Do Bitcoin Users Change their Behavior in Price Bubbles?

--- A Statistical Analysis of the Blockchain

Introduction:

Bitcoin ("BTC") is a consensus network that enables payment through an entirely digital currency. Over the course of BTC's history, it has grown rapidly to become a significant medium of exchange, both on- and offline. However, there is still plenty of mystery surrounding it. In our project, we attempt to unmask some of the mysteries surrounding BTC using data pulled from the BTC ledger. We measure the level of interest in BTC by calculating the number of transactions per day and number of BTC transacted per day. We also explore the correlation between the price of BTC and number of daily transactions.

Background:

For the past decade, BTC has been the preeminent cryptocurrency. Many other cryptocurrencies have emerged, but none has attained the level of interest and investment as BTC. As seen in **Figure A** below, prior to its explosion in price over the past few months, BTC reached a peak price of $19,345 in December 2017. This corresponds to a market capitalization of almost $238 billion.[1] To put that figure in context, that is slightly more than the GDP of Portugal in 2019.[2] Thought of another way, it is almost as much as the combined wealth of Jeff Bezos, Warren Buffet, and Bill Gates.[3] That's a lot of money.

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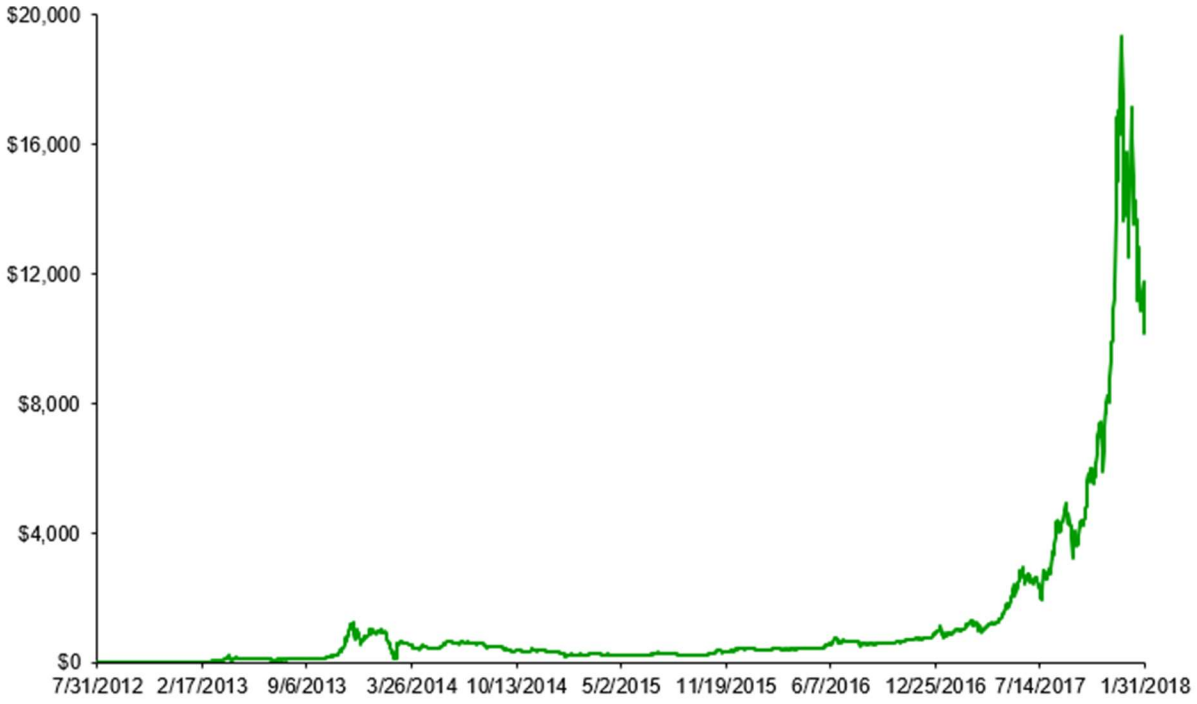
[1] "Market capitalization of Bitcoin from October 2013 to December 3, 2020," *Statista*, https://www.statista.com/statistics/377382/bitcoin-market-capitalization/#:~:text=Market%20capitalization%20is%20calculated%20by,the%20fourth%20quarter%20of%202017.

[2] "List of Countries by GDP (nominal)," *Wikipedia*, https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(nominal)

[3] "The Richest in 2020," *Forbes*, https://www.forbes.com/billionaires/

Figure A: BTC Price, 7/31/12–1/31/18



But what do we know about all that money? As the price takes off in 2017, do BTC users change their behaviors? This paper attempts to answer those questions by focusing on the period from July 2012 through February 2018, shortly after BTC's peak. We focus on this period because of the extreme change in price that happened. In 2016, the price of BTC averaged $567. By 10/12/17 it rose nearly ten-fold to $5,432. Then, by 12/1/17, it doubled to $10,862, and, by 12/16/17, it nearly doubled again to $19,345. An investor might rationally expect yet another rapid doubling in price. Indeed, a hedge fund manager put a $40,000 price target on BTC during this time period.[4] It is not a leap to assume that this price optimism could cause both new users to jump into the world of BTC and cause current users to change their investment behavior.

