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Market Microstructure: Trading and Liquidity

**Lecture 1. Introduction.
Trading Mechanisms and Market Structure**

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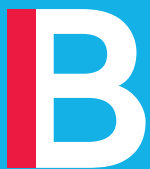
1

Introduction

Readings:

- Introduction and Chapter 1 - Foucault, Pagano and Röell, *Market Liquidity* 2nd edition, 2024.
- "Walter Bagehot" (aka Jack Treynor), The only game in town, *Financial Analysts Journal*, 1971, available at https://www.jstor.org/stable/4470784.
- Stoll, Hans R., 2006. Electronic trading in stock markets, *Journal of Economic Perspectives* 20(1), 153-174, available at https://www.jstor.org/stable/30033638.

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Outline

- **Introduction:** what is market microstructure?
  - Perfect vs. real-world financial markets
  - Liquidity and price discovery
  - Empirical puzzles and policy issues
- **Basics of securities trading**:
  - Trading platforms and market participants
- **Basics of market mechanisms**:
  - Auction (order-driven) vs. dealer (quote-driven) markets
  - Features: centralization, intermediation, transparency, continuity
- **Who sets the rules?**
  - Regulation vs. self-regulation: governance of exchanges
  - Role of (i) competition between exchanges and (ii) technology

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What is market microstructure?

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Perfect financial markets

- The price reflects all investors' "consensus view" about fundamentals (future cash flows, etc.)
- This requires several assumptions:
  - All potential buyers and sellers are present on the market, and act as price-takers
- All trade at a single market-clearing price
- There are no "frictions":
  - brokerage commissions and transaction taxes
  - bid-ask spreads
  - cost of acquiring information, *etc.*
- Order flow *per se* has no effect on prices

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Real-world financial markets

- Not everyone participates all the time: at each moment, prices are determined by a few participants who absorb orders (*market makers*)

- "Frictions" are commonplace

- Differences in information among participants

- The order flow affects transaction prices

- These prices may deviate from the "consensus prices" that would prevail under perfect markets:

  - how much they deviate $\Rightarrow$ **illiquidity**, **volatility**

  - how fast they converge $\Rightarrow$ speed of **price discovery**

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Illiquidity

- **Degree to which transaction prices deviate from the consensus value of the security**

- Buy orders raise transaction prices, sell orders lower them:
    - ask price > bid price $\Rightarrow$ bid-ask spread = illiquidity

- Bid-ask spreads differ greatly, especially with market cap:

Stock	Amazon	Boeing	Campbell Soup	Borr Drilling
Market capitalization (bn $)	1566.88	117.65	13.78	0.23
Best bid price	3124.00	207.71	45.48	0.99
Best ask price	3124.75	207.79	45.36	1.03
$ bid-ask spread	0.75	0.08	0.38	0.04
% bid-ask spread	0.02%	0.04%	0.83%	3.96%

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Price discovery

- **Speed and accuracy with which transaction prices impound available information**
- Security markets can be very good and fast at aggregating many bits of information and using them to price assets:

    - explosion of Space Shuttle Challenger on 28 January 1986

    - within 15 minutes the market "knew" which of the 4 possible manufacturers was responsible for the accident $\Rightarrow$ sell-induced trading halt for its shares

    - scientists reached the same conclusion 15 days later

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Why should we care?

- Liquidity:
  - in **illiquid markets** investors face higher **trading costs** $\Rightarrow$ **lower return** on securities $\Rightarrow$ require an offsetting liquidity discount $\Rightarrow$ companies face **higher cost of capital** on primary market
- Price discovery:
  - slow discovery $\Rightarrow$ **errors** in investors' **portfolio** choices, and unreliability of the stock price as a reference point for
    - managers' **real investment** choices, and
    - evaluating **managers' performance** and devising equity-and option-based compensation schemes to incentivize them

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Market microstructure

- A framework to understand:
  - how securities markets work
  - how we can measure liquidity
  - what are its determinants
  - which market characteristics affect it
  - whether liquidity is priced
  - whether liquidity and price discovery affect company choices, and how
- Useful to **market participants** in thinking of ways to minimize transaction costs and identify profit opportunities
- Useful to address **empirical puzzles** and **policy issues**: for example
  …

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Puzzle # 1: illiquidity and the subprime crisis

- During the crisis of 2008, bid-ask spreads on stocks (esp. financials) rose steeply
- Several fixed income markets went further: "market freeze"

