

How to Succeed as a High-Frequency Trader: Problematizations of Trading Subjects in an Era of Automated Trading

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Abstract: This paper examines the financial markets' recent turn toward high-frequency trading (HFT). This turn is being legitimized (even celebrated) with reference to how algorithms are allegedly more rational and efficient than human traders, and less prone to emotionally motivated decisions. This article argues that although HFT does not render humans irrelevant, it is leading to a reconfiguration of both the ideal trading subject and the human-machine relation. Drawing on an investigation of HFT 'how to' books, as well as interviews with and ethnographic observations of high-frequency traders, the paper presents a problematization analysis of the subjectification and self-techniques of the ideal high-frequency trader. It is demonstrated that, in order to be successful, the high-frequency trader must acquire a range of skills – not just computer proficiency, but the ability to ensure and maintain emotional detachment from markets and to avoid overadjusting algorithms in response to losses or profits. The paper shows that, in surprising ways, such features

associate HFT with early twentieth-century subjectifications of the ideal (pre-HFT) trader.

Keywords: financial markets; economic sociology; skills; sociology; USA

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Introduction

Financial markets have undergone a profound transformation in recent decades. These days, the popular images previously associated with markets and their key participants are almost nowhere to be seen. A visit to the Chicago Mercantile Exchange, an iconic site among modern financial markets, will confirm this. While the pits in the Chicago Board of Trade Building used to be buzzing, full of yelling and pushing traders, today they are mostly silent, occupied by just a few market professionals. Only the options pit still does business the old-fashioned way, and is really an exception to the overall trend. Of course, this does not imply that the financial markets are now less active than they used to be. Rather, the activity has moved elsewhere. The 1990s saw a great push toward computerization. This involved a reconfiguration of the markets, from a pit-based system to one in which most of the action took place between participants linked via their screens (see, e.g. Knorr Cetina and Bruegger 2002). Located in trading rooms in, say, large investment banks, traders started connecting to one another through the numerous computer screens in front of them. In the past decade, this computerization has been taken to a new level. Today, a substantial proportion of all transactions in financial markets are executed not by individuals connected via their screens, but by computerized algorithms. According to some estimates, high-frequency trading (HFT), in which orders are executed by algorithms in micro- or even nanoseconds (i.e. millionths or billionths of a second), made up around 50 per cent of US trading volume in equities in 2012 (compared to 66 per cent in 2008) and 35 per cent of the volume in spot currency trading in 2013 (as compared to 9 per cent in 2008) (Detrixhe, Gammeltoft, and

Mamudi 2014). In the futures market, HFT volumes are around 60 per cent and have remained more or less constant in recent years.

A significant part of the emergent body of sociological literature examining HFT has focused on the technological aspects pertaining to this new type of trading (see especially MacKenzie 2014a; forthcoming; MacKenzie, Beunza, Millo, and Pardo-Guerra 2012). This makes sense, since HFT has sparked a veritable technological arms race, in which trading companies invest billions of dollars to reduce the time it takes to transmit data by a few microseconds, e.g. by deploying new fibre-optic cables or utilizing microwaves (Hammer 2013: Ch. 6; Lewis 2014; MacKenzie 2014b). And yet, as this article argues, although HFT seems to mark the beginning of a posthuman era, in the sense that high-frequency traders (HF traders) are competing on a scale far surpassing human perception, the shift to HFT does not render the human level entirely obsolete. This is not to suggest, in a trite manner, that behind every algorithm there is an individual on whom we must focus in order to understand HFT sociologically.¹ Rather, our assertion is that HFT appears to change the interaction between the human trader and the market, just as moving to trading via screens did (Knorr Cetina and Bruegger 2002). Against this backdrop, the aim – and contribution – of this article is to show and analyse how a new ideal trading subject has emerged with HFT, i.e. a trading subject who is widely seen to be able to master the new market situation, as well as how he or she (but, indeed, it is usually *he*) is discursively construed. What core features characterize such a trader? To what central problems is he or she exposed, and how should he or she respond to them? We seek to answer these questions through a Foucauldian problematization analysis, focusing on (1) how the emergence of HFT has produced a new problematization of the human trader subject and his or her relation to financial markets; and (2) what responses, on the level of human trader subjects, have been suggested to deal with this problematization. These questions are examined on the

¹ Searching for the individuals behind algorithms is, however, important to legal and regulatory bodies, since liability is ascribed to subjects, and algorithms are (still) not considered legal subjects.

basis of an empirical analysis of ‘how to’ books that offer advice on becoming a successful HF trader, as well as interviews with and ethnographic observations of HF traders.

The aim of deploying a Foucauldian framework is to pay particular attention to this level of subjectivity, a level that has escaped attention in the extant sociological literature on HFT. Subjectivity and the ways a subject ought to act in specific contexts are, Foucault emphasized, very much discursively produced. This is the reason why we not only attend to how actual HF traders work and reflect on their work (as manifested in our interviews and ethnographic observations), but equally to how the ‘how to’ books discursively frame expectations and recommendations for successful HF trading behaviour. Attending to this broader discursive level allows us to go beyond extant sociological analyses of HFT. By utilizing a Foucauldian framework the present article further contributes to a series of recent attempts to deploy Foucault’s work in analyses of markets, finance, and the economy more broadly (e.g. de Goede 2005; Folkers 2014; Tellmann 2011).

The analysis demonstrates that a new ideal trading subject has certainly appeared with HFT, namely one is who is proficient in mathematics and computer science – thus resembling a savant type more than the Princeton or Harvard graduates who, for example, populate Wall Street investment banks (Ho 2009). We also demonstrate that, in spite of the special traits ascribed to the ideal HF trader, both the ‘how to’ literature and our respondents problematize aspects of financial market behaviour, in particular the role of emotions in markets – something that is strikingly similar to the problematizations of markets that can be identified with the emergence of contrarian speculation theory in the 1920s and ’30s. In other words, despite the vast technological differences, a number of problematizations unite the pre-HFT and HFT eras.

