	0	0
MSCI Pacific	0.2155***	0.1603**	-0.0214**	-0.0180*
Gold	0.2745***	-0.1096***	0.0129**	-0.0097**
Bond Index	0.2500***	-0.0624***	0.0069**	0.0051*
USD	0.2852***	-0.3199***	0.0468**	0.0291*
EURO	0.2561***	-0.1086***	0.0133*	0.0109
JPY	0.2434***	0.0144***	-0.0020***	-0.0013**
Brexit	0.1422***	0.1653***	-	-

Notes: All values given to 4 d.p.
*** Significant at 1% level.
** Significant at 5% level.
* Significant at 10% level.

The coefficients demonstrate that Bitcoin acts as a diversifier for all the asset classes considered and is, or extremely close to being, a weak safe haven, for most assets, thus supporting the 1st hypothesis of this paper. However, Bitcoin lacks the superior negative correlation hedging abilities of gold (Beckmann (2014)).

Bitcoin also has no safe haven characteristics in certain Asian markets, for instance every 1% point increase in daily absolute log returns, given that the return is in the worst 25% of market days for the KOSPI, causes a $\frac{0.1697}{100} = 0.001697$ increase in the index's correlation to Bitcoin. This result supports the 2nd hypothesis of differences across geographic regions, but is contrary to the expectations defined in the framework which suggested that high Bitcoin adoption rates across Asia would mean Bitcoin's price rises as consumers flee falling equity assets in the region.[29] A key reason why this does not occur may be due to the current high volatility of Bitcoin biasing decisions since it means Bitcoin is not a low risk alternative such as cash or gold. As a result, investors may not increase demand for Bitcoin, and may even flee the asset in times of wider market uncertainty. This would represent a limitation of the model due to the excess volatility of the dataset. Secondly, Bitcoin and Asian market may also share the same determinants of demand, meaning potentially poor macroeconomic news could reduce demand for both assets. This is especially true given the number of retail investors in Bitcoin, meaning news of falling growth in Asia may result in a major investor base having less disposable income to invest in assets of any kind. No extra increase in correlation appears during extreme market days of the worst 5% and 10% as shown by low coefficients of α_2 and α_3. This indicates that no extra effect of entering into 'panic territory' exists, i.e. the rarity of the shock has no impact on correlation, it is merely the scale of the log return loss as captured by α_1.

Curiously, Bitcoin has close to weak safe haven abilities in Japan and China but not in Hong Kong and South Korea, despite being geographically close. Further econometric analysis has shown that a higher correlation to Western markets is found in Hang Seng (0.21) and KOSPI (0.17) indexes than in China (0.08). This suggests that the Bitcoin market may not be negatively reacting to these particular Asian equity markets but a globally weak market performance for that particular time period.

There is no evidence to support the 3rd hypothesis of Bitcoin's ability to function as a strong safe haven in currency crises, in fact slightly positive α_2, α_3 coefficients were found, suggesting not even weak safe haven

[29] *Bitcoin Adoption Rates* (2018)

characteristics are present. However, the currencies considered (USD, EUR, JPY) have not endured a severe currency crisis during the data period considered. When considering Brexit to model a currency shock, Bitcoin has a strong positive correlation - again suggesting no safe haven abilities. However, it is not possible to fully reject the hypothesis since there is the lack of capital controls placed on GBP following the Brexit vote - meaning there was little incentive to flee from GBP into Bitcoin more than any other fiat currency. In short, Brexit may not have been an extreme enough currency shock to lead to these strong safe haven effects becoming present.

The presence of a positive correlation when studying the period following Brexit may be a result of the current exchange mechanism for Bitcoin. Most western online crypto exchanges offer fiat currency deposits in Euros or Dollars only, when GBP fell upon news of the vote to leave, Bitcoin which has to be purchased via. USD or EUR, became dramatically more expensive for UK residents purely on fiat FX changes, resulting in a potential sell-off by holders and muted demand from UK buyers; resulting in falling Bitcoin prices.

