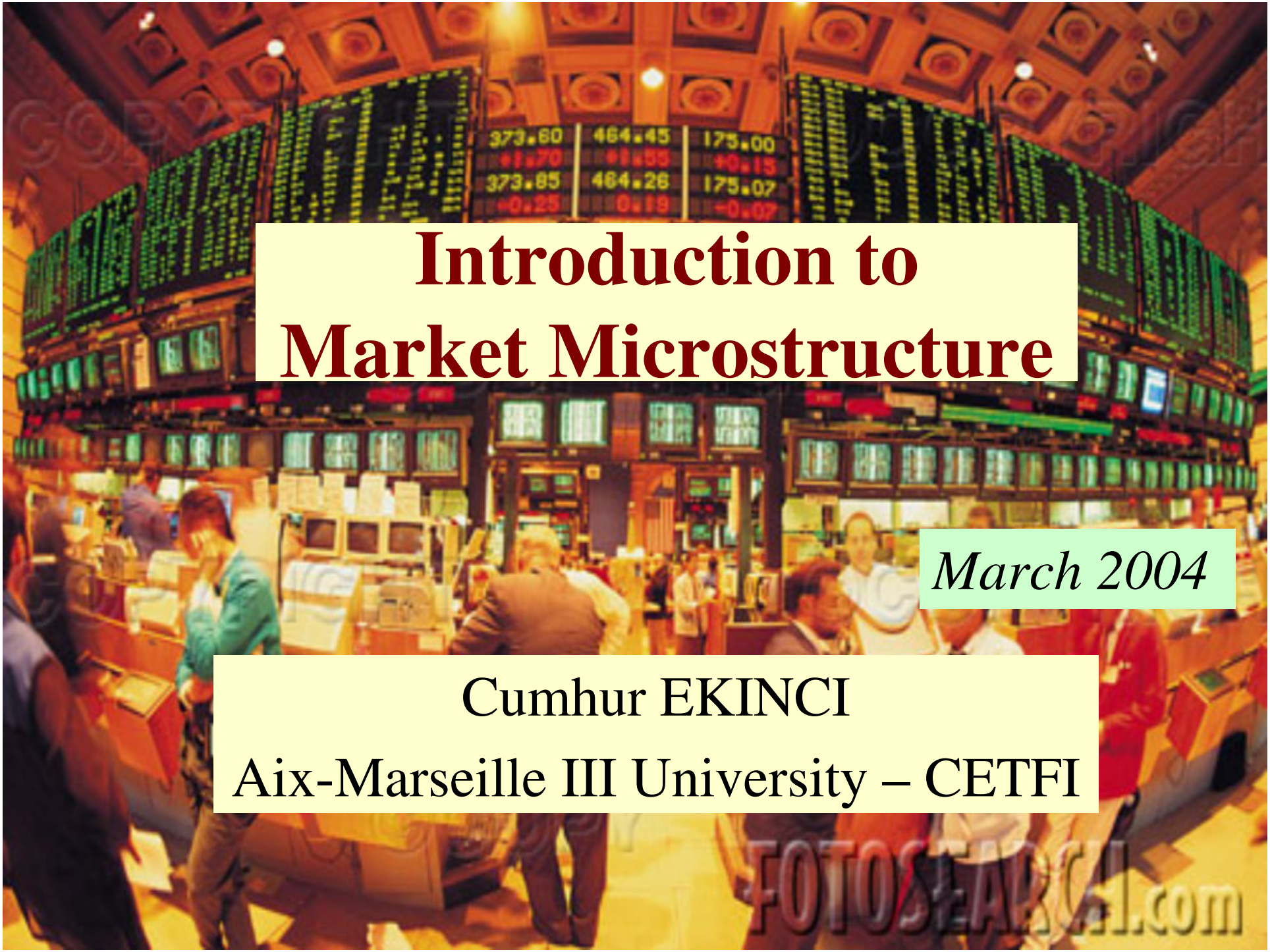


Introduction to Market Microstructure

March 2004

Cumhur EKINCI

Aix-Marseille III University – CETFI

Objective of microstructure

Explain (especially short-term) price formation process, by peculiarities and imperfections of the market

