# Greece withdraws from Euro and runs on Bitcoin; April Fools Prank or Serious Possibility?

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**Abstract:** This paper assesses whether the way in which the Greek crisis was communicated by media and social networking increase the debt deal uncertainty and the possibility of abandoning the euro in favor of Bitcoin. Through an improved frequency approach, we attempt to disentangle short-, medium- and long-run causality between Google Trends (search queries) and Twitter (social media) data related to the Greek crisis and Bitcoin unconditionally and conditioning upon relevant control variables. Our results unambiguously show a short-run unidirectional causality running from search queries and the number of tweets to the use of Bitcoin. These findings remain meaningful when a number of control variables are accounted for, while the cycle length becomes shorter. These results change substantially by the arrival of the left-wing Syriza party in power, on January 25th, 2015, with its radical approach to debt negotiations. The cycle becomes longer (short- and medium-run). Not surprisingly, doubts have increased as to whether Athens can appropriately settle its debt repayment obligations. This study indicates that Greece's withdrawal from euro and running on Bitcoin is likely to be an April fool's joke rather than serious possibility. It also proves a sharp distinguishability among Googlers and Twitters.

**Keywords:** Greek crisis; Social media; Google Trends; Bitcoin; frequency domain causality.

## 1. Introduction

One of the defining factors of Bitcoin is its extra-volatility (greater appreciations and precipitous depreciations in its value). Since its inception in 2009 by a computer programmer using the pseudonym Satoshi Nakamoto, Bitcoin deeply undergoes quick rises and devastating falls. Mark Williams of Boston University indicates that the uncertainty about the price of this nascent virtual currency is 7 times that of gold price. While almost any currency is obviously characterized by its volatile behavior, the Bitcoin price risk appears more problematic. During 2014, the price of Bitcoin undergoes large day-to-day variations, which appear trended down. By mid-January 2015, this nascent crypto-currency appears more stable. This was roughly coincided with growing indications that Greece will be unable to meet its financing needs/ debt repayment obligations. Some believe the default could result in Greece leaving the eurozone (i.e., the Grexit from the euro may soon become inevitable). This sharp coincidence cannot be accidental. It seems clear that a large of Greeks want to stay in the eurozone and see a deal/amicable resolution with EU creditors. Nevertheless, the negotiations appear bumpy and the risk of the exit of Greece leaving euro area remains elevated. On January 25th 2015 and with a great desire to settle upcoming debt obligations, the left-wing Syriza[1] party received the largest number of votes in Greece's elections. However, the formation of a coalition government with the independent Greeks (a right-wing anti-bailout party), the second day after election, has deeply threatened negotiations between creditors and the Greek government and has left Greece in a state of limbo. The great debt deal crisis uncertainty and the Grexit risk have been considered as the major headwind to Greek economic growth and as response government tax receipts have decreased markedly. Moreover, the massive outflow of capital observed during May and June 2015, can push the Greek banks to block all accounts in euro. At the same date, it is well seen from the Vaultoro[2] platform that 124% pick-up in inflows from Greek IP addresses. This clearly indicates that the Greeks are worried and prefer to keep their savings in private assets like gold and Bitcoin that may constitute safe havens, rather than depending widely on the goodwill of banks. The Cypriot crisis is on everyone's mind. The Greeks cannot simply forget what happened when the Cypriot banks have blocked deposits and withdrawals banned in 2013. They did not hesitate to tax individuals' deposits and withdrawals. The value of Bitcoin has soared 700%.

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[1] It is a left-wing political party in Greece, founded in 2004, as a coalition of left-wing and radical left parties.

[2] Vaultoro is an internet platform where users can trade physical gold and Bitcoin. It holds Bitcoins for its customers and allows them to exchange it for gold and vice versa.

This increase is certainly not only due to the Cyprus problem, but also attributed to the Greek crisis and other factors (see Bouoiyour and Selmi (2015) for more details about the determinants of Bictoin value).

These uncertainties culminated when the Greek finance minister Yanis Varoufakis made shares in his Twitter account that Greece will adopt the Bitcoin if eurozone doesn't give Greek government a deal. The second top thinker in the world according to prospect magazine surprised all by saying "We' ve had enough, we' ll run on Bitcoin. We'll go to Bitcoin, we will be ahead of all the world economies and although it may be painful in the beginning, Greece's economy will thrive in the long term". If there is indeed an April fool's joke, the fact remains that a year instead (when he was still in the power), he seriously suggested an independent currency that works on the model of Bitcoin for peripheral countries by saying that "Governments in Europe's Periphery can create their own payment system backed by future taxes and denominated in euros. Moreover, they could use a Bitcoin-like algorithm in order to make the system transparent, efficient and transactions-cost-free". By thinking about to what extent Varoufakis's statement may be serious and in the wake of growing uncertainty about Grexit and the possibility of abandoning euro in favor of Bitcoin, bloggers, policymakers, commentators and followers began dealing with this issue by revolving around multiple questions: Does Bitcoin the solution of Greece's future? Is Bitcoin ever going to become safe haven? Is the uncertainty about Greece leaving the eurozone pushed to increasingly adopt Bitcoin? Could the rejection of the euro prompt nationwide adoption of crypto-currencies? Is the arrival of the radical left in power facilitates the abandon of euro in favor of Bitcoin?

Our contribution in this paper is twofold. The first relies on the choice of the topic, while attempting to assess (1) how plays media' stance towards the Greek crisis in accentuating the possibility of abandoning the euro in favor of Bitcoin, and (2) to what extent the arrival of the radical left in power may increase the Greeks anxiety about the Greece's debt deal uncertainty. The second concerns the methodological framework by using an innovative frequency approach allowing us to examine the causality between the variables of interest under well-specified horizons (short-, medium- and long-run). Unlike the causal standard approaches that consider the direction of causality between economic variables across the full studied period, the frequency causality enables to evaluate causality among different frequencies. Basically, the standard measurement of the causality for various periods may be performed by standard models by subdividing the sample period to well specific sub-periods.

This procedure seems vulnerable since it is based on a relatively small number of data that may threaten the robustness of the results. To avoid this drawback, the frequency analysis seems able to keep all the observations over the period of investigation in each of the frequencies involved. Moreover, while defining standard causality is straightforward in the case of pairs of variables neglecting potential control variables that may affect intensely the relationship studied, multivariate or conditional data analysis seems less obvious (Hosoya, 2001);  hence the relevance of the present study.

