A DISCOURSE ON TOKEN VALUATION

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Many storied institutional investors have spoken out against cryptocurrencies as investments. Warren Buffett, Jamie Dimon, and John Pfeffer have all come to the same conclusion: crypto is overvalued. Although their analyses are informed by years of financial knowledge, it has become evident their biases too are shaped by lifelong careers focusing on equity. In contrast, long-time professional macro investors like Michael Novogratz and Dan Morehead are some of crypto's biggest supporters. These two specialties, equity and macro, use very different valuation models. In this paper, I present the principal models used by the equity camp and detail why they are misinformed at best. Considering the numerous similarities to the macro financial products commodities and currencies, I argue that the Supply and Demand macro model is the correct framework for evaluating token economics. In so doing, I propose that the key variance of demand for crypto— and thus the largest driver of its price— is determined solely by the variance in the number of crypto units actively withheld.

Investors with strong backgrounds in equity valuation are inclined to apply their own models to each new financial opportunity. Carefully reviewing the two most popular models demonstrate why their valuations are inadequate:

1 Discounted Cash Flow (DCF) Model

Warren Buffett and other career equity investors dismiss crypto given its inability to extract continued economic rent. With equities, on the other hand, there are dividends. Through a discounted cash flow (DCF) model, this revenue stream may be expressed as value today.

Indeed, nearly all coins lack cash flow and therefore have zero value by DCF. However, consider the commodity corn. It too does not generate cash flow. Just as it would be imprudent to DCF a currency or a commodity, it is similarly imprudent to DCF a cryptocurrency. On Wall Street, macro products like commodities are valued on the basis of their supply and demand curves. The crypto community should evaluate coins in the same way.

2 Convergence to Network Costs (CNC) Model

In his work "An (Institutional) Investor's Take on Cryptoassets," Pfeffer conceives of CNC— a model presuming a supply source pegged to computation. Specifically, Pfeffer reasons that the supply curve is bounded above and below by processing (costs) and thus long-term equilibrium price must converge to these costs.

Before considering Pfeffer's argument, a review of some background information on cryptocurrency markets is helpful. Most crypto protocols define economies relying on two entirely separate markets. The first is a "token market," run by popular online exchanges. Users participate to buy and to sell units of currency. The second is a "fee market," which governs the cost of transactions within the network. Distinctly, users of the protocol are the buyers (through transactions) and miners are the sellers (through processing power). Unfortunately, these markets are commonly confused. It's particularly vexing that 1) while the token market is quoted in USD, the fee market is quoted in units of the network token; and 2) sometimes, the fee market has its own token which can itself be traded directly on an exchange. Nevertheless, the two markets have completely different supply and demand fundamentals. Both Bitcoin and Ethereum incorporate a two market design. Bitcoin's and Ethereum's primary network tokens (let's call them Protocol Mandated Fixed Supply Coins (PMFSC)) can be bought and sold at the token market Coinbase.com. Additionally, while the two slightly differ in structure, both networks have separate fee markets (Bitcoin fees and Ethereum fees). The biggest difference between them is that Ethereum associates a second coin "gas" with these fees.[1] However, gas is not limited in supply, and it can be created and destroyed by the network.[2] (Let's call the currencies used in fee markets "Computationally Pegged Coins" (CPC).)

Back to Pfeffer's argument, he successfully identifies (quite thoroughly) the two different markets here:

> Ethereum's developers understood that for Ethereum to fulfil its potential, the cost of using it as a smart-contract-executing utility must be as low as possible and must not depart at equilibrium from the actual cost of the computational resources consumed. To ensure this will be the case, they built the GAS mechanism into Ethereum to decouple the use of the network (and the cost thereof) from the value of the ETH token.

He identities it again in quoting the Ethereum Homestead Documentation

> Gas and ether are decoupled deliberately since units of gas align with computation units having a natural cost, while the price of ether generally fluctuates as a result of market forces. The two are mediated by a free market: the price of gas is actually decided by the miners...

Despite this, he actually struggles to keep them logically separated throughout the entirety of his paper. Later in his paper during his critical passage on the valuation of Ethereum, he makes a noticeable error.

