'Smart Settlement'

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The Most Important Paper of our Generation

Bitcoin: A Peer-to-Peer Electronic Cash System

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Abstract. A purely peer-to-peer version of electronic cash would allow online payments to be sent directly from one party to another without going through a financial institution. Digital signatures provide part of the solution, but the main benefits are lost if a trusted third party is still required to prevent double-spending. We propose a solution to the double-spending problem using a peer-to-peer network. The network timestamps transactions by hashing them into an ongoing chain of hash-based proof-of-work, forming a record that cannot be changed without redoing the proof-of-work. The longest chain not only serves as proof of the sequence of events witnessed, but proof that it came from the largest pool of CPU power. As long as a majority of CPU power is controlled by nodes that are not cooperating to attack the network, they'll generate the longest chain and outpace attackers. The network itself requires minimal structure. Messages are broadcast on a best effort basis, and nodes can leave and rejoin the network at will, accepting the longest

Overview: Research Questions

Two main research questions

1. How fast should financial transactions be settled?
2. Equilibrium with competition in settlement time?

This paper in context

- Timely issue 1: Active market design issue for regulators post GFC (e.g., most EEA's markets adopted $T+2$ in 2014)
- Timely issue 2: Blockchain transforming post-trade service industry (and accounting): Distributed ledger is a "revolution in reconciliation"
- Original + forward looking! Competition in settlement times does not yet exist (that I know)
  - (i) 3-dimensional LOBs?
  - (ii) Intermediaries differentiation?

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Overview: Results

Optimal Time Settlement

$$T^* = \max\left\{0, \frac{\lambda - \delta(\theta - 1)}{2\delta\lambda}\right\}$$

$$\text{Comp Statics: } \frac{\partial T^*}{\partial \lambda} > 0; \frac{\partial T^*}{\partial \delta} < 0; \frac{\partial T^*}{\partial \theta} < 0$$

Main Policy Implications

1. If time to settlement is endogenous, intermediaries' rents increase in default risk. This could weaken risk management.
2. Imposing a unique time-to-settlement can improve welfare relative to the duopoly equilibrium

Comments. Lower T trade-off

The Good

- **Lowers counterparty risk**
- It may free capital for some participants

The Bad

- **Increases intermediation / liquidity costs**
- Less time for margin call calculation
- Less time to for managers to determine funding requirements
- Shorter window to recall stock from loan
- Data management (esp. for non exchange traded products)
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Settlement delay trade-off

Trade-off 1: Risk Management is absent. Overweighting default costs and benefits?

- Effective δ may be very small with CCP and novation
- Transaction default is a 'benefit' for intermediary.
  - Artifact of static framework? Likely a (large) cost in dynamic setting (continuation value $\downarrow 0$, margin other assets, etc.)
  - Both buyers and sellers exposed to counterparty risk

Trade-off 1: Interplay with Trading Mechanism

- Centralized: inventory management (risk tolerance, capital)
- OTC: actual search for securities is difficult (endogenous λ)

Trade-off 3: Role of Blockchain? non-liquidity costs savings?

Alternative: $\uparrow T$: *market* liq cost $\downarrow$, *funding* liq cost $\uparrow$ (for all)