A similar but reversed argument can be applied to explain the very negative α_1 coefficients for USD and EUR. As these currencies fall in value, buying Bitcoin with other currencies becomes relatively cheap, thus increasing demand and therefore Bitcoin price.

Furthermore, the strongest mean correlation (α_0) is with Gold and USD, supporting the academic literature outlined in section 1.2 suggesting Bitcoin is an asset lying somewhere between Gold and USD. However, α_1 shows a strong fall in correlation between Bitcoin and gold as the gold market worsens. This suggests a useful characteristic of Bitcoin, that whilst it does not possess the same degree of hedging and safe haven abilities as gold, it moves inversely in price as gold falls, suggesting a use as a unique asset which can be a diversifier against both the two typically negatively correlated markets of equities and gold.

These results are similar to that of Bouri (2017) who found widespread diversification capabilities of Bitcoin but only very limited hedge and safe haven properties.

5.2 Validity Testing

Three main tests are typically performed to ensure the validity of mGARCH model results, (Bollerslev (1990)).

The first test is to ensure that the standardised residuals of the model approach a normal distribution. This is tested through a Shapiro-Wilk normality test.[30] All assets fail this test of normality, due to the residuals having excess kurtosis.[31] This non-normality of the residuals may lead to coefficients that are still consistent but have higher variances than under the true normal distribution. The cause of the non-normality is due to a combination of the use of an mGARCH model which is known to produce heavy-tailed outputs, (Hall & Yao (2003)), as well as the leptokurtic stock returns of the initial data, a common issue in stock returns (Sheikh (2009)).

Also, the standardised squared residuals from the GARCH model are tested for autocorrelation. This is done through the Portmanteau test for white noise - using the Ljung-box Q-statistic. [32] The testing demonstrated that there is no evidence to reject the null hypothesis of white noise for any asset and as such all coefficient results are valid under this test.

The residuals are also tested for any remaining ARCH effects via. an ARCH LM test. These results demonstrate no lags beyond the order specified in the model - order 1.[33]

5.3 Limitations of the Model

Whilst the results prove relatively robust to econometric testing, some limitations in the design of the model also need to be considered. Firstly, the results of the model are somewhat limited by the length of the dataset. For instance, when considering the worst 5% performance this only translates to only 60 results for each asset - resulting in α_3 coefficients with weak significance in some assets.

Furthermore, despite the use of a mGARCH model controlling for the high mean return of Bitcoin, the rapid growth has resulted in a high volatility that is almost certain to be above its long run average, resulting in some noise with respect to the results found.

This was not performed in this paper due to strong evidence that the whole cryptocurrency market is heavily tied to Bitcoin performance [34] but given the falling dominance of Bitcoin in recent months,[35] further investigation into this topic could be of value.[36]

[30]Results shown in Appendix 8.4
[31]An example of this excess kurtosis is seen in Appendix 8.5.
[32]Full results in Appendix 8.7.
[33]Full results in Appendix 8.8.
[34]Bitcoin and alt-coins have near identical market capitalisation charts over last few years - https://coinmarketcap.com/charts/.
[35]https://coinmarketcap.com/charts/
[36]This could be done by studying an index of the whole crypto-market, such as the C20 index.

Finally, the implicit assumption of rationality of investors may be unrealistic given the number of inexperienced investors in the cryptocurrency market.

5.4 Policy Implications and Future Research

This paper suggests that Bitcoin represents no feasible threat of replacing fiat currencies, nor is the losses from the 2017 bubble substantial enough for any risk of mass contagion and as such government regulation of Bitcoin is not essential from an economic viewpoint.[37] Furthermore, since the 3rd hypothesis could not be rejected given available data, capital control regulation may need updating to consider cryptocurrencies.

