Market Design with Blockchain Technology

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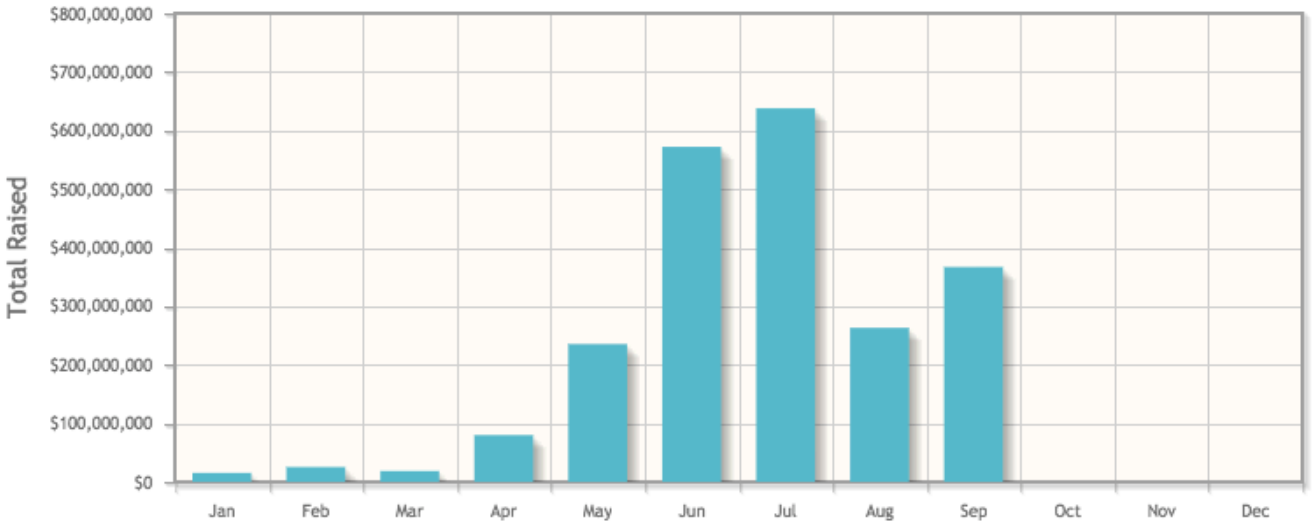
We first presented this paper in June 2016 ...
... and for 1 year people told us that trading of blockchain "stocks" was years away

How did these guys put it ...?

- Available tokens for trading (Coinmarketcap)
  - August 19: 182
  - Sept 25: 257
- Capital raised from mid-2016 to date:
  - $1.3B (NYT July 27, 2017);
  - $2.5B (Coinmarketcap, Sept 26, 2017)
- Market cap (Coinmarketcap, Sept 26, 2017)
  - ~$8B

Initial Coin Offerings are now a reality

Cryptocurrency ICO Stats 2017



Totals raised are grouped by the ICO closing date and are valued using BTC exchange rate at that time. Data correct on 7th September 2017 14:00 UTC