By applying frequency domain causality test-based on conditional data analysis, with special reference to Greece, we show unambiguously that social media and search queries related to Greek crisis Granger-cause the Bitcoin price under highest frequencies (short-run) conditioning upon potential control variables divided into supply demand fundamentals, economic and financial indicators and speculative and technical drivers. It is also well noticeable that the arrival of left radical party to power has led to heavy doubts as to whether the new government will be able to meet upcoming debt obligations, increasing thus the Greeks' interest to Bitcoin as possible safe haven currency. Our research clearly indicates how social networking website and search for information on the World Wide Web may reinforce Grexit uncertainty and the Greeks' stance towards Bitcoin.

The structure of the article is as follows: Section 2 presents the main drivers of Bitcoin. Section 3 describes the data and presents the empirical strategy. Section 4 reports our main findings. Section 5 discusses the results and concludes.


## 2.  The main Bitcoin drivers

From 2009, Bitcoin has succeeded to win an increasingly popularity in few times. The global financial crisis has sustained the investors' attractiveness towards this currency.  It is an alternative currency to the fiat currencies including dollar, euro and yen, with several advantages like lower transactions fees and transparent information about transactions and some drawbacks including the lack of legal security, the extra volatility and the great speculation (Kristoufek 2014; Bouoiyour and Selmi 2015; Bouoiyour et al. 2015). Everyone knows that Bitcoin is extremely volatile, even with a stable price currently. Nevertheless, it is still difficult to fully address what determines the price of this nascent cypto-currency and how effectively prepare for what's yet to come. This study uses a novel approach that links the value of Bitcoin on the Greek crisis uncertainty (through media and social networking).

The existing literature on this virtual currency suggests different factors that may affect substantially its evolution. The present research relies on the possible impacts of supply-demand fundamentals (the exchange-trade ratio, the monetary velocity and the estimated output volume), economic/financial indicators (the gold price, the Chinese market index and financial crisis such as the recent Cyprus and Greek crises), speculative determinants (investors' attractiveness) and technical drivers (hash rate). We attempt in the following to rigorously explain these fundaments.

- *Supply-demand determinants:* One of the main fundamentals of Bitcoin price is the great interaction between supply and demand on the crypto-currency market. The demand seems potentially driven by its value as a medium of exchange, whereas the supply is determined essentially through the stock of Bitcoins in circulation (Buchholz et al. 2012; Ciaian et al. 2014). As it is clear that firms need to convert Bitcoins into fiat currencies, as they operate in economies using these moneys for purchase production factors. Indeed, the frequency at which one unit of Bitcoin is used to purchase tradable or non-tradable products for a given period (monetary velocity) may affect widely the price of this new digital money. Recently, Kristoufek (2014) adds that an increase in the estimated Bitcoin transactions volume may also lead to a drop in Bitcoin price in the long-run.

-*Speculative fundamentals:* Bitcoin has attracted a substantial number of users since its creation. To measure investors' attractiveness to Bitcoin, we use the daily Bitcoin views from Google Trends or (Kristoufek 2013; Piskorec et al. 2014) or the number of tweets or mentions in Twitter (Dergides et al. 2013). In that context, Lee (2014) indicates that the attention-driven the behaviors of investors and Bitcoiners can affect the central digital money either positively or negatively, depending on the type of news (good or bad) that dominate in the media and social networking at specified period.

- *Technical drivers:* The emergence of Bitcoin has provided new approaches concerning payments. Hence, some new words have emerged such as the "hash rate". It represents an indicator of the processing power of the Bitcoin network. For security goal, the latter must make intensive mathematical operations, leading to an increase in the hash rate. This may affect widely Bitcoin purchasers and increases considerably the demand of this new currency and in turn their prices (Kristoufek 2014; Bouoiyour and Selmi 2015).

- *Macroeconomic and financial indicators:* Recent studies have highlighted to what extent macroeconomic and financial factors affect Bitcoin price. Van Wijk (2013) puts in evidence how global macroeconomic and financial development captured by time series such as

exchange rate and oil price explain the Bitcoin volatility. These proxies may affect differently the focal digital currency via several channels. For instance, favorable and continuous macroeconomic and financial developments may markedly improve the use of Bitcoin in transactions (trade and exchanges) and as a result enhance its demand and affect positively its prices. Thus, the trade and exchange transactions can be used as effective proxy here. It is measured through the ratio between volumes on the currency exchange market and trade. In addition, Bouoiyour et al. (2015) suggest that the Shangai market plays considerably on Bitcoin dynamic and thus may be perceived as a potential source of Bitcoin price volatility. This effect has been clearly seen by the announcement that Baidu[3] is accepting Bitcoin as transactions tool. Interestingly, financial and economic crises may also drive the development of Bitcoin price. The Greek crisis is an interesting thing to observe. Social media have played a substantial role in increasing the interaction between Grexit and Bitcoin as possible safe haven' currency. Obviously, social media tools have influenced profoundly the global flow of information. The Greek experience worthy provides how and to what extent social media can influence society and public sphere. Notably, there are several blogs that touch on how Grexit uncertainty can reinforce the adoption of Bitcoin including "Can a Bitcoin-style virtual currency solve the Greek financial crisis", "Why is the price of Bitcoin not rising despite the Greece crisis?", "Bitcoin is the real winner in Greece crisis", "why Greece should not switch to Bitcoin?" and "Bitcoin as a solution for Greece during the current crisis: what you need to know?",etc. This highlights the great interest and the stance of media and social networking websites towards Greek crisis. This allows us to use Google Trends (search queries) and information and/or the volume of activity contained in social media (Twitter) as appropriate proxies for examining if the way in which the Grexit was communicated by Googlers and Tweeters increase the possibility of abandoning the euro in favor of the most exciting crypto-currency (Bitcoin).