This paper suggests little change in future policy for asset managers since whilst Bitcoin possesses some diversifying benefits, they are not as strong as gold. Moreover, Bitcoin as an asset has substantial purchasing complexities, storage concerns and hacking risks that are likely to outweigh much of the benefit of diversification. Whilst this may change with the introduction of ETFs improving access and security, better diversification options currently exist - even when not considering the huge Bitcoin price volatility. One unique ability of Bitcoin however is its ability to diversify against both gold and equities falling at the same time, as they did in late 2017.[38]

Future research could also focus on assessing how Bitcoin reacts in times of extreme fiat currency crises where capital controls are imposed, assuming a suitable crisis to model can be found.

Furthermore, the time period considered in this paper which featured the significant 2017 bubble was non-optimal in times of excess volatility being present. More recent data from the final 2 months of Q1 2018 have shown far less volatility as prices have stabilised following the preceding crash so future research could focus on a potentially less volatile time period such as this.

6 Conclusion

This paper has found Bitcoin to be a weak diversifier as well as a weak safe haven; thus supporting the first hypothesis of this paper. However, whilst these diversification benefits are weaker than that of the traditional hedge of gold (Capie et al. (2005)), Bitcoin's diversification against both gold and equities downturns creates a potentially unique and useful investment asset.

Furthermore, whilst the large regional variations in coefficients, in particular within Asia, support the 2nd hypothesis of this paper, they also suggest that the suitability of Bitcoin as a hedging asset is hugely influenced by the geographic focus of the investor's portfolio.

This paper has found limited evidence to support the 3rd hypothesis of this paper - Bitcoin's strength as a hedge against currency crises. The lack of any extreme currency crisis in this dataset that could invoke the benefits of Bitcoin's capital control circumvention capabilities suggests that such an event is so rare as to be irrational for all but the most emerging-market focused portfolios to commit a large proportion of a portfolio to hedge against. As a result, even if Bitcoin was found by further research to have strong safe haven effects, it is unlikely to offer much value to long-term asset managers. It could, however, offer strong potential for developing-world citizens and traders seeking a profitable outcome to local crises.

Despite these relatively positive results for Bitcoin's potential success as a hedging asset, its immediate use in an investment portfolio is unlikely to be suitable for most investors. This is due to security concerns, knowledge barriers and huge short-run price volatility as well as a lack of price floor provided by an intrinsic value. But if these issues were to fade away as the sector and technology matures,[39] there is strong evidence from this paper that Bitcoin, or its technically similar successor, could provide strong diversification potential for both retail and institutional investors alike.

Word Count: 4998

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[37] Regulation is likely needed to control for fraudulent initial coin offerings (ICOs) and money laundering concerns.

[38] Kaminis (2018)

[39] Some cryptocurrencies have aimed to provide intrinsic value through pegging their value to a range of commodities such as energy.

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8 Appendix

8.1 Traditional Assets

The equity indexes considered are; FTSE100 (UK), DAX 30 (Germany), S&P 500 (USA), Nikkei 225 (Japan), Hang Seng (Hong Kong), Shaghai A-Share Composite (China) and KOSPI (South Korea).

Geographic correlation relationships will be studied through European, Pacific and World indexes collected by Morgan Stanley Capital Investment (MSCI).

The gold price is quoted as gold bullion USD/troy ounce rate whilst Bond index is the Bloomberg Barclays US Aggregate Bond Index.

USD, JPY, GBP has been measured through indexes which show the strength of the currency against key trading partners.

8.2 DCC Model

The estimation of a multivariate DCC model has two main stages as outlined by Bouri (2016). First a univariate GARCH (1,1) model is estimated, then a time-varying correlation matrix is computed.

The mean equation of the DCC model is specied as:

$$r_t = \mu_t + wr_{t-1} + \epsilon_t$$

r_t is a vector of price returns for Bitcoin and the other traditional asset considered. μ_t and ϵ_t are the conditional mean and residual vectors respectively.

The model then takes the residual (ϵ_t) and specifies a variance equation of:

$$h_t = c + a\epsilon_{t-1}^2 + bh_{t-1}$$

c is a constant whilst the $a\epsilon_{t-1}^2$ and bh_{t-1} terms capture the short-run and long-run GARCH effects respectively.