> Let's work through some numbers to see what in fact the utility value of ETH might be. Ethereum GDP (i.e., [Price x Quantity (PQ)]) is the total 'revenue' of the computing network performing the underlying operations, which can be directly measured as GAS used multiplied by the average GASPRICE.... [a]nnualized this is about $355m per year.... The combined net effect would imply 'Ethereum GDP' (PQ) doubles each year. At this rate, Ethereum GDP would grow form $355 million to $363 billion in ten years, an over thousand-fold increase. If we assume an ETH velocity of 7, the network value of ETH would be $52 billion in 10 years, about 24% less than its current network value of approximately $68 billion

Simplifying his paragraph:

1. We want to calculate revenue of the computing network
2. We know how much GAS is used in computing per day
3. Converting "GAS Used" into USD we find it's about $355m per year
4. With some more math, we arrive at a network value of $363 billion
5. By adjusting for velocity, we calculate a market cap value of $52 billion in 10 years
6. Compare this to the current market cap

Very, very strangely he suddenly exclaims that this is the market value of Ether. Hopefully, it is pretty clear that Pfeffer has instead very meticulously calculated the value of the gas network— Ethereum's associated computational network. Utilizing this now malformed model, he attempts to find some profound conclusions; unsurprisingly though, this leads him to contradictions of his own previous statements:

> The implication of this section is not that utility protocols won't have any network value. PQ/V does represent positive value. The implication is that network value of a utility protocol will converge on or near an equilibrium, where it is a fraction (denominator V) of the actual cost of the computing resources consumed to maintain the networks.

In a bewildering turnabout, he concludes that the price of Ether (ETH)[3] must ultimately converge to a value slightly greater than the price of gas. Remember, by his own logic, all the value associated with computation is already stripped out by gas. So it would be mistaken to double count this and attribute that value to ETH.

While there are issues with Pfeffer's premises; nonetheless, his ideas can at least be taken to their logical conclusion in an internally consistent way. Pfeffer should have argued that ETH approaches 0. It must retain a non-zero value— otherwise it could never be exchanged for the definitely valuable commodity gas (pegged to the cost of computation). Without its sole source of value, ETH would race to the bottom always approaching zero. Even if short-term it did somehow retain value, in the long run, infinite forks would guarantee all tokens hit near-zero. While this is at least a well-formed thought, it too doesn't properly consider market forces.

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3 The Supply and Demand (S&D) Model

CNC was actually a step in the right direction, but the very specific supply curve assumptions that Pfeffer makes do not apply to all cryptocurrency markets. Learning from Pfeffer's mistakes, a new, more general model can be deduced. To determine the value of any commodity, macroeconoimc theory demands an analysis of the supply and demand curves.

For a given crypto-economy, it has proven deceptively difficult to identify the underlying units of supply and demand. The best heuristic is to consider the forces which govern the most restrictive scarce resource. Scarce resources have value. S&D determines what that value is.

3.1 Computationally Pegged Coins (CPC) Valuation

Pfeffer's valuation framework is roughly correct for CPC, assuming the system has the capacity to handle all transactions.[4] By calculating the costs of the network and extending that into a network valuation, a price for each token unit can be derived.

In the long run, the price of gas converges to the cost incurred by the network for performing that unit of work. Fees priced too high would encourage the creation of new mining operations, increasing "processing supply" (thus pushing up the difficulty, thus reducing revenue) until the price of a transaction returns to equilibrium. Similarly, fees priced too low would make mining unprofitable. Some miners would go out of business, reducing "processing supply" (thus reducing the difficulty, thus increasing revenue) until the price of a transaction returns to equilibrium. Therefore, supply— and by extension price— is bounded above and below by network costs.

However, if the network does not have the capacity to handle all transactions— its throughput is less than demand— then instead of the price being determined by computational supply and difficulty, there will be a new more restrictive market for throughput which will determine the price: [Constrained throughput supply] vs [demand for system usage]. The market would equalize at a price greater than solely the cost of processing.[5]

3.2 Protocol Mandated Fixed Supply Coins (PMFSC) Valuation

At system maturity, there will be a fixed (scarce) number of tokens; it is written into the core code and agreed upon by the participants. It may even be the only scarce resource at scale (considering all future scaling efforts). Therefore, it is the resource relevant for determining equilibrium price.

While there exist a few other widely discussed resources, they do not fulfill the necessary criteria to significantly impact valuation/price. Consider here a few other candidates:

Is [transaction space in a block] the scarcest resource? Block space is notably limited. But planned scaling endeavors allow crypto to handle all worldwide transactions at nearly zero cost. This directly means there is infinite supply of transaction processing. When supply is infinite (and free), then the equilibrium price is 0. So [transaction space] isn't a scarce resource.

