Validator Economic Incentive Model for Ethereum 2.0

Phase zero of Ethereum 2.0 is expected to launch during the second or third quarter of 2020. It's the first transitional stage of Ethereum network from Proof of Work (PoW) to Proof of Stake (PoS), which will pass block validation function from miners to validators.

A rational validator has a decreased chance of participation if the opportunity exhibits weak profitability. Based on the data/evidence gathered and assumptions made, we'll elaborate on the following economic incentive model with the motivation of exploring the future profitability of Ethereum 2.0.

Economic Incentive Model = Validator Rewards + Network Fees + Gain/(Loss) From Ethereum Price Change – Costs To Be A Validator

Data/Evidence

- *The Annual Reward Return Rate of Ethereum is approximately 3.20%.*
- *The target Staking Amount of Ethereum is 32 million.*
- *Currently, Network Fees is about 600 ETH per day.*
- *Currently, the Interest Rate of four-week Treasury Bill is 1.53%.*

Assumptions

- *There is no inactivity leak, which means >2/3 of validators are online all time long.*
- *The Hardware Cost is $600 and has a useful life of 10 years.*
- *The Software Cost is $0.*
- *Sharding does not necessarily affect rewards, network fees, gain/(loss) from Ethereum price change and costs that we've covered because we target validators who stake 32 ETH for 18 hours.*
- *Since risks depend on validators' risk preferences and are difficult to measure explicitly, we assume validators are 100% risk loving, thus we do not consider cost of risks.*

Also, some beforehand Clarifications

- *The time and the amount of Ethereum a validator chooses to stake varies by individuals. Because the minimum amount for staking is 32 ETH and the minimum period of lock up time is 18 hours, we typically evaluate **the profitability of a validator who stakes 32 ETH for 18 hours**.*
- *We use $130.60 as the price of Ethereum at period t-18 in the analysis because the opening price of Ethereum on Jan 1st 2020 is $130.60.*
- *Apart from the major costs we've covered in the following analysis, we simplify the scenario not to consider any other miscellaneous costs.*

Terms

- ***Validator Rewards**: rewards that a validator earns when successfully proposes and attests for blocks.*
- ***Staking**: a process of holding funds in a cryptocurrency wallet to support the operations of a blockchain network.*
- ***Network Fees**: fees that people pay to use the network. Transaction Fees is the same as Network Fees. In Ethereum 1.0, these two are also same as Gas Fees. A certain portion of Network Fees are earned by validators, the rest are burned as gas.*
- ***Sharding**: a way of partitioning large chains into smaller and faster ones, hence making the entire system more scalable. It should be noted that sharding may affect profitability owing to the fact that the validator requires additional hardware and software cost if he/she stakes more.*
- ***Lockup Time**: a set amount of time validators must wait to get their Ethereum back. The minimum wait is 18 hours.*

Validator Rewards

A validator who participates in Ethereum 2.0 will receive rewards when blocks are successfully proposed and attested for. As it is estimated by *Justin Drake*, researcher at the Ethereum Foundation, the *Annual Reward Return Rate* is approximately *3.2%* and the target *Staking Amount* of Ethereum is around *32 million*.

Based on this evidence, we convert the *Annual Reward Return Rate* to be *18-hour Reward Return Rate*.

$$\frac{3.2\%}{365} * \frac{18}{24} = 0.006575342\%$$

In the next part, we will need *Staking Amount* of Ethereum to calculate the *Network Fees* for a validator who stakes 32 ETH for 18 hours.

Network Fees

Validators earn a cut of the transaction fees that people pay to use the network. During phase zero, all user transactions will still occur on Ethereum 1.0 chain as indicated in *EthHub*.

Currently, the whole Ethereum network is paying about 600 ETH per day also as mentioned in *EthHub*. Because we know the whole *Staking Amount* is 32 million, we can calculate the *Network Fees* for a validator who stakes 32 ETH for 18 hours as below.

$$600 * \frac{18}{24} * \frac{32}{32{,}000{,}000} = 0.00045 \text{ ETH}$$

Gain/(Loss) From Ethereum Price Changes

Ethereum price changes will affect a validator's profit. Gain will arise when the selling Ethereum price exceeds its purchase price, and vice versa.

