On the nature and the financial performance of Bitcoin

Elise Alfieri
elise.alfieri@univ-grenoble-alpes.fr

Radu Burlacu
radu.burlacu@univ-grenoble-alpes.fr

Geoffroy Enjolras
geoffroy.enjolras@univ-grenoble-alpes.fr

CERAG Grenoble-Alps University

May 14, 2017

Abstract

Bitcoin is a major "crypto-currency" that provides high returns for investors, but with high levels of risk. The objective of this article is to raise the question about the true nature of the Bitcoin and to study empirically its performance. After questioning the nature of Bitcoin as a currency and justifying its asset nature, this research aims to test empirically its performance using traditional models such as the CAPM and the Fama-French 3-Factors. We use daily data from August 2010 to June 2016 and find that, while integrating Bitcoin in portfolio highly improves its diversification, it also provides positive and significant risk-adjusted returns in the World, European and Asia-Pacific regions.

Key words:
Crypto-currency, Bitcoin, market efficiency, diversification, performance

1 Introduction

Bitcoin is a crypto-currency, a part of the electronic currency family, [Nakamoto, 2008]. Recently, on the 4th January 2017, the Bitcoin's price was equal to $1 126, thus reaching the threshold of $1 000 for the second time in its history.
Electronic currencies, which is recorded on computer or others electronic devices, may take two forms: digital cash and cryptographic currency. The former is a simple digital version of physical money. The latter, which is the focus of this article, is an electronic currency that uses cryptographic principles to ensure security. This type of currency is developed in a decentralized system.

The objective of this article is to raise the question about the true nature of the Bitcoin and to study empirically its performance. We argue that the Bitcoin could have common characteristics with a currency, with gold but also with a financial asset. Bitcoin is a new and highly specific asset, but its economic and legal profile, its risk-return characteristics, the independence of its value relative to any other existing asset, and its liquidity makes it behave like mostly an equity-like financial asset, [Baur et al., 2016], [Glaser et al., 2014].
The justification of studying the performance of Bitcoin resides on the fact that it is a relatively young, risky financial innovation, not yet well known by the market. While some market imperfections such as transaction fees are almost inexistent, Bitcoin is affected by informational asymmetries between investors, mainly because many of them do not understand the technology behind it. Consequently, the market value of this financial asset may differ from its "true value", that is, the value on a market without informational asymmetries, thus providing opportunities to earn positive risk-adjusted returns. In line with this view, we now attend the emergence of mutual funds whose objective is to track Bitcoins; this suggests the possibility of earning superior risk-adjusted returns by trading this financial asset.

In most existing articles, the performance of the Bitcoin is assessed by using simple measures, such as the Sharpe ratio, [Brière et al., 2015], [Burniske and White, 2017]. The problem with this measures is that they do not take into account the huge potential for portfolio diversification with Bitcoins. Being highly uncorrelated with existing assets, most of the Bitcoin's variability can be diversified away, which strengthens its performance. Based on this important aspect, and on the premise that Bitcoin has the nature of an asset, our paper is the first measuring the performance of this financial asset by using the traditional performance models as the CAPM, which uses the market portfolio as a benchmark, but also the two-factors Fama and French (1992) model, hereafter FF, and its extensions considering several factors. Taking into account the international dimension of the Bitcoin, we use the global market portfolio as a benchmark, and the global versions of the FF factors, [Fama and French, 2012].

To test Bitcoin performance, we compute the alpha estimated with these models for the period between 09/22/2010 and 06/30/2016 for different regions: Global, Europe and Asia-Pacific. We find positive and highly significant alphas for the Bitcoin for Global, Europe and Asia-Pacific regions. These results are robust to the performance model specifications.

Section II presents Bitcoin characteristics. Section III describes performance models and data. Section IV discusses the results, and robustness tests. Section V presents the conclusion.

2 What is the true nature of Bitcoins?

The nature of Bitcoin is subject of debate. Academics and professionals suggest various definitions and do not always agree on whether Bitcoin is a currency, a commodity, a safe investment such as gold, a debt contract, or common stock. We attempt to show that Bitcoin has mainly the characteristics of an asset, especially a common stock, [Glaser et al., 2014], [Baur et al., 2016].
Bitcoin is a payment system that is independent of any government and operates without a third-party (such as the Central Bank). Any participant in this system may check the behavior of other participants in order to ensure the reliability of the transactions and the stability of the system. In other words, this responsibility is not assumed by a third party. Moreover, all participants have the possibility to know about the transactions made by everyone. However, the identity of participants remains anonymous.

There are three ways to acquire Bitcoins: exchange money, sell goods and services or mining process. The first two ways, which are exchanging money and selling goods or services through e-businesses that accept Bitcoin units, makes the Bitcoin behave like fiat currency. However, a fundamental aspect that makes Bitcoin behave like a financial asset is that one may create Bitcoins through the mining process, which underlying technology is named “blockchain”.This is a secured and distributed database that contains the history of transactions. The technology may be viewed as a ledger that stores all exchanges realized on the network, [Nakamoto, 2008], [Tschorsch and Scheuermann, 2016]. This ledger is composed of “blocks” linked to each other. Each block contains a transaction list of some exchanges. Special users, namely “miners”, create a block locally by choosing different pending transactions. Then, each new block is drawn by a mathematical process, comparable to Sudoku. When a miner finds the grid solution, s/he wins a predetermined number of Bitcoin and others participants must start again the competition with another grid. Grid difficulty is adjusted so that miners find the grid solution with an interval of 10 minutes between each discovery, [Antonopoulos, 2015].
Miners are compensated for their work of integrating transactions to the blockchain and making the system reliable. They obtain a number of Bitcoins when they succeed to add block in the blockchain. This return is predefined at the advance and the number of released Bitcoin decreases with time because the maximum number of Bitcoins is capped at 21 million.

From an economic point of view, the question if Bitcoin has common characteristics with a currency makes debate. According to the basis properties of traditional economics, a currency should be a convenient “medium of exchange”, a stable “unit of account” and a durable "store of value" [Grant, 2014]. Bitcoin is a medium of exchange in the sense that a high number of businesses, such as Dell, Microsoft or Paypal, are willing to accept Bitcoins, [Figuet, 2016].
The popularity of using Bitcoins is based on lower transactions costs compared to the traditional system (no fees for logistic, no fees for banks, no taxes for foreign transactions), the user’s anonymity, and the transparency of the system (blockchain). However, participants could be reluctant to participate in this new system because Bitcoin has no legal basis (companies makes the choice to use Bitcoin or not), the fixed costs of adopting this technology is high (technical knowledge), and there are

network externalities effects (if few businesses accept Bitcoin, few consumers may accept them, which in turn implies that few companies decide to accept them). Resolving this vicious circle is impossible because there is no regulation by an institution, and there is no possibility to make loans on the market, [Kancs et al., 2015]. Empirical studies confirm the controversial property as medium of exchange based on the fact that users not entirely turn to Bitcoin for its role of medium of exchange, [Baur et al., 2016].
Bitcoin may be considered to some extent as a "unit of account". However, merchants do not display prices in Bitcoin for two reasons. First, its supply is inelastic (a Bitcoin price of a given product needs many digits after the comma). Second, volatility does not insure the price stability. Because of this high volatility, merchants are forced to change frequently the price of their products. So, price are displayed in US dollars, and are then converted in Bitcoins at the transaction time,[Figuet, 2016].
Finally, while Bitcoin has features that make it behave like a store of value, the possible cyber security risks reduce trust in this currency. The trade-off between the non-inflation and the deflationary pressure and the unstable purchase power make it difficult to consider Bitcoins as a store of value.
To conclude, Bitcoin is different from traditional money because it does not respect the fiat currency properties, and in particular there is no issuer responsible for it. Rather, Bitcoin is governed by a protocol run by a network of computers which is distributed around the world, government monetary policies having no direct impact on it. In any way, in economics there are different perspectives related to a currency: another point of view is to see currency through institutionalist economics, [LakosmkiLaguerre and Desmedt, 2015].

