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Understanding the Relationship Between Digital Currency and Search Engine : An Empirical Analysis

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ABSTRACT

One of the hot debates from last few years that had been not only in academia but also in non-acedamic circles very viral is digital currencies (Bitcoin, Litecoin, Ethereum). Bitcoin as the most popular of the digital currencies which is used and distributed electronically is an innovative internet protocol created by the japanese pseudonymous « Satoshi Nakamoto » in October 2008, it is a new form of decentralized electronic currency system, it stands for an IT innovation based on advancement in peer-to-peer networks and cryptographic protocols, it has low processing fees and trustworthy. The digital currency is based on the IT innovation so having the assocation and dependence on internet access. So in this back drop this paper makes an attempt to understand the relashionship between the Bitcoin prices (BTC) and search queries on Google Trends as a measure of the interest in the currency in the world. The relationship will be examined by using weekly data for the 2013-2018. Make use of time series models to develop and understand the relationship in scientific way.Our preliminary results conclude that there exists a strong and significant relationship between Bitcoin price movements and the queries in Google Trends by investment professionals in Bitcoins. The paper will conclude with some suggestive remarks.

Key words : Bitcoin, digital currency, Information Technology, Google Trends, Blockchain.

INTRODUCTION

Digital currency is a digital representation of value that can be digitally traded and functions as : a medium of exchange, a unit of account composed of unique strings of numbers and letters and/or a store of value but does not have legal tender status in any jurisdiction. (FATF, 2014). Bitcoin was the first decentralised peer-to-peer payment convertible global virtual currency and the first cryptocurrency, it is an innovative internet protocol created by the pseudonymous « Satoshi Nakamoto » in 2009 that enables value to be transferred over a communications channel.(Satoshi Nakamoto,2009).

Bitcoins are created (for the purpose to replace cash, credit cards and bank wire transactions) as reward for payment processing work in which users offer their computing power to verify and record payments into a public ledger. The activity is called mining and miners are rewarded with transaction fees and newly created bitcoins. Transactions are made with no middlemen so anyone van transfer money anywhere in the world without using any centralized service like a bank or paypal. It is based on advancements in peer-to-peer networks and cryptographic protocols for security. It is based on a distributed register known as ”blockchain” to save transactions carried out by users. Like any other currency.

Search queries prove to be a useful source of information in financial applications, where the frequency of searches of terms related to the digital currency can be a good measure of interest in the currency and it has a good explanatory power (Kristoufek, 2013). Mondria et al. proved that the number of clicks on

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search results stemming from a given country correlates with the amount of investment in that country (Mondria et al, 2010).

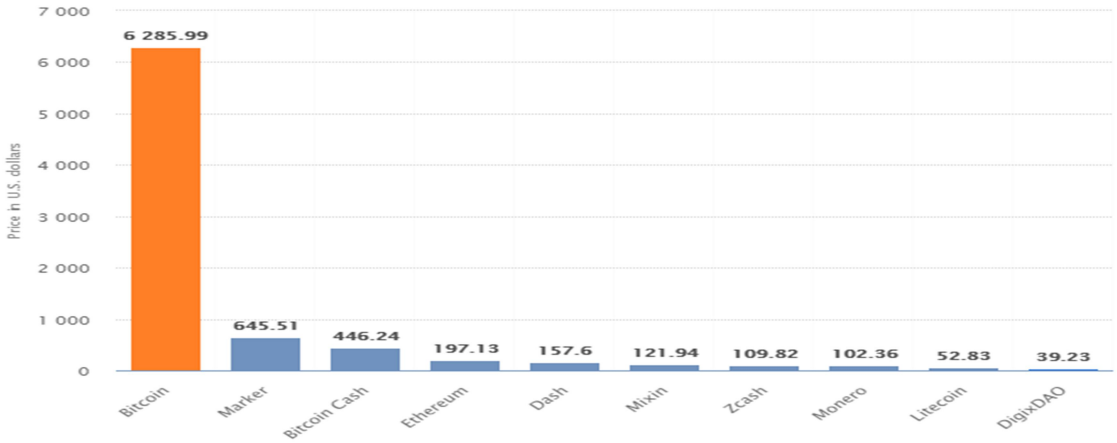
Matta et al. examined the striking similarity between Bitcoin price and the number of queries regarding Bitcoin recovered on Google search engine (Matta et al,2015). In their work, Garcia et al. (Garcia et al, 2014) proved the interdependence between social signals and price in the Bitcoin economy, namely a social feedback cycle based on word-of-mouth effect and a user-driven adoption cycle. They provided evidence that Bitcoins growing popularity causes an increasing search volumes, which in turn result a higher social media activity about Bitcoin. A growing interest inspires the purchase of Bitcoins by users, driving the prices up, which eventually feeds back on the search volumes.

The relationship between Bitcoin price and the interest in the currency as measured by online searches in Wikipedia and Google was examined by Kristoufek (2013). The Author found a strong bidirectional causal relationships between the prices and searched terms and there exist a strong correlation between price level and the queries in Wikipedia and Google.