Is [number of transactions] the scarcest resource? If a person simply buys a token at an exchange, uses it (immediately), and offers it back, then the supply count is unaffected. Specifically, there is infinite ability (at nearly zero cost) to perform this action, assuming transactions are near instantaneous. So [number of transactions] also isn't a scarce resource.

Also worth noting are things like [block/transaction dissemination time], [level of decentralization], [storage on the network][6], [latency to finality], etc. In one way or another each of these could be considered a possibly scarce network resource. However, similar to transaction capacity, current scaling efforts plan to offer a sufficient level of each resource at the base price for using the system. Therefore, none of these are scarce enough to be the major determinant of price.

3.2.1 Supply of Ether

Given the unique scarcity of tokens, it is tautologous to specify that supply is the number of coins in circulation. Notice that while the supply of ether has inflation, this change is based on time; price is not a factor. At a specific point in time, the supply of ether is constant.

3.2.2 Demand of Ether

With a strong understanding of supply, working backwards, a definition for demand can be constructed. Universally, demand and supply must act on the same underlying unit. As the resource is scarce, when one unit is demanded there must be one less unit supplied to the rest of the system. Applying our generated definition for supply, one unit of demand removes one unit from circulation over the demanded period. Coincidentally, there already exists a word for this exact definition, "withholding."

Forgetting speculators, generally people will withhold Ether for the promise of using the world computer at a future point— it's a guarantee of code execution. A user could choose to store value in another token and convert at the moment of execution, but this is not a perfect substitute. This user then would have three risky dependencies instead of one: 1) the SoV network 2) his/her preferred exchange 3) the Ethereum network. In order to avoid this exposure, some people (businesses) will likely choose to hold mission critical ether themselves.

Besides the promise of future execution, there are a few additional reasons to withhold Ether. Some people will hold Ether for staking. Some people will choose to lock it up in other contracts (e.g., payment channels, plasma, and escrow).

Finally, network processing time (read: non-instantaneous transactions) is a type of withholding done by the network. But at scale, current roadmaps expect processing time to be negligible.

The point-in-time demand for Ether is the aggregate number of tokens withheld by people "off exchange."[7]

3.2.3 Equilibrium Price

The point at which long-term demand meets long-term supply is the equilibrium price of the system. Let's consider a few common situations and what the model says about price action.

Question 1. Why does the price move?

Because supply is fixed, price rises and falls with demand alone. When speculators buy Ether today they are expressing their view that more people will want to *withhold* Ether (be it for staking, use, contract lockup, or speculation) tomorrow.

Furthermore, the model can help explain how sentiment affects price. At the end of 2017, crypto went mainstream and caused a lot of people to buy and trade cryptocurrencies. For a period of time, significantly more units were held offline by new diehard hodlers.[8] This pushed the demand curve out, increasing the equilibrium price.

Question 2. How does demand for Ethereum competitors affect ETH?

Generally, the same people considering withholding Ether are also possible holders of EOS. If holders move from Ethereum to EOS, this contracts the demand curve and reduces price.

Question 3. Pfeffer argues that if ETH is greater than 0 and forking is free, then the protocol will fork until there is no economic rent (i.e. price = 0). Does the model agree?

Given these assumptions and setup, Pfeffer's question doesn't make any sense.

1. ETH is NOT an indication of how much economic rent is being charged. As discussed above, the price of Ether has its own market governed by its own S&D.
2. In Ethereum, there is no economic rent being charged already! This is handled by the gas network and Pfeffer is right, the price of gas can never get too far out of line with the cost of computation, otherwise there could be a fork.

Question 4. According to the model, how do forks affect price?

Creating new competitors through forks is bad for Ether investors. While holders can hedge themselves somewhat by retaining all forked tokens, a split community is negative for network effects. In accordance with Metcalfe's law, network effect is a quadratic factor in deriving network value. So the total value of a split community is necessarily lower than that of one unified community.

This emphasizes that forking has costs greater than zero. There is a financial disincentive to contentious hard forks. Holders experience this cost through the decreased network value described above. Non-holders still lose time/money trying to coordinate a hard fork without any promise of acquiring new coins thereafter (assuming no pre-mine).

The largest (and most successful) reasons for forks are philosophical differences which are strong enough to justify the existence of multiple communities in the face of negative value.

