ETHEREUM PRICE FORECAST INTO 2020:
Data-first analysis

TECHEMY GROUP PROPRIETARY RESEARCH 2019

Executive Summary

This research report offers a structured, data-first approach to understanding Ethereum's tumultuous 2019. It attempts to address the question - is a price reprieve on the horizon? In order to answer this question, the report consists of several sections that build upon one another.

First, we discuss Ethereum's price rollercoaster in 2019, and we assess the growing pains that lie ahead as the network switches from 1.0 to 2.0. Second, we analyze Ethereum's seasonal characteristics and use the Hurst exponent to tease out a likely trajectory in 2020. Third, we verify the fundamental metrics driving price and assess their implications for the future of the Ethereum network.

Contents

Ethereum 2019 by the Numbers

Ethereum in 2019

Market Data

bravenewcoin.com

SOURCE: BRAVENEWCOIN.COM

Ethereum Market Data Price 2019

After a roller-coaster year, ETH ends around where it started

bravenewcoin.com

SOURCE: BRAVENEWCOIN.COM

Ethereum 2019 by the numbers

Network Statistics - as at Q4 2019

BNC. bravenewcoin.com

TOTAL NUMBER OF ETH NODES: **7,615**

Total unique addresses (As of November 17th 2019): **~80,000,000**
representing an **~45% increase** since the start of the year

Smart contracts created in 2019:
743,951 (total)
(Generated using Alethio query builder, As of November 11th)

Smart contracts destroyed in 2019:
414,193 (total)
(Generated using Alethio query builder, As of November 11th)

Average Daily gas usage in 2019 :
82.76%
Min. daily average = **59.13%**
Max. daily average= **96.15%**
(Generated using Alethio query builder, As of November 17th)

Average Hashrate 2019:
157.98
Min. Daily Average = **126.61TH/ps**
Max. Daily Average = **187.29**
(Average Terahashes per second, As of November 17th)

SOURCE: BRAVENEWCOIN.COM

Ethereum DApp and DeFi in 2019

Size and Growth - as at Q4 2019

BNC. bravenewcoin.com

DApps: Growth in Building

Total number of DApps on the Ethereum network:
2,654
(Source: State of the Dapps)

Approx. growth in DApps building between January to November 2019
21.69%

DApp building growth in 2018
169.26% SLOW DOWN in 2019
(Source: State of the Dapps)

DeFi: Size of the market

Total amount of ETH locked in DeFi as of 19th November:
1,939,398

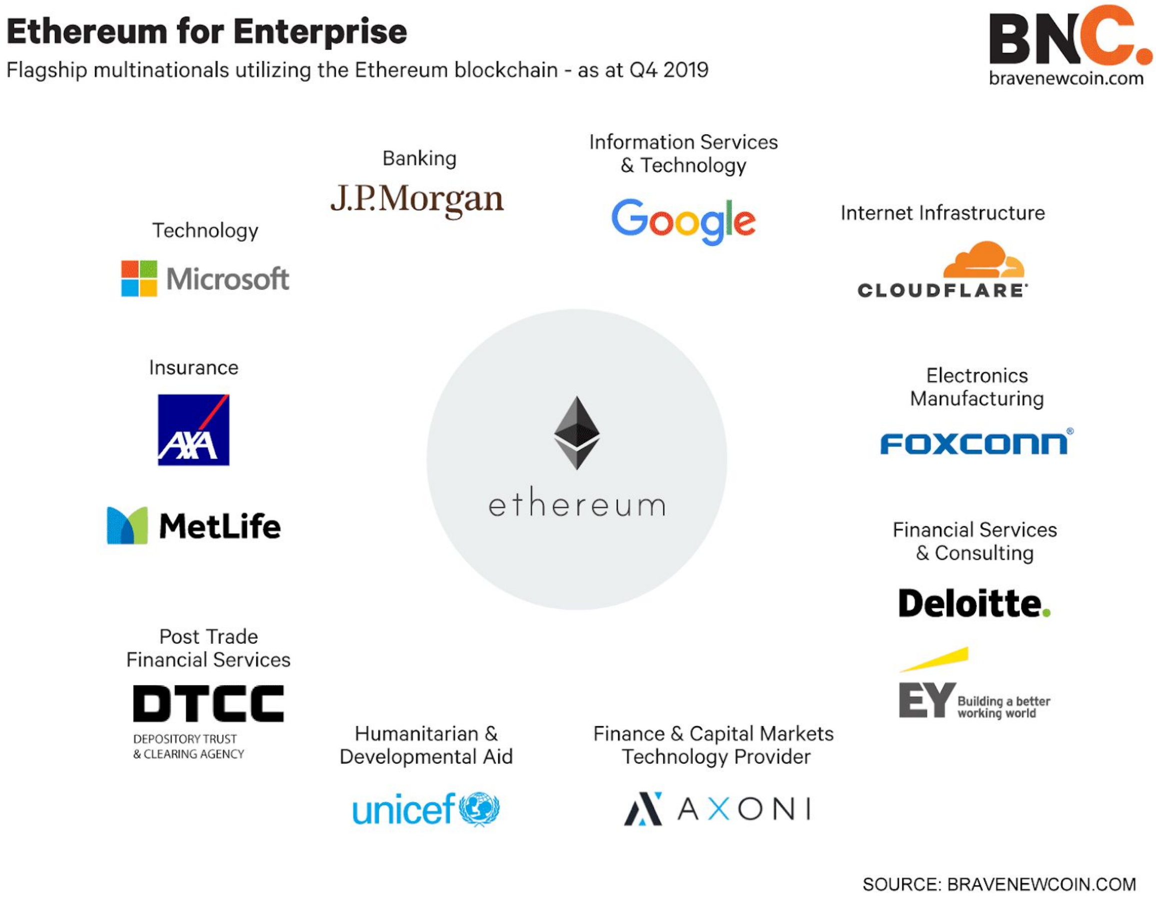
US dollar value:
~US$33,666,165.72

Composition

MAKER	95.61%
Uniswap	3.78%
Compound	0.13%
Veil	0.01%
augur	0.16%
δY/δX	0.00%
MOLOCH	0.31%

(MAKER, Compound, Augur, Uniswap, Veil, dYdX, Moloch DAO platform data included, collected via Alethia.io Query builder)

SOURCE: BRAVENEWCOIN.COM


Ethereum for Enterprise
Flagship multinationals utilizing the Ethereum blockchain - as at Q4 2019
BNC.
bravenewcoin.com
Banking
J.P.Morgan
Information Services & Technology
Google
Technology
Microsoft
Internet Infrastructure
CLOUDFLARE
Insurance
AXA
MetLife
ethereum
Electronics Manufacturing
FOXCONN
Financial Services & Consulting
Deloitte.
EY Building a better working world
Post Trade Financial Services
DTCC
DEPOSITORY TRUST & CLEARING AGENCY
Humanitarian & Developmental Aid
unicef
Finance & Capital Markets Technology Provider
AXONI
SOURCE: BRAVENEWCOIN.COM

Issues transitioning from Ethereum 1.0 to 2.0

Ethereum is one of the most popular blockchain networks in the world and the industry's leading platform blockchain. It is one of the largest open-source projects on GitHub - the Ethereum-go repository has over 25,000 stars (users provide stars on GitHub to suggest interest or satisfaction for a project).

Since its launch in 2015, development work on Ethereum has been ongoing. The focus is on pushing network performance to a level where the platform can be considered the world's decentralized, permissionless supercomputer.

The upcoming, long-anticipated launch of Ethereum 2.0 in January will be the most important and comprehensive update in the network's history. The 2.0 launch will reconfigure and adjust many existing Ethereum network dynamics. Existing Ethereum Dapp and token operators will need to consider how a switch to the new sharded blockchain will affect their daily operations.

