

High-Frequency Trading: Networks of Wealth and the Concentration of Power

Abstract

The development of High-Frequency Trading (HFT)—automated trading of stocks, as well as bonds, options, and other investment instruments—provides a signal example of the political effects of computerization on a discrete social sphere. Despite the widespread rhetoric that computerization inherently democratizes, the consequences of the introduction of HFT are widely acknowledged to be new concentrations of wealth and power, opacity rather than transparency of information flows, and structural resistance to democratic oversight and control. Even as computerized tools undoubtedly provide individual investors with more power relative to what they had before, they also provide powerful actors with relatively more power as well, in some cases effectively excluding the majority of individuals from insight or meaningful participation whatsoever, especially with regard to the political impacts of market activities. Reports on recent financial crises, and the 2011 film *Margin Call* provide narrow windows into the operations of HFT and the challenges it poses to democracy; these in turn raise significant problems for the view that computerization inherently democratizes.

1. Introduction: Democratization and Digitization

We are told today with remarkable insistence and frequency that computerizing parts of society can or even does inherently lead to their democratization. In particular we are told that the introduction of networked computing—sometimes, a product as specific as Facebook or Twitter—into a previously authoritarian, totalitarian or otherwise anti-democratic political or

public sphere (often, but not always, a state characterized by these political formations) will—perhaps even will *automatically*—overturn that political system in favor of one in which political power is distributed relatively more equally, concentrations of power are dispersed, interactions become transparent, and individual rights become difficult if not impossible to abuse.

This view is promulgated with particular force in the news media, popular culture, and by computer evangelists both inside and outside the technology industries, but echoes of it can be found in the scholarly and part-scholarly literatures, especially in writings on recent political changes and the “Arab Spring” such as Ghonim (2012). Shapiro (2000), Negroponte (1996), Trippi (2005) and Castells (2009) are among the most vigorous intellectual proponents of versions of the democratization thesis. In work with a fair amount of prescience, Iacono and Kling (1996) aptly called the thesis, with some skepticism, the “democratization technological action frame”; Quan-Haase and Wellman (2008) offer a sober and critical assessment of the specific Iacono and Kling version of the thesis from theoretical and empirical vantage points and find evidence for few of the dramatic effects proponents suggest, even within an organization apparently primed for the anti-hierarchical effects of networked computing.

With regard to political government, as for example in the case of the Arab Spring uprisings of 2010-11, the effects of computerization are often said to include direct popular empowerment that is thought to dissolve State power in clear and distinct ways:

Thanks to modern technology, participatory democracy is becoming a reality.

Governments are finding it harder and harder to keep people isolated from one another, to censor information, and to hide corruption and issue propaganda that goes unchallenged.

Slowly but surely, the weapons of mass oppression are becoming extinct (Ghonim 2012, 292-3)

At times, these sentiments are confined to something advocates want to call “media” or “information” in order to make explicit a contrast with previous forms of media, especially mass media; the most compelling of these arguments rely on the many-to-many distributive features of the Internet as over against the one-to-many broadcast features of prior forms of mass media. Whether or not these arguments are correct with regard to media per se, the very pursuit of real-world effects of networked computing tends to mitigate against the restriction to media as subject: the point of greater distribution of information is always to affect parts of the world that are not, strictly speaking, informatic. Two of the most full-throated advocates for the democratization theory, for example—Clay Shirky (2009) and Yochai Benkler (2006)—repeatedly suggest that commercial markets, and not merely the mechanisms of communicative interchange, are being transformed utterly by networked computing, even if it is media and social production that serve as the main engines for this changes.

Benkler is perhaps the writer who makes the most direct connections between the computerization of media and the transformation of economic markets. Benkler’s seminal work on the subject, *The Wealth of Networks: How Social Production Transforms Markets and Freedom* (2006), deliberately reformulates the title of Adam Smith’s foundational 1776 volume *The Wealth of Nations*, a book that is resolutely about the commercial economy and markets rather than political representation or information. Benkler embraces the suggestion that what he calls “the Internet revolution” is creating a “radical transformation” that “is structural” and “goes to the very foundations of how liberal markets and liberal democracies have coevolved for

almost two centuries” (1). Radical transformations can, of course, be for good or ill (and the same transformation might be seen as for good or ill depending on the viewer’s perspective), but Benkler and writers like him tend to focus almost exclusively on—at times, at least, to write as if they are the only ones possible—those transformations that sound as if they are toward “fuller democratization” and away from centralization and concentrated power: “This new freedom holds great practical promise: as a dimension of individual freedom; as a platform for better democratic participation; as a medium to foster a more critical and self-reflective culture; and, in an increasingly information-dependent global economy, as a mechanism to achieve improvements in human development everywhere” (2).

Such change, Benkler claims, “threatens the incumbents of the industrial information economy” (2). It does so

because it upsets the dominance of proprietary, market-based production in the sphere of the production of knowledge, information, and culture. The upset ... will likely result in significant redistribution of wealth, and no less importantly, power, from previously dominant firms and business models to a mixture of individuals and social groups on the one hand, and on the other hand businesses that reshape their business models to take advantage of, and build tools and platforms for, the newly productive social relations.

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The rhetorically-demoted clause at the end of Benkler’s sentence deserves particular attention. In all the enthusiastic writing about internet transformation, it is difficult to understand, at least on the surface, why these transformations should in any principled way be confined to “the people,” to “democracies,” or to non-corporate bodies—it is hard to imagine (and rare to find) a principle

according to which corporations (and even nation-states) would be prevented from making use of the power that has also been given to individuals. The rhetoric, to be sure, almost always points this way, and this is surely the way most people take Benkler's nod toward "social production" transforming "freedom" in his book's title; yet the most strident capitalist voices in our country insist that individual freedom just is corporate freedom, that individuals express their rights most perfectly through corporate agency, and that any restrictions on corporate power—even if those restrictions are intended to ensure the rights of all individuals—narrow freedom in the most important sense. Thus despite the rhetoric, it is hard to understand what about the "internet transformation" prevents corporate actors (and others with existing political and financial power) from using any power exposed by that transformation to its own benefits, even if that power appears at first to mitigate against corporations.

