The Changing Nature of Cryptocurrencies: Bitcoin and Its Copies During Their Cloning

Thomas H. A. Joubert
LEMMA, Université Paris 2, Panthéon-Assas
Thomas.Joubert@u-paris2.fr

Abstract

This article tests the effect of cloning Bitcoin and its copies on their nature as financial assets. Characterising the consequence of cloning is relevant since duplications of a cryptocurrency are likely to happen again in the future. Moreover, each version of Bitcoin seeks to meet a particular need, which is tested in this paper. The empirical strategy consists of testing different hypotheses. Some are based on existing literature and relate to the supply and demand of money as well as to the attention captured by each version of Bitcoin. An additional hypothesis is added to investigate the competition between Bitcoin versions. This paper uses linear regressions and GARCH models to deal with non-stationarity and take into account the particular volatility of each crypto-asset. Results illustrate that the financial nature of the Bitcoins is changing over time, but this cannot be attributed to duplications. Additionally, the performance of different versions of Bitcoin did not appear to correlate after the first derivation, while they become all strongly and positively correlated after a certain time after their disjunction.

Keywords— Bitcoin, cryptocurrency, asset pricing, hard fork

1 Introduction

In 2009, in the aftermath of a global economic crisis, Bitcoin was launched. Highly idealistic, it is a so-called new currency whose purpose is to escape the control of states through an original operation. Like many other currencies, Bitcoin is not backed by anything, its value depends on the expectations of its users. Therefore, its value was nil at its start because almost nobody knew of its existence. Since then, its exchange rate has been highly volatile: $\$20,000$ at the end of 2017 and approximately $\$12,000$ at the end of October 2020.

Over the course of its life and like any protocol, Bitcoin was updated regularly to fix bugs, or to improve its performance. Of course, there were sometimes compromises to be made.

If a protocol changes making the new and the old versions incompatible, then both versions can co-exist. One that follows the new rules and one that does not. In the case of a cryptocurrency, this situation results in two versions of the currency. One following the updated protocol, and another reflecting the old one. This is called a hard fork.

In the absence of a central authority, it has happened that not all Bitcoin users agree. There have been several occasions when the Bitcoin community has been irreversibly torn apart. A first split took place in August 2017. Some of the users wanted to allow Bitcoin to handle more transactions, which resulted in making Bitcoin potentially heavier to digitally store. This version of Bitcoin is called Bitcoin cash (BCH).

A small part of the community that was not satisfied with either the BCH version or the status quo, launched Bitcoin gold (BTG) version on October 24^{th}, 2017. This version allows more people to participate in the validation of the transactions[1]. Finally, a third split also appeared among the users of Bitcoin cash, which is already a derivative version of Bitcoin. The new derivation of BCH appeared on November 15, 2018, taking the name Bitcoin Satoshi's Vision (BSV, or Bitcoin SV). This discrepancy is rather ideological, as it claims to follow the ideology of

[1] https://bitcoingold.org/

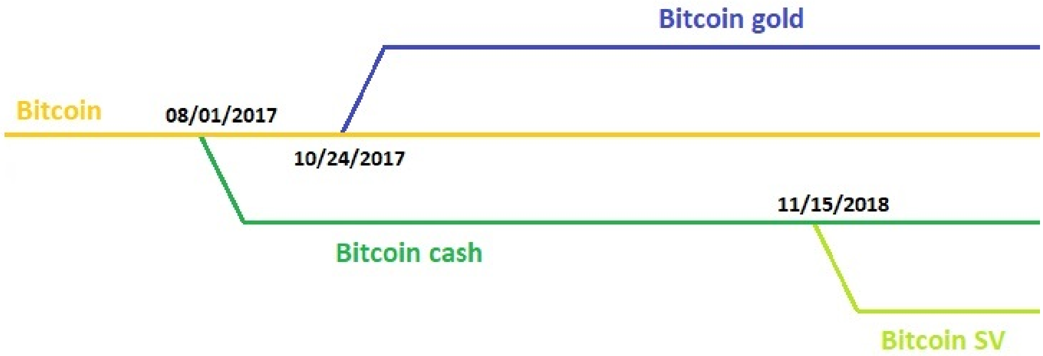

Figure 1: Appearances of the versions of Bitcoin

the anonymous creator of Bitcoin, which the current developers would not do. The different persistent versions are illustrated in the figure 1.

Both the theoretical and empirical literature on Bitcoin are relatively varied. Starting from the theoretical side, Biais et al (2018) show that there is a Nash equilibrium in which a cryptocurrency is duplicated. Abadi and Brunnermeier (2018) establish that there is no distributed ledger that is at the same time decentralized, rigorously accurate and cost optimized. Huberman et al (2017) show that Bitcoin eliminates some welfare losses due to a monetary monopoly, but creates other losses. Garratt and Wallace (2018) introduced cryptocurrency in an overlapped generation model. Zhu and Hendry (2018), Chiu and Koeppl (2019), and Fernàndez-Villaverde and Sanches (2018) did so in a search model. Zhu and Hendry (2018) show that a cryptocurrency can discipline a central bank, but that the first best allocation cannot be reached. A central bank digital currency could solve this problem. According to Chiu and Koeppl (2019), the operation of a Bitcoin-like cryptocurrency could cause 500 times more welfare losses than a currency with 2% inflation. Fernández-Villaverde and Sanches (2018) show that the multiplicity of cryptocurrency does not solve the problem of possible frictions. There can be stationary states, however the competition between a state currency and cryptocurrency is sub-optimal.
Weber (2016) imagines a world in which currencies would be backed by Bitcoin. Sockin and Xiong (2020) show that the cryptocurrency market can collapse because of speculators. Routledge and Zetlin-jones (2019) create a model in which monetary policy can protect its cryptocurrency from speculative attacks. Cong et al (2028)

model the price of Bitcoins. According to them, it increases with the number of exchange platforms, the heterogeneity of agents and the size of the network. Biais et al. (2018) model Bitcoin in an overlapping generation model. They find that there can be an equilibrium and volatility simultaneously. By empirically testing their results, they identify that their parameters are significant but explain only a fraction of the Bitcoin prices variations.

