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Risk, Reason and Technology: Prediction and Calculative Rationality in Global Financial Markets

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Trading the Numbers: Calculation and Ambiguity in the Pits and on the Screen

Introduction

On the corner of Walbrook and Cannon Streets in the heart of the City of London stands a bronze cast of a man. Erected in 1997, the figure poses legs spread, one arm flung out and head cocked toward a now outsized cell phone. Two badges are pinned to his coat—one a security pass for the trading floor of the London International Financial Futures Exchange (LIFFE) and the other a three-letter identification tag. His loosely fitted trading jacket is permanently spread against the wind that streams through the glass and stone funnel of London's financial district.

This figure – the LIFFE floor trader- is the latest casualty of the ascendance of electronic markets in financial futures. The demise of the pit trader and, before him, the slow erosion of runners, clerks and back office staff, marks a transformation in futures trading technologies from face-to-face auctions that thrived on the controlled chaos of the pits to electronic futures markets that link traders in a neatly networked web of dealing rooms dispersed throughout the world.

In the new on-line trading networks that are replacing the pits, market transactions are played out not in shouts and frenetic gestures but through the boldface type of constantly changing numbers on a graphic user interface. Rather than standing shoulder

to shoulder and back to back, scanning the pit for changes in the market and listening for the pitches of alarm and bravado in the voices of traders as they call out their bids and offers, the electronic trader spends his days sitting uncomfortably in front of a computer terminal, eyes trained on the image inside a glass and plastic box. Leaving behind the intense sensory cues of the pit, traders now receive the most important market information in the form of digital data streams.

Many critics assign transformational potential to the speed, size and distance-smashing *possibilities* of the new information technologies associated with the global spread of financial markets. The amplified pace of transactions, flows of capital and extent of global market interconnection has spurred scholarly observations and analyses of the effects of speed and linkage in capital markets (Comaroff and Comaroff 2000, Hutton and Giddens 2000, Jameson 1997, Appadurai 1996, Harvey 1989). And indeed, these conditions may signal that financial markets now work “in real time on a planetary scale” (Castells 1996).

Yet a focus on movement (Maurer 2000) or networks, leaves unexamined the financial practices that provide the specific forms and directions of contemporary capital circulation.¹ Grappling with the primary changes in economic labor that shape and direct flows of financial capital can help us to recognize the specificities of contemporary financial capitalism. Understanding new information technologies as tools traders use to

¹ Many theories of globalization focus on technological transformation assigning the power of change to technology itself (Postman, Negroponte). Arguing against such technological determinist framings, Claude Fischer has shown for the telephone that information technologies do not have qualities of their own that operate independently of users (Fischer 1992). Speed and transparency do not inhere in technologies themselves. Technologies are always imbricated with the day-to-day practices of users.

construct economic action shifts an analytic focus to the specific arrangements of technology and calculation that produce contemporary capitalist action.

Financial traders, who generate capital flows, perform at the intersection of technological forms, practical market knowledge and techniques of economic action. This paper, an investigation into the constitution of economic actors at the heart of a globally interconnected market, focuses specifically on the intersection of technologies of exchange, numerical representation and calculative practices at two connected sites-- the financial futures trading floor at the Chicago Board of Trade and a proprietary options and futures dealing room in London. I look closely at the conditions for economic assessment and action in the pits and on the screen to examine the transition between technological forms where a new kind of economic actor is emerging and how each assemblage of technologies and techniques provokes specific forms of calculation. Analyzing the informational conditions that shape the practices of financial traders, I ask what forces shape the representation of the market?, and, How do traders use that information to craft calculative practices?

Traders' decision-making strategies engage rationalities embedded in technological design of markets but are not determined by them. Traders' primary material for decision-making is the numbers that make up the bids and offers of the market. In the financial futures markets, the shift from traditional open-outcry technologies to screen-based trading marks a significant shift in the presentation of the bid/ask numbers that traders use to orient their market strategies. This transfiguration of the market requires traders to form new understandings of the numbers they use to make decisions. Each technology of exchange configures the field of calculation by presenting

the primary image of the market. Both open-outcry and electronic technologies create contexts of calculation framed by the rules of trade, the representation of the market, and practical understandings of numerical market information.

The interface of design and practical market knowledge engenders an informational context that generates particular forms of ambiguity traders can exploit for profit. The economic subject of financial markets thrives on the uncertainties of fast-paced transactions and exploits informational ambiguity for profit.

The transformation of futures markets from exchange based in the face-to-face pits to the development and implementation of on-line trading fits neatly into a narrative of modern rationalization. However, while technological design has eliminated specialized local information available only to traders inside the pits, the rationalized electronic markets create new forms of informational ambiguity that traders exploit for profit. Under the conditions of both technologies, traders are informational entrepreneurs who use the particularities of market representation to enact trading decisions. While traders both in the pits and on the screen share entrepreneurial techniques of calculation, their skills located firmly in the particular technology of exchange. The pits and the screen require different techniques for reading the market and different bodily and interpretive engagements. Each technology of exchange conditions and presents particular opportunities for informational innovation.

Whether traders deal contracts face-to-face or on-line, the technology of exchange casts the information traders use in making decisions to buy and sell financial commodities. In molding the representation of the market, technology shapes the process of economic judgment by configuring the informational environment of futures traders.