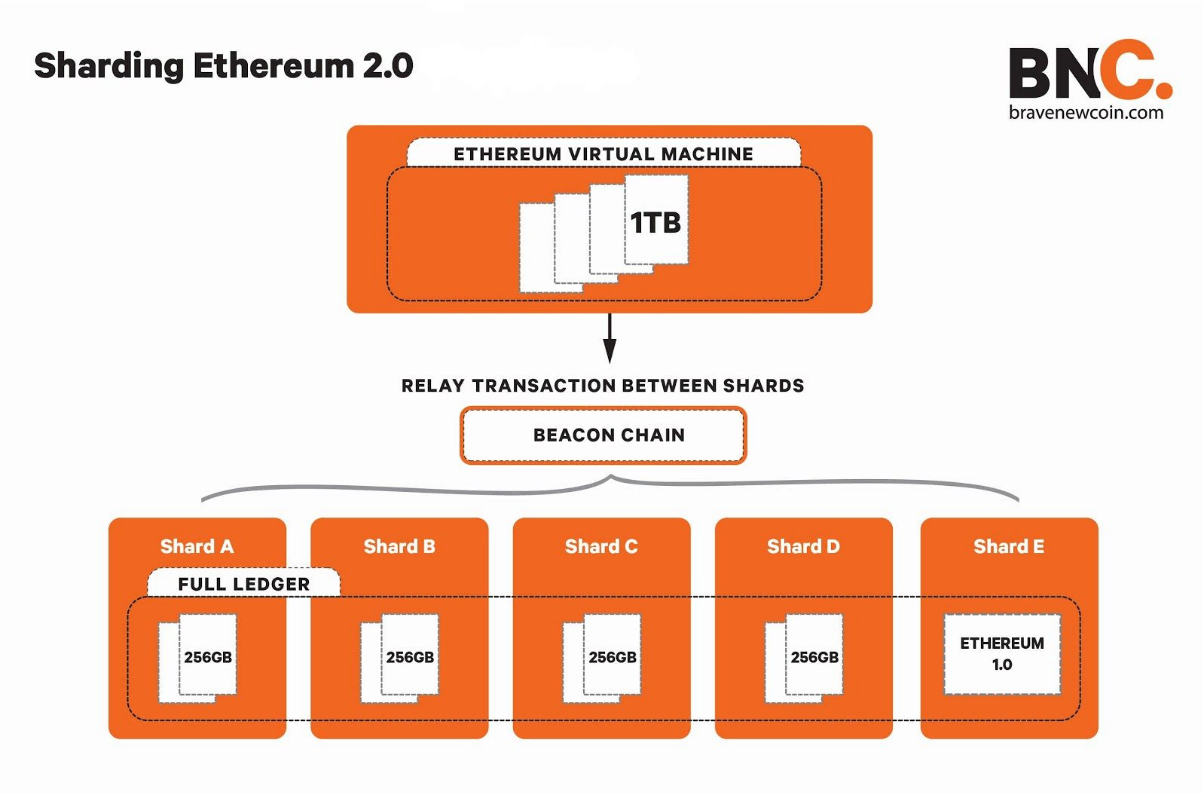
Can DeFi transition? The composability problem

One of the key reasons Blockchain Dapp builders choose to develop on Ethereum is the access to network effects and developer tools offered through its high composability. It is easy for apps to interact with each other because of the permissionless nature of Ethereum smart contracts. Composability describes the degree to which various components in a software stack can combine together.

Within some Dapp-building communities, particularly DeFi, composability significantly speeds up development timelines. DeFi apps can bootstrap the UX of their apps by offering connectivity to tools like liquidity, banking services, and unique trading pairs.

An example of this composability is a DEX like Uniswap which could be used to sell funds sitting in a MakerDAO CDP if one of their positions is liquidated.

Ethereum 2.0 is structured differently from ETH 1.0, in that it focuses on Dapps existing as unique shards under the umbrella of Ethereum. Transactions within an individual shard can operate the same way they did before, but sending tokens cross shard will involve using a receipt.



The architecture for ETH 2.0 is based on a relay or 'beacon chain' that effectively bounces transactions between shards.

In early October Ethereum creator Vitalik Buterin wrote an essay suggesting how 'cross-shard DeFi composability' could function fluidly in ETH 2.0. For current and prospective Ethereum 1.0 Dapps, however, the shift to the new network is potentially disruptive. These projects will be weighing up their options, and will need to decide whether to stay with Ethereum 1.0, transition to Ethereum 2.0, or jump ship to a non-sharded platform blockchain alternative like EOS.

Asset Classification: Does the switch to Ethereum 2.0 affect ETH's Security categorization?

Commodities and Futures Trading Commission (CFTC) chairman Heath Tarbert suggested in October 2019 that the US regulatory body views ETH as a commodity. Tarbet said that he expected regulated ETH futures in as soon as six months.

Speaking a month later at Consensus Invest: NYC, Tarbert explained that the CFTC, and its sister body, the Securities and Exchange Commission (SEC), were now carefully studying the implications of the upcoming Ethereum 2.0 chain switch on ETH's asset classification.

The switch to Ethereum 2.0 will mean a switch from PoW to PoS and there are concerns that the switch of consensus algorithm will affect the 'sufficiently decentralized' distinction needed for an asset to avoid a stricter security classification under US law. A switch to PoS from PoW means shifting away from confirming transactions based on a processing power competition - and instead gives nodes the opportunity to ease their computational requirements by staking their tokens to the network.

"Staking is different than mining in the sense that mining is by its very nature sort of more decentralized, whereas with the stake it reduces energy costs because you're just giving it to one validator or line of validators," Tarbert said during the speech.

Much will depend on how high the requirements will be to stake on the Ethereum 2.0 chain. There are Ethereum diehards who view the switch to PoS as something that will add to ETH's 'sufficiently decentralized' argument. PoW mining is a cost intensive operation and processing power requirements in the Bitcoin network are now at a level where it has become impossible for retail or individual miners to compete with dedicated, large-scale miners.

The 32 ETH staking requirement is considered more accessible. This is because as well as making it cheaper to access block rewards over time, it will also require a smaller capital outlay, as there is less hardware to purchase.

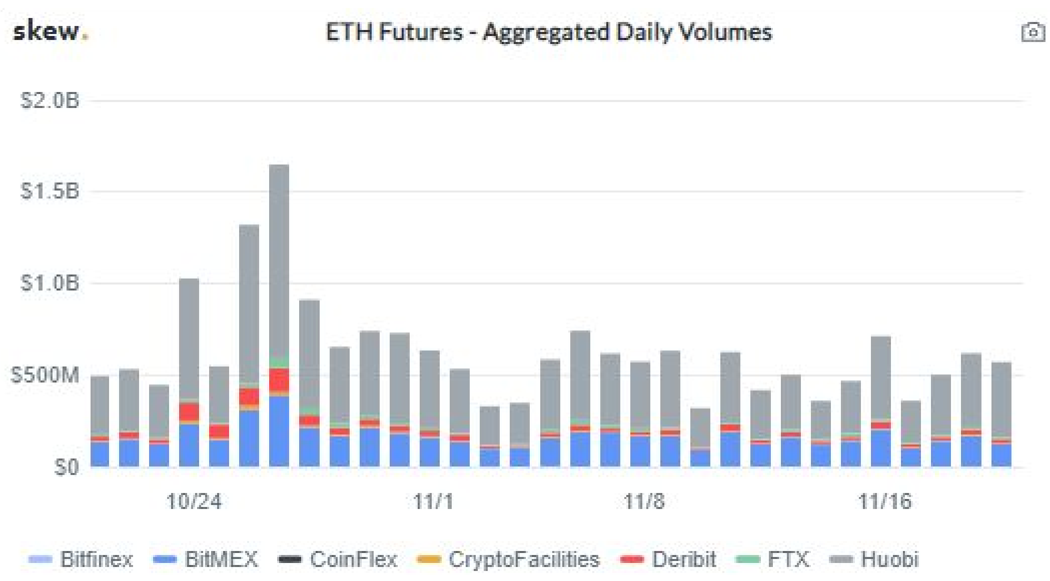
Ethereum researcher Danny Ryan, speaking to news website Coindesk, responded to Tarbert's comments. "In Ethereum's PoS, the capital that you need to acquire to participate is much more readily available. Converting capital into an asset that allows you to stake in the protocol is much cleaner."

It is difficult to tell at this stage what effect the switch from Ethereum 1.0 to Ethereum 2.0 will have on ETH's asset classification. Unsurprising, the CFTC expect months of further study to determine where ETH 2.0 falls under the Howey test.

There are also concerns around whether Ethereum can ship its new build by the previously announced January 2020 deadline. It is clearly a complicated release with many possible points of failure and developers still need to make some key decisions regarding the transition.

A delay in the approval of regulated ETH futures appears increasingly likely due to both uncertainty around how the switch to PoS will affect Ethereum's decentralized nature and exactly when this switch will occur.

In the meantime, ETH speculators can use the unregulated ETH futures markets, accessed through KYC-light exchanges like Bitfinex and Bitmex. Daily volume for the existing unregulated ETH futures market ranges between approximately US$500 million and US$1 billion.