On the econometric side, economic reasoning approaches have not been very successful in explaining the course of Bitcoin (Ciaian et al. 2016, Ciaian et al. 2018, Wang and Vergne 2017, Biais et al. 2018). On the contrary, the attractiveness of cryptocurrency had more stable results. Kristouphek (2013) obtain strong ones by testing the visits of the Bitcoin Wikipedia page and google trends. Bouoiyour and Selmi (2015), Ciaian et al (2016), Mai et al (2018) and Liu and Tsyvinski (2018) were able to confirm the importance of the attention captured by Bitcoin. Aalborg et al. (2018) find that this could explain the volatility of its price rather than its price directly.
The links between Bitcoin and stock market values have also been studied, but with mixed results. Jareño et al. (2020) find that Bitcoin could be a good asset to diversify a portfolio. Selmi et al (2018) and Dyhberg (2015a) find that Bitcoin could potentially be a safe haven. Stavroyiannis and Babalos (2017) and Baur et al. (2017) find that Bitcoin did not have this property. Dyhberg (2015b) argues that Bitcoin is somewhere between gold and the dollar.
Finally, part of the literature deals with various cryptocurrencies and electronic tokens. Drobetz et al (2018) discover that token emissions tend to be timely. Benedetti (2018) finds that tokens offer a return that compensates for the presence of scams. Ciaian et al (2017), Hu et al (2018) and Borri (2018) detected strong links between cryptocurrencies and tokens. Additionally, they would all be linked to Bitcoin.

To the best of my knowledge, no articles focus on the appearance of new versions of Bitcoin specifically. However, this could reveal some interesting phenomena. Especially since there is no particular reason why there will not be another duplication of a cryptocurrency in the future. Does this change the variables that explain its course? If so, are they the same for the two currencies resulting from a duplication? Do some versions have specific characteristics that make them more efficient than others to perform a certain function? Do the versions of Bitcoin compete between themselves?

My findings show that the importance of the attention captured by cryptocurrencies varies mainly as a function of time, but does not seem to depend on disjunctions. Moreover, a reasoning based on the supply and demand of money or based on financial markets is of little relevance to explain the variations in the price of cryptocurrencies. In these cases, there are changes over time, but there is no typical change as a result of duplication. Finally, the performance of different versions of Bitcoin is not necessarily found to be correlated immediately after they are separated, but it is still correlated after six months.

The article is organized as follows: the hypotheses tested are presented in part 2. The econometric approach is explained in part 3. The data used are detailed in part 4. The estimates and their interpretations are presented in part 5. Results are challenged in section 6. Finally, section 7 concludes.

2 Tested hypothesis

In the context of repeated duplications of Bitcoin, I have retained four hypotheses to explain the variations in price of each cryptocurrency. The first hypothesis takes up the conclusions of Kristoufek (2013) and Ciaian & al. (2016). They found that the attention captured by Bitcoin had an important role on its course. Therefore, the objective is to test whether this statement is valid for alternative versions of Bitcoin, in addition to seeing if it is still remains for Bitcoin.

The second is to examine the reaction of cryptocurrencies towards price variations or volatility through financial markets to determine possible typical characteristics of each versions.

The third is a so-called economic hypothesis that follows the reasoning explained below. A similar approach has already been made on Bitcoin by Ciaian & al. (2016) and Bouoiyour (2015).

Finally, the fourth hypothesis aims to study the relationships between cryptocurrencies.

Hypothesis 1 : The attractiveness of cryptocurrencies

In financial markets, the attention captured by stocks or indexes can have a positive effect on their price. Moat et al (2014) tried to capture changes in stock market indexes using Google trends and the activity of relevant Wikipedia pages (visits and updates). Wei and Wang (2016) simulated investment strategies for all NYSE and NASDAQ stocks based on Wikipedia activity. They outperformed the market. Regarding Bitcoin, we can think that the effect of news on its price depends on the nature of the news. But on the other hand, the very first condition that a private individual must meet in order to use a cryptographic system for payments is be aware of this means of payment. As such, one can legitimately think that the attention given to each cryptocurrency will rather have a positive effect on its course or no effect at all. Indeed, even if a particular user is not sensitive to this means of payment (or this asset), one can also expect that the rate of the currency in question will not vary rather than going down.

So far, the number of views of the Wikipedia page has given positive results in the literature to explain the price of bitcoins (Kristoufek 2013, Bouoiyour et al. 2015, Ciaian et al. 2016).

$$P_{b,t} = \beta_0 + \beta_5 \alpha_{b,t} + \epsilon_t \tag{1}$$

where $\alpha_{b,t}$ is the measure of attractiveness of the observed cryptocurrency, and ϵ_t is the residual. In the context of duplications of currencies, two anticipations can be issued. The first is that the attractiveness is important whatever the cryptocurrency studied. A second valid anticipation assumes that Bitcoin is now relatively or that the Wikipedia page does not give sufficiently technical details, in particular about differences between the versions.

Ciaian et al (2016) already noted that the attractiveness of Bitcoin had less impact between 2010 and 2013 than between 2013 and 2015. According to this reasoning, the measure of attractiveness might not be significant, at least for the 'classical' version of Bitcoin. Liu and Tsyvinsky (2018) also found that attention had an impact on the price of Bitcoin. Aalborg et al (2018) found that this could not explain its price, but rather its volatility. No author found a negative impact of captured attention.

Hypothesis 2 : the impact of financial markets

As an asset, it is questionable whether cryptocurrency is correlated with financial markets in one way or another, and whether it is more or less risky than the latter. Some people see cryptocurrencies as a protection against possible crises, comparable to gold.

In this approach, the literature is more nuanced. Van Wijk (2013) found that financial markets could explain the price of Bitcoin. Jareño et al (2020) showed that the level of risk in the financial markets has a negative effect on the price of Bitcoin, which is contrary to what is expected from a safe haven value. Ciaian et al (2016) and Bouoiyour et al (2016) could not confirm these results. Selmi et al (2018) and Jareño et al (2020) found that Bitcoin could be a safe haven against oil prices.

Empirically, the hypothesis takes the following form :

$$P_{b,t} = \beta_0 + \beta_7 f_t + \beta_8 \sigma_{f,t} + \epsilon_t \tag{2}$$

Where f_t captures the level of financial markets, and $\sigma_{f,t}$ their volatilityFor reasons of collinearity, the two variables will never be present simultaneously in a model. This hypothesis could, for example, make it possible to identify the most suitable currency for an investor according to his needs. Perhaps there is a version of Bitcoin that would be a better safe haven than gold itself or perhaps their price has no connection with financial markets.

Hypothesis 3 : the factors of supply and demand of money for exchange purposes

The economic intuition is taken from Barro's (1979) model for gold. This article deals with a commodity that can be exchanged for money, as could be Bitcoin.