It is worth noting from the outset that the transition to HFT is followed by particular changes in the organizational structure of trading firms. While it would require a separate paper to analyse these changes in detail, a few obser-

vations can be made here. First, with some notable exceptions, HFT firms are usually small-scale proprietary trading firms. This means that traders do not trade on behalf of clients but trade from their own account. Second, the trading room of a HFT firm often looks more like an entrepreneurial software start-up than a traditional trading room (as seen within larger brokerage firms). Third, these firms often operate in a team-based manner. A trading team would consist of a developer, a programmer and someone with expertise in finance. It is difficult, within such a team, to separate the ‘trader’ function from that of the programmer and developer; they somehow coalesce. It is crucial for the purposes of this paper to stress that in spite of this team-based organization, which might seem to devalue the meaning of the notion of a trader (in the traditional sense as the singular individual executing orders), the notion of ‘traders’ remains the central term that these actors deploy to describe themselves. It is, in other words, an emic term – and hence also the term used here.

The article is structured as follows. In the first section, we present the analytical framework as well as the data upon which we draw in the subsequent analyses. The second section provides a brief account of the historical backdrop to HFT, with particular emphasis on the US situation. The third section then discusses the emergence of a new trading subject, whose profile is a response both to the new overall market situation and to the corresponding problematization of previous trading subjectivities that are no longer deemed adequate in an era of HFT. In the fourth section, we zero in on one of the key problematizations in much HFT ‘how to’ literature, namely the problem of how to keep emotions under control and not overadjust algorithms. The fifth section further explores this theme by addressing one of the central means suggested to respond to emotional swings, namely self-discipline. The conclusion summarizes and points to further research.

Problematization and Trading Subjects

Our analytical framework in this article is derived from Foucault's reflections on problematization analysis as articulated in the final years of his career. Foucault did not develop the notion of problematization in a fully elaborated and systematic manner, but did so with sufficient clarity that it can be used for our purposes.² According to Foucault, a problematization analysis essentially studies 'how and why certain things (behavior, phenomena, processes) became a *problem*' and the responses triggered by the problematization (2001: 171, italics in the original). What this entails is attentiveness to how something that might either be taken for granted or appears to emerge in the first place is being transformed into a problem that requires particular responses. In Foucault's own words:

This development of a given into a question, this transformation of a group of obstacles and difficulties into problems to which the diverse solutions will attempt to produce a response, this is what constitutes the point of problematisation and the specific work of thought. (1989: 421)

Importantly, it is not possible to infer a response directly from a problematization – the latter does not causally determine the former, although the problematization does mark out a terrain of possible responses. Consequently, a problematization analysis should attend to the contingent nature of the problem–response configurations. On a similar note, Foucault stated that any problematization constitutes 'an "answer" to a concrete situation which is real' (2001: 172), meaning that no problematization arises out of the blue. This relates to Foucault's historical attentiveness, which is also central to his conception of problematizations: a problematization analysis will need to address the historical conditions that made possible a particular form of problematization, and to which an 'answer' – or rather, a response – was produced

² Discussions of Foucault's problematization analysis are still sparse, although a growing body of literature focuses on this distinct part of his work (e.g. Gudmand-Høyer 2013; Lemke 2011; Lopdrup-Hjorth 2013; O'Leary 2010). What we present in this article only attends to a few key aspects of the notion of problematization that are directly relevant to our analysis. For a more in-depth account, we refer readers to this wider literature.

(which is not to say that this ‘answer’ or response is necessarily fair, effective, legitimate, etc.).

Of particular interest in the present article is how problematization relates to subjectification and, especially, to techniques of the self. Our basic assertion is that any kind of market configuration, whether HFT-dominated or not, produces certain kinds of trader subjectivity that are deemed particularly fitting. When a market configuration is rendered problematic, this also affects what are considered adequate forms of subjectivity. In addition, and this is crucial to our analysis, the problematization may also affect the techniques of the self that are prescribed for traders. Foucault defines techniques of the self as ‘the procedures [...] suggested or prescribed to individuals in order to determine their identity, maintain it, or transform it in terms of a certain number of ends, through relations of self-mastery or self-knowledge’ (1997: 87; see also 1992: 10–11). Following this definition, we will discuss how HF traders are prescribed or suggested to conduct and act upon themselves in ways that correspond to the problematizations to which HFT has given rise.

Previous sociological studies have focused upon different market configurations and their corresponding trading subjectivities. For example, studies have examined the ‘financial subjects which are fabricated in the production of financial markets’ (Langley and Leyshon 2012: 370). Evoking various concepts from governmentality to affect and attachment, scholars have shown the production of gendered, calculative, and entrepreneurial subjects within the financial industry (e.g. Deville 2012; Hall and Appleyard 2012; Langley and Leaver 2012). More directly related to the concerns of the present paper is the work of Karin Knorr Cetina and Urs Bruegger, who have argued that electronic markets, in which traders interact with one another via screens, are best described in terms of ‘post-social relationships’, i.e. ‘new kinds of social bonds such as those constructed between humans and objects’ (2002: 162). According to Knorr Cetina and Bruegger, the fact that such ‘click traders’, as

they are commonly known,³ do not relate to one another on an intersubjective, face-to-face level (as in the old pits), but anonymously and through screens, reshapes their subjectivities. Their market orientation is precisely not intersubjectively guided (say, by paying attention to the counterparties' facial expressions). Rather, it is intimately tied to how their screens constitute the market, with the result that these 'traders' engagement with markets is based on a match between the self as a sequence of wantings and an unfolding object that provides for these wants through the lacks it displays' (2002: 164).