Some researches consider the possibility that Bitcoin acts like a commodity, more precisely as gold, for some reasons: supply is limited; monetary creation is based on the mining process; there is no control by any government; and Bitcoin acts as a medium of exchange [Dyhrberg, 2016b]. Precious commodities such as gold are safe and Bitcoins may often play a role of safe investment, [Bouri et al., 2016]. For example, after the Cyprus crisis in 2012-2013, some depositors exchanged euro for Bitcoin because of the bankruptcy of banks and taxes on deposits. The second peak at $1 000 was explained by the international context in both developed and emerging countries. Chinese depositors turned toward Bitcoin because of the Yuan drop and Chinese restrictions on capital outflows (this trend was accelerated by Donald Trump's election in the USA). At same way, instable monetary policies in emerging countries (inflation Venezuela, demonetization India, liquidity crisis Zimbabwe) encouraged local depositors to turn to Bitcoin. Empirically, Bitcoin is a weak safe investment reserved to special cases, not financial crisis, [Bouri et al., 2016], [Baur et al., 2016].
While Bitcoin may act as a safe investment in few cases, there are major differences with precious commodities such as gold. First, Bitcoin is capped at 21 million and the release of new Bitcoins is divided by two approximatively every four years until the maximum number of Bitcoins is reached whereas we do not know precisely the supply for the gold case. Second, the price of the Bitcoin is independent from that of gold. The factors affecting the value of these two assets are different. In particular, the value of Bitcoin depends heavily on technology. Finally, gold (or any commodity) has the physical shape;Bitcoin possesses a virtual one.

An alternative complementary category was created by Selgin, named "Synthetic commodity money" that is both commodity-money and fiat money, [Selgin, 2015]. In our case Bitcoin could be compared to gold for the former and dollar for the later, [Baur et al., 2016]. This link was empirically confirmed: there is a low convergence to the long-run equilibirium with volatility clustering and high volatility persistence like gold and Bitcoin is more affected by demand as a medium of exchange and less affected by temporary shocks, [Dyhrberg, 2016b].

Bitcoin could also resemble cash or cash equivalent. But a cash equivalent implies that the asset must be highly liquid and convertible into a known amount of cash. Bitcoin is convertible but it is not enough liquid to be considered as cash equivalent, [Raiborn and Sivitanides, 2015]. Furthermore, Bitcoin cannot be assimilated to a debt contract because Bitcoin cannot insure a predefined stream of cash-flow to the owner. The risk-reward profile of the Bitcoin is fundamentally different from risk-reward profile of debt.

The above arguments show that it is difficult to consider Bitcoin solely as a payment system, a commodity, or a debt contract. We argue that Bitcoin has mostly the characteristics of common stock. Owning Bitcoins implies owning a portion of a specific technology (blockchain) that generates benefits. The Bitcoin's value depends on the quality of the work performed by many individuals running code and using mathematical procedures in order to enhance the credibility of the system; the Bitcoin's value is not dictated by a small group of people, by banks or governments. Bitcoin is a part of the intangible asset represented by the human capital of the people participating in the system. As common stock, Bitcoin has a virtual shape and produces gains for investors taking risk; the high risk – high reward pro-file is clearly mostly related to the profile of common stock.
Stocks are property securities from business and possess a virtual shape. The similarity of the Bitcoin with property is supported by IRS in 2014 (the US Internal Revenue Service)[1] which considers Bitcoin as property and its holders are considered as market investors. This approach is supported by empirical studies in the Bitcoin literature that find Bitcoin is an asset more than a currency, indirectly by testing diversification or performance trhough Sharpe ratio, [Bouri et al., 2016] and [Burniske and White, 2017] or directly by analyze users, [Baur et al., 2016] or network volume, [Glaser et al., 2014].
As with common stock, investors have incentives to buy Bitcoin in order to exchange or speculate. For example, in 2015, two funds have been created to track Bitcoins for investors: Bitcoin Investment Trust and ARK Investment Management. The former works as an Exchange Trade Fund (ETF) and tracks Bitcoin, while the latter integrates the first one in two innovation funds.

[1] https://www.irs.gov/pub/irs-drop/n-14-21.pdf

3 Performance Models

The Bitcoin price has increased between 2009 and 2017 from \$0 to \$1 000, Figure 1 - *Bitcoin Market Price*.
However, its fluctuations raise questions about its performance. Indeed, on the 2010-2017 period, the daily volatility is around 5.997% for a daily return of 0.474%, compared to a 0.93% daily volatility and a 0.0498% daily return for the S&P500 index and respectively 1.072% and -0.006% for gold, Table 1 - *Bitcoin and Indexes*. The annualized mean of Bitcoin is around 461.82% for a annualized volatility about 115.57% whereas S&P500 provides 19.94% of annualized return and 17.73% of volatility. This remarkable risk-return profile compared to other financial assets suggest to analyze its performance.
The objective of this research is to test empirically Bitcoin performance thought the traditional performance models of the CAPM, the Fama and French (1992) model and its extensions with others factors.

The first traditional model considered in this paper is the CAPM model:

$$E(R_i) = R_f + \beta \times [E(R_m) - R_f] \tag{1}$$

where $E(R_i)$ is the expected return of the common stock, R_f is the risk-free rate $E(R_m)$ the expected market return, $[E(R_m) - R_f]$ measures the expected excess rate of return.

The empirical specification of this model is

$$R_i - R_f = \alpha + \beta \times (R_m - R_f) + \epsilon \tag{2}$$

where ϵ is the disturbance term.

Fama and French (1992) extended the CAPM model by adding two factors, SMB (Small Minus Big) and HML (High Minus Low):

$$R_i - R_f = \alpha + \beta_1 \times (R_m - R_f) + \beta_2 \times SMB + \beta_3 \times HML + \epsilon \tag{3}$$

where SMB is the average return on three small portfolios minus the average return of three big portfolios, based on the firm's market capitalization ("size premium"). The underlying explanation, which is of empirical nature, is that smaller firms tend to outperform large firms. HML , is the average return on two value portfolios (high book-to-market) minus the average return on two growth portfolio ("value premium")[2].
The underlying empirical explanation is that firms with higher book-to-market tend to outperform firms with lower book-to-market. Both variables are the results of six value-weight portfolios constructed based on size and book-to-market: two groups according to market capitalization: big (B) and small (S); three groups according to B/M (Book-to-Market): value (V), neutral (N) and growth (G).

SMB and HML variables are computed as follows:

$$SMB = \frac{SV + SN + SG}{3} - \frac{BV + BN + BG}{3} \tag{4}$$

$$HML = \frac{SV + BV}{2} - \frac{SG + BG}{2} \tag{5}$$

[2] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

The return of the market portfolio and the returns of the Fama-French port-folios are based on the common stock market. Common stocks are not representative of the entire investment universe. In particular, bonds are not included in the above-specified benchmarks. Furthermore, since Bitcoin have features in common with commodities, and more precisely with gold, we also consider gold as a benchmark.

The general model allowing to measure Bitcoin risk-adjusted returns is as follows:

$$R_i - R_f = \alpha + \beta_1 \times (R_m - R_f) + \beta_2 \times SMB + \beta_3 \times HML + \beta_4 \times R_{gold} + \beta_5 \times R_{bonds} + \epsilon \quad (6)$$

Where R_{gold} and R_{bonds} represents resp. gold return and bonds returns.

Our main hypothesis is to measure the risk-adjusted return generated through the Bitcoin, which is measured by the alpha coefficient from model 1 (equation 2), model 2 (equation 3) and model 3 (equation 6):

$$H0 : \alpha = 0$$

$$H1 : \alpha > 0$$

The relevant benchmarks considered in our study are necessary global. Indeed, Bitcoin is used across the world because it is not linked to a special country; as stated before, Bitcoin works without any third party (e.g., a central bank). The link between international events and Bitcoin price (the more users turn to Bitcoin, the higher its price) suggests that Bitcoin is used in both developed and emerging countries. In their paper published in 2015, Fama and French apply their 3-factors and 5-factors models at an international level. They created global (and regional) portfolios using global (and regional) size breakpoints and B/M breaking for four regions to allocate the stocks of these regions to the global portfolios [Fama and French, 2012].

$Market$, SMB, HML, and R_f returns are from Fama and French website for both Global, European and Asia-Pacific studies. The world region is composed of Australia, Austria, Belgium, Canada, Switzerland, Germany, Denmark, Spain, Finland, France, Great Britain, Greece, Hong Kong, Ireland, Italy, Japan, Netherlands, Norway, New Zeeland, Portugal, Sweden, Singapore, and Unites-States. The European region contains Austria, Belgium, Switzerland, Germany, Denmark, Spain, Finland, France, Great Britain, Greece, Ireland, Italy, Netherlands, Norway, Portugal, and Sweden. Asian-Pacific region refers to Australia, Hong Kong, New Zeeland and Singapore. R_f is the one-month US treasury Bill rate. Other data (stocks, bonds, currency, commodities indexes) used to estimate model 3 (R_{bonds} and R_{gold}) come from the Datastream database. Finally, Bitcoin (BTC) prices come from the Blockchain info . The Bitcoin's return is computed as follows:

$$R_{asset} = [\log(P_{asset,t}) - \log(P_{asset,t-1})] * 100 \quad (7)$$

We estimate the above-specified models over the period from 09/22/2010 to 06/30/2016. The starting date is relatively recent because the Bitcoin is a recent innovation, before this date the Bitcoin price is \$0. The ending date is 06/30/2016 because Fama and French provide their data until this date therefore. We use daily returns in order to have a robust number of observations considering regressions, and we obtain 1 507 daily observations over the specified period.

