

FINA 4103
Financial Markets Trading and Structure
Class Note 1: Introduction

Jun Aoyagi
HKUST

Fall 2026

This Class

What is this class?

- ▶ Market microstructure class
- ▶ Advanced finance

Instructor

- ▶ Jun Aoyagi, giving $80\text{min} \times 25$ classes
 - ▶ LSK 5005, junaoyagi@ust.hk
 - ▶ Office hours by appointment
 - ▶ Ph.D., UC Berkeley / BA. & MA., U Tokyo
 - ▶ Research in Market Microstructure, information in finance, and FinTech
 - ▶ Website: [\[here\]](#)

Teaching assistant

- ▶ Yaqi Wang, Ph.D. student at FINA
 - ▶ ywangpn@connect.ust.hk
 - ▶ Office hours by appointment

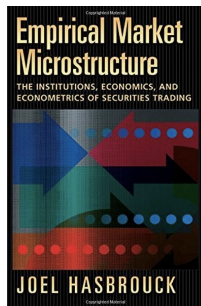
Class Materials

Official class webpage on Canvas:

- ▶ <https://canvas.ust.hk/courses/>

Materials:

- ▶ Class notes
- ▶ Hasbrouck, Joel (2007), "Empirical Market Microstructure," Oxford Univ. Press
- ▶ Foucault, Pagano, and Roell (2013), "Market Liquidity: Theory, Evidence, and Policy" Oxford Univ. Press
 - ▶ Online ver. available via UST library
 - ▶ Just as a reference



Grading

Homework (3 or 4 $\times$ 6~8% = 20%)

- ▶ Multiple choice questions on Canvas
- ▶ Submit your own answers but you can discuss with your friends
- ▶ (aiming at >95% on average)

Midterm (Oct 22th, 7pm; 25%) and Final (TBD; 55%)

- ▶ MCQ and short-answer questions
- ▶ All assigned textbook, slides, supplementary readings, HW, and anything mentioned in class will be covered
- ▶ Closed book but bring an A4 cheatsheet (see syllabus)
- ▶ Bring a calculator (smartphones and other devices are not allowed)
- ▶ (aiming at $\approx$ 65~70%)

Course Rules (see syllabus)

► Email:

1. Please contact TAs first if you have inquiries. Class recording, logistics, and exam/HW arrangements are all handled by Yaqi
2. Please contact the Student Office if your question is about the class quota or request special assistance in exams
3. Please sign up for the office hour if your question involves lines of equations

► Recording will be provided only if students

1. could not attend the class during the add/drop period due to schedule conflicts;
2. take sick leave or school-related leave (e.g., participating in a conference/competition as an official representative of the school)
 - please submit a formal document (doctor's letter); and
3. will be made available for one week before the midterm and final exams

Course Rules (refer to the syllabus)

- ▶ Make-ups will NOT be given by default. If there are family or medical emergencies, and prior notice is given, prorations will be done. For the final exam, you need to file and go through the formal process via the Student Office.
- ▶ Class attendance is strongly encouraged. Will cover exercise problems very similar to those in exams.
- ▶ Will start class exactly on time. Do not disturb other students in the class.
- ▶ Student Honor Code: any violations will be dealt accordingly
<http://publish.ust.hk/acadreg/generalreg/index.html>

Expected Background

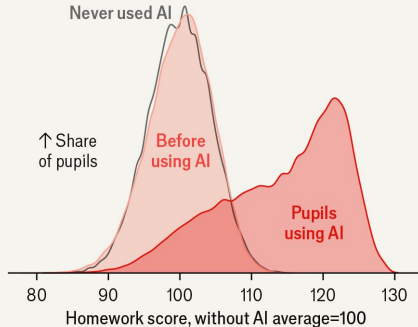
- ▶ Prerequisite: FINA 3103 or equiv
- ▶ Basic knowledge of statistics
 - ▶ Random variable, computing expectation, variance and covariance
 - ▶ Sample vs population data
 - ▶ Linear regression (OLS)
- ▶ Algebra and calculus
 - ▶ Economic models of financial markets
 - ▶ Optimization (taking first-order derivative)
- ▶ **Objective:**
 - ▶ to bridge the gap between UG-level knowledge and grad-level learning
 - ▶ to understand the details of the actual structure of markets
 - ▶ to be able to make decisions based on theory

AI

- ▶ AI is allowed—and encouraged, except during midterm & final exams
- ▶ You may use AI to solve homework
- ▶ **But:** You must be able to solve similar problems on your own in exams

Pupils using AI have higher average homework scores...

