Information's Metropolis

Chicago and the New Nature of Global Finance

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Text accompanying the book by Geissler & Sann, *Volatile Smile*

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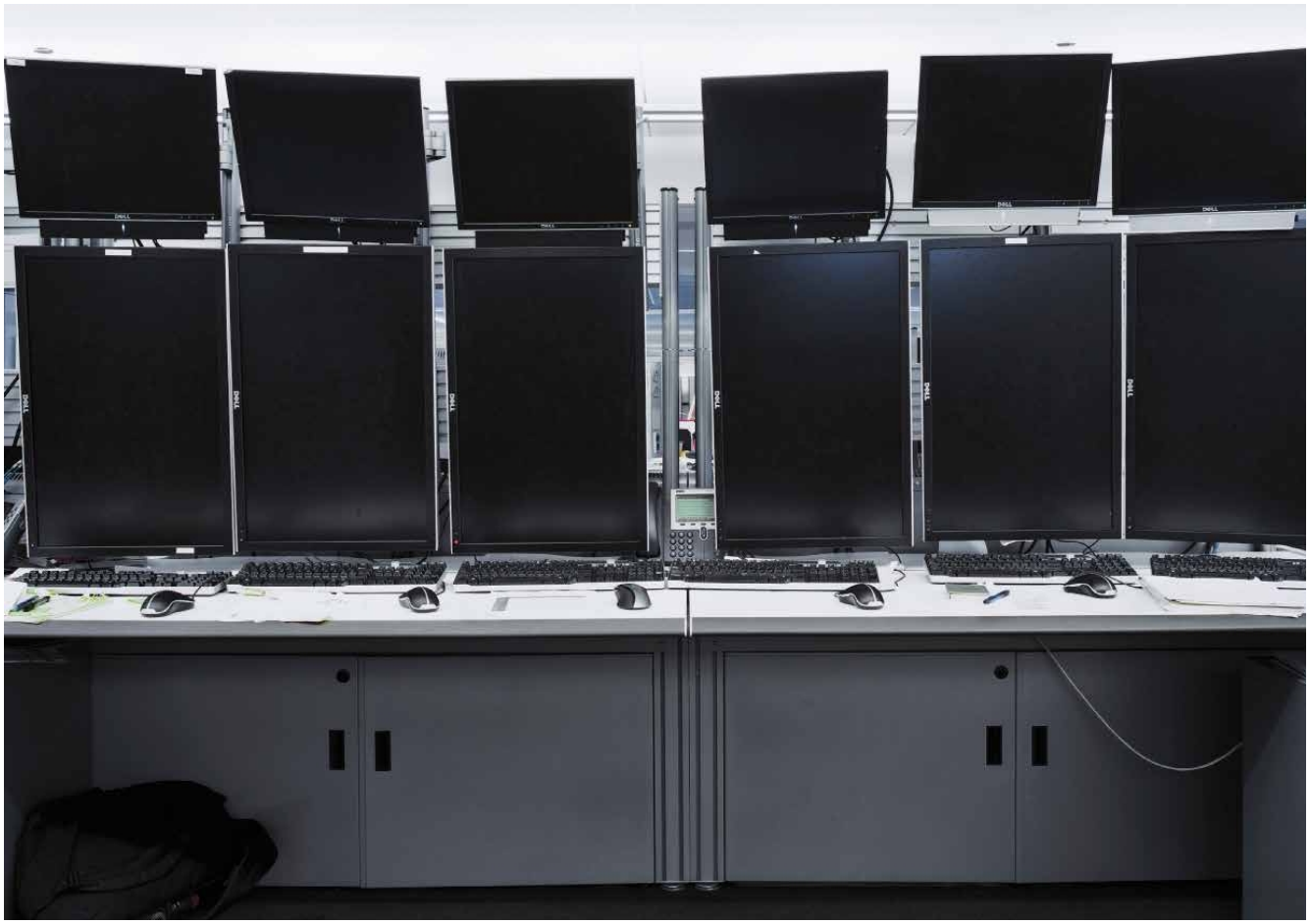

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High above the city stands a faceless deity: Ceres, the goddess of grain and gain. She's the artistic symbol of a venerable financial institution, the Chicago Board of Trade, which merged just a few years ago into the world's largest computerized futures exchange, the CME Group. Created in the late 1920s and inaugurated less than a year after the Wall Street crash of '29, the futuristic goddess is cast in aluminum, with stylized Art Deco lines that echo the powerful fluted columns of the building. She has no eyes, so it's impossible to locate her gaze. Some would say she is blind, like Justice. But perhaps in reality she looks everywhere at once, through a multitude of electronic instruments, processing data about runaway global growth and endless harvests of fresh green money. Could her invisible gaze be the perfect metaphor for the institution she represents?

It is time to take on this inhuman vision, in all its abstraction and ubiquity. If we could look through the walls of the exchanges, if we could see past the bewildering screens, if we could feel the very pulse of the fiber-optic cables, then maybe we could make some sense of the changes that have radiated outwards from the great financial centers, transforming the nature of our societies.

