The value of trust: pricing utility tokens in a blockchain-based network

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Abstract. Blockchain technology has the potential to revolutionize the way trusted computing is delivered to end users. One of the pillars enabling the shift is a decentralized token-based business model. While intuitively appealing, little is known about the economic properties of such models. In this note we consider a setting where trusted computation is delegated to the nodes with probabilities proportional to their "stakes" in the network, that is, the number of tokens they own and lock up as a collateral. In this setting we find the equilibrium token price, number of miners participating in the system and show how trust created by the blockchain is reflected in the token valuation.

Keywords: blockchain, tokenomics, business models, trust

1 Introduction

The early adoption of blockchain protocols by technology enthusiasts generated novel ways of doing business on the web. In particular, they enabled a new class of business models that provide trusted computing as a service, backed by the utility tokens issued by the blockchain network.

The most widely adopted utility token to date is Ethereum ([1]). Tokens are typically freely tradable and are therefore subject to fluctuating prices. In addition, tokens can be "mined", i.e. created in order to remunerate independent computer nodes for their participation in the network.

We consider a token-based distributed computing protocol that assigns a computation task to a node with the probability proportional to the number of tokens it owns and locks up as a collateral – "stake". This model closely follows the assignment rule of the NuCypher protocol.([2]).
We derive the equilibrium number of miners and the token price as a function of the expected network lifetime, trust created by distributed computation, total supply of tokens in circulation and demand for the computation.

2 Model

There are two types of users: consumers and miners. Consumers arrive to the system at the rate Λ, measured in the number of consumer requests per second. A miner has a stake S_j, i.e., number of tokens locked in the system. Assume that

all tokens are already mined and used as stake, that is, the total token supply equals $\sum_{j=1}^{N} S_j$, where N is the total number of miners. A miner j gets assigned to a consumer request with probability $\frac{S_j}{\sum_{j=1}^{N} S_j}$ and gets the reward r (i.e., price charged to the consumer) while incurring the cost c (e.g., hardware, energy) to deliver the service to the consumer.
Then, the miner j's revenue rate is given by

$$R_j = \frac{S_j}{\sum_{k=1}^{N} S_k} \Lambda \left(r - c\right)$$

The value of the "last" token at stake for miner j is

$$\sum_{t=0}^{\infty} \delta^t \frac{dR_j}{dS_j} = \frac{\Lambda \left(r - c\right)}{1 - \delta} \frac{\sum_{-j}^{N} S_k}{\left(\sum_{k=1}^{N} S_k\right)^2},$$

where δ is the (time) discount factor. Thus, the higher the miner's stake S_j, the lower the return from each additional token. Hence, it makes sense for a miner with a higher stake to sell the token to a miner with the lower stake.
As a result, in equilibrium, each miner should have the same number of tokens at stake $\bar{S} = \frac{\sum_{k=1}^{N} S_k}{N}$.

3 Results

The equilibrium number of miners N^* is defined by the balance of the long-run δ-discounted individual miner's revenue and the market entry cost C_0:

$$\sum_{t=0}^{\infty} \left(\delta^t \frac{1}{N^*} \Lambda \left(r - c\right)\right) \equiv \frac{\Lambda \left(r - c\right)}{N^* \left(1 - \delta\right)} = C_0$$

Thus, the equilibrium number of miners is given by

$$N^* = \frac{\Lambda \left(r - c\right)}{C_0 \left(1 - \delta\right)}$$

The equilibrium token price is therefore given by

$$p^* = \sum_{t=0}^{\infty} \delta^t \frac{dR_j}{dS_j}\bigg|_{\bar{S}} = \sum_{t=0}^{\infty} \delta^t \frac{\Lambda \left(r - c\right)}{\sum_{k=1}^{N} S_k} \frac{N^* - 1}{N^*} \simeq \frac{\Lambda \left(r - c\right)}{\left(1 - \delta\right) \sum_{k=1}^{N} S_k} \text{ for } N^* \gg 1 \tag{1}$$

4 Concluding remarks

The premium $(r - c)$ that consumers are willing to pay for the blockchain-based service (instead of performing the computation themselves at the cost r), reflects the amount of trust created by the decentralized mechanism. Thus the equilibrium price is proportional to trust created by the distributed computation. In addition, it reflects the trust in the long-term sustainability of the decentralized mechanism. In particular $\frac{1}{1-\delta}$ is the expected lifetime of the network. The price is also proportional to the demand for trusted computation Λ and inversely proportional to the total supply of tokens, in agreement with common intuition. Hence, the equation (1) provides a simple and intuitive way to price utility tokens that can be used by market participants to identify the fair valuation.

References

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