Total Raised: $2,214,989,369

Total Number of ICOs: 148

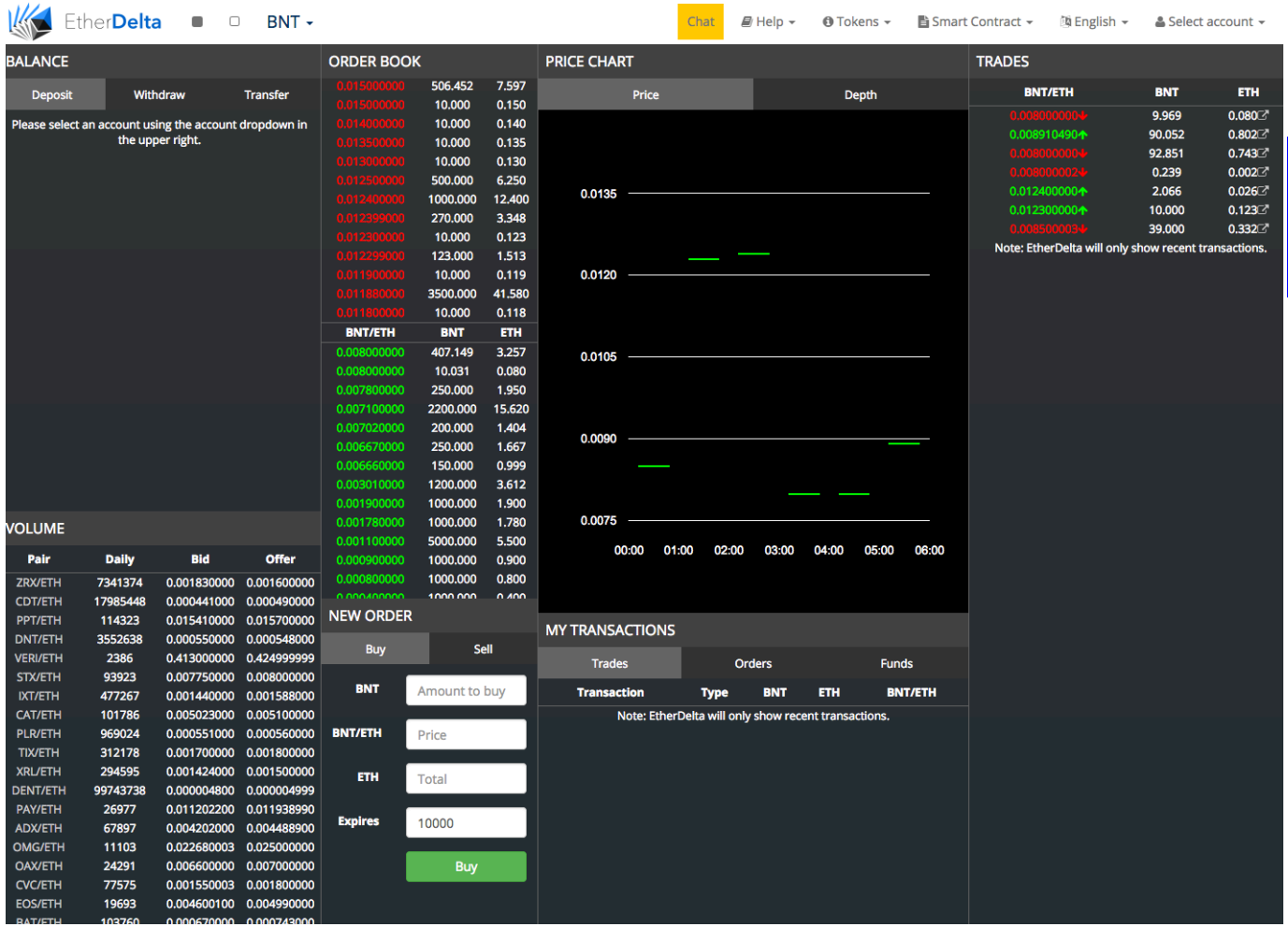
Top Ten ICOs of 2017

Position	Project	Total Raised
1	Filecoin	$257,000,000
2	Tezos	$232,319,985
3	EOS Stage 1	$185,000,000
4	Bancor	$153,000,000
5	Status	$90,000,000
6	TenX	$64,000,000
7	MobileGO	$53,069,235
8	Sonm	$42,000,000
9	Aeternity	$36,960,594
10	Monetha	$36,600,000

What is different?