While Knorr Cetina and Bruegger's Lacan-inspired analysis does not relate to HFT, one might speculate that the era of HFT might be characterized by similar forms of post-social relationship, as well as the kinds of emotional market attachment analysed by Knorr and Bruegger. This indeed is what Jakob Arnoldi (2015) suggests. Advancing Knorr Cetina and Bruegger's analysis he examines HFT algorithms themselves as post-social actors and argues that some degree of agency should be attributed to them. What Arnoldi does not study is how trader subjectivity changes with HFT. Some indication of this level can be found in the work of Marc Lenglet (2010). Although he is looking more at algorithmic trading than HFT proper, Lenglet describes how traders might not feel as responsible when working algorithmically as when being easily recognized as 'human' traders. While this suggests a change on the level of trader subjectivity, our findings suggest that rather than disappearing, responsibility changes with the transition to HFT: HF traders certainly feel responsible for their algorithms, to the extent even that they develop attachments to them.

Another study in line with the research presented in this paper is Caitlin Zaloom's investigation of how traders seek to discipline themselves (Zaloom 2006). Drawing explicitly on Foucault's notions of discipline and ethical self-relationships, Zaloom convincingly demonstrates how traders are deeply con-

³ 'Hand traders' is another term deployed to describe these traders. We prefer 'click traders', because that notion better illustrates that, while these traders are fixated on their screens, the actual trading takes place by clicking a mouse. This is radically different from HFT, which requires no manual behaviour.

cerned with how to subject themselves to techniques of the self. Her study singles out four such techniques (2006: 128 et passim):

- 1) Ensuring a separation between traders' actions on the trading floor and their outside lives;
- 2) Learning to control the impact losses may have on trading behaviour;
- 3) Breaking down narratives of success and failure in order to treat each trade in isolation; and
- 4) Learning to focus acutely on the market as it is given at any moment.

Zaloom's study concerns both pit traders and click traders, but her discussion of self-disciplining techniques focuses mainly on the former. As we shall demonstrate below, some of disciplining techniques that Zaloom identifies also play a key role for HF traders, though there are important differences.

However, before getting to the analyses, a few words are warranted regarding our data. The paper draws on two types of data. The first is what we broadly refer to as 'how to' books and manuals on becoming a successful trader in an era of HFT. Although HFT is a relatively new phenomenon, there is an extensive array of literature that provides insight into how it operates, which newcomers might deploy in pursuit of a successful HFT career. For present purposes, only a subset of this literature is relevant, namely books that contain a *prescriptive* dimension. In Foucault's (1992: 12) words, prescriptive books 'suggest rules of conduct', i.e. they prescribe how to behave in order to become (in our case) a successful HF trader, and outline the rules of conduct that must be followed in order to achieve success. As such, these books relate directly to the problem–response configuration mentioned above, as they pinpoint particular problems and allegedly adequate responses, in the form of techniques of the self (although they rarely, if ever, deploy that terminology explicitly). We have included HFT 'how to' books in our analysis if such prescriptive or advice-giving traits are advertised in the titles or subtitles or elsewhere in these books. To give a few examples, the books we ana-

lyse include *Building Winning Algorithmic Trading Systems* (Davey 2014), *Quantitative Trading: How to Build Your Own Algorithmic Trading Business* (Chan 2009), *Trading the Measured Move: A Path to Trading Success in a World of Algos and High-Frequency Trading* (Halsey 2014), *Dark Pools & High-Frequency Trading for Dummies* (Vaananen 2015), and *All About High-Frequency Trading* (Durbin 2010), the cover of which promises that the book provides ‘the easy way to get started’ and ‘everything you need to know’.

Focusing on manuals for success enables us not only to analyse HFT problem–response configurations, but also to compare these with other types of problematizations. In the pre-HFT era, an immense number of books were published on how to beat the market. We shall briefly relate to some of this literature, namely the prominent field of contrarian investment theory, in order to demonstrate that some of the problematizations prevalent among HF traders evoke older (early-twentieth-century) tropes.

While the ‘how to’ books, qua their prescriptive nature, are in line with Foucault’s recommendations for what to include in a problematization analysis, only relatively few such books are available on HFT.⁴ As a consequence, we have decided to supplement these books with a second source of data, namely interviews with and ethnographic observations of HF traders. Conducting interviews and engaging in ethnographic fieldwork was not part of Foucault’s own methodological toolkit. However, in recent years, more scholars have argued that Foucault’s approach can be combined with more ethnographically driven analyses (e.g. Hill 2009). For the purposes of the present paper, such a combination of sources and methods does indeed makes sense, partly because interviews and ethnographic observations provide a better sense of the field that the ‘how to’ books cover (and seek to co-constitute), and partly, and relatedly, because certain tropes circulate between the ‘how to’ books and the field. Even if our interviewees may not articulate problem–

⁴ Within the genre of HFT ‘how to’ books, we have decided to focus only on those that seek to give advice to traders who wish to utilize HFT. An alternative type of ‘how to’ literature that we therefore do *not* address is about how to survive as a non-HFT day trader in an HFT era (e.g. Oliveira 2014).

response configurations explicitly, they certainly address some of the struggles that HF traders face, many of which relate directly or indirectly to the problematizations found in the prescriptive ‘how to’ literature.⁵ Also, when we ask HF traders to explain their conduct, their responses are not merely descriptive, but also normative and indirectly prescriptive, in the sense that they often implicitly legitimize specific forms of HFT conduct and outline how one *ought* to conduct oneself as a trader in an HFT era.