In this article, Barro distinguishes between gold used for monetary purposes and gold used for industrial purposes. As Bitcoin is an entirely digital asset, I will only use the monetary part. The major difference between Bitcoins and gold is that Bitcoins cannot be used for production. Bitcoins are only used for trading or speculation. Following this intuition, the supply of money in the form of Bitcoins at date t is such that :

$$M_t^s = P_{b,t} M_{b,t} \tag{3}$$

where $P_{b,t}$ is the price of a bitcoin and $M_{b,t}$ is the number of bitcoins in circulation. The demand for money depends on the general price level P_t, the opportunity cost of holding money rather than another asset, and the quantity of goods traded in bitcoins $y_{b,t}$. Here it must be understood that it is not the goods that could be exchanged for Bitcoins, but the goods that are currently exchanged for Bitcoins. For example, if a new currency appears and a good that was previously traded with Bitcoins is now traded with the new currency corresponds to a decrease of $y_{b,t}$. The alternative to the currency would be an asset that yields at an interest rate of i. The opportunity cost of holding currency is equal to the expectation of the interest rate $\pi = E(i)$. Thus, we have

$$M^d = k(\pi)P_t y_t \tag{4}$$

where k is a decreasing function of the interest rate. The higher the interest rate, the higher the cost of holding money and the lower the demand for money. This can be interpreted as the reverse of the velocity of money, that is, the frequency with which money changes hands. I use the version with the interest rate because I found reliable data as a proxy for the current interest rate.

The equilibrium between supply and demand of Bitcoins is given by

$$P_{b,t} = \frac{k(\pi)P_t y_t}{M_{b,t}} \tag{5}$$

Following this reasoning, the price of a bitcoin is supposed to increase with the price level and the quantity of goods traded in bitcoins and decrease with the interest rate (k being a decreasing function) and the stock of bitcoins.

The hypothesis can be formalized with the form

$$P_{b,t} = \beta_0 + \beta_1 P_t + \beta_2 y_{b,t} + \beta_3 M_{b,t} + \beta_4 \pi + \epsilon_t \tag{6}$$

According to the model, β_1 and β_2 are expected to be positive while β_3 and β_4 are expected negative.

Nevertheless, the evolution of Bitcoin's money supply and each of its duplications follows the computer protocol that has governed Bitcoin since its introduction. Increases in the money supply depend on the resolution of cryptographic problems that are designed to be solved in a specific time. These variations can be precisely anticipated at any time. This parameter could be significant if the number of new Bitcoins is smaller or larger than expected.

Hypothesis 4 : the competition between the different versions of Bitcoin

Ciaian et al (2017) and Hu et al (2018) point out the link between various cryptocurrencies and Bitcoin but without focusing on the different versions of the same cryptocurrency. The purpose of this hypothesis is to see if this link is present in the case where the very existence of these assets is the result of a conflict.
Naturally, three results are possible. Currencies are in conflict and it can be assumed that when the price of a currency increases, the price of its alternative version decreases and vice versa. Investors might not be interested in a conflict between the different versions. If they are perfectly unbiased, cryptocurrencies would rather tend to be unrelated. They may also vary in the same direction considering that they are substitute assets.
This hypothesis can be tested in the following empirical form:

$$P_{b,t} = \beta_0 + \beta_8 P_{b',t} + \epsilon_t \tag{7}$$

where $P_{b',t}$ is the price of another version of Bitcoin. No anticipation is made on the sign of β_8.

3 Econometric approach

This study begins in September 2016, one year before the first disjunction and shortly after a drop in the number of new daily bitcoins[2], in July 2016.
In order to test the changing nature of cryptocurrencies and whether or not it can be robustly attributed to duplications, a diff-in-diff approach is implemented. Each hypothesis is also tested on another cryptocurrency that acts as a control, for all periods. Ethereum (ETH) was chosen for several reasons. The currency must exist since 2016 at the latest. It must have a functioning comparable to Bitcoin. However, the validation of transactions in ethers [3] is also based on a so-called 'proof-of-work' algorithm. Additionally, it is beneficial that its importance in the global market of cryptocurrencies has remained relatively stable over time. Over the studied period,

[2]The number of new daily bitcoins is halved every four years, it happened again on May 11, 2020

[3]Ethers are the monetary unit of the Ethereum protocol

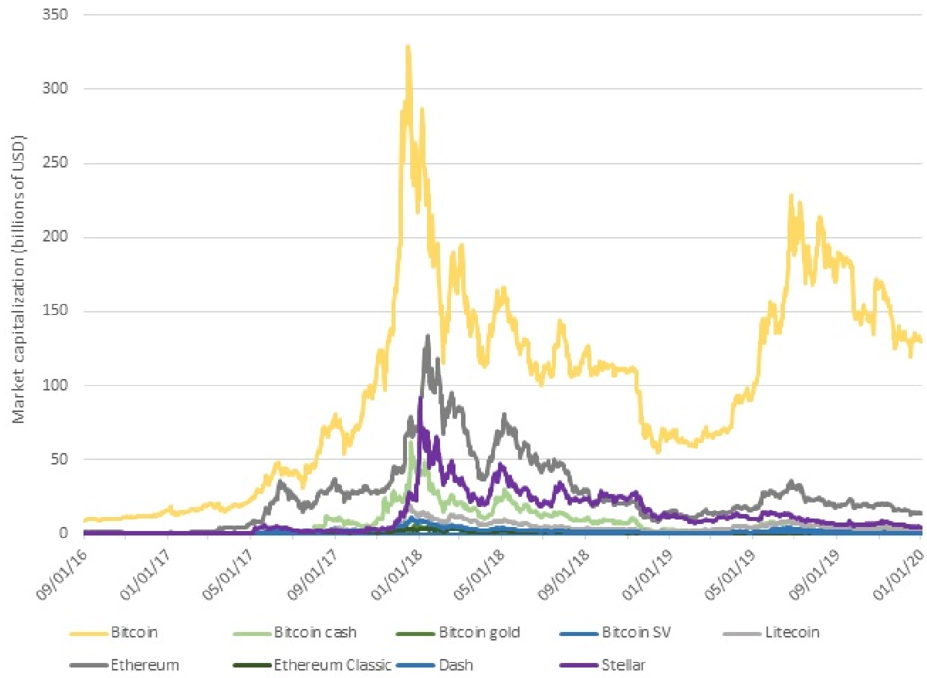

Figure 2

Ethereum has always been the second most quoted cryptocurrency. The chart 2 illustrates the capitalization of the best-known cryptocurrencies. The next step is to delineate each study period. They should be chosen so that they always fall between two duplications.

To help us choose dates, two algorithms designed by Cho and Fryzlewicz (2014) and Cho (2016) are used. Their purpose is to identify dates of change in nature in time series. For example, we can expect a particularly speculative period at the end of 2017 and the beginning of 2018, when the price of Bitcoin reached its highest peak. Thus, the chances of obtaining significant results in subsequent regressions are increased. These two algorithms were chosen because of two particularly relevant characteristics to this study. The first is that they are applicable to several time series at the same time. The second is that they are designed to potentially find several points of change while trying to limit their number[4][5].

