Written Exam Economics summer 2025

Financial Markets Microstructure

June 06, 2025

This exam question consists of 7 pages in total
Answers only in English.

A take-home exam paper cannot exceed 10 pages – and one page is defined as 2400 keystrokes

The paper must be uploaded as one PDF document. The PDF document must be named with exam number only (e.g. '1234.pdf') and uploaded to Digital Exam. Please write the exam number on your exam paper as well.

Use of AI tools is permitted. You must explain how you have used the tools. When text is solely or mainly generated by an AI tool, the tool used must be quoted as a source.

Be careful not to cheat at exams!

Exam cheating is for example if you:

- Copy other people's texts without making use of quotation marks and source referencing, so that it may appear to be your own text
- Use the ideas or thoughts of others without making use of source referencing, so it may appear to be your own idea or your thoughts
- Reuse parts of a written paper that you have previously submitted and for which you have received a pass grade without making use of quotation marks or source references (self-plagiarism)
- Receive help from others in contrary to the rules in the Faculty of Social Science's common part of the curriculum

You can read more about the rules on exam cheating on your Study Site and in the Faculty of Social Science's common part of the curriculum.

Exam cheating is always sanctioned by a written warning and expulsion from the exam in question. In most cases, the student will also be expelled from the University for one semester.

Final exam

Write up your responses to questions below and submit them to Digital Exam before the deadline. No cooperation with other students is permitted.

Be concise, but show your work and explain your answers. Some questions may require you to make additional assumptions beyond those provided in the question; be clear about the assumptions you make. Some questions are open ended in that they may not have a unique correct answer. You are allowed to refer to textbooks, lecture notes, slides, problem sets, etc.

Problem 1: HFT with limited liquidity supply

Consider a Biais-Foucault-Moinas model of high-frequency trading that we considered in class. We assumed in that model that fast institutions (FI) always find trading opportunities, whereas slow institutions (SI) find trading opportunities with a fixed probability $\rho < 1$.

Suppose now instead that there is a fixed supply of liquidity in the market, denoted by $\xi \in (0, 1)$. FI are the first to dip into this liquidity, and then SI split among themselves whatever liquidity is left. For example, if the share of institutions that are fast, α, is such that $\alpha \leq \xi$, then all FI find a trading opportunity. Then the $1 - \alpha$ slow institutions have to split the remaining $\xi - \alpha$ trading opportunities, so each individual SI gets to trade with probability $\rho(\alpha) = \frac{\xi - \alpha}{1 - \alpha}$.

Keep the rest of the model as presented in class. Explain how this tweak changes the incentives to invest in speed: would you expect the equilibrium FI share α^* to be higher when SI's trading probability is exogenous (ρ) or endogenous in the way described above ($\rho = \rho(\alpha)$)? Why?

Note: you do not need to provide closed-form solutions. You are, however, expected to verbally identify the main consequence(s) of such a tweak.

Problem 2: Kyle model with information acquisition

Consider a single-period Kyle model, where the speculator does not know the asset's fundamental value v perfectly, but instead decides how much to invest in a noisy signal about v. In particular, suppose that before submitting an order, the speculator chooses σ_s^2, pays cost $c(\sigma_s^2)$, and then receives signal $s \sim \mathcal{N}(v, \sigma_s^2)$.

After that, the game proceeds as in the regular Kyle model. The speculator chooses their trade size, $x \in \mathbb{R}$, to maximize their expected profit $\Pi_I \equiv \mathbb{E}[x(v - p)]$. The noise traders submit a random market order $u \sim \mathcal{N}(0, \sigma_u^2)$. The competitive dealer observes the aggregate order imbalance $q = x + u$ and quotes a price $p(q)$ at which they are willing to absorb it. All agents have a common prior belief that $v \sim \mathcal{N}(\mu, \sigma_v^2)$.

1. Fix some signal precision σ_s^2 for the speculator and suppose they follow a strategy that is linear in the signal s: $x(s) = \beta(s - \mu)$ for some β. Derive the price schedule $p(q)$ that the dealer would offer given the equilibrium β and σ_s^2. Specifically, show that $p(q) = \mu + \lambda q$ and provide an expression for λ.
2. Derive the speculator's optimal trading strategy $x(s)$ given σ_s^2 and the dealer's pricing schedule $p(q) = \mu + \lambda q$.
3. Calculate the speculator's expected trading profit for given σ_s^2, σ_v^2, and λ.
4. Suppose now the speculator's information cost is given by $c(\sigma_s^2) = \frac{\gamma}{\sigma_s^2}$ for some information cost parameter γ. Derive the amount of information $\tau_s \equiv \frac{1}{\sigma_s^2}$ the speculator acquires as a function of $\lambda, \gamma, \sigma_v^2$.
5. How does the speculator's information choice depend on γ and σ_v^2 given λ? How does it depend on λ? How does it depend on σ_u^2 in equilibrium? Explain.

