The ICO Paradox
Transactions costs, token velocity and token value

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Motivation

Blockchain led to a novel method of financing: Initial Coin Offerings

Figure: Capital raised via ICOs (Davydiuk et al, 2019).
Motivation

In an ICO, firm sells rights to buy its good in advance.

- Blockchain is not essential here. The good does not have to be on blockchain, nor does rights to good. Could be games at a fair and the rights could be tickets.
- Blockchain may make it easier. Right to buy a good is called a *utility token* on a blockchain.
- What makes ICOs novel is that (a) they sell rights to buy a good in advance to finance the project to make the good and (b) this is done at a large scale.
Contribution

1. Selling advance rights is a revenue model, not a financing model.
2. We show that selling purchase rights requires friction to generate additional revenue. We formalize the velocity problem for ICOs.
3. We present conditions under which advance rights is a better revenue model than a standard markup.
4. We discuss ways to create frictions without reducing sales.
Related literature

1. Theoretical literature on rationale for ICOs.
   ▶ Li & Mann, 2018 (ICOs solve the first-mover problem that can scuttle platforms that require network effects)
   ▶ Lee & Parlour, 2018 (internalize total consumer surplus created by entrepreneurs)
   ▶ Bocks et al., 2019 (limit the moral hazard created by sale of equity)

2. Theoretical literature on weakness of ICOs.
   ▶ ICOs create incentive problems for entrepreneurs (Chod & Lyandres, 2018; Canidio, 2018; Garratt & van Oordt, 2019; Sockin & Xiong, 2018)
   ▶ Catallini & Gans, 2018 provides more practical advice on vesting and monetary policy.

3. Velocity problem with ICOs.
   ▶ Vitalik Buterin (2017) mentioned it in an early blog post. See also Pfeffer, 2017; Selkis, 2018; Xu, 2018.
   ▶ Samani, 2017b, uses Fisher’s equation to describe the velocity problem. See also Locklin, 2018.
   ▶ AFAIK, we are first to connect problem to underlying market. See also Evans, 2018.
Utility tokens are essentially a revenue model

- Consider a firm with selling a good or operating a market place.
- The firm can earn revenue by charging a positive price for its good. It earns a profit by charging a markup over costs.
- The firm can also earn a profit by (a) selling the good at cost, (b) requiring that the good be purchased with a utility token, and (c) artificially creating illiquidity. The profit comes from how much people are willing to pay for liquidity, i.e., for the tokens, above and beyond cost.
- Utility tokens are not uniquely a financing model because the firm could sell rights to its markup in advance just as it could sell utility tokens in advance.
- Incidentally, utility tokens are not the only token that can be sold in an ICO. Firm can also sell security tokens, which are a right to profits, i.e., the markup.
Most ICOs are used to finance market platforms

**Figure:** Capital raised via ICOs (Source: https://cointelegraph.com/news/from-2-9-billion-in-a-month-to-hundreds-dead-trends-of-the-rollercoaster-ico-market-in-18-months).
Trade in underlying good

Before platform starts, trade in good entails friction $F > 0$. Operate like a per-unit sales tax of $F$.

Competitive equilibrium is $(q^*_p(F, t), q^*_c(F, t), X^*(F, t))$ where

$$q^*_c(F, t) = q^*_p(F, t) + F.$$

**Assumption 1**: Supply and demand curves stable over time.

Theoretical lit on ICOs takes timing seriously. But time is not essential to our insight. Allows suppression of $t$. 
Firm offering the market platform

Monopolist has technology that can reduce friction to $f < F$.

To produce platform, first needs to finance fixed cost $I$. Marginal cost of marketplace is 0.

**Assumption 2**: Fixed cost same regardless of revenue model.

Firm can raise revenue by charging a markup (transaction fee for trades) or by selling utility token.

Firm can finance $I$ by selling rights to either revenue stream.
Transaction fee revenue model

If firm imposes fee of $k$, revenue is

$$R^TF = k \int_0^\infty e^{-\delta t} X(f + k, t) dt = \left(\frac{k}{\delta}\right) X(f + k).$$

The firm need to finance its investment: $\phi^TF\left(\frac{k}{\delta}\right) X(f + k) \geq I$.

The financing constraint just binds, so the firm’s problem is

$$\max_k (1 - \phi^TF\left(\frac{k}{\delta}\right) X(f + k), \text{ subject to } f + k \leq F, \quad (1)$$

Optimal (interior) fee is where elasticity of equilibrium quantity wrt fee is 1.

$$X^*(f + k^*) = -k^* \frac{\partial X^*(f + k^*)}{\partial k^*} \iff \eta x^*k(f + k^*) = 1. \quad (2)$$

Raising fee 1% increases revenue 1%, but decreases number of transactions.
Utility token revenue model: how blockchain ledgers work

A ledger on blockchain uses a set of “miners” to record transactions in a “reliable” way.

Some process selects one miner to record the transaction. The process entails some cost to miners. Miners have to compensated that cost.

E.g., Bitcoin uses PoW, a puzzle that requires electricity. Ethereum is moving to PoS, which requires staking capital (coins), during which capital isn’t available to miner. Costs are roughly proportional to time it takes to validate transaction. Though exact relationship varies with protocol.

Parameterize choice of technology as follows.