In Golumbia (2009) I argue that there is no reason to suspect that the very real user-empowerment effects of computerization can or will be limited to individual persons—or even worse, to persons with whom "we" (whoever "we" are) generally agree politically—and therefore that sites of existing power will not also benefit massively from computerization. In other words, it is probably correct that the rising tide of computerization does in fact lift *all* boats, and there is no reason to think that computerization comes along with some kind of built-in circuit breaker that prevents it from empowering the most powerful. The persistence of many contemporary institutions of social and economic power, and the rise of new ones just as or even more concentrated than existing ones, certainly suggests this: many of the most powerful sites of concentrated capital in our world show no signs of relaxing their grips on power in the face of computerization. They further show absolutely no signs of being afraid of losing their grip on power due to computerization, in the sense of shying away from technology because indulging it

will distribute the power they have. To the contrary, many of the most powerful actors in our world openly embrace, endorse, and often produce and sell the very tools which democratic evangelists claim will dissolve concentrated power. The very corporate success of giants like Apple, Facebook, Twitter, Cisco, Intel, and many others should (but rarely often does) give pause to evangelists who claim that computerizing a social site will somehow (often enough, by means that can only be called magical) strip power away from those who have it. Of course, the frequent reference to specific corporate actors (Facebook, Twitter, Google) in the very sentiments in which proclamations of “internet democracy” are made should also produce some of the same hesitancy, although it is rarely seen.

In perhaps the most probing exploration of these dynamics to date, *The Myth of Digital Democracy* (2009), the political scientist Matthew Hindman carefully interrogates the rhetoric of democratization-via-computerization and the reality of the effects of computerization on actual democratic spaces and spheres. While his main focus is politics in the strict sense, Hindman notes that several aspects of the democratization thesis do not bear out close scrutiny, in thematic terms that will be useful for my inquiry here. While the many-to-many features of internet communication are often trumpeted as dissolving the stranglehold of broadcast media, Hindman notes just how persistent is concentration among both media producers and consumers, even if minority voices have also increased their influence:

From the beginning, the Internet has been portrayed as a media Robin Hood—robbing audience from the big print and broadcast outlets, and giving it to the little guys. But the data in this chapter suggest that audiences are moving in both directions. On one hand, the news market in cyberspace seems even more concentrated on the top ten or

twenty outlets than print media is. On the other, the tiniest outlets have indeed earned a substantial portion of the total eyeballs. (Hindman 2009, 100)

This proliferation of smaller sites—perhaps not unlike the proliferation of local media outlets that have been all but eliminated in the internet age—does not gainsay the fact that “the odds of hitting it big online are vanishingly small. Individually, each of the myriad sources that make up the long tail are insignificant; even together, they remain only a fraction of the content that citizens actually see” (101). Not only does attention in the internet age remain focused on the leading news sources; those sources have radically decreased in number, and the filters through which we access them has decreased even further; it seems ironic to be praising the internet as a distributive medium when almost all search traffic passes through Google (along with a small amount passing through Bing) and much of the news people receive is aggregated through Google, Facebook or Twitter.

2. Democratization: Of Media and Markets

When we are told that computerization democratizes, the sentiment appears to include at least three, connected, ideas. First, as we have seen, is the idea that the internet dissolves concentrations of power; second, that it flattens or eliminates hierarchies; third, that it creates transparency, making impossible the reliance on proprietary or hidden information, in part because such reliance inherently makes this information available to outside observers. As we shall see, at least with regard to financial markets, computerization has not produced these benefits, and in the time since the large-scale computerization of markets began, including the availability of mass-market and social media financial tools, it is arguable that matters have become if anything *less* democratic: more concentrated, more hierarchical, and more opaque. In

some cases, the computer itself is used to increase antidemocratic qualities, which should be no surprise if we follow on Benkler's quiet suggestion that corporate actors, too, will make competitive advantage of any edge offered by computerization.

Many of my intuitions along these lines were formed in the particular social space in which I worked as a software designer and developer for about a decade (1992-2001), namely the world of investment banking. As part of a company that built software tools for individuals and professionals—and in particular for those professionals whose job it is to package and create securities “deals” of which the best-known is the Initial Public Offering—I was always acutely aware that large financial firms benefited tremendously from computerization, even as individual investors were empowered by the computerized tools they were given within the relatively narrow area of securities trading.¹ (“Securities” here includes stocks and bonds as well as more exotic investments such as options, futures, and other forms of derivatives.) To suggest that the specific characteristics of financial markets exclude them from democratization effects would seem analytically dubious at best. Securities trading is highly quantitative, arguably more so than some other social spheres. It would be tendentious to suggest that the democratizing effects of computerization, if they exist, should be *less* pronounced in that field due to this reliance on quantification, precisely because computers process numbers more efficiently than non-quantitative data.

If we ask questions about the roles and functions of digital media and computerization in our world, there is ample evidence that we as users see very little of their most important operations and effects, and that much of what we see is tailored for and aimed at users from the perspective of those in power, often (and without particular conspiratorial intent) deliberately

hiding its most potent effects from us. Perhaps the closest analogy to understanding the question from this perspective is from that of print: if we ask, as so many scholars have, about the effects of print culture on the social fabric, it is easy and in many ways correct to look at the famous and public exponents of print to see the forms that culture takes—Shakespeare’s plays, the Declaration of Independence, the widespread availability of religious and philosophical texts—yet there is a risk of thereby ignoring the much harder-to-see effects of print culture for the powerful themselves, within the courts of Europe and the business powers and even religious authorities—at times, the critical literature reads almost as if print could only have been, and was only, used by the democratic masses and was not used by the powerful. My point is not in any way to gainsay the examination of print as a demotic technology or to tear our attention away from its popular exponents and uses; it is to suggest that the partial picture we obtain by presuming that the demotic represents the whole of print culture is not just incomplete, but tends to already presume the power of print for the demos in large part because the material of print is much more numerous and available in its demotic rather than puissant forms.

Recent studies of both writing itself and print culture have to some extent taken on these problems, and much of the most sophisticated analyses of print culture, along with the passage of time that allows or forces the exposure of the documents of the powerful to scholars, have offered a more complete picture of the ways such technologies enable the powerful to become more powerful and to control the *demos* that also uses these tools. It would not seem to be a surprise to find, when histories of this period are written in the future, that similar dynamics occur now; what is surprising is to read the amount of analysis that presumes no such activities are possible and that computerization largely benefits the less-powerful.

For digital media these problems are much more severe than the critical literature would suggest. For it goes without saying that every industry, every government, even most individuals with power have themselves been profoundly affected by the advent of digital media, and are often themselves the creators and primary users of such technology. Where cultural studies often emerges from a left political perspective that is at least suspicious of absolute free-market capitalism, the creators and propagators of digital media rarely share such commitments; thus cultural criticism today often finds itself in the strange position of arguing, at least implicitly, that the vast proliferation of commercial digital products under near-absolute free-market capitalism is somehow not merely compatible with but an inherent realization of an egalitarian politics skeptical of the potential for unregulated capitalism to distribute democracy more widely. Such a perspective risks siding with corporate and powerful agendas even more when it accepts too easily the user's perspective on these products, as if the power perspective simply did not exist; as if, in the worst case, Apple and other hyper-powerful capitalists were distributing their products despite the fact that they are likely to overturn basic principles of capitalism. In this way one often sees the restrained enthusiasm for absolute free-market capitalism in cultural criticism merge with an absolute, profoundly Libertarian and anti-regulation form of capitalism about which even Schumpeter was profoundly concerned. Schumpeter (1950) used Marx's concept of "creative destruction" not to recommend it for democracy, but to describe massive, unsustainable, and largely undemocratic social upheavals that would necessarily (if unfortunately, in Schumpeter's view) be countered by a socialist redistribution of wealth that has, so far, failed to materialize.