In this work we analyse Bitcoin, which is a novel digital currency system and study the relationship that exists between trading volumes of Bitcoin currency and the queries volumes of search engine. The frequency of searches of terms about Bitcoin could be a good explanatory power, so we decided to examine Google, one of the most important search engine. We studied whether web search media activity could be helpful and used by investment professionals, analyzing the search volumes power of anticipate trading volumes of the Bitcoin currency.

We compared USD trade volumes about Bitcoin with those in a media, namely, Google Trends. This is a feature of Google search engine that illustrates how frequently a fixed search term was looked for. Following this kind of approach, we evaluated how much bitcoin term, for the specific time interval, is looked for using Google's search engine. The figure below shows statistic of the most expensive virtual currencies globally as of October 12, 2018. Bitcoin was the most valuable cryptocurrency at 6.285.99 U.S. dollars per unit.

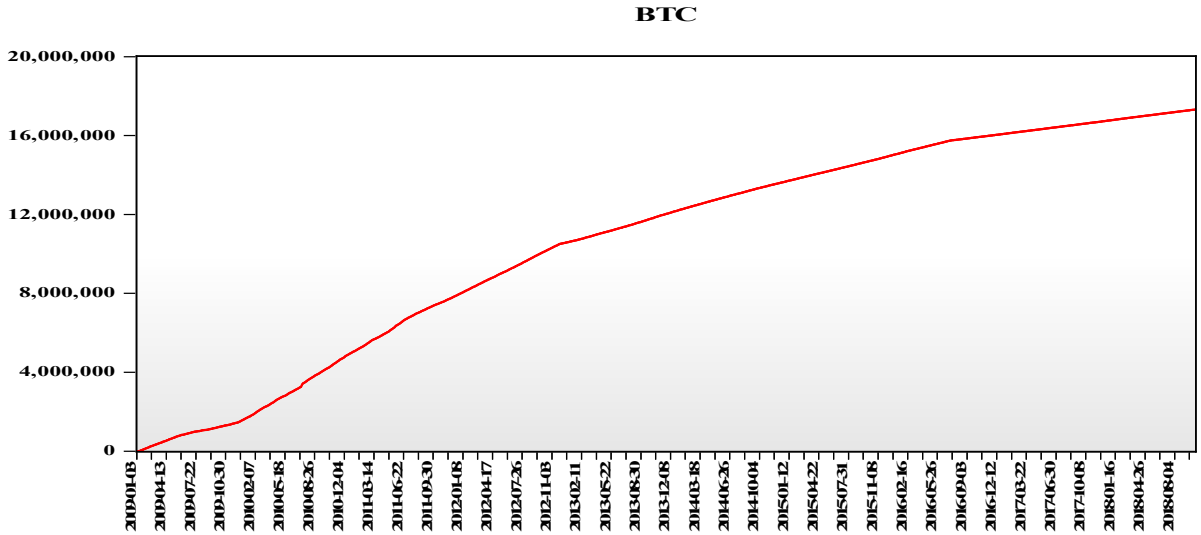
Figure 1 : Most expensive virtual currencies globally as of October 2018



Source: https://www.statista.com

The statistic presents the total number of Bitcoins in circulation from first quarter of 2011 to third quarter of 2018. The number of Bitcoins has been growing since the creation of this virtual currency in 2009 and reached approximately 17.30 million in September 2018.

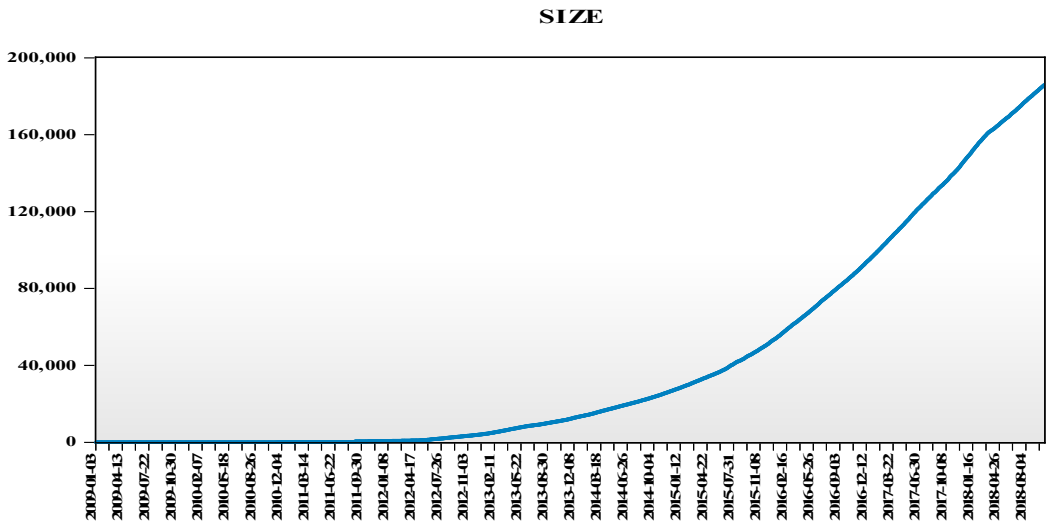
Figure2 : Number of Bitcoins in circulation worldwide from 3rd January 2009 to 11 October 2018 (in Millions)