Average Percentage Bid-Ask Spread Around the World
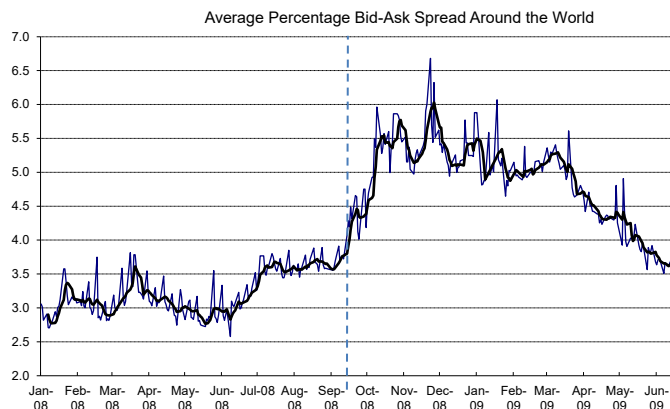
Source: A. Beber and M. Pagano, "Short-Selling Bans around the World: Evidence from the 2007-09 Crisis," *Journal of Finance*, 2012. The vertical line marks the Lehman Brothers collapse.
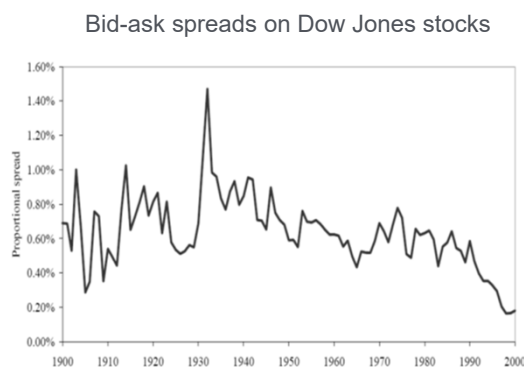
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Puzzle # 2: long-run trend in transaction costs

- Bid-ask spreads have declined since the 1930s, in particular since the late 1980s
- Since the mid-1970s, commissions also declined (from 0.9% to 0.1%)

Bid-ask spreads on Dow Jones stocks

Source: C. Jones, "A Century of Stock Market Liquidity and Trading Costs," Working Paper, 2002
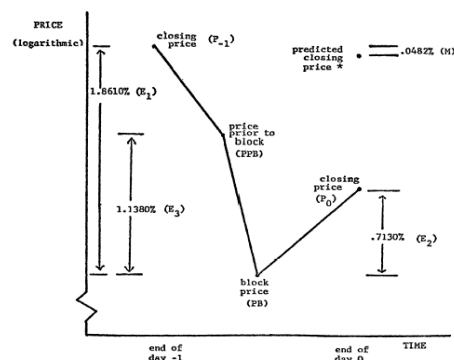
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Puzzle # 3: price effects of block trades, and reversals

- Known since Kraus & Stoll (1972): block sale depresses transaction price
- … but effect is largely reversed by market close
- Symmetric for block buy

Source: A. Kraus and H. Stoll, "Price Impacts of Block Trading on the New York Stock Exchange," Journal of Finance, 1972
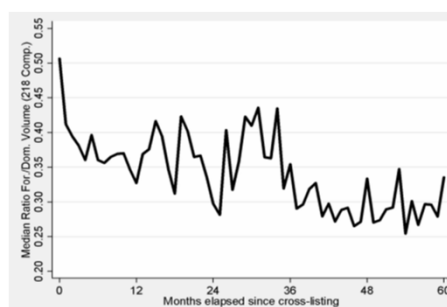
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Puzzle # 4: agglomeration of trading activity

- Why do existing markets exert a "gravitational pull" on new trading venues, *e.g.* after cross-listing?
- Why does trading concentrate over time, especially at the open and close of the trading day?