What do the transformations wrought by digitization do for the powerful? How do they enable the concentration and deployment of power? What are in the interactions between the vast

majority of the demos who have relatively less power, and the very rich and socially powerful? One place where some of the effects of these transformations can be viewed, at least in part, by the general public is in the world of high finance; in part these transformations are visible because, for whatever reason, cultural criticism and even political commentators see little reason to pay close attention to them. As a former worker in the world of the digitization of finance, this situation has always struck me as odd and unfortunate. Often the most skeptical and realistic understandings of the computerization of society produced today are those expressed to the public by the mainstream business reporters of national and international outlets like the *Wall Street Journal*, *Bloomberg*, the *Financial Times*, and CNBC; it is not at all uncommon to hear realistic and skeptical critiques of the operations of Facebook and Twitter and other major digital properties in supposedly pro-capitalist organs like these, while simultaneously reading nominally anti-capitalist cultural criticism extolling the virtues of the same products as if the very issues being reported non-controversially in the “conservative” business press (and there subject to great deal of crowd-sourced examination by other reporters) simply did not exist.²

The particular subject we want to examine is the effects of digitization on the world of securities trading. The importance of this world for all of us seems impossible to contest; its effects on all of us are visible with extreme frequency; even its salutary effects for individual users are clear. Yet it is also abundantly clear that digitization has not, in fact, on any reasonable understanding of these terms, made the worlds of stock trading “more democratic,” or “less concentrated on/in/by the powerful,” than they were prior to digitization; that in many ways the powerful have become more rather than less powerful due to digitization; that the powerful have a great deal of influence over how digital tools and effects are distributed throughout the world and can and do monitor and control the distribution of power.

3. High-Frequency Trading: The Computerization of Finance

The term used most widely today to signal the computerization of securities trading is High-Frequency Trading (HFT). HFT derives its name from the frequency with which securities trades can be executed (and/or cancelled before execution), in part because frequency in particular and speed in general are the features most salient for participants and regulators. Nevertheless as a shorthand term HFT is partly misleading, because HFT encompasses not simply and not even directly the speed of trading (which in the abstract might be conducted by any number of means, although computers happen to be particularly good at implementing speed), but rather stands in for the general automation of trading. There are any number of uses of computerized trading, many of which do not need to rely on the high-speed techniques characteristic of HFT; nevertheless, what is absolutely clear is that the rise of HFT precisely tracks and is in fact much the same phenomenon as computerized and network trading in general, that HFT would be unthinkable without networked computers, and that rather than simply existing as one flavor of computerized trading, HFT may be better understood as the name for the suite of effects that computerization has had on the worlds of securities trading.³

There is little controversy about this picture within the trading world, including both trading firms themselves and the government bodies that regulate them; there, HFT

refers “to professional traders acting in a proprietary capacity that engage in strategies that generate a large number of trades on a daily basis.”⁴ A variety of proprietary firms practice HFT, based on the SEC’s broad definition, commonly exhibiting the following characteristics: (1) utilization of high-speed, complex computer programs and equipment to effect trades; (2) utilization of co-location services to reduce latencies; (3) extremely small time-frames for opening and closing positions; (4)

placing numerous orders and quickly cancelling them; and (5) “ending the trading day in as close to a flat position as possible.”⁵ (Serritella 2010, 436-7)

While computers have been used to aid securities trading nearly from their first availability to private industry, fully-automated trading became possible only in the late 1980s, and became practicable only when the stock markets themselves—starting with the technology-friendly NASDAQ market, but eventually including the major-stock New York Stock Exchange as well as other stock and commodity bourses—allowed electronic trading to supplement or even bypass the more familiar human-staffed trading floors. These changes began slowly, and at first looked to be a specialized niche that would be exploited only by extreme market participants, at first taking advantage of one of the first electronic trading services, the NASDAQ’s Small Order Execution System:

Since 1984, NASDAQ had had in place an electronic trading system so that it could guarantee small investors who sent their orders through registered brokers instantaneous executions up to 500 shares. The Small Order Execution System, or SOES, made it more difficult for market makers to pull a bait and switch the way they could over the telephone. SOES seldom was used, however, primarily because not many customers knew of its existence. Following Black Monday, the National Association of Securities Dealers (NASD), reacting to shrill complaints from customers who had been unable to execute as the market plunged, passed rules obligating the market makers to offer firm quotes. Under the new regime, if the order came through SOES, the market maker was obliged to honor the displayed quote up to 1,000 shares, even if the price had moved. (McTague 2011a, 136-7)⁶

The few traders who exploited the timing and automation features of the SOES market were viewed as renegades by the majority of financial companies; the players who did use SOES, in particular an early innovator named Harvey Ira Houtkin, were labeled “SOES Bandits”

by institutional traders due to their use of computers to exploit market inefficiencies that were either too small or required reactions times too fast to be usefully managed by human beings.

A light bulb went off over Houtkin's head. The trader, who wore a neatly trimmed brown beard and aviator-style lenses, perceived the opportunity to profit from NASDAQ market makers who were slow to update their SOES quotes as prices changed. He began using SOES at his brother-in-law's brokerage company to front-run the slowest, least organized market makers. Houtkin made hundreds of thousands of dollars for himself because most market makers were trying to track the progress of dozens of stocks at once, and they devoted most of their attention to big institutional block trades, which were the source of most of their commissions. The market makers often were slow to update the prices of lower volume stocks. Many of them relied on older SOES terminals that did not update prices as quickly as the newer models. Houtkin learned who the worst market makers were through trial and error and legally front-ran them, owing to his faster machine. (McTague 2011a, 136-7)

Over-the-counter (OTC) dealers hated Houtkin because he was eating into their profits. They derogatorily called him and his customers 'SOES Bandits' and attempted unsuccessfully to have the Securities and Exchange Commission (SEC) ban him from using SOES. (McTague 2011a, 137)

When money and power could not defeat the singular (although highly-capitalized) individual who used his own machines to find such inefficiencies, the solution was obvious: take that power in-house. By the early 1990s, many varieties of automated trading schemes were being developed in every corner of Wall Street, and even the most prestigious and largest firms were beginning to dabble in such methods themselves, to invest in boutique specialist firms, and even to acquire such firms once they had proved their utility. Within a decade a marginal activity had become not just mainstream but was becoming dominant, and individuals with PhDs in Physics, Computer Science, and other highly computerized fields from the world's elite

universities were being recruited to Wall Street with no trading backgrounds whatsoever, but simply because of the complexity they could build into algorithmic trading platforms; called “quants” (Patterson 2010) these individuals became stars of Wall street trading firms, even if they rarely or ever themselves were part of the actual chain of securities trading.