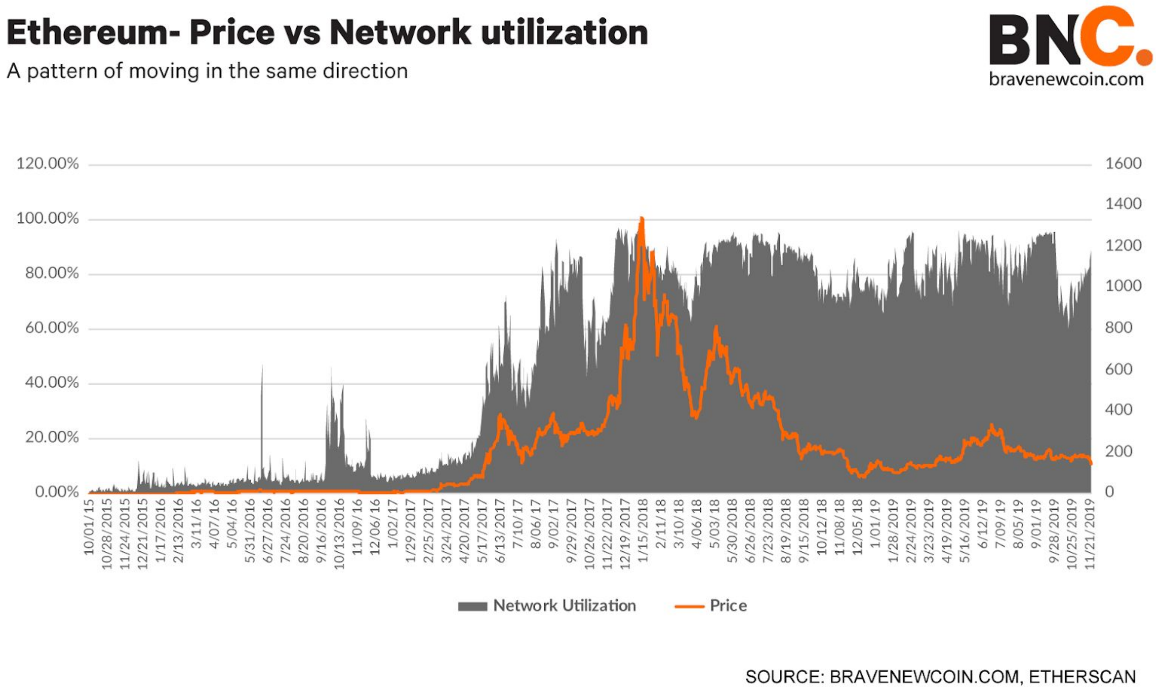


Source: Skew.com

Ethereum network capacity

The Ethereum network currently supports hundreds of Dapps that are constantly processing the smart contracts and peer-to-peer transactions that need to be verified by the Ethereum blockchain.

The Ethereum Dapp-building community exploded in 2017 and 2018, leading to a corresponding increase in the number of transactions needing to be processed by the network. Concurrent to this has been a rise in the time and cost of individual user transactions, negatively influencing the UX and number of return users to the network.



During the bull market cycles of late 2017 and mid 2018, ETH price tops have coincided with network utilization levels of above 90%.

The historical relationship between the price of Ether and Ethereum network utilization has been positive. Intuitively, this relationship makes sense - higher price means more demand for ETH tokens. An increase in demand for ETH tokens, given their utility, means more network activity and a higher level of gas required per smart contract.

The relationship takes on an added level of importance, if, as the data suggests, the network's gas capacity creates a price ceiling that has historically kept a lid on positive price cycles. During some bull market cycles, particularly during late 2017 and mid 2018, price tops have been closely correlated with a network utilization level of above 90%.

This may imply a "too big, too fast" feedback loop, where if the network grows too quickly and the value increases at a similar rate - the network gas limit results in blockchain congestion. This results in higher fees and slower transaction times for users, which eventually leads to users abandoning transactions and moving assets off the Ethereum network. This allows network utilization to drop to a more manageable level, and the network can return to normal operations.

Beacon lights the path ahead

Ethereum, in its present 1.0 form, can support about 15 transactions per second. This is not sufficient for the decentralized network to scale to millions of users. In an interview in January, Ethereum creator Vitalik Buterin suggested that Ethereum will need to be able to process at least 100,000 transactions per second to become a viable platform to host applications in the future.

The impending Ethereum 2.0 updates aim to streamline the overheads for transactions and smart contracts. Ethereum will launch an all-new beacon chain blockchain that relays transactions between all shards and uses proof-of-stake consensus. Consensys describes it as "the heartbeat that keeps the system alive. It is the conductor coordinating all the players."

The beacon chain acts as a decentralized coordinator ensuring that the shards making up the majority of Ethereum operations are running fluidly. Dapps are encouraged to function within separate shards that communicate with the primary PoS beacon chain. The majority of Dapp-based transactions will happen on these individual shards, with nodes on the beacon chain performing key tasks such as being an anchor for shards to register their states to facilitate cross-shard transactions, and applying rewards and penalties to validators within the shard ecosystem.

It will likely be several years before the beacon chain is functioning at full capacity, as designed. Ethereum 2.0 is set to be launched in phases. Phase 0 will launch with a functioning PoS beacon chain, however, it will not yet support Dapps, and shards will not serve much of a purpose during this phase while the groundwork for Ethereum 2.0 is laid. Phase 1 will begin to add Ethereum 2.0 Dapp support and introduce shards as data chains. Network data will be split into shards, but the network state will continue to be stored on the older Ethereum blockchain, and will not yet be sharded.

By Phase 2, Ethereum 2.0 will be fully sharded. State execution will be fully enabled and it will have full smart contract functionality. Phase 3 updates onwards are set to iterate, optimize and add features to the Ethereum 2.0 ecosystem and are designed to help it progress to a point where it can be considered a true world computer.

Developers have suggested that once complete, Ethereum 2.0 will function with 1024 shards, and will be able to handle 15,000 transactions per second. This is an enormous improvement on the current capacity and this should provide headroom for the network to handle large influxes of capital should market demand for ETH drive a new bullish price cycle.

However, it will be some time before Ethereum achieves this 15,000 txp/s goal and we do not expect to see a fully-functioning sharded Ethereum blockchain in 2020.

> *"Ethereum 2.0 (Serenity) won't be fully rolled out for another 2-3 years with Phase 0 and Phase 1 due within 1-2 years, and Phase 2 due sometime in 2022. Ethereum 2.0 is being deployed as a separate blockchain so it does not supersede ETH 1.0, which means the chain needs to be sustainable for another 5-10 years."*
>
> - Source: Ethhub.io

The launch of Ethereum phase 0 (Serenity) in early 2020 is likely to be a speculative price driver as opposed to a fundamental one. It is unlikely to have an impact on Ethereum's network capacity or utilization limit until at least the phase 1 launch. However, as with conventional markets, a successful Serenity launch in 2020 with appropriate guidance and tracking on scalability deliverables, will allow investors to 'price' the expected future scalability, i.e. more developers and users, into the ETH price.

Seasonal Investment Cycles

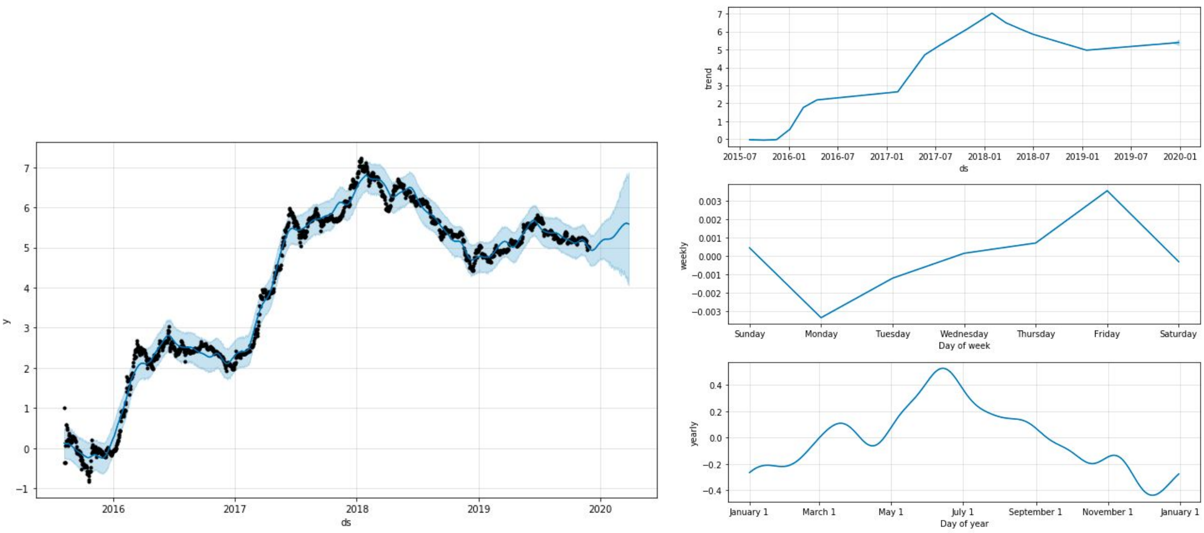
Introduction

Like many financial or commodity assets, digital assets have seasonal characteristics. These seasonalities offer the investor an opportunity to understand market gyrations and potential risks. To understand Ethereum's seasonality, we must use a semi-robust time series model on the natural logarithm (log) of Brave New Coin's Ethereum Liquid Index (ELX), which breaks down the price components into three buckets:

1. Log Price
2. 30 day Volatility
3. Price Return, i.e. first difference change in price

Price Seasonality

The first chart (left) is the historical log price distribution of the ELX, including a rudimentary 120 day price forecast with 95% confidence intervals. The mean forecast of $265 offers a bullish Q1 2020 scenario. Note: the goal is not to produce correct price forecasts, but rather generate a potential range based upon historical characteristics. The second chart (top right) is the historical trend of log price, which shows a positive linear trend of ETH since inception, despite the recent weakness. The third chart (middle right) shows the weekly trend of log price, which exhibits an increasing trend until the weekends. The last chart (bottom right) is the yearly trend breakdown, and articulates more bullish periods for ELX price from Q1 to Q2 before gradually diminishing from Q3 onward.

