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August 2018

DRW Venture Capital

Fundamental Valuation of Cryptoassets

Generic Approaches to Valuation

Cryptoasset valuation applies specialized versions of traditional valuation methods

Cost Approach	• Based on the substitution principle that a reasonable buyer will not pay more for an asset than it would cost to acquire or create an asset with comparable utility • Business valuation: Typically involves adjusting balance sheet items to adjust assets and liabilities to market values • Cryptoasset valuation: Must consider cost to replicate code, which is trivial, and costs to incentivize developer activity and other network effects, which may be material
Market Approach	• Also based on the substitution principle, the market approach compares the subject asset to similar assets, e.g. resulting in a ratio of value to an operating or financial metric • Business valuation: Publicly traded companies or acquisition transactions evaluated to provide multiples such as EV / EBITDA or EV / revenue • Cryptoasset valuation: Analogous multiples include network value to transactions (NVT) or network value to Metcalfe (NVM) ratios
Income Approach	• Closest to pure theory, the income approach values an asset based on the present value of all future benefits derived from owning the asset • Business valuation: Dividends or other income streams are forecasted and discounted at a market-based rate • Cryptoasset valuation: Cryptoassets typically do not have income streams, so future benefits are estimated based on expected utility value or the Fisher Equation, MV = PT

Note: See, for example, course materials for "BV201: Introduction to Business Valuation Part 1" prepared by the American Society of Appraisers, for a discussion of the three generic approaches to valuation

Valuation Context

Valuation process should coexist with pricing and strategic analyses

1. Pricing ≠ valuation

- Price is driven by market mood/momentum, incremental information, and liquidity
- Value is driven by fundamentals, i.e. the ability to generate cash flow or provide utility
- There are different views on the persistence of gaps between price and value, but complete analysis should include both pricing and valuation metrics

2. Tokenized securities may use more traditional valuation methods

- This presentation focuses on valuing tokens in three broad use cases: network backbone / virtual machine (e.g. Ethereum), distributed applications, and monetary stores of value
- Tokens representing ownership of a traditional asset, e.g. real estate or a percentage of company revenues, can be valued with the typical methods for the underlying asset

3. Valuation and strategic analyses are inextricably linked

- Application of cost, market, and income approaches must also include a strategic evaluation of the project
- Analysis of market need, decentralization edge, community/developer activity, technical comparison to other blockchains, etc. will all impact valuation variables

Note: See, for example, http://people.stern.nyu.edu/adamodar/pdfiles/country/valueversuspriceShort.pdf for a discussion of price vs. value

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Cost Approach

Cost to Replicate Crypto Project

Cost Approach

Cost approach is of limited use but highlights some sources of network value

- Cost approaches, also known as asset-based approaches, are based on the substitution principle that a reasonable buyer will not pay more for an asset than it would cost to acquire or create an asset with comparable utility
- In traditional assets, cost approaches can be particularly useful for valuing investments or real estate holding companies and businesses based on a liquidation scenario
- Cost approaches are more difficult to apply when intangible value is a greater portion of total value, which is often the case for crypto projects with network effects from developer communities, dApps built on a given platform, integrations with other services, etc.
- For this reason, cost approaches are not appropriate to valuing the vast majority of crypto projects

CASE STUDY: Bitcoin Cash

- Bitcoin Cash was the result of an August 2017 hard fork of the Bitcoin network that increased block size and therefore transaction throughput
- At the time of the fork, anyone owning Bitcoin also owned the same number of Bitcoin Cash coins
- Despite technical similarities and the same initial coin distribution, Bitcoin Cash has traded at less than 25% of the price of Bitcoin, averaging ~0.1258 BTC/BCH
- Bitcoin Cash illustrates that although cost to fork a project is low, it is difficult to replicate the network effects derived from a community of developers, miners, etc.

