Written Exam Economics summer 2021

Financial Markets Microstructure

June 16, 2021

This exam question consists of 3 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 <u>one PDF document</u>. The PDF document must be named with exam number only (e.g. '1234.pdf') and uploaded to Digital Exam.

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 laid down in part 4.12 of the Faculty of Social Science's common part of the curriculum on cooperation/sparring

You can read more about the rules on exam cheating on your Study Site and in part 4.12 of 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.

Problem 1

We have discussed throughout the class that larger presence of uninformed traders in the market improves market liquidity. However, some recent evidence shows that more active trading through Robinhood (trading app used by predominantly retail investors) leads to *lower* liquidity in the exposed markets.

Give a possible explanation, intuitive or via a model, to this empirical phenomenon. Use the knowledge you have obtained in the course and/or any external sources you can find (remember to give appropriate credit to your sources).

Problem 2

Consider the Biais-Foucault-Moinas model of high-frequency trading we discussed in class, but assume now instead that adverse selection is mild: $\epsilon < \delta$.

In particular, suppose there is a unit continuum of profit-maximizing institutions $i \in [0,1]$, of which share $\alpha \in (0,1)$ has access to HFT technology (fast institutions). There is a single asset; institutions value the asset at $u_i = v + y_i$, where $v \in \{\mu - \epsilon, \mu + \epsilon\}$ with equal probabilities is the fundamental value, and $y_i \in \{-\delta, \delta\}$ with equal probabilities, independent across i, is the institution i's idiosyncratic value for the asset. Given a trading opportunity, the institution can submit a market order to buy or sell one unit of the asset. At the time of trade, a fast institution knows both v and y_i, while a slow institution only knows y_i. Further, trading opportunities arrive to fast institutions with probability 1, while slow institutions only receive a trading opportunity with probability ρ. Risk-neutral liquidity providers are competitive and provide bid and ask quotes for one unit of the asset so as to get zero expected profit on any trade.

Answer the following questions given $\epsilon < \delta$ and $\alpha > 0$.

1. Equilibrium multiplicity is still an issue in this case. Focusing on the ask side of the market, what are the equilibria that can arise in such a market? Calculate the equilibrium ask price in each of these equilibria.

2. When do each of these equilibria exist? Derive the exact existence conditions.

3. Calculate the expected profits of slow and fast institutions in the Pareto-dominant equilibrium. How do they depend on α?

   HINT: Pareto-dominant is the equilibrium with the largest amount of trade.

4. (Conditional on the Pareto-dominant equilibrium:) How do incentives to invest in speed depend on α? Do you think these incentives will result in efficient investment or will there be over-/underinvestment? Explain why (intuitively). Explain how this relates to the case of severe adverse selection ($\epsilon > \delta > \epsilon/2$) that we explored in class.

Problem 3

Blockchain markets attempt to experiment with novel ways to organize markets and provide liquidity. For example, Uniswap trading protocol on the Ethereum blockchain implements the "liquidity pools" scheme described below. You are asked to analyze the implications of this market design for liquidity provision.[1]

If a trader is willing to provide liquidity for a given asset, they must buy into a liquidity pool for that asset. If the liquidity pool consists of A units of the stock and C units of cash (or cryptocurrency), then to enter the trader needs to contribute a units of asset and c units of cash s.t. $a/c = A/C$. The trader would then own fraction $\frac{a}{A+a}$ of the liquidity pool indefinitely. If the trader wants to quit the pool, they can claim their share of the asset and the cash and withdraw from the pool.

Any market order must necessarily trade against the whole liquidity pool. I.e., you can think that every liquidity provider executes a part of every incoming market order equal to their share of the liquidity pool. The price per unit for an infinitesimally small trade is given by $p = C/A$, but trading any non-trivial amount would have a price impact. For this problem, assume that the average price at which a trade of size q executes is given by $p = C/A + \lambda q$, where q is trade size, and the price impact coefficient λ is determined by the size of the pool (larger pool leads to lower λ).[2]

Answer the following questions.

1. Assume that all elements of the model except for liquidity providers are the same as in the (single-period) Kyle model: the fundamental value is $v \sim \mathcal{N}(\mu, \sigma^2)$, the midquote is $C/A = \mu$, the order flow is given by $q = x + u$, where x comes from a profit-optimizing informed trader who knows v, and $u \sim \mathcal{N}(0, \sigma_u^2)$ comes from uninformed traders. Further, assume free entry into the liquidity pool – i.e., the liquidity providers enter until the expected profit from entry is zero.

   Derive the equilibrium pool depth λ. How does it compare to depth that would arise in the presence of a single dealer? How does it compare to depth that would be generated by a limit order book?

   HINT: when considering entry decisions, ignore the cost of buying into the pool and focus on profit from incoming trades only, since the latter will dominate if the trader stays in the pool long enough.

2. What are the benefits and drawbacks of the liquidity pool as opposed to dealer markets? As opposed to the limit order book? (In dimensions other than market depth.)

[1] Note: this problem explores a modification of the Uniswap V2 protocol, not the just-released V3 protocol.

[2] The actual Uniswap V2 protocol has a more sophisticated pricing algorithm, in which the price the trader gets is such that in the end, $\frac{A+\Delta A}{C+\Delta C} = \kappa$ for some exogenously fixed constant κ.