At the beginning of the study, only one version of Bitcoin existed. In order for the results to reflect the cryptocurrency market in general, the algorithms are applied to the time series of Bitcoin and ether prices first. Then, a new table is created each time a version of Bitcoin has appeared. It contains the prices of all versions of Bitcoin that existed from that date. It ends on December 31, 2019. Considering there are 4 different versions of Bitcoin, there are 4 given tables where we apply 8 algorithms.

Regressions of interdependent and non-stationary variables can lead to biased results. For example, Vector Error Correction models require all explained and explanatory variables to be stationary, or at least the first difference in the variables must be stationary (Engle and Granger (1987)).
By using several cryptocurrencies during several duplications, it becomes impossible to stricly keep stationary series. Indeed, this would multiply the number of variables, considering each must be stationary, whatever the studied period. One of the solutions to this problem could be to keep adequate specific periods, but in the case of our study, this is impossible because these same periods must necessarily lie between two duplications. The econometric models used are therefore linear regressions, ARCH or GARCH models depending on the case. Indeed, these models have the advantage of not requiring the variables to be stationary (Engle 1982, Bollerslev 1986). In a first step, linear regressions are estimated on the daily

[4] Technically, the first algorithm (SBS, Cho and Fryzlewicz 2014) works as follows: a cumulative sum statistic is calculated at each date of a segment. If there is a date on which the statistic exceeds a threshold, the algorithm considers that there is a point of change and will find the best possible date. It will then redo the operation on each side of the date of change.

[5] The second algorithm, abbreviated DCBS, works in a similar way, but it applies to a cumulative statistic of the cumulative statistic of the first algorithm. Finally, this statistic is maximized across the different series of a data table and over time.

performance of cryptocurrencies systems using ordinary least squares such as :

$$\ln(P_{b,t}) - \ln(P_{b,t-1}) = \beta_0 + \sum_{i=1}^{n} \Big(\beta_p x_{i,t}\Big) + \epsilon_t$$

$$\epsilon_t \hookrightarrow \mathcal{N}(0, \sigma^2)$$

where $x_{i,t}$ is the observation of the explanatory variable i at date t. $\mathcal{N}(0, \sigma^2)$ is a normal distribution of expectation 0 and constant variance σ^2.

To better fit certain time series, we can test the consistency of the residuals σ^2. To do this, I use the Breusch-Pagan[6] test on linear regressions, which allows us to detect a possible lack of homoscedasticity in the model. Indeed, heteroskedasticity leads to a biased estimation of the standard deviation of the model's coefficients. However, if they are underestimated, it increases the chances of rejecting the hypothesis $\beta_i = 0$ (type 2 error).

If the residuals of a model are homoscedastic, the regression is preserved. If not, the Engle's Lagrange multiplier test is performed (Engle 1982). It tests whether the volatility at date t can be explained by earlier dates. This is called the ARCH effect (Autoregressive conditional heteroskedasticity). If the test rejects the absence of an ARCH effect, then a GARCH(1,1) model is estimated with the same variables[7]. The GARCH(p,q) models have the following form:

$$\ln(P_{b,t}) - \ln(P_{b,t-1}) = \beta_0 + \sum_{i=1}^{n} \Big(\beta_p x_{i,t}\Big) + \epsilon_t$$

$$\epsilon_t \hookrightarrow \mathcal{N}(0, \sigma_t^2)$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{p} \alpha_i \sigma_{t-i}^2 + \sum_{j=1}^{q} \gamma_j \epsilon_{t-j}$$

where α_i is the coefficient measuring the impact of the i-th lag volatility on volatility at t. γ_j is the coefficient measuring the impact of the j-th lag residual on volatility at t.

A GARCH model is of the type ARCH if the lag residual is considered estimate the volatility of the residuals at date t. In other words, an ARCH(q) model is a GARCH(0,q). An ARCH model is stable if $\gamma < 1$. Similarly, a GARCH model is

[6] Breusch and Pagan (1979)

[7] No model with more than one lag was found significant and with a better log likelihood.

stable if $\alpha + \gamma < 1$.

Finally, if heteroskedasticity is detected but no ARCH effect is found, then the variables are changed to find a more suitable model. If, for some variables, no solid model is found, then the initial regression is kept, but with a 'HS' annotation.

The four hypotheses are tested several times separately at each study period. The detailed results for each hypothesis are shown in the appendix under the name of the corresponding hypothesis. Variables identified as significant a repeated number of times are again tested several times by including them in so-called general models, which group the four hypotheses together. The results of these models are in the appendix 'General models'. Section 5 summarizes the relevant and robust variables and interprets the results.

4 Data

The variable explained is the daily return in US dollars of each cryptocurrency (Return), calculated using the logarithm as described in section 3.

The first hypothesis aims at testing the effect of the attention caught by cryptocurrencies. The number of views of the Bitcoin Wikipedia page was successfully used as evidence to explain the course of Bitcoin in the existing literature (Kristouphek 2013, Ciaian et al. 2016). The series of each version of Bitcoin are found through the Wikipedia API. Views can be counted either on the English version of Wikipedia (variable $Wiki$) or on all versions (variable $Wikim$). Although these variables have the advantage of being similar for each cryptocurrency, Wikipedia pages are naturally not identical. A currency which Wikipedia page was not properly made has a disadvantage in terms of visibility. For example, to date, Bitcoin SV does not have a Wikipedia page in English but is only a sub-section on the Bitcoin cash page. The Wikipedia API allows you to count the number of users who were directed to this sub-section by searching for the Bitcoin SV page. Therefore, it is still accounted as a Wikipedia time series for Bitcoin SV, but it should be kept in mind that it is not strictly comparable to other currencies having their own page. Moreover, when all versions are accounted,each page has a variable number of translations. To date, the Bitcoin page exists in 100 languages while the Bitcoin

gold page only exists in 8 languages.
The third proxy is the number of subscribers to the cryptocurrency section on the Reddit forum. The number of subscribers is provided by subRedditstats.com and is verified on Redditmetrics.com. The daily number of new subscribers is used to be consistent with the explanation for price variations submitted by this article. For attention variables, multiple lags may be included. For example, it is possible that there is a cooling-off period between consulting the Wikipedia page of a cryptocurrency and purchasing it. If some lags are found significant but with opposite coefficients, the first difference of these three variables are tested (variables $DWiki$, $DWikim$ and $DReddit$).

For the three other hypotheses, I use daily variations in the explanatory variables. The second hypothesis tests the impact of financial markets. For this, several indices are collected worldwide: The $S\&P500$ in the United States, the Eurostoxx 50 ($SX5E$) in Europe, the Footsie 100 ($FTSE$) in United Kingdom and the $Nikkei225$ in Japan. Jareño et al (2020) found that the level of risk has an impact on Bitcoin's price, particularly the level of volatility of the SP500. The volatility of each stock market index is also included, respectively the VIX,$VSTOXX$,$VFTSE$ and $JNIV$. Additionally, I test the sterling-dollar and the euro-dollar exchange rates. Historical price and volatility levels for the S&P500 and Eurostoxx 50 are provided by Bloomberg, just like the exchange rates. The FTSE and VFTSE are provided by Euronext. Finally, 'Nihon Keizai Shinbun' provides historical price and volatility data for the Nikkei.