4 Results

4.1 Univariate results

4.1.1 Overall Assets Returns

Table 1 - *Overall Asset Returns - daily* et Table 2 - *Overall Asset Returns - annualized* present descriptive statistics between Bitcoin and other classes of financial assets: stock indexes (several stock indexes such as S&P500 and NASDAQ for US stock market, FTSE100 for UK stock market, DAX30 for Germany, NIKKEI225 for Japan, CAC40 for France), MSCI Indexes (for the World, Europe and Asia-Pacific regions), commodities indexes (Oil, Gold and Commodity Index), bonds index (Pimco), and currencies (Dollar Index, Yen, Euro and Yuan). The Bitcoin risk-return profile is particular compared to asset classes. Indeed, Bitcoin obtains the couple of 6% - 0.47% daily risk-return on the period 2010-2016 that represents 114.57% of volatility per year and 461.82% of return per year. This result confirms results found in the literature, [Brière et al., 2015], [Bouri et al., 2016], [Baur et al., 2016].

The seconds higher risk-return profiles are the Dollar Index (30.42% of annualized volatility and 25.16% of annualized return), the NASQAD (resp. 20.02% and 22.52%). The order of magnitude of the existing assets and the innovate Bitcoin is very remarkable. Risk-return of Bitcoin is very different from bond classes with 5.83% volatility for 6.18% return. Stock index as S&P500 provides 17.73% of annualized volatility and 19.94% of annualized return. As we said, Bitcoin is compared to commodity especially gold. In terms of risk-return profile, the findings that make Bitcoin moves away from commodity family. Indeed, gold provides 20.48% volatility and negative return of -2.17%.

Bitcoin possesses the higher return, the higher volatility, the higher minimum (-47.83%) and the higher maximum (64.19%) compared to all other financial asset classes that encourage investors to analyze Bitcoin in financial point of view.

4.1.2 Correlation between assets

Even if the risk-return profiles are different, it is necessary to analyze the correlation between Bitcoin and other assets. It is acknowledged that integrating Bitcoin in portfolios highly improves their performance thanks to diversification, Bitcoin being lowly correlated to other assets [Brière et al., 2015], [Bouri et al., 2016],[Yermack, 2013], [Baur et al., 2016]. We compute Pearson correlation coefficients for all financial asset classes: stock indexes, MSCI indexes, commodity indexes, bonds index and currencies. Table 3 - *Correlation coefficients Bitcoin and other assets* presents correlation coefficient results and shows that Bitcoin return is uncorrelated to others financial assets. These results confirm those found in the literature for longer periods. For example, [Brière et al., 2015] calculate correlation coefficients over three years periods and show that Bitcoin is lowly correlated to other financial assets except for bonds and gold. For our seven years period, results in Table 3 display that the Bitcoin is weakly correlated to bonds and gold. Bitcoin is very different from other assets in terms of risk-return profile and correlation that means returns in Bitcoin doesn't depend on the returns of other financial assets.

4.1.3 Testing performance through Sharpe ratio

The objective of the article is testing the Bitcoin performance. Before measure alpha running regressions, we provide Sharpe ratio which measures returns per unit of risk taken and we compare our results with the existing ones in the literature, [Brière et al., 2015], [Burniske and White, 2017].

Table 4 - *Global and annual Sharpe ratio* present annual and global Sharpe ratio for all assets. Figure 2 - *Sharpe ratio* represents the Sharpe ratio of all assets over the period 2010-2016. On this time, the asset with the higher ratio is Bitcoin which obtains 4.03 whereas the maximum for the other assets is 1.12 for S&P500 and NASDAQ, that is conforming with existing researches. Indeed, [Brière et al., 2015] find a Sharpe ratio of 2.30 on a smaller period (2010-2013).

We analyze the evolution of the Bitcoin Sharpe ratio on the Table 4 and the Figure 3 - *Annual Sharpe ratio for Bitcoin*. Bitcoin recorded its highest ratio in 2013 due to the peak of $1 000 reaching in December 2013. This ratio increases from the creation (2010) to 2013 before decreases in 2014. We could have thought that after this year, Bitcoin performance through Sharpe ratio could have continued to decrease because the innovation is declined. In reality, the Bitcoin Sharpe ratio increases again after 2014 to 2016 (2.33). This evolution respects the Bitcoin price curve: in 2014, the price of Bitcoin has strongly decreased through the closure of the Mt. Gox (the famous bitcoin exchange) in February 2014. When we compare this evolution to other assets evolution, we find that in 2013, the Sharpe ratio of bond, Euro, Yen and Yuan (currencies class) is negative, Table 4, Figure 4 - *Sharpe ratio: MSCI Indexes, Stocks Indexes and Bitcoin* and Figure 5 - *Sharpe ratio: Bonds, Commodities, Currencies and Bitcoin*.

4.2 Multivariate results

In this section, we complete the Sharpe ratio as measure of performance by applying alpha measure trough the three models presented before in equations 2, 3 and 6. Table 5 - *Descriptive statistics of variables* shows descriptive statistics for variables of estimated models: the dependent variable ($Bitcoin\_RF$ that is the Bitcoin return minus the risk-free rate, $R_i - R_f$) and independent variables used in our models (Mkt_RF that is $R_m - R_f$, SMB, HML, *Gold* and *Bonds* that are resp. the gold, R_{gold}, and bonds, R_{bonds} returns). The order of magnitude is the same for the World, European and Asia-Pacific regions. On average, Bitcoin generates a higher return (491.69%) and a higher volatility (116.26%) compared to the other indexes, which never exceed on average 13.62% annualized return and on average 22.71% annualized volatility.

4.2.1 A confirmed diversification finding

We now run the regressions specified in the previous section. Correlation coefficients results (Table 6 - *Correlation Matrix* and Table 3) shows that Bitcoins and other assets are weakly correlated; which may explain diversification results found in the literature. Before running regressions, we expect to find betas with low value and perhaps non-significant betas meaning factors has not impact on the dependent variable. The results confirm this expectation: regression coefficients are not significant, regardless the benchmark and the model used, Table 7 - *Performance*. This results confirms that Bitcoin is weakly correlated to other assets on the market.

4.2.2 Testing performance through alpha

Table 7 shows the regression results for the 3 models. The main result is that the regressions' intercept, α, is positive and significant at the conventional levels for the World, European and Asia-Pacific regions. For all regions, the CAPM model provides a lower α than FF model and than the extended model that toke in consideration size premium, value premium, bonds and gold effects. These two models generate a higher value of alpha in the European and Asia-Pacific regions than in the World. Countries in European and Asia-Pacific regions are also in the World region plus others countries; these other countries influence alpha value (lower than European and Asia-Pacific regions).

The Asia-Pacific region does not provide a higher annualized alpha than the European region, notably with the model 2 where the European region recorded an annualized alpha of 503% whereas 500% in the Asia-Pacific region. Investing in Bitcoin gives the possibility to earn positive risk-adjusted return regardless the region.

The main reason is that Bitcoin is an international asset that outperforms market internationally and there is no regional arbitrary opportunities. Results could be different regard to China because the Asia-Pacific region does not take into account China. However, the mining businesses is mainly based in China and the three Chinese exchange markets which are Okcoin, Huobi and Btcchina cover 90% of the Bitcoin transactions.

4.2.3 Annual Performance

Table 8 - *Annual Performance* presents the Bitcoin performance by year and by region. The α is measured by running the above-specified regressions for each year with daily data. Over time, the market becoming more efficient, Bitcoin performance should decrease all things remaining equal: informational asymmetries between investors notably linked to technology understanding should also decrease. According to the literature, Bitcoin is inefficient on the sub-period 2010-2013 and moving towards the efficiency after-that, [Urquhart, 2016], [Bartos, 2015]. However, in the World region, α is significant and positive in 2012 and 2013. From 2012 to 2013, annualized α increases with values of 907% and 33 137%, respectively. Similar results are obtained for the European and Asia-Pacific regions: α is equal to 1 023% in 2012 and 47 863% in 2013 for Europe, respectively 1 184% and 38 559% for Asia-Pacific region. Investing in Bitcoin in Asia-Pacific in 2012 provided higher risk-adjusted returns than other regions whereas in 2013 it was slightly better to invest in European region. The trend is consistent with the Sharpe ratio evolution presented in previous subsection: the performance increases between 2010 and 2013 reaching the peak Bitcoin price in 2013 (more than $1 000), 2014 is the year where the performance is negative (alpha) or lower (Sharpe ratio) linked to the the fall in the Bitcoin price, then the performance increases again.