Both in the pits and on the screen, traders use these technological frames (Goffman 1974) to interpret the actions of the market and make financial predictions. Traders take on financial positions based on the flow of information that they can construct in the interaction between the stream of numbers and the organizing principals of technological design. Technologies of exchange are not simple conduits for market information. The technologies are themselves integral to what a trader can learn form the bids and offers of other market participants. In the technological transformation of futures markets traders must come to novel understandings of information and develop new techniques of calculation.

Both the pit and the screen create a representation of the market based primarily in numbers. But the visual and auditory context that shapes production of rational economic decisions in open-out-cry pits create different opportunities and ambiguities than the visually simplified graphic user interface of a digital exchange. In the transition to from face-to-face markets in the futures industry to electronic technologies, the contrasting representations of market in numbers demands that traders develop 1) *a new orientation to numerical information* and 2) *new strategies for using numbers in calculations*.

Understanding the effect of numbers in the calculations of traders and the importance of technological presentation first requires a shift in the way we think about numbers as an element of knowledge production. Instead of increasing objectivity by hardening information, the fluid numbers of futures markets introduce a fundamental instability and uncertainty into economic calculations.

To examine more closely the consequences of technological change for calculative practices, I ask the question, How do new technologies rework the symbolic representation of the market? And how does the change from a representation of the market in the shouts and gestures of face to face trading to a market visually configured as a set of streaming, printed numbers alter traders' conditions of calculation? In other words, how does each technology open opportunities for profiting from new types of information in numbers?

Methods

To present these contexts and strategies of calculation, I draw on ethnographic work I conducted on the financial trading floor at the Chicago Board of Trade (CBOT) and in the digital dealing room of a London proprietary firm where I traded German T-bond futures on an electronic platform. As a clerk at the CBOT, I worked outside the financial pits acting as the link between traders and outside market participants. I observed trading while the pits were open, conducted formal interviews with traders during slow periods in the market, and reviewed the triumphs and defeats of the trading day over drinks at the bar after work. In the electronic dealing room that hovered over the defunct trading floor of the London International Financial Futures Exchange, I spent nine hours a day fixated on my screen, fingers laying lightly on my mouse poised to click the second I identified an opportunity for profit. In addition to trading, I interviewed my co-workers in this 65 person dealing room during slow-paced markets and joined them at the pub after work to review their trading days. To supplement my work and observations in the arenas of exchange, I interviewed officials at the exchanges and technology companies and attended meetings on the reorganization of the industry.

Questions about the transformation of economic rationality did not become visible to me from within the electronically savvy London Dealing Room (LDR). They surfaced in the context of the face-to-face trading floor. Until last year, the CBOT was the world's largest futures exchange. Today, the all-electronic, German-based Eurex exchange has claimed this title. Recognizing the impact of digital exchanges on the organization of futures markets, the CBOT headed off a threat to its monopoly hold on the flagship 30-year T-bond contract. In 1998 the CBOT entered into a strategic alliance with the Eurex, the all-electronic German-Swiss exchange that was eroding its dominance in global trading volumes. In August 2000, the Chicago Board of Trade and the Eurex launched their common electronic trading system. Through the a/c/e platform members of either exchange can trade American and German Treasury bond contracts on a single screen.

This alliance and common trading platform marks a decisive shift for the Board of Trade. Still clinging to the traditional trading methods of the open-outcry system, the CBOT is belatedly coming to grips with the ascendance of on-line trading that has shut down trading floors in London and Paris.

During my fieldwork at the CBOT in 1998, the floor was filled with anxiety about the coming dominance of electronic trading. The traders expressed concern that the cool calculation of the screen² would stifle the market by ridding trading of the emotional environment and the deep affinities of family, ethnicity and friendship that power exchange in the pits. They worried that trading would wither without these factors that compelled traders to jump into the market. In this contest over the forms of exchange,

² The professionalized setting of the trading floor produces a discourse about the rationalizing possibilities of electronic trading. In contrast, the media discourse focuses on how the Internet enables the follies of day traders in the stock markets.

floor traders expressed in negative terms what proponents of electronic markets extended as positive—that electronic technology would rationalize the pits out of existence.

Rationalities of Numerical Information

According to classical social thinkers such as Weber and Simmel, floor traders have reason for concern. Electronic trading brings together two of the most powerful forces of rationalization, money and numbers, with computer technology. Following the logic of rationalization, the printed numbers allow equal access to unambiguous data powered by efficient delivery systems. By increasing and democratizing information, the floor traders worry, the kind of decision-making processes that worked in the socially mediated environment the pits would be outmoded. The future sources of information and techniques for trading lay in the realm of digital information technology. The simple representation of a market in numbers would provide freely available and transparent information.

The discursive struggle between the old and new technologies is not simply a description of traders' anxieties about the destruction of a way of life and labor based on the Chicago pits. Disagreements about the effectiveness of technologies of exchange are arguments over both the structure and operation of the market and the norms of economic calculation. Discursive struggles over new technologies are struggles over the constitution of new economic actors and calculative subjects. Arguments about the power of technological framing of calculation and the efficacy of market technologies are part of the discursive struggle over the institutional norms of global financial markets.

The seeming inevitability that electronic trading will come to dominate the market draws on ideal of speed, efficiency and the uncontested desirability of global

interconnection. The vision of ideal markets also contains an idea of the appropriate form of market information according to these rationalized standards. In the struggle between open-outcry and digital technologies the competing parties agree on the ideal of freely available, self-explanatory information. The unquestionable good of deepening what I will call “informational transparency” is a foundational idea for the rationalization of competitive, electronic markets. Informational transparency and the democratic ideal of markets are the basic conditions of agreement that make the argument possible.