In this book, the artists Geissler & Sann have used the camera's eye to assemble a portrait of Chicago. It shows extremes that never meet, the opposing sides of financialization's enigmatic coin. On one side – let's call it tails – you will find the interiors of foreclosed homes, voided of their occupants and turned over to a highly uncertain market. These spaces run the gamut from the crisply resurfaced housing commodity to the abjectly decayed ruin, with ample traces of lived experience, poignant memory and human tragedy in between. We see the stains of inhabitation on the walls, an adolescent's magazine clippings tacked up in a corner, a TV cable snaking in from outside, a bedroom inexplicably filled with used tires. Many of these dwellings have been rented or sold by now, others squatted, others destroyed. Today the entire real-estate crisis is fading into the background, on the edge of oblivion.

Now let's flip the coin. What the other set of images shows are the desks of high-speed traders, with their keyboards and cables and personal paraphernalia overshadowed by looming arrays of darkened screens. These machines run algorithmic programs that make deals automatically, by the millisecond. They probe far-flung networks, hunting for minute variations in price, provoking them, cashing in. What's missing here are exactly the heads: these work stations are all strictly empty. You seem to have tiptoed into the scene of a crime. Mounted in a frame on one of the desks, right where the family photo should be, is a picture of the old trading pits, with bodies pressed against each other in the passion of exchange. But any clue you might hope to glean about the operators of these machines – their lives, their intentions, their contradictions – is negated by the blank severity of the computer architecture.

There is surely some connection between the two sets of images, intuitively one feels there must be. Yet the high-speed traders did not *cause* the real-estate crash. To the contrary, their rise to dominance came only after 2008, under the conditions of extreme volatility created by the continually mutating economic crisis. The link, if there is one, must be sought in a more overarching social relation. That relation is captured in the book's only full-face portraits, showing young people jacked into multiplayer video games of the "personal shooter" variety. What we see is the grimace of satisfaction or rictus of pleasure on the gamer's lips at the moment of the kill. A cyborg with a volatile smile.

Throughout its long history, Chicago has been a site of exchange, a warehouse town, a portal between the Eastern Seaboard and the Great West. The steel plows that broke the prairie came here by boat along the St. Lawrence River, with a host of other manufactures from New York, Boston and distant Europe. Timber was cut up north, near the Canadian border, and floated to the city's lumber yards before leaving from the railhead to build the rural farming economy. Wheat and corn flowed back to Chicago, where it accumulated in heavy sacks on the quays. Then the elevators were constructed and the quantities and qualities of grain were standardized to create tradable commodities. The earliest futures

contracts were sold to protect the millers and bakers from the vagaries of the weather, and also to line the speculators' pockets. Always the Chicago merchants played the mediating role between the countryside's resources and the wealth of the great urban centers. In one of the most memorable histories of the city, William Cronon dubbed it "Nature's Metropolis."[1]

More recently, a sea-change has come over Chicago and the world. It began in the mid-1960s with speculative runs on the dollar, when European treasuries sought to get rid of excess US currency balances by cashing in their dollars for gold. According to the Bretton Woods treaties established in 1944, all participating currencies were pegged to the US dollar at a fixed "par value" that could only be renegotiated by international agreement. The currencies were exchangeable on the open market, but governments continually intervened to keep prices within one percent of par. The US dollar was the anchor of this system: its worth was unconditionally guaranteed, because countries holding US dollars could redeem them for gold. However, the expansion of the US money supply, changes in the country's export balance, increasing corporate activity abroad and a surge of military spending in Vietnam all led to a glut of foreign-held dollars and a flight of precious metal from American shores. By the late 1960s the Bretton Woods exchange-rate system had begun to collapse, as governments proved unable to halt the open-market fluctuations. As the former head of Citibank, Walter Wriston, wrote in his book *The Twilight of Sovereignty*:

> The final blow was administered on August 15, 1971, when President Richard Nixon terminated the convertibility of the dollar into gold and the era of floating exchange rates began.... The world since that time has been operating with a monetary system for which there is no historical precedent in that no major currency in the world is currently tied to a physical commodity. The old discipline of physical commodities has now been replaced by a new kind of commodity: information.[2]

For Wriston, the early 1970s marked an historic shift from the Gold Standard to what he calls the "Information Standard." Information can be understood as a means to register and correlate changes in the underlying factors that make a currency or a security valuable (the availability of resources, the productivity of labor, the profitability of enterprises, the stability of governments, etc). In this sense, information concerns the past and the present. But information can also be used to calculate the probable volatility of values in the future. A radically different set of possibilities then appears on the horizon.