Quickly, and somewhat surprisingly, it was discovered that the single greatest source for potential mistakes—especially on a day-to-day basis—was to let human beings fiddle with the computers that executed the trades and realize trading strategies. The full automation of trading was first made real in the mid-1990s by the company Process Driven Trading (PDT). “‘Process-driven’ was essentially shorthand for the use of complex mathematical algorithms that only a few thousand people in the world understood at the time” (Patterson 2010, 123). The physicists and computer scientists of PDT’s “‘dream team’ built an automatic trading machine, a robot for making money” (126). The effectiveness of these tools depended on blindly following the computers’ instructions (this is before fully automated markets eliminated even the human beings performing trades for the fund). After the two lead managers of PDT made several decisions to override the computer programs with negative results, “they quickly concluded the computers were more reliable than people. Every time they tried to outsmart the computer, it turned out to be a bad move. ‘Always trust the machine’ was the mantra” (Patterson 2010, 128).

Today, automated trading in general and HFT in particular have become the norm for securities markets. *The New York Times* reported that in the early 2000s, automated trading accounted for about 10% of all equity trades (Duhigg 2009); “currently, HFT is estimated to comprise about 50% of all trading activity by volume in equity markets and represents a significant source of liquidity”⁷ (Serritella 2010, 436-7), and some estimates place the total

volume in trades across all markets even higher, in some markets approaching 70% or more (Grant 2010). This is real Artificial Intelligence in action; much and perhaps most of the market action is conducted by computers beyond human oversight and beyond human vision, largely because the trading actions are by definition conducted at speeds faster than human beings can follow. (A typical sentiment of a human trader in a market recently invaded by HFTs: “‘The electronic platform is too fast; it doesn't slow things down’ like humans would, said Nick Gentile, a former cocoa floor trader” (Cui and Lauricella 2011). Regulators remain deeply troubled by the widespread use of HFT and also the conundrums it produces for democratic oversight. It is by no means clear what can or should be done about HFT, or at another level who it is that runs HFT at all—that is to say that it is not at all clear anymore who is in charge of the securities markets, or whether, as many commentators and market participants now suggest, a vast majority of the market is made up of machines talking to other machines, with human input and oversight ruled out by necessity.

In the most recent market crisis to receive wide press attention, the so-called “Flash Crash” of May 6, 2010, many regulators and participants blamed HFT for a brief but remarkable dislocation in the prices of certain kinds of derivative and “synthetic” securities (including Exchange-Traded Funds, ETFs, and options and futures, and in particular futures contract called the E-mini S&P 500) with regard to the underlying instruments whose value they exist to track. Because the actions of HFTs are so difficult to track, however, the cause of the Flash Crash and the role of HFTs in it remain unclear, and this uncertainty troubles regulators and legislators tremendously. Echoing the sentiments of regulators at the SEC and legislators concerned about the non-transparency of computerized trading, the authors of the most detailed study of the Flash Crash and the roles played by HFTs in it to date conclude that the role of HFTs was significant,

that the commitment of HFTs to the market as it is traditionally understood as a source of liquidity for investment is dubious, and that it is not technology per se but rather the opacity and other features of the specific implementations of HFT technology that today pose significant risks to trading markets as a whole:

We believe that High Frequency Traders exhibit trading patterns inconsistent with the traditional definition of market making. Specifically, High Frequency Traders aggressively trade in the direction of price changes. This activity comprises a large percentage of total trading volume, but does not result in a significant accumulation of inventory. As a result, whether under normal market conditions or during periods of high volatility, High Frequency Traders are not willing to accumulate large positions or absorb large losses. Moreover, their contribution to higher trading volumes may be mistaken for liquidity by Fundamental Traders. Finally, when rebalancing their positions, High Frequency Traders may compete for liquidity and amplify price volatility.

Consequently, we believe, that irrespective of technology, markets can become fragile when imbalances arise as a result of large traders seeking to buy or sell quantities larger than intermediaries are willing to temporarily hold, and simultaneously long-term suppliers of liquidity are not forthcoming even if significant price concessions are offered.

We believe that technological innovation is critical for market development. However, as markets change, appropriate safeguards must be implemented to keep pace with trading practices enabled by advances in technology. (Kirilenko, Kyle, Samadi, and Tuzun 37-8)

As Serritella (2010) and others have argued, though, the desirable shape of such regulation is unclear. Recent market commentators, especially McTague (2011b) also point toward the increasing reliance on automated trading in all its forms, including the creation of computer-based and highly obscure forms of securities derivatives, as increasing the likelihood of new

forms of market crises, along the lines of the “black swan” events described by Taleb (2007) and non-continuous market events predicted by Mandelbrot (Mandelbrot and Hudson 2004). That so little of these processes are visible to the public and even to governmental and non-governmental regulatory officials is cause for great concern across the board (“Findings Regarding the Market Events of May 6, 2010”).

4. The Opacity of HFT: Culture Without Semiosis

Among the most fundamental tenets of cultural criticism, perhaps so fundamental that at times it rarely requires overt statement, is that because culture exists and has some relation to all the motivating facets of human life (cultural and also economic, geographical, and so on), it will be reflected in something like a relative weighting in the semiotic sphere. That is to say that if something important is happening, we know about it via cultural production, and that culture thereby provides us a good map of what is happening in the world and that therefore cultural criticism can begin with its focus trained on those objects which culture itself brings most to the fore.

At one level one might imagine that the computerization of securities trading provides a worthy exemplar of this principle, since computers everywhere are used to make visible investment activities that prior to computerization were visible either only to those inside the investment world, or not at all. Just a few decades ago, individual investors had to visit or at least place a phone call to a brokerage office not only to make trades—usually through an intermediary trader at the brokerage firm, who then would relay the order through many levels down to actual traders on the stock exchange floors—but even to get information about the current price and other trading characteristics of particular stocks.

Today, through mass-market venues such as Yahoo!, Bloomberg, Motley Fool and others, and even more notably through the vast array of tools provided to individual investors through brokers like TD Ameritrade, eTrade, and Charles Schwab and mutual fund/retirement account providers like Vanguard and Fidelity, investors have an almost unbelievably improved view not just of individual stocks but of the market as a whole than was ever conceivable. I remember hearing as a child stock reports on the evening radio or tv news, wherein the day's price change in a major stock like ITT or Standard Oil would be announced with an air of surprise and newsworthiness, because the majority of the audience would have had no access to such information during the 6 or 7 hours of open trading. Today not only are such reports much the exception rather than the rule, but most individuals know that trading during the day may be so intense and varied that the simple end-of-day price constitutes at best a partial, and only partly useful, data point.