4.3 Are the hypotheses of the classical regression model violated?

The Bitcoin risk-return profile being atypical, it is important to check the problems that may appear with our regressions. First, we analyze the normality of Bitcoin returns. The empirical distribution of the returns is presented in figures 6 and 7 - *Bitcoin return analysis resp. Histogram and QQplot*. The symmetry of Bitcoin return indicates that the data skewed on the right that means the tails on the right of the distribution are longer or fatter than the left side confirmed by the skewness (0.99) in Table 2. A normal distribution possesses a kurtosis near to zero but for Bitcoin we obtain 20.83 that indicates "heavy-tailed" distribution that means there are greater number of tail events in Bitcoin return, Table 2 and [Baur et al., 2016]. While the return tends to exhibit a normal distribution shape, normality tests as Shapiro-Wilk presented in Table 9 - *Bitcoin return normality test* reject the null-hypothesis of normality distribution.

We have also checked multicollinearity problems between dependent variables ((Mkt_RF), SMB, HML, *Gold* and *Bonds*). The correlation coefficients between these variables in Table 6 are significant for several dependent variables but for most of them the value is less than +/- 50% except for (Mkt_RF) and SMB in European region (-0.70). VIF and Tolerance (1/VIF),hereafter TOL, are presented in Table 10 - *Collinearity test of independent variables*: there is no collinear variable because VIF is always lower than 4 and TOL is always higher than 0.25.

Table 11 - *Residuals analysis* analyses the autocorrelation between residuals. The residuals do not appear to exhibit time-series correlation because the Durbin-Watson statistic is closed to the value of 2. This is true whatever the model, the region, and the period used. Additional analyses show based on White test that the homoscedasticity hypothesis is respected for all regressions. This is true whatever the model, the region, and the period used. However, the residuals normality hypothesis is not respected based on Shapiro-Wilk test that which be explained by the non-normality distribution of Bitcoin return.

5 Conclusion

Bitcoin is a crypto-currency that appeared in 2008 with a very volatile price and provides a specific risk-return profile for investors. The main objectives of this article are to justify the common-stock-like nature of Bitcoin and empirically test its performance. Even if Bitcoin belongs to “crypto-currencies”, this asset does not seem to respect all properties of a fiat money (medium of exchange, unit of account and store of value). Indeed, its economic and legal characteristics, together with its risk-return profile make it look mostly like financial assets and more precisely common stocks.

To determine whether Bitcoin provides opportunities to earn extra risk-adjusted returns for Global, European and Asian-pacific regions, we run regressions through 3 models: CAPM, Fama-Fench-3 factors and its extension that include 2 others factors (Bonds and Gold) using a sample of daily returns from August 2010 until June 2016. Results fully confirm our hypothesis: Bitcoin increases diversification (low correlation between Bitcoin and other assets) and provides positive and significant risk-adjusted returns in all these regions.

For further research, it would be interesting to run performance measures by considering annual returns and adding more recent data after June 2016. Indeed, during this period new peaks over $1 000 where noticed because of Chinese restrictions on capital outflows and instable monetary policies in emerging countries. Moreover, it seems important to perform specific analyses with regard to China, especially because the mining businesses is mainly based in this country. The three Chinese exchange markets which are Okcoin, Huobi and Btcchina cover 90% of the Bitcoin transactions could be factor of risk, instability and lack of trust.

References

Andreas Antonopoulos. *Mastering Bitcoin*. O'Reilly Media, 2015.

Jakub Bartos. Does bitcoin follow the hypothesis of efficient market? *International Journal of Economic Sciences*, IV(2):10–23, 2015.

Dirk G. Baur, Kihoon Hong, and Adrian D. Lee. Virtual currencies: Media of exchange or speculative asset? *SWIF Institute Working Paper*, (2014-007), 2016.

Ole Bjerg. How is bitcoin money? *Theory, Culture and Society*, 33(1):53–72, 2015.

Rainer Böhme, Nicolas Christin, Benjamin Edelman, and Tyler Moore. Bitcoin: Economics, technology, and governance. *The Journal of Economic Perspectives*, 22(2):213–238, 2015.

Elie Bouri, Peter Molnár, Georges Azzi, David Roubaud, and Lars Ivar Hagfors. On the hedge and safe haven properties of bitcoin: Is it really more than a diversifier? *Finance Research Letters*, 20:192–198, 2016.

Marie Brière, Kim Oosterlinck, and Ariane Szafarz. Virtual currency, tangible return: Portfolio diversification with bitcoins. *Journal of Asset Management*, 16(6): 365–373, 2015.

Chris Burniske and Adam White. Bitcoin: Ringing the bell for a new asset class. *White paper*, 2017.

Anne Haubo Dyhrberg. Bitcoin, gold and the dollar–a garch volatility analysis. *Finance Research Letters*, 16:85–92, 2016a.

Anne Haubo Dyhrberg. Hedging capabilities of bitcoin. is it the virtual gold? *Finance Research Letters*, 16:139–144, 2016b.

Eugene F. Fama and Kenneth R. French. Size, value, and momentum in international stock returns. *Journal of financial economics*, 105(3):457–472, 2012.

Jean-Marc Figuet. Bitcoin et blockchain: quelles opportunités? *Revue d'économie financière*, (3):325–338, 2016.

Florian Glaser, Kai Zimmermann, Martin Haferkorn, Moritz Christian Weber, and Michael Siering. Bitcoin - asset or currency? revealing users' hidden intentions. In *Twenty Second European Conference on Information Systems*, 2014.

John Micheal Grant. Is bitcoin money: implications for bitcoin derivatives regulation and security interest treatment of bitcoins under article 9 of the uniform commercial code. *New York University (NYU), School of Law*, 2014.

D'Artis Kancs, Pavel Ciaian, and Rajcaniova Miroslava. The digital agenda of virtual currencies. can bitcoin become a global currency? *Publications Office of the European Union, JRC Technical report*, 2015.

Odile LakosmkiLaguerre and Ludovic Desmedt. L'alternative monétaire bitcoin : une perspective institutionnaliste. *Revue de la régulation*, 18(2), 2015.

Satoshi Nakamoto. Bitcoin: A peer-to-peer electronic cash system. *White paper*, 2008.

Cecile Raiborn and Marcos Sivitanides. Accounting issues related to bitcoins. *Journal of Corporate Accounting and Finance*, 26(2):25–34, 2015.

George Selgin. Synthetic commodity money. *Journal of Financial Stability*, 17 (92-99), 2015.

Florian Tschorsch and Björn Scheuermann. Bitcoin and beyond: A technical survey on decentralized digital currencies. *IEEE Communications Surveys & Tutorials*, 18(3):2084–2123, 2016.

Andrew Urquhart. The inefficiency of bitcoin. *Economics Letter*, 148:80–82, 2016.

Russ Wermers. Mutual fund performance: An empirical decomposition into stock-picking talent, style, transaction costs, and expenses. *The Journal Of Finance*, LV(4):1655–1695, 2000.

David Yermack. Is bitcoin a real currency? an economic appraisal. *National Bureau Of Economic Research*, 2013.

6 Appendix

List of Figures

List of Tables

Figure 1: **Bitcoin Market Price**
This figure shows the Bitcoin Market Price expressed in US dollars (USD) over the period January 2009 – February 2017.

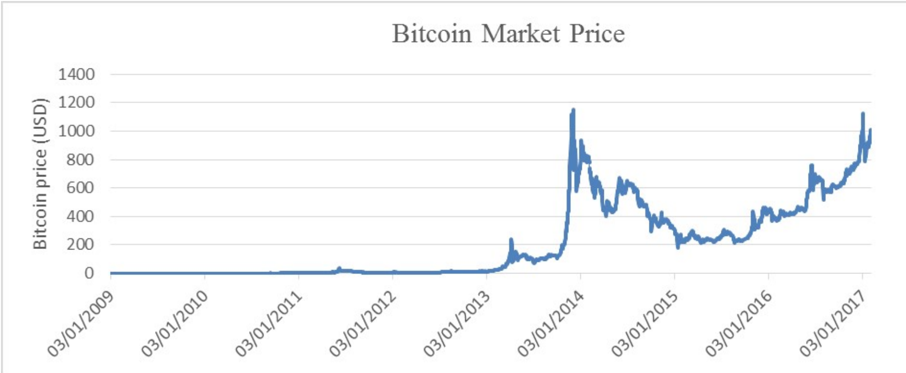

Figure 2: **Sharpe ratio**
This figure shows the Sharpe ratio for Bitcoin (red) and other assets over the period September 2010 – December 2016.