www.blockchain.com

The statistic presents the total size of the Bitcoin blockchain, the distributed database that contains a continuously-growing and tamper-evident list of Bitcoin transactions and records, from the third quarter of 2010 to the latest quarter. The size of the Bitcoin blockchain has been growing since the creation of the Bitcoin virtual currency in 2009, reaching approximately 185 gigabytes in size by the end of September 2018.

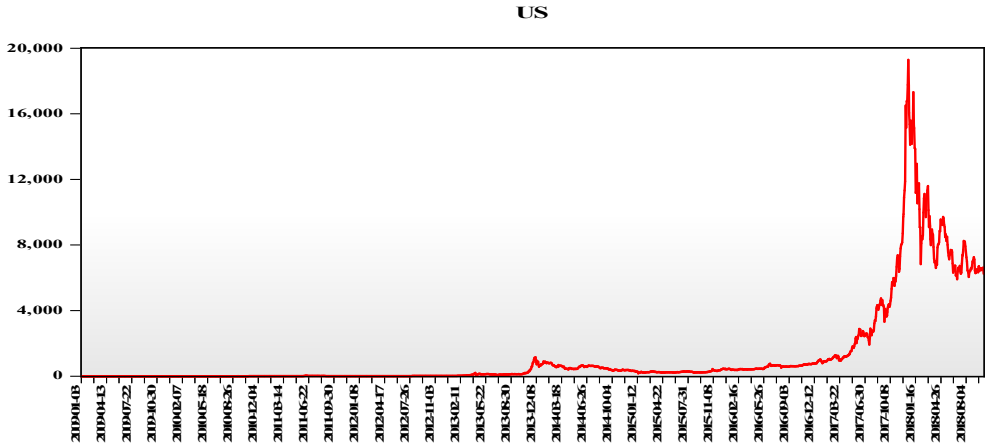
Figure3 : Size of the Bitcoin blockchain from 2009 to 2018, (in megabytes)



Source: https://www.statista.com

The graph presents the evolution of bitcoin price index from September 2009 to September 2018. The bitcoin price index is an average of bitcoin prices across leading global exchanges. The bitcoin index value for the end of September 2018 amounted to 6.604.97 U.S. dollars.

Figure 4 : Bitcoin price index from September 2009 to September 2018 (in U.S. dollars)

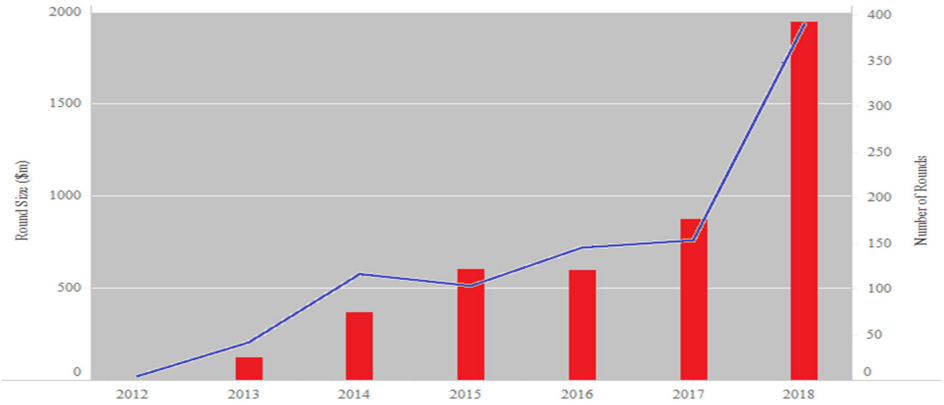


Source: https://www.statista.com

Since the Bitcoin creation in 2009, the price of this virtual currency remained quite stable until January 2013, reaching a maximum value of approximately 20 U.S. dollars. Afterwards a monthly price growth was observed until October 2013 when the price reached 198 U.S. dollars. This nearly tenfold increase in Bitcoin value proved to be insignificant in comparison to the price rally in November 2013, when the threshold of 1.100 U.S. dollars per coin was broken. After a period of downtrend which followed, Bitcoin price reached 1.349.19 U.S. dollars in April 2017.

The number of Bitcoins in circulation has grown month on month and reached over 17 million in September 2018. The global value of Bitcoin amounted to approximately 10.1 trillion U.S. dollars as of January 2014 and was much higher than the value of other internet currencies such as Ripple, Litecoin or Peercoin.