The third hypothesis tries to explain the price of cryptocurrencies by an economic reasoning. The necessary explanatory variables for the equation (5) are the following. The proxies of the current interest rate are the 1-month and 1-year U.S. Treasury interest rates. They are retrieved directly from the U.S. Treasury's website[8]($IR1month$ and $IR1year$). The quantity of goods exchanged using a particular currency is represented either by the number of transactions ($transactions$) or by the number of distinct active addresses during the day($addresses$). The money

[8] https://www.treasury.gov/resource-center/data-chart-center/interest-rates/Pages/TextView.aspx?data=yield

supply is provided by blockchains($inflation$). This data is provided by the coinmetrics.com website and compared to other sites such as bitinfocharts.com to verify their reliability. The coinmetrics.com website has the advantage of providing data for all the cryptocurrencies that we are interested in. Thus, the data comes from the same source for each of them.

Hypothesis 4 should determine the nature of the relationships between the different derivations. The simplest approach is to test the explanatory potential of performance of cryptocurrencies between themselves. Therefore, there is no need for additional data.

5 Results

5.1 Segmentation

Two algorithms are used to determine the most relevant study periods possible. Each algorithm is run on the tables containing the prices of cryptocurrencies over time. The first table starts on September 1st, 2016 and contains the prices of bitcoins and ethers. The second table contains the prices of bitcoins and bitcoins cash and starts on the day of the creation of Bitcoin cash. Similarly, the third table starts on the day Bitcoin gold is launched and contains the prices of the two previous versions, in addition to those of Bitcoin gold. Finally, the fourth table contains the prices of the four versions and starts on the launch day of the last studied version: Bitcoin SV. The dates of changes detected by these algorithms are provided in the table below.

	SBS algo.	DCBS algo.
BTC	16/05/2017	16/05/2017
BCH	08/11/2017 13/03/2018	08/11/2017 13/03/2018
BTG	03/12/2017 20/02/2018	20/02/2018
BSV	07/05/2019 22/07/2019	07/05/2019 22/07/2019

Table 1: Detected breakpoint date

Each period is used to observe the changes after the previous hard fork and before the next hard fork.

The first period, when there was only one version of Bitcoin, is the simplest to decide. Period 1 will run from 09/01/2016 to 05/16/2017. The second period, 2, must be included between the launch of Bitcoin cash and Bitcoin gold, which are relatively close in time. It will run from 08/08/2017 to 10/20/2017 and comprises two currencies: BTC and BCH.

A year passed between the start of BTG and BSV. This year included a period of great enthusiasm in the cryptocurrency market from late 2017 to early 2018 during which Bitcoin's price reached $20,000. Many dates are found within this interval, which is why this period is divided into two sub-periods. To confirm the robustness of this choice, the Zivot-Andrews test is used on each currency individually. The results can be found at robustness appendix. The rush sub-period runs from 11/08/2017 to 01/09/2018, is called 3A. It contains 3 currencies: BTC, BCH and BTG. The quieter sub-period, named 3B, starts on 03/14/2018 and runs until 10/31/2018, few days before the launch of Bitcoin SV. It also contains the three currencies. Unlike the other periods, Sub-period 3A is important to understand the change in nature of the cryptocurrencies after the BTG disjunction in October 2017 only. It will be necessary to compare its results just with those of period 2. On the other hand, sub-period 3B is used to study changes caused by the BSV disjunction in November 2018. It is appropriate to compare its results with those of the following period, period 4.

This last period, covers the range from 12/01/2018, shortly after the beginning of BSV, to 05/07/2019. The chosen segmentation is summarized whithin figure 3. By the way, some break dates correspond more or less to the hard fork dates, but some are far from it. This suggest hard forks are not the main reason of the changes to explore.

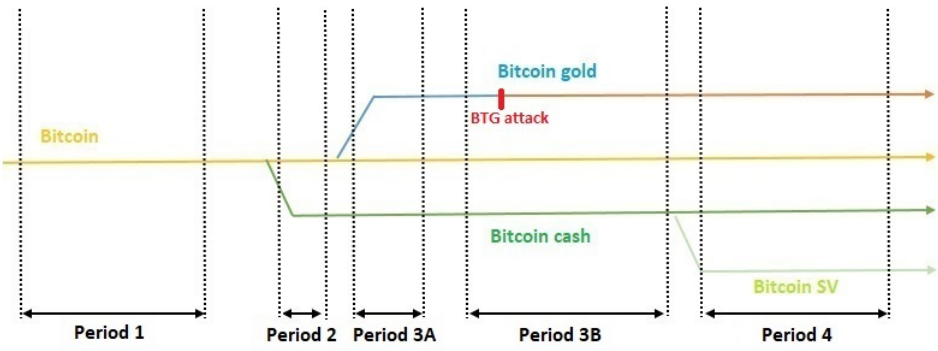

Figure 3

5.2 Results

The results of the estimations are summarized by assumption in the tables 2, 4 and 5. Since financial markets hypothesis is not conclusive, a few significant variables are summarized in the reduced table 3. The tables exhibit the significant and robust variables and the adjusted R^2 that can be achieved according to the approaches and periods studied.

Hypothesis 1 : the attractiveness of cryptocurrencies

Period	Results	ETH	BTC	BCH	BTG	BSV
1.	Variables	$DWiki(285)$ $DReddit(15)$				
	Avg. Val.	$Wiki(2095)$ $Reddit(78.5)$	NS	X	X	X
	Adj. R^2	8.5% with $Reddit$ 7.5% with $Wiki$				
2.	Variables		$DWiki(5000)$			
	Avg. Val.	NS	$Wiki(34,718)$	NS	X	X
	Adj. R^2		1%			
3A.	Variables	$DReddit(100)$	$DWikim(32,000)$	$DWiki(2600)$	$DWikim(60)$ $DReddit(1.5)$	
	Avg. Val.	$Reddit(1984)$	$Wikim(263,458)$	$Wiki(6,130)$	$Wikim(728)$ $Reddit(8)$	X
	Adj. R^2	20%	11.5%	17.5%	13.5% $DWikim$ 12.5% $Dreddit$	
3B.	Variables			$Wiki(4300)$	$DWiki(50)$ $DReddit(50)$	
	Avg. Val.	NS	NS	$Wiki(780)$	$Wikim(198)$ $Reddit(2.5)$	X
	Adj. R^2			3%	3%	
4.	Variables	NS	NS	NS	NS	NS

Notes: This table summarizes the variables found to be robustly significant for each cryptocurrency. The approximate number of views on Wikipedia or new subscribers needed to justify a 1% increase in price is in brackets.
The average number of views or new subscribers for the relevant period and cryptocurrency is shown in the middle of the boxes.
The part of the variations that the variables can explain is specified at the bottom of the boxes.
Crosses mean the relevant cryptocurrency did not yet exist.'NS' means there are no significant and robust variable.
If both $Wiki$ and $Wikim$ are significant, only the variable that best explains the variations is indicated.