The time-varying unconditional correlation matrix (Q_t) of ϵ_t is defined as:

$$Q_t = (1 - \alpha - \beta)\bar{Q} + \alpha\epsilon_{t-1}\epsilon_{t-1}^{''} + \beta Q_{t-1}$$

Finally, the DCC between assets i (Bitcoin) and j (traditional asset) are defined as:

$$\rho_{ij,t} = \frac{Q_{ij,t}}{\sqrt{Q_{ii,t}}\sqrt{Q_{jj,t}}}$$

8.3 Distribution of Nominal Values

This table provides summary statistics for the nominal values of the assets considered, given to 2 decimal places.

Table 3: Summary Statistics

Assets	*N*	*Mean*	*S.D.*	*Min*	*Max*
Bitcoin	1,021	1036.86	1465.03	177.28	9908.23
FTSE 100	1,021	6766.32	441.28	5536.97	7562.28
DAX 30	1,021	10736.12	1168.86	8571.95	13478.86
S&P 500	1,021	2121.91	198.48	1741.89	2627.04
Nikkei 225	1,021	17839.81	2041.75	13910.16	22937.6
Hang Seng	1,021	23664.24	2343.21	18319.58	30003.49
Shanghai A-Share	1,021	3039.24	622.99	1991.25	5166.35
KOSPI	1,021	2064.12	156.57	1829.81	2557.97
MSCI World	1,021	1744.24	115.82	1468.90	2066.55
MSCI Europe	1,021	1612.65	130.46	1305.76	1845.73
MSCI Pacific	1,021	2401.69	150.81	1942.54	2822.06
Gold	1,021	1232.402	70.99	1051.97	1376.15
Bond Index	1,021	104.70	1.36	101.47	107.93
USD	1,021	93.08	6.76	79.14	103.26
EUR	1,021	98.96	3.41	90.27	105.63
JPY	1,022	82.67	5.27	72.78	94.90
GBP	1,022	84.58	5.88	73.85	94.68

8.4 Shapiro-Wilk Normality Test

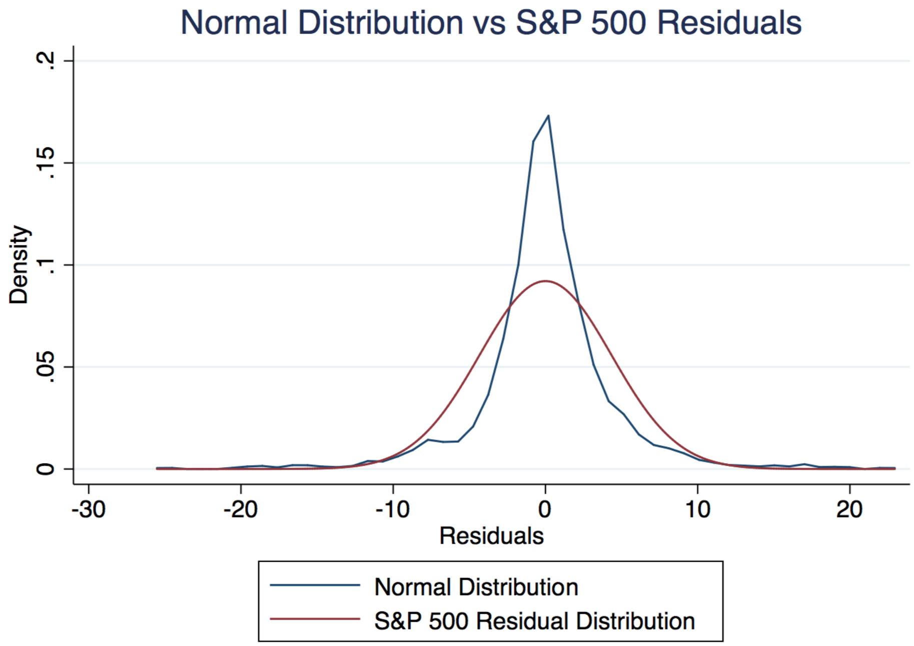
The full test results from the normality test - of which no asset passes due to excess kurtosis.