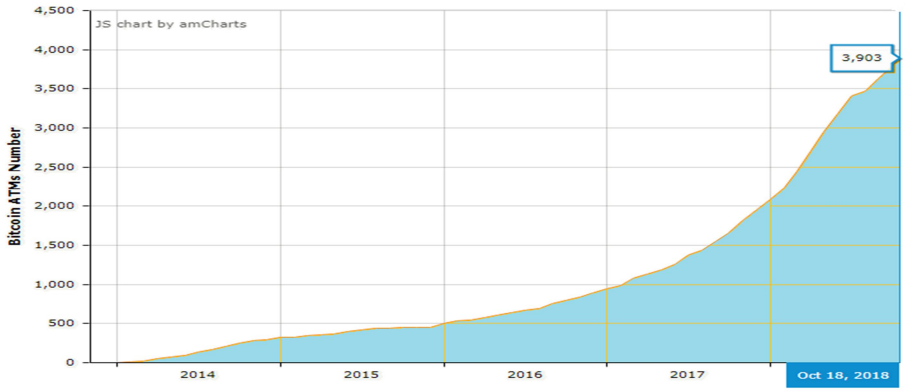
Figure 5 : Venture capital total funding VS number of founds



Source : coindesk.com

Bitcoin hasn't received nearly as much attention from the media in 2018 as it did in 2012, but Bitcoin-based startups continue to be of great interest to venture capitalists. With two months remaining in 2018, there has already been $ 1943 million invested in Bitcoin startups more investment than in any previous year with 390 rounds.

Figure 6 : Number of Bitcoin ATM installed over time



Source : coinatmradar.com

ATM (automated teller machine) is a device enabling the holders of debit or credit cards to withdraw cash from their banking accounts. The option of printing a part of the account information is also available to the ATM users. The withdrawal of cash from the ATM of the company where the payment card is registered is usually for free, while the owners of cards belonging to other banks have to pay a defined amount of money. There are also more complicated ATMs, incorporating advance options such as depositing funds or facilitating credit card payments.

As far as Bitcoin ATMs are concerned, there are two main types of such ATMs: the basic ones, allowing the users only to purchase Bitcoins, and more complex ones, enabling the users both to buy and sell the virtual money. In case of complex ATMs, only the members of a particular ATM producer can use the ATM. As of April 2018, the main manufacturers of the Bitcoin ATMs were Genesis Coin and General Bytes, with 33.69 % and 26.89 % of the market share, respectively.

As of October 2018, there were 3.903 Bitcoin ATMs worldwide. In the same time period, the countries with highest number of Bitcoin ATMs were United States (2.183), Canada (598), Austria (228), United Kingdom (200) and Russian Federation (70).

There are still many concerns about using Bitcoin for online transactions and the security of this virtual currency is seen as one of the most important factors influencing the decision about the Bitcoin purchase.

Table1 : Bitcoin ATMs by continent

Country	North America	Europe	Asia	Oceania	South America	Africa
Bitcoin ATMs	72.10%	22.98%	2.46%	1.38%	0.90%	0.18

Source: coinatmradar.com

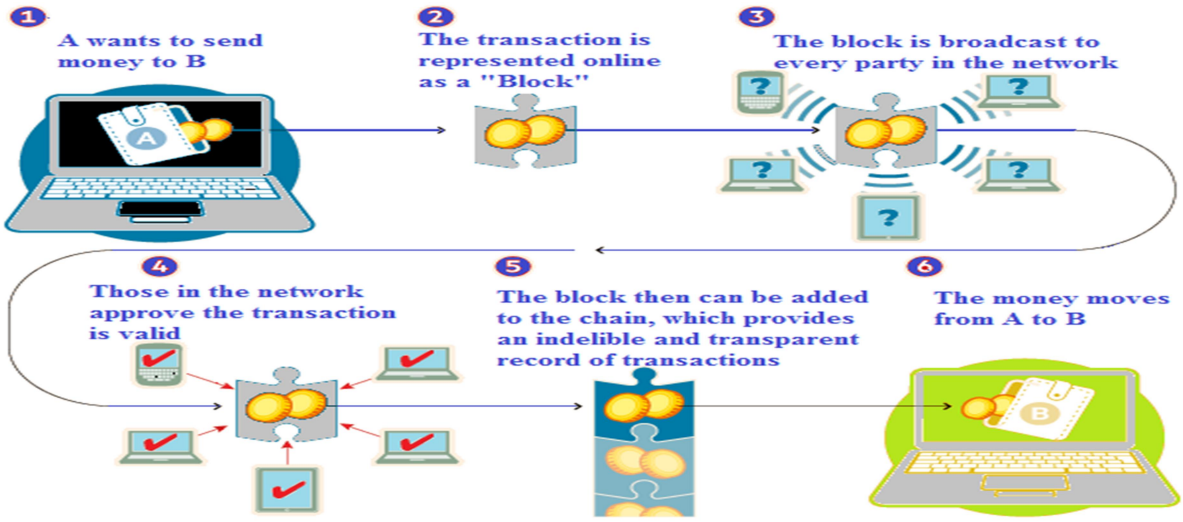
The highest number of Bitcoin ATMs was recorded in the United States as of October 2018. In total, approximately 72.10 % of global ATMs were concentrated in North America.

