The Determinants of Bitcoin

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Introduction

- First introduced in 2008 by a person or a group of people which have the pseudonym of Satoshi Nakamoto, Bitcoin is the most popular cryptocurrency that ever existed.
- The most important advantage that Bitcoin has to offer, is the anonymity that it provides, to both counterparts, during all transactions.
- As Bitcoin seems to be a decentralized asset (not controlled by any central bank), many claim, that its price is determined solely by the laws of supply and demand and thus it has a unique behavior for any financial asset, while all other assets have a strong correlation with financial markets, which can arise investigation of its hedging potential.

Introduction

- In a new asset like this, a significant question has to be answered: Once someone decides to invest on Bitcoin, the question is which are the real market determinants of the returns of Bitcoin? The contribution of this paper is to add an extra approach to the ongoing attempt to identify the determinants of Bitcoin, a such popular and ambiguous asset.
- This paper is going to based on some methodologies that have been used in the past to identify the determinants of Bitcoin returns. Also, we are going to use one more methodology that has not been used in this field, and add some new approaches. However, we should take a look of the properties and history of Bitcoin.

The history of Bitcoin

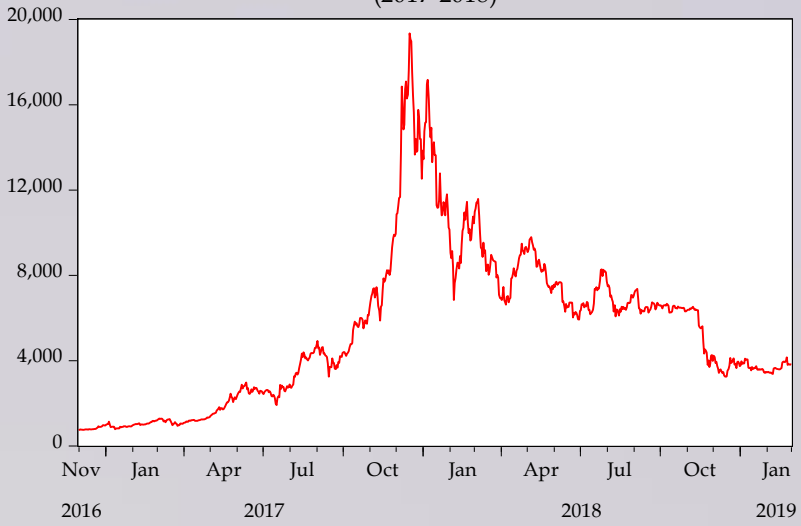
- In 2009, Bitcoin released in public as an open-source software. It is worth noting, that despite the fact that Bitcoin is considered as a first-time-seen phenomenon no one ever expected, some economists pointed the future development of such currencies, long before their existence. Two major economics schools, talked about the creation of a currency with these characteristics.
  - Back in 1909, Carl Menger, a representative of the Austrian school, described a non-government money system. In the beginning of his theory, Menger acknowledges the importance of the state in the creation of the monetary system, contradicting with his later theory, in which he depicts the monetary system as spontaneous orders in which governmental interventions should be minimized.
  - In a more conventional statement, Milton Friedman, head of the Chicago School, being against governmental collectivism, foresaw that in the future, governmental power will be restricted, and a new form of a digital currency will be born, providing anonymity along with its drawbacks.

The eventful path of Bitcoin

The eventful path of Bitcoin

(2013-2014)

(2017-2018)



(2019-2020)

A brief look on literature

- The past literature seems to suggest to different and opposing perspectives on this matter. Many claim that while Bitcoin is an asset merely connected or totally detached from the real economy and capital markets, and thus can be used as a hedging tool in investment portfolios, while its low correlation with other assets can be beneficial for portfolios and lower their risk (standard deviation). On the other hand, many analysts have found that bitcoin can be explained by some economic and market variables through a series of approaches.
- That contradiction among the Bitcoin's nature in literature indicates one thing; additional research is needed to identify the true characteristics of Bitcoin, while it is one of the most recent added in the interest of the investors, but many of them are hesitant of utilizing it, due to its volatile and unpredictable nature.

A brief look on literature

- The questions that emerge here are: Once we have proved that Bitcoin has some interesting hedging abilities, taking into consideration its peculiar characteristics, can we predict the trajectory of Bitcoin's price or returns? Are there any driving factors or determinants that have explanatory power over the Bitcoin's price future fluctuation?
- Except Kristoufek (2013), which finds a bidirectional relationship between Bitcoin and both Google and Wikipedia searches, and Kristoufek (2015), which finds a diminishing in time positive relationship with hash rate on the long run, that are widely mentioned in the past literature, we are going to focus in more recent articles.

A brief look on literature

- Many analysts in the past have pinpointed the significance of some economic and technologic factors such as news, number and amount of transactions, exchange rates, stock market indices, commodities, money supply, EPU, hash rate (mining difficulty), interest rates, volatility etc.
- On the other hand, some papers such as Ang et al. (2012), Brière et.al. (2015), Bampinas-Panagiotidis (2016) and Platanakis-Urquhart (2020), through different methodologies, proved that portfolios can benefit from the addition of Bitcoin, by lowering their total risk.
- This paper is going to be based on one more notion which has not so many applications in the field of economics. It was first introduced by Dufour and Renault (1998) in their paper named "Short Run and Long Run Causality in Time Series: Theory", where they propose a new way of conception of the Granger causality. The same method then advanced by more contemporary articles such as Breitung-Candelon (2006), Dufour-Taamuti (2010), Al-Sadoon (2019) and many others.