Between April and October 2014, interviews were conducted with 21 HF traders in Chicago and New York. Here, ‘HF traders’ refers to persons who are either currently actually doing HFT (in accordance with the definition below) or who have past experience with it. Some HF traders were interviewed more than once. An additional 40 interviews were conducted with other actors in the HFT industry, such as regulators, exchange officials, software providers, and infrastructure and clearance firms. These interviews are not referred to directly below, but they informed the historical analysis and contributed insights into how to set up a proprietary trading shop in the HFT domain. The interviews typically lasted around one hour, though some were significantly longer. In addition, one of the authors spent six weeks conducting ethnographic observations inside a Wall Street HFT firm in spring 2014, with follow-up observations in October 2014. The ethnographic work focused on daily practices and conversations amongst HF traders, including how they trade at their desk while monitoring pre-programmed algorithms.⁶

⁵ This is the case despite the fact that many HF traders ridicule ‘how to’ books, arguing that as soon as a trading strategy is made public, it ceases to be profitable. Trading edge depends to a large degree on keeping one’s strategies secret. However, this issue is not critical to our analysis, mainly because we are not interested in trading strategies as such (which are often rather generically portrayed in the literature), but in how the ‘how to’ books problematize the trading subject. Here, as we shall demonstrate, the overlaps with the practitioners’ level are more pronounced than the latter seem to acknowledge.

⁶ It is worth emphasizing that while our analysis mainly concerns the USA, there appears to be certain geographically based differences in the composition of US HFT firms. Our interviews thus suggest that in Chicago people in the HFT industry are more likely to have a floor-trading background than is the case for people working in the HFT industry in New York. This is not a difference that really matters for the present paper, though, as our findings suggest that the former floor-based traders that transition into the HFT industry tend to work in clearance and as technology providers rather than as actual HF traders who algorithmically execute orders.

Two central methodological issues regarding sociological studies of HFT should be addressed: generalizability and delineation. To begin with the latter, although most market professionals have a sense of what HFT means, there is no generally accepted definition of the phenomenon. The US Securities and Exchange Commission (SEC) defines HF traders as ‘professional traders acting in a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis’ (Securities and Exchange Commission 2010: 45). A working group under another US regulatory body, the Commodity Futures Trading Commission (CFTC), has proposed a broader definition that focuses more on the trading activity itself than on those engaged in it:

High frequency trading is a form of automated trading that employs:

- (a) algorithms for decision making, order initiation, generation, routing, or execution, for each individual transaction without human direction;
- (b) low-latency technology that is designed to minimize response times, including proximity and co-location services;
- (c) high speed connections to markets for order entry; and
- (d) high rates of orders or quotes submitted. (CFTC 2012)

We subscribe to the latter definition and have excluded interviews with traders who, for example, trade in seconds rather than milli- or microseconds.

The lack of a hegemonic definition of HFT entails a need for extra caution when it comes to the use of ‘how to’ books in our analysis (not so much for the interviews, as most of our interviewees would fit the CFTC definition). At times, HFT is conflated with algorithmic trading, whereas it is in fact better described as a subset of algorithmic trading, as per the CFTC definition. In order to avoid any problems, here we only focus on books on algorithmic trading if they (1) contain explicit discussions of HFT (which is often the case for books on algorithmic trading), and/or (2) discuss aspects of algorithmic trading that most people within the field would also apply to the subset of HFT (such as how (not) to relate emotionally to one’s algorithms).

The question of generalization is trickier. The field of HFT is highly secretive, and gaining access is very difficult (a few interviewees did not wish their interviews to be recorded). As a result, nobody knows precisely how many HFT firms are operative, and generalizing from our interviews and observations to the entire field is therefore difficult (a difficulty also faced by other sociologists studying HFT, see MacKenzie 2014b: 14–15). Furthermore, in the main, the HFT companies we followed ethnographically trade US Treasury bond and index futures, whereas HFT practices in other markets might appear somewhat different. In spite of these caveats, we believe that our data points to widespread problematizations of HFT and the human trader subject. We have either filtered out observations that appear exceptional or note their seemingly exceptional character in the analysis.

In the analysis below, we treat the two sources of data as one, i.e. content-wise we do not differentiate between them, although it will be clear to which source we are referring. Our reason for not analysing ‘how to’ books and interviews/observations separately is that, despite certain stylistic differences (some ‘how to’ books tend to assume a somewhat paternalistic language), there are greater overlaps than differences between the two when it comes to their problematizations and responses.

Historical Background

HFT evolved as a response to technological developments, regulatory changes, and a change in the market microstructure. McGowan (2010), for instance, sees the rise of HFT as a direct effect of the enactment of a set of US rules known as Regulation National Market System (Reg NMS). These were passed by the SEC in 2005 and fully enacted in 2007 in order to strengthen the US equity markets. In part, Reg NMS was a direct response to a problematization of the behaviour of specialists. The role of specialists is to facilitate trading by serving as market makers, meaning that if there are insufficient buyers or sellers, they maintain order flow by trading with their own capital. In 2004, however, a group of NYSE specialists were accused of a misdemeanour,

namely that they were not maintaining a fair market. Against this backdrop, Reg NMS aimed to secure fair competition and decrease the discretionary power of specialists (Lewis 2014: 96). Among other things, this resulted in an updated rule prohibiting ‘trade-throughs’, i.e. the execution of trades at prices lower than the national best bid and offer (NBBO). By emphasizing the need for immediate and automatic order execution at the NBBO, Reg NMS not only targeted the discretionary power of specialists; in effect, it enabled ultra-fast market participants to exploit price discrepancies between different exchanges.

However, in the US futures markets, HFT did not evolve directly from such regulatory enforcements, as trading in these markets remains dominated by a few trading venues, mainly the Chicago Mercantile Exchange (MacKenzie forthcoming). Characteristic of the futures market is how HF traders operate by exploiting highly correlated financial instruments traded on different exchanges (see also Hanson and Hall 2012). For instance, the price difference between highly correlated asset classes, such as US Treasury bonds listed at the NYSE and their corresponding futures contract traded at the CME, can be bought and sold at a profit by utilizing a 13-millisecond delay in the transmission of data between the two exchanges. Technological developments are central to exploiting such delays. Most literature dates the technological development toward fully automated trading back to the 1970s (Hanson and Hall 2012; McGowan 2010). In 1971, the NASDAQ became electronic and introduced an electronic quotation system via which competing market makers could trade securities. A few years later, in 1976, the NYSE introduced its Designated Order Turnaround system, allowing for the electronic transmission of orders to buy and sell securities (Burr 2014). This gave rise to what is called programme trading, which exploited the spread (the difference between the best offer to sell and the best bid to buy) between S&P 500 equity shares and the futures market. In the 1990s, with the introduction of Electronic Communications Networks (ECNs), this practice became widespread across different financial markets. In 1998, the SEC introduced the Regulation Al-

ternative Trading Systems, which authorized ECNs. The intention was to restrict the monopoly that the NYSE and NASDAQ had gained by automating their order-matching systems. As a result, more computer systems were developed to facilitate the entry and execution of orders electronically via the use of algorithms.