Echoing the neoliberal linkage of economic logic and democracy, traders agree that by moving toward screen-based technologies that “gimps,” “dweebs,” and women will be able to enter as full participants in the market. The discursive strength of the connection between electronic markets and rationalization relies on the trope of equal *access* to information and rests on the assumption that information itself is non-interpretive. The designer of the Eurex Graphic User Interface championed the connection of technological rationalization and democratizing information. “The truth comes out in the electronic world. There are no physical crutches required.” All you need to trade is a set of eyes and a finger to click.

The idea of informational transparency both draws on and provides justification for economic descriptions of the role of information in financial markets (Callon 1998.) This elision of normative form and descriptive content establishes a kind of feedback loop between the practice of the financial industry and the logic of Economics (MacKenzie 2000). The economists’ imposition of “the things of logic” on “the logic of things” (Marx in Bourdieu 1989) is itself an actor in the construction of financial markets.

In the field of economics, Efficient Markets Hypothesis (Malkiel 191, Henwood) and the associated Random Walk Theory display the ideals of informational transparency most clearly. Market efficiency is the idea that players in securities markets will quickly integrate new information into the price of a financial product. Under the conditions of efficiency, markets are unpredictable because all available information is immediately reflected in the price of stock, bond, or derivative.

This theory rests on a particular conception of the gathering and processing of information-- every person who receives the same piece of information will react to it in a uniform manner. Accounting for irrationalities in the market according to the logic of EMH, Fischer Black contrasts proper and improper interpretations of market information. In his article, Black has focuses on “noise” in the market—people buying or selling on improper analysis, misinformation, or gut-feeling. “Noise is what makes our observations imperfect” (Black in Bernstein 1992, 124). Rather than the object of observation being always uncertain and approximate, this logic posits a stationary, knowable market object. In this theory, market actors produce bad information and are susceptible to its charms. If information conformed to the ideals of transparency observations would be perfect, obvious and would yield rational action. The logical conclusion of Black’s argument is that distorted information causes economic actors deviate from the norms of rational calculation.

As economist Eugene Fama has noted, EMH has two untenable assumptions about how traders and investors receive and act on new market data : 1) “information is disseminated equally among all market participants”; and 2) “all participants hold similar interpretations of that information” (Fama summarized in Henwood, 164).

As Fama suggests these assumptions do not hold up empirically. And indeed, since every buyer requires a seller to complete a transaction, there would be no market if every actor interpreted information in the same way. Many economists have moved beyond EMH and returned to the search for predictable patterns in financial markets (Jacobs and Levy 1989) or, like Richard Thaler, have created work on the irrationalities in markets according to the norms of the field of economics. However, the formal goals of informational transparency maintain common sense currency among those designing new markets and training new traders.

As Michel Callon has observed, the logic of economics has concrete effects on the production of markets as institutions (Callon 1998). Ex-floor traders and business school trained exchange managers design trading technologies and prepare new recruits within the framework of these expectations and formal ideals. In his training class, Joshua Geller, a graduate of the University of Chicago Business School and manager at LDR responsible for training new traders combines Fisher Black's understanding of information of the market with a perspective on trading psychology drawn from his years of trading experience. "Human beings cause noise around the move." Prices moving "causes us to act in certain ways. The pile on effect creates noise in the prices."

The particular configurations of informational transparency both draw on and provide justification for economic descriptions of the role of information in markets and work as discursive guideposts for market rationalization along these lines.

However, rather than establishing informational certainty, the technological designs for creating transparency maintain particular forms of *ambiguity* located in the interaction between the presentation of market data and the technology of exchange.

These uncertainties inspire different interpretations and establish the possibility for profit. Examining the information available through the technology exposes more than the quantitative description of the market alone allows.

The representation of the market as a set of numbers is critical to the production of informational transparency. Yet, neither the trader's theories of rationalization nor scholarly theories of numbers and quantitative representation are sufficient to provide an adequate interpretation of the power of numbers to represent the market in financial futures.

From hard to fluid numbers

From the invention of numbers-based accounting practices such as double-entry book keeping, numbers have been a cornerstone of economic rationality, providing the essential tools for rationalized calculations. These "firm" numbers that scholars have pointed to as a foundation for accounting and scientific knowledge contrast in character from the fluid numbers of the pit and screen.

In a discussion of 19th century credit rating, Bruce Carruthers describes how numbers acquire the status of definitive statements, as "firming up." Such solid numbers are, in their ideal form, stable in time and interpretation and add to a transparent presentation of knowledge. The firm numbers that Carruthers and others analyze work in service to accountability, objectivity and as tools of standardization and commensuration. As such scholars as Ted Porter, Michael Power and Mary Poovey have shown for the sciences of wealth and nature, such numbers act to: 1) establish expertise and authority; 2) make knowledge impersonal, 3) portray certainty and universality, and 4) contribute to resolving situations of doubt, conflict and mistrust. To use Poovey's phrase, numbers

perform ideally as representations of “non-interpretive facts.” As stable objects, numerical units resist conjecture or theory and serve in the production of systematic knowledge.

In contrast, the most abundant numbers in futures markets are momentary markers of valuation. Bids and offers, which represent the “needs and expectations of hedgers and speculators” (CBOT 1997)³, are not established facts. Rather they are temporary assessments of market conditions.

