регулирование высокоскоростных торгов
анализ микрокомпонентов поведения, оптимальных решений и парадигмы эффективности на высокоскоростных рынках

Камилло фон Мюллер

Университет Штаден - Институт управления
Дуфферстрассе 40а, 9000 Штаден
Камилло.Фрайхеррвонмуeller@unisg.ch

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Абстракт

Данное исследование рассмотрит вопрос регулирования высокоскоростной торговли (HFT). Вместо обсуждения макроуровня эффектов HFT, которые все еще обсуждаются (Sornette & Von der Becke, 2011), его анализ сосредотачивается на вопросе регулирования с точки зрения HFT предприятий. Предполагается, что HFT предоставляет преимущества фирмам, позволяя им торговать с меньшей задержкой, чем их конкуренты. Бинарные решения HFT инвестиций приводят к неэффективным агрегатным распределениям, если физические ограничения по задержке не учитывались. Корректировки в структуре платежей предполагаемой модели показывают, что регулирование может минимизировать негативные внешние эффекты, если законодатель может различать между участниками рынка и их стратегиями HFT. Результаты альтернативной модели указывают на то, что законодатели должны быть обеспокоены негативными внешними эффектами некоторых типов поведения HFT предприятий, а не HFT в целом. План действий Мифид II, похоже, обещает служить более точным инструментом для регулирования HFT, чем общий налог на финансовую трансакцию.

Ключевые слова: высокоскоростная торговля, проблема заключенной игры, регулирование, von Thünen. 
Классификация JEL: G18, G19, C72, C73, R1.
1. INTRODUCTION

In the “Flash Crash” on May 6 2010 the Dow Jones lost about 1 trillion USD of market value (Sornette & Von der Becke, 2011). “[I]n the course of about 30 minutes, U.S. stock market indices, stock-index futures, options, and exchange-traded funds experienced a sudden price drop of more than 5 percent, followed by a rapid rebound” (Kirilenko et al. 2011). This “brief period of extreme intraday volatility” has put increased focus on the issue of High Frequency Trading (HFT). More specifically, it raised questions about the responsibility of HFT firms for the crash, and the impact of HFT on the structure and stability of financial markets in general (ibid.; Sornette & Von der Becke, 2011).

Clark (2010) points out that in the US HFT strategies are only carried out by “a small group of high-frequency algorithmic trading firms...” (italics in the original). Yet these firms play a dominant role in current markets. According to the TABB Group, “a financial markets research firm, ... algorithmic trading in the U.S. equities market grew from 30 percent of total volume in 2005 to about 70 percent in 2009” (ibid.). Compared to markets in the US, financial markets in Europe are less dependent on HFT. However, HFT makes up for significant shares in European market volumes as well. For example, Deutsche Bank estimates that HFT accounts for 35-40% of volumes on its trading platforms (Gomber et al., 2011) while the TABB Group estimates that HFT accounts for 77% of transactions in the UK market (Sornette & Von der Becke, 2011).

Given the significance of HFT in US and European financial markets, the questions whether and how to regulate HFT are essential not only to financial markets but also to the wider economy. These questions are usually addressed from a macro-level perspective (e.g. Hendershott et al., 2011; Hendershott & Riordan, 2009). Yet, macro-level effects of HFT are hard to estimate. Consequently, results in the current literature are often inconclusive (Chlistalla, 2011; cf. for example Gsell (2008) and Zhang (2010)). In light of these
ambiguities I take a different approach and examine the issue of HFT regulation from a micro-level perspective. I.e., the present paper does not discuss the issue of HFT regulation by addressing potential impacts of HFT on global phenomena such as overall market quality and systemic risks. Rather, I look at the costs and benefits of HFT through the lenses of market participants in order to find out whether financial service firms themselves should be interested in HFT regulation.

The paper proceeds as follows. In Section 2, I review the relevant literature. Section 3 provides the background and assumptions of the analysis. In section 4, I address the question whether HFT firms should be interested in HFT regulation in context of a Von Thünen Model before discussing payoffs and choices of HFT firms within a strategic framework. In section 5, I identify features and content of HFT regulation that would be beneficial to both, HFT investing firms and HFT non-investing firms. Section 6 concludes.