A **block chain** is a transaction database shared by all nodes participating in a system based on the Bitcoin protocol. A full copy of a currency's block chain contains every transaction ever executed in the currency. With this information, one can find out how much value belonged to each address at any point in history.

Blockchain is arguably one of the most significant and disruptive technologies that came into existence since the inception of the Internet. It's the core technology behind Bitcoin and other crypto-currencies that drew a lot of attention in the last few years.

As its core, a blockchain is a distributed database that allows direct transactions between two parties without the need of a central authority. This simple yet powerful concept has great implications for various institutions such as banks, governments and marketplaces, just to name a few. Any business or organization that relies on a centralized database as a core competitive advantage can potentially be disrupted by blockchain technology.(Kondor et al, 2014).

Figure 7 : How a blockchain works



Source: https://www.ft.com

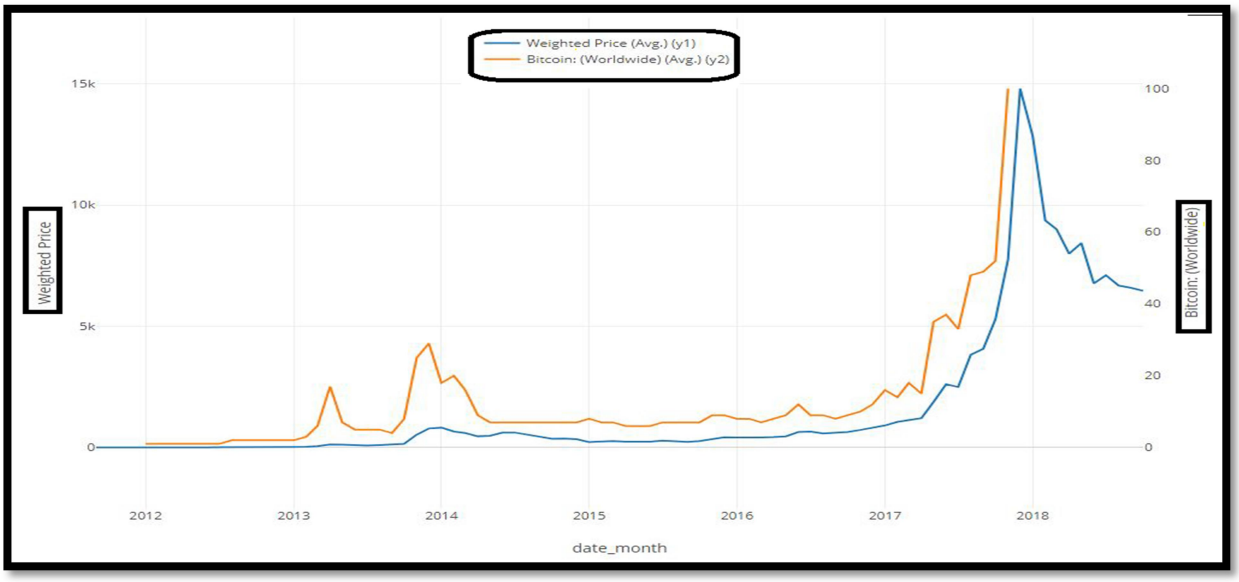
Blockchain is an online system that provides detailed information about Bitcoin market. Launched in August 2011, this system shows data on recent transactions, plots on the Bitcoin economy and several statistics. It allows users to analyze different Bitcoin aspects: Total Bitcoins in circulation, number of Transactions, total output volume, USD Exchange Trade volume and market price (USD) (Mataa M et al, 2015).

Methodology

The data used for the analytical purpose are Bitcoin price index and Google Trends**.** The Bitcoin price index is an index of the exchange rate between US dollar (USD) and Bitcoin (BTC). The data is daily

and it is formed as a simple average of the covered exchanges. The series are available at Blockchain.com. Google Trends is a feature of Google Search engine that illustrates how frequently a fixed term is looked for (in our study We downloaded data about how much the term "Bitcoin" was referred on 14/7/2013 with an ending date of 07/10/2018.). We can get the trend data for "Bitcoin" search keyword at Google Trends at: https://trends.google.com. The data is monthly and contains only year and month information so, we convert it to date data type to join together. First, we test the correlation between the variables with explanatory program, We observe that the prices of Bitcoin are strongly correlated with the search engines (Google Trends).