Ratio of foreign to domestic trading volume after cross-listing

Source: M. Halling, M. Pagano and J. Zechner, "Where Is the Market? Evidence from Cross-Listings in the United States," Review of Financial Studies, 2008

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Other puzzles

- **Why do some traders disclose their trades, and others hide them?**
    - Some preannounce their orders: "sunshine trading"
    - Others submit "hidden orders" or trade in "dark pools"
- **Persistent deviations from arbitrage-free prices**:
    - Why can prices of assets or portfolios with same cash flows differ persistently, and even diverge?
        - *Example 1*: "Siamese twins" = pairs of companies incorporated in different countries that operate the same business. They should trade at the same price, yet in 1980-2002 arbitrage in their shares could produce abnormal returns of almost 10% per year
        - *Example 2*: in 1998 the LTCM fund engaged in large arbitrage trades to exploit the price difference between similar bonds with different liquidity. In September, this price difference widened due to the Russian crisis: LTCM lost $4.6bn, and was bailed out by a consortium of banks (who ended up recouping their money after the panic abated)

Policy issues

- One can also **address market design and regulation issues**, by looking at the effect of reforms: for instance,
    - what are the effects of raising **stock market transparency**?
        - e.g., the TRACE system in the U.S. corporate bond market increased liquidity, especially for small trades (Goldstein, Hotchkiss and Sirri, 2006).
    - do investors prefer **continuous trading** to batch auctions?
        - e.g., investors valued the transfer of stocks from call auction to continuous trading by the Tel-Aviv exchange in 1997-98 (Kalay, Wei and Wohl, 2002).
    - how do **short-selling bans** impact liquidity and price discovery?
        - e.g., short-sales bans introduced in 2007-08 were detrimental for liquidity and price discovery, especially in bear markets (Beber and Pagano, 2012)

Caution: three meanings to the word "liquidity"

- **Market** liquidity (market microstructure)
  - ability to trade a security quickly at a price close to its consensus ("fundamental") value
  - this is the dimension that we shall deal with in this course
- **Funding** liquidity (banking)
  - ability to obtain credit at acceptable terms, or to have sufficient cash to meet obligations without incurring large losses
  - it affects market liquidity: this is explored in chapter 11 of the textbook
  - it is also affected by market liquidity: mutual feedback → "liquidity spirals"
- **Monetary** liquidity
  - cash provided by central bank = money supply
  - it affects funding liquidity by enhancing banks' ability to extend credit
  - hence it also affects market liquidity, especially at times of crisis

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Basics of securities trading

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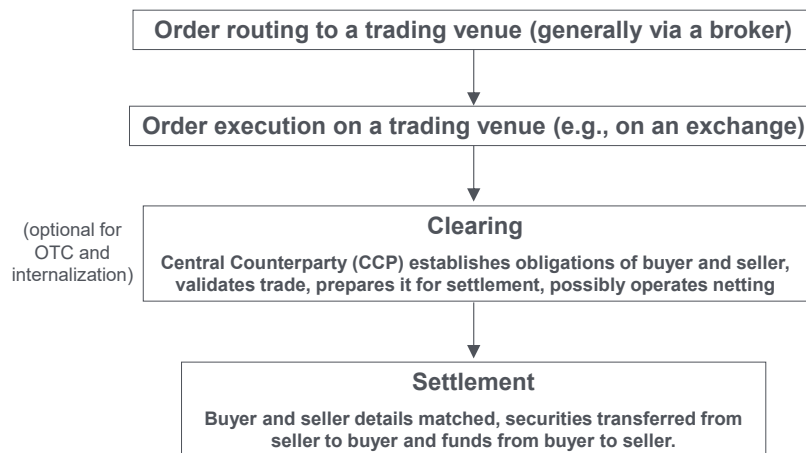## Where does trading take place?

Possible trading venues:

• Regulated exchanges

• Alternative trading systems
  • ECNs (electronic communication networks)
  • Crossing networks

• OTC (over-the-counter) markets: operated by dealers, totally unregulated

• "Internalization": broker-dealers match client orders or fill orders on own account

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Who are the players?

• **"Buy side"** : traders who buy trading services:
  • individuals (retail)
  • institutions (wholesale): mutual funds, pension funds, firms, government

• **"Sell side"** : traders who sell trading services:
  • dealers: trade on own account
  • brokers: trade on behalf of clients
  • broker-dealers (dual traders): do both

  Note: these terms have nothing to do with whether the trader is buying or selling a security

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Life cycle of an order: trading and post-trading

| Order routing to a trading venue (generally via a broker) |

↓

| Order execution on a trading venue (e.g., on an exchange) |

↓

(optional for OTC and internalization)

| **Clearing** |
| Central Counterparty (CCP) establishes obligations of buyer and seller, validates trade, prepares it for settlement, possibly operates netting |

↓

| **Settlement** |
| Buyer and seller details matched, securities transferred from seller to buyer and funds from buyer to seller. |