2. LITERATURE

“Being a fairly new phenomenon academic research on ... [the] subject [of HFT] is still limited in numbers...” (Sornette & Von der Becke, 2011). Gomber et al. (2011) present an “Academic Literature Overview on High Frequency / Algorithmic Trading” in which they show that the number of annually published papers gradually increased between the years 2006 and 2010.

A reoccurring theme in the papers cited by Gomber et al. (2011) are questions concerning macro-level effects of HFT, such as impacts on welfare and economic value (e.g. Jovanovic & Menkveld, 2011; Ende et al., 2011); market liquidity (e.g. Cvitanic & Kirilenko, 2010; Chaboud et al., 2009), volatility (e.g. Groth, 2011; Gsell, 2008); efficiency (Hendershott & Riordan, 2011), and market quality (e.g. Hendershott et al., 2011).
Sornette & Von der Becke (2011) quote several studies that underline the positive effects of HFT such as Brogaard (2012); Hendershott & Riordan (2009), and Hendershott et al. (2011). Other studies cited by Sornette & Von der Becke (2011) such as Zhang (2010), and Smith (2010) are more critical in their assessments on the overall effects of HFT. This view is also shared by Sornette & Von der Becke (2011) themselves.

The literature reviews of Gomber et al. (2011) and Sornette & Von der Becke (2011) illustrate that researchers have been paying only limited attention to strategic decisions of HFT firms and their micro-level outcomes. The question, whether HFT firms themselves should be interested in regulated HFT markets hence presents under-researched territory. By addressing this question, the present paper aims to contribute to current debates on HFT regulation and to narrowing gaps in the existing literature.

3. BACKGROUND

The term “High Frequency Trading” is relatively new and not well defined (SEC, 2010). Most definitions agree in that trading firms employ HFT strategies in order to reduce exposures to market price movements:

“[A] main goal of high frequency trading strategies is to reduce latency, ... in placing, filling, and confirming or canceling orders. This is important because price takers – those who place orders to buy or sell – are exposed to market risk prior to receiving confirmation that their orders have been filled. Price makers – those who provide resting bids (buy orders) and offers (sell orders) or respond to buy or sell orders – are exposed to the risk that their prices will remain in the market at a time when the market has moved in the opposite direction of their strategy” (Clark, 2010).

This paper follows Clark’s (2010) assumptions. It presumes that firms apply HFT strategies to limit their exposures to market risks from price movements by trading at lower latencies than other market participants.
As Clark (2010) notes, latency has “various components, including speed at which market data signals from the marketplace are processed and geographical distance and response time from the exchange matching ... computers....” If firms send “their buy and sell orders to exchange matching engine at breakneck speeds”, HFT only yields advantages to them as long as it guarantees that HFT “trades will be executed first” (ibid.). In other words, HFT is a relative concept (Zwick, 2011). I.e., firms profit from HFT technologies as long as these technologies allow them to trade at lower latencies than the market.

The natural limit “for moving bits from one location to another” is the speed of light as “fundamental constraint of the universe according to the current understanding of the laws of physics” (Kay, 2009). Under the assumption that it is possible to control for interface-, processing-, and queuing-delays (ibid.), the speed of light hence represents the ultimate barrier to reducing latency in HFT. In vacuum the speed of light is exactly 299,792,458 meters per second (ibid.). The maximum speed at which a signal can propagate 1 kilometer equals thus 1 kilometer divided by 300,000 kilometers, or \( \sim 3.3 \) microseconds (ibid.).

Since “signals in fiber or copper cables can travel at roughly \( \sim 70\% \) of the speed of light” the true latency barrier of HFT is \( \sim 3.3 \) microseconds per kilometer (ibid.). While researchers in optical computing hold that the evolution of photonic computing will allow one day for transmitting and processing information at the speed of light (Lerner, 1997), this limit is assumed to hold as fix physical barrier in context of the current investigation.

The fact that there is a physical barrier to reducing latency should have consequences upon the strategic choices of firms that decide whether to invest into technologies of HFT or not. In the subsequent paragraphs I will discuss these consequences.
4. SHOULD FIRMS SUPPORT HFT REGULATION?

I begin the investigation by looking into the nature of choices that firms make when adopting HFT strategies. Given the natural limits to transmission speed, I assume that HFT technologies uniformly allow firms to trade at $\sim 70\%$ of the speed of light.