Our analyses yield an interesting result: when the price of BTC takes off in 2017 there is a sharp increase in the number of daily transactions, with little to no change in the amount of BTC transacted per day. This decrease in average transaction size is consistent with the entry of small-time players into the BTC market in 2017. We expand on these results by looking at the correlation between BTC transactions and price. Overall, we find evidence that the rapidly increasing price environment leads to an

[4] "Novogratz Sets Next Target Price for Bitcoin at $40,000," *Bitcoinist*, http://bitcoinist.com/novogratz-sets-next-target-price-for-bitcoin-at-40000/

increase in the number of transactions, further evidence that investors, new and existing alike, began to chase returns.

Data:

We base our analyses on data scraped from the BTC ledger spanning from its genesis in 2009 through February 2018. This period covers the first 508,000 blocks in the BTC blockchain. Our blockchain data comes from a user on kaggle who scraped it from blockchain.com.[5] The raw data is organized in a series of csv files that each have five columns: block height, input hash, output hash, sum of BTC transacted, and timestamp. The block height is the number of the block in which the transactions are recorded (like the page number in a ledger book). The input hash is the address(es) of the account(s) sending BTC and how much they have sent. The output hash is the address(es) of the account(s) receiving BTC and how much they have received. The sum of BTC transacted is the total amount transacted in the transaction. The timestamp is the generation time of this block. The raw data is stored in 72 csv files that are 72.41gb in total. While not identical in size, each file is about 1gb. Additionally, we gather the price of bitcoin from investing.com.

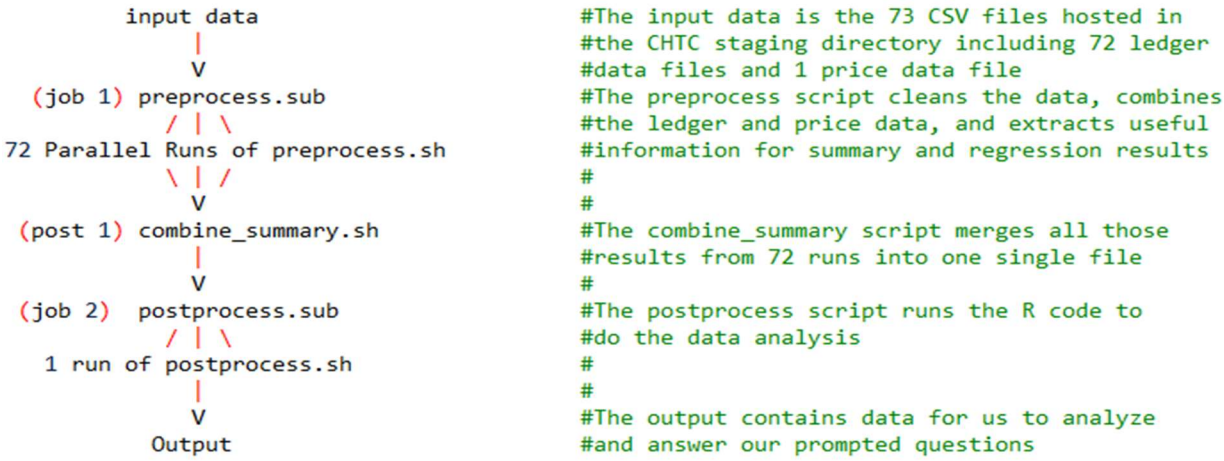
Analysis Methods and Computational Notes:

The analyses are conducted with the help of the computing resources from UW-Madison's Center for High Throughput Computing ("CHTC"). We download the BTC ledger data using the kaggle API and host it in the CHTC staging directory. The BTC price data is also hosted in the staging directory.

Each of the 72 csv files of ledger data is processed individually using a bash script that copies the data from the staging directory onto the CHTC node and calls two R scripts. The results of these individual analyses are then compiled and summarized to create our final output. We structure our analyses according to the Directed Acyclic Graph ("DAG") shown in **Figure B** below.