Figure 8: Bitcoin price index average and Google trends



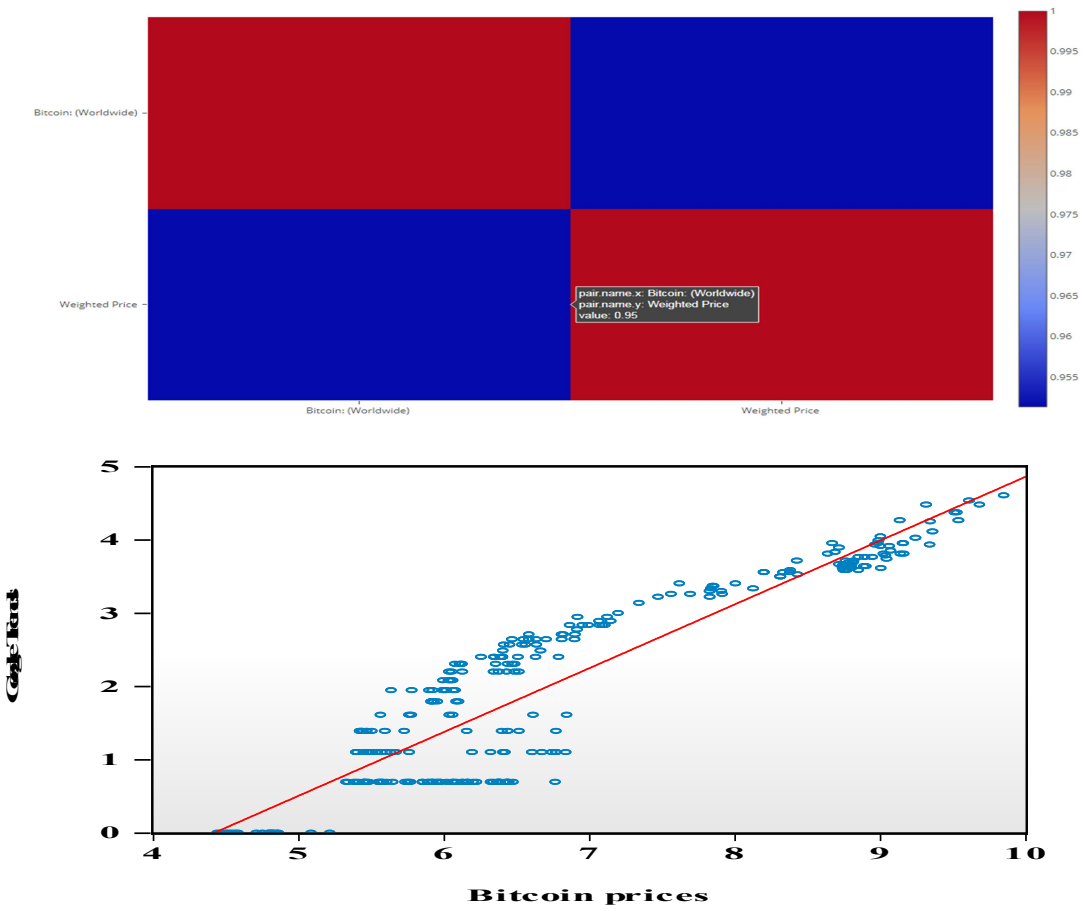
The R-Squared of the model is 0.95 (It should be between 0 and 1, and 1 is the highest.) And the P-Value is showing 0 (or close to 0), so we can reject the null hypothesis, meaning that the prediction quality of this model is statistically reasonable. The P-Value is 0 (or close to 0) and the Coefficient is 79.25, meaning that one value increase in the Google Trend Score will make the Bitcoin Price increase about 79.25 USD.

Table 2: Results of correlation between BTC and Google Trends

R Squared	Adj R Squared	RMSE	F Ratio	P Value	Degree of Freedom	Log Likelihood	AIC	BIC	Deviance	Residual DF
0.95	0.95	392.81	20.62	0	2	-15.97	31.95	31.97	333.125	2.16

The correlation value for the Bitcoin price and the Google Trend is showing 0.95, which means they are highly correlated.

Figure 9 : Correlation between variables



Unit root test:

The first step of the analysis focuses on the stochastic properties of the series by testing for the presence of unit roots. This allows for the identification of stationary and non-stationary time series, which in turn permits the specification of a model that should not produce spurious results. Broadly speaking, a stochastic process is said to be stationary if its mean and variance are constant over time and the value of the covariance between two time periods depends only on the distance or lag between the two time periods and not on the actual time at which the covariance is computed. Symbolically, letting Y represent a stochastic time series, we say that it is stationary if the following conditions are satisfied (Gujarati & Porter, 2009):

$$\text{Mean} : E(Y_t) = \mu$$

$$\text{Variance: } \text{Var}(Y_t) = E(Y_t - \mu)^2 = \sigma^2$$

$$\text{Covariance} : \gamma_k = E[(Y_t - \mu)(Y_{t+k} - \mu)]$$

where γ_k, the covariance (or autocovariance) at lag k, is the covariance between the values of Y_t and Y_{t+k}, that is, between two values of Y, k periods apart. If k= 0, we obtain γ_0, which is simply the variance of Y ($=\sigma^2$); if k = 1, γ_1 is the covariance between two adjacent values of Y.