More recent factors that have buttressed the rise of HFT include the narrowing of spreads. In 2001, US stock exchanges were permitted to quote prices in decimals instead of fractions in order to increase liquidity. This move is known as decimalization, and is widely acknowledged to have affected the overall functioning of all financial markets, as it reduced the minimum tick size or spread from one-eighth of a dollar to one cent (Chen, Chou, and Chung 2007; Jennings 2001). This further decreased the importance of specialists on the exchanges and eventually led to a vast increase in algorithmic trading. In this new and more liquid market structure, the institutional traders were splitting up orders executed by algorithms in order to reduce their market impact and to execute trades faster and at better prices (Burr 2014).

These changes all acted as catalysts for the increase of very fast, ultra-low-latency techniques, such as the use of high-speed computer programmes for the execution of orders with a high level of frequency. This came along with the use of co-location services, which reduce latency by placing one's server in physical proximity to the exchanges' matching engines, and the supply of individual data-feeds, i.e. the ability to buy information about market movements from the exchanges before it is made publicly available.

The Math- and Computer-Savvy Trader

Crucially for the purposes of the present paper, the computerization of financial markets has contributed significantly to problematizing the skills a trader should ideally possess. Some of our HFT interviewees had previously been pit traders. One described how he had been recruited for that job due to his stature – he used to play American football and had a physique that was not easily ignored, meaning that he would most likely be seen and heard in the pit.

Such physical attributes are no longer valued in an era of HFT (MacKenzie forthcoming). Although HFT-dominated markets are still gendered, since the vast majority of HF traders are male (except from secretaries and PAs, we did not encounter a single woman in our HFT fieldwork),⁷ an entirely different, non-physical set of traits is now in demand. One interviewee described the ideal HF trading subject as possessing the following features: ‘decently mathematical’, ‘very computer proficient in terms of using analysis languages’, and ‘able to code’ – indeed, a ‘savant-like type’.

The emphasis on math and computer skills not only signifies a change in the ideal trading subject compared to the days of the pit. It also differs markedly from the recruitment profile portrayed by Karen Ho in her ethnography of Wall Street investment banks (Ho 2009). Ho found that major investment bank recruiters ‘*do not care* if undergraduates are trained in finance because a skilled background or already-acquired technical expertise is *not* really what they are looking for’, as long as the candidate’s degree is from Princeton or Harvard (Ho 2009: 63, italics in the original). These banks would rather look for people with ‘[e]nergy, a history of excellence and achievement, leadership and interpersonal skills’, as a Goldman Sachs recruiter put it (quoted in Ho 2009: 63). Although Ho examined investment bankers rather than traders, her account can be productively contrasted with our findings to demonstrate the immense variety that characterizes contemporary financial markets. And while interpersonal skills are also appreciated by HFT firms – the interviewee quoted above preferred ‘jovial’ colleagues – the math- and computer-savvy, savant-like qualities are the most desirable attributes in the HFT domain.

The kinds of topics covered and advice offered in the ‘how to’ manuals echo the implicit problematization of the older-type traders who are not deemed well suited to the HFT era, and the corresponding emphasis on the

⁷ Also, some of the HFT offices we have seen have striking similarities with common images of a rather messy (shared) bachelor’s apartment, containing several computer screens, Coca-Cola bottles, a flipper machine or similar kind of leisure device, a couch – and no flowers. While there is certainly room for a discussion of the gendering of HFT, this is an aspect we will leave aside in this article. For discussions of gender and finance, see instead Maltby and Rutherford (2012) as well as McDowell (1997; 2010), though none of these studies address HFT.

new math- and computer-savvy trading subject. For example, many books dig into software solutions particularly suited to HFT, with some manuals discussing the pros and cons of different programming languages often used by HF traders, such as C++ and Java (e.g. Durbin 2010: 108–11; Ye 2011: Ch. 13). There is also an emphasis on the technological infrastructure needed to implement HFT. Reflections on infrastructure include considerations on co-location and whether the CPU (central processing unit) of one's computer could be offloaded by processing some HFT simulations in the GPGPU (general-purpose computing on graphics processing units) (Durbin 2010: 114–19, 123–5). All of these are presented as need-to-know aspects of HFT.⁸

On the level of problematization, the computerization of financial markets has given rise to a new ideal trader subject, namely one who is first of all proficient in the computer and math domains. In other words, the possession of high-level IT and mathematical skills is a key response to the market reconfiguration described above. This implies that the disciplines of physics, engineering, and computer science now partake in performing the economy alongside economics, or even in a manner that pushes economics into the background (cf. Callon 1998). Indeed, quite a few traders in the HFT field have backgrounds in physics and computer science rather than economics. Some of those interviewed argued that this gave them a competitive advantage over economists in the current market situation. While traders with a background in economics would approach the market with certain preconceptions about how markets operate (the laws of the market, as Callon puts it), physicists and others claim to approach markets in a purer, non-distorted

⁸ In fact, some of the technological parts can be outsourced. Firms exist that provide entire packages of infrastructure to start-ups, including access to fibre-optic cables and co-location via their servers. The price for a medium-level package is around USD 2,000 per month. Similarly, licences are available for advanced software that provides easy-to-use solutions, meaning that one can in principle become an HF trader without having strong programming skills. Mathematical skills, however, are generally considered a must-have, and are both more difficult and more risky to outsource. As one 'how to' manual puts it, 'If you get the math wrong in this game you are just dead. And there is a mountain of it' (Durbin 2010: 96).