### 3. Hypotheses, data source and methodology
### 3.1. Hypotheses and data description

The consideration that a relationship between economic variables can be repetitive or cyclical over time remains of great importance with respect to standard investigations assuming independent behavior over the period. Generally, the procedures of standard models are still

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[3] Baidu is a Chinese web services company. It offers various services,such Chinese language-search engine for websites, audio files and images. It is considered as a potential determinant of the Chinese online shopping.

vulnerable, since they do not account for nonlinearity and cycle length. These difficulties are absorbed satisfactorily by decomposing the Granger causality in the frequency domain. The latter provides a powerful tool for the cyclical phenomenon analysis and the determination of the contribution of a variable to change of other series depending on frequency-to-frequency variation. Hence, investigating time series across different frequencies could be helpful in supplementing the information obtained through the time-domain assessment (Granger 1969) by highlighting the cyclical properties of data. Throughout the rest of this paper, we provide an accurate distinction between lowest frequencies highest frequencies among the variables studied. A priori, we believe that search queries and social media related to Greece's crisis can affect Bitcoin price in lower frequencies (short-run). Our belief is mainly attributed to the fact that Greeks try a new currency in order to deal with debt deal uncertainty, but this cannot, in any case, be ultimate. Bitcoin may be perceived as the currency of people, while it would appear hard to consider Bitcoin as a currency for a country. Because it is deflationary, Bitcoin would be bad for Greece. It is well known that the Bitcoin system will stop creating new coins in the long term, eliminating thus the subsidy to check transactions. To start our analysis, we formulate two hypotheses to be verified:

***$H_1$: Is the uncertainty about Greece leaving the eurozone pushed to increasingly adopt Bitcoin? If so, is it a short-, medium- or long-run relationship***?

***$H_2$: Is the arrival of the radical left in power (Syriza) will facilitate the Greek withdrawal from euro in favor of Bitcoin?***

For empirical context, we use daily time-series data related to Bitcoin (BPI) and the interest to Greek crisis (GRK) over the period from 04/12/2010 to 08/06/2015. The long time range of our time series data may help policymakers to reach accurate information and fully picture about how media's stance towards Grexit can increase the possibility of leaving eurozone and running on Bitcoin. The Bitcoin is collected from Blockchain (https://blockchain.info/), while the search queries for key phrases related to Greek debt crisis (i.e., "Greek crisis"and "Grexit") have been used as proxies of the crisis in Greece by referring to Google Trends (http://www.google.com/trends). Note that for twitter, we use the tweet backs related to two same keywords (i.e., "Greek crisis" and "Grexit"). The data for the exchange-trade ratio (ETR), the monetary velocity (MV), the estimated output volume, the Shangai market index (SMI), the hash rate (HR) and users' attractiveness to Bitcoin (TTR) are accessed from quandl

website and via daily Bitcoin views from Wikipedia, respectively. All the time series under consideration are converted to natural logarithms in order to smooth them.

Figure 1 clearly indicates that Bitcoin experienced several jumps and excessive swings over the period spanning between 2010 to 2015. Bitcoin's price has been volatile since its creation in 2009, mainly due to greater appreciations and precipitous depreciations in its value. By mid-2013, Bitcoin's dollar exchange rate increase considerably from $50 to $350 before falling back then to $70. During 2014, Bitcoin's price showed large day-to-day variations, which appear generally trended down. Since the start of the year, something interesting has happened to the price of Bitcoins and it has gradually gotten much less volatile than the previous years (Figure 1.1). After a period of great volatility especially during 2013 and 2014, having been less than $20 in January 2013, and reaching $1,100 in December 2013, and falling then to $320 in mid-December 2014, Bitcoin seems to some extent stable. From mid-January 2015, a single Bitcoin was valued at around $220 and does not exceed $320 over the period spanning between 26/01/2015 and 15/06/2015. It is also well noticeable that the number of transactions per day seems very volatile for the period [04/12/2010-15/06/2015] and becomes much less volatile for the period between 26/01/2015 and 15/06/2015 (Figure 1.2).

**Figure 1. The evolution of Bitcoin price and the number of transactions**

**(Normalized data)**

*1.1. Bitcoin and number of transaction for the period [04/12/2010-15/06/2015]*



04/12/2010-15/06/2015
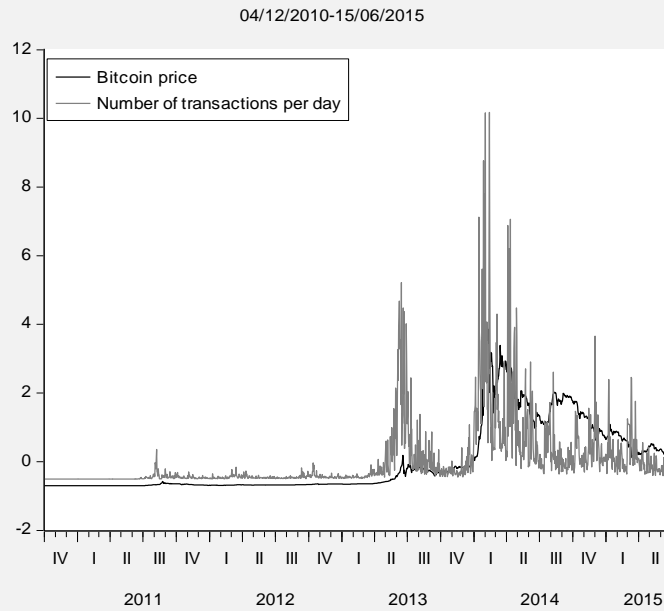
*1.2. Bitcoin and number of transaction for the period [26/01/2015-15/06/2015]*