Methodology

- In order to extract our results, we employed a plethora of methodologies, reaching to a safe conclusion. The *Results* section will be constructed around the following methodologies:
  1. Stationarity testing (ADF, Bai-Perron multiple structural break test)
  2. Correlation Analysis
  3. Vector Autoregressive model (VAR)
  4. Impulse response function (IRF), IRF by local projections (Jorda (2005))
  5. Variance and Historical Decomposition
  6. Subspace Granger Causality (SGC)

Methodology: Subspace Granger Causality

- Standard Granger causality testing, introduced by Granger (1969) is a basic way of finding a dynamic relationship between time series.
- This notion can be perceived as the predictive power that a vector X has from its own past, the past of another vector Y, or an auxiliary variable vector Z, at only one horizon. standard causality measures cannot provide evidence about any indirect causality, in a horizon over 1.
- Subspace Granger causality, which was first proposed by Dufour-Renault (1998) identifies causality at different horizons and quantifies short- and long- run causality between the vectors. Subspace Granger non causality (SGNC) is based on a VAR(p) process. This method allows us to pinpoint any causality of the variables, both in short and long run horizons.

Data

Variable Name:	Source:
(btc): Bitcoin closing price	investing.com
(brent): Brent Crude Oil	stooq.com
(chn_epu): China Policy Uncertainty Index	policyuncertainty.com
(cnyusd): Chinese Yuan/US Dollar	investing.com
(dji): Dow Jones Industrial	yahoofinance.com
(eu_epu) Europe Policy Uncertainty Index	policyuncertainty.com
(eurusd): Euro/US Dollar	yahoofinance.com
(fedfunds): FED Funds Rate	fred.stlouisfed.org
(gbpusd): GB Pound/US Dollar	yahoofinance.com
(gold): Gold price	yahoofinance.com
(gtrends): Google trends for the term "Bitcoin".	trends.google.com
(jpyusd): Japanese Yen/US Dollar	yahoofinance.com
(nasdaq): NASDAQ Composite Index	yahoofinance.com
(ng): Natural gas Price	stooq.com
(nikkei): NIKKEI 225 Composite Index	yahoofinance.com
(shc): Shanghai Composite Index	stooq.com
(sp_500): S&P 500 Index	yahoofinance.com
(tedrate): TED Spread Rate	fred.stlouisfed.org
(us_epu): US Policy Uncertainty Index	policyuncertainty.com
(fsi): US Financial Stress Index	fred.stlouisfed.org

Results: Stationarity Testing

- The majority of the market variables are not stationary at level, and the 1st difference will be taken into account. However, there are some variables that are stationary at level, some even at the 1% level of significance (fsi, gtrends, jpyusd, tedrate), and thus, no logarithmic differences are necessary in this occasion.
- Only a few variables have a statistically significant correlation with Bitcoin. In the 5% level of significance only NIKKEI Composite Index and the Financial Stress Index have a relationship (0.101525 and -0.104143 respectively). We observe that both are weak relationships, and one of them is negative. That means, that when FSI increases a drop in Bitcoin returns can be observed.

Results: Bai-Perron Test

Breaks:	F-statistic	Scaled F-statistic	Weighted F-statistic	Critical Value
1	1595.128	1595.128	1595.128	8.58
2	951.1571	951.1571	1130.322	7.22
3	664.9663	664.9663	957.2836	5.96
4	497.7779	497.7779	855.8988	4.99
5	397.2246	397.2246	871.6590	3.91

UDMax statistic:	1595.128	UDMax critical value	8.88
WDMax statistic:	1595.128	WDMax critical value	9.91

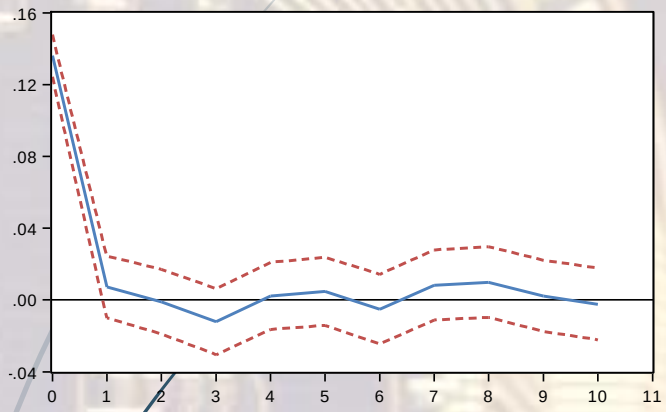
- According to UDmax and WDmax statistics, the optimal determined breaks is one. In this case, the selected break is at 10/1/2017, and thus we are going to divide our sample into two subsamples, one ending at 09/24/2017, and one starting at 10/01/2017. According to Akaike's information criterion, the optimal lag length for the entire sample is 2.

1st period (01/13/2013-09/24/2017)		2nd period (10/01/2017-09/06/2020)	
Coefficients		Coefficients	
	DJI (-2)	BTC (-1)	
	9.362585	-0.185282	
	[3.77260]	[-2.06271]	
	Gold (-2)	Chn EPU (-1)	Chn EPU (-2)
	1.415093	-0.866138	0.539894
	[-2.711758]	[-3.91260]	[2.35625]
	S&P 500 (-2)		EU EPU (-2)
	-10.23539		-1.021951
	[-2.71758]		[-2.78449]
Gtrends (-1)	Gtrends (-2)	NG (-1)	
0.071712	-0.071138	-0.352753	
[3.87319]	[-3.78222]	[-2.18352]	
		FSI (-1)	FSI (-2)
		-0.30218	0.031018
		[-1.97029]	[2.03324]
		Gtrends (-1)	Gtrends (-2)
		0.007460	-0.006998
		[3.42566]	[-3.24295]
R-squared=	0.255399	R-squared=	0.424887
Adj. R-squared=	0.108680	Adj. R-squared=	0.221307
F-stat =	1.740735	F-stat =	2.08076