In these scenarios, it is absolutely best to hard fork. But holders of Ether should always consider it a pyrrhic victory. Contentious hard forks forever damage Ether as an investment (by creating a philosophical competitor with a very strong user base).[9]

Although many more contentious hard forks are likely to occur in the future, there is one possibly saving factor. It is unclear how many strong competitors can popup and have significant communities at any one time. Looking to the open source communities surrounding programming languages/OS's, there aren't infinite forks of every project. There are a few forks (even worth noting), but most people just use the major release of the biggest projects.

Given the non-zero costs, the limit to active communities, and the strength of the crypto network effects, it's most likely the value will be split among a few top surviving competitors; "forking an entire project space to 0" seems unrealistic.

4 CONCLUSION

Wall Street has largely overlooked crypto. It is a grassroots project relying on technologically sophisticated code and has received little guidance from regulators. This launch has perplexed most "qualified" investors, thus compelling them to misemploy their own valuation models.

Within this paper, I have shown why current models are lacking. But there does exist one ubiquitous economic framework for evaluating macro assets: the Supply & Demand Model. I have applied its principles to help evaluate equilibrium price. Regardless of future code changes, the generality of this model guarantees its relevancy.

Furthermore, I have demonstrated (presently and even considering expected protocol updates) the most significant factor in demand to be the number of units actively withheld. However, this is a distinctive feature of crypto. With physical commodities, like corn, there is a very substantial amount created and destroyed in each period. Therefore, the majority of variance for price is determined by changes in units in existence. Stockpiling ("withholding") is less important. Unique to crypto, there is forever a constant number of units in existence; therefore, the variance in withholding becomes the key factor affecting demand.

These S&D forces are determined by decisions in the protocol's base code. It is possible that future changes could create different dynamics where withholding is less important. With any new design decision, a new evaluation of each the supply and the demand must be conducted to identify the relevant factors. Any prediction of long-term price without considering the dynamics of the S&D is worthless.

Finally, there are a couple obvious areas for further thought:

- Armed with a "new" model on cryptocurrency pricing, how can the demand of a system be quantified? How many tokens are held by users, developers, and businesses?
- Given its importance to demand, there should be more meticulous consideration of design decisions governing the holding of tokens. There is recent work by Alex van de Sande here: focusing on the praiseworthy goal of maximizing usability. However, it should be of equal importance to consider the monetary policy consequences of imposing a certain holding scheme on users and the overall system.

1. While not exactly popular to trade, Project Chicago went through the process of creating "gasToken" built around Ethereum's gas. They further provide information on how this token can even be expressed as an ERC20 compliant token which could then be traded on exchanges.

2. Admittedly this is a very simplistic explanation of how gas works, but the upshot is that the supply of the theoretical "coin/construct" is not permanently fixed by the protocol. This is very different than Ether.

3. As far as I am aware, there is no generally accepted terminology. But in the course of this paper I will use "Ethereum" to mean the system/network referring to the protocol code; "Ether" to mean the tokens within the Ethereum system; and "ETH" to be the price of Ether tokens.

4. One could argue at mature equilibrium, the system will not have throughput constraints. I have no view whether or not this is true.

5. There are different types of processing on the network (memory vs storage vs processing). Theoretically, the price of gas should reflect all of the incurred costs but a discussion of this is beyond the scope of this paper and irrelevant to the points made herein.

6. Like processing is split out with the GASPRICE mechanism in Ethereum, storage costs will probably be split out also. So while this will be a scarce resource, there will be a different mechanism which governs it. There are several different active areas of research on how to split it out from Ethereum.

7. Here "off-exchange" is a little confusing because most exchanges also provide basic wallet services. The important aspect is that the tokens shouldn't be offered in any exchange's order book. In this way, they are not available to others, no matter the price.

8. There is an unfortunate overlap of terminology. The fact that the action of withholding is the key to demand is distinct from the existence of the "hodling" movement. While it is certainly possible that early investors began to "hodl" after noticing it have a positive effect on price, overall the movement is irrelevant to the supply and demand analysis.

9. Phil Daian aptly notes here that in the short term it is possible another similar platform could charge below market rates (either at a (early investor's) loss, or by specifically reducing scalability) in order to try and steal market share from Ethereum. A set of users will be enticed by cheaper costs and encouraged to switch. But 1) This is only sustainable short term specifically because the platform is small. Once large enough, the rates would be the same. 2) Users of the forked system are compromising on network security and are being paid for increased risks.