1. Multiple trading protocols are possible

User-facing exchange mask



Fully Decentralized, "OTC", Peer-to-Peer Exchange

0x

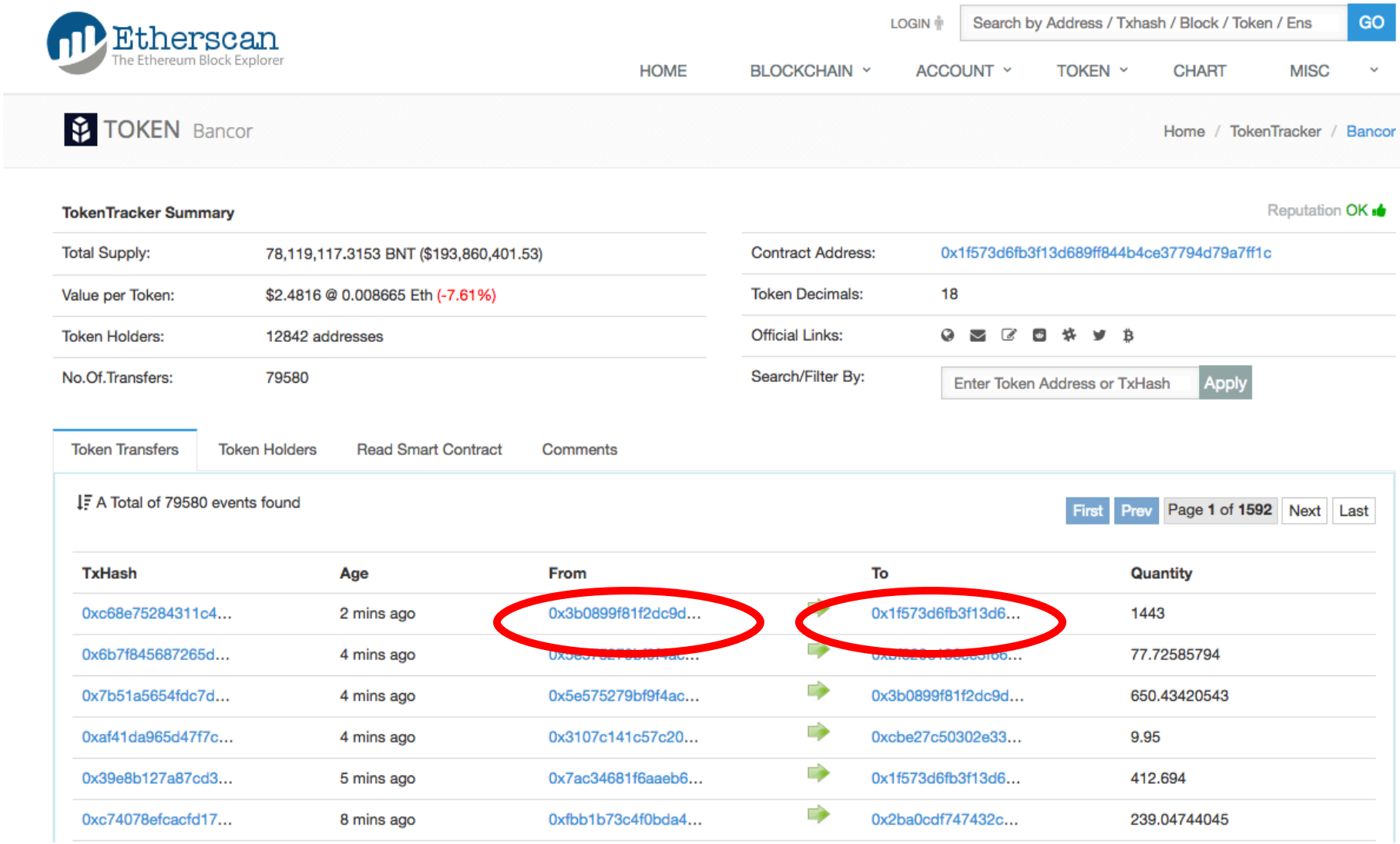
The Protocol for Trading Tokens

TOKEN SALE WHITEPAPER

What is different?