Bid and offer numbers surge into the market and fade away in instants. The tempo of the market speeds and slows as the number of contracts on bid or offer increases or diminishes and one set of possible trades slides into the next price level. The trader will not always “get ‘em,” or be able to turn their evaluation into a real position. Or he⁴ may withdraw his bids and offers as time changes market conditions. Not all bids and offers become firm prices; they are rather representations of a time-bound willingness to buy or sell contracts based. Bids and offers become prices only through an exchange of contracts with another trader.

The primary feature of numbers both in the pits and on traders’ screens is *instability*. Because the numbers presented at the market as bids and offers are constantly changing, the traders must develop styles of calculation that do not require “firm” numbers. Traders enter bids and offers under conditions of informational uncertainty.

³ Bids and offers theoretically represent the totality of supply and demand for a product in a given moment. Market participants must be able to see all the bids and offers in the market to evaluate market conditions accurately.

⁴ I use the masculine pronoun throughout for gender realism. At the time of my research, the CBOT’s largest pit held 600 traders, two of whom were women. At LDR there were three women out of 65 traders.

What traders know about numbers

These goals of transparency and the “non-interpretive” character of numbers create the conditions for the particularities of calculative practices located in each technology. Numbers in this context are more than a technology of recording. Between the intentions of the designer and decision to buy and sell futures contracts lies what traders “know” about numbers.

Traders learn contradictory interpretations of the role of numbers in the market. The first thing they learn is that *numbers tell very little*. While the full number of a bond futures price is five digits long, traders use only the last one or sometimes two digits, playing the differences between fractions of a point in the price of a bond. Numbers, in this sense, are placeholders in a sequence leading from 1-9. Once a price passes the 0 level, traders refer to their bids and offers as 1’s or 9’s again without specifying the larger change. The number is only a symbol in a sequence that could be any other sequential set.

For short-term traders, larger numbers do not indicate potential for profits. Rather than always “going long” or buying contracts anticipating that the price will rise, futures traders play both the short and long sides of intra-day volatility. Traders have the opportunity for profit as prices ascend and descend the scale.

Traders know that numbers stand on their own without reference to events outside the immediate bids and offers. Outside events such as rate cuts, election news economic reports or the intervention of a large buyer can storm the market unexpectedly. The immediacy of the market dictates that attention remains on the bid/ask figures that represent the position of the market at that second. Outside news is supplemental to the information available in the bid/ask numbers. A surprise government intervention that

occurred during my time at LDR shows the attenuated connection between trading in second-by-second markets and the fundamentals of their underlying assets.

On Nov. 3 2000, the LDR dealing room was a relatively calm. The market was steadily ticking up and down. There were whoops from behind the computer terminals as routine patterns snapped and the market for all European products spiked upwards.

Traders who had taken the long side of the market that morning rode the move upward and those with short positions cursed as the market pummeled their bearish expectations and forced them to take losses. The market move took only thirty or so seconds but reversed the downward trend in bond prices denominated in the ailing European currency that had dropped toward .80 to the US dollar. Once the move was over and the traders had regained their composure, they leaned toward their neighbors asking each other what had caused that move. The first trader to lift himself from his seat and find a terminal with a Reuters wire, scrolled down the screen until a headline appeared on the electronic tickertape that read, "C-bank intervenes in Euro." The traders started buzzing about how *Citibank* had intervened in the Euro until an older trader pointed out, non-chalantly, that "c" bank meant central bank. To these traders who deal in a time frame of seconds, it is immaterial if it is Citibank or the European Central Bank that takes action, the market prints the result before the news comes through the news wires. Knowing the cause is more important for satiating an ex post facto curiosity than for organizing market action. The news wire confirms the reason but doesn't cause the reaction or lead it. The screen holds all of the necessary information for these second-by-second traders.

The instability and ambiguity of numbers in futures markets can sometimes catch unaware even those responsible for overseeing traders' financial exposure. Andrew

McGregor, the global risk manager for LDR, and Adam Berger, the head of trading operations, were sitting at Andrew's computer in London watching one of their traders in New York struggled to get out of a trade in the 2 yr German contract know as the Schaz. The trader couldn't shed his position because the weight of the market was heavily in the offer. He was poised to lose a lot of money if the market fell. Andrew and Adam deliberated on how to advise the New York trader who was stuck "the wrong way round." The company's other traders, seeing the offer building had all sold contracts and were waiting for the market to begin its downward chute when one large buyer came into the market and lifted every offer from 101.76 to 102.00. Andrew wrote to me:

The Schaz had traded very quickly and it was only 3 P&L [profit and loss] alerts that disturbed us. All the traders had been caught short and reacted once the market started moving by buying any offer they could. But there was a massive loss showing in the P&L. It was only when we looked closely at the Big Figure that [we saw that] 3 of our traders who all thought that they had paid a 78 offer suddenly realized that they had paid the offer at 108.78 not 101.78. This was slightly disturbing because if the trades stood then we were as a firm in a lot of trouble.

Luckily for LDR, Andrew was able to take advantage of a Eurex rule that allows firms to annul trades with jumps over 8 ticks in price. Andrew and Adam and the traders they supervise were slow to understand the gravity of the loss because their own assessments of the trades were based on only the last two numbers of the price as is normal practice. Even Andrew, with 20 years experience in spot currency and futures markets, had to look closely to understand the explosion of the loss figure in the company's accounts.