→ critical to asset pricing theories and Efficient Markets Hypothesis

Tools

Modeling:

- Game theory (static/dynamic-sequential/strategic)
- Agents: Rational (but recently behavioral models → irrationality), risk averse/neutral/loving

Empirics:

- Extensive use of (high-frequency) data: orders-transactions
- Stats – econometrics (Engle, Nobel 2003)

Topics

- **Market design and quality**
- **Bid-ask spread and its components**
- **Transaction costs**
- **Agents, info and info asym, insider trading and manip'n**
- **Liquidity**
- **Orders et orderbook**
- **Price discovery (or price formation)**
- **Ticks and price discreteness**
- **Trading, blocs, and trade frequency**
- **Volatility**
- **Relations bw volume, frequency, size, volatility et returns**
- **Seasonalities**
- **Linkages with technical analysis**
- **Data processing, and interaction with econometrics**

Market Types *according to*:

- Establishment and regulation: **organized** *vs* **non-organized** (Over-the-counter, OTC)
- Quotation system (existence of intermediaries): **quote (price)-driven** (market maker, dealer, specialist) *vs* **order-driven**
- Sequence of trades: **call auction** *vs* **continuous**
- Automation in order registering and matching: **automated** *vs* **non-automated** or e**lectronic** *vs* **non-electronic** (floor)
- Place where orders are gathered and executed: **central'd** (concentrated) *vs* **decentral'd** (fragmented)
- Access to (real-time and past) data and info: **transparent** *vs* **non-transparent**

Examples

- **Euronext** (stocks): organized, order-driven, continuous*, automatized, centralized, transparent
- **NYSE**: organized, quote-driven*, continuous*, non-automated*, fragmented, less transparent
- **LSE**: organized, dealer, continuous, automated, fragmented, less transparent
- **Taiwan Stock Exchange**: organized, order-driven, call, automated, centralized, transparent

* hybrid

Market Design and Quality

- What are the ways of building a good financial market ((informationally) ***efficient***, ***liquid***, ***with little volatility*** and ***low transaction costs***) and make it work efficiently?

Quote- or order-driven? Call auction or continuous? Automated or floor? What level of transparency?

- Which priority rules for orders (price, time, size, agent…)?
- Which rules? Restrictions' (such as short sales, price limits, non-canceling of orders) effects?

Bid-ask spread and its components

B-A spread: Difference bw the best priced buy (**bid**) and sell (**ask**) orders

results from:

- Mm's inventory holding costs
- Order-processing costs
- Adverse selection (info asym bw Mm and informed traders)

Spread (cont'd)

- quoted: $P_{ask} - P_{bid}$
- relative: $(P_{ask} - P_{bid}) / P_t$
- effective: $2 \mid P_t - (P_{ask\boldsymbol{t-\varepsilon}} + P_{bid\boldsymbol{t-\varepsilon}}) / 2 \mid$
- realized: $2 \mid P_t - (P_{ask\boldsymbol{t+\varepsilon}} + P_{bid\boldsymbol{t+\varepsilon}}) / 2 \mid$

Roll's (1984) Implicit Measure:

$$2\sqrt{-\operatorname{cov}(\Delta P_t - \Delta P_{t-1})}$$

Transaction costs

- **Explicit**: Charges, commissions and taxes on trades
- (but also) **Implicit**:

-Spread

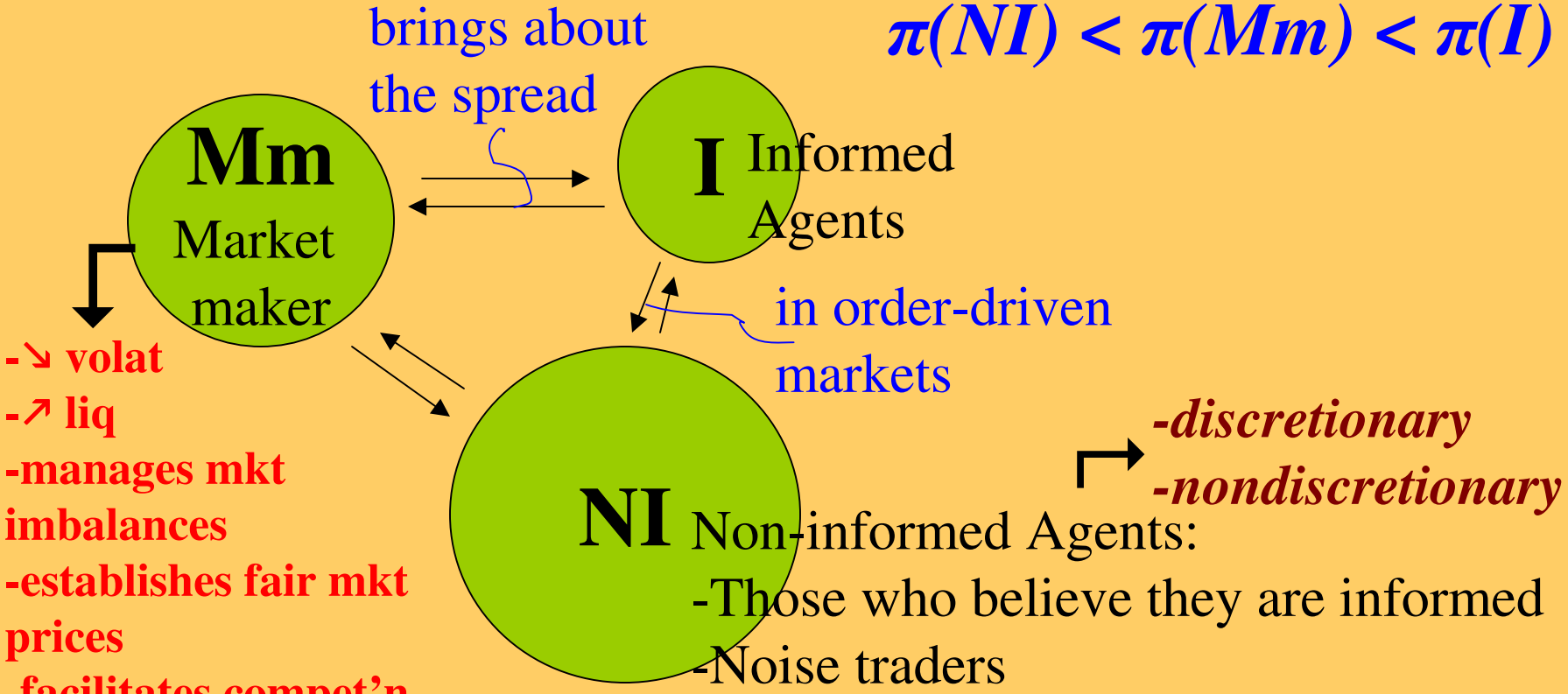
-Price impact of (big) trades (*concerns especially institutional investors*)

Obviously, if costs fall, trading volume rises

Agents, info and info asym, insiders, and manipulation

Main hypothesis:

$\pi(NI) < \pi(Mm) < \pi(I)$



Agents, info and info asym, insider trading, and manip'n (cont'd)

- ∃ agents having prior info on price. They earn from non-informed traders. The Mm should take them into account in quoting her bid and ask prices (sometimes crime)
- **Insider trading**: Position-taking upon an info that has not been public, e.g., by a member (or his relative) of the board of directors of a listed company (crime)
- Manipulating prices, e.g., by fictitious buys-sells (crime)

Liquidity

Ability in executing a (big) order without causing a considerable impact on price