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Basic trading mechanisms

Readings:

Chapter 1, Foucault, Pagano and Röell, *Market Liquidity*, 2nd edition

Stoll, 2006. Electronic trading in stock markets, *Journal of Economic Perspectives*

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Basic trading mechanisms: limit order *vs.* dealer market

- **Limit order market: centralized, direct**
  - Customers route orders to an "auctioneer" (= device that balances demand and supply via an auction, now automated)
  - Examples: Paris, Madrid, Milan, Tokyo

- **Dealership: decentralized, intermediated**
  - Customers place orders with dealers (who post bid and ask quotes and trade on own account)
  - Examples: OTC markets for corporate bonds, municipal bonds ("munis"), currencies, many derivatives

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Limit order market
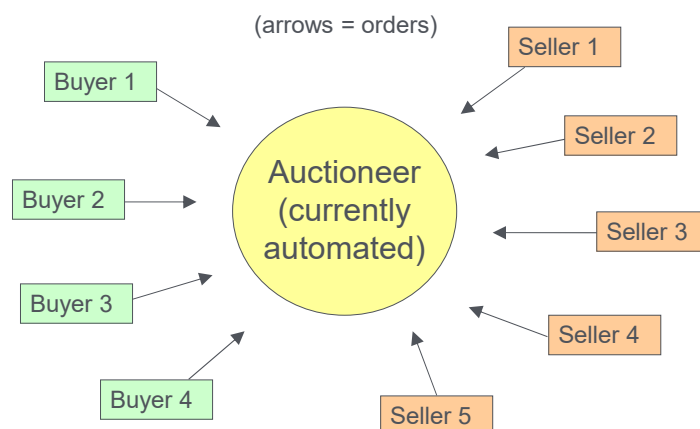
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Common types of orders

- Market orders:
  - no price indication: "instruction to trade a quantity at the best price currently available in the market"
  - Pro: quick (demands immediacy, consumes liquidity)
  - Con: may get worse price (pay for immediacy and liquidity)
  - "Market orders pay the bid-ask spread"
- Limit orders:
  - price indication: "instruction to trade at best price available if it is no worse than specified *"limit price"*
  - Pro: may get good price for trade
  - Con: may not execute (execution risk)

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Less common types of order

- Stop order
  - Triggered when price reaches the specified *stop* price
  - Pro: can be used to limit losses when trader is not present
  - Con: demands liquidity when *least* available
- Hidden (or iceberg) order
  - Limit order only part of which is visible, the rest "emerging" as the visible part executes against incoming orders
  - Helps trickle in a large order without making it visible

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Limit order market: call *vs.* continuous

- **Call (or batch) auction:**
  - Buy orders sorted by decreasing price ($\rightarrow$ demand), and sell orders by increasing price ($\rightarrow$ supply)
  - Price set so that supply = demand
  - All executable orders are filled at that same price
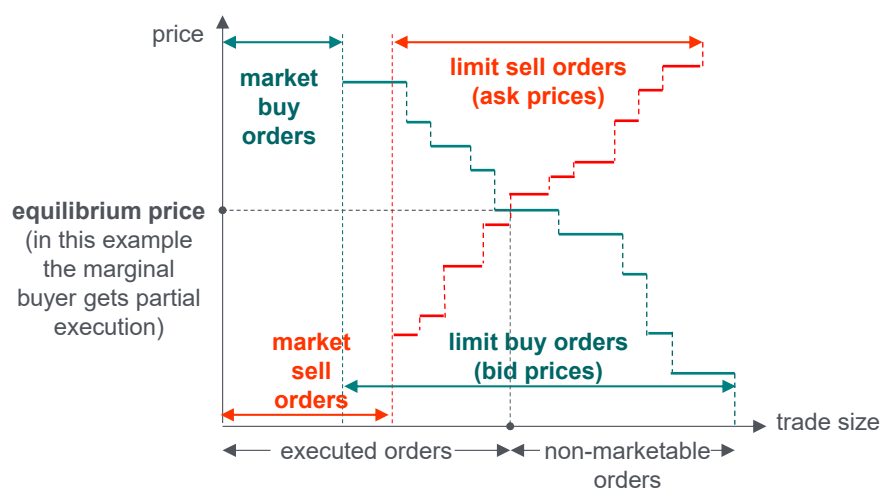
- **Continuous auction:**
  - "Non-marketable" orders (e.g., those not executed in the initial call) are placed in a *limit order book* (LOB)
  - Incoming orders are executed against the LOB according to price and time priority rules