Under this premise HFT strategies can be decomposed into a frequency of different choices. First, a given firm has to decide whether or not to invest into HFT technology so as to be able to exploit minimum latencies. If the firm decides to invest into HFT technology, subsequent choices follow. Assuming that other firms invest into HFT technologies as well and that all other things are held constant, the only way for a firm to exploit gains from HFT due to lower latencies is to reduce geographical distance to the server of the trading platform (Haldane, 2011). In turn, this will have implications on whether a firm should have invested into HFT technology in the first place. I will demonstrate this in the subsequent paragraphs.

4.1. A Von Thünen Model of HFT

The fact that there is a natural barrier to minimum latencies has direct implications for how HFT firms make use of space. These implications can be summarized along the mechanics of the classical model proposed by von Thünen (1826 [1966]). In order to do so, I assume that firms share a common interest in trading at lower latencies than competitors. However, due to different trading strategies it is possible to distinguish between three types of firms:

1. **Type 1**: Firms that apply HFT strategies as core element of their trading strategies.
   
   These firms should have the highest willingness to pay for being located as close as possible to the servers of the trading platform.
2. **Type 2**: Firms that apply HFT strategies such that they are opposed to risks resulting from the fact that some firms are trading at lower latencies than they do, as long as there is a third group of firms that trade at higher latencies. These firms should have a lower willingness to pay for immediate proximity to the server of the trading platform than the aforementioned group of firms.

3. **Type 3**: Firms that apply trading strategies such that low latencies make operations more efficient but are not decisive for performance. These firms should have the lowest willingness to pay for being located in proximity to the server of the trading platform.

Figure 1 summarizes results along the scheme of Fujita et al. (2001). Its y-axis represents the firms’ willingness to pay location premiums as function of server proximity. Each firm’s willingness to pay for server proximity declines from a maximum at the server location that is equal to expected gains resulting from zero server distance, to zero at the point where the firm is indifferent about server proximity at all. The x-axis represents a given firm’s distance to the server of the trading platform.

The equilibrium “bid-rent” curves are represented in the Northern part of the figure. The curves represent the maximum location premium that firms would be willing to pay at any given distance to the server of the trading platform. The enveloped curve defines the rent premium gradient. Along each of the three sections of the curve, firms of one of the aforementioned types are willing to pay more for location than others. The outermost firm pays zero premiums. The result consists of concentric rings of firms allocated according to strategic preferences. The Southern part of the figure shows a quarter section of the layout.
4.2. Implications of the HFT-Von Thünen Model

While the results of the model seem to be obvious its implications are less evident. Figure 1 illustrates that Type 3 firms attribute the lowest value to server proximity. As a consequence, they will be located such that – even if they had invested into HFT like the rest of the firms - they would trade at higher latencies than the other firms. Under this presupposition, HFT technologies will yield zero benefits to Type 3 firms. Therefore, the latter will abstain from investing into HFT technologies.

If Type 3 firms abstained from investing into HFT technologies, should Type 2 firms invest into HFT technologies? If Type 2 firms invested into HFT technologies, their location determined in the model is such that they would trade at higher latencies than Type 1 firms, and lower latencies than Type 3 firms if all firms had invested into HFT technology. But we have just seen that Type 3 firms do not invest into HFT technologies. Thus, Type 2 firms can trade at lower latencies than Type 3 firms without investing into HFT technologies either. If neither Type 3 nor Type 2 firms invested into HFT technologies, what should Type 1 firms do? Let’s remember that Type 1 firms aim at trading at lower latencies than other participants. If no other firms are employing HFT technologies their choice of location suffices to realize this goal. Hence, they should not invest into HFT technologies either.

Why then do firms invest into HFT technologies? In order to answer this question let’s assume an initial situation in which firms were allocated as described and all firms had committed themselves to not invest into HFT. Let’s further assume that HFT technologies
were such that if the outermost firm invested into HFT while all its competitors remained as Non-HFT firms, this firm would be able to dominate the market by trading at lower latencies than the rest. How would firms behave under these assumptions?

Let’s focus on Type 1 firms before we look at how other firms would behave. Remember that Type 1 firms have homogenous preferences in aiming at dominating as much of the market in terms of speed as possible.