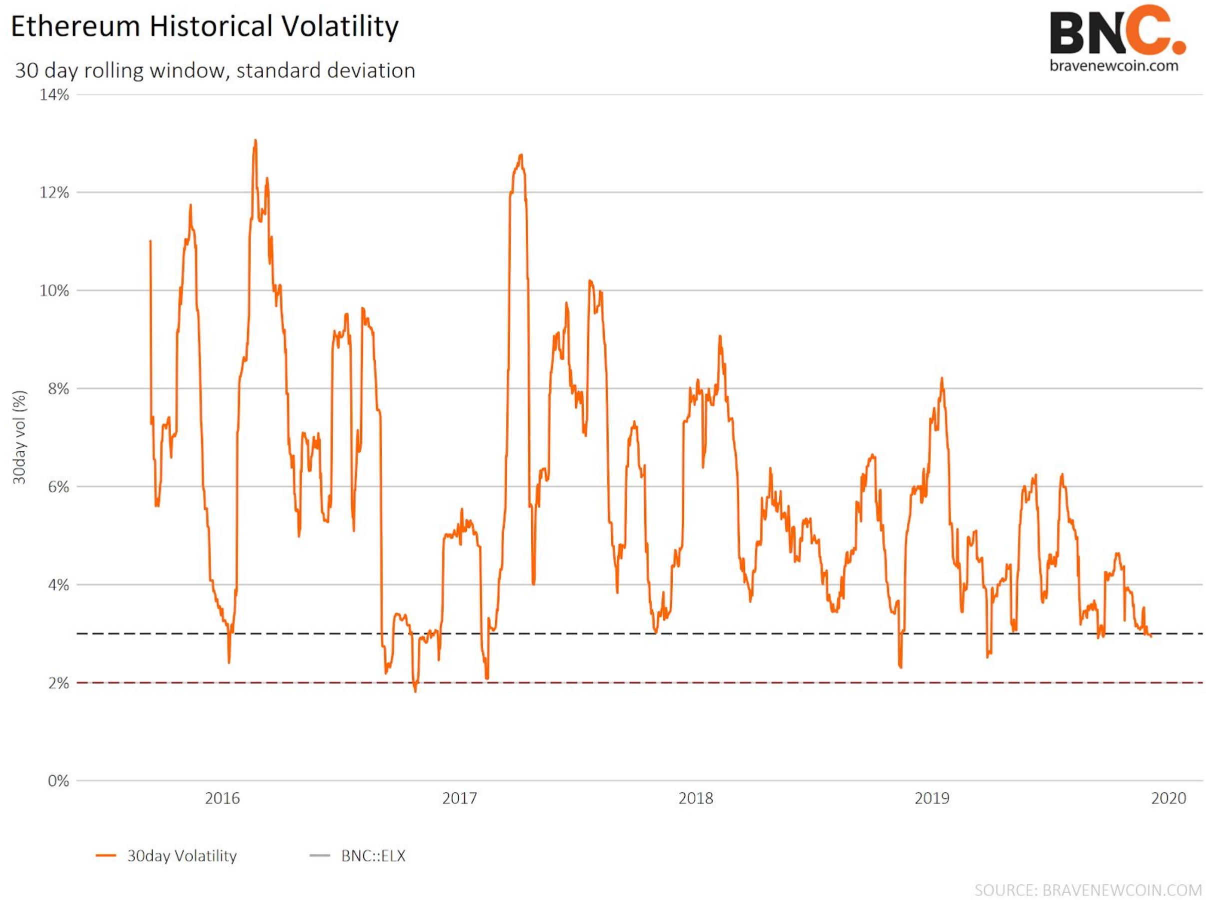


* Souce: Brave New Coin

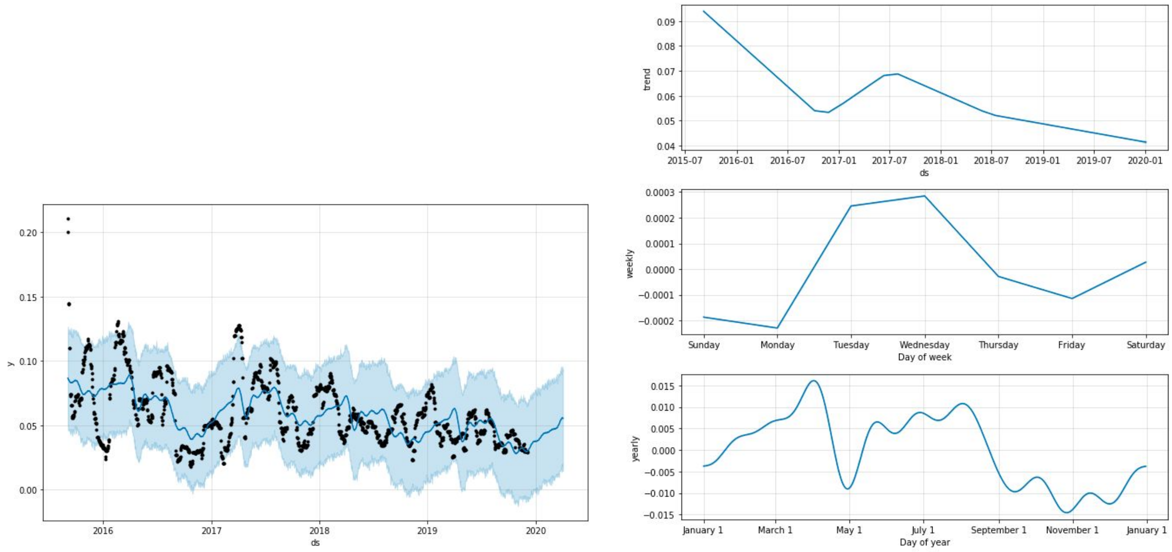
Volatility Seasonality

The chart below plots the 30-day moving average (MA) of ELX's daily price volatility. There are two primary levels which ignite large volatility spikes, 2% (red dash) and 3% (black dash). Historically, the 2% level has produced the largest spikes, but volatility has yet to fall that low in 2019. Furthermore, the recent volatility surges witnessed throughout Q4 2019 have all originated from the 3% level.

At the time of writing, ELX 30-day volatility is sitting at ~3%, which could signal that another spike is on the horizon.



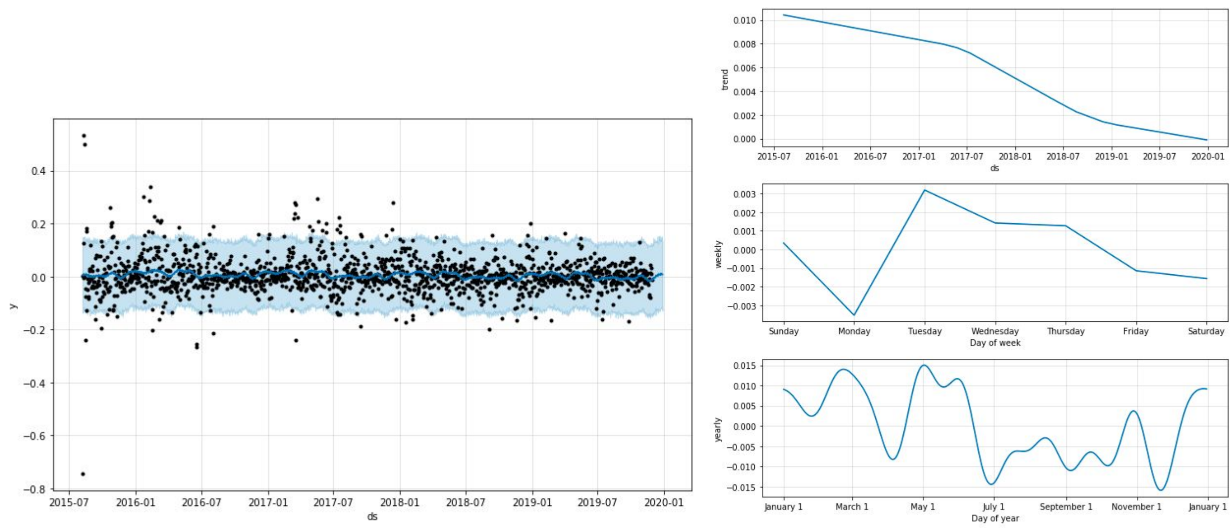
The first chart is a rudimentary 120 day forecast with 95% confidence intervals of ELX 30 day volatility, which tells a similar story as above - an increase in volatility is likely in the near term. The second chart is the historical trend and shows diminishing volatility since inception, which is common among maturing commodity assets. The third chart shows the weekly trend of volatility with large moves earlier in the week before dampening down into the weekend. The last chart is the yearly trend breakdown and articulates more volatile periods from Q1 to Q2, which makes the recent spikes historically uncharacteristic.