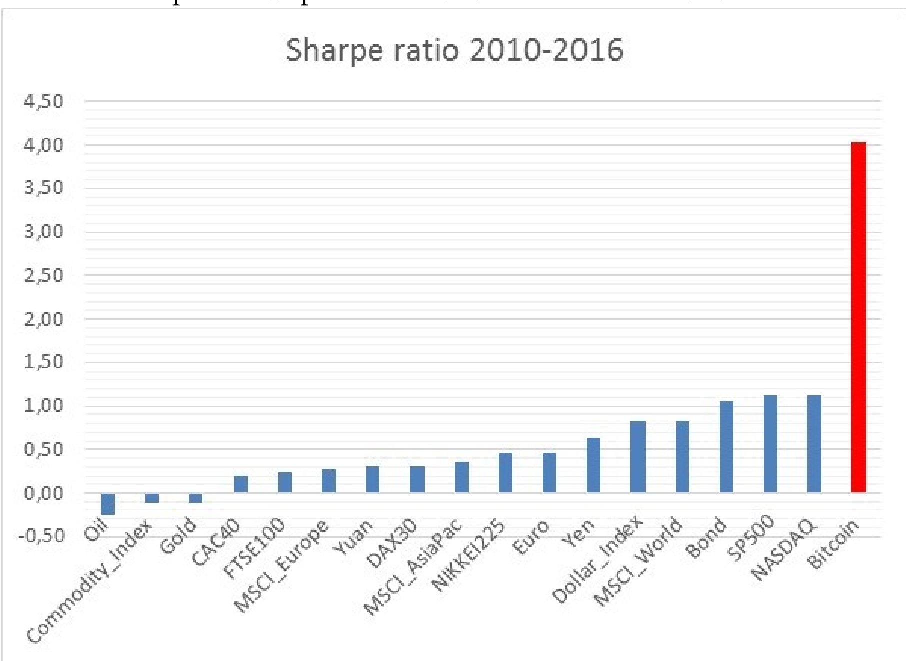

Figure 3: **Annual Sharpe ratio for Bitcoin**
This figure shows the Bitcoin Sharpe ratio per year over the period 2010-2016.

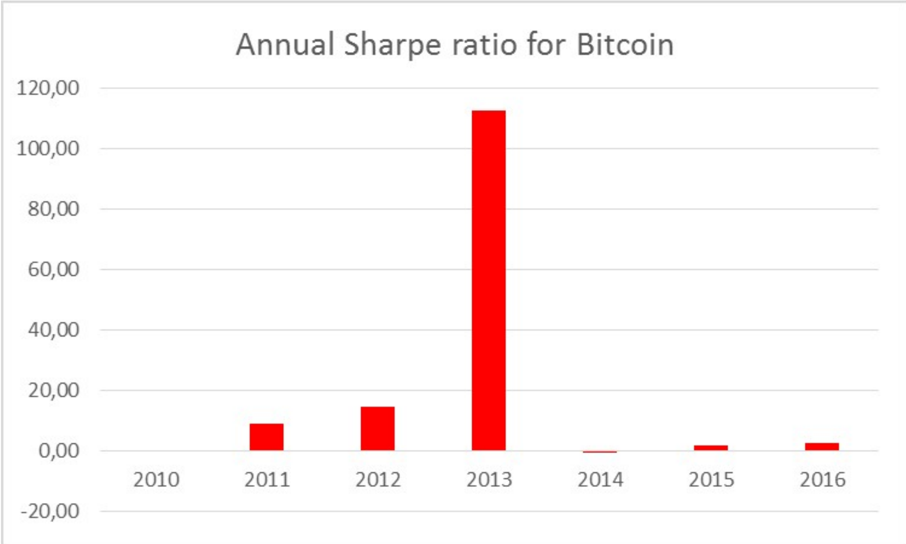

Figure 4: **Sharpe ratio: MSCI Indexes, Stocks Indexes and Bitcoin**
This figure shows the Sharpe ratio for MSCI Indexes, Stocks Indexes and Bitcoin per year since over the period 2010-2016.

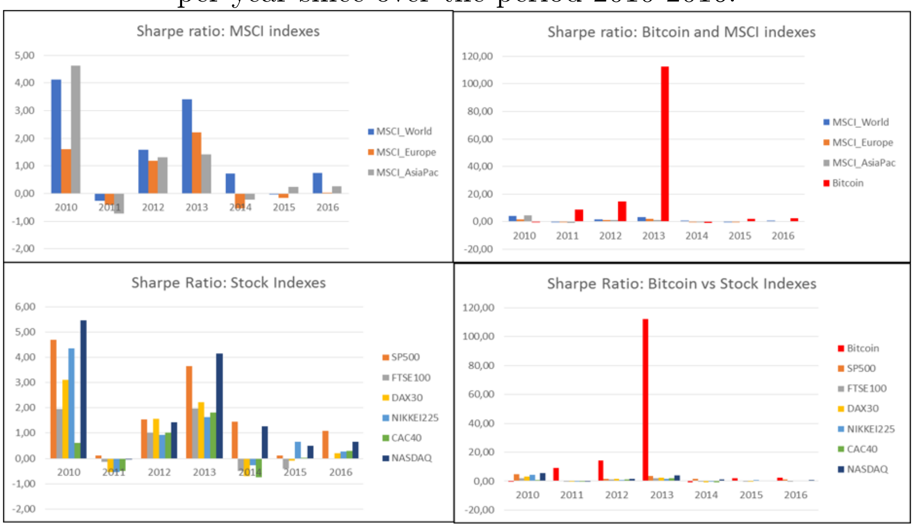

Figure 5: **Sharpe ratio: Bonds, Commodities, Currencies and Bitcoin**
This figure shows the Sharpe ratio for Bond, Commodities, Currencies and Bitcoin per year over the period 2010-2016.

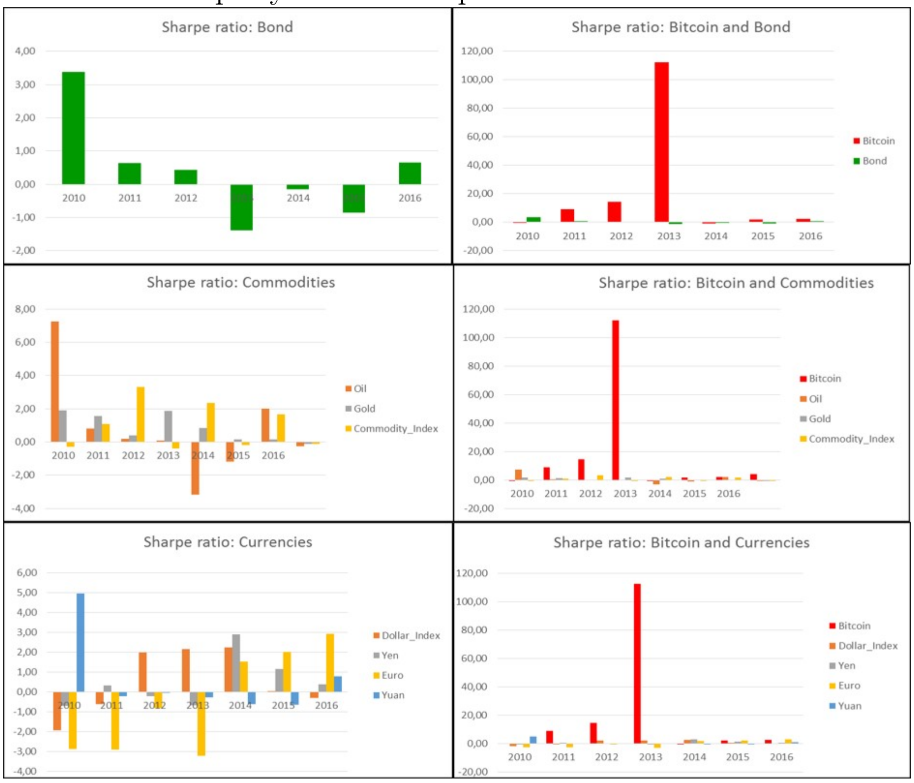

Figure 6: **Bitcoin return analysis - Histogram**
This figure shows the histogram of Bitcoin related to the normal distribution.