fashion, enabling them to recognize patterns that economists might never notice.⁹

Keeping Emotions under Control, or How Not to Intervene in Algorithms

The description of HFT in computerized and mathematical terms is not merely diagnostic, highlighting the seemingly ubiquitous features of this new market configuration. The computerized, quantitative terminology is also *normative*, in the sense that ‘how to’ books and HF traders alike characterize algorithms as a rational response to (and replacement for) the kinds of errors that humans are purportedly prone to make. Recall that Reg NMS, which contributed to the HFT rush, was launched in response to a problematization of market efficiency being undermined by human specialists. Indeed, it is widely held that HFT and other forms of algorithmic trading derive a crucial part of their legitimacy from their alleged superiority over human individuals when it comes to the efficient execution of orders. While humans are portrayed as fickle, easily swayed by emotions and susceptible to following crowds, algorithms are seen as a means to ensure rationality in markets. One ‘how to’ book puts it as follows:

An important part of algorithmic trading is that it takes out the human emotional aspect of trading. Trading decisions made by algorithms are based solely on the data analysed and not the whims, fear and greed of an individual trader. (Vaananen 2015: 210)

⁹ This argument is in line with Miller’s (2002) critique of the notion of performativity. He argues that, since economic transactions are caught up in social and cultural relations and actual economic agents are not always fully aligned with the kind of economic rationality that are assumed in market models, the markets cannot be fabricated in the image of their models. Following the same path, Mirowski and Nik-Khah (2007) argue for the need to focus not only on economic theory in order to understand the role of economics in society, but also on what actually counts as legitimate economics among market agents (2007: 198). Relatedly, in *Machine Dreams* (2002), Mirowski points to an expanded economic model showing from a historical view how physics became integrated into economic models.

It is certainly a common assumption among HF traders that algorithms can steer free from human susceptibility to emotions and irrationality, and as a result algorithms are often described as a rational bulwark against allegedly irrational crowd and herd behaviour in markets. In the words of one HF trader we interviewed:

Human beings are naturally trend followers. If the market is selling off, they start panicking and everybody else does. But that's not what machines do. What machines do is they'll say, 'okay, historically, when everybody else is selling, it's more profitable to be a buyer'. Because that's what the data says. So machines are not emotional. They don't really care. They can be preprogrammed so that if they hit a stop-loss then they can stop trading. But that's not an emotional decision. Very often, traders may have a stop-loss too, but they might ignore it because they are emotional and they don't want to go home losing money. So they'll keep trading and just get wiped out.

Similarly, another interviewee stated that 'machines never disobey their rules and their rules are more intelligent because they are not arbitrary, they are not based on emotions [...], they are based on what the data says you should do'. So, to repeat, a central motivation for HFT is that it can exclude or minimize incorrect decisions or human biases that stem from irrational and contagious emotional responses. Such human faults might not lead directly to a loss, but they do compromise the consistency of the trading strategy and may therefore lead to greater risk-taking. In the words of a HF trader managing a HFT firm:

I like the quantitative, very computer-based approach. Get rid of the emotion, you know? If you lost [...] money yesterday, you might be pushing more to make it up. A computer programme never pushes to make up for an error from yesterday. If it lost money yesterday, it's not

taking more risk to make more money. It's going to take exactly [the risk it is programmed to].

Such views are strongly held and often heard among HF traders, and repeatedly articulated in 'how to' books (e.g. Narang 2012: xv, 20, 148). And yet, as we shall demonstrate, in spite of this persistent celebration of the virtues of the non-emotional nature of HFT algorithms, the *interference of human emotions* is widely problematized in the 'how to' literature and among the HF traders we interviewed. One 'how to' book describes the schism as follows:

Traders face a variety of emotions throughout the trading day. Emotions such as fear, greed, euphoria, and anxiety can make you a victim if you do not take control of them. A great trader should have a grasp of math and probabilities. (Halsey 2014: 165)

The quote captures a central message conveyed in much of the HFT literature and in many of our interviews: while problematic, emotions cannot be entirely excluded from markets. Nevertheless, they should not interfere in the algorithms. If the latter are correctly defined, they should be left untouched to do their work, which in the long run will be better than adjusting the algorithms based on emotional fluxes – or at least so it is widely thought. One HF trader echoed this view, arguing specifically that profits and losses and the emotional responses they trigger have to be kept in check:

I try not to get too happy on a winning day. I try to temper myself in both directions. When it's a losing day, it's very much part of the strategy. So I try as much as possible not to let myself experience the emotional swings.

So, contra Zaloom's emphasis, self-disciplining is not just about controlling the impact of *losses*. It is just as much about preventing one's *successes* from

causing the trader to impulsively adjust the algorithms. In other words, greed must also be tempered. Keeping calm is a widely recognized necessity. Talking about the fact that the futures market is open 23 hours a day, one futures trader described how, in the one-hour close, traders seek to train themselves not to ‘overreact’. The trader explained how he struggles to keep calm in the one-hour period and how he would often leave the computer so as not to ‘overadjust’ the algorithms by, say, changing the value or risk parameters. Indeed, he said, the desire to adjust the algorithms, while knowing that this may reflect a short-term emotional impulse, means that ‘that hour can be emotionally complex’ (see also Zaloom 2006: 137).