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Market Approach

Cryptoasset Ratio Analysis

Cryptoasset Ratio Analysis

Compare relative network values based on readily observable value drivers

- **Overview**
  - Market approaches are based on the substitution principle and rely on comparing network value / market cap to readily observable value drivers for other cryptoassets or for the same cryptoasset over time
  - Network value to transactions (NVT) is the most commonly discussed ratio for valuing cryptoassets, and network value to Metcalfe (NVM) provides another indication of value
- **Advantages**
  - Direct method of valuation if similar assets can be found for comparison
  - Ratio analysis relies on metrics that are generally observable
- **Disadvantages**
  - Can be difficult to find truly similar projects or to adequately adjust ratios to account for project differences
  - Ratio analysis is less detailed and farther from pure theory than income approaches (although the two approaches should produce consistent results when properly applied)

Network Value to Transactions (NVT) Ratio

NVT, inverse of velocity, uses transaction volume as indicator of fair network value

Overview

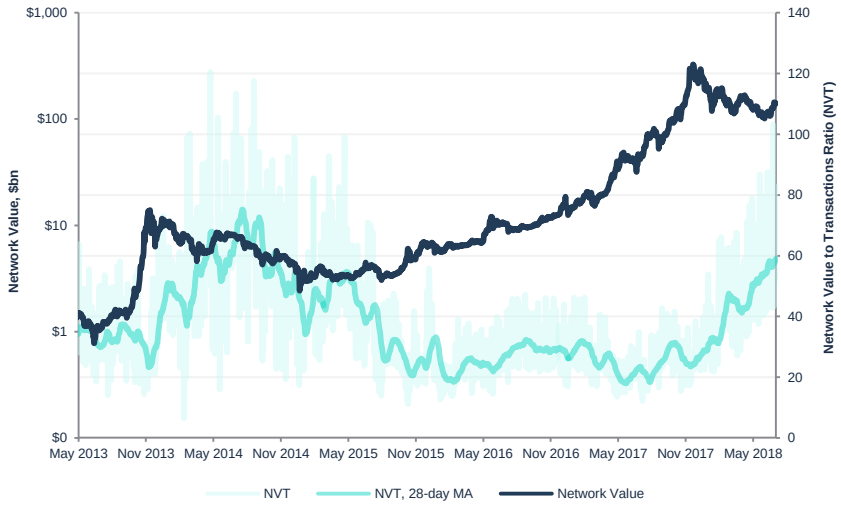
Definition & Theory

- NVT = Network Value / Daily Transaction Value
- Equivalently, NVT is the inverse of velocity
- Although cryptoassets do not have earnings or revenues like companies, transaction volume is a proxy for the utility that users derive from the network

Adjustments

- Transaction volume should exclude non-economic transactions, e.g. churn within exchanges
- On-chain, non-economic transactions may be material, but they are difficult to consistently separate from economic transactions
- Daily transaction volume is noisy, so it is often useful to smooth the metric with moving averages
- Calculating moving averages based on different time periods will affect the conclusions / utility of the metric
- Given the variety of possible adjustments, use the same source for comparisons across different cryptoassets

BTC Example



- 28-day MA NVT has averaged ~37 since May 2013
- BTC reached ATH of ~$1,152 on December 5, 2013. NVT was elevated during subsequent 83% correction through January 2015, peaking at 121 in May 2014
- Following ATH in January 2018, NVT remains >1 SD above 2013-2018 average
- Above uses data from Coinmetrics.io, which adjusts volume to remove non-economic transactions

Sources: https://woobull.com/introducing-nvt-ratio-bitcoins-pe-ratio-use-it-to-detect-bubbles/, https://medium.com/cryptolab/https-medium-com-kalichkin-rethinking-nvt-ratio-2cf810df0ab0, https://coinmetrics.io, https://coinmetrics.io/introducing-adjusted-estimates/