Today, via internet tools and no less through media outlets like Bloomberg and CNBC, investors are accustomed to seeing real-time changes not just in price but in volume and in “technical indicators” like Relative Strength and Moving Average that in turn depend on the visibility of primary data to be offered at all. (That is to say that Moving Averages are derived by first plotting the historical trading of a stock on a visible chart and then secondarily performing calculations on the underlying data, and in most cases make sense only when viewed against the chart of raw prices.)

Such charts and the underlying data for them are not merely available but producible by individual investors, and can be used to track not just individual securities but indexes, commodities, options and futures, and even more exotic derivatives **<insert Figure 1 here>**.

There is no doubt whatsoever that such tools greatly empower each individual investor; it is literally the case that each individual investor can have (and most do have) trading tools that far surpass those of most professionals of a half-century ago. Once again: there can be no doubt that computerization of securities trading empowers individuals, if by “empowerment” we mean the relative increase in power over what was available prior to digitization.

Yet it is far too easy to look at such artifacts of empowerment from the individual perspective and thus fail to ask two questions that seem absolutely necessary for any serious inquiry into the effects of computerization. First: to what extent do such developments distribute power more widely across the actors and social networks that existed before computerization? Second: to what extent has previously-centralized power become less centralized, particularly due to the empowerment of individuals that is visible onscreen to most of us? A related question is: does the visible empowerment of individuals guarantee or even suggest that non-visible parts of the now-digitized social sphere have become available to democratic or distributed control?

It would also be profoundly mistaken to suggest that computerization somehow leads inevitably to transparency and visibility. One finds examples of just the opposite trend occurring again and again in securities markets—where computers do not directly lead inevitably or irrevocably to hiddenness, but where they are extremely useful to actors who make it their business to hide their activities from democratic oversight. In Golumbia (2009, Chapter 7) I discuss the well-documented use of actual computers and the rhetoric of computerization by Enron, a company whose success was thought to be fueled by a computer-based energy trading market that turned out to be largely a sham, and where even Enron’s own internal accountants were frustrated by CFO Jeffrey Skilling’s repeated assertions about the sophistication of his

computer models in their attempts to stop the company's illegal activities.⁸ Even more widespread were the consequences of the creation of "swaps" in the 1990s by any number of major market players, with the implicit or even explicit assent of the governmental and nongovernmental market oversight bodies. During this period, former Commodities Futures Trading Commission (CFTC) head Brooksley Born tried repeatedly to expose loopholes in the law exploited by financial companies created financial instruments that were neither stocks nor insurance product, but instead a new kind of derivative for which no regulation yet existed, despite the clear intent of Congress and the President not to allow such "neither fish nor fowl" instruments to exist ("The Warning"). The connection of powerful capital interests with major market regulators allowed a "dark market" to develop that was designed to escape oversight:

Unlike the commodity futures regulated by Born's agency, many newer derivatives weren't traded on an exchange, constituting what some traders call the "dark markets." There were now millions of such private contracts, involving many of Wall Street's top firms. But there was no clearinghouse holding collateral to settle a deal gone bad, no transparent records of who was trading what. (Faiola, Nakashima and Drew, 2008)

Born's efforts were especially vigorous in the years 1996-98, which coincided with the so-called "Internet Bubble" in stock trading, when computerization and the internet were to be found everywhere in investment banking and securities trading and in stocks themselves. Yet not only did such widespread computerization fail to inoculate the market against malfeasance, or force transparency; without actual democratic control, or even actual will of the democracy to enforce both the letter and spirit of laws already on the books, one of the 20th century's greatest financial crises occurred during the advent of widespread computerization, without that computerization apparently providing significant safeguards, or even visible evidence of such activities taking

place, despite the highest level executives and regulators knowing of their existence. To the degree that citizens in a democracy believe that computerization does inevitably entail transparency and openness, the risk is very clear: transparency and openness can only exist when they are mandated and when the rules of the mandates are enforced. Believing computerization entails visibility often produces the worst results possible, creating faith in the notion that everything is visible while indirectly and even directly contributing to invisibility, through failure to insist on and implement protocols that would have ensured transparency, and through the use of technical devices designed to hide rule-breaking activities .

There are several more ways in which computers are directly implicated in the hiding of what democracy mandates visible within its markets. The company whose activities most reflected the worries of Brooksley Born, Long-Term Capital Management (LTCM), was among the first to deploy in an institution-wide manner the Black-Scholes-Merton model for options pricing, which requires computers to function in fast-enough time to profit from very small pricing differentials (see MacKenzie 2006, Chapters 5 and 6; also see Mandelbrot and Hudson 2006); the firm's products were sold to clients up and down Wall Street specifically because its new computerized models sounded magical, did things no individual investor could do, and promised returns that would otherwise be thought impossible in their regularity. (While LTCM was not technically speaking a Ponzi scheme, its rhetorical reliance on computerization resembles that of Bernard Madoff, now the admitted operator of the largest Ponzi scheme in US history.) One of the most astute commentators on Wall Street, Michael Lewis, writes that the new breed of "young professors" who made up LTCM's brain trust "were nothing like the others on the trading floor. They were physically unimposing, their bodies merely life-support systems for their brains, which were in turn extensions of their computers" (Lewis 1999).

Despite their use of real computers to develop and execute LTCM's trading strategies, their computers also provided them with what strikes me as a characteristic computationalist ideology according to which simply having computers makes one superior to others both in one's own eyes and the eyes of those others:

The young professors weren't happy making money unless they could explain to themselves why they were making money. And if they couldn't find the reason for a market inefficiency they became suspicious and declined to bet on it. But when they stood up on Oct. 19, 1987, and peered out over their computers, they discovered the reason: everyone else was confused. Salomon's own long-bond trader, the very best in the business, was lost. Here was the guy who was meant to be the soul of reason in the government-bond markets, and he looked like a lab rat that had become lost in a maze. This brute with razor instincts, it turned out, relied on a cheat sheet that laid out the prices of old long bonds as the market moved. The move in the bond market during the panic had blown all these bonds right off his sheet. "He's moved beyond his intuition," one of the young professors thought. "He doesn't have the tools to cope. And if he doesn't have the tools, who does?" His confusion was an opportunity for the young professors to exploit. (Lewis 1999)

Thus as early as the 1987 "Black Monday" crash, during which eventual LTCM CEO worked for investment giant Salomon Brothers, the seeds were planted for the emergence of a pattern that continues to this day, according to which many investors buy into financial products specifically because they are fueled by computerization wholly proprietary to the selling firm, and whose very operation is not, cannot, and will not be made visible to anyone outside the firm. Rather than information "wanting" to be free, as the originator of that slogan, *Whole Earth Catalog* publisher Stewart Brand, said from the beginning, this is very much computers engaging in information wanting to be very expensive, hiding itself from public and even private scrutiny.⁹

5. *Margin Call*

Margin Call, a 2011 film written and directed by J. C. Chandor and financed and produced largely outside the mainstream Hollywood production studios, dramatizes the actions of a group of employees at a large investment bank that closely resembles Lehman Brothers and the financial crisis of 2007-08. The film illustrates in stark clarity exactly the dynamics I have so far outlined; that the film has to my knowledge not yet been taken by any writers as a largely accurate depiction of the role of computers and computerization in not just the specific mechanisms of the financial crisis itself but just as much the vital role played by computerization in the larger consequences of that crisis suggests to me the continued unwillingness or inability of cultural critics to reflect critically on computerization. (That the film has been roundly praised as a largely accurate assessment of the financial and social facts underlying recent crises within the business press itself makes this lack of criticism all the more unfortunate.) Further, while the film shows in many ways the direct effects of computerization on the people and actions involved (both in the fictional film and the basic facts at which the film gestures), it is also unable at many key points to show those effects directly, precisely because so much of what computers enable in securities trading is simply not visible to anyone, other than the machines to which trading itself has been trusted.