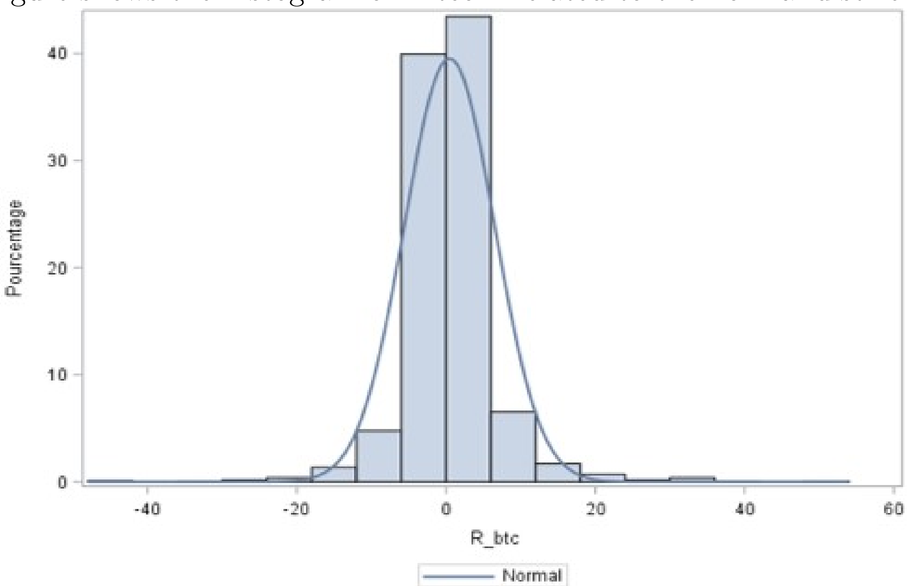

Figure 7: **Bitcoin return analysis - QQplot**
This figure shows QQ plot curve for Bitcoin returns.

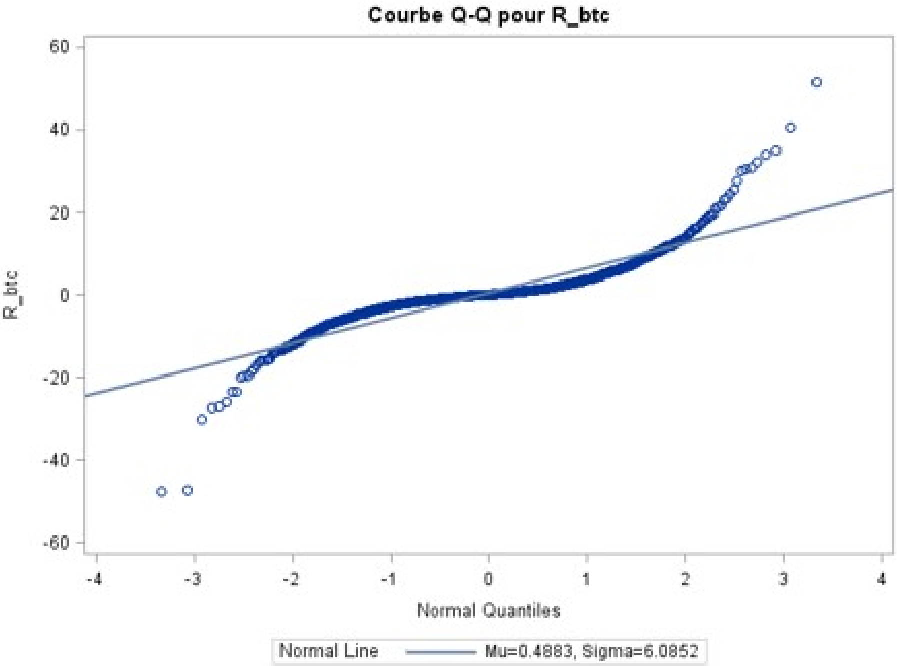

Table 1: **Overall Asset Returns - daily**

This Table presents summary statistics (Mean, Standard Deviation (StD), Sum, Minimum and Maximum) of daily returns expressed in USD for Bitcoin, for Stock indexes (represented by S&P500 and Nasdaq for US, FTSE100 for UK, DAX30 Germany, NIKKEI225 for Japan and CAC40 for France), MSCI indexes for the World, European and Asia-Pacific regions, Commodity indexes (Gold, Oil and Commodity), Bond index (Pimco), and Currencies (dollar, yen, euro and yuan). The sample is drawn from the Blockchain Info website and the Datastream database over the period 22/09/2010 through 03/01/2017.

Descriptive statistics - daily

Variable	**N**	**Mean**	**StD**	**Sum**	**Minimum**	**Maximum**
Bitcoin	**1640**	**0.47%**	**6.00%**	**777.25%**	**-47.83%**	**64.19%**
S&P500	1640	0.05%	0.93%	81.73%	-6.88%	4.63%
FTSE100	1640	0.01%	1.21%	24.12%	-11.51%	5.76%
DAX30	1640	0.02%	1.49%	37.81%	-9.16%	7.52%
NIKKEI225	1640	0.03%	1.29%	48.53%	-10.15%	6.41%
CAC40	1640	0.02%	1.52%	25.11%	-10.48%	8.40%
NASDAQ	1640	0.06%	1.05%	91.27%	-7.14%	5.16%
MSCI_World	1640	0.03%	0.86%	57.22%	-5.25%	4.12%
MSCI_Europe	1640	0.02%	1.24%	28.05%	-9.18%	5.77%
MSCI_AsiaPac	1640	0.02%	1.04%	31.56%	-6.59%	5.09%
Oil	1640	-0.02%	1.52%	-33.79%	-6.11%	10.65%
Gold	1640	-0.01%	1.07%	-9.84%	-10.16%	5.43%
Commodity_Index	1640	-0.01%	1.34%	-13.44%	-10.75%	10.55%
Bonds	1640	0.02%	0.31%	26.93%	-1.58%	1.12%
Dollar_Index	1640	0.06%	1.59%	100.86%	-19.39%	11.00%
Yen	1640	0.02%	0.62%	32.44%	-3.41%	3.71%
Euro	1640	0.01%	0.60%	23.48%	-2.60%	2.26%
Yuan	1640	0.00%	0.13%	3.65%	-1.15%	1.81%

Table 2: **Overall Asset Returns - annualized**

This Table presents summary statistics (annualized mean, annualized volatility, skewness and kurtosis) based on daily statistics (Table 1) expressed for Bitcoin, for Stock indexes (represented by S&P500 and Nasdaq for US, FTSE100 for UK, DAX30 Germany, NIKKEI225 for Japan and CAC40 for France), MSCI indexes for the World, European and Asia-Pacific regions, Commodity indexes (Gold, Oil and Commodity), Bond index (Pimco), and Currencies (dollar, yen, euro and yuan). The sample is drawn from the Blockchain Info website and the Datastream database over the period 22/09/2010 through 03/01/2017.

Descriptive Statistics - annualized

Variable	**N**	**Mean**	**StD**	**Skewness**	**Kurtosis**
Bitcoin	**1640**	**461.82%**	**114.57%**	0.99	20.83
S&P500	1640	19 94%	17 73%	-0.49	5.03
FTSE100	1640	5 51%	23 02%	-0.74	7.30
DAX30	1640	8 78%	28 47%	-0.32	3.41
NIKKEI225	1640	11 40%	24 65%	-0.48	4.69
CAC40	1640	5 75%	28 94%	-0.32	4.06
NASDAQ	1640	22 52%	20 02%	-0.45	3.84
MSCI_World	1640	13 58%	16 33%	-0.57	4.55
MSCI_Europe	1640	6 44%	23 73%	-0.48	4.25
MSCI_AsiaPac	1640	7 27%	19 77%	-0.37	3.12
Oil	1640	-7 24%	29 00%	0.37	4.60
Gold	1640	-2 17%	20 48%	-0.82	7.59
Commodity_Index	1640	-2 95%	25 52%	-0.11	13.05
Bonds	1640	6 18%	5 83%	-0.32	1.55
Dollar_Index	1640	25 16%	30 42%	-0.98	19.31
Yen	1640	7 49%	11 77%	0.22	4.26
Euro	1640	5 37%	11 39%	-0.02	1.48
Yuan	1640	0 81%	2 50%	1.56	29.79

Table 3: **Correlation coefficients Bitcoin and other assets**

This Table presents Pearson correlation coefficients between Bitcoin return and other financial assets such as Stock indexes (represented by S&P500 and Nasdaq for US, FTSE100 for UK, DAX30 for Germany, NIKKEI225 for Japan and CAC40 for France), MSCI indexes for the World, European and Asia-Pacific regions, Commodity indexes (Gold, Oil and Commodity), Bond index (Pimco) and Currencies (dollar, yen, euro and yuan). The sample is drawn from the Blockchain Info website and the Datastream database over the period 09/22/2010 through 01/03/2017. If the p-value is higher than 5% the null-hypothesis of no-correlation (rho=0) is accepted.