In Chicago from the late nineteenth century onward, commodity futures had already been a primarily speculative business: grains at the Board of Trade, butter and eggs at the Mercantile Exchange. But the world of floating values that emerged from the crisis of the 1970s would be dominated by financial products, not agricultural ones. Sheaves of data, not of wheat, would be the raw material of the global traders. Stocks and currencies, not butter and eggs, would form the basis of the new futures contracts. The culmination of this shift came in 1982, when the Commodity Futures Trading Commission established the legality of settlement in cash for stock-index futures, thus overturning the old regulatory position that considered any futures trading without a possible delivery in kind as a form of gambling. Two decades later, automated computer algorithms would bet directly against each other, with only fiber-optic networks in between. The old relation to nature fades into the background. Ceres opens her electronic eyes, and Chicago becomes Information's Metropolis.

The traders in the pits were slow to adapt, so the full force of the electronic revolution only hit them in the late 1990s. Yet at least one of them had seen it coming. He was Leo Melamed, the lawyer, operations manager and science-fiction writer who oversaw the transformation of the Chicago Mercantile Exchange into the powerful CME Group. In 1995 he evoked an onrushing generation of cyberwizards: "Tomorrow's futures traders grew up with Nintendo and Sega. They were given a keyboard for their fifth birthdays; their homework was done on a computer; their recreation time was spent in video centers; the World Wide Web was their playground; Cyberspeak is their language."[3] This is what Geissler & Sann have captured so perfectly. The cyborg with the volatile smile holds the secret of our financial futures.

1. Light Up the Screens

The inland ocean of Lake Michigan laps at the feet of Chicago's downtown Loop. From the upper decks of the skyscrapers you can see the sailboats tracing complex curves across the rippling blue. To the north are the patrician mansions of the Gold Coast, and further on, the wealthy suburbs. To the south, the mixed-race community of Hyde Park is an enclave of high culture and prosperity amid a tangle of poverty and shattered industry. No one who has ever visited the city can forget the spectacular trip from the University of Chicago on the South Side up Lake Shore Drive, toward the banks, corporate headquarters and financial exchanges of the Loop. But what does globalization have to do with the sleepy Midwest? What exactly happened in the City by the Lake in the course of the 1970s?

Let's start a bit early, in 1968. Not with the infamous street riots that accompanied the Democratic National Convention, but with a letter in the post by Milton Friedman: "A Proposal for Resolving the U.S. Balance of Payments Problem: A Confidential Memorandum to President-elect Richard Nixon."[4] Here and in subsequent columns in *Newsweek*, Friedman outlined his long-held belief that American interests, both private and public, would be best served by a free international market in currencies. The libertarian economist did not call for the abolition of state-printed fiat money or a return to the discipline of the gold standard. Instead, he thought the Federal Reserve Bank could insure stable currency values by simply augmenting the money supply at an inexorable rate of 3% yearly. Businessmen who needed to buy and sell abroad would overcome any lingering exchange-rate uncertainty by hedging their projected transactions with currency futures. As Friedman observed way back in 1953, "Futures markets in foreign currency easily develop when exchange rates are flexible."[5]

Leo Melamed, the star trader who pioneered pork bellie and live cattle contracts at the Merc in the early 1960s, had often made the trip down Lake Shore Drive to sneak in on Friedman's lectures at the university. They fired his imagination: "Here was the voice of supreme economic authority saying that the system of fixed exchange rates was wrong. That it was time for its demise."[6] When the fixed exchange system was effectively kiboshed on August 15, 1971, Melamed was ready. He contacted Friedman and commissioned him to write a proposal for the creation of what would become the International Monetary Market (IMM). The two went together to argue their case before the regulators in Washington. Friedman's prestige ensured success. The IMM opened on May 16, 1972, even before Bretton Woods had been officially abandoned. Far from stabilizing under the steady hand of the Federal Reserve, currency exchange rates began to gyrate chaotically, both due to fundamentals (the declining US balance of trade) and incidentals (rash economic policies designed to insure Nixon's reelection). Speculators at the Merc were soon making fortunes. Today, some $4 trillion changes hands on global currency markets *every day*, about a hundred times the total volume of cross-border commercial transactions. With floating rates and currency futures, Friedman and Melamed opened up a Pandora's box of finance.

Meanwhile at the University of Chicago, a newcomer arrived in September of 1971: Fischer Black. Working with Myron Scholes, he developed a formula to price a formerly obscure instrument known as a "European call option." That's a contract granting the right, but not the obligation, to buy shares of a stock for a fixed price at a future date. Such a guarantee could be extremely useful to a speculator, as a kind of price insurance – but the question was how much it should sell for. To answer, Black and Scholes constructed a differential equation whose key variable was the volatility of the stock, or the fluctuation of its price over time. When the volatility was estimated on the basis of past behavior (its standard deviation from its historical mean) the equation could be solved. A third colleague, Robert Merton, developed a technique of "dynamic hedging" to continually buy and sell shares of the underlying stock, balancing out the losses that could be incurred by the seller of the option. He was able to model this continuous process by using a piece of stochastic calculus called "Ito's lemma" (which was literally Japanese rocket science). On one hand, the Black-Scholes formula lent scientific rigor to option markets, so they looked less like mere gambling. On the other, it showed a path toward the computerized calculation of dynamic hedges. "In its mathematical assumptions," writes theorist Donald MacKenzie, "the model embodied a world