The Quest for Discipline

Obviously, there are different ways of dealing with emotions and eliminating their potential interference. One type of response to this problematization of human emotions in financial markets focuses on the level of the individual trader’s self-techniques. Similar to Zaloom’s findings with respect to pit traders and click traders, it is widely held, for example, that *discipline* is the key to preventing emotions interfering in HFT algorithms. But precisely how this discipline is to be exercised is a more intricate matter – and what we see in the HFT domain does not fully overlap with Zaloom’s four key techniques. Different manuals recommend varying approaches. According to one ‘how to’ book:

[T]he emotions can be eliminated by strict discipline – following the rules of the system without question, without fail. This discipline takes time to develop, especially if you are trading only one strategy. Your tendency will be to watch that strategy carefully, think about it often, and inevitably ponder overruling the strategy. My advice in this case is to trade multiple strategies if you can. Once you are trading three or more strategies, it becomes hard *not* to follow the rules. This is akin to a serial liar, who tells so many lies to so many people that eventually the truth comes out. You’ll

get so confused by what you are actually doing and what you should be doing that just following the rules will be much, much easier. (Davey 2014: 192, italics in the original)

What is interesting here is that an overload of complexity becomes the means with which to avoid emotions and ensure discipline. So while confusion might otherwise be thought of as triggering an emotional response, it is presented here as a deliberate strategy for keeping emotions at bay. To be sure, adding confusion and complexity is not a universally accepted strategy. Other manuals propose to eliminate emotions – ‘these psychological weaknesses’, as Chan (2009: 111) calls them – by proceeding very slowly, and only incrementally adding complexity to the algorithmic strategies:

As with most human endeavors, the way to [overcome emotions] is to start with a small portfolio and gradually gain psychological preparedness, discipline, and confidence in your models. As you become emotionally more able to handle the daily swings in profit and loss (P&L) and rein in the primordial urges of the psyche, your portfolio’s actual performance will hew to the theoretically expected performance of your strategy. (Chan 2009: 111)¹⁰

Interestingly, as already mentioned, mobilizing discipline in response to perceived market emotions is not unique to HFT. As Urs Stäheli has demonstrated (more clearly than Zaloom, whose ethnographic study was conducted in the late 1990s), discipline as a particular individualizing technique for traders dates back at least to the so-called contrarian investment thinking of the 1920s and ’30s (Stäheli 2006; 2013). Led by ‘Vermont Ruminator’ Humphrey B. Neill, the contrarians asserted that financial markets are characterized by

¹⁰ Similarly, a manual on algorithmic trading, not confined to HFT, suggests to proceed in a careful manner: ‘A comprehensive understanding of all the components which go into the construction of the algo, its parameters, strengths and limitations will give you the basic confidence and reduce, if not completely remove, the emotional burden in trading’ (Leshik and Cralle 2011: 30).

the same traits attributed to mass gatherings by late-nineteenth-century crowd psychologists such as Gustave Le Bon (1960) – namely irrationality, suggestibility, heightened emotional intensity, impulsiveness, and de-individualization. On the basis of this diagnosis, Neill developed the notion of contrarian speculation: if markets are irrational, and if they threaten to seduce the investor into following the market crowd – and hence capture him or her by means of contagious market irrationality – then the only rational and intelligent way to invest would be to do the opposite of whatever the market crowd does (hence the notion of contrarian speculation).¹¹ However, enacting this contrarian strategy required a number of self-disciplinary techniques, some of which are strikingly similar to those found in today’s HFT literature and in our interviews. For example, Neill emphasized the importance for the contrarian investor of ‘attaining a mastery of himself: of his temperament, emotions, and the other variables that go to make human nature’ (Neill quoted in Stäheli 2006: 416, n. 449).

According to the contrarians, the key means of ensuring that one could resist the hypnotic spell of the irrational market crowd were spatial and communicative isolation, e.g. by moving physically – essentially, escaping the big cities where the exchanges are based (cf. Nelson 2007: 51–3) – or by focusing on issues other than the constant flow of market rumours (Stäheli 2006: 285–6). As mentioned earlier, isolation as a means to eliminate imitative behaviour among traders is used in today’s HFT environment. However, the communicative isolation has a further dimension in contrarian thinking, as the basic idea is to combine physical attachment in markets with partial mental detachment. This could purportedly be achieved by writing down market events. ‘Use pad and pencil since it will occupy your mind and concentrate your attention,’ Neill recommended. ‘Try it, you will never be able to chatter and

¹¹ As Hansen (2014) notes in an analysis of the rise of contrarian investment philosophy, Neill did not coin the term contrarian speculation until 1954, but the basic idea of investing against the market, and mobilizing crowd psychology for this endeavour, emerged in the 1920s.

keep track of trades at the same time' (Neill quoted in Stäheli 2006: 286). As Stäheli notes, this recommendation:

articulates two very different purposes: it combines the permanent observation of the market with the individualization of the speculator. Writing is presented as a technique to keep from losing oneself within the noise of the marketplace and the never-ending circulation of rumors and tips. (2006: 286)

Since HFT, qua its computerized-algorithmic base, is by definition operating in the medium of writing (a significant part of HFT is about writing one's code as efficiently as possible), the individual HF trader is in a different situation than his early-twentieth-century contrarian counterpart. In itself, writing is not a means to eliminate emotions. In fact, our interviewees reported that writing code can create new forms of unwanted emotional attachment. In the words of one HF trader, it can result in a 'gambler's fallacy':

You get attached to the algorithms that you have developed. Like, if you see that it's not working as you expected it to, you want to make it work. You know, rationally, it won't. All the science tells you it won't. But still you think, 'If I can tweak it a little bit it might work'.

So, contra Knorr Cetina and Bruegger's argument, attachment for HF traders is not so much about attachment to the screens, but to the algorithms themselves. And contra Zaloom's account, the key for HF traders is not to focus acutely on the market itself, but on the algorithms. Indeed, we have seen HF traders with two sets of screens: one consisting of three screens displaying market movements and profit and losses; and another consisting of six screens displaying the various algorithms under construction. Little attention was paid to the former set of screens, since the focus was on the development

of new algorithms. Another HF trader described the attachment to algorithms as follows:

You are compelled to let [the algorithm] run longer [than is rational]. [...] You do feel this personal attachment to what the algo is doing, because if you write something from scratch you feel like you are acting indirectly through the algorithm. So when it is doing a trade, you know what it was thinking when it made that trade. It is sort of an extension of yourself in that way. [...] I see what it is doing and I think it is smart, because I programmed it to be smart. It's like people taking pride in their child's accomplishments.