26/01/2015-15/06/2015
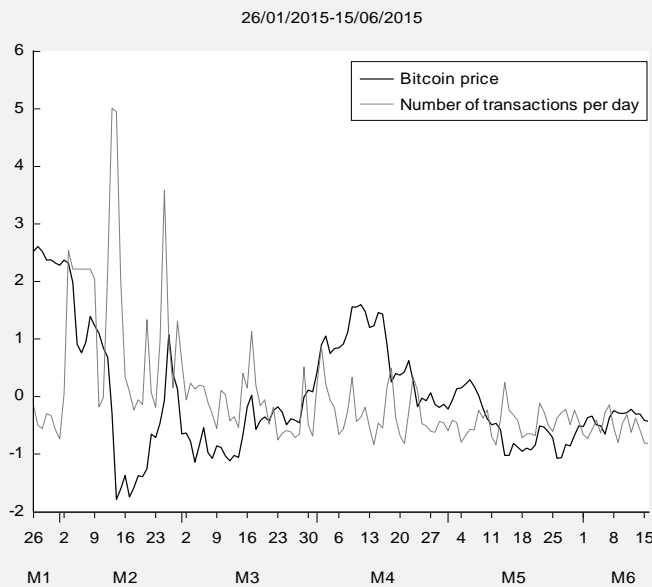
For more details about this nascent digital currency, Table 1 reports Bitcoin activity since its creation to day (i.e., from 2009 to 2015). Notably, this new crypto-currency has served approximately 73.477million transactions in 2015 compared to 10.566 million in 2012. The number of transactions has increased substantially (almost 7 times) over two years. In addition, the transaction volume per day has risen markedly from 2009 (150 bitcoins) to 2015 (110715 bitcoins) and the total market value of all bitcoins in circulation expands depending to year-to year variation. It was approximately $1.5 million in 2010 and reached almost $3.5 billion in 2015 from 2009 (1.5 million). It is also well shown that the cost per transaction fluctuates widely among the years considered varying between 4,248 (in 2010) and 59,114 (in 2013).

### Table 1. Bitcoin activity from 2009 to 2015

|  | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|
| Total Bitcoin mined | 1623400 | 5018350 | 8000050 | 10613175 | 12198800 | 13670575 | 14316875 |
| Total Bitcoin in circulation | 0 | 1505500 | 39960250 | 144233048 | 8,917E+09 | 4,339E+09 | 3,465E+09 |
| Estimated output volume | 0 | 4557 | 415486 | 2475471 | 70158408 | 53657583 | 47808896 |
| Total number of transaction per day | 150 | 579 | 5357 | 34228 | 52382 | 83768 | 110715 |
| Total (cumulative) number of transactions | 32687 | 217899 | 2118551 | 10566336 | 30205064 | 55462897 | 73477005 |
| Cost per transaction | 0 | 4,248 | 7,508 | 1,677 | 59,114 | 14,727 | 8,559 |
| Blockchain size (GB) | 0 | 0,001 | 0,05 | 0.40 | 12,8 | 26,45 | 36,04 |

Source: Quandl website (https://www.quandl.com/collections/markets/bitcoin-data).

### 3.2.Methodology

The concept of causality test was initiated by Granger (1969). Subsequently, Geweke (1982) proposed a measure for this Granger causality under a frequency domain framework. Given its usefulness, testing causality has been widely and extensively examined (Breitung and Candelon 2006) and then has been employed in several researches to evaluate lead-lag relationships between macroeconomic variables with respect to frequency rather than time (Bodart and Candelon 2009; Dergides et al. 2013; Bouoiyour et al. 2015, among others). The Breitung and Candelon (2006)'s test disentangles the short-, medium- and long-run Granger-causality between two series investigated. Hence, the starting point of this testing procedure

will be the Granger causality test"A variable $Y_t$ is said to Granger cause $X_t$, if $Y_t$ contains information to predict $X_t$ that is not available otherwise" (Lütkepohl 2006, pp.41). In computational viewpoint, this technique is restrictive since it cannot capture the studied links at different horizons and while accounting for cycle length. It can be written as matrix notation as following:

$$\Theta(L) = \begin{pmatrix} X_t \\ Y_t \end{pmatrix} = \begin{pmatrix} \theta_{11}(L)\theta_{12}(L) \\ \theta_{21}(L)\theta_{22}(L) \end{pmatrix} \begin{pmatrix} X_t \\ Y_t \end{pmatrix} = \varepsilon_t \tag{1}$$

$Y_t$ does not Granger cause $X_t$ if ($\Theta_{12}(L)=0$), indicating that the past values of $Y_t$ are not closely related to $X_t$. This can be tested by using an F-Test for the coefficients $\Theta_{12,i}$ for $i = 1\dots$ p.

Then and based on the pursued method, an F-test for the coefficients $\Theta(L)$ at different frequencies is constructed, indicating that bivariate causality (unconditional analysis) measure ($F_{Y\rightarrow X}$) can be decomposed as follows:

$$F_{Y\rightarrow X} = \int_0^\pi f_{Y\rightarrow X}(\omega)d\omega \tag{2}$$

And multivariate causality (conditional data analysis, i.e., additional control variables (Z) are accounted for including ETR, MV, SMI, HR and TTR) measure ($F_{Y\rightarrow X/Z}$) can be expressed as following:

$$F_{Y\rightarrow X/Z} = \int_0^\pi f_{Y\rightarrow X/Z}(\omega)d\omega \tag{3}$$

Specifically, to measure the causality under different frequencies, the above equations (unconditional vs. conditional) should be re-written in matrix form as following:

$$\Psi(L)\upsilon_t = \begin{pmatrix} \psi_{11}(L)\psi_{12}(L) \\ \psi_{21}(L)\psi_{22}(L) \end{pmatrix} \begin{pmatrix} X_t \\ Y_t \end{pmatrix} = \begin{pmatrix} \upsilon_{1t} \\ \upsilon_{2t} \end{pmatrix} \tag{4}$$

where $\psi_{11}(0) = 1; \psi_{22} = 1; \psi_{12} = 0; \psi_{21} = 0; \mathrm{cov}(\upsilon_{1t}, \upsilon_{2t}) = 0; \Psi_t = [\Theta(L)G]^{-1};$ $G$ denotes the lower triangular matrix of the Cholesky decomposition; $\upsilon_t = G\xi_t$.

$$\Gamma(L)\kappa_t = \begin{pmatrix} \tau_{11}(L)\tau_{12}(L)\tau_{13}(L) \\ \tau_{21}(L)\tau_{22}(L)\tau_{13}(L) \\ \tau_{31}(L)\tau_{32}(L)\tau_{33}(L) \end{pmatrix} \begin{pmatrix} X_t \\ Y_t \\ Z_t \end{pmatrix} = \begin{pmatrix} \kappa_{1t} \\ \kappa_{2t} \\ \kappa_{3t} \end{pmatrix} \tag{5}$$

where $\tau_{11}(0) = 1; \tau_{22} = 1; \tau_{33} = 1; \tau_{12} = 0; \tau_{21} = 0; \tau_{13} = 0; \tau_{31} = 0; \tau_{23} = 0; \tau_{32} = 0; \Gamma_t = [\Phi(L)G]^{-1}$; $G$ denotes the lower triangular matrix of the Cholesky decomposition.