Problem 3: 0dte traders

1. Which motives for trading have we proposed throughout the course as reasons for trading in financial markets? Mention and briefly describe them.
2. Read the essay attached at the end of this exam. Which of the motives above drive the behavior of the retail traders mentioned in the essay? Are there any other motives driving them that we have not discussed?

bloomberg.com

The Fastest Options Are the Most Fun

Matt Levine

24–30 minutes

Single-stock 0dtes

Some of the work in the financial industry involves finding and fostering bad counterparties. If you are a stock market maker — you buy stock from customers who want to sell, and sell to customers who want to buy — and your customers are mostly huge sophisticated hedge funds, you will have a lot of unpleasant days. They are smart and large; when they buy stock from you, it will mostly go up and you will regret selling; when they sell stock to you, it will mostly go down and you will regret buying.

On the other hand, if you have customers who like a gamble and are always wrong, that's great! When they sell stock to you, it will mostly go up, and you will make money. The obvious business model is:

1. Find more of those people.
2. Take them out to steak dinners, be nice to them, and generally make them feel like valued customers.
3. Proactively work to offer them trading opportunities that satisfy their urge to gamble, that give them more chances to be wrong, and that have a lot of profit built in for you.
4. Do as many trades as possible with them, though preferably not

so many that you blow them up entirely. You want them to have enough fun that they keep coming back for more.

This business model is obvious in part because it is the actual well-known business model of a casino: nice dinners, fun games and lots of edge.

In finance, we talk a lot about "payment for order flow," which is an important way that US equity market makers try to find bad counterparties: If you trade stock on the stock exchange, you run the risk of trading with sophisticated hedge funds, but if you trade exclusively with the customers of a retail brokerage, you know that all of your counterparties are retail traders. So market makers pay those brokerages to trade with their customers, and in fact there is evidence that the market makers discriminate even among retail customers: Some retail brokers' customers are more sophisticated than others', so market makers should pay more to trade with the unsophisticated ones.[1]

But you don't have to just take your counterparties as you find them; you can work to encourage and develop bad ones. This is often a matter of product development: If you build a product that does nothing for sophisticated professionals but that is really good for noisy addicted gamblers, you will attract exactly the right sort of counterparty. This arguably explains much of crypto.

Anyway the the Wall Street Journal reports:

> A popular, fast-paced trade has boosted the options market to record volumes in recent years. Now, Wall Street is looking to push it even further.
>
> Zero-day-to-expiry options let investors bet on whether a particular stock-market index will rise or fall by the end of the day. They have drawn an enthusiastic following among amateur investors, even as skeptics call them a form of gambling. They are

> sometimes known by the hashtag #0dte.
>
> So far, the #0dte boom has been limited to options tied to indexes such as the S&P 500 or Nasdaq-100. The next frontier could be options on stocks such as Tesla or Nvidia. ...
>
> Michael McCaskill, a 48-year-old day trader and volleyball-programs coordinator in Louisville, Ky., trades short-dated options in hopes of hitting the jackpot. He's intrigued by the prospect of more-frequent expirations on single-stock options.
>
> "The percentage gains are incredible," said McCaskill, who has previously made profitable bets on GameStop, Netflix and PayPal. "It's the short-dated options that give you that, whether it's weekly or daily."

I am sorry, I am sure he has lots of profitable trades and I don't mean to be rude, but just, statistically speaking, for equity market makers, there are few more beautiful phrases in the English language than "day trader and volleyball-programs coordinator." If you walk into the offices of Susquehanna International Group and say "hi I am a day trader and volleyball-programs coordinator from Louisville, Ky., and I love short-dated options but I wish they were shorter-dated, can you help," they will treat you like a celebrity and give you anything you ask for. You are their muse.

As it happens, Susquehanna is salivating over single-stock 0dtes but Robinhood, less so:

> In closed-door industry meetings, retail brokerages such as Robinhood Markets, Schwab, Tastytrade and Morgan Stanley's E*Trade have advocated for a cautious approach, concerned they could face a customer backlash if investors' options trades blow up, the people said.
>
> Other firms—including Susquehanna International Group, a

> huge options-market maker, and Nasdaq—have actively promoted bringing daily expirations to single-stock options, the people said. Both market makers and exchanges stand to benefit from the volumes that could come from further growth in the #0dte phenomenon.

The retail brokers *basically* make money if their customers are happy; the market makers *basically* make money by trading against them. There is an overlap in their interests, but it is not complete. If Robinhood gives its customers new ways to lose money faster, that's probably bad for Robinhood in the long term, but it's very good for whoever is on the other side of those trades.