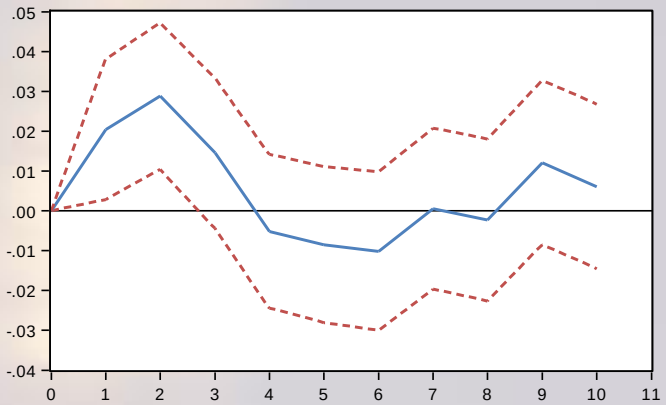
- In the first period only four variables are significant: DJI, Gold, S&P 500 and Google trends. It is quite interesting to pinpoint that the significance of these variables comes from 2 periods (weeks) in the past, and not earlier. This means that Bitcoin's provides a delayed reaction to market aspects, either positive or negative.
- From October 2017, Bitcoin's returns can be explained by Bitcoin itself, China's and Europe's Economic Policy Uncertainty Index, Natural Gas, Financial Stress Index, and Google trends. China's EPU and FSI's coefficient sign seems to be shifting, while one period in the past has negative influence on Bitcoin returns, and two periods in the past has a positive one. This can be explained; as the China's Economic policy uncertainty and the financial stress increases, Bitcoin returns will drop momentarily for one period, reacting to this change, and then it will have a positive reaction to these variables.

Results: IRF by local projections (Period 1)