We recall that the outermost firm in the Von Thünen Model is paying zero premiums for server proximity. If HFT technology would allow firms to dominate the market independent of location, any firm that is located within the inner concentric rings of the model could save money and pay lower rental premiums by investing into HFT technology and moving closer to the zero premium area.¹ If there was only one firm that invested into HFT technology and moved to the zero premium area, it would even be better off than before since HFT technologies would allow it to pay lower rent premiums and yet trade at lower latencies than all its competitors. The firm located at zero server distance can only prevent other firms from doing so by investing into HFT technologies itself. Analogous reasoning applies to the firms that are second, third, fourth, etc., in server proximity. Consequently, any firm that would not invest into HFT technology would run the risk to be dominated by all other firms.

Equivalently Type 2 and Type 3 firms have to invest into HFT technologies in order to secure their relative position within their market segment. The pressure to invest into HFT technologies thus persists for firms independent of their location. A closer look at the payoff structure of HFT technologies elucidates resulting efficiency problems.

¹Provided that costs of HFT investment do not exceed savings from reallocation.
4.3. HFT Payoffs

In order to discuss these problems, I assume a case of two firms that are confronted with the decision of whether to invest into a HFT technology or not. This choice is to be considered a one-shot game. I.e. each firm decides ones and for all whether to invest into HFT. I further simplify assumptions of the HFT-Von Thünen model by making this decision the only strategic choice of firms. I.e. once firms have adopted HFT technologies they do not differ in HFT trading strategies. This assumption condenses empirical observations according to which algorithmic trades show high levels of correlation (Chaboud et al., 2009).

Both firms choose strategies so as to maximize benefits ($B$). If one firm trades at lower latencies than the other, it can capture all of the benefits ($B$). If the two firms trade at equivalent speed, gains are shared so that their pay-offs are ($\frac{B}{2}$) for each firm. In order to minimize latencies, each firm can purchase access to HFT technology. This technology is available at fixed costs ($C$) that are across HFT market participants, where ($B > C > 0$).

Any given firm would clearly be best off, if it would be the sole agent having access to HFT technology. This situation would allow the firm to exploit the technology at full capacity by trading at lower latencies than the other firm. In this situation, the HFT investing firm would capture the full benefits of the technology enjoying total payoffs minus costs of HFT investment ($B - C$).

In reverse, under given assumptions a firm is worst off, if it is the only agent that does not have access to HFT technology. In this case, its competitor can exploit the technology at full capacity by trading at lower latencies than the firm itself. From the perspective of the firm that does not have access to HFT-technology, this outcome implies zero payoffs ($0$).

How do firms rank the two residual outcomes? Both outcomes are characterized by symmetric choices, either both firms invest into HFT-technology, or they do not. What
does happen if both firms do invest? In this case, they both allocate resources, each at costs \((\frac{C}{2})\) for being able to trade at minimum latencies. Since both firms will trade at the physical limit determined as constant fraction of lightening speed, no firm will be able to trade at lower latencies than the other. As both firms will trade at identical speed, they do not enjoy any advantages over each other from HFT. Since they both invested into the technology at costs \((C > 0)\) net benefits to each firm are \((\frac{B-C}{2})\).

What does happen if neither of the firms does invest into HFT-technology? While each of the two firms will be processing orders at much higher latencies than if it would have invested into HFT-technology, the result is structurally the same: none of the firms will be able to dominate the other in terms of trading speed. Yet, since firms did not undergo any costs for investing into HFT, net benefits are \((\frac{B}{2})\) for each firm respectively.

### 4.4. Prisoner’s Dilemma

Table 1 summarizes the strategic choices of the firms: The structure of payoffs shows that each of the two firms has the dominant strategy of investing into HFT. I.e. this “choice is preferred, irrespective of which choice the other ... [firm] makes” (Schelling, 1973).

<table>
<thead>
<tr>
<th></th>
<th>Invest into HFT</th>
<th>Do Not Invest into HFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invest into HFT Technology</td>
<td>((\frac{B-C}{2}))</td>
<td>((B - C))</td>
</tr>
<tr>
<td>Do Not Invest into HFT Technology</td>
<td>((0))</td>
<td>((\frac{B}{2}))</td>
</tr>
</tbody>
</table>

Note: The payoffs are those achieved by individuals in the left-hand column when interacting with an individual in the given row.
Each of the two firms also has a dominant preference with respect to the other’s choice preferring the other firm to not invest into HFT. This “preference for the other … [firm’s] action is unaffected by the choice … [the firm] makes for … [itself]” (ibid.). As each firm prefers the other firm to not have access to the HFT technologies while wanting the technology for itself, its preferences go in opposite direction: “the choice that each prefers is not the choice … [it] prefers the other to make” (ibid.).