▶ $s = \text{time for validating transaction on ledger}$
▶ $\theta = \text{features of ledger other than } s$
▶ $d(s, \theta) : \frac{\partial d}{\partial s} > 0$ is miner compensation
▶ WLOG, assume $d(0, \theta) = 0$. (If positive, fold into $f$.)
Utility token revenue model: valuing tokens

**Key #1**: \( V(s) = 1/s \) is velocity

**Assumption 3**: Firm mints \( M \) utility tokens and chooses its ledger technology once and for all time.

- \( p(z) \) is USD price of token with trading frictions \( z \)
- Total value of tokens is \( p(z)M \)

Aside: token price of good is \( r(z) = q_d(X^*(z))/p(z) \)

**Key #2**: Fischer’s equation of exchange:

\[
D = q_d(X^*(f + d))X^*(f + d) = pMV(s) = S
\]

\[
p(d) = \frac{q_d(X^*(f + d))X^*(f + d)}{MV(s)}.
\]

(3)

Token price rises in demand for good per period, falls in the supply of tokens per period.
Utility token revenue model: velocity problem

Frictionless tokens have zero value:

\[
\lim_{s \to 0} p(d(s)) = \frac{1}{M} \cdot \frac{\lim_{s \to 0} \left[q_d\left(X^*(f + d(s))\right)X^*(f + d(s))\right]}{\lim_{s \to 0} V(s)}
\]

\[
= \frac{q_d(X^*(f))X^*(f)}{\infty} = 0.
\]
Utility token revenue model: Optimal frictions

Given tech $\theta$, choose $M$ and transaction time $s$ (identically, miner compensation $d$) to solve

$$\max_{M,d}(1 - \phi^U) p(d) M \text{ s.t. } f + d \leq F.$$  \hspace{1cm} (4)

where we assumed financing constraint binds. Plugging in Fisher’s equation, $M$ drops out because token prices adjust:

$$\max_d(1 - \phi^U) q_d(X^*(f + d))X^*(f + d)$$

$$\frac{X^*(f + d)}{V(s(d))}.$$  \hspace{1cm} (5)

Interior solution satisfies

$$\eta_{qd}X^*(X^*(f + d^*) \eta_{x^*d}(f + d^*) + \eta_{vd}(d^*) = \eta_{x^*d}(f + d^*)$$  \hspace{1cm} (6)

Higher compensation increases consumer price and lowers velocity, but reduces quantity. Markups just balance consumer price and quantity.

**Velocity problem**: lower $d$ now increases velocity, lowering token value.
Comparing revenue models

Ratio of revenue from two models at a given level of friction $w$:

$$\frac{R_{UT}^R}{R_{TF}^R}(w) = \frac{q_d(X^*(f + w))X^*(f + w)}{V(s(w))} \cdot \frac{1}{wX^*(f + w)} = \frac{q_d(X^*(f + w))}{w} \cdot \frac{1}{V(s(w))}.$$

1. If, at the optimal transaction fee $w = k^*$ ($w = d^*$), ratio is greater (less) than 1, then the UT (TF) model generates more revenue than the maximal revenue under TF (UT) model.

2. Ratio is decreasing in token velocity.

**Proposition**: (a) The utility token model generates more revenue if $V(s(k^*)) < q_d(X^*(f + k^*))/k^*$. (b) The transaction fee model generates more revenue if $V(s(d^*)) > q_d(X^*(f + d^*))/d^*$.

This implies that if velocity is sufficiently low, then the utility token model is preferable, and vice versa.
Choice of technology is key to choice of revenue model

The ICO firm will want to search for an available protocol that lowers \( \eta_{sd} \), the elasticity of validation time to miner compensation, as that reduces the ICO paradox.

- ICO firm’s problem as maximizing token price via choice of miner compensation.

- The ICO paradox is that lowering compensation to increase equilibrium revenue also increases velocity, lowering price. The latter effect is driven by the fact that lower compensation means less validation time.

This drag on token price is mitigated, however, if the firm chooses a technology where validation time is not responsive to miner compensation, i.e., low \( \eta_{sd} \). Recall optimality condition:

\[
\eta_{q_d} x^* (X^* (f + d^*)) \eta_{x^* d} (f + d^*) + \eta_{v_d} (d^*) = \eta x^* d (f + d^*) \quad (7)
\]
Moving out the technological frontier

Techniques proposed to reduce velocity conditional on miner compensation.

1. Work token: require miners to hold utility tokens.
   - Augur (prediction mkt), Filecoin, Keep (data storage), Livepeer (video services mkt), Truebit (off-chain computation), Gems (mech Turk).
   - Like POS, this lowers the miner compensation and transaction time, but unclear if it changes the slope.

2. Burn and mint: hold tokens between transactions
   - Destroy utility tokens after purchase and re-mint after a delay (Samani, 2018; Lau, 2018).
   - Factom, GnosisSpankchain (porn).
   - Changes slope!
Conclusion

1. Selling advance rights is a revenue model, not a financing model.
2. Selling purchase rights requires friction to generate additional revenue. The velocity problem is really the problem of not reducing friction so much that you reduce token price by increasing velocity.
3. When velocity is sufficiently low, the utility token model becomes feasible. Maybe that’s why we see it after emergence of blockchain.
4. Burn and mint is a viable technology to improve revenue from utility token model.