Pearson correlation: Bitcoin daily return with other daily return assets					
Stock Index					
	S&P500	**FTSE100**	**DAX30**	**NIKKEI225**	**CAC40**
Bitcoin	0.04	0.03	0.04	-0.01	0.05
p-value	0.07	0.22	0.14	0.70	0.06
MSCI Index					
	MSCI_World	**MSCI_Europe**	**MSCI_AsiaPac**		
Bitcoin	0.04	0.04	-0.01		
p-value	0.10	0.12	0.63		
Commodities					
	Oil	**Gold**	**Commodity_Index**		
Bitcoin	0.04	0.03	-0.01		
p-value	0.15	0.23	0.80		
Bonds					
	Bonds				
Bitcoin	0.00				
p-value	0.88				
Currencies					
	Dollar_Index	**Euro**	**Yuan**	**Yen**	
Bitcoin	-0.01	-0.03	-0.01	-0.00	
p-value	0.82	0.28	0.64	0.9274	

Table 4: **Global and annual Sharpe ratio**

This Table presents the global Sharpe ratio and the Sharpe ratio per year for Bitcoin, Stock indexes (represented by S&P500 and Nasdaq for US, FTSE100 for UK, DAX30 Germany, NIKKEI225 for Japan and CAC40 for France), MSCI indexes for the World, European and Asia-Pacific regions, Commodity indexes (Gold, Oil and Commodity), Bond index (Pimco), and Currencies (dollar, yen, euro and yuan). The sample is drawn from the Datastream database and the Blockchain Info website over 2010 - 2017.

Annual and Global Sharpe ratio

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2010-2016**
Bitcoin	**-0,34**	**8,98**	**14,46**	**112,37**	**-0,77**	**1,87**	**2,33**	**4,03**
SP500	4,70	0,11	1,53	3,64	1,46	0,10	1,09	1,12
FTSE100	1,95	-0,13	1,01	1,97	-0,49	-0,42	-0,02	0,24
DAX30	3,10	-0,54	1,56	2,22	-0,70	-0,09	0,19	0,31
NIKKEI225	4,36	-0,53	0,92	1,64	-0,28	0,67	0,28	0,46
CAC40	0,62	-0,50	1,02	1,82	-0,74	0,03	0,30	0,20
NASDAQ	5,46	-0,04	1,43	4,14	1,26	0,49	0,66	1,12
MSCI_World	4,13	-0,27	1,58	3,40	0,72	-0,03	0,74	0,83
MSCI_Europe	1,60	-0,41	1,18	2,20	-0,53	-0,16	0,00	0,27
MSCI_AsiaPac	4,63	-0,73	1,32	1,41	-0,22	0,24	0,27	0,36
Oil	7,25	0,79	0,17	0,07	-3,18	-1,18	2,02	-0,25
Gold	1,89	1,56	0,37	1,87	0,85	0,16	0,16	-0,11
Commodity_Index	-0,28	1,09	3,31	-0,40	2,33	-0,20	1,66	-0,12
Bonds	3,39	0,63	0,43	-1,39	-0,16	-0,86	0,66	1,05
Dollar_Index	-1,92	-0,63	1,97	2,16	2,23	0,05	-0,29	0,82
Yen	-0,70	0,33	-0,21	-0,66	2,89	1,15	0,38	0,63
Euro	-2,88	-2,91	-0,83	-3,22	1,51	2,01	2,93	0,47
Yuan	4,96	-0,21	-0,04	-0,27	-0,63	-0,65	0,79	0,30

Table 5: **Descriptive statistics of variables**

This Table presents summary statistics (Mean, Standard Deviation (StD), Sum, Minimum, Maximum, Annualized Mean and Annualized Volatility) of daily returns expressed in USD for the depend variable (Bitcoin_Rf) representing Bitcoin return minus the risk free rate (one-month US Treasury Bill) and for the independent variables (Mkt_Rf representing excess return, SMB is size premium, HML is the value premium, Bond and Gold). The sample is drawn from the Datastream database, the Blockchain Info and Fama French websites over the period 22 September 2010 – 06 June 2016 in the World, European and Asia-Pacific regions.

World

Variable	**N**	**Mean**	**StD**	**Sum**	**Minimum**	**Maximum**	**Annualized Mean**	**Annualized StD**
Bitcoin_RF	1507	0.49%	6.09%	735.80%	-47.83%	51.53%	491.69%	116.26%
Mkt_RF_W	1507	0.04%	0.87%	52.74%	-5.12%	4.16%	13.62%	16.59%
SMB_W	1507	0.00%	0.34%	-4.22%	-1.86%	1.92%	-1.02%	6.46%
HML_W	1507	-0.01%	0.28%	-9.97%	-1.20%	1.24%	-2.39%	5.39%
Gold	1507	0.00%	1.09%	3.50%	-10.16%	5.43%	0.85%	20.87%
Bonds	1507	0.02%	0.31%	28.93%	-1.58%	1.12%	7.26%	5.84%

Europe

Variable	**N**	**Mean**	**StD**	**Sum**	**Minimum**	**Maximum**	**Annualized Mean**	**Annualized StD**
Bitcoin_RF	1507	0.49%	6.09%	735.80%	-47.83%	51.53%	491.69%	116.26%
Mkt_RF_E	1507	0.02%	1.19%	34.70%	-8.80%	5.60%	8.77%	22.71%
SMB_E	1507	0.01%	0.49%	8.67%	-2.13%	3.28%	2.12%	9.40%
HML_E	1507	-0.02%	0.44%	-27.04%	-2.17%	1.84%	-6.34%	8.48%
Gold	1507	0.00%	1.09%	3.50%	-10.16%	5.43%	0.85%	20.87%
Bonds	1507	0.02%	0.31%	28.93%	-1.58%	1.12%	7.26%	5.84%

Asia - Pacific

Variable	**N**	**Mean**	**StD**	**Sum**	**Minimum**	**Maximum**	**Annualized Mean**	**Annualized StD**
Bitcoin_RF	1507	0.49%	6.09%	735.80%	-47.83%	51.53%	491.69%	116.26%
Mkt_RF_AP	1507	0.01%	0.93%	20.56%	-5.70%	4.67%	5.10%	17.82%
SMB_AP	1507	-0.01%	0.48%	-10.16%	-3.41%	4.79%	-2.43%	9.24%
HML_AP	1507	0.01%	0.46%	18.63%	-1.82%	1.95%	4.61%	8.71%
Gold	1507	0.00%	1.09%	3.50%	-10.16%	5.43%	0.85%	20.87%
Bonds	1507	0.02%	0.31%	28.93%	-1.58%	1.12%	7.26%	5.84%

Table 6: **Correlation Matrix**

This Table presents the correlation matrix between the dependent variable (Bitcoin_Rf) and independent variables (Mkt_Rf, SMB, HML, Gold, bond) with each other. The sample is drawn from the Datastream database, the Blockchain Info and Fama French websites over the period 22 September 2010 – 06 June 2016 in the World, European and Asian-Pacific regions. If the p-value is higher than 5%, the null-hypothesis of no-correlation (rho=0) is accepted.