Table 2: Attention hypothesis

The results are in line with Ciaian and Al. (2016). They found that the attractiveness was less and less important over the years. I find that this had a definite impact on all currencies during the end of 2017, after the Bitcoin gold disjunction (period 3A). This is, among other things, the period during which the price of Bitcoin reached its historical highest point at $20,000. There may have just been an influx of new investors at the end of 2017. During this period, the number of visits explains between 10% and 20% of the price variations, for all the cryptocurrencies except Bitcoin gold. It took between 60 and 40,000 views on the Wikipedia page to explain a price variation of 1% over one day, depending on the cryptocurrency. In most cases where the Wiki and Reddit variables are significant, I find that their first difference is a better proxy to explain price variations. To see its price increase, a cryptocurrency not only had to catch attention, it had to catch more attention than the day before. In other words, a cryptocurrency had to continuously attract attention in order not to reverse its performance.

There is no other period during which this had such a pronounced impact. It cannot be said that this change in the explanatory variable is due to duplication. Indeed, attention is almost not important before and after the Bitcoin cash hard fork (periods 1 and 2), and before and after the Bitcoin SV hard fork (periods 3B and 4).

Thus, we can assume that the functioning of cryptocurrencies is roughly known and that Wikipedia page consultations no longer have impact.

The results also highlight the importance of considering each version of the relevant Wikipedia page and the relevance of Reddit as a potential explanatory variable. The multilingual variable is often found to better explain variations than the English version. On the other hand, Reddit is sometimes found to be significant. Is is even a better proxy than the number of views of the Wikipedia page for Ethereum in period 1.

Hypothesis 2 : financial markets influence

Financial markets are almost never found relevant. The table 3 shows the only two cases where some variables were found significant: Bitcoin cash in period 3B and 4 an Bitcoingold in period 4. Stock market values are not the same in each cases and explain only 1% of the variations.

Obviously, we cannot conclude anything about the consequences of a duplication. These results are in line with Stavroyiannis and Babalos (2017) and Baur et al. (2017), but contradict the authors who see in Bitcoin a possible safe haven (Jareno et al. 2020, Selmi et al. 2018 Dyhberg 2015a and 2015b).

Period	BCH	BTG
3B.	$SX5E$ (1.1) 1%	NS
4.	USD-GBP exchange rate (-1.5) $FTSE$ (2) 1%	USD-GBP exchange rate (-1.9) 3%

Table 3: Financial markets hypothesis

Hypothesis 3 : money supply and demand factors

As with Ciaian and Al. (2016) and Wang and Vergne (2018), the economic approach fails to correctly explain the variations of Bitcoin in any version. Interest rates are sometimes found to be significant, but with a positive coefficient contrary to expectations, especially in period 3A. My interpretation would be that agents lose interest in state currency when interest rates rise. They turn to other assets, like cryptocurrencies, resulting in a the price increase.
Ciaian and Al. (2018) also found a positive impact of interest rates on the price of Bitcoin. Unlike Ciaian and Al. (2016), but like Wang and Verge (2018), the money supply has a positive impact or no impact. The nature of money supply, which is known and which variations can be anticipated, perhaps limits the negative impact that could be expected. On the other hand, we can think that if it increases, it is interpreted as a good signal since this is exactly what is planned by the protocol, intended to be immutable. Miners are paid with the new bitcoins to encrypt transactions. If the money supply was not increasing, it could mean that miners were having difficulty to fulfill their role.
Just like the attention hypothesis, there is nothing that suggest the observed changes are due to duplications, since they are different each time.
These results agree with Baur and Al. (2017), few users adopted Bitcoin as a mean of payment. However, Bitcoin cash is the only version of Bitcoin for which the number of active addresses or the number of transactions tends to have a positive and significant impact. This is in line with expectations and was observed over several periods of time, suggesting that Bitcoin cash would be the least bad choice

for usage as a currency.

Period	ETH	BTC	BCH	BTG	BSV
1.	NS	NS	X	X	X
2.	NS	NS	NS	X	X
3A.	IR 1mo (0.8) 7%	IR 1 year (2) 5 to 10%	$inflation$(8) $transactions$(0.15) 25% to 30%	$transactions$(0.15) 10%	X
3B.	NS	IR 1 year(0.4) 2%	inflation (4.5) addresses (0.05) IR 1 month(0.65) 5%	X	X
4.	NS	NS	inflation(15) addresses(0.04) 4%	addresses (0.4) transactions (0.4) 2%	NS

Notes : This table summarizes the variables found to be robustly significant for each cryptocurrency.
Their rounded coefficient is in brackets and the adjusted R^2 attainable is specified below.
A cross means the relevant cryptocurrency did not yet exist. 'NS' means that no variable is significant and robust.

Table 4: Economic hypothesis

Hypothesis 4 : the competition between the different versions of Bitcoin

The existing literature (Ciaian et al. (2017), Borri (2018), Hu and Al. (2018)) already established a strong link between the different cryptocurrencies, but without focusing on the different versions of the same cryptocurrency.

My findings corroborate with the literature, there is no period during which negative links are observed. A drop the price of one version of Bitcoin was never a good news for another version. Bitcoin and Bitcoin cash initially explained only 5% of their variations to each other. Following the Bitcoin gold disjunction, this link disappeared while Bitcoin cash and Bitcoin gold became linked, being two alternative versions of Bitcoin

After a few months, the binding between Bitcoin and Bitcoin cash became strong and stable until the end of the study, they explained two thirds of their variations to each other. Ciaian and Al. (2017) showed that many cryptocurrencies are linked to Bitcoin, I find that this connection between Bitcoin and Bitcoin cash seems particularly strong. My interpretation is that there may have been a period of conflict to pass, but now the two currencies are stably installed in the landscape of cryptocurrencies, they can be substitutes.

On the other hand, these links between Bitcoins are observed directly after the Bitcoin SV disjunction. It is possible that the disjunctions are welcomed more leniently now than at the first instance.

