

Decentralized-Market Design: Advances and Open Problems

Marzena Rostek
University of Wisconsin-Madison

SaMMF Lecture Series

June 24, 2022

Financial markets

▶ Financial markets are

- Imperfectly competitive
- Fragmented/decentralized

▶ Parallel developments in other markets

Production, labor, international trade, monetary policy, ...

(Surveyed, e.g., in the special issue of Journal of Economic Perspectives in the Summer' 2019, and the special issue of Journal of Monetary Economics in May 2021 re: the Carnegie- Rochester-NYU Conference)

Financial markets

▶ Financial markets are

- **Imperfectly competitive**

Dominated by institutional investors

Investors rely on price impact estimation

Price impact costs dominate explicit trading costs

- **Fragmented/decentralized**

Proliferation of trading venues

New online marketplaces:

TradeWeb.com, BondDesk.com, MarketAxess.com, BrokerTec, eSpeed

This lecture

Decentralized-market design

- I. Will be a different kind of theory compared to centralized markets
- II. Challenges the methods we have used
- III. Has already significantly advanced

Models so far

▶ Imperfectly competitive markets

At least since Wilson (1979), Glosten and Milgrom (1985), Kyle (1985, 1989), ...

▶ Decentralized/fragmented markets

- **Search and matching approach (random graphs)** (e.g., Gale (1986), Duffie, Garleanu and Pedersen (2005), Vayanos and Weill (2008), Weill (2008), Duffie, Malamud and Manso (2009, 2011), Golosov, Lorenzoni and Tsyvinski (2009), Lagos and Rocheteau (2009), Alfonso and Lagos (2015), Gofman (2018), Lester, Shourideh, Venkateswaran, and Zetlin-Jones (2018, 2019), Uslu (2019), Chang and Zhang (2020), Hugonnier, Lester, and Weill (2020), Bethune, Sultanum, and Trachter (2021), Colliard and Demange (2021), ...)
- **Networks approach (fixed graphs)** (e.g., Biais (1993), Kranton and Minehart (2001), Gale and Kariv (2007), Blume, Easley, Kleinberg and Tardos (2009), Manea (2011), Nava (2011), Abreu and Manea (2012 a,b), Bramoulle, Kranton and D'Amours (2013), Acharya and Bisin (2014), Elliott, Golub, and Jackson (2014), Acemoglu, Ozdaglar, and Tahbaz-Salehi (2015), Condorelli and Galeotti (2016), Opp and Glode (2016), Cabrales, Gottardi, and Vega-Redondo (2017), Choi, Galeotti and Goyal (2017), Malamud and Rostek (2017), Babus and Kondor (2018), Rostek and Yoon (2021, 2022), ...)

Financial market design: modeling approaches

▶ Limit order book models

(surveyed, e.g., by Harris (2003), Foucault (2010))

▶ Uniform-price double auction (Games in demand/supply functions)

(e.g., Wilson (1979), Grossman (1981), Hart (1985), Klemperer and Meyer (1989), Kyle (1989), Vayanos (1999), Vives (2011))

- **Past decade:** Trader heterogeneity, general information structures, flexible market structures
- Common analytic framework for static, dynamic, centralized and decentralized markets
- Growing literature on financial market design¹

¹(e.g., Wilson (1979), Klemperer and Meyer (1989), Kyle (1989), Vayanos (1999), Vives (2011), Rostek and Weretka (2012, 2015), Ausubel et al. (2014), Sannikov and Skrzypacz (2016), Babus and Kondor (2017), Babus and Parlatore (2017), Du and Zhu (2017a,b), Kyle, Obizhaeva, and Wang (2017), Kyle and Lee (2017), Malamud and Rostek (2017), Duffie (2018), Zhang (2019), Babus and Hachem (2020a,b), Bergeman, Heumann, and Morris (2020), Chen and Zhang (2020), Yoon (2020), Allen and Wittwer (2021), Antill and Duffie (2021), Budish, Cramton, Kyle, Lee, and Malec (2021), Chen and Duffie (2021), Manzano and Vives (2021), Rostek and Yoon (2021, 2022), Wittwer (2021), Somogyi (2021))

Scope for integrating

- ▶ Trading relationships are neither purely random or fixed
- ▶ Separate the implications of fragmentation in cross section vs. time series
- ▶ Market structures with diverse trading arrangements: multilateral and bilateral relationships

e.g., NYSE executes $< 25\%$ of trade in its listed stocks

16 public exchanges

> 30 private exchanges

> 200 dealer networks

Opportunities to contribute

▶ Questions in policy/regulation:

- Mandate to clear assets in a centralized platform rather than OTC
- Standardization
- Benchmark manipulation (LIBOR)
- Privacy
- Pre-trade and post-trade transparency
- Trading technology
- Alternative m.c. arrangements
- Weaknesses in design exposed during the pandemic
- Proposal to eliminate intermediaries

▶ Focus has changed:

Before the financial crisis: Frictions, inefficiencies due to market fragmentation

After the financial crisis: When is centralized trading efficient?

