Welfare and Trading Frequency in Dynamic Double Auctions

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Key Market Design Issues

- Environment: Competition in demand schedules
  - Financial assets (e.g., bonds auctions)
  - Other markets: wholesale electricity, bidding for government procurement contracts, management consulting, airline pricing systems
- Trading frequency in Financial Markets
  - Is faster socially better?
  - What is the optimal trading frequency?
  - What are the drivers?
- Underlying big question: What is the rationale for (the prevalence of) continuous-time markets?

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Thinking about Fast Trading

The Good

- **Single asset**
  - Shorter waiting times. Better allocations.
  - Faster social learning through information aggregation into prices
- **Multiple assets**
  - More effective Hedging
  - More effective Arbitrage
  - More effective cross-learning

The Bad

- Thinner liquidity
- Higher picking-off risks
- Arm races. Too much intermediation?

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And the Ugly

Sniffing, Spoofing, Stuffing,...

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The Model in Context

- Framework related to Vayanos (1999)
  - n large traders with strategic non-competitive behavior
  - Asymmetric information about private value of trading (endowments)
  - Submit demand schedules (as in Kyle, 1989)
  - Trades take place at intervals of length $\Delta \geq 0$
  - Market clearing mechanism: uniform double-auction
- Vayanos' main results
  - Welfare loss increases as the time between trades decrease
  - Exponential convergence as n increases
  - In the limit $\Delta \to 0$, welfare loss is of order $1/n$ and not $1/n^2$ as in the static double auction literature (e.g., Gresik and Satterthwaite (1989), Satterthwaite and Williams (1989))

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Du-Zhu's Setting

- Three key differences with Vayanos (99)
  1. Asymmetric information about asset payoff.
     - Tractable with linear-quadratic preferences + affine information structure (as in Vives (2011))
  2. Information arrival: Deterministic ('scheduled') vs. stochastic times
  3. Heterogeneous speeds
- New Results
  - Slower convergence with asymmetric information regarding common value
    - $n^{-4/3}$ instead of n^{-2}; $n^{-2/3}$ instead of n^{-1} in the continuous-time limit
  - Optimal trading frequency crucially depends on info arrival
    - For deterministic arrival times: slow trading (matches info frequency)
    - For Poisson arrival times: faster frequencies provide valuable flexibility
  - Heterogeneous speeds: slow traders prefer slower speeds