.”[7]

The model would become reality. Fischer Black had been hired at the University of Chicago Graduate School of Business by a group of economists around Eugene Fama and Merton Miller, who were pushing for the introduction of an options exchange offering complex contracts that could take full advantage of the prevailing financial instability. The Black-Scholes option-pricing model opened up a vast new space of calculability for these derivative products, whereby the risks of both commercial and financial operations could be balanced against the fluctuations of unrelated assets. Dynamic hedging was the name of the game. The Chicago Board Options Exchange was spun off from the Chicago Board of Trade, opening on April 26, 1973. Black decided not to use his own formula in the pits, but to sell information to the traders. He provided them with paper print-outs showing his estimates of the key variable of the Black-Scholes model: the average volatility of the stocks. The traders bet that real prices would fluctuate randomly around these historic averages. Later they just derived the “implied volatility” of the underlying stocks from the recorded prices of the options sold in Chicago and on other new exchanges.

The 1970s were a period of historic technological and organizational innovations, many related directly to finance. Already in 1969, Arpanet, the precursor of the Internet, had gone online. In 1971 the microprocessor was invented. That same year, the world’s first electronic stock exchange was founded: the NASDAQ, or National Association of Securities Dealers Automated Quotations. 1973 marked the launch of the Reuters Monitor, a networked terminal displaying currency prices – the granddaddy of today’s Bloomberg Terminal and dozens of other information services. The same year saw the inauguration of the Society for Worldwide Interbank Financial Telecommunication, or SWIFT network. And in 1975 the Treasury Bill pit opened at the Merc, creating a futures market in government debt, just as the first personal computer, the Altair, went into circulation. The geeks of Silicon Valley learned their hacks on those compact little machines, paving the way for the “cyberwizards” of today's financial markets. Exchanges like the Merc and the CBOE did not immediately integrate the new technologies into the pits, where asks and bids were still exchanged with cries and hand signals. Yet the following two decades would be marked by the gradual encroachment of computing devices and networked communications technologies, programmed with increasingly sophisticated equations invented in the wake of the Black-Scholes model.

Economic and political power accumulated in advance of computerization. By the early 1990s, Walter Wriston was able to crystallize all the changes in a single image: the shift from the Gold Standard to the Information Standard. What he portrayed with brutal clarity was the transition to a highly integrated financial governance, with no popular mandate, no elected representatives and no responsibility to anything but profit. This was a cyborg system, integrating human beings and machines in an improvised and rapidly changing network. As Wriston explained in 1997:

> Unlike all prior arrangements, this new system was not built by politicians, economists, central bankers, or finance ministers. No high-level international conference produced a master plan. The new system was built by technology. While clearing systems reside in real buildings, the new world’s financial market is not found on any map, but consists of more than 200,000 electronic monitors in trading rooms all over the world linked together, and the value of any currency is determined by the price that the market will pay for it in exchange for another.... Moments after the president makes a statement in the Rose Garden, thousands of screens light up, and traders all over the world vote on whether the new policy is good or bad.... Increasingly, currency values reflect less the power and privileges of the sovereign as much as a discipline on the economic policies of imprudent sovereigns.[8]

What Friedman bestowed on the Nixon administration, and what governments across the world saw reflected in Melamed’s trading pits, was a new way of establishing basic economic values. The

policies that the bond and currency markets favored most were low interest rates and expansions of the money supply (preferably well beyond Friedman's 3% per annum). Disappointing moves by central bankers could provoke a crisis. Meanwhile, economists nostalgic for Adam Smith spoke of a "self-regulating market" governed by an "invisible hand." Others, enamored of mathematics and particle physics, considered the markets to be natural phenomena, obeying rational laws that could be studied scientifically. The financial markets could therefore be presented as objective mechanisms of *veridiction*, or truthful speech, replacing any *jurisdiction*, or arbitrary statement of judgment originating in the political sphere.[9] Yet the institutional history of the Chicago exchanges proves the contrary. The Information Standard was deliberately constructed. Theorists, regulators and managers gave specific contexts, capacities and missions to the emerging technologies.

To return to our question, what happened in the City by the Lake in the course of the 1970s? In brief, what happened were the first fateful steps toward the privatization of government. Where the democratic state promised welfare for the lives of the many, the derivatives markets offer insurance for the speculative endeavors of the few, the "world class investors," conceived as the only ones who really matter. Government is no longer supposed to take care of you, because private people (at least if they are billionaires) can easily take care of their own. All of this – complete with the exclusion of the *demos*, or the majority of the population – is conveyed in the motto of today's CME Group: "Where the world comes to manage risk."