Table 4: Shapiro-Wilk Normality Test

Assets	*W*	*V*	*Z*	*Prob>Z*
FTSE 100	0.9091	58.44	10.08	0.00
DAX 30	0.9092	58.38	10.08	0.00
S&P 500	0.9090	58.52	10.09	0.00
Nikkei 225	0.9096	58.14	10.07	0.00
Hang Seng	0.9092	58.36	10.08	0.00
Shanghai A-Share	0.9090	58.48	10.08	0.00
KOSPI	0.9091	58.46	10.08	0.00
MSCI World	0.9089	58.55	10.09	0.00
MSCI Europe	0.9091	58.42	10.08	0.00
MSCI Pacific	0.9096	58.14	10.07	0.00
Gold	0.9088	58.64	10.09	0.00
Bond Index	0.9091	58.45	10.08	0.00
USD	0.9098	57.97	10.06	0.00
EUR	0.9091	58.43	10.08	0.00
JPY	0.9092	58.39	10.08	0.00
GBP	0.9090	58.502	10.08	0.00

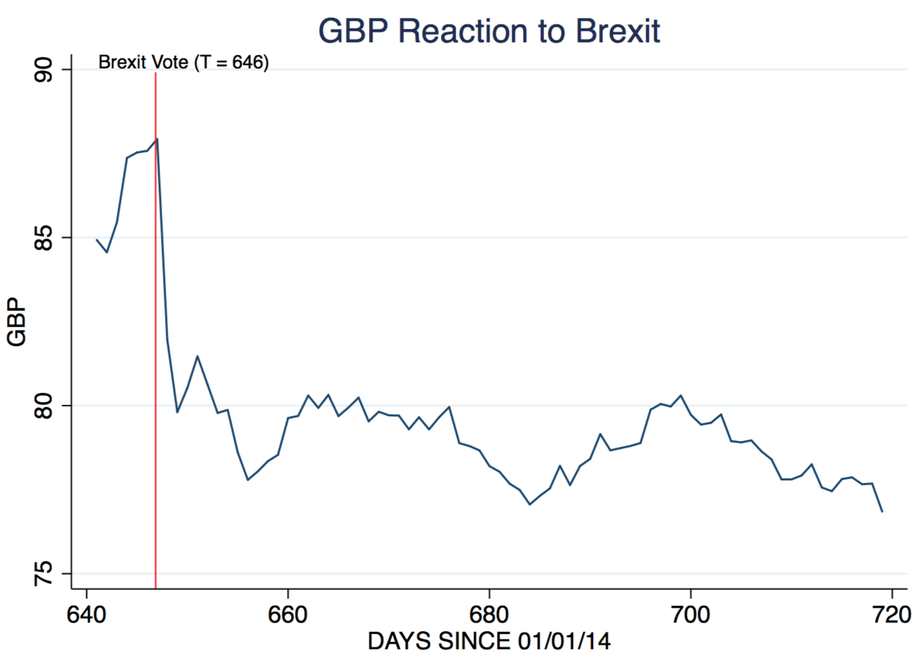
8.5 Distribution of Residuals

This graph demonstrates the presence of excess kurtosis in the residuals of the DCC mGARCH model. The distribution of the S&P500 residuals was typical of all assets considered.



8.6 Brexit Lag Period

This graph demonstrates the suitability of the 14 day lag period since the most dramatic changes in GBP value occur between T = [646,660].



8.7 Autocorrelation Test

The full test results from the autocorrelation test - of which every asset passes.