Since minimum latencies are physically defined, no firm will be able to trade at higher speed than the other all other things being equal. In effect, this result is identical to the situation where firms abstained from investing into HFT technology. Thus, both firms would be better off if they would not invest into HFT technologies as this choice implies lower costs for each firm.

4.5. The Need for Regulation

It might seem a simple matter to overcome the Pareto-inefficiency of the current situation and to determine that each firm should just agree to not invest into HFT technology. Yet, this is far from the case for two reasons.

The first is that firms will have no way of enforcing such an agreement. In the two-firm model no firm could punish the other firm by imposing an embargo should the latter break the agreement and invest into HFT technologies without punishing itself. The second reason is that firms have no way of knowing if another firm has violated the agreement. In the two-firm model agents could induce \textit{ex post} from the payoffs they receive if the other firm has been acting as an HFT firm or not. As soon as there are more than two firms this information no longer suffices to prove which firms have broken the agreement. Yet, the problem of Pareto-inefficiencies also persists in situations with more than two players.
The strategic dynamics of situations with more than two players become evident under the assumption that in the initial state of the alternated model\(^2\) the population is mixed such that HFT investing and HFT non-investing firms exist. New firms, which enter the market, have to choose whether to invest into HFT technologies or not. Even if members of the population are paired randomly the given payoff matrix is such that investing into HFT is an unbeatable choice. As a consequence new firms will enter as HFT-investors. Over time when old firms leave the market non-HFT-investing firms will vanish from the population. Average payoffs to members of the monotype population are lower than to members of the mixed population (cf. also Nowak 2006). Analogous to the framework discussed further above, payoffs are not Pareto-optimal. Hence, the goal of regulatory intervention should be to dis-incentivize firms to invest into HFT-technologies.

5. WHAT SHOULD REGULATION LOOK LIKE?

A common proposal for regulating HFT is the introduction of a tax on financial transactions, or Tobin Tax (Sornette & Von der Becke, 2011). Empirical evidence suggests that the main problem of a Tobin Tax as instrument for HFT regulation is that it is crowding out the wrong parties (e.g. Westerhoff 2003; OECD 2002). In context of the present model this would always be the case if interactions described by the Northeastern, Southwestern, and Southeastern quadrants in the payoff matrix of Table 1 would be prevented from happening. For, these are situations in which firms either are not trading at high frequency (Southeastern quadrant), or are using HFT successfully for purposes of insurance

\(^2\)All other assumptions are held constant, i.e. payoffs are the same as before, and a given firm’s decision whether to invest into HFT is a binary one-shot game. Consequently, learning effects (Nowak & May 1992) are excluded.
(Northeastern and Southwestern quadrants). Therefore, under current assumptions the problem to solve is the situation in the Northwestern quadrant when both firms invest into HFT technologies so that the benefits of the latter cease to exist while costs remain.

Hence, the current model suggests that rather than introducing a general financial transaction tax regulators should aim to regulate HFT so as to limit the number of interactions of the type described in the Northwestern quadrant. In the following I will discuss the effects of this kind of regulation. For reasons of clarity and operationability, I assume that costs of HFT-investments ($C$) are zero,\(^3\) and that the regulator is able to charge targeted and specific trading fees ($\theta$) on payoffs in the Northwestern quadrant. Hence, the new payoffs in the quadrant are \((B-\theta)\) for each firm.

5.1. Determining Regulation in a Hawk-Dove Game

What should be the value of ($\theta$)? The payoffs in Table 1 are such that an HFT-investing firm encountering another HFT-investor still earns more than a non-investing firm facing an HFT-investor. Yet, whereas the non-investing firm produces zero externalities in the second scenario, HFT investing firms in the first scenario produce costs to the economy since they make choices that shift equilibria to Pareto-inefficient outcomes.