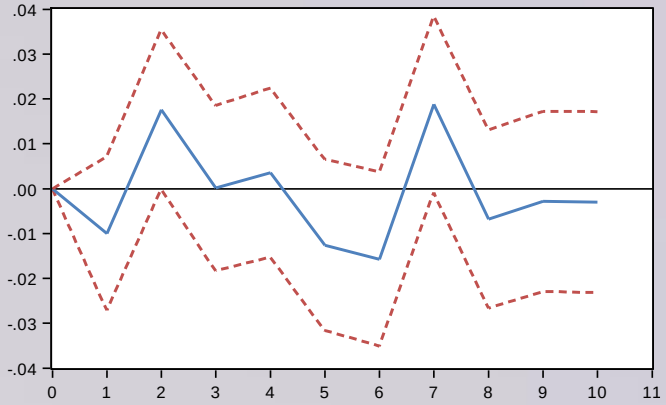
Response of DBTC to DBTC



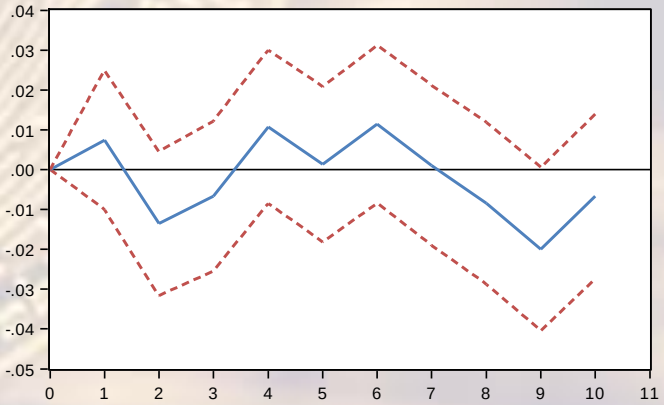
Response of DBTC to DDJI



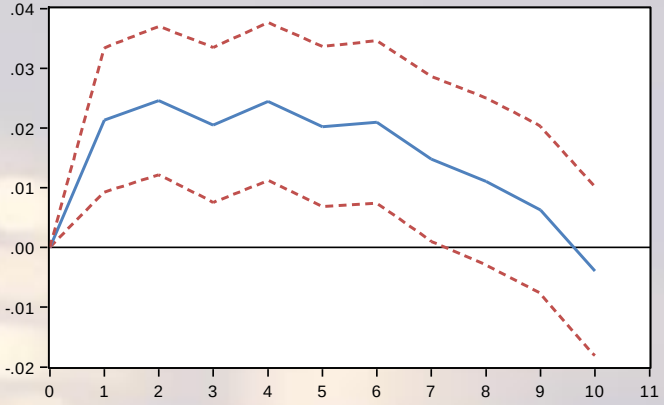
Response of DBTC to DGOLD



Response of DBTC to DSP_500



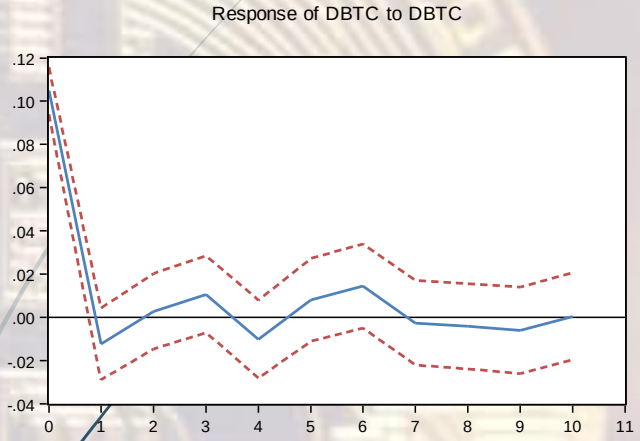
Response of DBTC to GTRENDS

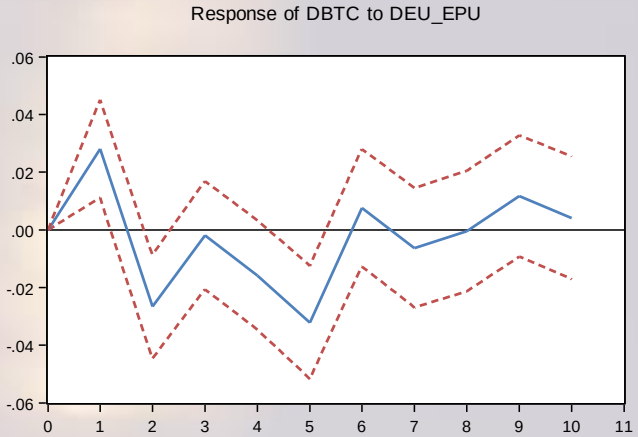


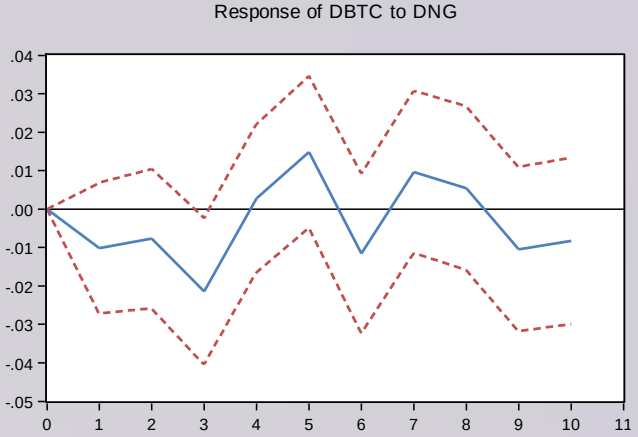
Results: IRF by local projections

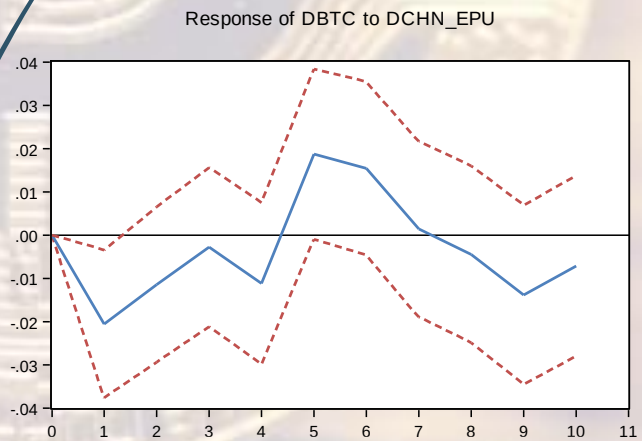
- In the first subsample we still detect a positive response on a DJI shock for the first three periods, that declines over time. This result has the same impact as the results from the VAR model, but in a more dynamic approach. Google trends also have a positive impact on Bitcoin, but for a longer period of time, and seems to decline after five periods, but still being positive.
- In the second subsample, we see a positive impact of Bitcoin in Europe's EPU, in contrast with VAR's coefficients, and a negative in China's EPU. In addition, Google trends have a positive impact on returns for three periods. In the second model, it is quite apparent, that all these impulse responses are significant only in the short run. In both periods standard IRF process confirms our results.

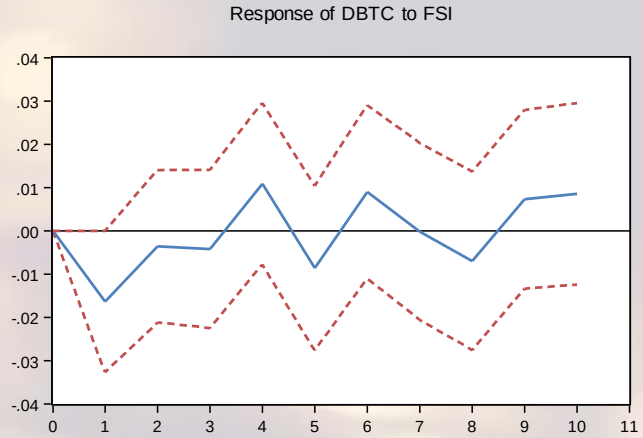
Results: IRF by local projections (Period 2)