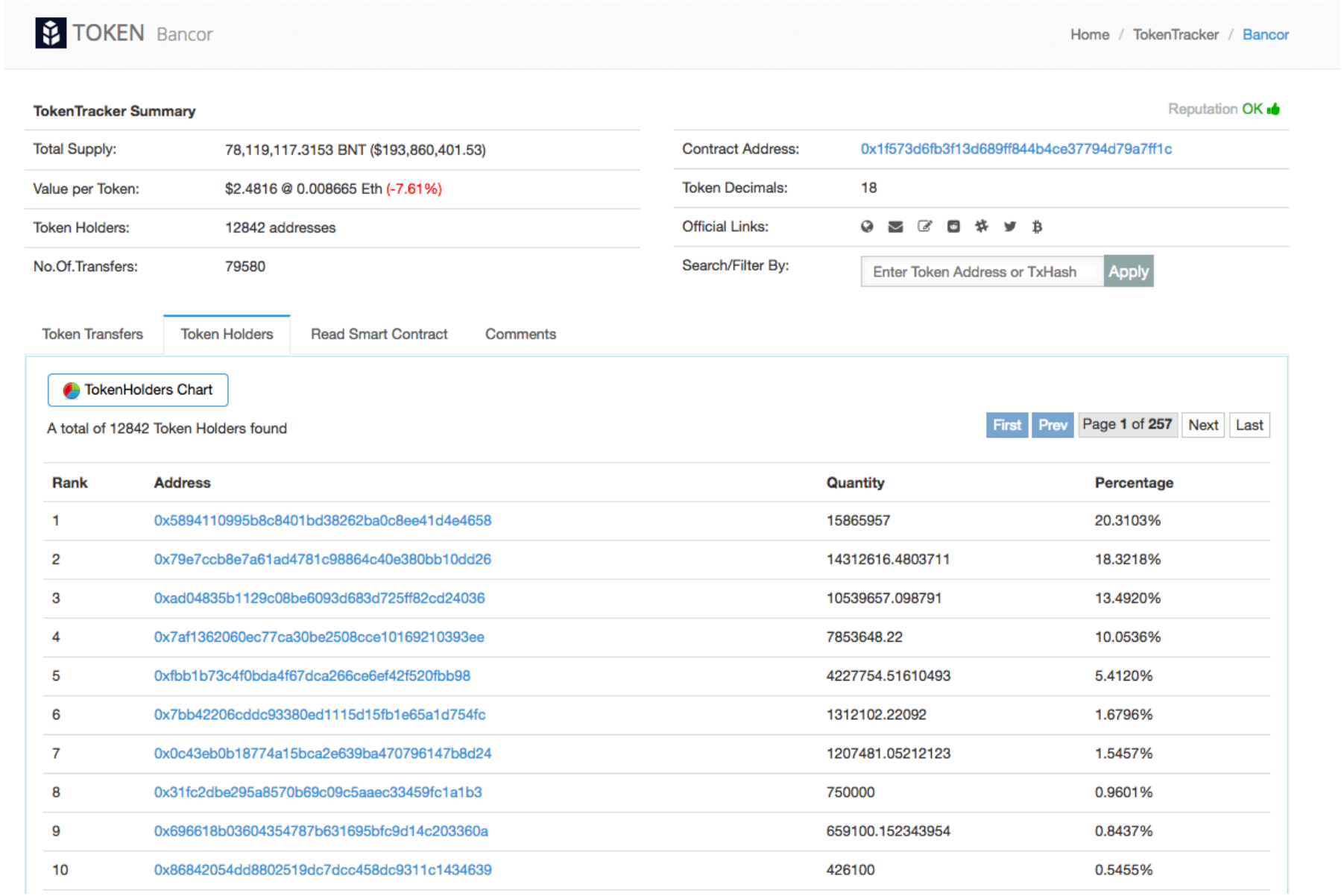
2. High Level of Transparency

See transactions *between "addresses" (="IDs")*



What is different?

3. You can tell who owns what



TOKEN Bancor

Home / TokenTracker / Bancor

TokenTracker Summary

Reputation OK

Total Supply:	78,119,117.3153 BNT ($193,860,401.53)
Value per Token:	$2.4816 @ 0.008665 Eth (-7.61%)
Token Holders:	12842 addresses
No.Of.Transfers:	79580

Contract Address:	0x1f573d6fb3f13d689ff844b4ce37794d79a7ff1c
Token Decimals:	18
Official Links:	
Search/Filter By:	Enter Token Address or TxHash Apply

Token Transfers | Token Holders | Read Smart Contract | Comments

TokenHolders Chart

A total of 12842 Token Holders found

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Rank	Address	Quantity	Percentage
1	0x5894110995b8c8401bd38262ba0c8ee41d4e4658	15865957	20.3103%
2	0x79e7ccb8e7a61ad4781c98864c40e380bb10dd26	14312616.4803711	18.3218%
3	0xad04835b1129c08be6093d683d725ff82cd24036	10539657.098791	13.4920%
4	0x7af1362060ec77ca30be2508cce10169210393ee	7853648.22	10.0536%
5	0xfbb1b73c4f0bda4f67dca266ce6ef42f520fbb98	4227754.51610493	5.4120%
6	0x7bb42206cddc93380ed1115d15fb1e65a1d754fc	1312102.22092	1.6796%
7	0x0c43eb0b18774a15bca2e639ba470796147b8d24	1207481.05212123	1.5457%
8	0x31fc2dbe295a8570b69c09c5aaec33459fc1a1b3	750000	0.9601%
9	0x696618b03604354787b631695bfc9d14c203360a	659100.152343954	0.8437%
10	0x86842054dd8802519dc7dcc458dc9311c1434639	426100	0.5455%

To sum up: What is different?

1. Exchange-trading and Peer to Peer is possible
   - current world peer-to-peer -- through intermediaries
     - a dealer/market maker is on one side of trade
     - parties know who they are trading with
   - technology enables frictionless value transfer
2. Past transactions are visible
   - may be able to see frequent "traders"
3. Current holdings are visible
   - may be able to tell who the "whales" are

=> Informational environment changes drastically

Key: wallets/addresses = IDs but NOT = traders

Research Question

- possible ledger transparency regimes:
  - visible to all
  - hidden (from some)
- possible identifier-usage regimes:
  - mandate single IDs per entity
  - allow multiple IDs
    - allows to obfuscate holdings (Buterin 2015)

How does the design of ledger transparency and identifier-usage with possible P2P interactions affect trading behavior and economic outcomes?

Who benefits and loses under which regime?