Network Value to Metcalfe (NVM) Ratio

NVM provides an indication of relative value based on active addresses

Overview

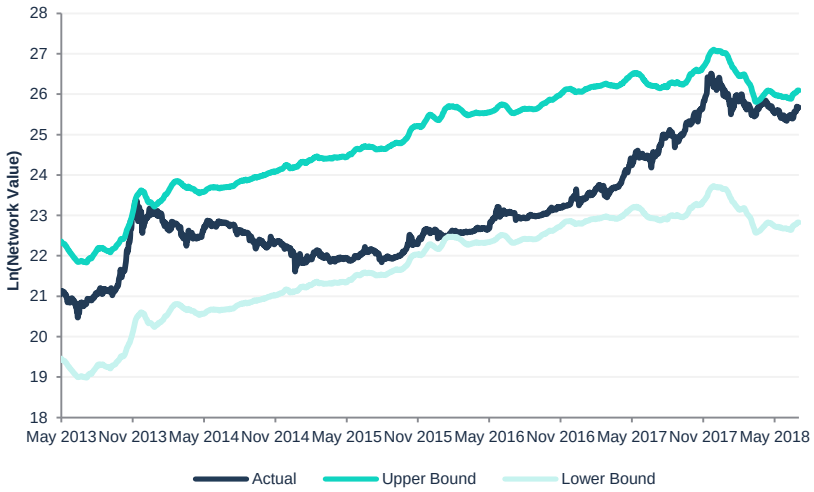
Definition & Theory

- Metcalfe's Law states that the value of a network is proportional to the square of the network nodes
- Because not all network connections are of equal value, others have suggested that network value is proportional to n • log n, known as Zipf's Law
- Ratio of actual network value to network value indicated by Metcalfe's or Zipf's Laws is an indicator of relative value; alternately, can use the two laws to determine range of plausible values

Calculation Details

- Upper Bound: $\ln(NV) < a_1 + b_1 * 28MA[\ln(n^2)]$
- Lower Bound: $\ln(NV) > a_2 + b_2 * 28MA[\ln(n*\ln(n))]$
- n is the number of active addresses in a given day
- 28MA represents taking the 28-day moving average of the indicated metric
- Constants a and b for each bound selected to provide the narrowest possible corridor

BTC Example



- Defining upper bound with Metcalfe's Law and lower bound with Zipf's law, BTC was relatively overpriced in late 2013 and relatively underpriced through 2015-2016
- Following correction in early 2018, BTC continues to trade near upper end of range as defined by Metcalfe's Law based on actual active addresses

Sources: https://medium.com/cryptolab/network-value-to-metcalfe-nvm-ratio-fd59ca3add76, https://spectrum.ieee.org/computing/networks/metcalfes-law-is-wrong/1, https://coinmetrics.io, https://coinmetrics.io/introducing-adjusted-estimates/

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Income Approach

Portfolio Competition with Gold & Fiat

Portfolio Competition with Gold & Fiat

Store of value use case with crypto replacing portion of gold, currency reserves

Overview

- Method to assess store of value function of cryptoassets based on projected future benefit
- Assumes that some portion of individuals and entities will substitute cryptocurrencies for foreign currency reserves, gold as a financial asset, and high inflation fiat currencies
- Apply method by:
  1. Forecasting applicable future aggregate demand
  2. Estimating share captured by cryptoasset over time
  3. Projecting cryptoasset supply curve
  4. Calculating projected prices in each future period
- Advantages: Simple to apply and relatively few key variables for sensitivity analysis
- Disadvantage: Does not consider utility other than store of value function

BTC Example

- Wedbush analysts Gil Luria and Aaron Turner published the first sell-side institutional research report covering BTC in December 2013
- Report, titled "Bitcoin: Intrinsic Value as Conduit for Disruptive Payment Network Technology," included the following application of the portfolio competition method:

Example Application of Portfolio Competition Method		
Global Foreign Currency Reserves, $mn	$	7,453,736
Money Supply in High-Inflation Countries, $mn		4,305,488
Gold as Financial Asset, $mn		1,900,000
Total Potential Aggregate Demand, $mn		$13,659,224
Penetration of Potential Demand		1.0%
BTC Market Cap at Full Adoption, $mn	$	136,592
Years to Achieving Peak Penetration		10
Est. 1-Year (2014) Market Cap, $mn	$	13,659
Est. 2014 BTC Supply, mn		13.1
1-Year (2014) BTC Price Target	**$**	**1,041**

Source: Luria, G. and Turner, A., "Bitcoin: Intrinsic Value as Conduit for Disruptive Payment Network Technology," Wedbush Securities, December 2013.