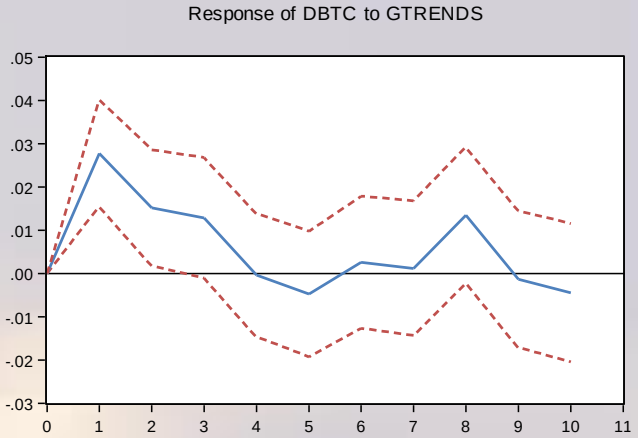




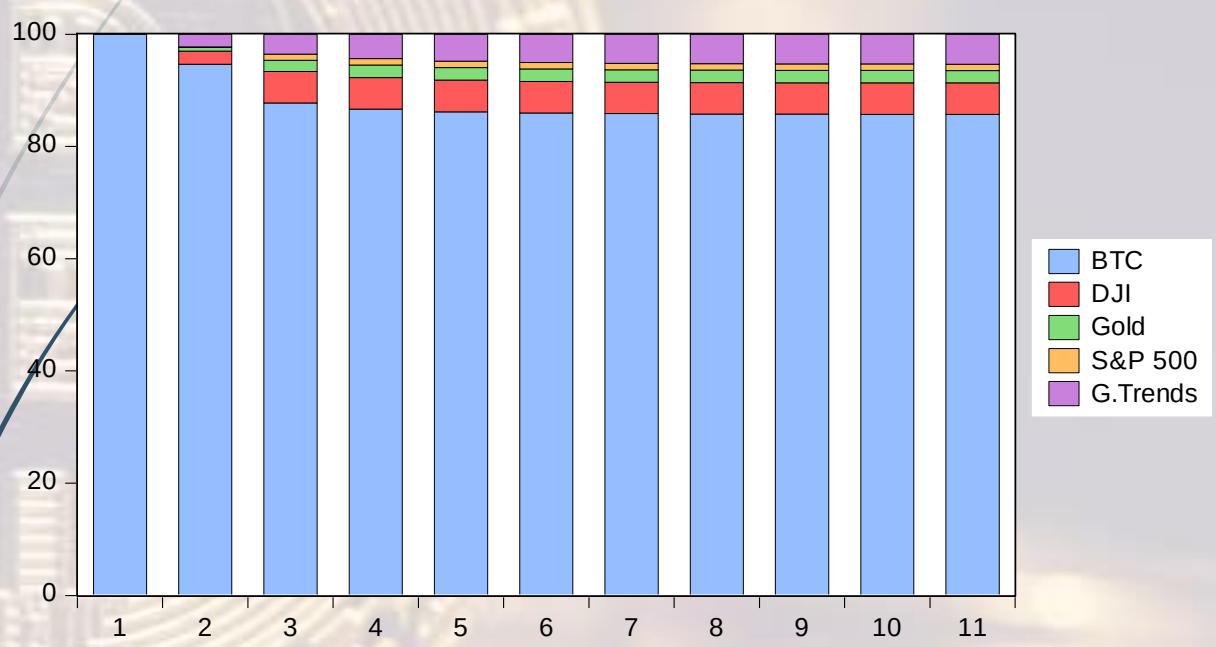






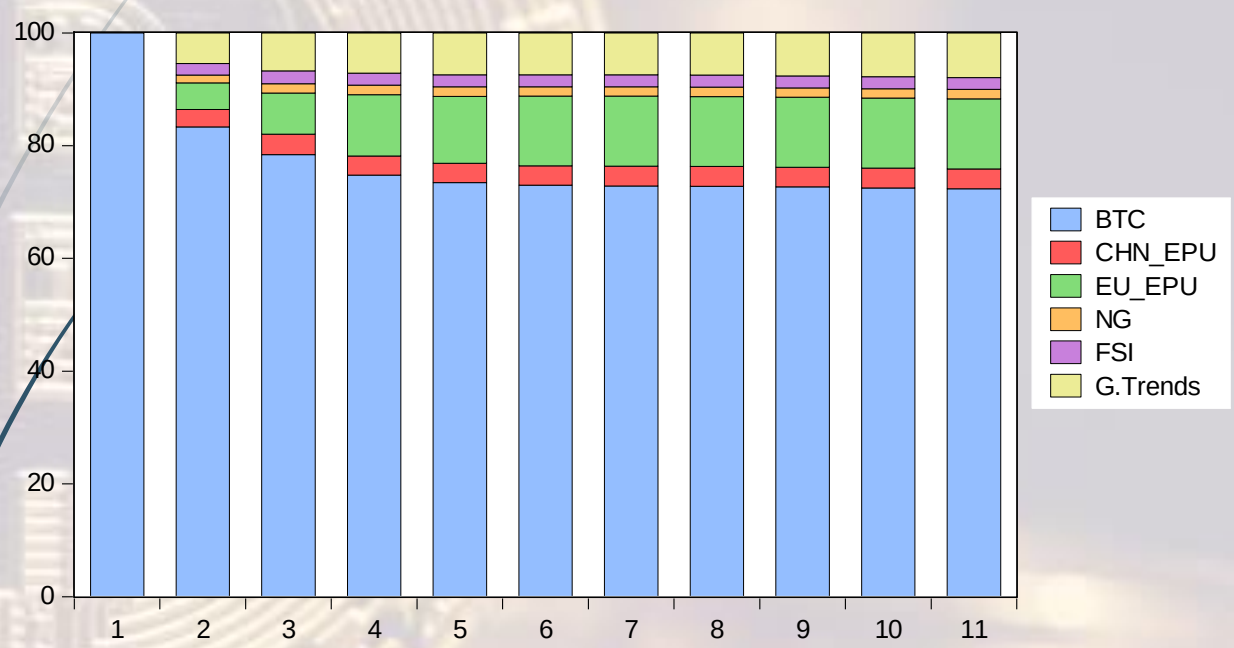


Results: Variance Decomposition (Period 1)



- The contribution of all significant variables does not exceed 14% of the variance, with DJI and Google trends providing the largest proportion of information of about 4-5% each, while the latter two providing only 1-3%.