The film's clearest candidate for a protagonist, 27-year old risk analyst Peter Sullivan (portrayed by Zachary Quinto) for a fictional firm called MBS, very much is one of those quants valued only for his skill at the implementation of complex computer algorithms. Sullivan, like many of his real-world counterparts, literally has been educated as a rocket scientist, and his knowledge of finance is far more limited and in many ways not relevant to his work for MBS.

Sullivan works in a part of MBS known as “risk management,” a catchall term for parts of investment firms that assess and manage the degree of exposure of the firm to any number of internal and external threats. In this case Sullivan and his immediate supervisor, Eric Dale (portrayed by Stanley Tucci) develop computer models that are not used only to analyze the exposure of the firm to potential changes in the overall market, but, again reflecting much of what is done in the real investment world and what was done in the firms whose actions are being partly fictionalized in the film, become active parts of the firm’s overall investment strategies. These firms routinely engage in the borrowing of huge amounts of money relative to the “actual” capital they own; but the forces of securities market dictate that even if a firm can borrow 100 or 1000 times the value of its “real” money, circumstances can arise in which the lender can or even must demand part of its capital be returned. Presuming that a firm like MBS actively invests all of the money it has borrowed, the demand that some of this money be returned—the “margin call” of the film’s title, since in the trading world “margin” is another word for “borrowed money”—can have dramatic consequences for the firm as a whole and even the various institutions who trade and invest with the firm. At its simplest, the risk is that the firm may be forced to sell securities to raise the cash necessary to pay back its loans, and that those securities may have to be sold at bad prices, or worse, at prices far lower than the firm currently claims their value; the realization of such low values can cascade throughout the rest of the firm and its investments, principally because selling a few shares of a security for much lower than its purported value causes the revaluation of all those holdings, which thus threatens to raise the percentage of capital-to-margin again, causing more margin calls, and so on. Just such cascade effects, almost entirely triggered automatically by computers at each party to a trade, have happened at every point in the recent wave of financial crises felt across the world.

Despite the fact that they work for one of the most central investment banks in the US, and in terms of income fall (at least in theory) at the very top of the economic ladder, both Sullivan and Dale can and should be taken as proxies for the empowerment of the individual via computerization. Each of them is far more powerful than any person could have been without computers; each of them has received extensive formal education and extensive on-the-job training in computerization as well; each displays obvious aptitude for the specific tasks at which they work. Yet again and again, *Margin Call* shows that not even these two relatively empowered individuals are able to impact the major effects of the financial events to any significant extent; in fact the movie is in part a dramatization of each of them coming to the realization that the powerful machine of capital in which they are implicated moves on without regard for them.

The movie begins with the unexpected layoff of Dale, a senior employee with more than 19 years of service to MBS. While such layoffs are familiar in the banking world and clearly familiar to Dale, his personal surprise cannot be masked. This too serves as a proxy for the individual, who may continue to presume that the power for which he works will somehow turn out to be under his control. Despite being perhaps the individual with the most direct computational contact with the details of the system that is about to explode—through a variety of private, ad-hoc, and almost completely non-public computational tools to measure the market and MBS's own investments—Dale sees that he never had any particular control over the concentration of capital that MBS embodies.

We learn early in the film that Dale and his division are not part of the team responsible for building MBS's computational trading system, but instead work primarily in determining the

various financial parameters that determine how far MBS can stretch its capital via borrowing or margin. While Dale does not see this at first, he is being laid off because the higher powers at MBS see that the computational trading system has already several times pierced the limits of its capital requirements. Because these operations are so hidden from any agent other than the specific computer programs executing the trades, and because the limits have been passed for very short periods of time and then returned to parameters within the models, MBS's lenders have not yet issued margin calls. Yet Dale's calculations show that market fluctuations are increasing and that more permanent violations of the risk limits are imminent.

As he is being escorted from the building, Dale passes a thumb drive with some of his calculations on to Sullivan. Again, despite the huge number of computer programs and tremendous power of the programs being used, even the staff member with expertise nearest to Dale—Sullivan—cannot see the disaster looming, but once provided with Dale's calculations he quickly reconstructs the work and, that night, makes visible to himself the huge risk to MBS's capital and, even more frighteningly, the risk that MBS's risk poses to much larger entities including the many individuals whose investments are directly or indirectly tied to the value of MBS as a firm. Sullivan immediately notifies his remaining superiors and this notification travels, almost immediately, to the highest executive level of MBS.

At this point we learn that those responsible for building MBS's trading models have been aware that these models depend on various market parameters staying within given ranges that, in fact, have already been exceeded several times. These parameters, here, represent one place where human beings have made decisions, although as we have seen in current HFT programs even this kind of decision has been transferred to machines, and to that extent made

even more opaque to all but the most concentrated centers of power. As Sullivan reports his findings up the chain and learns of the existing awareness of those above him of the risk to his firm, he grows skeptical of the power he or anyone below the highest levels of management has to influence the crisis at all.

In perhaps the most famous scene of the movie, Sullivan is called before a meeting of MBS's top executives including its CEO, John Tuld (portrayed by Jeremy Irons); the close hewing of the scenario to real history is reinforced by the closeness of his name to that of Richard Fuld, CEO of Lehman Brothers during its 2007-08 collapse, and perhaps also ex-Merrill Lynch CEO John Thain.¹⁰ (Writer/director J. C. Chandor's father worked at Merrill Lynch for more than 40 years.¹¹) Breaking protocol to some extent by addressing Sullivan directly, Tuld instructs him:

So, Mr. Sullivan why don't you tell me what you think is going on here, and please speak as you might to a young child or a golden retriever, I didn't get here on my brains I can assure you of that.