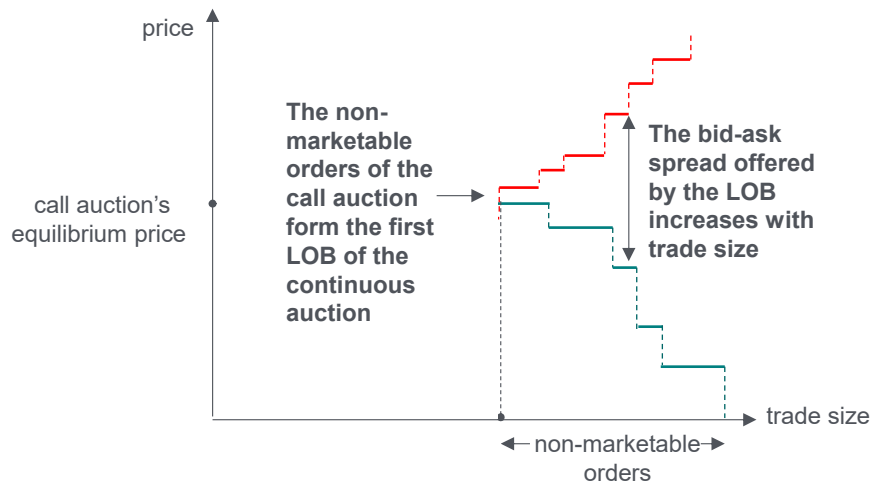Imperial College Business School

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Call auction

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Forming the limit order book after the call auction

price

call auction's equilibrium price

The non-marketable orders of the call auction form the first LOB of the continuous auction

The bid-ask spread offered by the LOB increases with trade size

trade size

← non-marketable → orders

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Market sell order of 200 (or limit sell with price < 74.42)

Market buy order of 900 (or limit buy with price > 75.74)

Continuous auction: limit order book

Bid			Ask		
Price	**Size**	**Time**	**Price**	**Size**	**Time**
74.42	300 100	11:49:39	74.48	300	11:49:35
74.41	100	11:46:55	74.48	500	11:49:40
74.36	400	11:48:30	75.74	100	08:25:17
74.36	400	11:48:32	76.00	150	08:02:02
74.00	13	10:56:00	76.77	20	07:01:01
73.75	5100	11:28:02	77.00	100	09:15:00
72.98	5100	10:56:99	77.06	200	10:14:11
72.15	120	08:01:39	77.35	1000	08:01:39
72.11					07:01:01
72.03					08:02:00
72.00					09:30:04
71.59					08:01:32
71.11					09:30:04
71.00	10	09:30:36	78.87	20	07:01:01
70.35	200	08:00:54	78.95	200	08:01:35
70.11	20	07:01:01	80.00	350	09:15:00

Because of the two orders, the bid-ask spread widens from 74.48 – 74.42 = **0.06** to 76.00 – 74.42 = **1.58**.
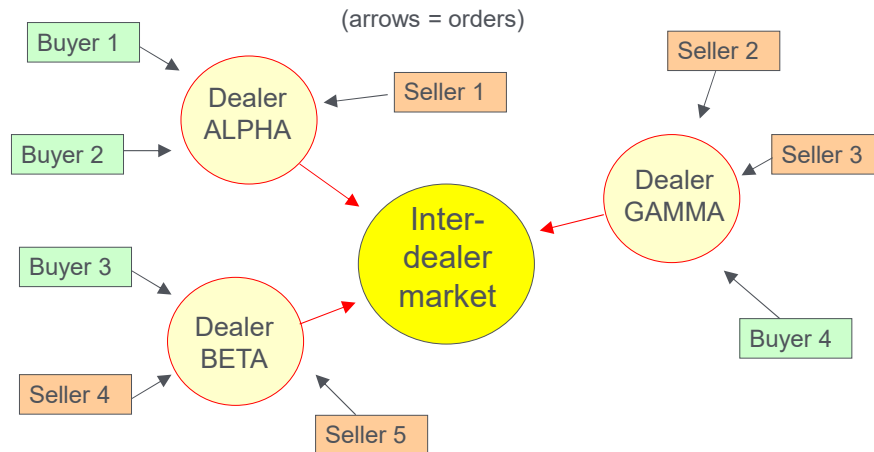
The two orders have "consumed" liquidity.