Ultimately, the null hypothesis of no Granger Causality at frequency $\omega$ can be expressed as following based on matrix notations (4) and (5):

$$H_0 : R(\omega)\Theta(L) = 0 \tag{6}$$

$$H_0 : R(\omega)\Phi(L) = 0 \tag{7}$$

where $R(\omega) = \begin{bmatrix} \cos(\omega)\cos(2\omega)...\cos(p\omega) \\ \sin(\omega)\sin(2\omega)...\sin(p\omega) \end{bmatrix}$

## 4. Main findings

### 4.1. Whole period

Figure 2 worthy depicts the predictive power of Google Trends for Bitcoin price in the whole period spanning between 04/12/2010 and 08/06/2015. The figure contains the test statistics with their 5 percent critical values (dashed line) over the interval [0, π]. We try to evaluate whether Google search queries Granger-cause Bitcoin or vice versa among different frequencies involved. Unconditionally, we clearly show a short-run causality running from social media/search queries related to Greek crisis or Grexit to Bitcoin (Figure 2.1). Specifically, the null hypothesis of Google Trends no Granger-cause Bitcoin is rejected for ω greater than 2.16 corresponding to a cycle length 2.9 days[4]. Our evidence remains strong, even if we incorporate potential control variables (macroeconomic, financial, speculative and technical fundamentals). Accurately, we support the same direction of causality at highest frequencies (ω greater than 1.95), corresponding to a cycle length inferior to 3.22 days (Figure 2.2). This highlights that global media's stance to Greece's epic crisis may affect differently the focal virtual currency over time depending to potential factors including monetary velocity, the hash rate and investors' attractiveness to Bitcoin among others; hence, the importance of applying a frequency approach-based conditional data analysis.

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[4] Recall that the frequency $(\omega)$ on the horizontal axis can be translated into a cycle or periodicity of $T$ quarters by $T = (2\pi / \omega)$, where $T$ is the period.

In further step, the same testing procedure (unconditionally and conditioning upon the same control variables) is implemented to the Twitter data related to Greek crisis in order to assess its impact on the Bitcoin. The non-Granger causality hypothesis running from Twitter to Bitcoin is rejected for the bi-variate model at the 5% significance level when $w \in [0.79\pi; \pi]$. This implies that the high frequencies of Twitter, with wave length of less than 2.52 days, are those able to offer predictive power with respect to Bitcoin price (Figure 3.1). When the causaliy test is re-conducted conditionally on the aforementioned relevant control variables (Figure 3.2), the range frequencies in which predictability is supported correspond to cyclical components with waves lengths of less than 2,41 days (i.e., $w \in [0.83\pi; \pi]$). It is also well shown that Google (search queries) displays different short-run predictive content compared to Twitter (twitter mentions/ tweet backs). This result may be deeply attributed to the fact that while Google is used by a large base, Twitter has increasingly become a very popular way of directing followers (especially high earners) to news (Mitchel et al. 2012). At this stage, we confirm our first hypothesis, i.e., the uncertainty about Greece leaving the eurozone is pushed to increasingly adopt Bitcoin. These finding hold in the high frequencies (i.e, short-run causality). Additionally, we find evidence to reject the reverse hypothesis in all frequencies within both unconditional and conditional investigations.

These results seem intuitive. Expectedly so, if Greece does choose to leave the eurozone, Greeks will choose to adopt a new currency in order to settle the great deal debt uncertainty. However, it is unclear what currency the government will choose. People will of course try to seek an easy and secure alternative. Bitcoin can be served as an exciting currency for Greeks, since people prefer a value of currency as it increases markedly over time. However, it seems difficult to perceive Bitcoin as a currency for a government. It is a bad idea for Greece to adopt the focal digital money. It is absolutely true that the Greek anxiety face to the great debt crisis led them to possibly choose Bitcoin as a safe haven currency, but the Greek state has no Bitcoin. In addition to that, Bitcoin faces a great challenge regarding its limited amount (21 million).