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Income Approach

Cryptoasset Equation of Exchange

Cryptoasset Equation of Exchange

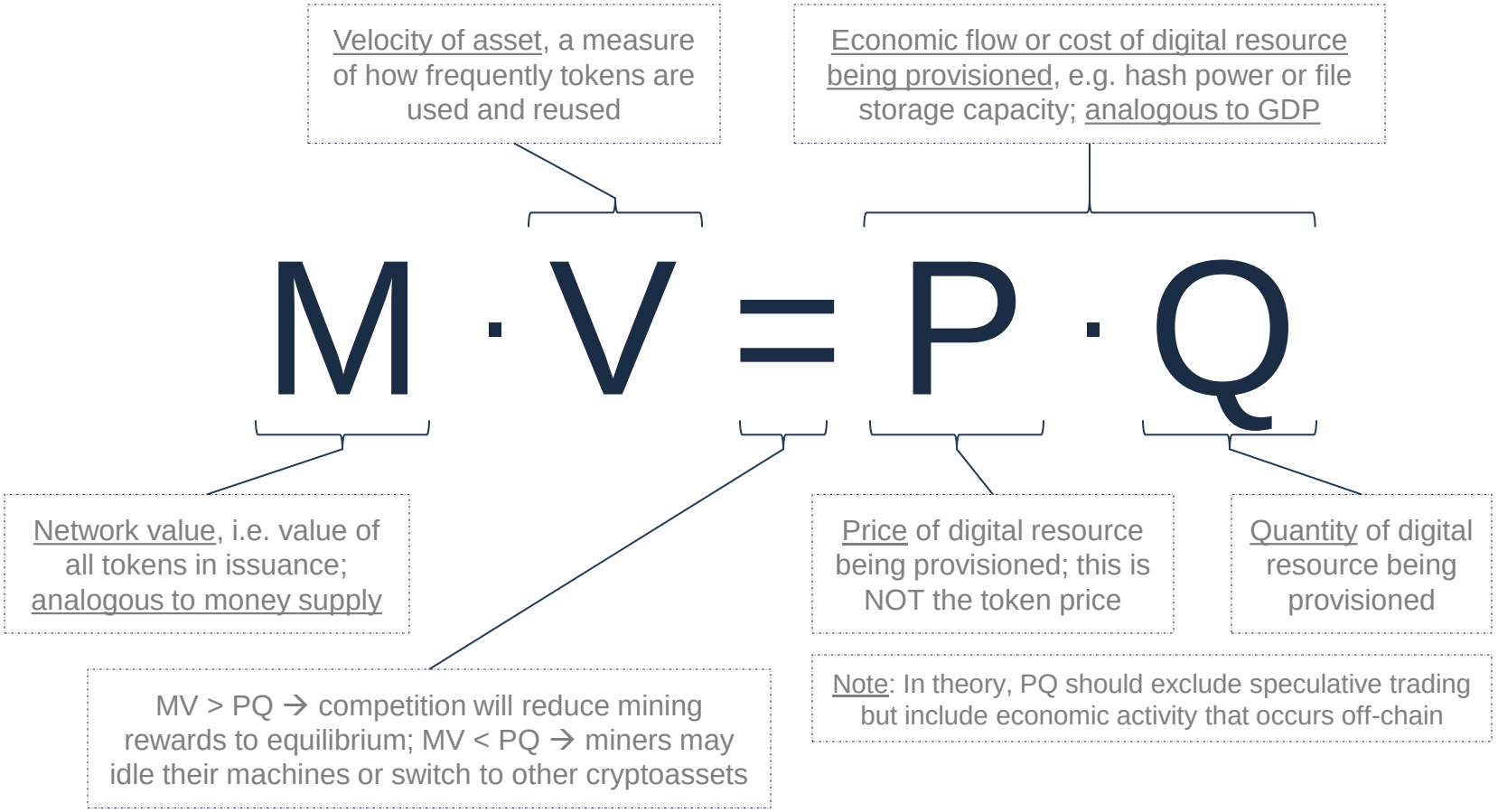
Modified equation of exchange to value crypto utility other than as store of value

- **Overview**
  - Cryptocurrency functions other than as a store of value require more nuanced valuation approaches
  - Equation of exchange, MV = PQ, underlies monetarist economic theory and relates money supply (M) and velocity/turnover of money (V) with average price level (P) and quantity of goods and services produced (Q)
  - Cryptoasset protocols are analogous to simplified economies, with “GDP” equal to the aggregate costs of the resource of the resource being provisioned. In other words, PQ represents the exchange of value in a crypto-economy
- **Advantages**
  - Flexible model that is adaptable to a wide variety of cryptoasset use cases beyond just store of value
  - Application of the equation of exchange highlights the different token value-drivers and potential incentives of users and speculators as a token economy evolves
- **Disadvantages**
  - Model inputs must be estimated based on limited historical data that often needs adjustments, e.g. removing non-economic transaction volume from velocity estimates
  - Model inputs are interrelated and dynamic over time, e.g. relationship between market price, current utility value, and expected future utility value can lead to a changing proportion of users and speculators holding tokens