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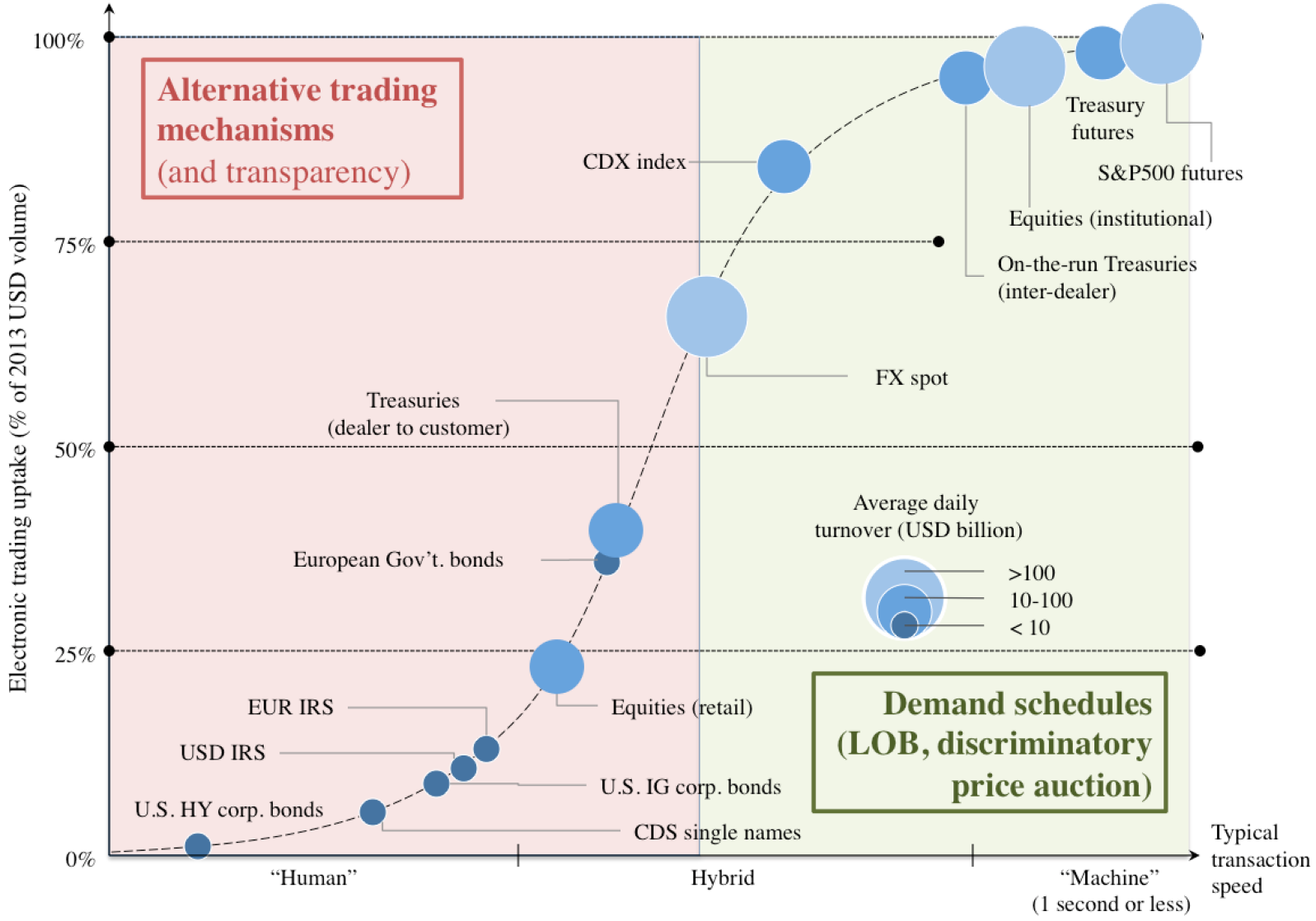
Opportunity: Inform Regulators, Industry Associations & Markets

- Calibrate model!
  - Specific risk management in place (margin-default fund)
  - Specific Trading Mechanism (Quote-driven market? Duffie-Garleanu-Pedersen's OTC? Crowdfunding platform?)
- Asset Classes Optimal settlement time may vary a lot for specific asset classes
  - **Cash Equities**: *"In a trading environment where quotes are updated with nanosecond frequency, a delay measured in days feels dated"*
    - 10 minutes sounds reasonable (time it takes for a single confirmation on the blockchain)
  - Fixed Income Instruments
  - Derivatives: ETFs, Warrants, Swap contracts
  - Repo transaction
  - Real estate

Analogy: Assets and Trading Speeds

Contrasts with very similar settlement cycles: T+2 or T+3



Duopoly Model

- Time-to-settle as vertical-differentiation factor. Nice!
  - Makes sense from the perspective of the buy-side customer
  - Can apply standard Shaked-Sutton-like analysis (e.g., finiteness property)
- It may be different if dealer and exchange are not the same agent: In that T may work **horizontally:** *ceteris paribus*
  - Buy-side prefers shorter T
  - Sell-side prefers longer T
  - Then we have a spatial or Hotelling-like equilibrium (quite different)
  - Most likely is a combination of both (e.g., Sutton 1986)

Revisiting Policy Implications 1: Intermediaries' rents increase in default risk.

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Settlement Speed vs. Trading Speeds

- **Connections with Pagnotta Philippon (2016)**:
  - Vertical differentiation through trading speed (no inventory)
  - In both cases opportunity cost of not getting the asset is $\neq$ (default, pref. shock)
- Both equilibrium frequencies (trade, settlement) are inefficient
  1. Imperfect discrimination (planner values infra-marginal types)
  2. Differentiation relaxes Bertrand competition

Communication tech: $\lim_{\text{speed cost}\to 0}$ duopoly welfare$\neq$first best

Blockchain: $\lim_{\text{settlement cost}\to 0}$ duopoly welfare$\neq$first best

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Concluding Remarks

- Thought provoking paper on important and timely issues
- Potential to influence market design (optimal T)
- Great scope for extensions that integrate Blockchain more directly
  - More sophisticated settlement contracts?
  - One blockchain per asset?
  - One blockchain globally? Cross-border regulations?