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Dealer market

(arrows = orders)

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Dealer bid and ask quotes

2	ALPHA ZETA 326 – 329 GAMMA EPSILON IOTA 3			
Market Maker Identity Code	Bid Price	Offer Price	Quote size	Time of Latest Quote Update
ALPHA	326	330	75 × 75	08:53
BETA	324	330	75 × 75	09:14
GAMMA	325	329	75 × 75	09:16
DELTA	323	332	75 × 75	08:53
EPSILON	325	329	25 × 25	09:36
ZETA	326	330	75 × 75	11:30
ETA	325	330	75 × 75	09:45
THETA	325	330	75 × 75	09:23
IOTA	324	329	75 × 75	10:27
KAPPA	323	330	75 × 75	09:45
LAMBDA	325	330	75 × 75	08:53

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Dealer market quotes for various trade sizes

price

ask (or offer) prices

Smallest bid-ask spread ("market touch")

Bid-ask spread for large trades

bid prices

Also in the dealer market, the bid-ask spread increases in trade size.

trade size
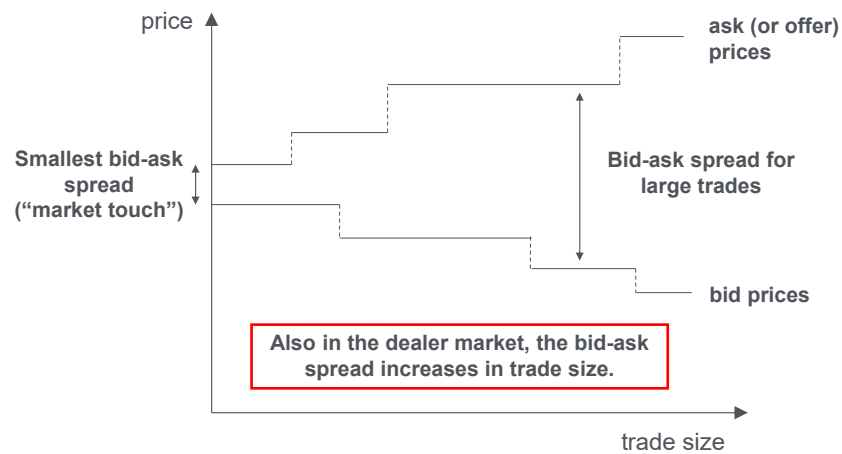
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Dimensions of market design

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Centralization and intermediation of trading

- Centralization and intermediation of trading are key features of market design
- In both dimensions, the two basic trading mechanisms that we have seen so far are polar opposites:
  - **centralization**: limit order markets are centralized, dealer (quote-driven) markets are fragmented
  - **intermediation** of trading: in limit order markets, sellers and buyers trade directly with each other; in dealer markets, they trade with dealers, who intermediate all trades
- But there are intermediate types of market structures, and also other features matter for market design

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Intermediate mechanisms: hybrid and dual markets

- Beside limit order and dealer markets, there are **hybrid markets**:
  - for example, the NYSE features three interacting trading mechanisms, *i.e.* a floor market, a designated market-making dealer and a LOB platform that enables to bypass the other two "intermediated mechanisms"
- There are also **dual markets**, where an order-driven platform operates side by side with a dealer mechanism:
  - both in U.S. and EU equity markets, investors may trade bilaterally with dealers (who internalize the trade) rather than in the LOB of the exchange

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Two other features of market design

- But markets may **also** differ along **two** <u>other</u> dimensions:

  - **transparency**: how much information is given to market participants about
    - past trades and prices (**post-trade** transparency)
    - current LOB or dealer quotes (**pre-trade** transparency)

  - **frequency (or continuity) of trading**: how often one can trade:
    - some markets clear at discrete intervals, and generate prices only at those times
    - other markets operate continuously, and generate prices during the whole trading day

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Transparency

- Differs across **financial instruments**:
  - Stock markets: most transparent
  - Structured debt and U.S. municipal bonds: most opaque (OTC markets, no firm quotes, delayed price publication)
- Also differs across **and** within **market types**:
  - Electronic LOB markets: generally transparent, but:
    - degree depends on detail of displayed LOB data
    - hidden orders reduce transparency
  - Dealer markets: generally more opaque. Reasons:
    - quotes may be: (i) not centrally displayed; (ii) "indicative", (iii) "firm", but subject to possible "price improvement"
    - past trades may be reported and/or published with delay