Contrary to numbers as inexact objects, traders also learn that numbers have particular personalities and concrete effects on the human mind. In technical analysis, the practice of predicting future market movements by examining historical trading patterns, individual numbers gain strength or weakness, optimism or negative potential,

as points of support and resistance to the overall trend of the market. Numbers that halt a decline in the market are support levels and numbers that “turn back a price advance” are resistance. According to the book known as the bible of chartists, *Technical Analysis of the Financial Markets* by John Murphy, large round numbers are particularly important for technical analysts because “traders tend to think in terms of important round numbers, such as 10, 20, 25, 50, 75, 100 (and multiples of 1,000), as price objectives and act accordingly” (Murphy 1999, 64). Traders invest these numbers with both their own psychological significance and the expectation that these numbers are significant to other traders.⁵

Numbers develop greater solidity as support or resistance as more traders invest in a particular price area. According to the Murphy, “The more trading that takes place in that support area, the more significant it becomes because more participants have a vested interest in the area” (Murphy 1999, 60). If the market seems about to fall, market begins to feel “heavy” to pit traders as the offers building up in around a price. On the screen, traders see the heavy or lightness of a number can in the depth of bids or offers around a price.

The larger the number of offers the greater the expectation that the market will begin to decline in price. Heavy numbers create an informational gravity attracting other traders to the price. For short-term traders the perceived judgments of other market participants contained in the bid/ask hold an opportunity for making money. As critics of technical analysis point out, this continuous evaluation of others’ perceptions of the

⁵ The logic of anticipating the significance of a number for other traders in the market creates a self-fulfilling prophecy in price action.

weight of the bid/ask creates a self-fulfilling effect that validates the circular judgment of traders in relation to the numbers they trade.

Because of the multivalent character of numbers in futures markets, traders use technological frames to ground their calculations. Numerical information and technological presentation are integrally bound. To create an interpretation of uncertain numbers, traders mine the crevices of the technology for context that will tell more about the numbers than they represent on their own. The technology of exchange provides new opportunities for interpretive information. As the pits give way to dealing rooms filled with the glow and hum of computer terminals, how do traders' tactics change for delivery and reading unstable numbers?

Constructing Information with Pit Technologies

Standing on the financial trading floor of the CBOT, noise and color swamp the senses. A roar from inside the raised octagonal pits follows the electronic screech of the opening bell. Some individual voices can be heard above the din shouting 50 at 3, or 2 for 100, indicating with prepositions and the sequence of the quantity and price if they are selling "at" a price or paying "for" it. Each call indicates how many contracts the individual trader is willing to buy or sell at their price.

These shouts—which represent the key technology of the open outcry system—are the main mechanism for conveying bids and offers to the pit. Every bid or offer is legally required to be shouted to the competitive market. In these human techniques of exchange, shouts are most often accompanied by hand signals, the hands turned toward the body palms possessively pulling inward to show a desire to buy and hands thrust forward, palms out, to sell. Numbers from 1 to 5 are shown predictably with the fingers

on each hand extended upward and turned side-ways to show 6-9. Zero is indicated with a closed fist.

In a simple transaction, a trader makes an agreement with another trader by meeting his eye in response to a bid or offer. The selling partner in the operation yells, “Sold.” The two jot down the price, quantity and three-letter code of their trading partner on a paper card, and each trader hands it over to his clerk who will hunt down his counterpart and confirm that each party agrees that the trade took place.

By design and by regulation, all trades must enter into the space of competitive bidding and offering. Rules 332.01A and 332.00 of the CBOT handbook state that:

Bidding and offering practices on the Floor of the Exchange must at all times be conducive to competitive execution of orders... All orders received by any member of this Association, firm or corporation, doing business on Change, to buy or sell for future delivery any of the commodities dealt in upon the floor of the Exchange must be executed competitively by open outcry in the open market in the Exchange Hall during the hours of regular trading (CBOT 1993).

The transparency of the market is located in these shouted quotations. Any trades that happen outside of this arena, either outside of trading time or in the whispers of trading neighbors, are therefore illegal. Each bid and offer in the market must be outwardly presented for all participants to see and hear.

In describing some of the foundational ideas of his theory of habitus, Pierre Bourdieu uses the metaphor of sport. Rules, in his description are, “a set of objective regularities imposed on all who wish to join the game” (Bourdieu, In other words, 60). The interplay he describes between the rules and players’ inventive strategies describes the “feel for the game” that operates in a literal sense for the development of traders’ calculative habitus.

Physicality of market numbers

Physical strategies for delivering and receiving bids and offers in the pits are part of the economic rationality of traders as conditioned by the technology of exchange. Yet, despite the technological possibility of transparency, the physical abilities of the pit trader mediate the openness of the market. The numbers of the pits are part of the auditory, emotional, physical, and visual immersion in the market. Both delivering and receiving the bids and offers of the pits is a full bodily experience. The pit requires stamina and strength. While there is only one ex-Chicago Bears player on the floor, many traders compete in height and width for his physical presence. Those who don't have the natural stature of a professional athlete can visit the cobbler in the basement of the CBOT who will add lifts to their shoes. Traders from the CBOT and the nearby Chicago Mercantile Exchange can be identified walking the streets of the western Loop not only by the loud oranges, blues, reds and yellows of their trading coats, but also by the extra inches of black foam affixed to the soles of their shoes.