2. The Computer and the Droid

Leo Melamed is not only the architect of the International Monetary Market and of the organizational innovations that followed. He is also a science-fiction writer, the author of a book called *The Tenth Planet*.[10] This intriguing novel (the only one he has published so far, though he did promise a sequel) is centered on the figure of the all-seeing Putral, a super-computer who is able to appear in human form, like a kind of truth-speaking oracle. Known as the "C-master," he serves as a scientific counsel to the parliamentary representatives of the Galotian Federation of Planets, which is under attack by a mysterious android. Always calm and self-possessed, the elegant-looking Putral is in reality "an amalgamation of millions of computers" which are fed information by teams of "Subs" and "Dacs." He (or it) is "capable of doing a billion things simultaneously ... every one of his programs interfaces with all the others ... each of his separate functions shares the same data banks." The question is, what relation did this sci-fi figure have to the computerization of society that was gradually unfolding in the 1980s? Could Putral be a metaphor for the world-spanning Globex trading platform, developed by a team of technologists, analysts, lawyers and traders at the CME under the leadership of Melamed himself from 1987 onward?

Perhaps we should approach the question by way of a reflection on Warren Weaver, a corporate-military science manager of the WWII era and the co-author, with Claude Shannon, of the seminal text on information theory. In a 1948 article titled "Science and Complexity," Weaver notes that classical physics has done very well with "two-variable problems of simplicity," such as the movement of a couple of balls on a billiards table (the gentlemanly stand-in for ballistics). Then in the nineteenth century, science began to take on the opposite of these simple problems, namely, problems of "disorganized complexity": thermodynamic situations involving billions of particles, none of whose trajectories could be plotted individually, but which could be treated statistically as aggregates. These investigations initially dealt with the expansion of steam and the theory of heat engines; but later they were extended to questions of population growth, actuarial problems in the field of insurance, or analyses of traffic patterns on freeways and telephone exchanges. Between the two types of problems lay what would become the major challenge of postwar science, Weaver claimed: the phenomena of "organized complexity" as encountered in biology. "The significant problems of living organisms are seldom those in which one can rigidly maintain constant all but two variables. Living things are more likely to present situations in which a half-dozen, or even

several dozen quantities are all varying simultaneously, and in subtly interconnected ways. Often they present situations in which the essentially important quantities are either non-quantitative, or have at any rate eluded identification or measurement up to the moment."[11]

Weaver stresses how difficult these problems are, but adds that "out of the wickedness of war have come two new developments that may well be of major importance in helping science to solve these complex twentieth-century problems." The first is the computer, which, he explains, can multiply ten-digit numbers "some 40,000 times faster than a man can say Jack Robinson." Computers would make possible the daunting calculations required to plot out interactive relations between large numbers of constantly changing variables. The second development, however, is less widely understood. It is the management science of *operations research*, which assembles theorists from different disciplines to tackle real-world problems in compressed time-frames, under conditions of risk and urgency. Weaver himself had been a crucial figure in organizing such teams during the war. As the historian of economics Philip Mirowski observes: "Weaver followed his own nose and became enthused when he caught a whiff of the combination that would prove so heady in the postwar years: usually, some physicist or engineer who had mathematized something that would conventionally be regarded as the province of biology or psychology, perhaps by accessing issues of thermodynamics, probability, computation, and electrical engineering."[12]

Now, it's clear that any derivatives contract deals with multiple, continuously evolving variables which are assembled into a dynamic equilibrium (as in the case of an option whose risk to the seller is offset by dynamic hedging). The continuous interaction between a large number of interrelated variables is what gives financial markets their aura of living beings. Yet this is an artificial life, a painstakingly constructed second nature. It's no surprise that Fischer Black, who invented equations to encompass such interactions, comes straight out of corporate operations research. Indeed, Black is one of the fathers of today's quants. He helped inaugurate the trend of bringing theoretical mathematicians and physicists to finance, by starting the Quantitative Strategies Group at Goldman Sachs in 1983.[13] What's perhaps less obvious is the degree to which the globalized electronic markets depend on a broad range of interconnected specialists. Lawyers, theorists and regulators must be coordinated to bring a market into existence, as we saw above. News networks, stock analysts and ratings agencies must be marshaled to scrutinize the evolution of firms, gathering data about their products and sales and scrupulously cross-checking the data that the firms themselves make public. These, in reality, are the "all-seeing eyes" of the financial markets, providing the flows of information that the quants synthesize into formulas for the traders. Finally there is the construction, by computer engineers, of a highly integrated and secure trading network. The creation of a modern financial market can therefore be seen as a problem of operations research. Indeed, Melamed's role at the CME from 1987 onward was that of an operations manager, bringing together the technologies and specialists required to deal with problems of organized complexity. The result was the Globex platform, which today is the world's largest and fastest round-the-clock electronic derivatives trading network.