**Figure 2. The frequency-domain causality between Greek crisis (Google Trends) and Bitcoin**

*2.1. Unconditional analysis*



*2.2. Conditional analysis*
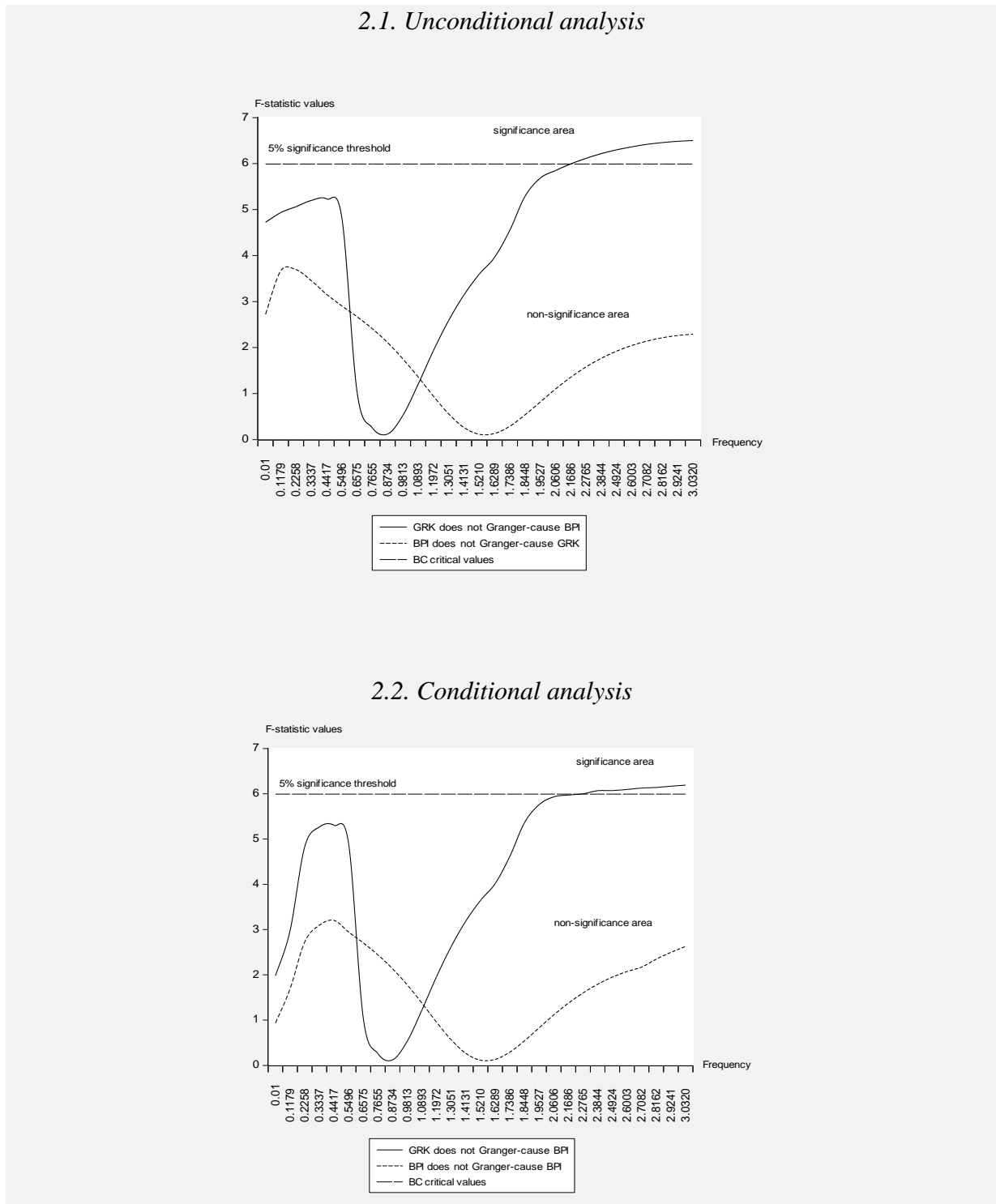


Notes: Bitcoin and GRK denote respectively Bitcoin price and Greek crisis. The horizontal dashed line represents the 5% critical value of the null hypothesis test of no Granger causality at frequency.

**Figure 3. The frequency-domain causality between Greek crisis (Twitter) and Bitcoin**

*3.1. Unconditional analysis*



*3.2. Conditional analysis*



Notes: BTP and GRK denote respectively Bitcoin price and Greek crisis. Notes: BTP and GRK denote respectively Bitcoin price and Greek crisis. The horizontal dashed line represents the 5% critical value of the null hypothesis test of no Granger causality at frequency *w*.
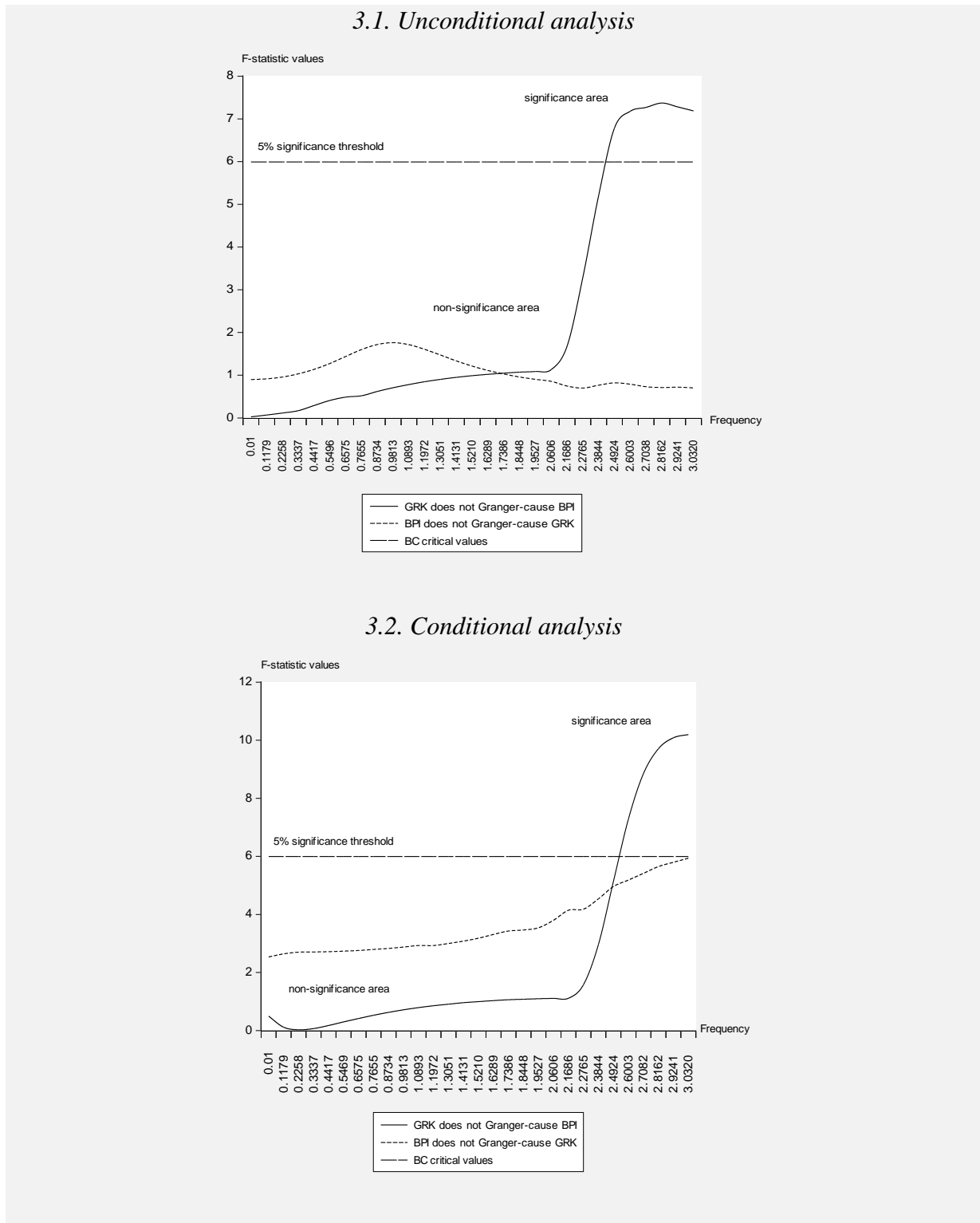
**4.2.The arrival of the left radical party to power**