Note that transparency has two dimensions:

Pre-trade transparency = visibility of the price that can be obtained for an upcoming transaction

Post-trade transparency = publication of information (size, price, *etc.*) about recently completed trades

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Frequency of trading

- Limit order markets:
  - trading may be possible at discrete intervals (call auctions) or continuously (as in electronic LOB markets)
  - now often both are offered: call at open and close, sometimes during the trading day; continuous auction at all other times
- Dealer markets:
  - continuous only insofar as some dealers ("market-makers") *commit* to quote *firm* prices continuously
  - this does not apply to OTC markets, where quotes are indicative, and dealers may stop quoting them

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Does market structure matter?

- Plenty of **evidence** that it does – and for good reasons: **theory**
- As we shall see in this course, it determines
  - how and when information is impounded in prices
  - how costly it is to trade securities, and how fast one can do so
  - who gains and who loses from trading
- Examples:
  - NASDAQ stocks' trading costs are twice those of matched NYSE stocks (Huang and Stoll, 1996)
  - in the late 1980s, the LSE attracted much volume from European Continental exchanges by enabling continuous trading

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Who sets the rules?

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Who sets the rules?

- Interplay of **public regulation** and **self-regulation** by trading platforms

- Large variation of their relative roles over time and across countries, from the very start:
  - Amsterdam stock exchange created by the Dutch East India Company to trade its own shares
  - LSE and NYSE emerged from agreements between brokers
  - Continental European exchanges created by government authorities, generally to provide a market for government bonds

- Recently, sharp changes in the governance of exchanges: "demutualization" in the UK and privatization in continental Europe → publicly listed companies

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The rule-makers differed from the very start
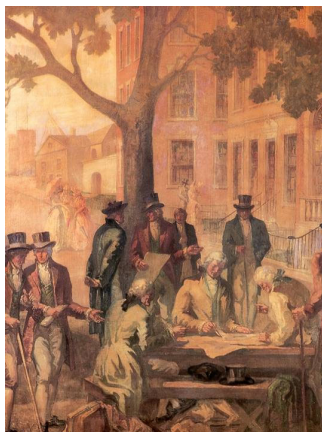
Precursor of the NYSE: brokers signing
the Buttonwood Tree Agreement
in 1792 on Wall Street

Paris Stock Exchange:
established by an order of the
Royal Council of State in 1724

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In whose interest?

- Policies of market platforms depend on (i) **balance between regulation and self-regulation** and (ii) their **ownership and control**:
  - domestic intermediaries may resist the provision of remote access to foreign intermediaries
  - intermediaries often conflict with issuers and investors, e.g. regarding transparency, which reduces intermediaries' rents
- **Competition** between market platforms also constrains rent-seeking by incumbent exchanges:
  - Euronext (= Paris, Amsterdam, Brussels and Lisbon exchanges) reduced its fees as soon as the LSE announced a plan to create a competing platform for Dutch stocks

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Dimensions of competition

1. Price/cost
   - Trading fees
   - Listing fees
2. Quality of service
   - Variety of trading mechanisms
   - Speed of execution
   - Variety of securities: index products, derivatives, etc.
3. Standards/rules
   - Listing standards
   - Trading rules (transparency, best execution)
   - Sarbanes-Oxley Act, 2002 (migration of US companies to London)

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What is behind the competition between platforms?

Three main factors:

1. **Liberalization of international capital flows**
   - globalization of trading and asset allocation
   - cross-listing
2. **Regulatory changes**
3. **Technological innovation**

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What is behind the competition between platforms?

Three main factors:

1. **Liberalization of international capital flows**

   - globalization of asset allocation (reduction of "home bias" in investors' portfolio choices) $\Rightarrow$ rise in cross-border trading
   - cross-listing by companies to cater to foreign investors

2. **Regulatory change**

3. **Technological innovation**

see next…

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Regulatory change

- Fixed commissions abolished:
  - 1975: U.S.
  - 1986: London ("Big Bang")
  - Later years: European Continental exchanges

- Activist regulators:
  - transparency and "trade-through" rule: Regulation National Market System in the U.S.
  - concentration rules dropped by EU Markets in Financial Instruments Directive (MIFiD): important for European exchanges