China*, Jan 2023-Jun 2025



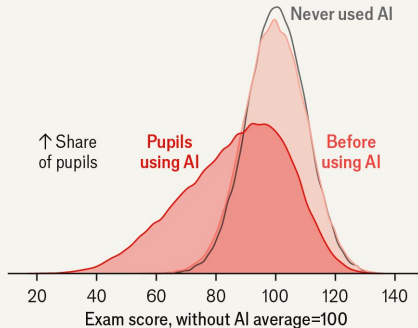
*26,811 pupils aged 12-18

Source: "The generative AI learning penalty",
by D. Strömberg et al., preprint June 2026



...but come exam time the technology proves less helpful

China*, Jan 2023-Jun 2025



*26,811 pupils aged 12-18

Source: "The generative AI learning penalty",
by D. Strömberg et al., preprint June 2026



Schedule

► No class on Sept 17th (Th)

No	Course Content	Readings
1	Introduction	Slides, Syllabus
2, 3	Overview of General Market Structures	Slides
4-6	Orders and Quotes	Slides
7	Players in Financial Markets	Slides, HW1 assigned
8-11	US Market Structure and Trading Rules	Slides
12	Platform Architectures	Slides
13	Microstructure Data Issues	Slides
14	Midterm Exam	Oct 22 (Th) 7pm-8pm (subject to change; check the announcement)
15-17	Information in Finance (w/ math prep)	Slides, HW2 assigned
18, 19	Models of Price Dynamics	Slides
20	Measuring Liquidity	Slides
21, 22	Order Size and Strategic Trading	Slides, HW3 assigned
23	High-Frequency Trading	Slides
24 (25)	Decentralized Market	Slides
	Final Exam	

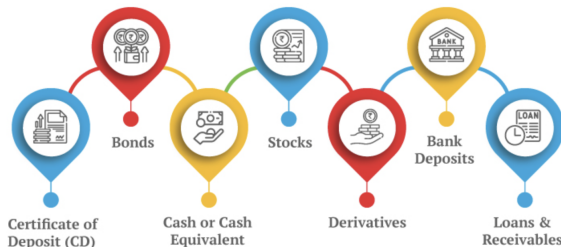
Introduction

How to Think about Finance

- ▶ **What is “Finance”?**
—Financial Assets, Financial System, and Participants

Financial Assets?

Financial Assets Types



- ▶ **Financial assets:** contracts that govern when and how resources are distributed across **time** and **states**
 - ▶ People and firm want resources at different points in **time**, in different **states** of the world
 - ▶ e.g., today and tomorrow, in boom and recession, etc

Financial System?

- ▶ **Financial system** governs how financial contracts are issued and exchanged
 - ▶ Banks, large financial institutions
 - ▶ Financial markets
- ▶ Highly heterogeneous
- ▶ Regulation: make sure these contracts to be enforced



Market Participants?

- ▶ **Market Participants** are those who get involved in financial transactions
 - ▶ Banks, large financial institutions; as brokers and dealers
 - ▶ Retail investors, households
 - ▶ Government
- ▶ Highly heterogeneous
- ▶ Many constraints on what they can do



Finance as an Academic Field

Tool to understand what you should (can) do in markets

Field of research that investigates financial market

- ▶ **Asset pricing**

- ▶ What is the fair price of an asset?
- ▶ e.g., Black-Scholes-Merton formula



- ▶ **Corporate finance**

- ▶ Firm's value and its decision making
- ▶ e.g., Modigliani–Miller theorem



- ▶ **Market microstructure**

- ▶ This course

How to Think about Finance (more advanced)

- ▶ **Positive perspective**—“What is happening?”
 - ▶ Mostly about financial system and participants
 - ▶ Understand who are playing what kind of game (from data)
- ▶ **Equilibrium perspective**—“How to play? What results?”
 - ▶ Given the environment, what should individuals do?
 - ▶ When individuals optimally behave, what happens to the market?
- ▶ **Normative perspective**— “How to design and regulate?”
 - ▶ Given all above things, what should government or market designer do?
 - ▶ Typically to maximize social welfare

How to Think about Finance (more advanced)

“If SEC imposes short-selling ban, what would happen?”