In a pit filled to bursting with 600 screaming traders arms slashing the air, strategies for penetrating the physical strains of the arena are crucial to a trader's calculative repertoire. Delivering bids and offers into the market requires acquiring the physical techniques (Mauss 1935) for transmitting and receiving market information conditioned by the pit. Leo, a trader whose voice is hoarse and scratched from 20 years of use in CBOT markets, describes training himself for the vocal and emotional demands of open-outcry trading, "When I first got in the business, I had to go in front of a full length mirror every night and practice screaming, looking at myself."

Where traders stand can limit or expand their access to other traders bids and offers. Because of the physical and emotional information conveyed with numbers, not all bids and offers are fully equal. Traders may have difficulty or particular ease being seen or heard when they deliver their bids and offers to market. They may have obstructed sightlines providing them access to only what lies between visual obstacles or clear angles of vision enabling transactions with a large area of the trading arena. Every bid or offer that pit traders engage in the day-to-day operation of exchange is received through the voice and bulk of another trader. The information of these numbers cannot be divorced from the bodies through which they are conveyed and received. The tone of the voice shouting, the body language of the trader who may be steadily and confidently holding his hands forward in engagement with the market, or who may be yelling his bids, spittle flying and eyes wide in desperation to get out of a trade are crucial inflections that traders draw on to form market judgments.

The intricacy of physical strategy in the pit becomes particularly clear when smaller traders must compensate for their undersized stature by manipulating the resources they have to get the attention of potential trading partners. It is not enough to be on the right side of the market, each trader needs to attract the others' attentions—to have another trader *receive* the numbers they shout into the market. Victor, an ambitious young broker, physically short and narrow, describes how he creates a presence in pit that will attract attention to his bids and offers.

Voice is number one... You have to be a controlled loud. You can't be like a panic loud because once the panic comes out of your mouth you're pretty much admitting to whoever wants to assume the other side of the trade with you that that's not a good trade... Tones of your voice are very important. A lot of guys have higher voices... and they can really be heard through out the pit... A lot of it is hand gestures, being able to kind of like offer your hands out at just the right pace to catch people's attention...

Sometimes it's jumping up. People watch me sometimes when I start to catch air and they go, hey, there's Victor, you know, bidding them.

In addition to orchestrating the presentation of bids and offers, timing the delivery is key. Victor describes how he attracted the attention of one of the “big dog” traders,

Just at the right time, I mean literally it was within a second, a split second—I literally caught a little pause in his offer where he was just kind of looking in all directions, I just happened to jump and bid and scream at him at literally— I mean I'm not even going to say tenths of a second—I'm going to say hundredths... If I didn't jump and jump a foot and a half off the ground and bid fours at that guy just as I did and the way I did it, he wouldn't have seen me.

The embodiment of market numbers in voice forces the traders cope with their immateriality. A number is rarely shouted once. Because each bid or offer hangs for only a second in the air, the trader barks the number into the pit repeatedly to make sure he is identified with it. At the same time the trader holds out his hands extended into numerical signals to bring a concrete visual presence to his bid or offer. The sounds of repeated numbers form the cadence of the market that can convey urgency or boredom.

In receiving the numbers that others bring to the market, traders appeal to most *feeling*. This word that encompasses all sensory information is the one traders use to characterize their knowledge of the market. The body of the trader is his key calculative instrument. Listening to rhythms of the numbers as they run in the pits brings on a sensation that leads traders to judge the market heavy or light, likely to rise or fall according to their sensory estimations. Beyond creating the basis for individual traders' economic judgments, the ambient noise of the pit affects the market as a whole.

Economists studying the noise levels of the CBOT pits have found that increased sound levels lead to higher trading volumes and foreshadow periods of high volatility in the pits

(Coval and Shumway 1998). But just as numbers cannot be divorced from the bodies that deliver them, noise around cannot be divorced from the numerical content that it conveys. Traders monitor the changing bids and offers of the pits receiving them into their bodies through their eyes and ears.

Numbers, in the dense arena of exchange, produce emotional states in the traders that are integral parts of their predictions. They see explicit calculation as a hindrance to their business and their ability to react. In training their bodies both as receiving and delivery instruments of the underlying information of market numbers, the first step is learning *not* to calculate.

Sean, a lawyer by training and a second-generation member of one of the CBOT trading families, assessed the effects of his legal education on his trading practice:

I am prone to get set in my ways. I'll reason to a particular conclusion based on assumptions that I've got built into the market... Just like I'd craft an argument. I'm crafting a plan and then all of the sudden my plan is this and boy the market had better listen.

Which of course, it never does. Sean's deliberative skills lead him to conclusions that may be theoretically correct according to the system he's established. In formulating arguments, he loses the ability to play on the indeterminacy of market movements. Explicit construction of logical systems inhibits his ability to adapt his positions to rapidly changing market conditions. Sean identifies the premium on interpretive agility in financial markets by using his calculative rigidity as a foil. Constructing elaborated systems can hinder a trader's ability to quickly adapt to swerving bids and offers. Focusing on actively formulating ideas takes the trader away from the market.

Leo—“In the commodity [futures] business, if you spend too much time thinking it’s a disadvantage. You do the thinking away from the market... If you start thinking too much during the course of the day when the battle is on, it is really a disadvantage.”