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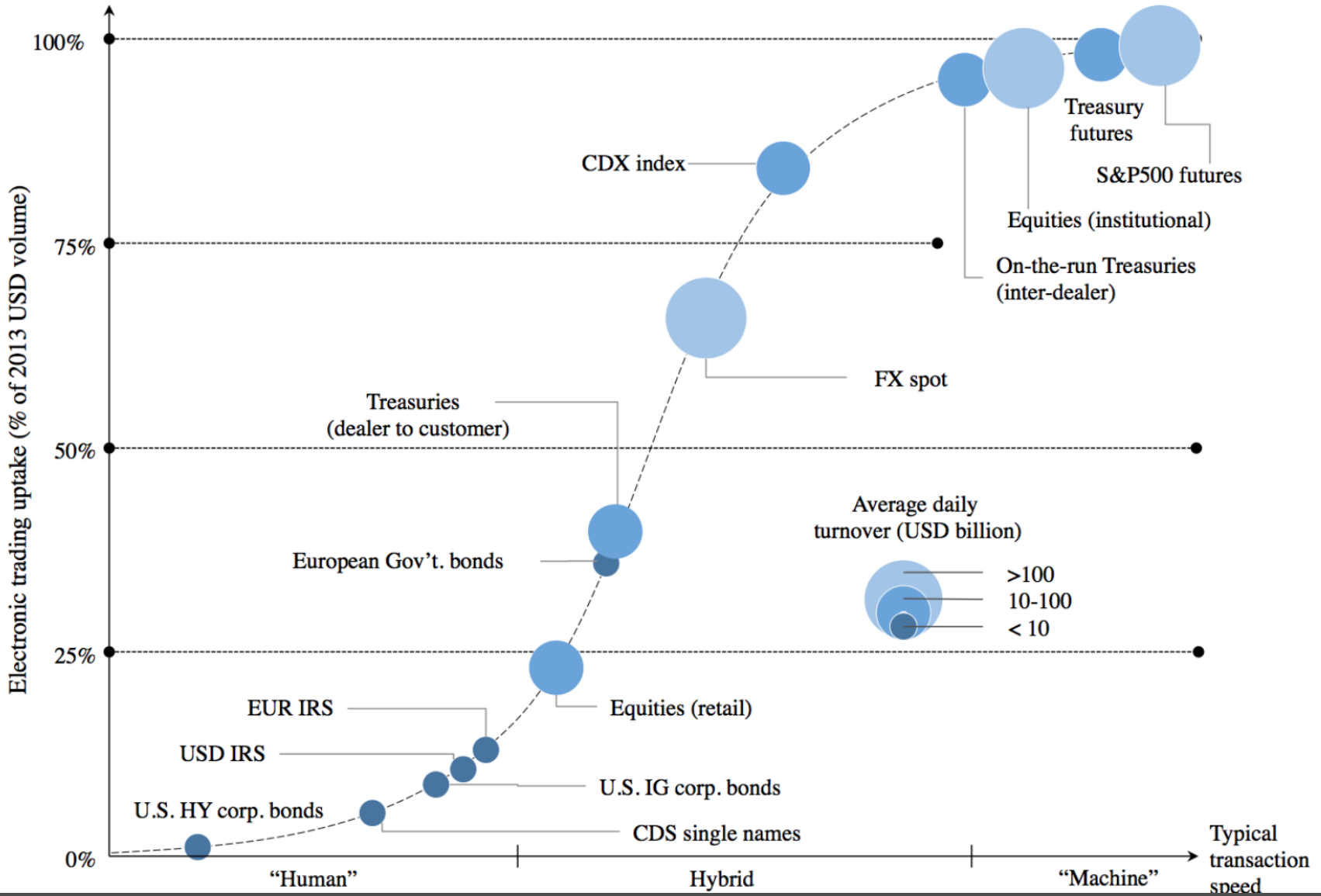
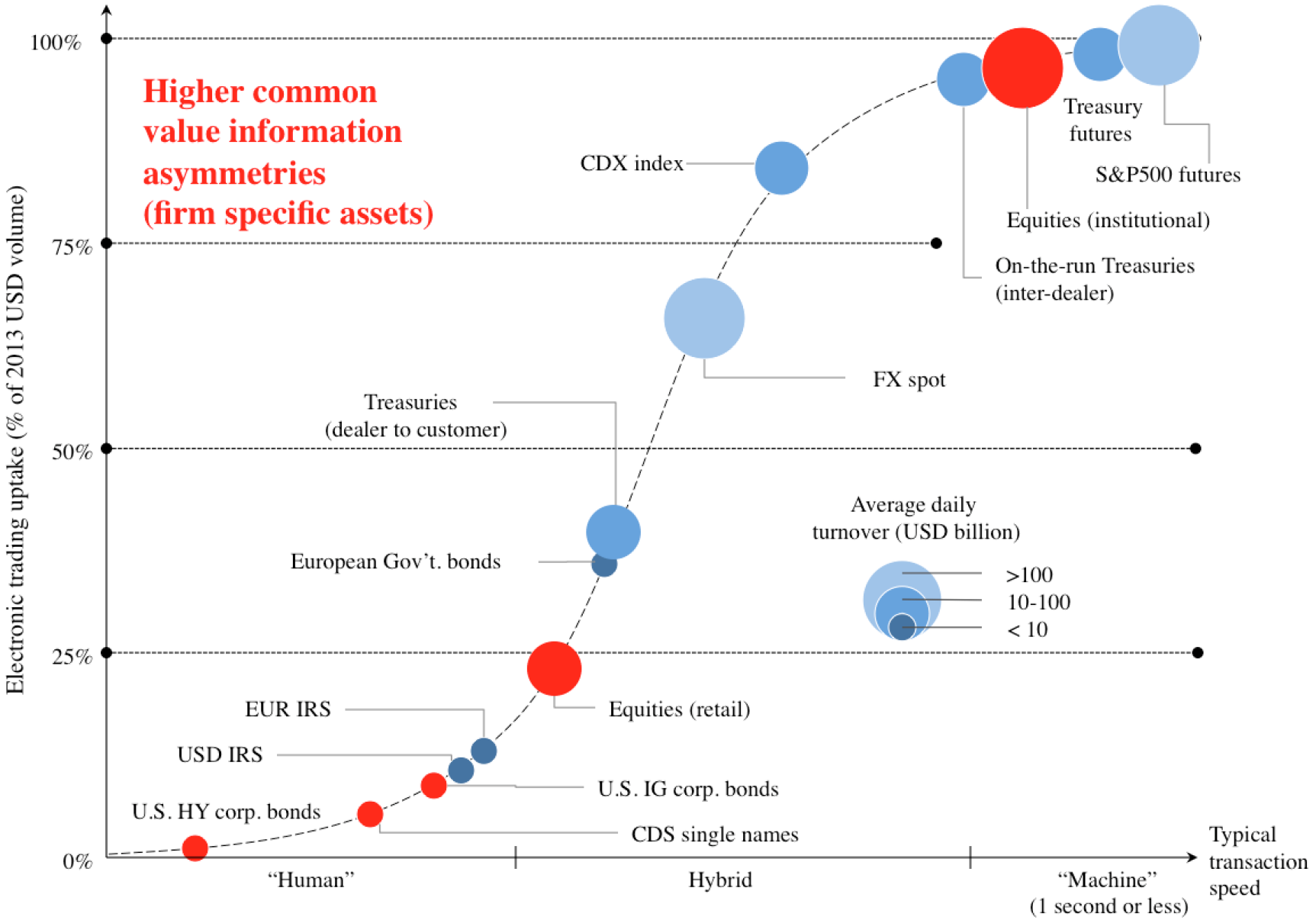
Markets and Trading Frequencies