Does the complex reality of the Globex network cast some light on the fictional powers of Putral, the oracular "C-master" of Melamed's novel? Connected like the great financial exchanges to continuous streams of information about activities unfolding all over the world, the C-master has thousands of eyes (the "Subs" and "Dacs"). He (or it) takes on human aspect at crucial moments, to supply valuable information to the Galotian Parliament and its commercial and military officers. Yet the inner workings of this complex system are largely invisible and ultimately unknowable, like the market itself, which neoclassical economics conceives as an impersonal information processor. Putral is feared by some for his capacity to appear anywhere at any time, speaking directly to anyone's consciousness through implants that allow so-called "imcom transmission." There is an anxious sense that he (like the market) could exercise dictatorial powers. Yet he consistently appears as impartial, impassive, beneficent.

Other commentators have noted the resemblance between this super-computer and the Globex

network. As Melamed himself asked, rather rhetorically, in an interview: "Here in my imagination, I could create a computer that could run five planets. Do you think the world can't create one little computer that could do all the rushing back and forth of [futures] orders?"[14] What's troubling about the novel, however, are not only the decision-making powers of the super-computer Putral, but also the violent outbursts of the immensely powerful yet strangely ignorant android, Agot. Millions of years ago this artificial alien being was cast into primitive humanoid form by visitors from another galaxy, the Sates. Agot was given tremendous capacities for cultural analysis, but he was left entirely bereft of scientific knowledge. He is desperately afraid of learning one thing: the location of the planet Terra (our own Earth). The reason why is that if he finds out where Earth is, he has been programmed to transmit that message to the Sates, who will destroy it. After this transmission, his life's work will be complete and he will die. In order to hold off his own death, he lashes out against anyone in the Galotian star system who may be on the verge of discovering Terra's location, using his fearsome powers to destroy spaceships, laboratories, observatories and great universities the size of entire cities.

What finally happens? Will the Galotian Federation be destroyed? Is the Earth really doomed? All we learn at the end of the novel is that through a stratagem of Putral, the android is given the scientific capacities needed to discover the location of Terra. He automatically transmits his fateful message, then ceases to function. The C-master has saved the day – at the cost of planet Earth.

Melamed spent four years writing the book, which was published in 1987. That fall, on the 19th of October, the markets took their deepest plunge since 1929. Automated program trading between New York and Chicago was widely alleged to be the cause of "Black Monday." This was the first major crisis for Federal Reserve Chairman Alan Greenspan. In the months that followed he propped up the shaky financial edifice by launching slashing interest rates to give cheap money to the markets (the so-called "Greenspan put"). Any hope of a steady hand at the Fed disappeared: the "Maestro" played his monetary music in immediate response to the wild gyrations of the exchanges. Melamed himself recounts that on Tuesday morning, the Merc came within a hair's breadth of not opening – a potentially catastrophic event, since it would have sent a negative message spreading panic across the globe. He believes this negative message could have set off another Great Depression. The solution came from a desperate telephone call at dawn to the Continental Illinois Bank, whose chairman provided $100 million in missing funds. With that amount the books were cleared and the Merc opened for business, saving the day for planet finance.

The potentially disastrous message was not sent. But another one was. When analysts scrutinized the real prices of options in the months after Black Monday, they saw that implied volatilities much greater than historical averages had been attributed to the underlying stocks. Traders were reacting to a new kind of systemic risk, created by each other's massive reliance on the same kinds of mathematical formulas. This added risk became a second nature. The characteristic "volatility smile" appeared in graphical representations, signaling to the world that the widespread use of the Black-Scholes formula was self-reflexively transforming the financial markets.[15] Scientific knowledge was having unpredictable effects. As the young cyberwizards began turning in their Segas and Ninetendos for computers jacked into global exchanges, a new and more dangerous era of trading was about to begin.

3. Stepping on the Moon

An enigmatic motto is printed on the cover of *The Tenth Planet*: "When human equals alien." The book is structured around two opposing forms of artificial intelligence. One is a calm, impartial, beneficent computer network. The other is a strangely primitive and impassioned android. Both seem to respond to the book's motto. Why not consider the relation *between these two* artificial life forms as the ultimate metaphor for the financial markets – and indeed, of the CME itself?

On the one hand, Putral would represent all the virtues of technological progress, organizational sophistication and capitalist efficiency that Melamed continually ascribes to the futures markets, and

notably to Globex. On the other, the android Agot – created by the complacent Sates – would represent the detractors of financial progress, the Keynesians, the would-be regulators, the satisfied flat-earthers and even a majority of the Chicago-based traders, who consistently resisted computers and preferred the fetishistic hand-signals and crude physical jostling of the pits. Beyond these immediate comparisons, one could also draw parallels between the threat of Earth's destruction by the Sates and the atomic standoff between the Americans and the Soviets that had marked the life of Melamed, an Eastern European émigré and staunch defender of Western capitalist freedoms against Communist tyranny. Yet all of this is at once too speculative and too personal. The two opposing forms of artificial intelligence become even more interesting when considered in relation to the two predominant understandings of the market in the twentieth century.