Jack-- “It’s just like you’re in there and you know—like sometimes you just don’t want to be buying or you don’t want to be selling. I presume like you could figure out after trading off the floor for a long time and really watching things and charting—but nothing like knowing—nothing like standing there and having that feeling.”

The immediacy of the market requires that traders have an interpretation of every present moment, a skill located in the senses as much as in the mind. The importance of sensory cues in both delivering and receiving numerical information in the pit makes use of all a traders’ wits and physical skill.

Eyes on the Screen

In contrast to the overpowering sensory information of numbers in the pits, screen-based technologies actually narrow the scope of information available to traders. Rather than expanding the sources of information available to traders, as information technology enthusiasts would predict, the visual representation of the market on the screen restricts the informational sources for electronic traders. The screen confines the market to a set of visual cues.

The graphic user interface (GUI) of the electronic trading system is the point of contact between traders and the market beyond their individual terminal. The GUI connects the each trader’s decisions and the technical operations of trade matching and accounting. The GUI places point-and-click technology at the center of the trading technology.

In the all-electronic German futures markets, the bids and offers for 10-yr, 5-yr, or 2-yr German Treasury bond futures print in bold black numbers on the traders’ screens.

Acknowledging the weak information available through the GUI, the managers of LDR bought a program called Market Sound to enhance the visual data of the screen. This software replicates the aural dimensions of the pit by recreating ambient noise levels linked to the size of bids and offers in the market. A trader hooks into the program by plugging an earpiece into the speakers on his computer. Yet, despite this software that exists to supplement the thin information of the screen, hardly any of the traders used it. The algorithm that replicates the noise of open-outcry trading recreates only a sliver of the total body experience of the pits. Despite the demonstrating effects of noise on trading activity in the pits, without the deeper context of interaction, the noise of Market Sound is more distracting to the traders than it is illuminating.

The second-by-second immediacy of the futures markets focuses their energies directly on the screen and on the numbers that appear and disappear from sight. The limited representation of the market as a set of changing numbers on the screen remains the primary source of information for traders in electronic markets.

The crystallization of the market in numbers is embedded in the design of the E-trader GUI. Alan Lind, the designer of E-trader, intentionally framed a numerical and visual representation of the market⁶. Fulfilling his role as a pragmatic technician (Rabinow 1995) of economic rationality, Lind's design cleaves to the dictates of transparency. The GUI design presents all market action and information as available in plain sight, introducing the closest to a "non-interpretive" format as possible to market

⁶ The GUI that trader's use at LDR is not the only GUI available. Members of Eurex have access to the exchange's stock GUI, a screen device that is also numerically based but visually more rigid than the E-trader model. Earlier GUI's, like those for the now defunct CBOT Project A trading system tried to replicate the face-to-face environment of the pit by associating names and personal trade histories with each exchange. The precursor to the Eurex exchange, the DTB, never operated with a pit system. Their electronic markets have always relied strictly on numbers.

action. Rather than creating a platform for consolidating all the information available, the transparency enacted in the GUI design pares market data down to the barest minimum. Alan Lind's central concern was to use the design to reduce the distance between the trader and the market. For him this meant assembling the simplest visual cues to represent market action. The result is a GUI that traders can manipulate to display any of the products on the Eurex exchange. The outward simplicity of the Graphic User Interface illustrates well its numerically rationalized representation of the market.

Organizing the markets in vertical or horizontal planes aligns visual representation of the market with easy calculation for that trader. The bids and offers for these products and the "depth" of the market—how many and the price levels of bids and offers—are shown in black lettering. The design crystallizes an organized simplicity that displayed the ideals of informational transparency.

This spare visual depiction displays a commitment to reducing the intermediation between trader and market. Designing according the principals of transparency is a commitment to represent the market in the most simple and unadorned way—through plain numerical representation. The use of numbers, as techniques of transparency, draws the trader toward a distilled idea of the market where disembodied actors display supply and demand for futures.

This attempt at suturing traders into the market by reducing the interface to bare bones, numerical representation, shapes the informational environment of traders by elevating numbers to the status of the market itself. Numbers gain a synecdochial power in their relationship to the market. The numbers that represent the bids and offers are

supposed to speak for themselves raising all hidden information to the surface of the GUI and delivering the total of market information into the bid and offer numbers. Rather than the complex information system in the pit where fathers and sons, friends and allies passed information through tightly controlled networks, the screen displays the market in simple terms available to the eyes of any trader with access to the screen. In addition to facilitating social and physical distance between actors (Porter 1995) bound into a global network of exchange, numbers are in this sense a technology of proximity drawing traders *toward* the market. This numerical technology casts aside the intermediation of the social connection of the pits in favor of an ideal of “pure” information based in a representation of the market in numbers.

Alan Lind brought traders into direct contact with market information through the numbers of his GUI. His plan was to “strip down the chassis” of the exchange technology.

Alan Lind-- They don't care about German economic status or European economic status. What they're looking at typically are numbers. They're trading numbers, using numbers to make decisions all day long. I would say that --- it's like a motor racing driver that doesn't look at the scenery as he's doing two hundred miles an hour going down the track. He's looking at the hazy outline of the road. He's looking at the numbers on his dial. That's it. He's focused.”