- ▶ Theoretical analyses
 - ▶ Develop an economic model, solve it, and derive testable implications
 - ▶ Typically, focus on a couple of important factors and omit complicated details
 - ▶ E.g., provide a guideline for the policy implementation
- ▶ Empirical analyses
 - ▶ Bringing data to test the derived implications
 - ▶ Finding new abnormality and interesting questions
 - ▶ E.g., test the actual impact of policy implementation

What is **Market Structure**?

Market Structure and Trading

What is **market structure**? Are all markets the same?

- ▶ Trading architecture, rules, types of orders, trade execution, transparency, etc...
- ▶ If not, how they differ? Why?

Example 1: FX vs Stocks Trading

- ▶ Want to buy USD/EUR. But how?
- ▶ Want to buy stocks of Amazon. How?
- ▶ In both cases, you may ask your brokers/dealers....but how do they trade?



Example 1: FX vs Stocks Trading

- ▶ Market for FX is over-the-counter (OTC)
 - ▶ Bilateral trading (customer-dealer, inter-dealer)
 - ▶ Need to find your counterpart through costly search-matching process
 - ▶ Called “decentralized” market



Example 1: FX vs Stocks Trading

- ▶ Trading structure of major stocks is “centralized” exchange
 - ▶ Placing “orders” (what orders are available?) to limit-order book (like double-sided auction)
 - ▶ No (or very small) search frictions and highly transparent

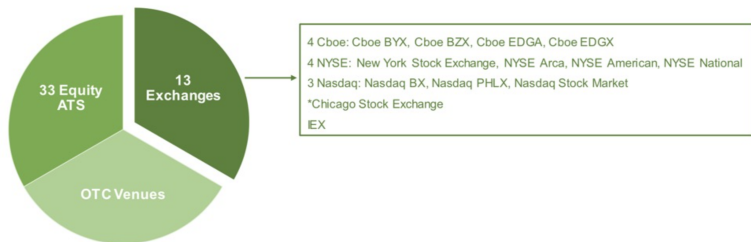


Example 1: FX vs Stocks Trading

- ▶ Want to buy a large amount of asset
- ▶ Which one of the trading structures you prefer?
 - ▶ OTC?
 - ▶
 - ▶ Centralized ex?
 - ▶
- ▶ Why they differ? How to optimize?
 - ▶ They offer different benefits/costs for different trading purposes
 - ▶ Optimal behavior depends on your motivation
- ▶ Are these structures socially optimal? Is it even possible?

Example 2: Competitive vs Monopolistic Exchanges

- ▶ In the US., there are 16 stock exchanges
 - ▶ Registered with SEC, “National Securities Exchanges”
 - ▶ Many other Alternative Trading Systems like Dark Pools



Source: Cboe Global Markets, FINRA, SIFMA estimates

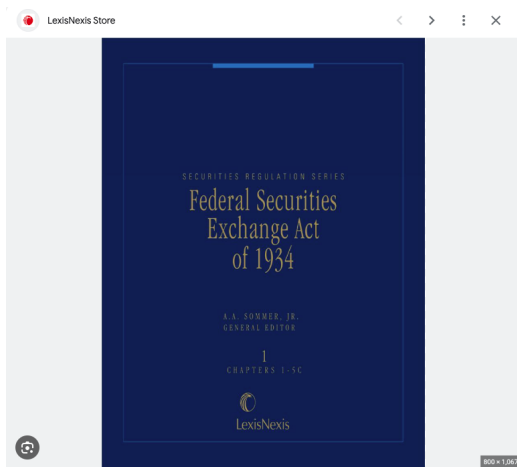
Note: Intercontinental Exchange (ICE) owns the NYSE exchanges, as well as other exchanges and clearing houses across the globe. In April 2018, ICE announced it entered into an agreement to acquire the Chicago Stock Exchange (CHX), pending regulatory approval.