Period	BTC	BCH	BTG	BSV
2.	$BCH(0.13)$ (5%)	$BTC(0.87)$ (7%)	X	X
3A.	NS	$BTG(0.4)$ (35%)	$BCH(0.8)$ (30%)	X
3B.	$BCH(0.4)$ $BTG(0.44)$ 65%	$BTC(1.4)$ $BTG(0.8)$ 67%	$BTC(1.4)$ $BCH(0.8)$ 65%	X
4.	$BCH(0.38)$ $BTG(0.56)$ $BSV(0.38)$ 67% with BCH or BTG 40% with BSV	$BTC(1.7)$ $BTG(1.2)$ $BSV(0.88)$ 67% BTC, 57% BTG 40% with BSV	$BTC(1.2)$ $BCH(0.5)$ $BSV(0.6)$ 67% BTC, 57% BCH 34% with BSV	$BTC(1.1)$ $BCH(0.47)$ $BTG(0.7)$ 35% to 45%

Notes : This table summarizes the variables found to be robustly significant for each cryptocurrency. Their rounded coefficient is in brackets and the adjusted R^2 attainable is specified below. A cross means the relevant cryptocurrency did not yet exist. 'NS' means that no variable is significant and robust.

Table 5: Competitive hyptohesis

6 Robustness

Ethereum was duplicated shortly before the start of the observation period. This duplication is studied to confirm the results found in part 5. The four hypotheses are extended on Ethereum before its duplication and on its derivation Ethereum classic (ETC) after the duplication to be able to estimate the consequences of this disjunction.

The two periods are delineated following the methodology described in part 3. The results of the segmentation algorithms are summarized in the table 6.

	SBS algo.	DCBS algo.
ETH et BTC before fork	11/02/2016	09/06/2016
ETH et ETC before fork	16/05/2017	16/05/2017

Table 6: Detected breakpoint date on Ethereum

Period 0, which studies Ethereum before duplication, starts on 09/01/2015, one month after its launch. It ends on 06/09/2016, the day of a computer attack that caused the duplication and which was detected relevant by Cho's algorithm (2016). The period following the duplication is the same as period 1 in the rest of the paper since the detected dates of changes are the same.

As the impact of financial markets was never found significant for these cryptocurrencies, hypothesis 2 is not summarized. The table 7 summarizes the results of hypotheses 1, 3 and 4 tested on Ethereum before duplication (period 0), and on Ethereum and classical Ethereum after duplication (period 1). The table 6 summarizes the results of the competitive hypothesis on Ethereum for periods 2 to 4.

Period	Attention	Economic	Competitive
Ethereum, period 0	$Reddit(0.001)$ $Reddit_{-2}(-0.0007)$	$inflation(-0.7)$ $address(0.18)$ $transactions(0.18)$	X
Adj. R^2	7%	5%	
Ethereum, period 1	$DWiki0.02$ $Reddit(0.0008)$ $Reddit_{-1}(-0.0005)$ $Reddit_{-2}(-0.0002)$	NS	$ETC(0.23)$
Adj. R^2	70% with $Wiki$ 13% with $Reddit$		11%
Ethereum Classic period 1	$Wiki(0.0003)$ $Wiki_{-1}(-0.0002)$ $Reddit(0.004)$ $Reddit_{-1}(-0.003)$	$transactions(0.05)$	$ETH(0.4)$
Adj. R^2	4% with $Wiki$ 9% with $Reddit$	1%	17%

Notes : This table summarizes the variables found to be robustly significant for each hypothesis. Their rounded coefficient is in brackets and the adjusted R^2 attainable is specified below.A cross means the relevant cryptocurrency did not yet exist. 'NS' means that no variable is significant and robust.

Table 7: Ethereum fork

The results show that the importance of attention captured by the two cryptocurrencies increased after the duplication. However, this was also observed following the Bitcoin gold (period 3A) duplication without any causal link being established. Indeed, we could observe a rebound in the importance of the attention captured by Ethereum even if it was not duplicated at that time. One explanation would be that the attention captured by a cryptocurrency is necessary fix its price and gain users in its early life, but it loses importance over time. This would explain why the literature before 2016 found that captured attention is important, while the more recent literature is nuanced.

The economic hypothesis can explain 5% of the variations in Ethereum before its duplication. This suggests that an economic reasoning is not totally impertinent before the price of a cryptocurrency becomes speculative. As with Bitcoin, no listed

value is relevant in any period.
Finally, the different versions of Ethereum tend to evolve in the same direction. The link seems weak but robust after the duplication, but gains strength in subsequent periods, as is the case for the different versions of Bitcoin.

Période	ETH, competitive hypothesis
2	ETC(0.58) 56%
3A	ETC(0.5) 40%
3B	ETC(0.73) 60%
4	ETC(0.7) 57%

Table 8: Ethereum compatitive analysis

7 Conclusion

Over the past few years, Bitcoin has gained visibility meanwhile its price has drastically increased. However, the nature of its protocol makes duplications possible which can be quite problematic for a currency. Such a phenomenon happened at least three times between 2017 and 2018 and could happen again in the future. This paper is the first to explore the eventual changes involved in during cloning.
Three hypotheses from the literature are tested to explain the price variation of cryptocurrencies before and after each duplication in order to observe the differences. The first hypothesis tests the effect of the attention captured by a cryptocurrency. This approach had the most success throughout research studies . The second hypothesis compares the variations in price of cryptocurrency with those of financial markets, which gave rather mixed results in literature. The third follows an economic reasoning taken from Barro (1979) and comparable to the quantity theory of money. This type of reasoning was tested as well by different authors, but results were rarely satisfactory. Finally, a fourth hypothesis, innovative in the

literature was to test the competition between the different versions of a same cryptocurrency.
The results show that there is no relevant variable which importance is constant over time. However, these changes cannot be robustly imputed on cloning. Moreover, the different versions of a cryptocurrency are not necessarily linked between themselves after a disjunction, but they generally become robustly bounded less than a year later. No negative link could be found between the cryptocurrencies although their existence is the result of a conflict.
As a means of exchange, we expect the price of currency to be relatively stable and depends on its usage. This is not the case with any version of Bitcoin. An asset does not have these requirements. Bitcoin offers diversification capabilities since its price was never found to be linked with any stock market value. Nevertheless, its speculative nature can hardly be discarded.

8 References

Aalborg H. A., Molnár P. , de Vries J. E., What can explain the price, volatility and trading volume of Bitcoin?, Finance Research Letters (2018), doi:https://doi.org/10.1016/j.frl.2018.08.010

Abadi, J. and Brunnermeier, M. K., Blockchain Economics (December 2018). NBER Working Paper No. w25407, https://ssrn.com/abstract=3308413

D.G. Baur, K. Hong, A.D. Lee, Bitcoin: Medium of Exchange or Speculative Assets?, Journal of International Financial Markets, Institutions & Money (2017), doi: https://doi.org/10.1016/j.intfin. 2017.12.004

Benedetti, H3 and Leonard Kostovetsky. “Digital Tulips? Returns to Investors in Initial Coin Offerings.” Innovation Finance & Accounting eJournal (2018)

B. Biais,C. Bisière,M. Bouvard,C. Casamatta and A. J. Menkveld , ‘Equilibrium Bitcoin Pricing’, TSE Working Paper, n° 18-973, December 2018.