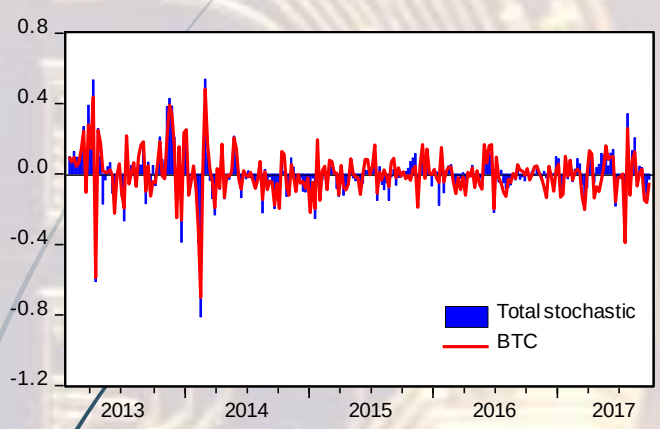
Results: Variance Decomposition (Period 2)



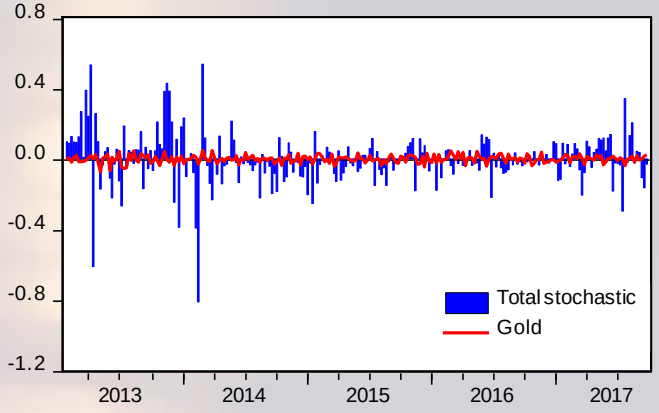
- In the second subsample, we can discern that a larger segment of Bitcoin's variance can be explained by its determinants of a percentage about 17-25%. Europe's EPU has the largest impact, in a percentage that grows over time, of about 12-13%. Similarly, to the first bar chart Google trends has also an increasing effect over time ranging in 5-8%. All other variables have a contribution of 2-6% each.

Results: Historical Decomposition (Period 1)