Table 5: Portmanteau Test

Assets	*Q Statistic*	*Prob* $> \chi^2$
FTSE 100	50.0876	0.1318
DAX 30	50.2147	0.1292
S&P 500	50.0465	0.1326
NIKKEI 225	50.6468	0.1207
Hang Seng	49.0205	0.1551
SHANGHAI A-SHARE	49.9318	0.1350
KOSPI	49.8855	0.1360
MSCI World	49.9964	0.1337
MSCI Europe	50.1341	0.1308
MSCI Pacific	50.5137	0.1232
Gold	49.9019	0.1356
Bond Index	50.0954	0.1316
USD	50.4857	0.1238
EUR	50.0166	0.1332
JPY	50.1563	0.1304
GBP	50.2097	0.1293

8.8 ARCH LM Test

Table 6: ARCH Effects

Assets	*Lags*														
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
FTSE 100	51.1	52.0	54.1	50.5	52.8	53.1	58.8	62.4	62.5	67.0	67.2	67.5	68.3	69.5	69.4
DAX 30	51.0	52.0	54.1	50.5	52.7	53.1	58.7	62.3	62.4	66.8	67.0	67.3	68.1	69.3	69.3
S&P 500	51.1	52.0	54.1	50.5	52.7	53.1	58.8	62.4	62.5	67.0	67.2	67.4	68.3	69.5	69.4
NIKKEI 225	52.3	53.1	55.0	51.7	53.7	54.0	60.1	63.7	63.8	68.2	68.5	68.8	69.6	70.8	70.7
HANG SENG	50.9	51.8	53.8	50.4	52.7	53.0	58.9	62.6	62.7	67.1	67.4	67.6	68.5	69.6	69.6
Shanghai A-Share	51.1	52.0	54.1	50.6	52.8	53.1	58.8	62.4	62.5	66.9	67.1	67.4	68.3	69.4	69.4
KOSPI	51.3	52.2	54.3	50.7	52.9	53.3	59.0	62.6	62.7	67.1	67.3	67.6	68.5	69.6	69.5
MSCI World	51.1	52.0	54.1	50.5	52.7	53.1	58.8	62.4	62.5	67.0	67.3	67.5	68.4	69.5	69.5
MSCI Europe	51.1	52.0	54.1	50.5	52.8	53.1	58.8	62.4	62.5	66.9	67.2	67.4	68.3	69.4	69.4
MSCI Pacific	51.2	52.1	54.1	50.6	52.8	53.1	59.0	62.5	62.6	67.0	67.3	67.5	68.4	69.6	69.5
Gold	51.2	52.1	54.2	50.7	52.9	53.2	59.0	62.7	62.8	67.3	67.6	67.8	68.6	69.9	69.8
Bond Index	51.1	52.1	54.1	50.5	52.8	53.1	58.8	62.4	62.5	67.0	67.2	67.5	68.3	69.5	69.4
USD	50.9	51.9	54.1	50.3	52.6	53.0	58.6	62.2	62.3	66.9	67.1	67.4	68.3	69.4	69.4
EUR	51.6	52.5	54.6	51.0	53.2	53.6	59.3	62.9	63.0	67.4	67.6	67.9	68.7	69.9	69.8
JPY	51.0	52.0	54.1	50.5	52.7	53.1	58.7	62.3	62.4	66.8	67.1	67.3	68.2	69.4	69.3
GBP	51.6	52.4	54.6	51.0	53.1	53.4	59.4	63.0	63.1	67.7	67.9	68.1	69.0	70.2	70.1

These values demonstrate that no significant ARCH effects have occurred past order 1 that are statistically significant. In order to check that the differences past lag 1 were not statistically significant, the following test was performed. First the difference between any two adjacent lag periods was calculated. Then this figure and the associated degrees of freedom were assessed against the Chi-tail distribution to find a probability result. For example, when testing significance of ARCH effects of order 2 for DAX 30 the associated test yields a result of $\chi^2(1, 1) = 0.31731051$ i.e. not significant. This testing method was used for lags of period 15 against all assets and found no ARCH effects beyond lag 1 - hence the use of a GARCH(1,1) model was deemed suitable.