For all series we tested the null hypothesis of unit root, using Augmented Dickey –Fuller (ADF), Phillips-Perron (PP) test and Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) unit root test (Maddala & Kim, 2007). each series tested for the presence of unit root. Test statistics suggest the presence of a unit root in the level, while first differencing the series yields the apparent lack of a unit root in the two variables « Bitcoin Price index, Google trends in log ». From these results we can conclude that each series has unit root at levels and it is stationary when first difference is taken. It can be said that all variables are integrated of order 1, I(1). We then check for the presence of cointegrating relations between these variables. (Table (A)

Cointegration Test

The notion of cointegration was introduced by Granger (1981, 1983), and Engle and Granger (1987). The simple idea behind cointegration is that sometimes the lack of stationarity of a multidimen-sional process is caused by common stochastic trends, which can be eliminated by taking suitable linear combinations of the process, there by making the linear combination stationary (Johansen1996). Seminal contributions in the literature on cointegration were made by Stock and Watson (1988), Johansen (1988,1991, 1996b), and Johansen and Juselius(1990). Engle and Granger (1987), and Stock and Watson (1988) considered cointegration in the framework of the linear process.

Johansen (1996a) notes that the reason why cointegration has been so popular in econometrics is that classical macroeconomic models are often formulated as simultaneous linear relations between variables following the Cowles Commission tradition. This type of modelling has a long history in economics, going back to the work of Tinbergen (1939) and Haavelmo (1944). For a modern rereading of Haavelmo (1944), see Juselius(1993). These models were developed for stationary processes, but in fact most economic variables are non stationary. If we think of the classical economic relations as long-run relations, we can easily imagine that such relations can be stationary even if the variables themselves are nonstationary.

We applied Johansen's trace test and Maximum Eigenvalue test for cointegration and the results are reported in table (B)

The trace test and the maximum Eigenvalue test indicate no cointegrating, we can accept the null hypothesis and we reject the alternative hypothesis. So, Bitcoin price index series are not cointegrated with Google trends series(no relations in the long run between variables).

We need to turn to the vector autoregression (VAR) methodology applied on the first logarithmic differences with 5 lags based on the Akaike AIC, Schwarz SC, Hannan–Quinn HQ, and Final Prediction Error FPE, Likelihood Ratio LR. (Table (C)).

Vector regression model (VAR)

Analysis of variance components (Variance Decomposition)

Using analysis of variance components tool to identify the amount of variation in the prediction of each variable of the model, which is due to an error in the prediction of other variables at the same variable variables. In the short run, impulse or shock to BTC account for 91.62% variation of the fluctuation in

BTC in the period 10 (Long run) and Shock to Google Trends can cause 8.37% fluctuation in BTC (Table (D&E). Impulse or shock to Google trends account for 78.19% variation of the fluctuation in Google trends in the period 10 (Long run) and Shock to BTC can cause 21.80% fluctuation in Google trends.

Impulse Response

The charts (F) show the response of a corresponding variable to a shock in the impulse variable. As we are working with logarithmic differences, we can interpret these shocks as a proportional reaction to a 1% shock. One standard deviation shock is given by Bitcoin price index the Google trends change (positive react). we find that the increased interest in the BitCoin currency measured by the searched terms increases its price. As the interest in the currency increases, the demand increases as well causing the prices to increase.

Conclusion

Internet has been one of the most revolutionary technologies in the last decades. The majority of daily activities radically changed, moving towards a « virtual sector », such as Web actions, credit card transactions, electronic currencies, navigators, etc. Digital currencies has been a hot topic over the last few years, with hundreds of alternative coins in existence attracting attention from investors. Bitcoin is a prominent platform with their respective currencies: bitcoin and ethers, having the largest market cap among cryptocurrencies. To evaluate long-term investment potential, investors need to understand the function cryptocurrencies serve, the underlying technology and their governance structure. Bitcoin prices have struggled this year, along with the cryptocurrency's ability to capture interest on the internet. Searches for the term "bitcoin" have dropped more than 75 % since the beginning of this year and roughly halved over three months, according to research from Google Trends. Our empirical results confirm that there exists a strong and significant relationship between Bitcoin price movements and the queries in Google Trends by investment professionals in Bitcoins.