Person correlation coefficients

World

	Bitcoin_RF	**Mkt_RF_W**	**SMB_W**	**HML_W**	**Gold**	**Bond**
Bitcoin_RF	**1**					
Mkt_RF_W	**0.04**	**1**				
	0.1574					
SMB_W	**-0.04**	**-0.40**	**1**			
	0.1422	0.0001				
HML_W	**0.02**	**0.17**	**-0.17**	**1**		
	0.3409	0.0001	0.0001			
Gold	**0.03**	**0.08**	**0.15**	**-0.03**	**1**	
	0.2239	0.0033	0.0001	0.2566		
Bonds	**0.00**	**-0.12**	**0.16**	**-0.08**	**0.17**	**1**
	0.9451	0.0001	0.0001	0.003	0.0001	

Europe

	Bitcoin_RF	**Mkt_RF_E**	**SMB_E**	**HML_E**	**Gold**	**Bond**
Bitcoin_RF	**1**					
Mkt_RF_E	**0.03**	**1**				
	0.1969					
SMB_E	**-0.04**	**-0.70417**	**1**			
	0.1048	0.0001				
HML_E	**0.03**	**0.48**	**-0.39**	**1**		
	0.2772	0.0001	0.0001			
Gold	**0.03**	**0.09**	**0.02**	**0.01**	**1**	
	0.2239	0.0007	0.5392	0.5979		
Bonds	**0.00**	**-0.09**	**0.15**	**-0.14**	**0.17**	**1**
	0.9451	0.0008	0.0001	0.0001	0.0001	

Asia-Pacific

	Bitcoin_RF	**Mkt_RF_AP**	**SMB_AP**	**HML_AP**	**Gold**	**Bond**
Bitcoin_RF	**1**					
Mkt_RF_AP	**0.03**	**1**				
	0.2874					
SMB_AP	**-0.02**	**-0.34**	**1**			
	0.5108	0.0001				
HML_AP	**-0.04**	**-0.38**	**-0.12**	**1**		
	0.1481	0.0001	0.0001			
Gold	**0.03**	**0.16**	**0.02**	**-0.13**	**1**	
	0.2239	0.0001	0.3829	0.0001		
Bonds	**0.00**	**0.02**	**-0.01**	**0.00**	**0.17**	**1**
	0.9451	0.4735	0.5665	0.8846	0.0001	

Table 7: **Performance**

This Table presents the regression results for the 3 models in equations 2,3,6.The sample is drawn from the Datastream database, the Blockchain Info and Fama French websites over the period 22 September 2010 – 06 June 2016 in the World, European and Asia-Pacific regions. ***, ** and * show that the coefficient is significant at 1%, 5% and 10% level respectively.

Performance measuring using CAPM (Model 1). FF (Model 2) and extensions (Model 3)

	α	Rm_Rf	SMB	HML	Bonds	Gold	R2	Adjusted R2	Annualized alpha
World									
Model 1	**0.48*** **	**0.26**					0.0013	0.0007	473%
p-value	0.0023	0.1574							
Model 2	**0.48*** **	**0.16**	**-0.46**	**0.35**			0.0022	0.0002	482%
p-value	0.0021	0.4064	0.3673	0.5382					
Model 3	**0.48*** **	**0.13**	**-0.60**	**0.37**	**0.10**	**0.19**	0.0034	0.0001	479%
p-value	0.0022	0.5277	0.2483	0.5167	0.8564	0.1941			
Europe									
Model 1	**0.48*** **	**0.17**					0.0011	0.0004	483%
p-value	0.002	0.1969							
Model 2	**0.49*** **	**0.01**	**-0.43**	**0.18**			0.0019	-0.0001	503%
p-value	0.0017	0.9498	0.3379	0.6575					
Model 3	**0.49*** **	**-0.02**	**-0.50**	**0.20**	**0.08**	**0.18**	0.0029	-0.0004	502%
p-value	0.0018	0.909	0.2737	0.6286	0.8778	0.2326			
Asia-Pacific									
Model 1	**0.49*** **	**0.18**					0.0008	0.0001	486%
p-value	0.002	0.2874							
Model 2	**0.49*** **	**0.05**	**-0.24**	**-0.49**			0.0019	-0.0001	500%
p-value	0.0017	0.8166	0.5028	0.2026					
Model 3	**0.49*** **	**0.02**	**-0.27**	**-0.47**	**-0.06**	**0.15**	0.0026	-0.0007	502%
p-value	0.0018	0.9316	0.4611	0.223	0.9092	0.3028			

Table 8: **Annual Performance**

This Table presents the regression results for model 2, year by year, in equation 3. The sample is drawn from the Datastream database, the Blockchain Info and Fama French websites over the period 2010 –2016 in the World, European and Asian-Pacific regions. We run year by year model 2 to estimate alpha evolution in the World, European and Asia-Pacific regions. ***, ** and * show that the coefficient is significant at 1%, 5% and 10% level respectively.

Daily and annualized alpha estimate evolution

World									
	2010-2016	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2015-2016**
α	**0.48*** **	-0.35	0.59	0.63***	1.60***	-0.25	0.26	0.14	0.21
p-value	0.0021	0.8571	0.2522	0.0017	0.0003	0.2565	0.199	0.5562	0.1812
Annualized α	482%	-72%	754%	907%	33137%	-60%	159%	64%	114%
Europe									
	2010-2016	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2015-2016**
α	**0.49*** **	-0.64	0.74	0.66***	1.71***	-0.25	0.27	0.12	0.22
p-value	0.0017	0.7426	0.1582	0.0011	0.0001	0.2505	0.1823	0.6019	0.1529
Annualized α	503%	-90%	1388%	1023%	47863%	-60%	172%	54%	126%
Asia-Pacific									
	2010-2016	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2015-2016**
α	**0.49*** **	-0.26	0.67	0.70***	1.65***	-0.29	0.21	0.14	0.19
p-value	0.0017	0.8918	0.2013	0.0006	0.0001	0.1938	0.3022	0.5339	0.2315
Annualized α	500%	-62%	1030%	1184%	38559%	-65%	115%	70%	97%

Table 9: **Bitcoin return normality test**

The Table presents the normality test for Bitcoin returns. The sample is drawn from the Blockchain Info website over the period 2010–2016. The normality hypothesis is based on Shapiro-Wilk test: if the p-value is lower than alpha, the null-hypothesis of normality is rejected.

	Shapiro Wilk	**Kolmogorov Smirnov**	**Cramer Von Mises**	**Anderson Darling**
Statistics	**0.80**	**0.16**	**15.75**	**80.73**
p-value	0.0001	0.01	0.005	0.005

Table 10: **Collinearity, test of independent variables**

This Table shows collinearity test of independent variables. The sample is drawn from the Blockchain Info and Fama-French websites over the period 2010 –2016 in the World, European and Asian-Pacific regions for the 3 models in equations 2,3,6. VIF is the variance inflation factor: if VIF is higher than 4 and TOL is lower than 0.25, variable is considered collinear with the dependent variable.

	World		**Europe**		**Asia-Pacific**	
	VIF	TOL	VIF	TOL	VIF	TOL
Model 1						
α	0	.	0	.	0	.
Rm_Rf	1	1	1	1	1	1
Model 2						
α	0	.	0	.	0	.
Rm_Rf	1.21	0.83	2.19	0.46	1.41	0.71
SMB	1.21	0.83	2.00	0.50	1.23	0.81
HML	1.04	0.96	1.31	0.76	1.27	0.79
Model 3						
α	0	.	0	.	0	.
Rm_Rf	1.24	0.80	2.24	0.45	1.44	0.70
SMB	1.26	0.79	2.04	0.49	1.23	0.81
HML	1.05	0.96	1.32	0.76	1.27	0.79
Bonds	1.07	0.93	1.05	0.95	1.07	0.94
Gold	1.06	0.95	1.06	0.94	1.03	0.97

Table 11: **Residuals analysis**

This Table presents the residuals analysis from the long-run regressions in the World, European and Asia-Pacific regions. The sample is drawn from the Blockchain Info and Fama-French websites over the period 2010 –2016 in the World, European and Asia-Pacific regions for the 3 models in equations 2,3,6. The residuals autocorrelation hypothesis is tested using Durbin-Watson statistic: if Durbin-Watson statistic is around 2, the residuals are considered uncorrelated. The homoscedasticity hypothesis is tested based on White test: if the p-value is lower than 5%, the null-hypothesis of homoscedasticity is rejected. The normality hypothesis is based on Shapiro-Wilk test: if the p-value is lower than 5%, the null-hypothesis of normality is rejected.

	World		
	Autocorrelation Durbin-Watson	Homoscedasticity White	Normality Shapiro-Wilk
Model 1	**1.75**	**2.67**	**0.80**
p-value		0.2629	0.0001
Model 2	**1.74**	**9.53**	**0.80**
p-value		0.3896	0.0001
Model 3	**1.75**	**24.44**	**0.80**
p-value		0.2238	0.0001
	Europe		
	Autocorrelation Durbin-Watson	Homoscedasticity White	Normality Shapiro-Wilk
Model 1	**1.75**	**0.66**	**0.80**
p-value		0.7179	0.0001
Model 2	**1.74**	**2.50**	**0.80**
p-value		0.9808	0.0001
Model 3	**1.75**	**19.73**	**0.80**
p-value		0.4748	0.0001
	Asia-Pacific		
	Autocorrelation Durbin-Watson	Homoscedasticity White	Normality Shapiro-Wilk
Model 1	**1.74**	**0.09**	**0.80**
p-value		0.9556	0.0001
Model 2	**1.74**	**5.01**	**0.80**
p-value		0.8337	0.0001
Model 3	**1.75**	**19.92**	**0.80**
p-value		0.4632	0.0001