Sources: https://www.britannica.com/topic/monetarism#ref184445 and https://medium.com/@cburniske/cryptoasset-valuations-ac83479ffca7

Cryptoasset Equation of Exchange

Network value is linked to the cost of digital resource being provisioned



Sources: See Pfeffer, J., *An (Institutional) Investor's Take on Cryptoassets. 2017.* or https://medium.com/@cburniske/cryptoasset-valuations-ac83479ffca7 for additional discussions of the equation of exchange

Equation of Exchange Application

Example applying equation of exchange to used car history report use case

- **Token Use Case**
  - Hypothetical Vehicle History Token, VHT, launching to challenge incumbents in vehicle history report (VHR) market
  - Dealers and retail customers purchase VHRs when purchasing used cars to verify and evaluate age, service record, number of owners, mileage, open recalls, use type, theft records, and other metrics
  - Highly concentrated market led by Carfax, owned by IHS Markit, and AutoCheck, offered by Experian
  - Blockchain solution has the potential to replace centralized providers that earn economic rents from users by incentivizing market participants to share and validate data
- **Outline of Approach**
  - Forecast project's economic flows, PQ, using top-down, bottom-up, or another approach
  - Estimate annual velocity, V, based on historical analysis of comparable tokens or other assets
  - Determine monetary base, M, by dividing PQ / V
  - Project free-float token supply based on token sale structure, mining schedule, vesting/lockups, etc.
  - Calculate current utility value and discounted expected utility value in each forecasted period to arrive at current estimate of token's intrinsic value
- **Note**
  - Vehicle History Token, VHT, is a hypothetical token not based on any actual token or company
  - The following is an example of the application of the equation of exchange to valuing crypto tokens and includes many simplifications that may not be appropriate in a real-world scenario
  - Equation of exchange valuation is only one technique for evaluating token projects. A complete analysis should include a variety of quantitative and qualitative analyses of valuation, pricing, strategy, and other factors

Equation of Exchange Application

Economic flow, PQ, can be estimated using top-down analysis or other methods

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
1 Used Vehicle Sales, millions	39.5	39.7	39.9	40.1	40.3	40.5	40.7	40.9	41.1	41.3	41.5
% Growth	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
2 # of Paid Reports per Used Vehicle Sale	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Vehicle History Reports, millions	98.8	99.2	99.7	100.2	100.7	101.2	101.7	102.3	102.8	103.3	103.8
3 Cost Per Report	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00	$15.00
Addressable Market, $mn	$1,481.3	$1,488.7	$1,496.1	$1,503.6	$1,511.1	$1,518.7	$1,526.2	$1,533.9	$1,541.5	$1,549.3	$1,557.0
VHT Market Share	0.3%	0.7%	1.5%	3.2%	5.9%	9.1%	11.8%	13.5%	14.3%	14.7%	14.9%
VHT Economic Flow (PQ), $mn	**$4.2**	**$9.8**	**$22.4**	**$47.6**	**$88.8**	**$138.5**	**$180.6**	**$207.1**	**$221.0**	**$228.0**	**$231.7**

4

Market Adoption Curve Assumptions	
Peak Market Share	15.0%
Start of Fast Growth, year	2020
Takeover Time, number of years	5.0

1 Used vehicle sales based on Cox Automotive estimate for 2018 and continued growth at 2017-2018 growth rate, 0.5%

2 Blended estimate of 2.5 paid reports per used vehicle sale includes dealer reports, reports run by consumers, and sales without vehicle history report

3 Forecasted pricing less than Carfax ($40-100), AutoCheck ($25) retail prices due to reduction of “centralization” mark-up

4 Market adoption modeled as S-curve where “fast growth” begins at 10% of peak market share, “takeover time” represents time to 90% of peak