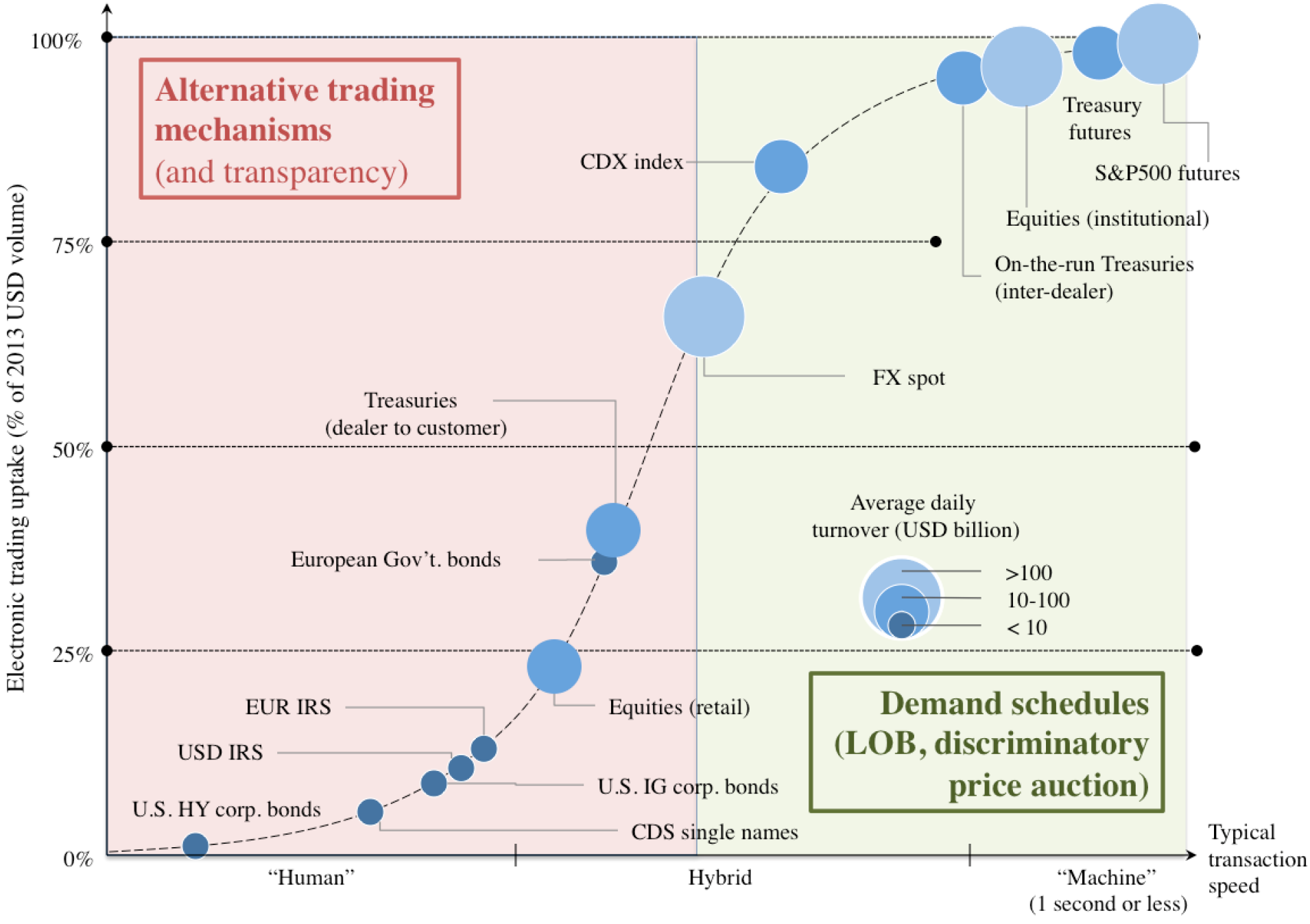


Asset Characteristics



Agenda: Towards a theory of optimal trading frequencies

- More realistic information structures. Unbundling private value shocks? (e.g., Lo, Mamaysky and Wang, 2004)
- Non-stationary shocks and price impact (Rostek and Weretka, 2015)
- Competition between trading venues (e.g., Pagnotta and Philippon, 2015)
- Alternative trading mechanisms (e.g, Budish, Cramton and Shim, 2013)
- Asynchronous trader arrivals, pick-off risk for limit order traders (e.g., Menkveld and Zoican, 2014)