Starting our sample by the arrival of the far left coalition (Syriza) in power, in January 25th 2015, we replicate the same testing procedure to the Google queries and Twitter in order to evaluate their impact on the determination of Bitcoin price (Figure 4 (Google) and Figure 5 (Twitter)). Unconditionally and conditionally to the same control variables (ETR, MV, SMI, HR and TTR), we clearly note that under this period (Syriza's rule), the null hypothesis of Google queries no Granger-cause Bitcoin price is rejected for the bi-variate model at the 5% significance level when $w \in [0.79\pi; \pi]$, implying wave length of less than 2.52 days (Figure 4.1). When we re-estimate our conditional model, we find credible evidence of predictability (when $w \in [0.89\pi; \pi]$, i.e., to cyclical components with waves lengths of less than 2.23 days). But, if we consider 10% signifiance level, the predictability vanishes in the medium frequencies (Figure 4.2).

Figure 5 reports our findings for causality running from Twitter to Bitcoin. We provide evidence of short-run predictability for bi-variate model (Figure 5.1.), corresponding to cyclical components with wave lengths inferior to 2.76 days. Depending to further potential control variables, predictability vanishes for wave lengths of less than 2.41 days (Figure 5.2). No predictability pattern is confirmed for the reverse causality that runs from Bitcoin to social media/search queries.

The obtained results (Google and Twitter) confirm our second hypothesis, i.e. Syriza's electoral triumph expands the anxiety over debt crisis and increases the interest to Bitcoin among Greeks as possible solution for Greece's future. Since Syriza's arrival to power, with its radical approach to debt negotiations, doubts have increased remarkably as to whether Athens can solve the high uncertainty surrounding Greece's debt crisis. We should add here that the formation of anti-austerity coalition government with the independent Greeks, the second day after Greece's elections, has played a powerful role in deepening Grexit uncertainty. Notably, the observed outcomes prove the sharp distinguishability among Googlers and Twitters. Compared to Google search queries, Twitter news stand out from users as more likely to be high earners and college well educated.

**Figure 4. The frequency-domain causality between Greek crisis (Google Trends) and Bitcoin from January 26, 2015**

*4.1. Unconditional analysis*



*4.2. Conditional analysis*



Notes: BTP and GRK denote respectively Bitcoin price and Greek crisis. Notes: BTP and GRK denote respectively Bitcoin price and Greek crisis. The horizontal line represents the 5% critical value of the null hypothesis test of no Granger causality at frequency *w*.

**Figure 5. The frequency-domain causality between Greek crisis (Twitter) and Bitcoin from January 26, 2015**
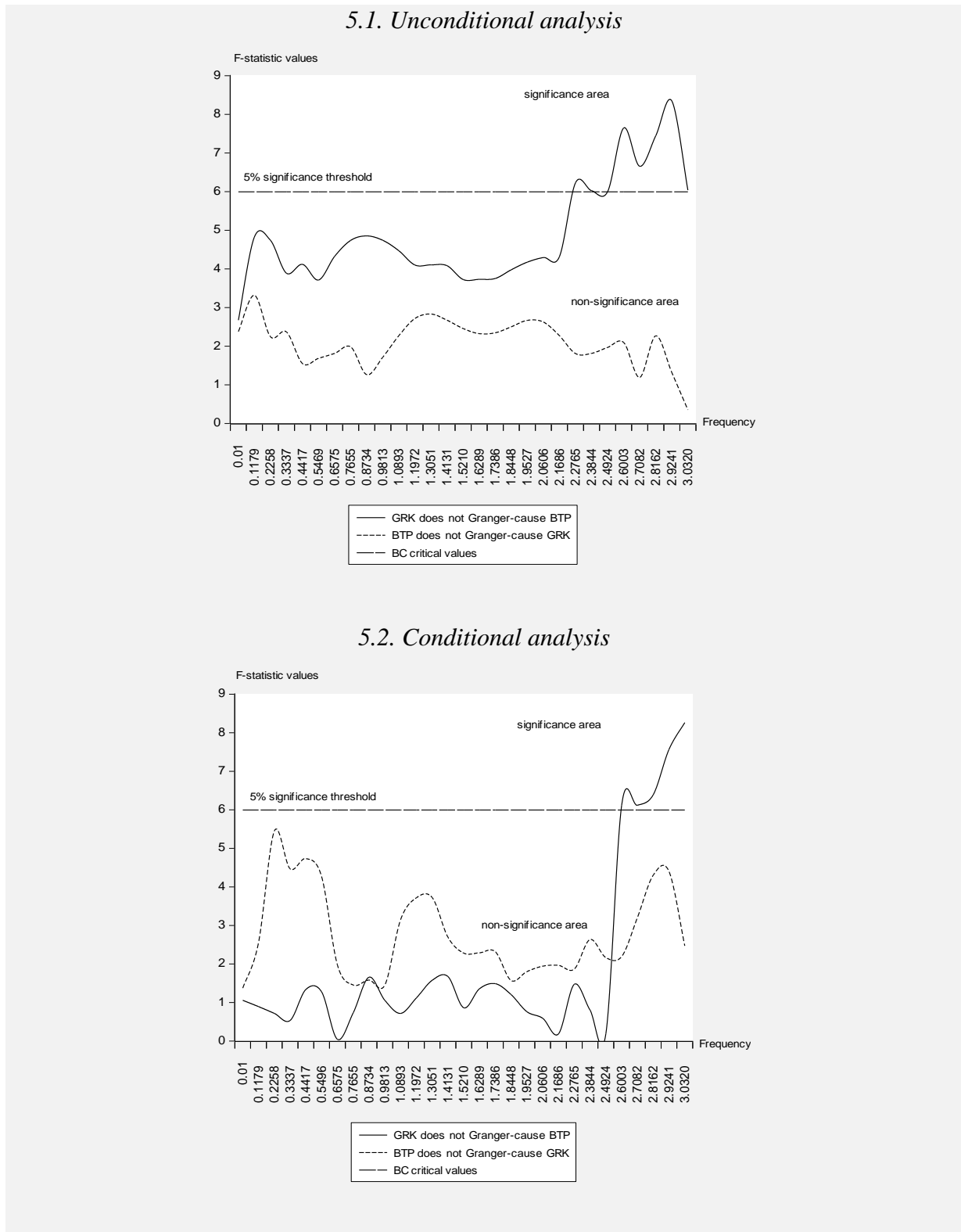
*5.1. Unconditional analysis*



*5.2. Conditional analysis*



Notes: BTP and GRK denote respectively Bitcoin price and Greek crisis. Notes: BTP and GRK denote respectively Bitcoin price and Greek crisis. The horizontal line represents the 5% critical value of the null hypothesis test of no Granger causality at frequency *w*.