For neoclassical economists, the market is a perfectly neutral, balanced and ultimately equitable information processor: a kind of super-computer integrating all the intuitive calculations of millions of rational economic agents and correctly allocating scare resources in return, so as to achieve a general equilibrium between supply and demand. This is still the mainstream version of academic economics in the United States, represented in the post-WWII period by the members of the Cowles Commission, who briefly resided in Chicago before moving on to Yale university. They used elegant mathematical formalisms to show that socialist planning and redistribution were entirely superfluous, so perfect were the spontaneous calculations of the market. Putral, the "amalgamation of millions of computers," could be taken as a figurative stand-in for this "efficient market hypothesis," whose unwavering general equilibrium is also the necessary background assumption for equations such as the Black-Scholes formula.[16] And just like Putral in his function as scientific counselor, the fiction of a perfectly rational market has frequently been offered to regulators and elected representatives in order to legitimate the institutions of global finance. Heads, you win the regulators' approval.

Yet there is another side of the coin. In his book *Machine Dreams*, Philip Mirowski shows that economists' fascination with computers, which grew in many cases out of their participation in operations research during the war, led increasingly beyond the equilibrium theories of neoclassicism, toward an experimental economics based on simulated situations and chaos theory. At the center of this experimental economics was not the sci-fi image of an android, like Agot, but instead, a more pragmatic and perhaps more disquieting figure: the cyborg. Experimental economics owes its inspiration to outlandish tales of really existing human/machine combos, like Geissler & Sann's first-person shooters jacked into a multiplayer game, or like any contemporary trader with his information read-outs, hand-held devices, computers, ear-buds, radio-connected support networks and quant teams continually delivering new models and algorithms.

The term "cyborg" stands for "cybernetic organism" and suggests artificially augmented or transformed human functions governed by real-time informational feedback. The idea was first proposed in 1960 in a discussion of the physiological adaptations required for manned space flight. Here's a quote from the inaugural article:

> What are some of the devices necessary for creating self-regulating man-machine systems? This self-regulation must function without the benefit of consciousness in order to cooperate with the body's own autonomous homeostatic controls. For the exogenously extended organizational complex functioning as an integrated homeostatic system unconsciously, we propose the term "Cyborg." The Cyborg deliberately incorporates exogenous components extending the self-regulatory control function of the organism in order to adapt it to new environments.[17]

The text sounds almost absurd. An "organizational complex" is located outside the human organism, but perfectly integrated into its physiology in order to provide advanced capacities for action in an outer-space environment. Yet, space travel aside, that's very close to what could be seen in the pits when handheld devices made their appearance at the Chicago Board Options Exchange in 1995. A declaration by a trader, recorded in the BBC film *The Midas Formula* (1999), captures precisely this

relation between the organism and the organizational complex: “The computer takes in all the data that I give it during the day, it sends it to... A, it sends it to a little beeping light *[he laughs, gesturing at the top of the handheld]* – it sends it to the CBOE, it sends it to the clearing firm, so that the exchange on an ongoing basis knows everything I'm doing online. In addition, I know online what I'm doing because this thing calculates, using a Black-Scholes model, what my risk is at all times.” In the language of the trader and in the way he gestures with his device to the seemingly endless banks of computers on the wall behind him, there appears to be no more distinction between flesh, volition, microprocessors, mathematical models, data flows and communications networks. This cyborg is real. The dark side of the market – its restless energies and propensity for sudden, unpredictable transformations – is embodied in an unstable hybrid of man and machine.

An “organizational complex” does govern the individual networked traders. In his recent book, *For Crying Out Loud*, Melamed recounts the seventeen-year trajectory that began with the proposal of the Globex platform in 1987 and ended, in 2004, with the transfer of the Merc’s Eurodollar futures contracts from the open-outcry pits to the network. The price of these contracts fluctuates according to changes in the interest earned by dollar deposits in foreign banks, making them a perfect hedge against interest-rate shifts (if the rate goes up, you may have to spend more to borrow, but you have also made money on your futures). Of course, they are also a perfect instrument for sheer unbridled speculation. The Eurodollar contract was the mainstay of the Merc: its shift to the screen would make or break the Globex platform. The turning point came in 2002, when the Merc was demutualized by the near unanimous vote of its owner-members and transformed into a publicly held corporation, in order to streamline its governance and enlarge its treasury for the period of intense competition that was about to ensue. The change in ownership created something radically new: an incorporated electronic trading network operating at transnational scale, with the power to influence global governance, just as the Merc had helped reshape the regulatory environment of the United States.[18] Melamed refers to this moment as “stepping on the moon.” Like moving from earthly life into science fiction.