[5] "Bitcoin data part [one - four] from Jan 2009 to Feb 2015," *Kaggle*, https://www.kaggle.com/shiheyingzhe/datasets

Figure B: DAG of Analysis Structure

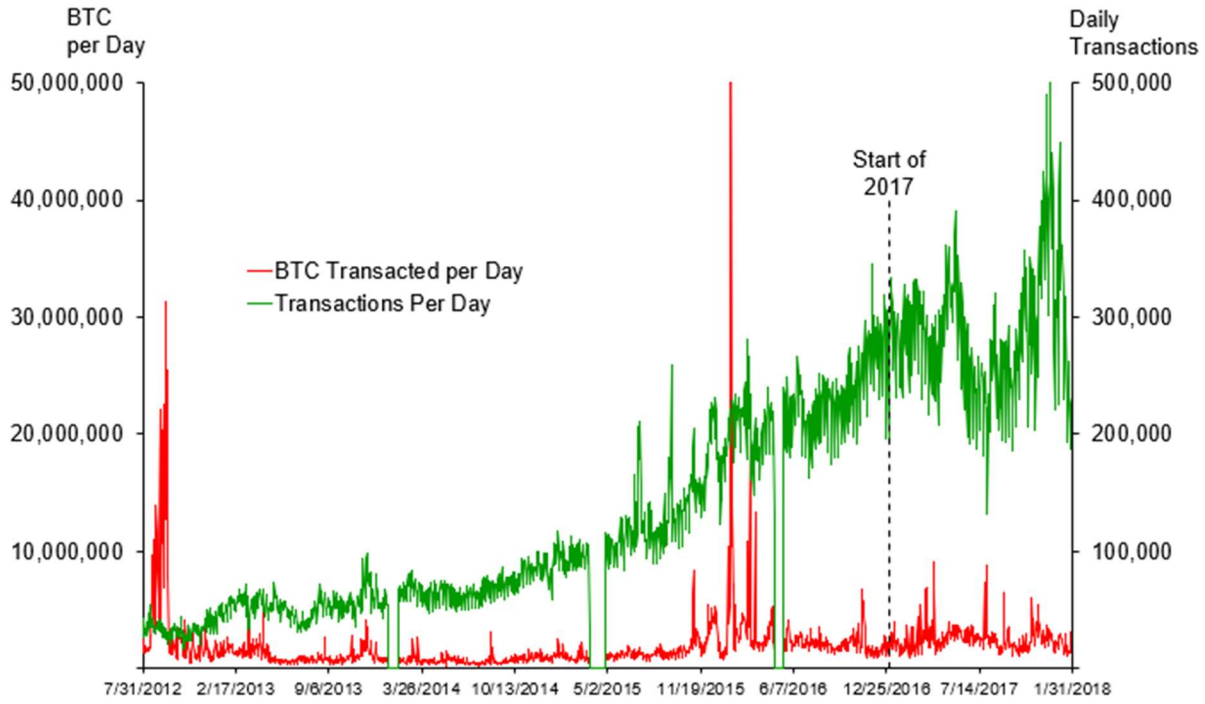


Tip-to-tail, our analysis takes about 25 minutes to run. The run time for preprocessing each of the 72 individual csv files of ledger data ranges from ten seconds to just under three minutes with an average run time of two minutes. The processing of each CSV file uses about 600mb of disk space and between 267mb and 1.3gb of memory.

Results:

To measure the level of interest in BTC, we look at two metrics: transactions per day and the number of BTC transacted per day. Our expectation is that the rising price of BTC would motivate an increased interest in BTC and therefore an increase in both of those metrics. **Figure C** below charts the data over time.