Some dimensions (Black, 1971):

- ***Immediacy:*** Availability of buyers and sellers at all moments: possible → liq
- ***Spread*** : narrow → liq
- ***Depth:*** Potential volume at best buy and sell price levels: high → liq
- ***Resiliency:*** Turn-back of price to its initial level after a temporary (non-fundam.) shift: fast → liq

Orders and orderbook

Market orders → to accomplish the trade (by impatient agents)

Limit orders → to the book (by patient agents)

Each order ***provides*** liq

Each transaction ***consumes*** liq

How do orders *flow*? Concept of *order flow*

How do agents react? Order aggressiveness (relation to Behavioral Finance)

Example of an orderbook: AIR FRANCE - 04.03.2004 / Source: Boursorama

Best limit prices / Last transactions

	BUY			SELL					
1	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	1	**200**	**16.37**	**16.39**	**448**	**1**	**16:46:44**	**16.37**	**11**
	7	3008	16.35	16.40	2857	2	16:46:21	16.39	125
	2	600	16.34	16.41	20	1	16:45:16	16.36	97
	6	2665	16.33	16.42	198	1	16:45:16	16.36	4
	1	228	16.32	16.43	1786	2	16:44:50	16.36	11

	BUY			SELL					
2	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	2	**916**	**16.38**	**16.39**	**312**	**1**	**16:47:31**	**16.39**	**136**
	7	3008	16.35	16.40	2857	2	16:46:44	16.37	11
	2	600	16.34	16.41	20	1	16:46:21	16.39	125
	6	2665	16.33	16.42	198	1	16:45:16	16.36	97
	1	228	16.32	16.43	1786	2	16:45:16	16.36	4

	BUY			SELL					
3	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	2	**916**	**16.38**	**16.39**	**312**	**1**	**16:48:16**	**16.38**	**33**
	7	3008	16.35	16.40	2857	2	16:47:31	16.39	136
	2	600	16.34	16.41	20	1	16:46:44	16.37	11
	6	2665	16.33	16.42	198	1	16:46:21	16.39	125
	1	228	16.32	16.43	1786	2	16:45:16	16.36	4

	BUY			SELL					
4	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	2	**485**	**16.36**	**16.40**	**3032**	**3**	**16:48:16**	**16.38**	**33**
	6	1748	16.35	16.41	520	2	16:47:31	16.39	136
	2	600	16.34	16.42	198	1	16:46:44	16.37	11
	6	2665	16.33	16.43	1250	1	16:46:21	16.39	125
	1	228	16.32	16.44	1045	1	16:45:16	16.36	4

	BUY			SELL					
5	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	2	**485**	**16.36**	**16.40**	**3032**	**3**	**16:50:06**	**16.40**	**100**
	6	1748	16.35	16.41	520	2	16:49:51	16.40	192
	2	600	16.34	16.42	198	1	16:49:23	16.38	331
	6	2665	16.33	16.43	1250	1	16:49:18	16.38	75
	1	228	16.32	16.44	1045	1	16:48:16	16.38	33

	BUY			SELL					
6	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	2	**469**	**16.36**	**16.40**	**2869**	**3**	**16:51:01**	**16.40**	**286**
	7	3008	16.35	16.41	520	2	16:51:01	16.40	258
	2	600	16.34	16.42	198	1	16:50:52	16.38	211
	6	2665	16.33	16.43	1250	1	16:50:52	16.38	198
	1	228	16.32	16.44	1045	1	16:50:52	16.38	255

	BUY			SELL					
7	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	2	**469**	**16.36**	**16.40**	**2869**	**3**	**16:51:01**	**16.40**	**286**
	7	3008	16.35	16.41	520	2	16:51:01	16.40	258
	2	600	16.34	16.42	198	1	16:50:52	16.38	211
	6	2665	16.33	16.43	1250	1	16:50:52	16.38	198
	1	228	16.32	16.44	1045	1	16:50:52	16.38	255