We will use Ethereum price over an 18-hour period in year 2019 from *Binance* to evaluate the gain/(loss) from the price changes in the final analysis part.

Costs To Be A Validator

Hardware Cost

Though the PoS system does not require large quantities of electricity – serving as a major benefit – the hardware cost is still TBD according to *EthHub*. We consider that a validator is required to have a computer, assuming that the price of a computer is $600, and that the computer has a useful life of 10 years. So, the cost for depreciation of 18-hour period is 0.1232877$.

$$\frac{600}{10 * 365} * \frac{18}{24} = 0.1232877\$$$

Software Cost

In regards to software cost, validators need to set up a node, download the Ethereum blockchain software – which is over 20 GB in size – and connect the node to the network. Under the condition that a validator only stakes 32 ETH for 18 hours, we assume no explicit costs for software since it only requires sufficient space of the hardware and network connection.

Capital Acquisition

A minimum of 32 ETH are required to be staked in order to become a validator.

Gas Burned

The majority of transaction fees on the network will be burned, while the rest will be given to the validator. We assume that the gas burned will account for 80% of the total transaction fees. Therefore, 0.00036 ETH is burned every 18 hours for a validator who stakes 32 ETH for 18 hours based on that the whole Ethereum network is paying about 600 ETH per day.

$$450 * 80\% * \frac{32}{32{,}000{,}000} = 0.00036 \text{ ETH}$$

Lockup Time (Opportunity Cost)

The minimum lockup time is 18 hours. When locked, validators lose the opportunity to invest in other assets (e.g: treasury bill: riskless investment in global financial markets).

We quantify the opportunity cost by calculating the reward validators could have obtained from the US treasury bill. Currently, the interest rate of four-week treasury bill is *1.53%*. Thus, the interest rate of 18-hour treasury bill should be 0.003143836%. The opportunity cost is:

1.53% ÷ 365 days ÷ 24 hours * 18 hours = 0.003143836%
0.003143836%* Staking Value Of The Validator ($)

Security Risk

There is currently no way to recover funds if a validator is hacked due to a security failure leading to forced downtime and/or misbehavior.

Code Risk

Poor code can be dangerous, especially since Ethereum is open-source. Different programmers can contribute to a project, making it difficult to develop code with consistent designs and qualities.

Analysis and a bit math for Profits

Now it's time for us to move to the exciting part: Profit of a validator.

$$Y_t = 32 * (0.006575342\% * P_{ETH,t}) + 0.00045 * \frac{PETH_{t-18} + PETH_t}{2} + 32 * (P_{ETH,t} - P_{ETH,t-18}) - 0.1232877 - 0.003143836\% * 32 * \frac{PETH_{t-18} + PETH_t}{2} - 0.00036 * \frac{PETH_{t-18} + PETH_t}{2}$$

where N denotes the amount of ETH a validator stakes, $P_{ETH,t}$ and $P_{ETH,t-18}$ denote the price of Ethereum at period t and period t-18 respectively.

After several rearrangements, we can get the following equation,

$$Y_t = 32.00165 * P_{ETH,t} - 32.00046 * P_{ETH,t-18} - 0.1232877$$

As we can see, *Profit* depends on the price of Ethereum the time a validator stakes and withdraws if he/she stakes 32 ETH for 18 hours.

Let's assume, a validator stakes 32 ETH at period t-18 with the price of 130.60$.
$P_{ETH,t-18} = \$130.6$
Solving $32.00165 * P_{ETH,t} - 32.00046 * P_{ETH,t-18} - 0.1232877 > 0$, we get $P_{ETH,t} > 130.599$.