Example 2: Competitive vs Monopolistic Exchanges

- ▶ How about other countries?
 - ▶ Hong Kong: HK Stock Exchange
 - ▶ United Kingdom: London Stock Exchange
 - ▶ Japan: Tokyo Stock Exchange
 - ▶ China: A-share and B-share?
- ▶ Why? What would be the consequences of fragmented markets?
 - ▶ Competing exchanges?
 - ▶ Price? Fee? Execution (service) quality?

Example 2: Competitive vs Monopolistic Exchanges

- ▶ SEC has promoted US exchange competition
 - ▶ Ex., the Security Exchange Act of 1934



Federal Securities Exchange Act of 1934 | LexisNexis Store

\$4,565.00 USD* · 在庫あり

表示

Example 2: Competitive vs Monopolistic Exchanges

- ▶ Basic idea: competition is good for consumers
 - ▶ We observe very small trading fees ($\approx 0.05\text{bps}$)
 - ▶ But...traders are still paying very expensive costs (for what?)
- ▶ Very complicated trading rules to ensure competition
 - ▶ Regulation National Market System (Reg-NMS)
 - ▶ e.g., Rule 611: order protection rule
- ▶ Optimal trading strategy? Equilibrium?
- ▶ Which design is better for individual users/social welfare?

Example 3: The Original Trading Floor 1879



Example 3: The Actual Trading Floor 2026

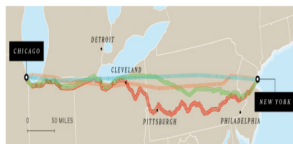


Example 3: Then, and Now

- ▶ Innovations in information technologies have dramatically altered the market structure
 - ▶ Electronic trading system: more accurate, faster, more transparent
 - ▶ Triggered structural changes in trade execution (and pricing)
 - ▶ Call auction vs Limit-order book
- ▶ Faster trading and execution always good?
 - ▶ High-frequency trading and arms race
 - ▶ AI-booms in Wall Street

Example 3: Then, and Now

- ▶ Fragmented market structure (due to RegNMS) $\times$ Electronic trading $\Rightarrow$ trading speed matters
- ▶ HFTs: speeds of microseconds (millionths of sec) $\sim$ nanoseconds (billionths)
 - ▶ a photon travels in a vacuum from NYC to Chicago in 5 milli-sec
- ▶ Huge investment in special-purpose techs, i.e., overinvestment



Original Cable	Spread Networks	McKay Brothers	Tradeworx
Buried fiber	Buried fiber	Microwave	Microwave
Mid 1980s	Aug 2010	July 2012	Winter 2012
~1,000 miles	825 miles	744 miles	731 miles
14.5ms	13.1ms	9ms	8.5ms
Follows rail lines	New right of ways	Microwaves faster than photons in fiber	

Market Manipulation by HFT: Spoofing

CFTC Fines J.P. Morgan Securities — a Fed Primary Dealer — \$100 Million for Failing to Surveil Potential Spoofing and High Frequency Trading for Eight Years

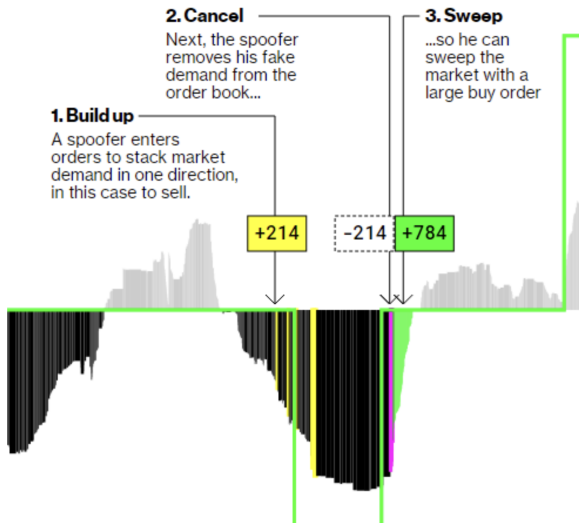
By [Pam Martens](#) and [Russ Martens](#): May 28, 2024 ~

How does a Wall Street trading firm gain competitive advantage to entice spoofers and high-frequency trading firms to use its trading platforms instead of those of its competitors? How about having its trading compliance personnel wear a blindfold as billions of trades occur over the span of 8 or 9 years?