*Source: Brave New Coin

Price Return Seasonality

The first chart is the historical price return distribution of ELX, which shows a fairly wide, but compressing band of daily returns. The second chart is the historical trend and shows diminishing returns since inception, which is common among maturing commodity assets. The third chart shows a steady decline in return size, onward from Tuesday. The last chart is the yearly trend breakdown, which articulates historically higher return periods from Q1 to Q2, and diminishing returns from Q3 onward.



*Source: Brave New Coin

Hurst Exponent Analysis

Introduction

The Hurst exponent (H) is rooted in mathematics founded by Benoit Mandelbrot, to determine if a financial market is trending or not. The Hurst exponent, H, has a value range from 0 to 1.

- H > 0.5 – Market persistence, i.e. trending market
- H = 0.5 – No persistence, i.e. random walk market
- H < 0.5 – Anti-persistence, i.e. mean reverting market

There are several ways to calibrate the Hurst exponent and we use a proprietary calibration that can be an early indicator of price inflection points for digital assets like Ethereum. Interestingly, our analysis uncovered an opposite dynamic compared to the traditional theory articulated above.

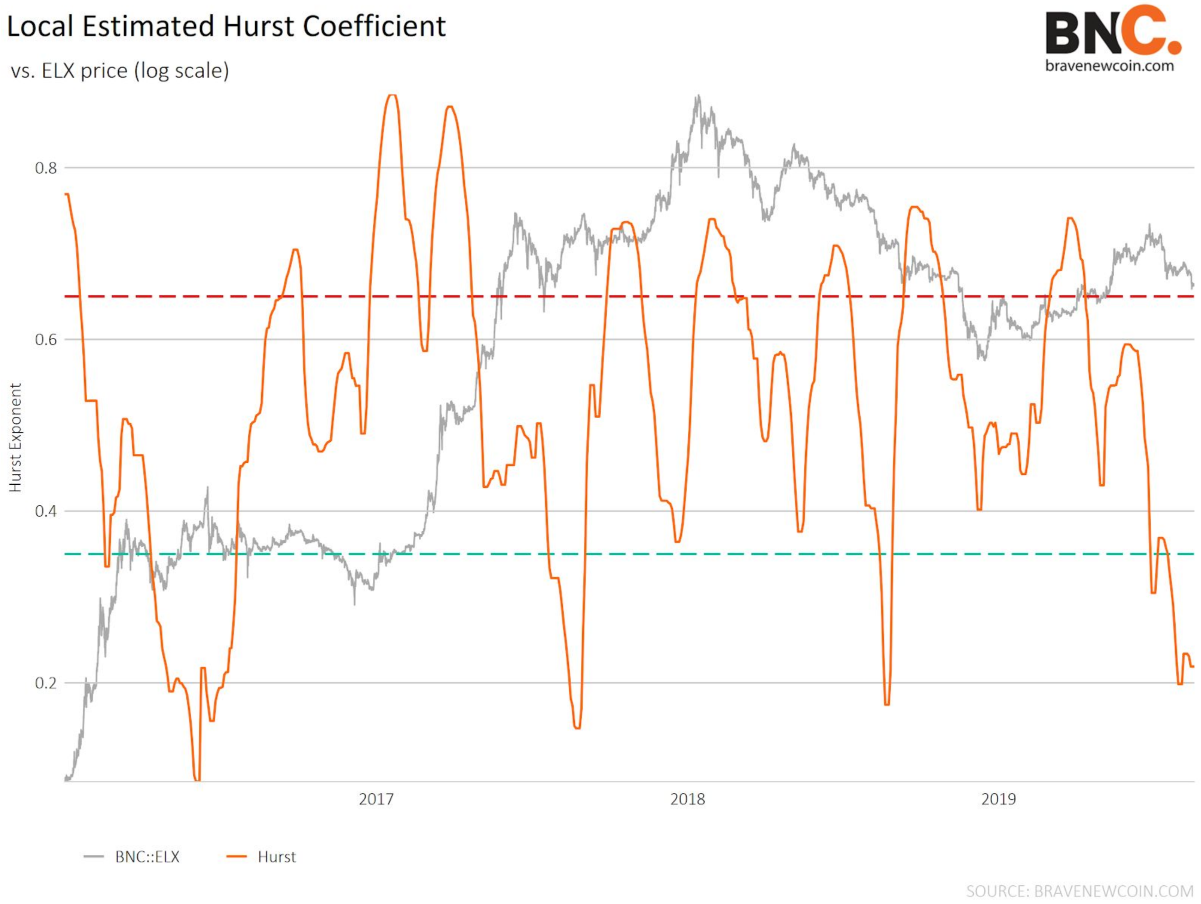
- Hurst > 0.65 – Signals a price decline is forthcoming (sell range)
- Hurst < 0.35 – Signals a price increase is forthcoming (buy range)

Hurst Exponent for Ethereum

If we analyze the chart below by observing when Hurst (orange line) enters either buy or sell ranges, then follows the resulting price trend (grey line), we can see it is a fairly consistent leading indicator for price movements; especially large inflection points.

Graph Legend:

- Historical plot (2016 to 2019) of Ethereum price (grey line)
- Hurst exponent (orange line)
- Level beneath 0.35, i.e. buy range (green line)
- Level above 0.65, i.e. sell range (red line)



*Source: Brave New Coin, Blocktap.io

Cautionary Note: In 2018, Ethereum offered a head fake with a Hurst in the buy range, but quickly saw that opportunity reverse into the sell range, which inevitably signaled the coming large drop in November 2018. Furthermore, the ETH 2019 price recovery began without Hurst entering the buy range. But, Hurst did signal the coming “summer price top” and subsequent decline beginning in Q3 2019.

As with all quantitative tools, Hurst is not a “silver bullet,” thus requires pairing with other information sources or analytics to enhance accuracy. One additional source of information to increase the reliability of Hurst is hourly estimated volatility.

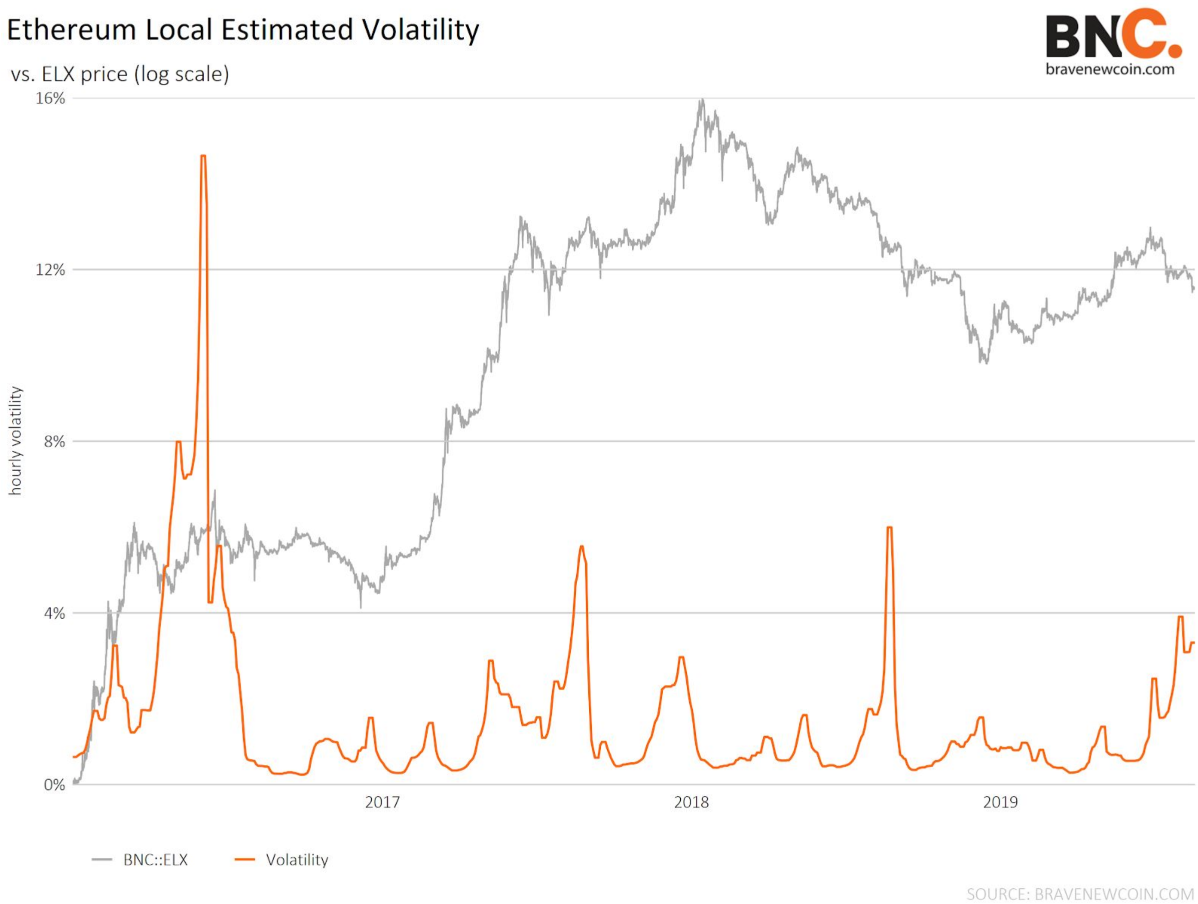
Estimated Hourly Volatility for Ethereum

The highest probability signal is when Hurst is firmly in either sell or buy range, and volatility is very low, i.e. ~0.50% or lower. However, analysis of estimated hourly volatility chart is a bit more nuanced. For example, hourly volatility can still be high, i.e. above 3%, and price can still move firmly upward or downward as volatility compresses back towards 0.50%.