B. Biais, C. Bisière, M. Bouvard, C. Casamatta, The Blockchain Folk Theorem, The Review of Financial Studies, Volume 32, Issue 5, May 2019, Pages 1662–1715, https://doi.org/10.1093/rfs/hhy095

Bollerslev,T.,1987.Generalized autoregressive conditional heteroskedasticity. Journal of Econometrics Volume 31, Issue 3, April 1986, Pages 307-327. https://doi.org/10.1016/0304-4076(86)90063-1

Borri N., Conditional Tail-Risk in Cryptocurrency Markets (2018). Journal of Empirical Finance https://doi.org/10.1016/j.jempfin.2018.11.002

J. Bouoiyour, R. Selmi. What Does Bitcoin Look Like?. Annals of Economics and Finance, 2015, 16 (2). ⟨hal-01879683⟩

Breusch, T. S.; Pagan, A. R. (1979). A Simple Test for Heteroskedasticity and Random Coefficient Variation. Econometrica. 47 (5): 1287–1294. doi:10.2307/1911963

Cho, H. and Fryzlewicz, P. (2014) 'Multiple-change-point detection for high dimensional time series via sparsified binary segmentation'. Journal of the Royal Statistical Society: Series B (Statistical Methodology), 475–507

Cho, H. Change-point detection in panel data via double CUSUM statistic. Electron. J. Statist. 10 (2016), no. 2, 2000–2038. doi:10.1214/16-EJS1155. https://projecteuclid.org/euclid.ejs/1468849969

P. Ciaian, M. Rajcaniova & d. Kancs (2016) The economics of BitCoin price formation, Applied Economics, 48:19, 1799-1815, DOI: 10.1080/00036846.2015.1109038

P. Ciaian, M. Rajcaniova, d. Kancs, Virtual Relationships: Short- and Long-run Evidence from BitCoin and Altcoin Markets, Journal of International Financial Markets, Institutions & Money (2017), https://doi.org/10.1016/j.intfin.2017.11.001

P. Ciaian, d. Kancs & M. Rajcaniova, 2018. "The Price of BitCoin: GARCH Evidence from High Frequency Data," EERI Research Paper Series EERI RP 2018/14, Economics and Econometrics Research Institute (EERI), Brussels.

Cong, L., Li, Y., & Wang, N. (2019). Tokenomics: Dynamic Adoption and Valuation. NBER Working Paper Series.

Drobetz, W. and Momtaz, P. P. and Schröder, H., Investor Sentiment and Initial Coin Offerings (November 2018). The Journal of Alternative Investments Spring 2019, 21 (4) 41-55; DOI: https://doi.org/10.3905/jai.2019.1.069

A.H.Dyhrberg, Bitcoin, gold and the dollar– A GARCH volatility analysis,Finance Research Letters(2015), http://dx.doi.org/10.1016/j.frl.2015.10.008

A.H.Dyhrberg, Hedging capabilities of bitcoin. Is it the virtual gold ?Finance Research Letters(2015), http://dx.doi.org/10.1016/j.frl.2015.10.025

Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. Econometrica Vol. 50, pp. 987-1007. DOI: 10.2307/1912773

Engle, R. F., and C. W. J. Granger. 1987. Co-Integration and Error Correction: Representation, Estimation and Testing. Econometrica 55 (2): 251–276. doi:10.2307/1913236.

Hu, A. S., Parlour, C. A., & Rajan, U. (2019). Cryptocurrencies: Stylized facts on a new investible instrument. Financial Management, 48(4), 1049–1068. doi:10.1111/fima.12300

Huberman, Gur and Leshno, Jacob and Moallemi, Ciamac C., Monopoly Without a Monopolist: An Economic Analysis of the Bitcoin Payment System (September 5, 2017). Bank of Finland Research Discussion Paper No. 27/2017, https://ssrn.com/abstract=3032375

Jareño, F., González, M. de la O, Tolentino, M. & Sierra, K., 2020. 'Bitcoin and gold price returns: A quantile regression and NARDL analysis', Resources Policy, Elsevier, vol. 67(C).

Kristoufek, L. 2013. 'Bitcoin Meets Google Trends and Wikipedia: Quantifying the Relationship between Phenomena of the Internet Era.' Scientific Reports 3 (3415): 1–7. doi:10.1038/srep03415.

Liu Y. and Tsyvinski A., 'Risks and Returns of Cryptocurrency.' Risk Management & Analysis in Financial Institutions eJournal (2018)

Mai F., Shan Z., Bai Q., (Shane) Wang X. & Chiang R. H.L. (2018) How Does Social Media Impact Bitcoin Value? A Test of the Silent Majority Hypothesis, Journal of Management Information Systems, 35:1, 19-52, DOI: 10.1080/07421222.2018.1440774

Moat H.S., Curme C., Stanley H.E., Preis T. (2014) Anticipating Stock Market Movements with Google and Wikipedia. In: Matrasulov D., Stanley H. (eds) NATO Science for Peace and Security Series C: Environmental Security. Springer, Dordrecht. https://doi.org/10.1007/978-94-017-8704-8_4

Routledge B. & Zetlin-Jones A., 2018. "Currency Stability Using Blockchain Technology," 2018 Meeting Papers 1160, Society for Economic Dynamics.

R. Selmi, W. Mensi, S. Hammoudeh, J. Bouoiyour , Is Bitcoin a hedge, a safe haven or a diversifier for oil price movements? A comparison with gold. Eneeco (2018), doi:10.1016/j.eneco.2018.07.007

Sockin M. & Xiong W., 2020. "A Model of Cryptocurrencies," NBER Working Papers 26816, National Bureau of Economic Research, Inc.

Stavroyiannis, S. and Babalos, V., Dynamic Properties of the Bitcoin and the US Market (May , 2017). https://ssrn.com/abstract=2966998

Wang S, Vergne J-P (2017) Buzz Factor or Innovation Potential: What Explains Cryptocurrencies' Returns? PLoS ONE 12(1): e0169556. doi:10.1371/journal.pone.0169556

Weber W. E. , 2016. "A Bitcoin Standard: Lessons from the Gold Standard," Staff Working Papers 16-14, Bank of Canada.

White, H. (1980). A Heteroskedasticity-Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity. Econometrica. 48 (4): 817–838. doi:10.2307/1912934