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Current strategies

- Regulatory change $\rightarrow$ ECNs and crossing networks have captured an increasing share of trading volume:
  - process well under way in U.S., just starting in Europe (after MIFiD)

- Exchanges' defensive reaction: demutualization, mergers
  - 2005: NYSE turns into a for-profit company and acquires Archipelago (a major ECN)
  - 2000-03: Amsterdam, Brussels, Paris & Lisbon merge $\rightarrow$ Euronext
  - 2007: NYSE merges with Euronext
  - 2007: LSE buys Borsa Italiana – resold to Euronext in 2020
  - 2017: merger attempt between LSE and Deutsche Börse blocked by EU competition regulator

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Technological innovation

- Computerization of trading:
  - order routing
  - trade execution
- Telecommunications:
  - information dissemination
  - web-based access
- Speed is an increasingly important dimension of competition between markets
- But the effects go beyond greater competition

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Algorithmic trading

- **Computerized** trading strategies

- Used for

  1. passive **market-making**

  2. **arbitrage** between platforms

  3. **directional** trades (information-driven)

  4. **order-splitting** (to execute large trades)

- **Co-location** of computers and/or **high-speed connections** make these trading strategies feasible at ultra-high speed:

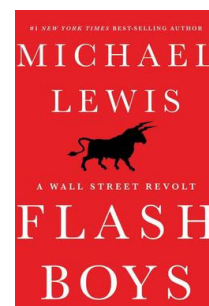 - much algo trading is high-frequency trading: **HFT**

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Raging controversy about HFT

- Hendershott, Jones and Menkveld (*JF*, 2011): "algorithmic trading improves **liquidity** and enhances the **informativeness** of quotes."

- Paul Krugman (*NYT*, 2009): HFT is "a kind of **tax on investors who lack access to those superfast computers**"

- Michael Lewis (2014): "The market is rigged" by **HFT traders** who **front run orders** placed by investors.


The Journal of
FINANCE
The Journal of THE AMERICAN FINANCE ASSOCIATION

#1 NEW YORK TIMES BEST-SELLING AUTHOR
MICHAEL
LEWIS
A WALL STREET REVOLT
FLASH
BOYS

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Flash crash: does algo trading amplify volatility?

- 6 May 2010: sale of 75,000 E-mini futures contracts on the S&P500 index traded on the CME

- 9% drop in the Dow Jones in a few minutes

- Figure: evaporation of liquidity in futures and S&P 500 stocks

- Price and liquidity effects were largely reversed by market close

- Algo trading suspected to have

  - **amplified** price movement

  - **propagated** it across markets

E-Mini, SPY, and S&P 500 Buy-Side Market Depth
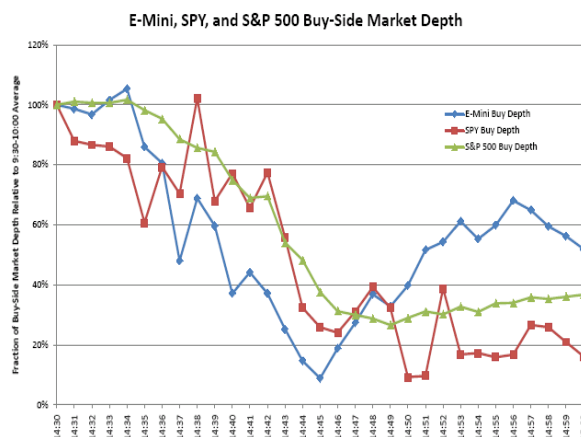
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Key takeaways - 1

- In real-world markets, transaction prices often deviate from fundamentals: markets are not perfectly liquid.

- Price discovery is the process by which transaction prices converge to fundamentals.

- Market microstructure studies how liquidity and price discovery are affected by the design of trading mechanisms.

- Limit order and dealer markets are the two basic market mechanisms, but hybrid and dual markets also exist.

- Trading platforms differ along four main dimensions, namely, the extent to which their trading is 1) centralized, 2) intermediated, 3) transparent, 4) continuous.

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Key takeaways - 2

- The design of security trading platforms depends on a mix of public regulation and self-regulation.
- Self-regulation of privately owned platforms depends on the governance of the companies owning them.
- In the last few decades, the design of trading platforms has also been affected by competition between exchanges.
- This competition was triggered by
  - liberalization of international capital flows,
  - sharp changes in security trading regulation
  - technological innovations, especially those enabling high-frequency trading.

Any Questions?

Thank You!

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