The aforementioned provides a weaker signal because price could follow or reverse the previous trend put forth by the volatility spike. Thus, the confluence of Hurst + volatility (low Hurst + low volatility, vice versa) produces a higher probability signal whereas the former example (low Hurst + high volatility, vice versa) produces a lower probability signal.

Graph Legend:

- Historical plot (2016 to 2019) of Ethereum price (grey line)
- Hourly estimated volatility (orange line)



*Source: Brave New Coin, Blocktap.io

Current Hurst Reading for Ethereum

The current Hurst exponent value is 0.22, which is firmly in the buy range, but only showing a slight sign of recovery. The low Hurst value potentially signals that a pronounced up move in price for Ethereum is on the horizon, which aligns with our seasonal analysis. Note: one point of caution is that price and Hurst values can stay depressed for an extended period of time or even decrease further from current levels.

Current Estimated Volatility Reading for Ethereum

The current hourly estimated volatility is 3.31% and beginning to compress slightly. As stated prior, price can still find itself in a pronounced trend (bull or bear) as volatility marches back towards 0.50%. Thus, the current estimated hourly volatility reading is less valuable. Note: A risky interpretation would be to assume that given Hurst is demonstrably in the buy range, that price will trend upwards as volatility diminishes.

Conclusion

The combination of Hurst and hourly estimated volatility offers a weak BUY signal for Ethereum currently. Price and Hurst can remain depressed for an extended time period, which makes any buy decision without a verifiable turnaround catalyst or confirmed Hurst recovery, a risky bet.

Potential Turnaround Catalyst

As mentioned in the previous section, to increase the reliability of the weak BUY signal, Ethereum requires a turnaround catalyst that will increase the probability of correctness. Albeit less robust than quantitative methods, certain technical analysis indicators are currently offering such a catalyst.

The volume flow indicator (VFI) and relative strength index (RSI) are both flashing a potential bottoming of price, in the near term. In the picture below, ETH price has strongly decreased in November whereas VFI has bounced twice off the support level of -22, and has since been trending upward towards 0. This divergence between price and VFI is one of the strongest buy signals for this indicator, albeit slightly premature. If VFI were to rise above 0, that would confirm a bottom and the beginning of a new uptrend in the near term.

Additionally, RSI is recovering from very oversold levels and currently producing an uptrend from 30. If the positive trend in RSI persists, positive momentum has a lot of room to run before reaching oversold levels near 70.

If VFI can rise above 0 and RSI can maintain its uptrend, the combination of both indicators provide a strong catalyst for an ETH price recovery, beginning December 2019 and into Q2 2020.

Statistical Price Drivers

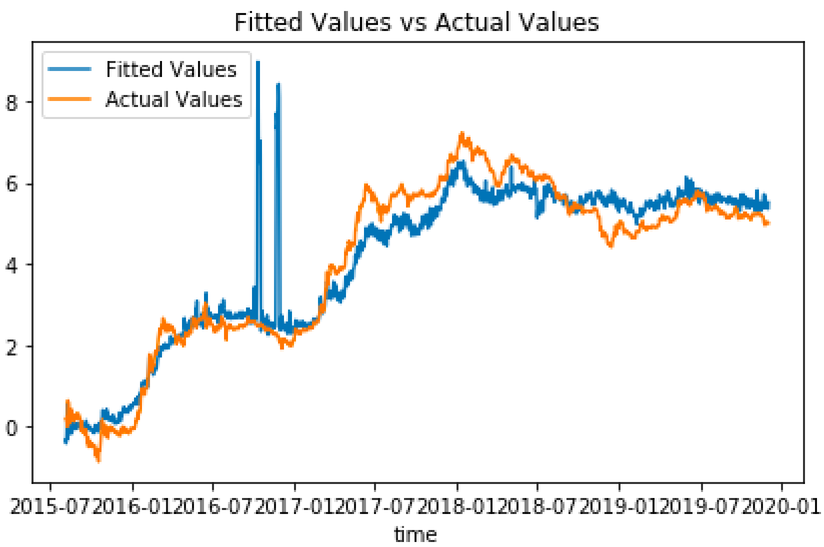
Introduction

The previous sections have painted a picture where Ethereum's price appears biased to the upside in the near term. However, as with all assets, fundamentals will ultimately drive the price trajectory in the long run. To fully understand the potential price implications for ETH now and in the future, we must analyze the key fundamental metrics driving price.

Price to Active Addresses

As used in our prior bitcoin research report, we leverage an ordinary least squares (OLS) regression model to articulate the strength of the relationship between price and active addresses, i.e. a demand. Furthermore, we validate the proper utilization of OLS assumptions by testing for cointegration between the natural logarithm of ELX and active addresses.

Leveraging the cointegration framework (originally used by Marcel Burger[1]) and Coinmetrics' data, we verified that active addresses is cointegrated to the price of Ethereum with a 90% confidence level[2]. Verifying cointegration allows the OLS model to be used to describe price relationships between the two variables, which boasts an R2 equal to 0.88, i.e. a strong fit, evidenced by the plot of fitted versus actual values of the natural logarithm of Ethereum price.



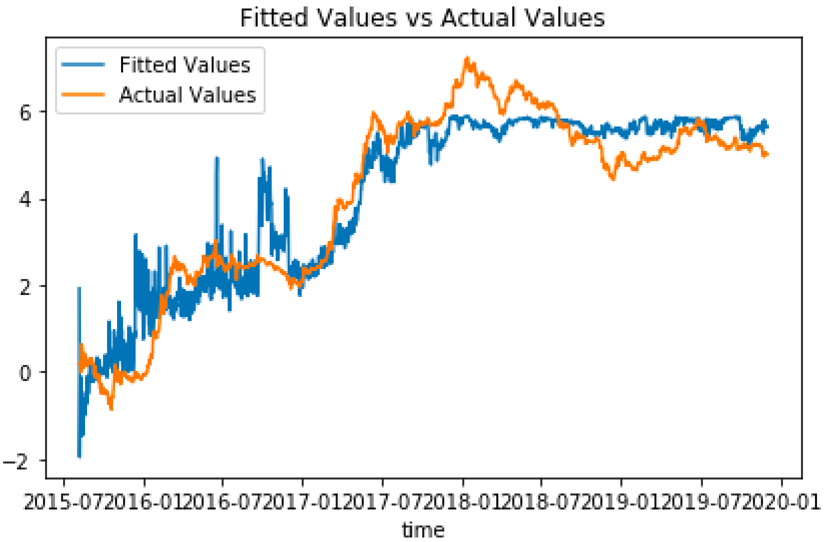
*Source: Brave New Coin, Coinmetrics.io

[1] https://medium.com/burgercrypto-com/reviewing-modelling-Ethereums-value-with-scarcity-part-ii-the-hunt-for-cointegration-66a8dcedd7ef

[2] See appendix for full cointegration analysis

Price to Network Capacity Utilization

Piggybacking off the analysis from sections "Transition from 1.0 to 2.0" and "Beacon," we use the cointegration framework and Coinmetrics' data to verify that network capacity is cointegrated to the price of Ethereum with a 95% confidence level[3]. Verifying cointegration allows the OLS model to be used to describe price relationships between the two variables, which boasts an R2 equal to 0.88, i.e. a strong fit, evidenced by the plot of fitted versus actual values.

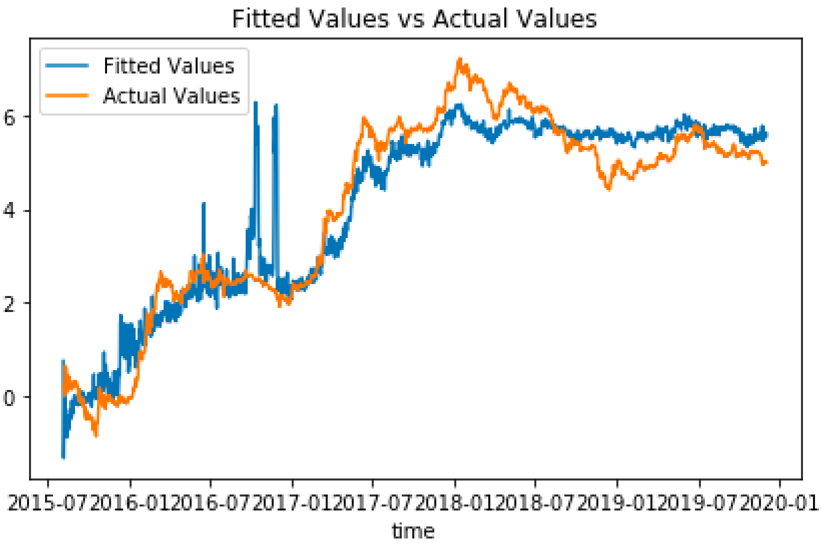


*Source: Brave New Coin, Coinmetrics.io, Etherscan.io

Price to Active Addresses and Network Capacity

We create a multivariate OLS model where the independent variables are active addresses and network capacity, both cointegrated to price, and boasts an R2 equal to 0.90, i.e. a strong fit, evidenced by the plot of fitted versus actual values.