Model Ingredients

- Risky asset, value normally distributed $N(0, \sigma^2)$
- Two large investors
  - Each period one is hit with size *Q=1* liquidity shock.
  - Other can absorb the shock at zero cost.
- Continuum of 1/ ρ small investors $\rho \leq 1/2$
  - trade with probability ρ at "public" price
  - each period, mass 1 wants to buy, mass 1 wants to sell
- Infinitely many trading periods

Disclaimer:
- no asymmetric information
- => our results need not be applicable to all asset classes

Model Ingredients: Trading and Timing

- When hit with a shock, the "liquidity trader" (LT) may:
  - trade peer-to-peer (OTC) (with small and/or large peers)
    - other large: "liquidity provider" (LP)
  - trade with a risk-averse intermediary at

$$p(q) = \frac{\kappa\sigma^2}{N}\left(-I + q\right) \equiv \frac{\ell}{2}(q - I)$$

    - Intermediary's inventory ***I*** "shifts" the public price
  - net-trades with intermediary = inefficient transfer of risk
- Unfilled positions clear with intermediary at end of stage game.

Model Ingredients: Costs

Direct

- Data processing/complexity to contact *q*
- *Quadratic cost to contact mass q of IDs:*
  - cost *c* is a loss to aggregate welfare
  - pay $\frac{c}{2}q^2$ and trade quantity ρq
- Linear *mining/validation* cost:
  - pay γq to trade with q IDs

Indirect

- LT to LP: Buy quantity *Q* at price *p*?
- 1. LP buys *Q* from intermediary and moves the "public price" *P* to $P + \ell/2 \times Q$
  2. LP to LT: "sell you *Q* at price » *p*?"
- Front-runner pays validation costs.

Idea:

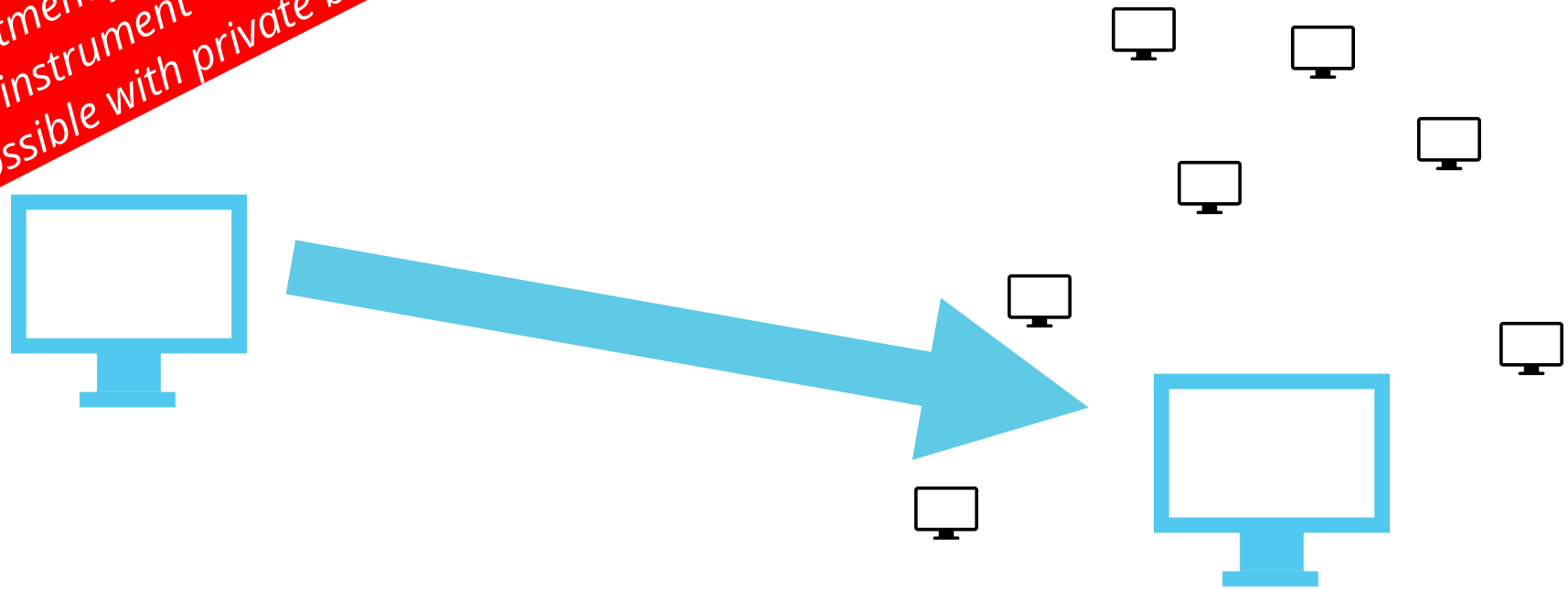
- *keep "risk" of transparency within trading model*
- *for investors, can think of other costs, e.g., stealing of investment strategies*

Model Ingredients: Transparency of Ownership

1. Full transparency = common knowledge of who is large
    - assume single ID (since validation costs increase in # of IDs)
2. No transparency
    - only single ID allowed
3. No transparency (ownership cannot be inferred)
    - continuum of IDs (to obfuscate ownership)

Benchmark:
fully transparent (single ID) ownership

Requires a system design choice:
- allow an entity (individual, investment fund) only a single ID per instrument
- possible with private blockchain



Options for Large Trader

Trade with small investors and intermediary

- costs:
  - complexity + validation
  - intermediation

Trade with large investor

- costs
  - reveal info about the trading needs
  - [model choice]:
    LT may get “front-run” by LP.