Inducing discipline vis-à-vis an attachment of this kind is clearly difficult. And yet, some 'how to' books do propose a response to this problematization of emotional attachment. One recommendation is to create distance to the algorithms by focusing more on the strategies. For example, one manual emphasizes the importance of determining when to stop trading a particular strategy. This may include defining particular metrics such as how much loss one is willing to take during a given period, or how many 'consecutive losers in a row' one is willing to incur (Davey 2014: 191). In any case:

The exact condition you select probably is not as important as writing it down and sticking to it. That is the key. It needs to be solid, definitive, and written down. Ideally, you'll also tell your spouse or a friend, too, since it is harder to back out when you make the proclamation public. (Davey 2014: 191)

Two points are important here. First, contrary to other 'how to' literature, in which the central point is often *change* (see e.g. the analyses of self-help literature by Bröckling 2005; Salmenniemi and Vorona 2014), the core to success in HFT is presented here as *stability*, i.e. the adherence to whatever strategy

one has. More correctly, it is widely acknowledged in HFT ‘how to’ books and by our respondents that one needs to constantly invent new strategies. The half-life of an HFT strategy is purportedly continuously decreasing – some of our interviewees suggest that a HFT strategy only remains profitable for about three months, six at most – and therefore the ideal HF trading subject should regularly change strategies, while adhering strictly to the ones that are in use at a given point in time.

Second, the strategy, or the conditions for when to stop trading a strategy, must be positivized, i.e. written down and made explicit. This echoes Neill’s recommendation, but also goes beyond it. While for Neill the central reason for recommending that the speculator should write in a notepad was to *concentrate attention* in the midst of market noise, the HFT advice seeks to *ensure commitment*. That is the underlying objective of the notion that what is written down should not simply be kept in a drawer or dealt with secretively (a fate to which the writings of Neill’s ideal investor might easily be destined), but be disclosed to significant others in order to further impose normative constraint on oneself. The basic notion seems to be that there is a relation between strategy and identity: adhering to the strategy implies that one’s identity appears consistent to others.

Yet defining and strictly adhering to a strategy is also an identity issue in a broader sense. It is essentially the strategy that sets the HF trader apart from the gambler – and in much of the literature, gambling is associated with more emotional behaviour. ‘Just remember’, one HFT manual states, ‘when your emotions take over and you do not follow the rules [as defined by the strategies], you are basically just gambling. Gamblers in the market usually lose’ (Davey 2014: 193). Importantly, however, in the field of financial markets, gambling is not just about losing money. It constitutes, as Marieke de Goede (2005) has convincingly demonstrated, the eternal ‘other’ of legitimate investment, i.e. the kind of activity financial market professionals have long sought *not* to take part in, but to replace with allegedly more sensible, rational, and socially valuable economic action.

Conclusion

This article has analysed how the rise of high-frequency trading has produced a new type of ideal trading subject, and how such a subject is discursively portrayed in 'how to' HFT books, by interviewees, and in our ethnographic study of HF traders. We have demonstrated how the computerization of financial markets, itself buttressed by regulatory developments, has rendered former trading subjects obsolete. Neither the pit trader nor the click trader embodies the profile demanded in the era of HFT. Indeed, such trader subjects are being problematized by the move towards HFT, with an entirely new trading subject emerging as a response to the novel market configuration: the IT- and math-proficient, savant type. While this ideal HF trader clearly has a different profile than his or her non-HFT colleagues, he or she shares with many of them a concern for how to deal with something as non-algorithmic as emotions. Thus, as we have demonstrated, the pre-HFT and HFT eras share a problematization of emotions in markets – more specifically, how to avoid emotions affecting one's trading behaviour, which in an HFT era means one's algorithms. It is widely held, again by pre-HFT and HFT 'how to' literature alike, that discipline is a key means by which to respond to the potential impact of emotions. Consequently, our analysis points to both continuity and discontinuity between HFT and pre-HFT problematizations. As such, even if the technological aspects clearly differ, there is some degree of stability when it comes to how human traders conceive of the market, its lures and its dangers.

Our analysis also prompts a series of questions in need of further research. One relates to observations we made at the beginning of the paper concerning the organizational setup of HFT firms. In pre-HFT markets, there would often be a distinction between traders and financial analysts, but such a separation becomes increasingly difficult to maintain in HFT. Although 'quant' has been a commonly used term for the analyst (referring to a trader using quantitative analysis), what we see in our fieldwork, as well as in the

‘how to’ literature, is that HFT requires such a wide range of skills that these are unlikely to be embodied in a single subject. This raises the question of whether the idea of the singular trader is apt in an HFT environment, or whether new types of collective trading subjects are emerging. While the ‘how to’ books are not yet heading down that path, maintaining as they are the ideal of an individual subject performing all the main tasks, reality points to how the notion of a singular trading subject is being increasingly replaced by teams of programmers, developers, and people with expertise in finance. So while ‘trader’ in a singular sense remains an emic term, the organizational reality might increasingly show the need for supplementing the discursive construction of individual trader subjectivities with a focus on collective subjects in these types of financial markets.

A related question concerns the changes in the core financial market professions that HFT implies. As we have argued, the ideal trading subject in HFT-dominated markets is a math- and computer-savvy person. In practice, this often translates into having a PhD in physics. One pertinent question this raises is what the growing influence of non-economists at the centre of financial markets might entail for the actual operations of these markets. As we noted, many non-economist HF traders pride themselves that they are better apt at dealing with markets than their economist colleagues. While it would certainly be overstating the point to speak about the death of the economist or of economics in financial markets, more research is needed on the consequences that this reconfiguration of the professions might have for financial markets.

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