[3] See appendix for full cointegration analysis



*Source: Brave New Coin, Coinmetrics.io, Etherscan.io

The multivariate OLS model and cointegration between active addresses and network capacity[4] assert that*Ethereum's price is currently capped by its network capacity because it restrains active address growth, i.e. demand. For ETH's price to sustainably increase over the long term, network capacity must be enhanced.*

Summary

Ethereum has had a wild ride in 2019 with future gyrations likely given the multi-year rollout of Ethereum 2.0. However, a successful Serenity launch in 2020, with appropriate scalability guidance, may allow investors to 'price' the expected future network growth into ETH, which could be sizeable given its head start in commercial Web 3.0 applications.

Additionally, our analysis in the "Seasonality" and "Hurst" sections, corroborates the likelihood of a coming speculative 'pricing' boost for ETH from now until Q2 2020.

However, as noted in the "Statistical Price Driver" section, sustainable, long term price appreciation for Ethereum will be capped until network capacity constraints are resolved, which is unlikely to occur until at least phase 1 launch, i.e. ~1-2 years. Furthermore, if the transition to 2.0 becomes disorderly and fractures the community, the price ramifications could be catastrophic.

1.1 For educational purposes only. This is not investment advice nor a recommendation or solicitation of any kind.

[4] See appendix for full cointegration analysis

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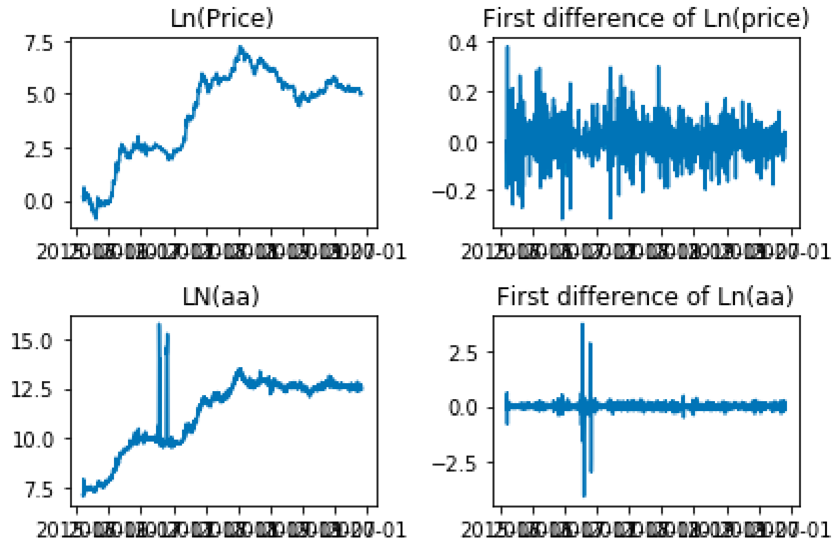
Appendix

PRICE TO ACTIVE ADDRESSES COINTEGRATION

1. Determining if both time series are Stationary visually, which both appear to be, Engle Granger test.



2. Confirming the above Stationary assumption by performing the Augmented Dickey-Fuller (ADF) test on both time series (Engle Granger test). Both p values are ~0.00, which are highly significant, thus we can reject the null hypothesis that the time series are not Stationary, i.e. appropriate to perform OLS regression.

First order difference of ln(price)

ADF Statistic: -6.938761

p-value: 0.000000

Critical Values:

1%: -3.435
5%: -2.863
10%: -2.568

First order difference of ln(aa)

ADF Statistic: -11.657053

p-value: 0.000000

Critical Values:

- 1%: -3.435
- 5%: -2.863
- 10%: -2.568

3. Ordinary Least Squares Regression results with Adjusted R2 = 0.88 and ln_aa coefficient = 1.07.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:               ln_price   R-squared:                       0.877
Model:                            OLS   Adj. R-squared:                  0.877
Method:                 Least Squares   F-statistic:                 1.121e+04
Date:                Wed, 04 Dec 2019   Prob (F-statistic):               0.00
Time:                        17:20:38   Log-Likelihood:                -1744.6
No. Observations:                1578   AIC:                             3493.
Df Residuals:                    1576   BIC:                             3504.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept     -7.9305      0.115    -69.021      0.000      -8.156      -7.705
ln_aa          1.0712      0.010    105.885      0.000       1.051       1.091
==============================================================================
Omnibus:                     1325.174   Durbin-Watson:                   0.119
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            52000.641
Skew:                          -3.690   Prob(JB):                         0.00
Kurtosis:                      30.137   Cond. No.                         71.4
==============================================================================
```

4. Running the Durbin-Watson test on regression residuals must be above 0 to confirm that the two variables are cointegrated. The Durbin_Watson test result is above 0, thus existence of Cointegration

0.11887059728356714

5. Running the Augmented Dickey-Fuller test (Engle Granger test) on residuals, i.e. if residuals are non-stationary, then the time series are not cointegrated. The p value significance is greater than the 99% confidence level, which means the time series are cointegrated.

Regression residuals

ADF Statistic: -3.815581

p-value: 0.002752

Critical Values:
1%: -3.435
5%: -2.863
10%: -2.568

6. Johansen test for Cointegration, i.e. if both test statistics (Trace and Maximum Eigenvalue) are higher than the critical values, we have to reject the null hypothesis of no Cointegration. Both test statistics are above the significance critical values, 99% and 90% confidence levels, respectively. Thus, we have to reject the null hypothesis of no Cointegration.

Trace Statistic:

[88.88456775 3.72534286]

Critical Values Trace Statistic [90% 95% 99%]:

[[13.4294 15.4943 19.9349]

[2.7055 3.8415 6.6349]]

Maximum Eigenvalue Statistic

[85.15922489 3.72534286]

Critical Values Maximum Eigenvalue Statistic [90% 95% 99%]

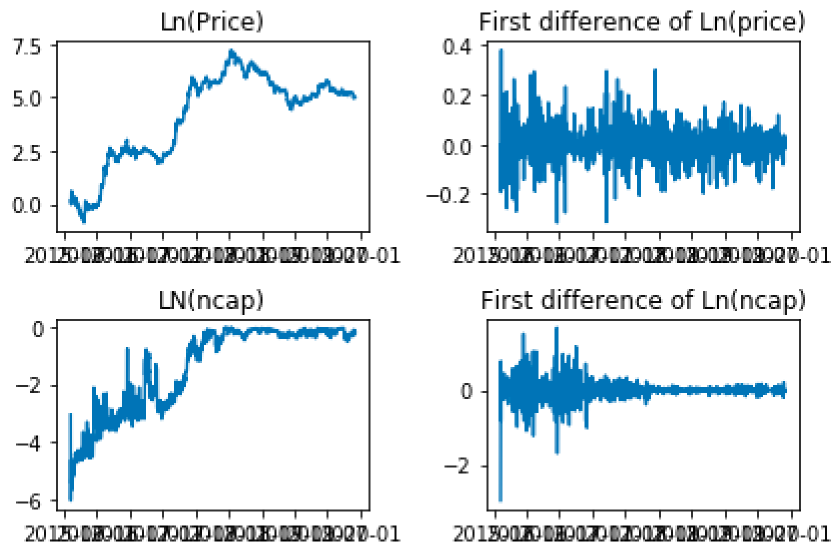
[[12.2971 14.2639 18.52]

[2.7055 3.8415 6.6349]]

7. We performed three separate statistical tests of Cointegration, i.e. Engle Granger, Durbin-Watson, and Johansen. The results of all three tests show statistical evidence (greater than 90% confidence) that Cointegration does exist between Ethereum price and active addresses.

ACTIVE ADDRESSES TO NETWORK CAPACITY COINTEGRATION

1. Determining if both time series are Stationary visually, which both appear to be, Engle Granger test.



2. Confirming the above Stationary assumption by performing the Augmented Dickey-Fuller (ADF) test on both time series (Engle Granger test). Both p values are ~0.00, which are highly significant, thus we can reject the null hypothesis that the time series are not Stationary, i.e. appropriate to perform OLS regression.

First order difference of ln(price)

ADF Statistic: -6.938761

p-value: 0.000000

Critical Values:

1%: -3.435
5%: -2.863
10%: -2.568

First order difference of ln(ncap)

ADF Statistic: -8.893002

p-value: 0.000000

Critical Values:
1%: -3.435
5%: -2.863
10%: -2.568

3. Ordinary Least Squares Regression results with Adjusted R2 = 0.879 and ln_ncap coefficient = 1.30.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:               ln_price   R-squared:                       0.879
Model:                            OLS   Adj. R-squared:                  0.879
Method:                 Least Squares   F-statistic:                 1.144e+04
Date:                Wed, 04 Dec 2019   Prob (F-statistic):               0.00
Time:                        17:33:11   Log-Likelihood:                -1730.6
No. Observations:                1578   AIC:                             3465.
Df Residuals:                    1576   BIC:                             3476.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept      5.9162      0.025    236.020      0.000       5.867       5.965
ln_ncap        1.3041      0.012    106.955      0.000       1.280       1.328
==============================================================================
Omnibus:                      110.301   Durbin-Watson:                   0.161
Prob(Omnibus):                  0.000   Jarque-Bera (JB):              144.995
Skew:                          -0.612   Prob(JB):                     3.27e-32
Kurtosis:                       3.841   Cond. No.                         3.18
==============================================================================
```

4. Running the Durbin-Watson test on regression residuals must be above 0 to confirm that the two variables are cointegrated. The Durbin_Watson test result is above 0, thus existence of Cointegration.