	BUY			SELL					
8	Orders	Quant	Bid	Ask	Quant	Orders	Hour	Price	Quant
	1	**738**	**16.37**	**16.40**	**2869**	**3**	**16:52:11**	**16.40**	**163**
	3	1069	16.36	16.41	520	2	16:51:52	16.36	11
	6	1748	16.35	16.42	198	1	16:51:41	16.36	5
	2	600	16.34	16.43	1250	1	16:51:01	16.40	286
	6	2665	16.33	16.44	1045	1	16:51:01	16.40	258

Price discovery (or price formation)

- How do investors reach a consensus on share's price? For instance, in market open, after suspension periodes, etc.

- How is new information incorporated into price?

Ticks and price discreteness

- **Tick**: Min price variation allowed (.01 $ at NYSE, varies bw .01 and .50 € at Euronext)
- The higher % ticks, the more prices discrete

Effects of a tick reduction :

- Trading volume increases
- Depth decreases (argued)
- Prices move less in size but more often

Trading, blocs, and trade frequency

- How is trading activity realized? Esp. at big amounts (blocs)? Where is most suitable (orderbook-floor / domestic market-abroad)? With visible-hidden orders?

→ Strategically submitting orders (deciding on the best ***type***, ***place***, ***timing***, ***size*** and ***price***)

- Sequence of transactions is informative (trading reveals info)

→ screen-watching (traders' job)

Volatility

- Price or return variation around a mean (var(ΔP), $\Sigma\sigma^2$, $\Sigma|\sigma|$, $\Sigma\sigma^2/N$, [max(P)–min(P)]/P)

- Volatility clusters ($\exists$ high and low volatility periodes, heteroskedastic and autocorrelated residuals) $\rightarrow$ ARCH-GARCH, stochastic volatility, and duration models

Relations bw volume, frequency, size, volatility and returns

DJ: "It takes volume to move prices"

Tech. Anal.: "A high supported with volume lasts"

Is there a relation between volume et volatility?

-positive relation bw number of trades and volat

-insignificant relation bw avg trade size and volat

Prices move due to the **buy-sell disequilibrium** ***directly*** (in order-driven mkts) ou ***indirectly*** (in quote-driven mkts)

Seasonalities

Regular movement in transactions during the:

- **year** > *tax effets, summer holidays*
- **month** > *monthly clearing*
- **week** > *weekly clearing*
- **day** (U-shaped patterns in volume, spread, volatility and sometimes in prices) > *Accumulation of info during non-trading periods and activity of informed traders*

Ties with technical analysis

- A technical (rather than fundamentalist) approche
- Focus on short terme
- Volume-volatility relation
- Seasonality analysis

However, MM tries to explain on a theoretical basis

Data processing and interaction with econometrics

- Abundant data (e.g. 20000 trades/day in a liquid share)
- Non-normal probability distributions (discrete, heteroskedastic and leptokurtic series)

→ sophisticated econometric methods

Keywords

order, transaction (trade) , financial markets, liquidity, orderbook, tick, bloc, volatility, volume, intraday, (bid-ask) spread, transaction costs, quotation systeme, OTC, floor, quote- (order-) driven, call auction, continuous, fragmentation, concentration, ECN, transparency, market quality, market maker, dealer, broker, specialist, info, info asymmetry, insider trading, manipulation, short-sale, high-frequency data

A few references

- Market Microstructure - O'Hara (Blackwell, 1995)
- Trading & Exchanges - Harris (OUP, 2002)
- nyse.com, nasdaq.com, londonstockexchange.com, euronext.com, sec.gov, fsa.gov.uk, amf.fr, //pages.stern.nyu.edu/~jhasbrou, market-microstructure.org
- Related academic journals: JF, RFS, JFE, JFQA, JFM, JFSR, JBF, PBFJ, JBFA, JFR, JIFMIM, FAJ, RFQA, Banque & Marchés, AES… (>1000 published papers)