## 5. Conclusion and discussion

The Varoufakis' report shared on Twitter, concerning the adoption of Bitcoin "Greece will adopt the Bitcoin if Eurogroup doesn't give us a deal, …, we don't have a clue on what we do, but this is the solution for Greece's future" surprised all. Does this an April fool's joke or serious possibility? Does this Varoufakis' proposal really able to avoid Greece's gloomy future? The great resurgence of interest in Greece's debt crisis and to the declaration of Greek Finance Minister create a real need to address two main hypotheses: Is the uncertainty about Greece leaving the eurozone pushed to increasingly adopt Bitcoin; if so, is it a short-, medium- or long-run relationship? Is the arrival of the radical left in power will facilitate the Greek withdrawal from euro in favor of Bitcoin? This paper provides a first attempt, to the best of our knowledge, in this respect. It examines the short-, the medium- and the long-run causality between Google search queries  and social media data related to Greek debt crisis and Bitcoin, while incorporating potential control variables and accounting for the arrival of left radical party to power (Syriza's rule).

Through a frequency approach, we obtain three main findings. First, we identify short-run causality running from Google search queries and Twitter data to the use of Bitcoin. Our results remain meaningful when a number of control variables are taken into account. Second, there is no evidence of reverse causality (running from Bitcoin to Google Trends and social media related to Grexit). This result seems quite intuitive. Third, the arrival of Greece's left-wing Syriza party has affected widely the Greeks' doubts about the uncertainty surrounding the debt crisis and increased as a result the interest to Bitcoin as a way of dealing with the current debt obligations. The cycle length becomes larger, i.e., the relationship from Google Trends and Twitter to Bitcoin becomes significant in the short- and the medium-run.

Our estimates worthy indicate the great interest of the Greeks to Bitcoin. But does this mean that Greek government can withdraw euro and run on Bitcoin? Introducing a parallel local currency to the euro by using safety and digital transparency of Bitcoin seems an exciting and seductive idea. It would allow Greece to default on payment delays that threaten the country for years, because of its colossal debt. By adopting Bitcoin, Greece will be able to recover part of its monetary sovereignty and could possibly succeed in pursuing a stimulus policy by creating money. However, this solution would encounter multiple obstacles.

First, Bitcoin is highly linked to great uncertainty surrounding the Bitcoin system. This digital currency is intrinsically worthless, without an underlying value derived from consumption or its use in production process (Yermack 2013). Unlike the fiat currency based essentially on trust, the expectations about trust and acceptance are problematic for Bitcoin, which being nascent digital money is in the phase of establishing its market share by trying to build credibility among users.

Second, Bitcoin supply is fixed and capped. It is well programmed to grow at a steady rate depending to the degree of mining activity. This nascent digital money is deflationary; which clearly goes against the Syriza government's objectives. There are 13,882,100 Bitcoins today, there will be 20,343,750 Bitcoins on January 1, 2025, and there will never be more than 21,000,000 Bitcoins implying that the money supply cannot continue to rise after reaching this value. This makes it difficult to adopt as a currency to completely replace the euro. If Greek government will choose to definitely switch from the euro to Bitcoin, Greece cannot have a control over how many Bitcoins are issued.

Third, being a crypto-currency, Bitcoin seems highly sensitive to cyber-attacks, which can deeply destabilize the whole system of this virtual currency leading to sizable price volatility (Barber et al. 2012; Moore and Christin 2013; Ciaian et al. 2014).

Fourth, even though the Bitcoin transaction process is heavily complex and computer scientists are continuously investigating aspects of its security, privacy, distributed control and incentive schemes, it is unknown for Greeks how far Bitcoin can go. It would be thus very difficult to convince the Greek citizens to adopt a new currency whose design seems very complicated. No one can predict the precise value and the specific form crypto-currency will take since the technological development is heavily unpredictable. As technology becomes increasingly integrated into our everyday lives, crypto-currencies will obviously continue to grow and Bitcoin may probably be displaced by better digital currencies. So, it will be easier for Greeks to return to Drachma rather than switch to Bitcoin.

It is clear that fears of a sovereign debt crisis developed rapidly into an unsustainable size among Greek citizens concerning the ability of Greece to settle its upcoming debt obligations, mainly due to a strong increase in government debt levels coupled with high structural deficits. In Greece, the tax burden has increased considerably, even if the tax collection seems hampered by a large informal sector. So if we cannot recommend the use of Bitcoin (for the different reasons mentioned above), Greece can learn from its philosophy to maximize tax

harvesting. If the focal crypto-currency cannot be served as appropriate solution for Greece's future, the sharp developments in the Bitcoin system and the technological innovation as proof of Bitcoin transactions (blockchain) might do.

Beyond the nuances of April fool joke or serious possibility, this paper clearly highlights the deeper role that have played Google search and the number of tweets on accentuating Greece's debt deal uncertainty. Despite their usefulness, we do not argue that media and social networking are fully comparable to a behavior/sentiment index. The use of the number of search queries (Google) and the number of tweets (Twitter) may be only served as meaningful indicators of interest or stance towards specific words as "Grexit" or "Greek crisis". Indeed, more will be the bad news in media, higher will be the debt deal uncertainty and more possible will be a currency substitution. Given their sharp effectiveness and appropriateness, Google Trends and the number of mentions in social networking can be further used for different topics to better understand their impacts on financial markets.

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