0.160743498722226762

5. Running the Augmented Dickey-Fuller test (Engle Granger test) on residuals, i.e. if residuals are non-stationary, then the time series are not cointegrated. The p value significance is greater than the 95% confidence level, which means the time series are cointegrated.

Regression residuals

ADF Statistic: -3.234674

p-value: 0.018063

Critical Values:
1%: -3.435
5%: -2.863
10%: -2.568

6. Johansen test for Cointegration, i.e. if both test statistics (Trace and Maximum Eigenvalue) are higher than the critical values, we have to reject the null hypothesis of no Cointegration. Both test statistics are above the significance critical values, 99% and 95% confidence levels, respectively. Thus, we have to reject the null hypothesis of no Cointegration.

Trace Statistic:

[54.8734614 3.91081645]

Critical Values Trace Statistic [90% 95% 99%]:

[[13.4294 15.4943 19.9349]

[2.7055 3.8415 6.6349]]

Maximum Eigenvalue Statistic

[50.96264495 3.91081645]

Critical Values Maximum Eigenvalue Statistic [90% 95% 99%]

[[12.2971 14.2639 18.52]

[2.7055 3.8415 6.6349]]

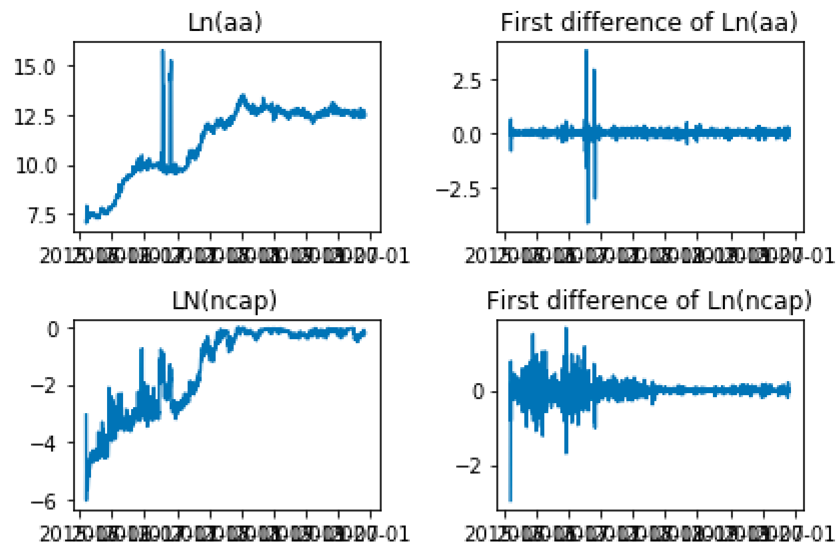
7. We performed three separate statistical tests of Cointegration, i.e. Engle Granger, Durbin-Watson, and Johansen. The results of all three tests show strong statistical evidence (greater than 95% confidence) that Cointegration does exist between Ethereum price and stock to flow ratio.

MULTIVARIATE OLS REGRESSION RESULTS

```
                            OLS Regression Results
==============================================================================
Dep. Variable:               ln_price   R-squared:                       0.900
Model:                            OLS   Adj. R-squared:                  0.900
Method:                 Least Squares   F-statistic:                     7065.
Date:                Wed, 04 Dec 2019   Prob (F-statistic):               0.00
Time:                        17:56:45   Log-Likelihood:                -1582.0
No. Observations:                1578   AIC:                             3170.
Df Residuals:                    1575   BIC:                             3186.
Df Model:                           2
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept     -0.9630      0.381     -2.525      0.012      -1.711      -0.215
ln_ncap        0.6844      0.036     18.985      0.000       0.614       0.755
ln_aa          0.5357      0.030     18.071      0.000       0.478       0.594
==============================================================================
Omnibus:                      503.186   Durbin-Watson:                   0.112
Prob(Omnibus):                  0.000   Jarque-Bera (JB):             2723.506
Skew:                          -1.389   Prob(JB):                         0.00
Kurtosis:                       8.806   Cond. No.                         265.
==============================================================================
```

ACTIVE ADDRESSES TO NETWORK CAPACITY COINTEGRATION

1. Determining if both time series are Stationary visually, which both appear to be, Engle Granger test.



2. Confirming the above Stationary assumption by performing the Augmented Dickey-Fuller (ADF) test on both time series (Engle Granger test). Both p values are ~0.00, which are highly significant, thus we can reject the null hypothesis that the time series are not Stationary, i.e. appropriate to perform OLS regression.

First order difference of ln(aa)

ADF Statistic: -11.657053

p-value: 0.000000

Critical Values:
1%: -3.435
5%: -2.863
10%: -2.568

First order difference of ln(ncap)

ADF Statistic: -8.893002

p-value: 0.000000

Critical Values:
1%: -3.435
5%: -2.863
10%: -2.568

3. Ordinary Least Squares Regression results with Adjusted R2 = 0.90 and ln_cap coefficient = 1.16.

```
                            OLS Regression Results
==============================================================================
Dep. Variable:                  ln_aa   R-squared:                       0.905
Model:                            OLS   Adj. R-squared:                  0.905
Method:                 Least Squares   F-statistic:                 1.504e+04
Date:                Thu, 05 Dec 2019   Prob (F-statistic):               0.00
Time:                        11:10:08   Log-Likelihood:                -1325.5
No. Observations:                1578   AIC:                             2655.
Df Residuals:                    1576   BIC:                             2666.
Df Model:                           1
Covariance Type:            nonrobust
==============================================================================
                 coef    std err          t      P>|t|      [0.025      0.975]
------------------------------------------------------------------------------
Intercept     12.8413      0.019    662.251      0.000      12.803      12.879
ln_ncap        1.1569      0.009    122.654      0.000       1.138       1.175
==============================================================================
Omnibus:                      848.303   Durbin-Watson:                   0.292
Prob(Omnibus):                  0.000   Jarque-Bera (JB):            26695.286
Skew:                           1.915   Prob(JB):                         0.00
Kurtosis:                      22.782   Cond. No.                         3.18
==============================================================================
```

4. Running the Durbin-Watson test on regression residuals must be above 0 to confirm that the two variables are cointegrated. The Durbin_Watson test result is above 0, thus existence of Cointegration.

0.2916145466658062

5. Running the Augmented Dickey-Fuller test (Engle Granger test) on residuals, i.e. if residuals are non-stationary, then the time series are not cointegrated. The p value significance is greater than the 99% confidence level, which means the time series are cointegrated.

Regression residuals

ADF Statistic: -5.123773

p-value: 0.000013

Critical Values:
  1%: -3.435
  5%: -2.863
  10%: -2.568

6. Johansen test for Cointegration, i.e. if both test statistics (Trace and Maximum Eigenvalue) are higher than the critical values, we have to reject the null hypothesis of no Cointegration. Both test statistics are well above the 99% confidence level critical values, thus we have to reject the null hypothesis of no Cointegration.

Trace Statistic:

[141.0390256 7.69291054]

Critical Values Trace Statistic [90% 95% 99%]:

[[13.4294 15.4943 19.9349]

[2.7055 3.8415 6.6349]]

Maximum Eigenvalue Statistic

[133.34611506 7.69291054]

Critical Values Maximum Eigenvalue Statistic [90% 95% 99%]

[[12.2971 14.2639 18.52]

[2.7055 3.8415 6.6349]]

7. We performed three separate statistical tests of Cointegration, i.e. Engle Granger, Durbin-Watson, and Johansen. The results of all three tests show statistical evidence (greater than 99% confidence) that Cointegration does exist between active addresses and network capacity.

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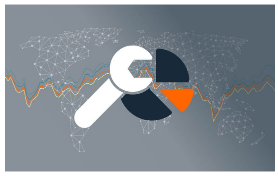

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