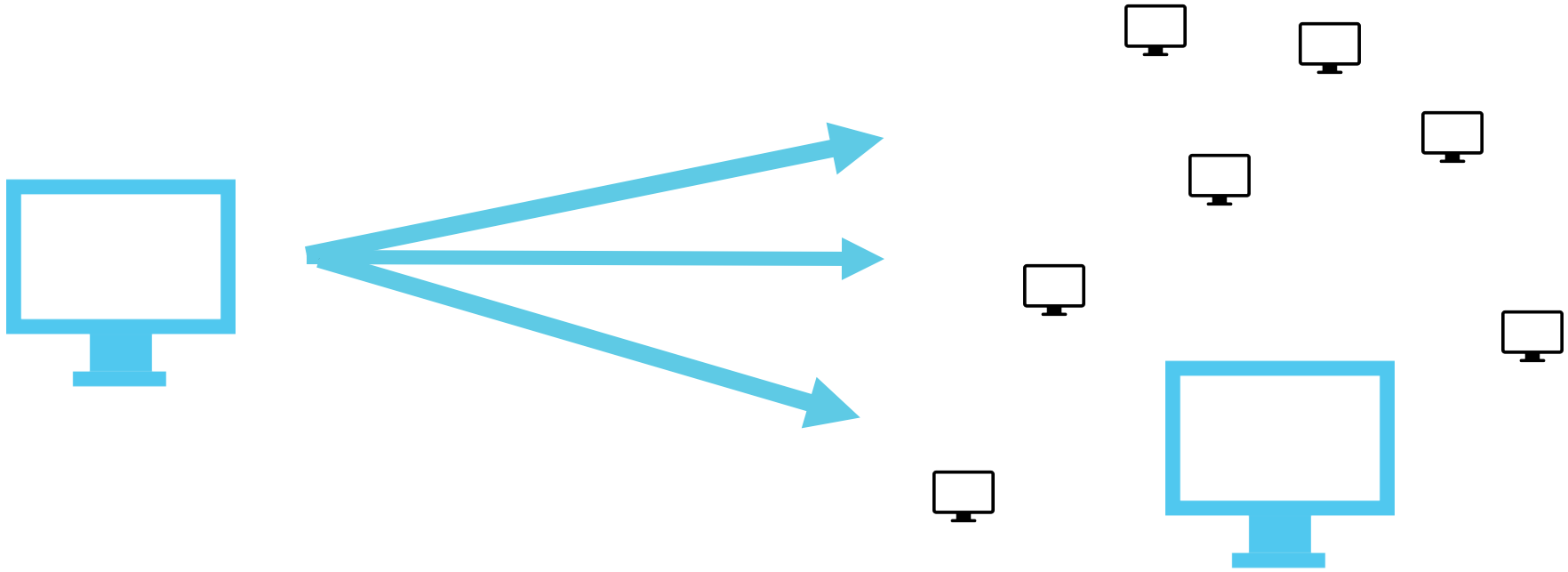
Single shot:
LP always extracts all surplus (or would front-run).

Repeated setting:
Front-running is punished by “grim trigger” & trade forever with small and intermediary.

The Benchmark Equilibrium

1. In a repeated game, "social norms" have bite and front-running can *always* be avoided.
2. LT always trades with LP.
3. LT and LP share the cost savings.
4. Price concession
    - For small discount factor (≈ infrequent interaction) price concession is necessary.
    - For large enough discount factors (≈ frequent interactions), price concession = 0 is an equilibrium.

Opaque single ID ownership



Equilibrium

- The optimal mass of IDs to contact is independent of the intermediary's inventories/public price.
- Mass *x** depends on:
  - ρ: probability of small traders accepting the offer
  - ℓ : the (il-)liquidity of the intermediated market
  - c : complexity/data processing costs.