This speech is wrongly understood if it is taken to literally mean that Tuld is stupid, or in some fashion out of touch with the tremendous intellectual power required to run the trading operations at MBS, although some early reviewers appear to have taken it that way. Rather, it shows, and the look on Sullivan's face can be thought to emphasize this, the degree to which the tremendous computational power harnessed by the senior quant turns out to be entirely under the control of the raw and centralized power of capital. Sullivan and Dale alike are without recourse in their (relatively slim) attempts to "fix" the problem they have found; they discover instead that no fix is available and certainly that any fix they might imagine will be wholly subservient to the central power, the concentrated capital, that is the heart of MBS.

To an extent, even Tuld himself walks a line between embodying this power or capital and being its servant. In one of the film's concluding scenes, Sam Rogers, a high-level executive for the firm's trading operations, serves as a very pointed proxy for the entire world of individuals and even democratic society itself as it experiences the destructive effects of MBS's solution to its problem, which is to use its power and the non-transparency of its own securities to unload them on temporarily-unsuspecting traders at other firms, despite the fact that even as they perform this sale the extent of their perfidy will become clear, likely ending the careers of almost all MBS employees. Both Rogers and Sullivan, despite having engaged in activities that violate every ethical principle they claim to have, turn out to be among the few individuals who will be retained in whatever new company rises out of the ashes of MBS; the film emphasizes that in joining the ranks of concentrated power they are both acutely aware of the huge number of knowing and unsuspecting individuals whose lives will have been harmed by their activities. Near the end of the film Tuld delivers a speech that displays how knowledgeable he is about what MBS has been doing, what its consequences are for the world, and the way in which it reflects exactly the same processes of financial concentration in which capital has always been implicated:

What, you think we may have helped put some people out of business today? That it's all just for naught? Well you've been doing that every day for almost forty years Sam. And if all this is for naught then so is everything else out there. It's just money, it's made up, a piece of paper with some pictures on it so we don't all kill each other trying to get something to eat. But it's not wrong and it's certainly not any different today than it's ever been. Ever. 1637, 1797, 1819, '37, '57, '84, 1901, '07, 1929, '37, '73, and 1987... God damn did that motherfucker fuck me up good, 92, 97, 2000, and whatever this is gonna be called. They're just the same thing over and over. We can't help ourselves,

and you and I can't control it, stop it, slow it, or even ever so slightly alter it. ... We just react... and we get paid well for it if we're right... and get left by the side of the road if we're wrong. There's always been and there's always gonna be the same percentage of winners and losers, happy fucks and sad sacks, fat pigs and starving dogs in this world. ... Yes there may be more of us today... but the percentages... they always stay exactly the same.

There can be no deeper expression of conservatism than this, and it is a conservatism that embraces the inability of any of us to make the world a more equitable place—to realize in any way the dream of democratization that we are told is a consequence of computerization. That Rogers, to whom this speech is delivered, ends the movie by burying in his ex-wife's front yard the being to whom he appears to be most closely tied, his family dog, underscores the profound failure of the financial system to recognize the deep needs of all those actors in whose lives it is directly implicated. Further, the movie carefully portrays, without focusing on them, a wide range of everyday citizens whose lack of financial power excludes them from any participation at all in the activities of MBS, while making clear in its final scenes that MBS's activities will have caused a great deal of economic devastation to these everyday citizens of an apparently world-leading democratic system.

6. Conclusion: The Democratization (to Come) of the Financial Markets

The thesis which I mean to contest in this essay is the one that says that the computerization of a part of the social sphere leads—and in particular that it leads necessarily, or irrevocably—to the democratization of that field. The thesis needs to be contested because it is promulgated widely, very often uncritically, and very often as if it is so obviously true as to need no examination. To do so, I have offered the example of the computerization of the securities trading markets, a

sphere which has if anything become more concentrated, more opaque, and less subject to democratic oversight than it was previously, specifically due to widespread digitization

One might argue that securities trading is not a representative social space, because it is so quantitative, because it is so close to (indeed identical with) the movements of pure capital, because it has available to it the most powerful computers and most expert computer technicians money can buy. Such an exceptionalist view deserves close scrutiny, but there seems little immediate reason to use it to discount the very real developments of HFT. Certainly the quantitative nature of securities trading can be thought just as reasonably to magnify the beneficial effects of computerization as it would to minimize them; furthermore if it is correct that the quantitative nature of securities markets immunizes them from the democratizing effects of computerization, this would require that we place a large asterisk next to the democratization thesis of the form, *not applicable to highly quantified markets or spaces. It is hard not to wonder what other social spheres would deserve the same asterisk, not least because it is very often commercial spaces in particular—the putative “empowering of the consumer”—that are said to be most easily and directly democratized, and that are themselves riddled through with the same or related quantitative features found in capital markets, and of course with many direct connections to them.

It is vital to see that I have not argued, either, the converse thesis, that computerization necessarily or inherently makes social spaces more authoritarian, more concentrated, or less democratic, despite finding a great deal of evidence to support such developments in recent securities trading. I have provided some evidence of such developments in securities markets so as to contest the democratization thesis, to be sure; but I am by no means convinced that

computerization either democratizes social spaces or prevents or retards that democratization. Rather I mean to call out in particular the unexamined faith in computer-based democratization and to show that computerization potentially and often actually leads in the other direction, especially when those in power intentionally use it that way, and to insist that faith in computerized democratization is itself among the contemporary forces most damaging to the maintenance of democrat spheres. As we have seen, it is the view of many analysts and regulators that the intense computerization of the markets today contributes heavily to their fragility and to the likelihood of “black swan” events (Taleb 2007; also see Mandelbrot and Hudson 2004) such as the collapses of LTCM and Lehman Brothers, the worldwide economic turmoil associated with Credit Default Swaps, and the still-not-fully-understood 2010 “Flash Crash.” In the brief time since *Margin Call* was released, another major trading firm, MF Global, one with connections to the Democratic Party via its CEO, former New Jersey Governor Jon Corzine, collapsed in a computer-trading fueled bankruptcy very similar to the one at Lehman Brothers, with disastrous consequences for its investors and segments of the financial markets, but where again regulators and investigators have found it nearly impossible to pierce the computer-aided veil of opacity erected by the firm (Nocera 2011). Then, in May 2012, Jamie Dimon, President of JPMorgan Chase, was called to testify before the US Congress due to trading losses incurred via a computationally-modeled and synthetic-instrument implemented “risk management” scenario quite similar to the one laid out in *Margin Call*. Here again those charged with regulatory oversight of the company, and even those inside the company who claim to have direct oversight (Dimon himself) cannot agree on how much capital was truly put at risk nor the original purpose of the trading that created the losses; what is universally agreed is only that the small amount of capital that could be accessed by the particular trading desk and other

internal curbs prevented that situation from escalating into one that threatened the firm itself, and the markets in which it is invested (Pollack 2012). Meanwhile, in US equity markets, “Quote spam [the sending of thousands of requests for instrument prices when no trade is placed] has exploded with no signs of stopping, while trade frequency has stalled and is actually lower than it was years ago” (Nanex 2012a); large portions of daily trading volume occur in “dark pools,” currently beyond all regulatory and investor observations (Patterson 2012; Nanex 2012d); and in the latter part of 2012, a single algorithm of unclear origin and purpose accounted for more than 4% of all stock trading and “accounted for 13.6 million quotes out of 510 million” for all Nasdaq National Market stocks (Nanex 2012c).