Alternative trading mechanisms (and transparency)
Demand schedules (LOB, discriminatory price auction)
Electronic trading uptake (% of 2013 USD volume)
100%
75%
50%
25%
0%
Typical transaction speed
"Human"
Hybrid
"Machine" (1 second or less)
Treasury futures
S&P500 futures
Equities (institutional)
On-the-run Treasuries (inter-dealer)
CDX index
FX spot
Treasuries (dealer to customer)
European Gov't. bonds
Average daily turnover (USD billion)
>100
10-100
< 10
Equities (retail)
EUR IRS
USD IRS
U.S. IG corp. bonds
U.S. HY corp. bonds
CDS single names

Investor Heterogeneity and Competition in Auction Frequencies

- **Connections with Pagnotta Philippon (2015)**
  - Small traders ('thick' mkts), public knowledge of common value
  - Ex-ante investor heterogeneity: Same abilities but different volatility of private value $\Rightarrow \neq$ preferences for frequencies
  - Increasing auction frequencies is costly
  - Auction frequency is an outcome of **venues' profit maximization**: Δ_j Poisson rate controlled by venue $j = 1, ..., J$
- Equilibrium frequencies are inefficient, lack of convergence
  - Inability of venues to perfectly discriminate frequencies (planner cares about infra marginal types)
  - Frequency differentiation relaxes price competition

$$\lim_{\text{speed cost} \to 0} \text{oligopolistic welfare} \neq \text{first best welfare}$$

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Competition in Auction Frequencies

Speed cost, speed regulation, and social outcomes (Walrasian case=100)

	Corporate Bonds				Equities				S&P500 Futures			
	Δ	$\mathcal{P}$	$\mathcal{V}$	$\mathcal{W}$	Δ	$\mathcal{P}$	$\mathcal{V}$	$\mathcal{W}$	Δ	$\mathcal{P}$	$\mathcal{V}$	$\mathcal{W}$
I. Baseline	$\gamma = 0.834, c = 0.0362$				$\gamma = 182.95, c = 0.000157$				$\gamma = 390.63, c = 0.00275$			
Monopoly	36.211	50.00	48.87	72.21	21,986	50.00	49.59	73.97	117,000	50.00	49.83	74.58
Venue 1	1.044	29.14	16.20	8.77	239.13	29.16	16.52	8.95	516.93	29.17	16.61	9.00
Venue 2	38.132	58.27	57.05	79.67	23,758	58.32	57.88	81.56	126,402	58.33	58.15	82.20
Duopoly	-	87.41	73.25	88.44	-	87.49	74.40	90.51	-	87.50	74.76	91.20
II. $c \downarrow$	$\gamma = 0.834, c = \frac{1}{2}0.0362$				$\gamma = 182.95, c = \frac{1}{2}0.000157$				$\gamma = 390.63, c = \frac{1}{2}0.00275$			
Monopoly	51.555	50.00	49.2	73.02	31,169	50.00	49.71	74.27	165,625	50.00	49.88	74.71
Venue 1	1.066	29.15	16.36	8.86	240.6	29.16	16.57	8.97	518.11	29.17	16.63	9.01
Venue 2	55.719	58.3	57.44	80.55	33,677	58.33	58.01	81.88	178,924	58.33	58.21	82.33
Duopoly	-	87.45	73.80	89.04	-	87.49	74.58	90.85	-	87.50	74.83	91.34
III. $\Delta_{\min} \uparrow$	$\gamma = 0.834, c = 0.0362$				$\gamma = 182.95, c = 0.000157$				$\gamma = 390.63, c = 0.00275$			
Venue 1	1.565	29.99	19.57	9.74	358.69	30.00	19.87	9.92	775.40	30.00	19.95	9.97
Venue 2	40.538	59.99	58.78	81.06	24,587	60.01	59.57	82.93	130,767	60.01	59.83	83.57
Duopoly	-	89.98	78.35	90.81	-	90.01	79.44	92.85	-	90.01	83.57	93.54

The terms $\mathcal{P}$, $\mathcal{V}$, and $\mathcal{W}$ denote participation, trading volume, and welfare, respectively.

Concluding Remarks

- Important technical contribution on key market design issue
  - Asymmetric information about private and common values
  - Highlights role of different stylized ("intuitive") information structures.
- Important Message: there is not a single solution for the market design problem!
  - Asset characteristics, investor heterogeneity matter