In terms of organization there are plenty of intermediaries between the traders. The mechanisms of exchange are located in the clearing firm, the material technology itself, the CBOT and Eurex and their programs for completing trades. However, in the technological framing of E-trader, they become virtually invisible (Brown and Duguid 2000) producing an experience of direct connection between the trader and the market. Alan Lind links traders into the power of the market as a mechanism of exchange while

side stepping the inevitable social and institutional embeddedness of markets⁷ by creating the representation in numbers. He created an informational environment focused solely on printed numbers and that reduces skill to the techniques of reacting more quickly than others. The profit-making skills in a situation of informational transparency is speed.

The technology of E-trader holds the informational frame steady while it delivers the constantly changing bids and offers to the trader's eyes held inches from his screen.

Using this data as fodder for calculation, the trader can leap into the market with a click of his mouse. By creating the direct representation of the market, he eliminates not only institutional intermediaries, but intervening tools of evaluation as well.

Alan Lind-- [I want to communicate] ultra fast prices. In other words, I want to show you the real market quicker than anyone else so that you can make the decision to trade. I'm not going to give you analytics, fancy recommendations because my recommendations may need some explanation or they may need to be mathematically complex... The Spartan approach with technology today is still the best one. Keep it down to the absolute minimum; get rid of the stuff you don't ever look at... Only observe the market that you want to.

In E-trader, Lind brought market transparency to the center of economic calculation by creating a system of information delivery that provides only the austere data of bids and offers. Where the interplay between rules and strategies in the pits is located between the rules of exchange and the practice of trading, on the screen the configuration of visual information sets the context that the traders use for producing practical knowledge about the market. Design creates the conditions for practical knowledge of the market. Creates the conditions for calculation and action.

⁷ The term "disintermediation" came into vogue in the 1980's as a way of describing the development of new instruments, such mortgage-backed assets, that allowed companies to borrow directly from the market rather than going through a commercial lender. The techniques of disintermediation removed institutional linkages and drew companies to the "core" processes of the market. The same rationality is operative in the logic of reducing the market representation to numbers.

While honing the market to a few printed numbers, Alex Lamb also opens the possibility of interpretation based on the very simplicity of representation enabled by the GUI technology.

Traders learn to look for key players that hide in the rhythms and the sizes of the changing bids and offers. These imagined characters are ideal types that describe other traders relationship to taking risks. The most persistent of these characters is called the “spoofer.” The spoofer is a someone (although in reality he could be many people or no one at all) who uses large quantities of bids or offers to create the illusion that there is more demand to buy or pressure to sell than the “true” bids and offers represent. The spoofer manipulates the weight of the numbers to force the market to go in his favor. Being able to identify a spoofer by watching changes in the aggregate number of bids or offers on the screen holds an opportunity for profit. By riding the tail of a spoofer, a small trader can make money on market direction. Traders who deal in large contract sizes aspire to “take out” the spoofer by calling his bluff, selling into his “false” bid and waiting for him to balk. There is great symbolic capital attached to “taking out” a spoofer by matching wits with this high-risk player.

While the surface of the interface reduces the market to a set of visual cues, traders use the rhythms of the market to understand more about the bids and offers than the numbers show alone.

Conclusion: Uncertain Numbers

An economic rationality based in numerical calculation produces the expectation of full information conveyed in a non-interpretive manner in both electronic and open outcry trading. The fluidity of numbers changes their status as calculative objects. The

bids and offers of the CBOT and Eurex destabilize the firmness of quantitative representation. They promote a style of calculation based in ambiguities created by the technology itself rather than rooted in the certainty of numerical information.

Each trading platform locates the techniques of exchange that frame traders' calculations in specific procedures of exchange. While both open-outcry and screen-based markets are presented in numbers, traders must learn to treat numbers as "soft" calculative objects rather than ones that contain definite information. By rethinking assumptions about the place of numbers in economic calculation is it possible to understand the specific changes that new technologies bring to the decision-making practices of financial traders. The technological designs of electronic trading platforms demand a new information gathering and evaluating processes. Yet these techniques of calculation are not wholly new. They emerge from the competitive advantages that traders have always drawn from the "soft" information in the interaction between numerical information and technology.

Futures traders depart from an actuarial logic that depends on firm numbers. Their calculations thrive on informational ambiguity. Even within the numerically based world of futures trading where decisions are yoked to assessments of numerical changes, calculation is not based in probabilistic assessments of risk and opportunity. Rather traders search for clues to market direction that are technologically enmeshed with market numbers.

Futures traders are informational entrepreneurs⁸ whose calculative field is shaped and contained by technological design. Traders in the pits and on the screen both maintain a flexible style of reasoning in relation to numbers. Yet each technology

⁸ This follows Pat O'Malley's description of the "uncertain subjects" of neoliberalism (O'Malley 2000.)

demands different skills to achieve interpretive competence. How traders develop market strategies lies in the tension between numbers and the technology of exchange that brings them to market.

Numbers in the context of futures markets demand an interpretive flexibility from traders. The interpenetration of technology and quantitative representation demands constant renegotiation and analysis of the market. Yet rather than creating a problem of incomplete information for a normatively driven idea of rationality, this informational uncertainty holds the opportunity for profit.

Traders' skills to read and interpret market information must adapt as technologies change the representation of the market. The transition from pit to electronic trading places traders in a new informational matrix. An assemblage of visually-based market representations, individuated practices of exchange, and globally dispersed institutional forms constitutes traders as particular kinds of calculative actors. The complex technological dimensions of gathering information within the context of electronic media require subjects who can read into the gaps created by the limited visual cues of the graphic user interface.

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