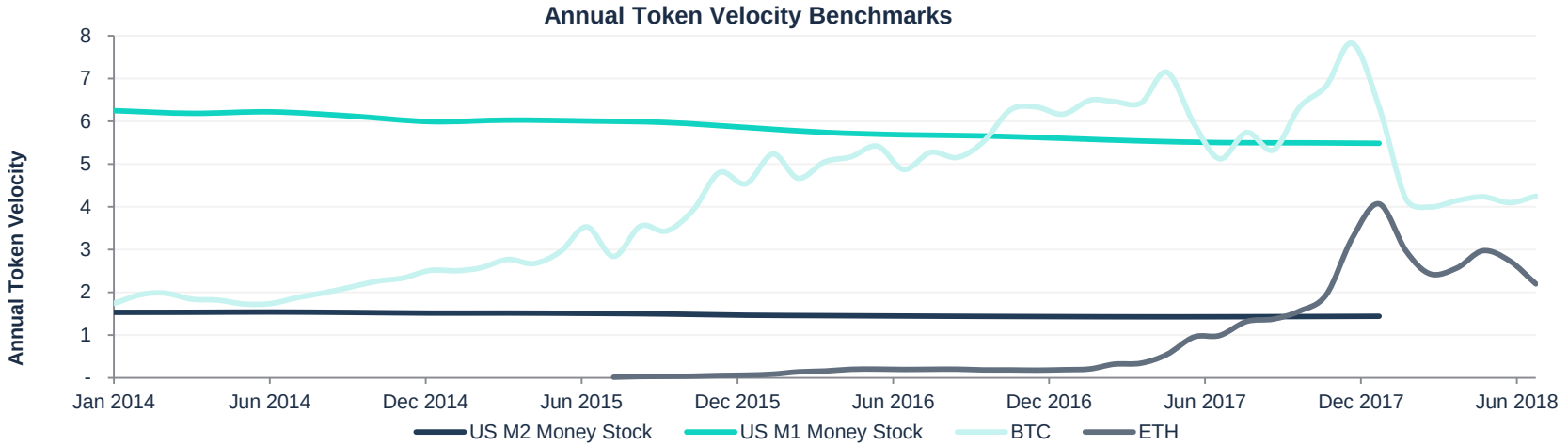
- **Top-down flow estimates**: Illustrated above, addressable market size and an assumed market share used to arrive at economic flow, or PQ.
- **Bottom-up flow estimates**: For this use case, could also consider bottom-up forecast, e.g. based on number of dealerships in sales pipeline.
- **Also consider**: Another proxy for economic flow is the aggregate IT budget of centralized competitors, including energy use and capital charges. For most use cases, improvements in computing power and scaling solutions expected to exert downward pressure on PQ.

Sources: 2018 used vehicle sales forecast from "Cox Automotive 2018 Used Car Market Report & Outlook," Cox Automotive, March 2018. See https://akapps.wordpress.com/2011/08/27/simple-s-curve/, for example, for explanation of market adoption curve methodology.

Equation of Exchange Application

Velocity, V, can be estimated based on historical or comps analysis

Market Size | Market Share | Economic Flow | **Annual Velocity** | Monetary Base | Token Supply | Future Value | Discounted Value



- **Use of velocity**: Model outputs are highly sensitive to velocity, which is the most difficult variable to forecast. There is considerable debate about how to precisely define, measure, and forecast velocity
- **Velocity increased by**: Users minimizing holdings of tokens, viewed as working capital, and lower barriers to trading between stores of value and utility tokens
- **Velocity reduced by**: Users holding tokens for speculation or as store of value, burning tokens, staking functions, other incentives to hold
- **Adjustments**: Velocity metrics should exclude speculative transactions and other transactions not associated with utility function, e.g. reshuffling balances between accounts, mining pool distributions, and spam/spoofing/manipulation. Per Coinmetrics, up to two-thirds of BTC and 45% of ETH transactions are non-economic. Also be aware of potential correlation between velocity and other variables, e.g. % tokens held by speculators

Sources: Federal Reserve Bank of St. Louis, Blockchain.com, Etherscan.io M1 includes currency in circulation (notes/coins, non-bank traveler's checks), demand deposits, and checkable deposits. M2 includes M1, saving deposits, CDs less than $100k, and individual money market deposits. BTC and ETH velocity based on monthly average of annualized daily transactions divided by money supply. See also https://www.bloomberg.com/news/articles/2018-07-26/up-to-two-thirds-of-bitcoin-transactions-have-no-economic-value for proportion of transactions that are non-economic

Equation of Exchange Application

Monetary base calculated based on formula, M = PQ / V

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Used Vehicle Sales, millions	39.5	39.7	39.9	40.1	40.3	40.5	40.7	40.9	41.1	41.3	41.5
% Growth	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
# of Paid Reports per Used Vehicle Sale	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
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Annual Velocity (V)	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Monetary Base (M = PQ / V), $mn	**$1.0**	**$2.5**	**$5.6**	**$11.9**	**$22.2**	**$34.6**	**$45.2**	**$51.8**	**$55.3**	**$57.0**	**$57.9**

M = PQ / V, where M is the monetary base, or token market cap

Equation of Exchange Application

Free float token supply modeled based on planned distribution, lockups, etc.