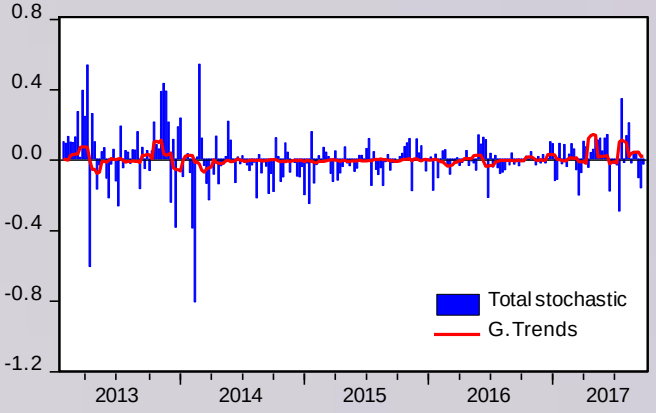
BTC from BTC



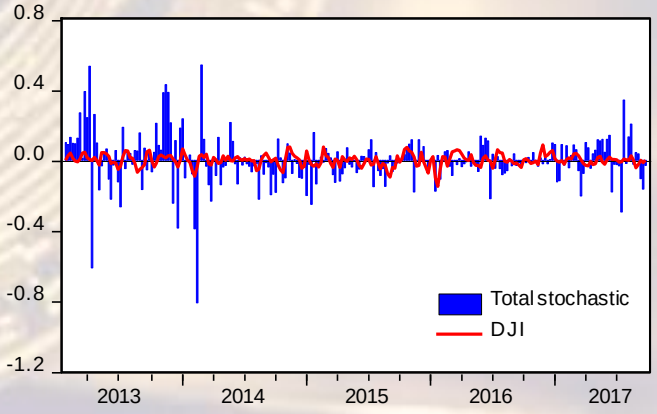
BTC from Gold



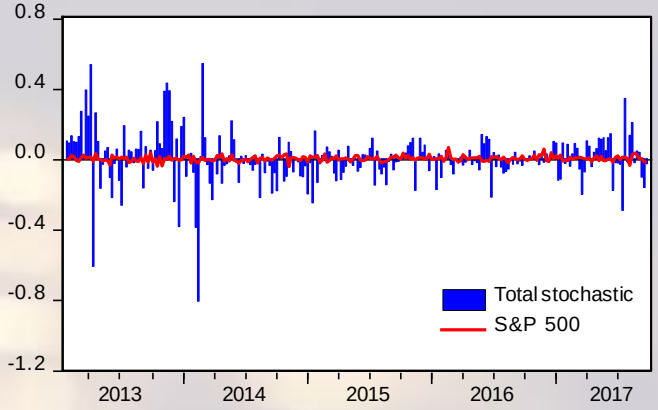
BTC from G.Trends



BTC from DJI



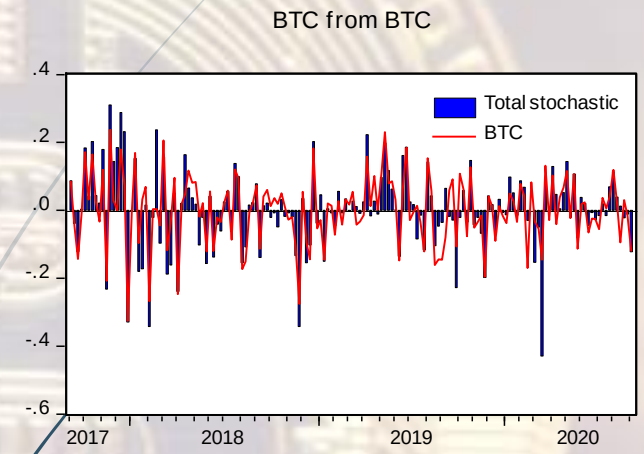
BTC from S&P 500

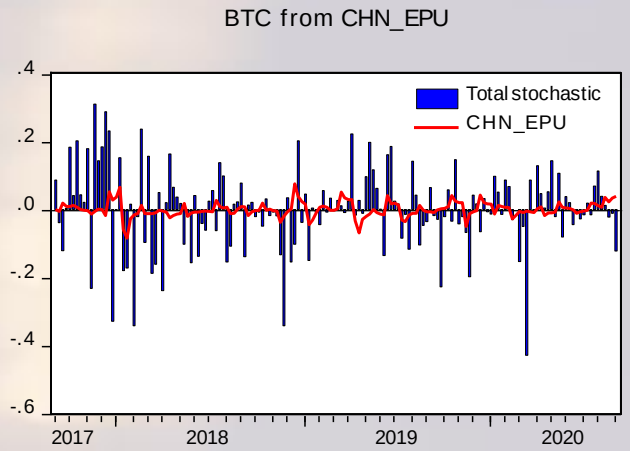


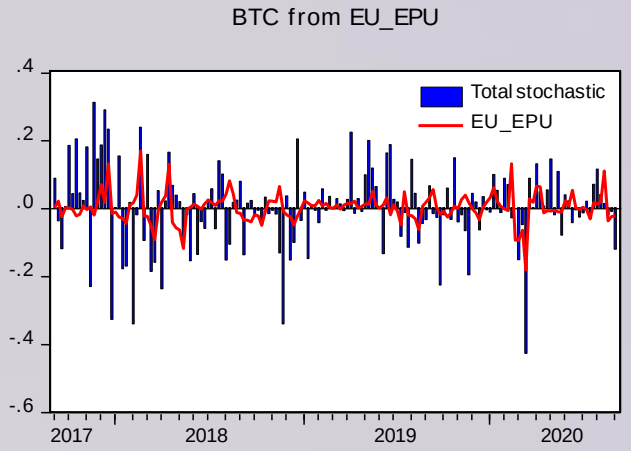
Results: Historical Decomposition

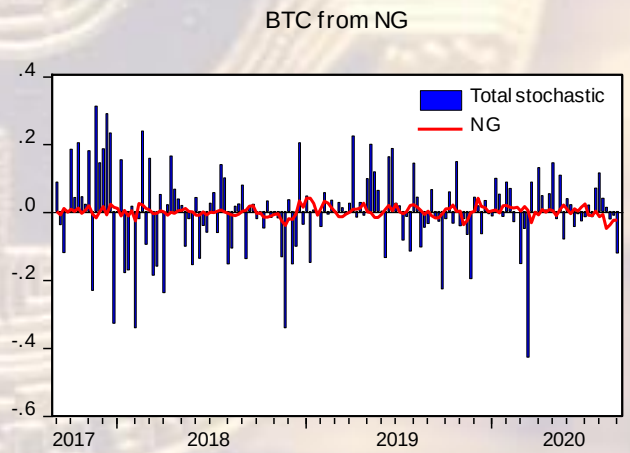
- In the first subsample Gold and S&P 500 have minor impact on returns. On the other hand, in Google trends and DJI we see a different picture. Through the years 2013-2014 Google trends seem to have higher importance in comparison with the other variables, and when that effect wanes, through the years of 2015-2016 when the returns of Bitcoin decrease as well, DJI gains some significance over the returns. Then through the last year of the sample, where the volatility rises again, Google trends have greater impact again.
- In the second subsample, FSI and Natural Gas are the variables of minor importance. We can see that Economic Policy Uncertainty shows a significant contribution for both indices. Europe's EPU shows a greater contribution than the other variables, and China's EPU has a weaker one, but also significant in some periods. Finally, for once more Google trends has a more noticeable impact on returns in periods of high volatility.

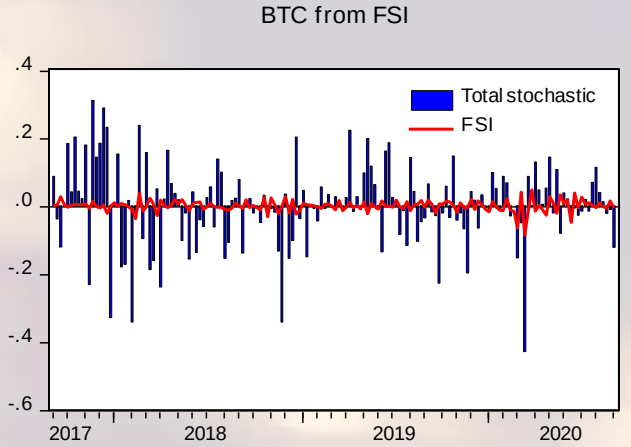
Results: Historical Decomposition (Period 2)

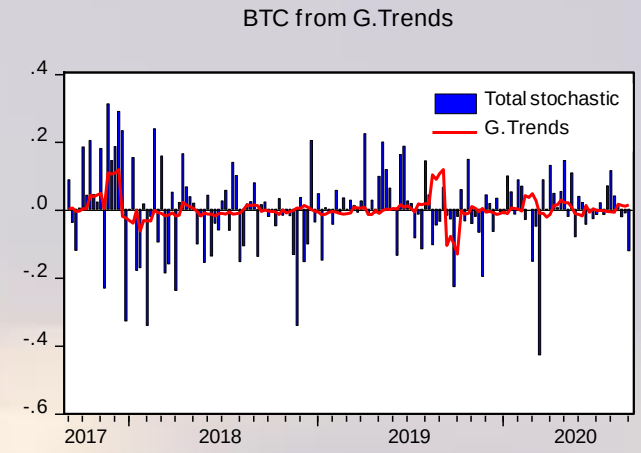












Results: SGNC (Period 1)