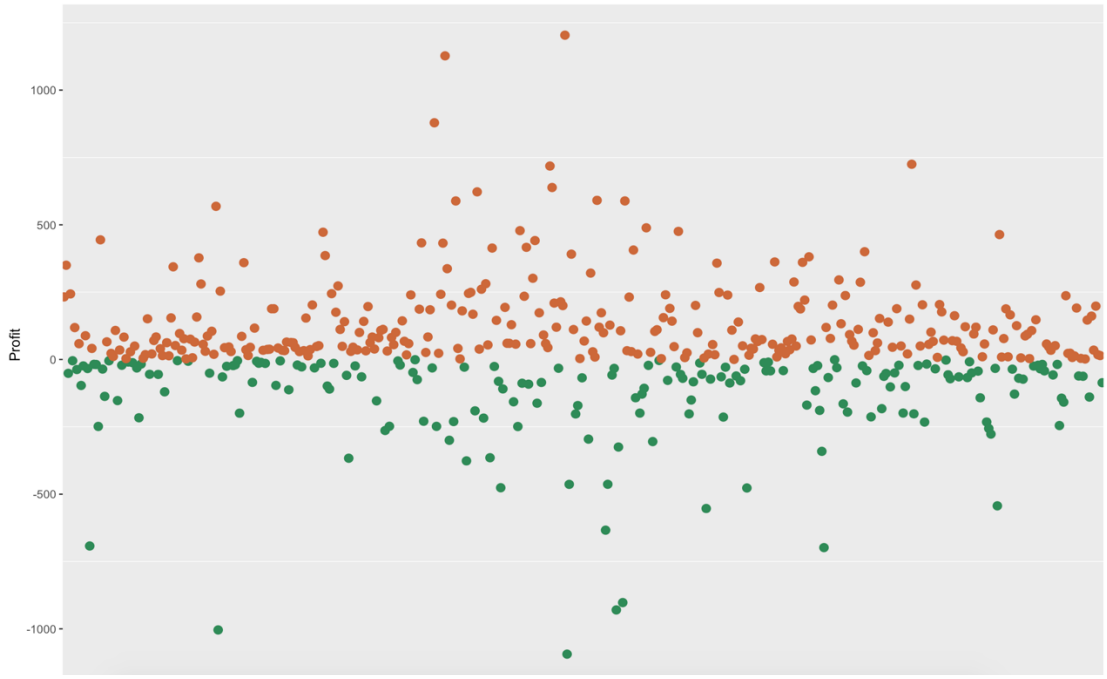
The above analysis shows that, as long as the price does not fall below 130.599$ when the validator withdraws the Ethereum, the validator will make profits on the condition that he/she stakes 32 ETH for 18 hours and the beginning price is 130.60$. Therefore, we can see that even the price drop by 0.00077% in 18 hour period (approximately 0.37% annually), the validator can still make profit when he/she stakes 32 ETH.

Some extra analysis

Ethereum 2.0 Phase zero, the beginning of Casper system, is more than an exploration stage rather than an actual execution. It is not easy for us to provide many deep insights because of a lack of further well-built explanations and solid data/evidence. However, one advantage may be that since phase zero is the beginning of PoS algorithm, the behind logic of Ethereum network does not change significantly. We can possibly use real data of year 2019 to estimate the rough picture of profitability in the near future.

We collected data of Ethereum price every 18 hours in year 2019 from *Binance*, and used data of validator rewards, network fees, costs based on our above analysis, finally produced the profit chart of a validator who stakes 32 ETH for 18 hours.

As shown below, points of profits are almost evenly distributed around breakeven line. Validators are not incentivized to participate in the beginning of Ethereum 2.0 due to the fact there is no absolute tendency that one can make profit, with the assumption that 32 ETH is staked and the Ethereum price in year 2020 does not significantly change from year 2019.



Conclusion

From our perspective, in transition from PoW to PoS, most people tend to wait after phase zero has launched in order to get more information and then make a decision whether to join or not. The future prospect of Ethereum 2.0 should be promising.