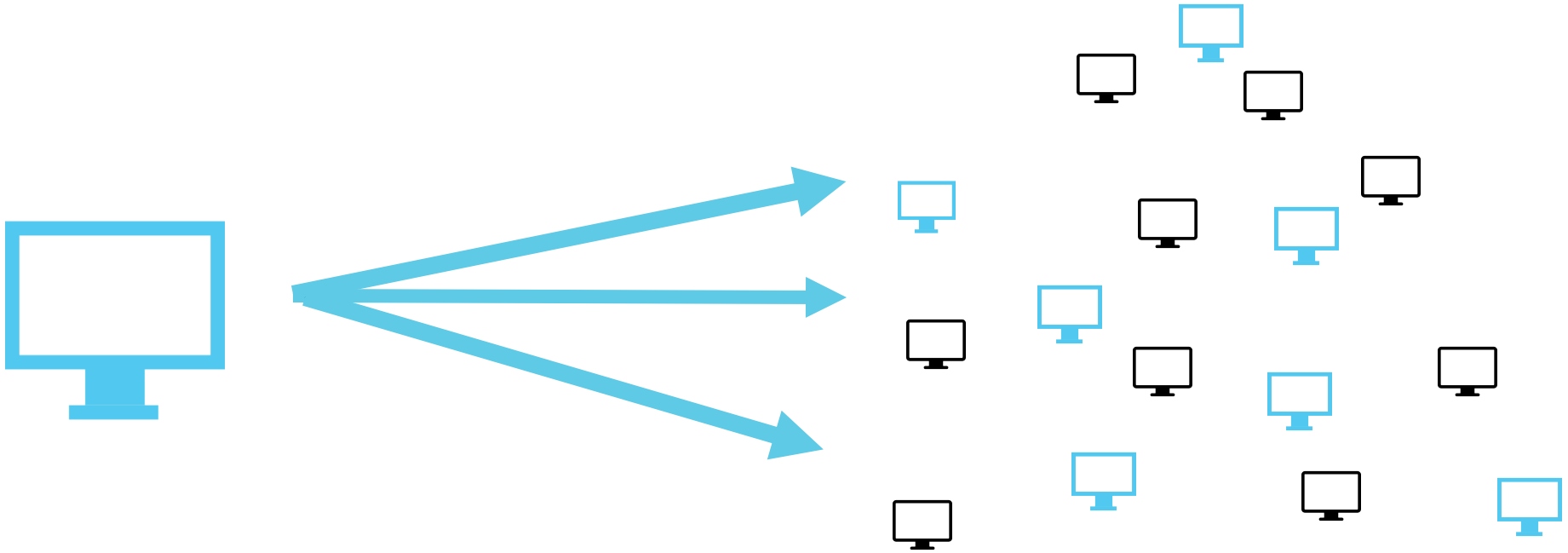
$$x^* = \max\{0, \frac{\ell\rho}{\ell\rho^2+c} - \frac{\rho\gamma}{\ell\rho^2+c}\}$$

- When the validation cost is not too large, $\gamma < \ell$, the liquidity trader trades with both continuum & intermediaries

Opaque multi-ID ownership

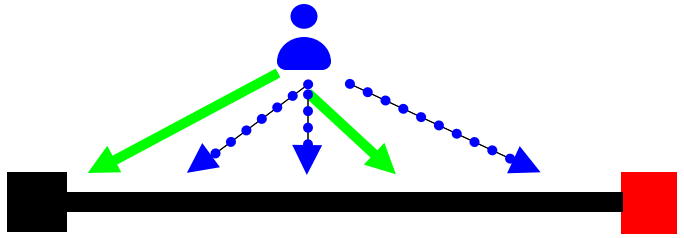
Closest and native to "public" blockchains:

- anyone can participate anonymously
- can create as many accounts as I want
- described by Ethereum founder as simple solution to achieve privacy
- private blockchains can choose to organize like this



Acceptance Probabilities: depend on LP's decision

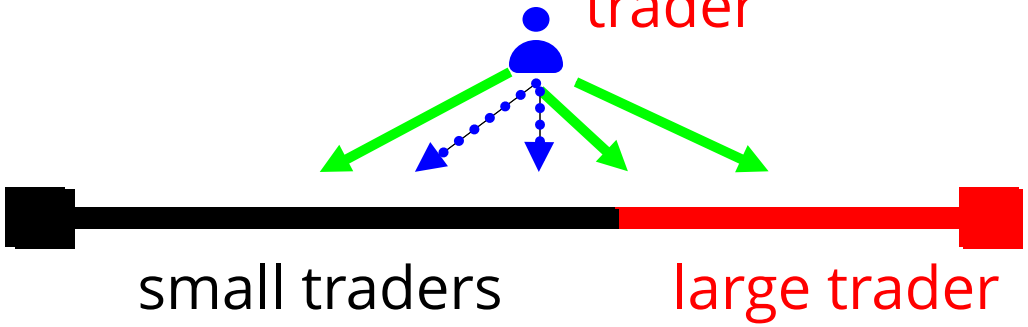
Opaque Single ID



ρ

Opaque Multi-ID:

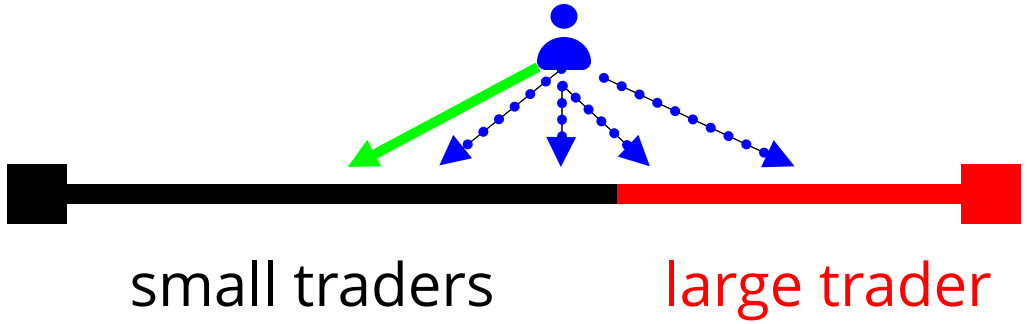
LP accepts



$$\frac{2\rho}{1+\rho} > \rho$$

Opaque Multi-ID:

LP rejects

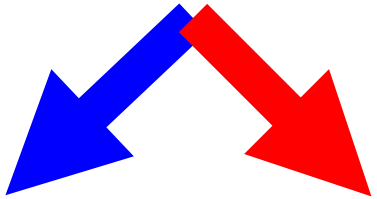


$$\frac{\rho}{1+\rho} < \rho$$

filled

unfilled

Decision problem LT



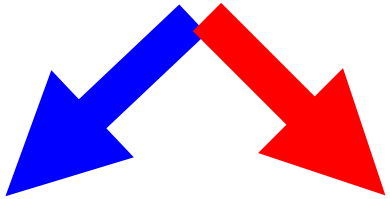
submit large amount to continuum

- (small) price concession to entice larger trader (but also paid to and "wasted on" small traders)
- larger search costs

submit large amount to continuum

- no price concession
- expensive interaction with intermediary
- smaller complexity cost

Decision problem LP



accept offer

front run

- incurs validation fee when front-running

Equilibrium & More

Result 1: There exists an equilibrium with no front-running where

- LP accepts
- price concession = 0

provided

- the discount factor is large enough
  - = frequent interactions.
- or the intermediated market is sufficiently liquid
  - = front running not very profitable (small quantity and low price advantage)
- or validation costs are sufficiently *high*
  - = sunk cost for front-running too high.

Equilibrium & More

Result 2 (numerical): For *small discount* (=infrequent interaction) factors, the equilibrium with no front-running where LP accept does ***not*** exist. Then:

- In equilibrium, LT offers p = 0 to the continuum, and
- LP's IDs reject the offer.

=> over-trading with intermediary

- **Observation:** an increase in the validation cost may curb front-running.

Comparing the designs

Observations

- Trades with intermediary => socially inefficient
  - better if large traders interact
  - otherwise: intermediary faces imbalance
- Small with large traders => complexity costs
- By construction, payoffs under the full transparency benchmark are highest.
- The trade-off for opaque regimes are:
  - complexity cost vs
  - intermediation cost

Comparing multi- vs single-ID opaque designs

- *Finding 1:*
  - *When large traders do not trade with each other, the welfare is the same in both opaque systems, irrespective of the ID-ownership setup.*
- Finding 2:
  - *When large do trade with one another with multi-ID ownership, the welfare in this setting is higher than in the single-ID setting.*

Payoffs to Large Traders

Finding 3:

For the average equilibrium stage payoffs of large traders.

1. In multi-ID, when large traders do not interact, eq. payoffs lower than in opaque single-ID.
2. In multi-ID, when large traders interact and $p=0$, eq. payoffs larger than in opaque single-ID.

Finding 4: (Numerical)

There exist parametric configurations such that large traders trade with each other at $p > 0$ in the multi-ID ownership setting, but their average equilibrium payoff in the opaque single-ID setting is higher.

Summary

1. "Back office" settlement has important front office implications!
   - with peer-to-peer there are critical design choices
     - Who can see the ledger?
     - How are virtual identities managed?
2. Findings:
   - Transparent ledger with single IDs is welfare optimal and has lowest wealth redistribution (almost by construction)
   - Between (A) public blockchain solution with multiple IDs and (B) private, non-transparent ledger with single IDs:
     - **public blockchain privacy solution** has higher aggregate welfare
     - but does not necessarily lead to higher payoffs for large investors.