What would it mean for securities markets to be “more democratized”? Certainly it would seem to suggest a distribution of power and perhaps wealth throughout a larger range of actors, and (at least in the farthest-left rhetoric of computerization advocates) the decentralization of those concentrated financial actors who, despite the severity of recent economic turmoil, often not merely survive but thrive, just as John Tuld and the other surviving MBS executives do in *Margin Call*.¹² One might argue that a much more direct important force on democratic control of financial institutions during the 1990s and 2000s has not been computerization but rather rampant deregulation, including the 1999 legislative repeal of the 1933 Glass-Steagall Act, which had been designed specifically to prevent mixing of commercial and depository banking interests in the US (Barth, Brumbaugh and Wilcox 2000); the impact of such deregulation on financial markets and on democracy remains an open question for study (Beck, Levine, and Levkov 2010 argue that some of those effects have been salutary for the distribution of wealth across society), but it would be mistaken to look toward computerization, or toward computerization by itself, and not toward such direct means of democratic oversight to

understand how and where democracy and finance intersect. It is by no means clear that these deregulatory maneuvers, and the deliberate lack of oversight of financial institutions detailed by Brooksley Born during her time at the CFTC (“The Warning”), constitute part of anything deserving the name of “democratization” of securities trading and banking more generally. Even in offering this perspective I am walking a careful middle ground; some commentators, such as the critical theorists Christian Marazzi (2011) and the business commentator and journalist Dylan Ratigan (2012), cogently argue that the financial markets today are both more dangerous to the whole of society (due to their pervasive influence on every part of social life) and less democratic (in the sense of responsible to the people in general, or subject to democratic oversight) than they have ever been.

What is clear is that in at least the most literal sense, “democratization” of the financial markets would mean that the activities conducted in them would be (a) visible to market participants and non-participants as well, particularly democratically-elected politicians and duly appointed oversight bodies (such as the US SEC), so that the whole of society could decide as a group or through representative means what the proper courses of action should be; and (b) susceptible to just the sort of regulation, oversight, and penalty for unlawful behavior to which any democratically-bound social institution must be subject (Beck, Demirgüç-Kunt, and Levine 2007 provides a broad discussion of the impact of financial market activities on economic distribution across social classes; also see Levine 2011). Neither (a) nor (b) is a computational process, and despite the cant in its favor, we have seen that computerization can be used very effectively to make market operations opaque, much as they can (and very much are) used to make them transparent—but only if and when it is understood that the desire to democratize precedes computerization in a logical sense and only happens if democratization is an overt goal

of regulatory processes. Thus if we look toward computerization to democratize for us, we risk simply giving up the democratic governance that must be at the heart of any serious conception of democracy. Computers do not build democracies by themselves; there is plenty of evidence that, left to their own devices (so to speak), they are just as likely to inhibit democratic control as to reinforce it. There is also evidence that thorough computerization, as in the case of contemporary HFT, puts so much power directly in the hands of automated systems that human actors cannot even observe it closely enough to regulate it (McTague 2011b, Serritella 2010), so that in some senses at least computerization poses new problems for democratization rather than offering new and automatic solutions. If we are to continue to build and develop a society that is democratic to its roots, the prejudicial (and commercially-aligned) view that computers democratize must be overcome, and people themselves must reassert their right and their responsibility to govern and operate the parts of society that are and should be democratized.

¹ The company for which I worked was known first as IDD Information Services and later Tradeline.com; in late 2001 the company was acquired by SunGard Data Systems.

² The most significant exception to this principle is the work of Donald MacKenzie, whose research has been singularly useful to the arguments made here; see especially MacKenzie (2005, 2006). Also see Holmes (2010).

³ For general overviews of HFT, see McTague (2011a) and Patterson (2010, 2012). Of particular note is the work of Nanex, LLC (<http://www.nanex.net>), a market data provider whose founder, Eric Scott Hunsader, has been one of the financial industry's most outspoken voices about the problems created by HFT and, even more acutely, the massive volume of high-speed price quotations created by HFT practitioners. Nanex provides an extensive library of data and research reports at <http://www.nanex.net/FlashCrash/OngoingResearch.html>. See in particular Nanex (2012a, 2012b, 2012d).

⁴ Concept Release on Equity Market Structure, 75 Fed. Reg. 3594, 3598 (Jan. 21, 2010), hereafter “Concept Release” (to be codified at 17 C.F.R. pt. 242), <http://www.sec.gov/rules/concept/2010/34-61358fr.pdf>. [Serritella’s note]

⁵ Testimony Concerning the Severe Market Disruption on May 6, 2010 Before the House Subcommittee. on Capital Markets., 111th Congress (2010) (statement of Mary L. Shapiro, Chairman, U.S. Securities and Exchange Commission), <http://www.sec.gov/news/testimony/2010/ts051110mls.pdf>. [Serritella’s note]

⁶ “Black Monday” here refers to the Oct 19, 1987 market crash, when the Dow Jones Industrial Average lost more than 22% of its value in a few hours.

⁷ Concept Release, 3607-08. [Serritella’s note]

⁸ Skilling was convicted in 2006 of multiple felony fraud and conspiracy charges while employed at Enron.

⁹ Brand’s actual statement is very much the opposite of the slogan technology advocates ascribe to him, and provides a reasonable view of information flows, consistent with the view offered here, that appears lost on those who quote only the first part of his statement: “On the one hand information wants to be expensive, because it’s so valuable. The right information in the right place just changes your life. On the other hand, information wants to be free, because the cost of getting it out is getting lower and lower all the time. So you have these two fighting against each other” (“Information Wants to Be Free,” Wikipedia entry, http://en.wikipedia.org/wiki/Information_wants_to_be_free.)

¹⁰ Julia La Roche, “Guess What the CEO’s Name Is in the New Movie About the Financial Crisis,” *Business Insider* (Oct 14, 2011), http://articles.businessinsider.com/2011-10-14/wall_street/30278363_1_financial-crisis-john-thain-ceo.

¹¹ “Richard S. Fuld, Jr.,” Wikipedia entry, http://en.wikipedia.org/wiki/Richard_S._Fuld,_Jr.

¹² Note that the question of whether financial concentration leads to more or less severe consequences for society as a whole is very much an open one; recent scholars such as Beck, Demirgüç-Kunt, and Levine (2006) provide

convincing data that, whatever their social desirability and their fit into one vision or another of democratic governance, concentrated financial institutions provide for more and not less social stability.

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