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Equilibrium fast trading[☆]

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ABSTRACT

High speed market connections improve investors' ability to search for attractive quotes in fragmented markets, raising gains from trade. They also enable fast traders to obtain information before slow traders, generating adverse selection, and thus negative externalities. When investing in fast trading technologies, institutions do not internalize these externalities. Accordingly, they overinvest in equilibrium. Completely banning fast trading is dominated by offering two types of markets: one accepting fast traders, the other banning them. Utilitarian welfare is maximized with (i) a single market type on which fast and slow traders coexist and (ii) Pigovian taxes on investment in the fast trading technology.

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1. Introduction

Investors must process very large amounts of information, in particular about trades and quotes, which are relevant both for the valuation of securities and the identification of trading opportunities. Timely collection of this information has become increasingly difficult due to the fragmentation of the markets, e.g., for U.S. equities, there are now more than 50 trading venues: 13 registered exchanges and 44 so-called Alternative Trading Systems.[3]

In fragmented markets, investors must search for quotes across markets. This can result in delayed or partial execution, which is costly. Chiyachantana and Jain (2009) find that delays in execution account for about one-third of total costs for institutional investors in their sample.[4] To reduce these costs, traders can invest in fast trading technologies. For instance, they can use smart routers that instantaneously

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[3] See, for instance, O'Hara and Ye (2011), or, http://fragmentation.fidessa.com/ which provides statistics on market fragmentation in the U.S. and Europe.

[4] In practice, delay costs stem from (i) a worsening of price conditions between an order arrival and its completion and (ii) opportunity costs due to partial execution. Margin constraints could also make delayed execution costly (see Zhu, 2014).

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compare quotes across trading venues and allocate their orders accordingly. Furthermore, to better inform their routing decisions, they can buy fast access to exchange data feed, using colocation rights (the placement of their computers next to the exchange's servers), or high speed connections via fiber optic cables or microwave signals.

By the same token, however, fast trading technologies also accelerate access to value-relevant information for an asset, conveyed by recent transaction prices and quote changes for this asset or related ones. Numerous empirical studies document that orders placed by fast traders reflect advance information.[5] This informational advantage generates adverse selection costs for other market participants. For example, Baron, Brogaard, and Kirilenko (2014) observe that high-frequency traders earn short-term profits on their market orders, at the expense of other market participants, and Brogaard, Hendershott, and Riordan (2014) write: "*Our results are consistent with …high-frequency traders imposing adverse selection on other investors*." Thus, firms investing in fast trading technologies generate adverse selection costs for the other market participants.

Fast trading firms have no incentives to internalize these costs when making their investment decisions, which can generate a wedge between privately and socially optimal investment in fast trading technologies.[6] In this paper, we analyze equilibrium investment decisions in fast trading technologies, their consequences for welfare, and possible policy interventions (taxation and slow markets) to achieve the socially optimal level of investment in fast trading technologies.

To examine these issues, we consider a simple model suitable for welfare and policy analysis. Financial institutions have (i) heterogeneous private valuations, e.g., due to differences in tax or regulatory status, and (ii) private information about common values. The latter is a source of adverse selection, whereas the former creates gains from trade.[7] Before trading, institutions decide to invest or not in a fast trading technology. Then, institutions seek to trade in a fragmented market. At each round of trade, a fraction λ of the trading venues offer attractive quotes, while the others do not. Fast institutions can instantaneously search across all markets and, consequently, always find attractive quotes. Slow institutions cannot do so. For simplicity we assume they can visit only one market venue per period. Correspondingly, at each period, they execute their desired trade with probability λ. Otherwise they must continue to search for quotes, and find this delay costly. Moreover, in addition to speeding up execution, fast institutions' ability to scan markets ultra rapidly enables them to obtain advance information (e.g., from observing prices of other correlated assets), generating adverse selection costs for the other market participants.

First, we analyze equilibrium allocations and prices for a given fraction, α, of fast institutions. The larger α, the greater the information content, and hence the price impact, of trades. Now, institutions prefer to abstain from trading when their price impact exceeds their private gain from trade. Hence, an increase in α lowers gains from trade for all market participants. Thus, fast institutions exert a negative externality upon the others, by increasing adverse selection in the marketplace.

Second, we study equilibrium investment in fast trading technologies, i.e., we endogenize α. Financial institutions invest only if the cost of the fast technology is smaller than the relative value of being fast, i.e., the difference between the expected profit of a fast and a slow institution. Now, the relative value of being fast depends on the fraction of institutions who choose to be fast. Hence, the equilibrium level of investment in the fast trading technology is the solution of a fixed point problem: if institutions expect the level of fast trading to be α^*, then exactly this fraction find it optimal to be fast. When the relative value of being fast declines with the level of fast trading (i.e., if institutions' decisions are substitutes), the equilibrium is unique. Otherwise, there can be multiple equilibria. This happens when entry of a new fast institution reduces the profit of slow institutions more than that of fast institutions. In this case, institutions' investment decisions are complements: they reinforce each other, because the technology becomes increasingly attractive as more institutions invest in it. As a result, all institutions can end up investing in the fast technology, even though other equilibria with less or no investment in fast trading exist as well. This outcome has the flavor of an arms race, as in Glode, Green, and Lowery (2012).

Third, we show that, because of the negative externality induced by fast traders, equilibrium investment in the fast trading technology exceeds its utilitarian-welfare maximizing counterpart.[8] This problem arises whether institutions' investment decisions are substitutes or complements. However, complementarities in investment decisions tend to worsen overinvestment because institutions can be trapped in an investment race, even if the socially optimal level of investment is low.

Fourth, we analyze various possible policy interventions to mitigate this inefficiency. A ban on fast trading precludes reaping the benefits of the technology. This approach is too harsh because the socially optimal level of investment is not necessarily zero. We therefore focus on less heavy-handed approaches.

The first approach is to let "slow markets" (on which fast trading is banned) coexist with fast markets. This approach always dominates a complete ban on fast trading. However,

[5] For instance, Brogaard, Hagströmer, Norden, and Riordan (2014), Brogaard, Hendershott, and Riordan (2014), Hendershott and Riordan (2013), Zhang (2013), and Kirilenko, Kyle, Samadi, and Tuzun (2014).

[6] As written by Hirshleifer (1971), "*the distributive aspect of access to superior information…provides a motivation for the acquisition of private information that is quite apart from any social usefulness of that information…There is an incentive for individuals to expend resources in a socially wasteful way in the generation of such information*."

[7] The differences in private values in our setting are similar to those in Duffie, Garleanu, and Pedersen (2005). Our assumption is also in line with Bessembinder, Hao, and Zheng (2013), in which private valuation shocks induce gains from trade and hence transactions between rational agents.

[8] In practice, trading firms invest significant amounts to obtain fast access to markets. For example, the cost of Project Express, which drew a new and faster fiber optic cable across the Atlantic, to connect Wall Street to the City, was $300 million. For 2013 alone, the Tabb Group estimates the investment in fast trading technologies at $1.5 billion, twice the amount invested in 2012.

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