To account for differences in externalities and to account for costs imposed upon the economy, firms in the Northwestern quadrant should receive lower payoffs than non-investing firms in the Southwestern and Northeastern quadrants. Hence, specific trading fees should be set such that ($\theta > B$). Table 2 summarizes the revised payoffs

\(^3\)Implications of non-zero costs are discussed in the appendix.
Table 2: Revised Payoff Matrix for HFT Investments

<table>
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<th>Invest into HFT</th>
<th>Do Not Invest into HFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invest into HFT Technology</td>
<td>((B - \theta))</td>
<td>((B))</td>
</tr>
<tr>
<td>Do Not Invest into HFT Technology</td>
<td>((0))</td>
<td>((B))</td>
</tr>
</tbody>
</table>

Note: The payoffs are those achieved by individuals in the left-hand column when interacting with an individual in the given row; \(\theta > B\)

5.2. Analyzing the Effects of Regulation

Under the new payoff regime, the choice to invest into HFT technology is no longer an unbeatable strategy. Rather decisions of firms are dependent on the frequency of HFT-investors in the population. I assume that firms do not know whether they will be trading with HFT or non-HFT firms. Consequently, if there are \((p)\) HFT-investors and \((1 - p)\) non-HFT investors in the population, a firm that enters the market will be randomly paired to trade either with an HFT-investing firm at probability \((p)\), or with a non-HFT-investing firm at probability \((1 - p)\). The new firm would then choose whether to invest into HFT technologies, or not depending on the expected payoffs \((W_{NO-HFT})\), and \((W_{HFT})\). Assuming only a single encounter payoffs as laid out in Table 2 are

\[
W_{NO-HFT} = p0 + (1 - p)\frac{B}{2}
\]

\[
W_{HFT} = p(B - \theta) + (1 - p)B
\]

Equation 1
Whenever \((W_{NO-HFT}) < (W_{HFT})\), firms that enter the market will invest into HFT-technologies. But this will drive down payoffs to HFT-investors as the following reasoning shows: Payoff in a mixed population when an HFT-investor is encountered is \([p(B-\theta^2)]\) with \((0 < p < 1)\). The payoff to a pure HFT investing population is \((B-\theta^2)\). Because \(B < \theta\) the payoff to a mixed population is greater than that in a pure HFT population. Hence, an increase in the proportion of HFT firms diminishes expected payoffs to HFT investors. If payoffs to HFT-firms have been decreased such that \((W_{NO-HFT}) > (W_{HFT})\), new firms that enter the market will abstain from investing into HFT technology. But payoffs to a pure non-HFT population are \((B^2)\). This is clearly less than the payoff in a mixed population when a Non-HFT investor is encountered. From Table 1 this is \([pB + (1 - p)\frac{B}{2} = (1 + p)\frac{B}{2}]\). Hence, an increase in the proportion of non-HFT firms will decrease expected payoffs of non-HFT firms. Consequently, firms will invest so that the equilibrium fraction of HFT-investing firms is

\[
W_{NO-HFT} = W_{HFT}
\]

\[
p(B-\theta^2) + (1-p)B = p0 + (1-p)\frac{B}{2}
\]

\[
p = \frac{B}{\theta}
\]

\[\text{Equation 2}\]

From this it can be seen that the equilibrium fraction of HFT-firms is increasing in the benefits of HFT-technologies and decreasing in the costs determined by the specific trading fee \((\theta)\) as one would expect. Assuming that \((\theta)\) can be set so that it reflects the true costs of HFT trading, the model further shows that the population would not necessarily be better off if without HFT. Figure 2 illustrates this.
6. CONCLUSIONS

The present paper makes a qualified case for HFT regulation. Rather than basing the argument on macro-level effects of HFT that are still under debate (Sornette & Von der Becke, 2011) its analysis focuses on the need of regulation from the perspective of HFT firms. The latter are assumed to apply HFT technologies in order to achieve relative gains in lowering latencies (Clark, 2010; Zwick, 2011). Acknowledging the fact that physical limits exist to reducing latencies in computerized trading the paper addresses the issue of HFT as binary choice that allows firms to trade uniformly at $\sim 70\%$ of the speed of light.