Table (A) : Results of unit root tests

		ADF		KPSS		
		Level	1st diff.	Level	1st diff.	
BTC	[2]	-0.940262	-15.12464	1.468390	0.106813	**I(1)**
		[0.7743]	[0.0000]			
	[3]	-1.377811	-15.10049	0.342745	0.114624	
		[0.8655]	[0.0000]			
	[1]	1.936615	-14.91026	//	//	
		[0.9876]	[0.0000]			
Google Trends	[2]	-1.074772	-23.19551	1.839544	0.061067	**I(1)**
		[0.7263]	[0.0000]			
	[3]	-2.241928	-23.16455	0.192779	0.056207	
		[0.4639]	[0.0000]			
	[1]	1.114131	-22.98511	//	//	
		[0.9313]	[0.0000]			

Source : Authors calculations (Eviews)

Table (B) : Johansen's trace test for cointegration

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None	0.018945	6.985846	15.49471	0.5793
At most 1	0.006916	1.859838	3.841466	0.1726
Trace test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	**Eigenvalue**	**Statistic**	**Critical Value**	**Prob.****
None	0.018945	5.126008	14.26460	0.7258
At most 1	0.006916	1.859838	3.841466	0.1726
Max-eigenvalue test indicates no cointegration at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source : Authors calculations (Eviews)

Table (C) : Length of the lag

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-668.9909	NA	0.503096	4.988780	5.015506	4.999513
1	318.7189	1953.389	0.000335	-2.325047	-2.244868	-2.292847
2	345.1271	51.83474	0.000284	-2.491651	-2.358019*	-2.437984*
3	351.6072	12.62290	0.000279	-2.510091	-2.323005	-2.434957
4	353.6213	3.893444	0.000283	-2.495326	-2.254787	-2.398725
5	**359.6642**	**11.59157***	**0.000278***	**-2.510514***	**-2.216523**	**-2.392447**

Source : Authors calculations (Eviews)

Table (D) : Variance Decomposition of Ltrend

Variance Decomposition of LTREND:			
Period	S.E.	LTREND	LBTC
1	0.145479	100.0000	0.000000
2	0.176796	98.23755	1.762452
3	0.215347	97.79861	2.201385
4	0.246402	96.76193	3.238069
5	0.266411	96.01423	3.985768
6	0.290332	96.04055	3.959451
7	0.309003	95.94631	4.053686
8	0.327451	96.09216	3.907843
9	0.345109	96.24862	3.751382
10	0.360830	96.38958	3.610421

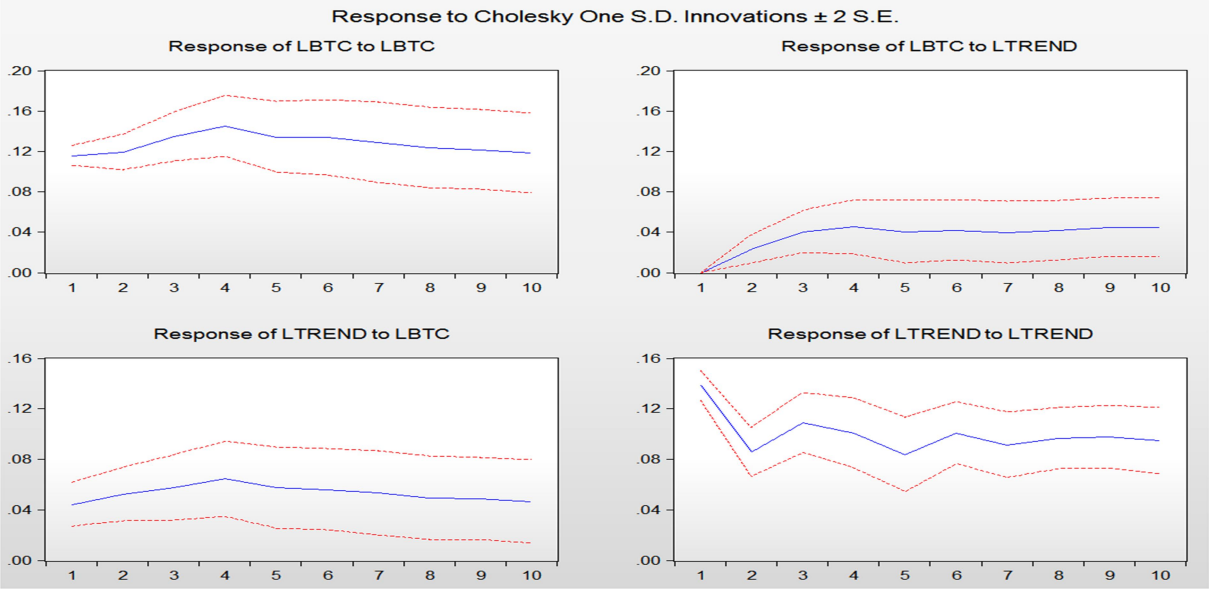
Source : Authors calculations (Eviews)

Table (E) : Variance Decomposition of LBTC

Variance Decomposition of LBTC:			
Period	S.E.	LTREND	LBTC
1	0.115690	9.262942	90.73706
2	0.167672	16.54287	83.45713
3	0.218675	22.90663	77.09337
4	0.266417	26.14010	73.85990
5	0.300989	27.44252	72.55748
6	0.332006	28.46539	71.53461
7	0.358330	29.06082	70.93918
8	0.381317	29.76560	70.23440
9	0.402682	30.56678	69.43322
10	0.422034	31.30662	68.69338

Source : Authors calculations (Eviews)

Chart (F) : Impulse response



Source : Authors calculations (Eviews)

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