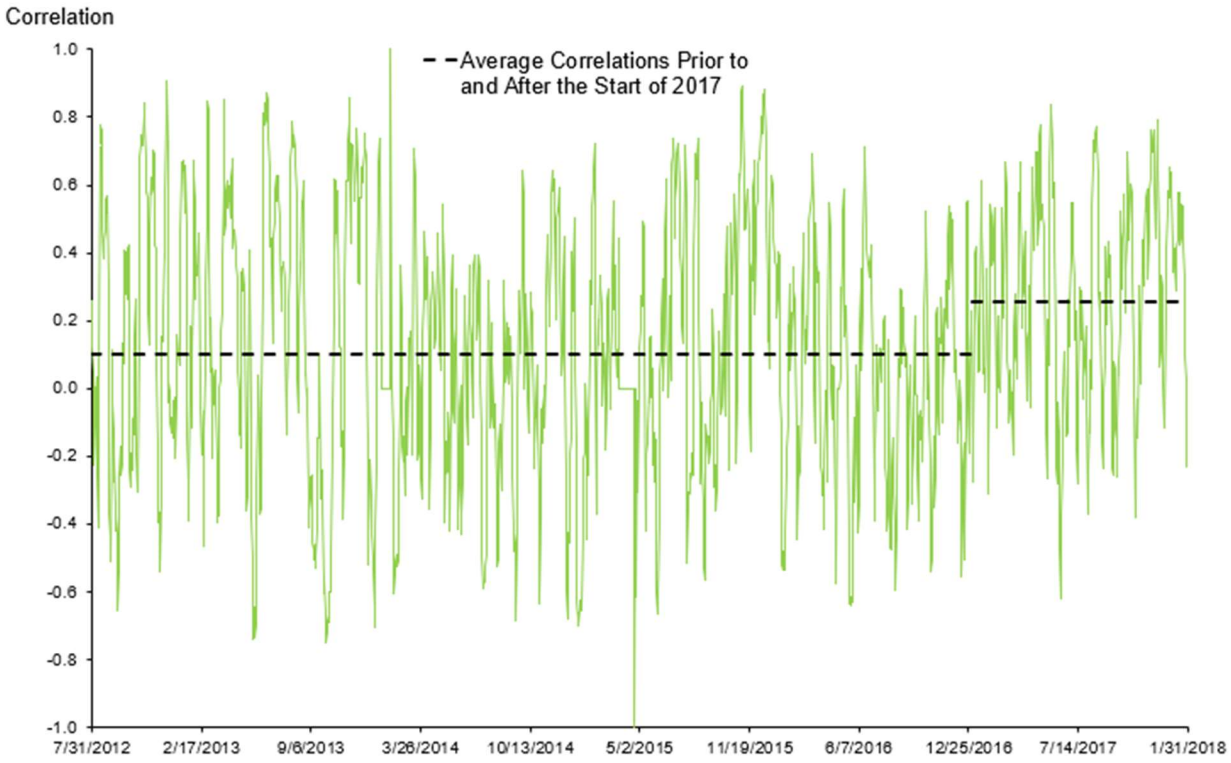
Figure C: Number of Transactions and Total BTC Transacted Per Day: 7/31/12–1/31/18



The chart reveals an interesting result. As the price of BTC increases in 2017, there is a marked increase in the number of daily transactions but we do not see a corresponding increase in the number of BTC transacted per day. This means that, as the price takes off, the average BTC per transaction drops. This result is consistent with the entrance of more small-time investors to the BTC market, which would be the case if individuals decide to buy BTC because of the rising prices. We would expect the typical individual investor to be cash-constrained. So, especially at elevated prices, we would expect new buyers of BTC to buy fewer BTC than what they did previously.

To analyze this relationship in a more rigorous way, we examine the correlation between price and BTC transactions. If it is the case that individuals started to chase returns by buying into BTC in 2017, we would then expect a higher level of correlation between BTC transactions and price in 2017 relative to earlier periods. **Figure D** shows the correlation between the price of BTC and the number of daily transactions over rolling two-week periods for each day from 7/31/12–1/31/18.

Figure D: Correlation Between the Price of BTC and Number of Daily Transactions: Two-Week Rolling Windows from 7/31/12–1/31/18



The black dotted lines in the chart show the average of the correlation values over the periods 7/31/12-12/31/16 and 1/1/17-1/31/18. As the lines demonstrate visually, there is a large increase in the average correlation between these two periods. This increase is statistically significant at the 1% level.[6] Intuitively, what this means is that the number of daily transactions and price exhibit a much stronger relationship in 2017 than they did before. From this result it is clear that the investing habits of BTC users changed in 2017. Combined with the increase in the number of daily transactions, we conclude that BTC users began to chase returns in 2017 to a degree that they had not done so before. This result, while not surprising, gives quantitative support to something many have suggested, BTC is subject to the same animal instincts that drive bubbles in the stock market and elsewhere.

Conclusion:

Findings—The rapidly increasing price of BTC in 2017 led to an increase in the number of daily transactions coupled with a decrease in the average size of transaction. This increase in daily transactions decomposes into two parts: an increase in transactions from existing BTC users and an influx of new BTC users. Our finding of a

[6] Specifically, using a two-sample, heteroskedastic t-test, the change in average correlation is significant at the 1% level.

statistically significant increase in correlation between the number of daily transactions and BTC price suggest that, in 2017, BTC users began to chase returns more actively than they had in the past. This is a definite change in the profile of the average BTC user, which is consistent with the entrance of new BTC users. Overall, the results of this analysis provide evidence, albeit not conclusive, for increase in individuals betting on BTC in 2017.

Further discussion—A natural extension to this analysis would be to study if these results hold in other price increases. As of 12/9/20, the price of BTC is currently close to the $20,000 mark, nearly double where it was six months ago. Have the changes in investor behavior that we saw in 2017 replicated themselves this year? Another avenue for future study would be to compare the returns chasing that happened in the 2017 BTC price bubble with other bubbles that happened surrounding new technologies, like the stock market Dot-com bubble of the 1990s. The results of such a study could provide a basis for using tools developed for studying stock market investing behavior when studying BTC investing behavior.

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