Under these assumptions it can be shown that firms, which maximize their self-interests, make Pareto-inefficient allocations. The paper illustrates this in form of a Von-Thünen Analysis on spatial decisions of HFT firms. In a second step, the assumptions of the paper are translated into a payoff matrix that allows to discuss HFT firms’ strategic choices in greater detail. The current analysis demonstrates that firms that choose whether or not to invest into homogenous HFT technologies, have “a uniform (dominant) internality [defined in terms of the effects of own choices on own payoffs] and a uniform (dominant) externality [defined in terms of the influence of own choices on payoffs of others]” (Schelling, 1973.). Due to the relative nature of HFT the internality and the externality are “opposed rather than coincident, and the externality outweighs the internality” (ibid.). As a consequence, firms make allocation choices that justify regulatory intervention.
In the last section of the paper I discuss features and content of HFT regulation. The results of the alternated model indicate that legislators should be concerned about negative externalities of certain types of HFT firm behavior rather than about HFT itself. The instrument of a Tobin Tax hence does not seem to be an optimal choice for limiting undesired effects of HFT. For, a general financial transaction tax “penalizes high frequency trading without discriminating between trades which may be destabilizing and those which help to anchor markets by providing liquidity and information” (OECD, 2002). The strong emphasis placed on greater transparency in MifID II proposals - e.g. by requiring automated trading firms to notify their algorithms to supervisors and to report transactions - will enable regulators to differentiate better between different HFT practices. Also, from a business perspective of HFT firms, these new rules mean additional costs associated with upgrading and maintaining IT infrastructures (Philips, 2011). These costs present implicit fees on transactions that will be borne exclusively by algorithmic trading / HFT firms. Hence, the transparency proposals of MifID II promise to serve as a finer tuned instrument for regulating HFT than a general financial transaction tax.

The paper aims at contributing to HFT discussions from different angles. So far, there is only a limited number of studies on the issue of HFT. The majority of these studies address HFT macro-level effects. Hence, the micro-level discussion of the current analysis aims to complement existing research by offering a fresh outlook on HFT, and HFT regulation. Also, the question whether HFT firms themselves should be interested in HFT regulation clearly presents under-researched territory. By discussing this question, the present paper aims to offer new insights to current debates on HFT, and HFT regulation.

Limitations persist with regard to methodology and content of the paper. The former result mainly from the fact that the paper derived its observations in abstract terms. Also, I have concentrated on speed at which market data signals are transmitted between
traders and the exchange matching computers in order to discuss HFT effects. Thus, I have neglected other factors (Clark, 2010) that may also be relevant for the determination of latencies in financial markets. In terms of content, limitations persist primarily due to the approach of boiling down HFT trading strategies to binary choices. This procedure increases the operationability of the theoretical models proposed in the paper at costs of the formers’ reflections of real world complexity. Given these shortcomings, the results of this paper should not be viewed as final call. However, by identifying scenarios that underline the desireability of financial regulation from the viewpoint of HFT firms themselves, the paper hopes to add value to current debates by suggesting strategies and structures for looking at HFT from an under-researched yet important perspective.

7. References


8. APPENDIX

Table A1: Revised Payoff Matrix for HFT Investments with $C > 0$

<table>
<thead>
<tr>
<th></th>
<th>Invest into HFT</th>
<th>Do Not Invest into HFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Invest into HFT Technology</td>
<td>$\left(\frac{B-C}{2}\right) - \vartheta$</td>
<td>$(B - C')$</td>
</tr>
<tr>
<td>Do Not Invest into HFT Technology</td>
<td>$(0)$</td>
<td>$\left(\frac{B}{2}\right)$</td>
</tr>
</tbody>
</table>

*Note: The payoffs are those achieved by individuals in the left-hand column when interacting with an individual in the given row;*

Given that $(C > 0)$, revised payoffs are

$$
W_{NO-HFT} = p0 + (1 - p)\frac{B}{2}
$$

$$
W_{HFT} = p\left[\left(\frac{B-C}{2}\right) - \vartheta\right] + (1 - p)(B - C)
$$

*Equation A1*

The equilibrium fraction of HFT investing firm is

$$
p = \frac{C - \left(\frac{B}{2}\right)}{\left(\frac{C}{2}\right) - \vartheta}
$$

*Equation A2*

As long as $\left[\left(\frac{B}{2}\right) > C\right]$, and $\left[\left(\frac{C}{2}\right) < \vartheta\right]$, the equilibrium fraction of HFT-firms is increasing in the benefits of HFT-technologies and decreasing in imposed costs determined by the specific trading fee $(\vartheta)$ as one would expect.
Figure 1: A Von Thünen Model of HFT

Figure 2: HFT Firms as Fraction of the Population, p