Opportunities to contribute

- ▶ **The literature has shown:** *If suitably designed*, decentralized market can²
 - Be more efficient
 - Improve distribution of risk
 - Simplify the design for market participants
 - Be more stable

- ▶ **Work ahead:** *Design principles for decentralized/fragmented markets*

²(e.g., Pagano (1989), Biais (1993), Zhu (2014), Glode and Opp (2016), Babus and Kondor (2017), Babus and Parlato (2017), Malamud and Rostek (2017), Even, Tahbaz-Salehi, and Vives (2018), Babus and Hachem (2020), Manzano and Vives (2020), Peivandi and Vohra (2020), Allen and Wittwer (2021), Dugast, Uslu, and Weill (2021), Chen and Duffie (2021), Rostek and Yoon (2021, 2022), Wittwer (2021), Yoon (2021), Somogyi (2022), ...)

II. A different kind of theory

Consider the “centralized market” assumption

(1) **Complete participation** (w.r.t. traders and assets)

II. A different kind of theory

Consider the “centralized market” assumption

- (1) **Complete participation** (w.r.t. traders and assets)
- (2) **Complete conditioning** (of (net) demands)
 - ▶ Contingent schedules:


$$q_k^i(p_1, \dots, p_K) : \mathbb{R}^K \rightarrow \mathbb{R} \quad \forall k \in K$$

- ▶ Uncontingent schedules:³

$$q_k^i(p_k) : \mathbb{R} \rightarrow \mathbb{R} \quad \forall k \in K$$

Decentralized market:

- ▶ Agents trade assets in K **exchanges**
- ▶ Each exchange is for one asset $k \in K$ (for now) and all traders I

³Studied by Cespa (2004), Chen and Duffie (2021), Rostek and Yoon (2021), Wittwer (2021). 

II. A different kind of theory

▶ Innovation in decentralized markets (neutral in centralized markets)

- New synthetic products (e.g., ETFs, ETPs, derivatives)
and new technologies (offered, e.g., by Etrade, Street Smart, Tradehawk)

Spanning does not hold

- **Welfare:** With synthetic products, decentralized markets can be designed to be at least as efficient as the centralized market

Joint market clearing is unnecessary and can be suboptimal

▶ A new market design problem: Design of market clearing

▶ New products vs. new technologies?

- Do not substitute as instruments in design
- Either can dominate in welfare terms

III. New methods needed

Decentralized trading

- (1) Weakens the role of **spanning**
- (2) Limits the scope for **recursive analysis**

Typical approaches in analysis of dynamic markets

- Markovian private information and symmetric traders (Vayanos (1999, 2001))
- Prices are fully revealing in all rounds, or information is disclosed fully after each round (Vayanos (1999), Antill and Duffie (2017), Du and Zhu (2017a), Kyle, Obizhaeva, and Wang (2018), and Sannikov and Skrzypacz (2016))
- Relax the assumptions about the state variables to keep track of; e.g., oblivious equilibrium (Weintraub, Benkard, and Van Roy (2006)) and variants of self-confirming equilibrium (e.g., Fudenberg and Levine (1993, 2009), Dekel, Fudenberg, and Levine (1999), Cho and Sargent (2008), Pakes (2016))
- Stationary equilibrium

III. New methods needed

Decentralized trading

- (1) Weakens the role of **spanning**
- (2) Limits the scope for **recursive analysis**
- (3) Calls for **general matching models (theory of stability)**

with substitutable *and* complementary agreements/contracts

- (4) Shifts the focus from efficiency to **(re)distribution**

e.g., Dworzak, Kominers, Akbarpour (2020, 2021); surveys by Pathak (2016, Annual Reviews), Li (2017, Oxford REP), Kearns and Roth (2019)

Additional research directions

Applied theory

- ▶ Mechanism design?
- ▶ Market design and HFT: Latency arbitrage
- ▶ Privacy

Empirical research

- ▶ Collect data! Stylized facts
- ▶ Portfolio choice in decentralized markets

Recent surveys

Kastl (2020, IJIO)

Milgrom (2019, Annual Reviews)

Rostek and Yoon (2020, prepared for JEL)

Teytelboym, Li, Kominers, Dworzak, and Akbarpour (2021, SJE)

Weill (2020, Annual Reviews)

Thank You