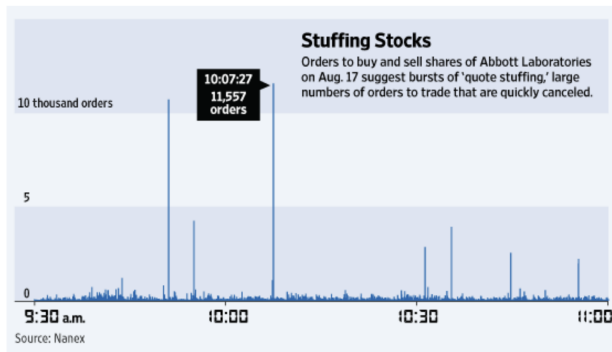


*Jamie Dimon, Chairman and CEO of JPMorgan Chase, Sits in Front of Trading Monitor in his Office
(Source: 60 Minutes Interview, November 10, 2019)*

Market Manipulation by HFT: Spoofing



Order-Flow Bursts hit Abbott Lab Inc.



- ▶ In normal time, 38 order/sec on average
- ▶ In one sec, 10,704 orders, and in the next sec, 5,483 orders
- ▶ All but 14 of them are cancelled within one sec

So What?

We need a metric to assess the impact of different market structures

- ▶ Welfare?
 - ▶ Traders, dealers, exchanges, firms, etc?
 - ▶ Typically not observable
- ▶ We use market-based approach
 - ▶ Asset prices and other metrics
 - ▶ Efficient market hypothesis

Market Quality

- ▶ Market microstructure is the field of study that analyzes how different structures affect **market quality**
- ▶ Two pillars of market quality
 1. Liquidity
 2. Price discovery (price efficiency)

Liquidity

- ▶ Often referred to as “market” liquidity ($\neq$ funding liquidity)
- ▶ Defined as the ability to execute a trade at a low cost and small price impact
 - ▶ Liquid market: your trading does not impact the price
- ▶ If the market is infinitely liquid, all trading needs will be filled without additional costs

Liquidity

- ▶ You are buying 100 units of AAPL in the LOB
- ▶ Which one of exchanges is more liquid?

Exchange A

Sell (ask)		Buy (bid)
100	\$101	
100	\$100	
100	\$99	
	\$98	100
	\$97	100

Exchange B

Sell (ask)		Buy (bid)
100	\$101	
80	\$100	
20	\$99	
	\$98	100
	\$97	100

- ▶ Trading cost (for a large order) = bid/ask spread + price impact
- ▶ What if you need only one unit of AAPL?
- ▶ What if RegNMS is imposed as in the US?

Liquidity

Exchange A

Sell (ask)		Buy (bid)
100	\$101	
100	\$100	
100	\$99	
	\$98	100
	\$97	100

Exchange B

Sell (ask)		Buy (bid)
100	\$101	
80	\$100	
20	\$99	
	\$98	100
	\$97	100

- ▶ Why “best ask > best bid” in general? What factors determine this gap?
- ▶ Is the bid-ask spread an appropriate measure of trading cost? Alternatives?
- ▶ Why liquidity is related to welfare?

Price Discovery (Price Efficiency)

- ▶ From FINA3103, the efficient price is

$$p^* = E[v|\text{available information}]$$

- ▶ The price discovery process: how quickly price incorporates new information
- ▶ Deviation from the efficient price stems from:
 - ▶ Absence of (informed) trading
 - ▶ Information frictions
 - ▶ Structural frictions
- ▶ How to exploit it?
- ▶ How to evaluate? How to formalize “information” in the price?

Our Plan

- ▶ First half (up to Midterm):
 - ▶ Definition, conceptual points, and knowledge
 - ▶ Will learn actual market trading in details (positive perspective)
- ▶ Second half
 - ▶ Explore the actual market via mathematical model (eqm/normative perspective)
 - ▶ Validity of theoretical prediction using data
 - ▶ Latest market innovations and their impact on trading
 - ▶ Electronic system and High-frequency trading
 - ▶ Blockchain and decentralization