Horizons:	1	2	3	4	5	6	7	8	9	10	11	12
Bootstrapped Small-b p-value:												
dji → btc	0.228	0.060	0.358	0.769	0.324	**0.022**	0.430	0.447	0.298	0.808	0.367	0.142
gold → btc	0.074	0.179	0.301	0.244	**0.000**	**0.002**	0.183	0.911	0.295	0.164	0.596	0.680
sp_500 → btc	0.367	0.135	0.478	0.709	0.551	**0.037**	0.377	0.547	0.181	0.795	0.380	0.127
gtrends → btc	**0.009**	**0.013**	**0.029**	**0.023**	**0.010**	**0.034**	0.288	0.561	0.175	0.552	0.324	0.582
Bootstrapped Fixed-b p-value:												
dji → btc	0.766	0.343	0.530	0.706	0.617	0.526	0.644	0.631	0.676	0.809	0.484	0.067
gold → btc	0.207	0.055	0.619	0.204	**0.016**	**0.012**	0.373	0.899	0.876	0.666	0.605	0.799
sp_500 → btc	0.817	0.405	0.581	0.711	0.792	0.558	0.503	0.604	0.623	0.794	0.610	0.071
gtrends → btc	**0.001**	**0.001**	0.120	0.057	**0.018**	0.389	0.331	0.305	0.140	0.263	0.071	0.684

- All variables are able to predict Bitcoin returns in horizon 6, indicating that these variables provide information about Bitcoin not in the present, but in a deeper horizon. Besides that, we cannot see any significant results for the majority of the variables, except Google trends. We can see that Google trends are able to predict returns for periods from 1 to 6.

Results: SGNC (Period 2)

Horizons:	1	2	3	4	5	6	7	8	9	10	11	12
Bootstrapped Small-b p-value:												
chn_epu → btc	**0.003**	**0.046**	0.366	**0.009**	**0.001**	**0.010**	**0.039**	0.152	0.437	0.754	0.299	0.273
eu_epu → btc	**0.002**	0.260	0.085	0.055	**0.043**	0.223	**0.026**	0.389	0.604	0.933	0.670	0.445
ng → btc	0.664	0.325	**0.029**	**0.028**	0.057	0.080	0.133	0.172	0.553	1.000	0.971	0.758
fsi → btc	**0.029**	0.814	0.886	0.198	0.140	0.788	0.862	0.659	0.789	0.526	0.678	0.763
gtrends → btc	0.061	0.075	**0.020**	1.000	0.186	0.750	**0.009**	**0.032**	0.943	0.549	**0.000**	0.249
Bootstrapped Fixed-b p-value:												
chn_epu → btc	**0.002**	**0.017**	0.183	**0.044**	**0.006**	**0.001**	0.103	0.475	0.658	0.675	0.577	0.389
eu_epu → btc	0.186	0.247	**0.046**	0.425	**0.020**	0.138	**0.036**	0.457	0.379	0.958	0.676	0.778
ng → btc	0.791	0.309	0.439	0.341	0.144	0.170	0.082	0.075	0.532	0.996	0.968	0.610
fsi → btc	**0.028**	0.813	0.935	0.106	0.134	0.773	0.889	0.860	0.619	0.245	0.609	0.893
gtrends → btc	0.672	0.733	0.105	1.000	**0.034**	0.565	**0.001**	**0.002**	0.976	0.509	0.082	0.192

- In this case it is interesting that Economic Policy Uncertainty can predict Bitcoin returns. China's EPU causes BTC in horizons 1,2 and 4-7. Europe's EPU test's small-b are significant in horizons 1, 5 and 7.
- The results for FSI in this table concur with our previous results as well.
- Finally, in our previous analysis, it was obvious that the explanatory power of Google trends lowers in the second subsample and other variables take its place. The same conclusion can be perceived from these two tables as well.

Conclusion

- In a dataset of a total 19 variables ranging from 01/13/2013, to 09/06/2020, we divided our sample into two subsamples according to Bai-Perron Multiple Breakpoint test, and employing a series of methodologies we extracted our results.
- For the first period, which can be named as the early stages of Bitcoin's evolution, data provide evidence for significant impact of Google trends on Bitcoin returns, and we can see a weaker relationship with Dow Jones Industrials.
- In the second period, we find more variables to be significant. Economic Policy Uncertainty (EPU) for two regions (Europe and China), seem to have an effect on Bitcoin, as in short as in the long run, and US Financial Stress Index has a minor effect in the short run, while Google trends' effect diminishes in this period, but it remains significant.

Conclusion

- Beyond doubt, Bitcoin is an asset, proven in the past, driven mostly by technological factors, and this fact can be seen in our data as well, with search intensity never losing its contribution over time.
- In the matter of the two contradicting theories prevailing right now, our results are nested somewhere in the middle. This means, that we proved that Bitcoin is far from being strictly connected with the markets, although we cannot neglect some of the relationships found above and thus, we cannot state that it is completely disconnected from them.
- It is safe to admit that, our data indicate the necessity of further investigation in the future, in order to identify new determinants that can be added or even replace the already existent.

Thank you for your attention!

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