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Tokens Released											
Private Sale	833,333	833,333	833,333	-	-	-	-	-	-	-	-
Public Sale	37,500,000	-	-	-	-	-	-	-	-	-	-
Team	1,250,000	1,250,000	1,250,000	1,250,000	-	-	-	-	-	-	-
Foundation	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Total Tokens Released	39,833,333	2,333,333	2,333,333	1,500,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000
Aggregate Token Supply	39,833,333	42,166,667	44,500,000	46,000,000	46,250,000	46,500,000	46,750,000	47,000,000	47,250,000	47,500,000	47,750,000
% Held by Speculators	50.0%	47.5%	45.1%	42.9%	40.7%	38.7%	36.8%	34.9%	33.2%	31.5%	29.9%
Free Float Token Supply	**19,916,667**	**22,137,500**	**24,419,375**	**26,280,375**	**27,414,543**	**28,509,593**	**29,567,227**	**30,589,074**	**31,576,692**	**32,531,577**	**33,455,156**

Token Supply Assumptions	
Total Token Supply	50,000,000
Private Sale	5.0%
Public Sale	75.0%
Team	10.0%
Foundation	10.0%
Total	100.0%
Private Sale Lockup, years	3.0
Team Vesting, years	4.0
Foundation Lifetime, years	20.0
Initial % Held by Speculators	50%
Annual Decrease in % Held by Speculators	5%

Token supply modeled based on distribution, lockup / vesting schedule, foundation distribution schedule, etc. from whitepaper. Also consider mining rewards, if applicable

Tokens held by speculators reduce free float. As token economy moves closer to equilibrium, token users should replace speculators. Also consider other mechanisms / incentives that reduce float, such as staked tokens

Equation of Exchange Application

Future token value based on forecasted monetary base and token supply

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Monetary Base (M), $mn	$0.4	$1.0	$2.5	$5.6	$12.0	$22.3	$34.8	$45.4	$52.0	$55.5	$57.3
Free Float Token Supply, millions	19.9	22.1	24.4	26.3	27.4	28.5	29.6	30.6	31.6	32.5	33.5
Current Utility Value	**$ 0.0220**	**$ 0.0474**	**$ 0.1013**	**$ 0.2145**	**$ 0.4363**	**$ 0.7828**	**$ 1.1772**	**$ 1.4835**	**$ 1.6476**	**$ 1.7071**	**$ 1.7124**

Market Value Based on Future Utility		
Discount Rate		50.0%
End Year		2023
2023 Utility Value	$	0.7828
Discount Factor		0.1317
Discounted 2023 Utility Value	**$**	**0.1031**
2018 Utility Value	**$**	**0.0220**

- Some market participants advocate use of a “crypto CAPM” where discount rate = risk-free rate + cryptoasset beta x crypto risk premium
- However, short history of the asset class and limitations of available market indices make it difficult to estimate the relevant variables
- Therefore, it may be more appropriate to apply a “venture capital” discount rate of 30-70%* based on the project stage

Discounted future utility value is sensitive to choice of terminal year. One reason is that we are using a single discount rate, but required rate of return should decline as project matures

- Estimates of current utility value and discounted future utility value should be compared to available market prices
- In this example, discounted future utility value is higher than current utility value, consistent with an early-stage project
- As the project matures, expect current utility value to increase as a percentage of discounted future utility value
- Potential next steps in the valuation include sensitivity analysis and adjusting assumptions to ensure internal consistency

Note: For a discussion of VC discount rates, see Bhagat, Sanjai, “Why do venture capitalists use such high discount rates?” The Journal of Risk Finance, 2014. See https://medium.com/@cburniske/the-crypto-j-curve-be5fdddafa26 for a discussion of the relative contributions of current utility value and discounted expected utility value to price.

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