In effect, the restructured CME would go on in 2006 to take over its historic rival, the CBOT, after emerging victorious from an intense struggle with the Atlanta-based Intercontinental Exchange (which itself went on to buy the New York Stock Exchange). One year later, the new CME Group would merge with the New York Mercantile Exchange (NYMEX), which specializes in energy futures. These mergers are what gave Globex its dominant position among the world’s electronic derivatives markets. Of equal if not greater importance in the narrative, however, is the resistance of traders and broker groups to screen-based operations. Again we think of Agot, who had no scientific capacities and destructively resisted new knowledge. The question was, how to overcome such resistance?

To explain how it was done, Melamed lays emphasis on the strategic importance of the Galax-C handheld device, designed for the Merc and introduced, quite late, in 1999. By allowing for simultaneous trading in the pits and on the network, the Galax-C nudged the traders toward a cyborg existence. Now we can see the organizational complex in action. When the corporate board of the restructured CME pressed, in the name of competitiveness, for a transfer of the Eurodollar contract from the pits to the screen, it was the Galax-C, in the hands of the traders themselves, that sent the definitive message. Trading was more efficient online. The pits were dead. The future of futures lay entirely within the electronic networks.

Today, the casual observer suspects rank hypocrisy when enterprises like the CME Group claim to welcome the Dodd-Frank financial reform bill, which seeks to move the derivatives market away from the shadowy realm of customized over-the-counter contracts and into the standardized and transparent world of exchange-based trading, where each transaction leaves a public record. But the casual observer is wrong. The fact is that the expansion of derivatives trading into fully automated networks would open up a vast new field for exactly the kinds of high-frequency operators whose desks – fittingly voided of people – have been photographed by Geissler & Sann. Their images take us directly to the heart of today’s algo-trading.

Experimental economics can only flourish in high-speed networks. Its strategies, which have

surged to the fore since 2008, were pioneered back in the 1990s at the Santa Fe Institute, where neoclassical economists met biologists and physicists from the nearby Los Alamos Laboratories. What emerged from their conversations were the "black box" strategies of the stripped-down quant shops that now cluster in the Loop, or further south in Hyde Park. In his book, *The Physics of Wall Street*, James Owen Weatherall describes how these algorithmic strategies were derived from scientific research:

> Suppose you are trying to identify the ideal conditions under which to perform some experiment. A traditional approach might involve a long search for the perfect answer. This could take many forms, but it would be a direct attack. Genetic algorithms, on the other hand, approach such problems indirectly. You start with a whole bunch of would-be solutions, a wide variety of possible experimental configurations, say, which then compete with one another, like animals vying for resources. The most successful possible solutions are then broken up and recombined in novel ways to produce a second generation of solutions, which are allowed to compete again. And so on. It's survival of the fittest, where fitness is determined by some standard of optimality, such as how well an experiment would work under a given set of conditions. It turns out that in many cases, genetic algorithms find optimal or nearly optimal solutions to difficult physics problems very quickly.[19]

On the automated global exchanges, evanescent generations of algorithms struggle with each other for momentary dominance before they are eclipsed by some new twist of mathematical logic. The men and women behind the computers have been reduced to the hard core of an operations research team: a quant on the lam from particle physics; a strategist with a broad grasp of the financial markets; a technologist with her fingers on the keyboard; and of course, a billionaire backer or an investment fund with a fortune to win or lose. The core groups meet each other, scrawl equations on the walls, then withdraw to their darkened rooms. You might run into them someday, by chance, at a lunch-counter, a bar, or a cubicle in Information's Metropolis.

Conclusion: The Underlier

It is as though the goddess Ceres had opened her thousand eyes, then closed them again. The fully artificialized practice of black-box trading no longer has any need for knowledge drawn from the fields of wheat and corn, or any of the archaic realms of nature. Information about information – the second nature of the financial markets – is all that matters. The great exchanges have become like space cruisers, turned inward on themselves, fixated on the hypothetical image of a perhaps infinitely unreachable destination. So what's life like in the most distant solar systems? Only the Sates, we are told, would shy away from this imperiously fascinating question.

So far in this text I have avoided any discussion of the real processes of production, distribution and use that underlie the frenetic rituals of Chicago's financial markets. Yet these facts on the ground are everywhere beneath our own eyes; and since the 1970s, they have changed dramatically under the influence of free-trade doctrines and Chicago-style finance. As Milton Friedman wrote in 1993, just after the Fall of the Wall and just before the rise of the World Wide Web:

> The collapse of communism plus the technological changes of recent decades – the so-called information revolution – have vastly expanded the possibilities of cooperation between the developed and underdeveloped countries of the world. The political troubles of communism have made available for participation in multinational production of commodities and services a billion people in China and three or four hundred million in Russia and Eastern Europe. In addition, improvements in communication and transportation, especially the introduction of fax, have made it possible for a company located anywhere to coordinate resources located anywhere to produce a product to be sold anywhere. One result is that Latin America provides a supply of labor available in a way that has not been available before. These developments offer the opportunity for an enormous expansion in world trade. If that is allowed to develop freely, it can produce a new

worldwide economic miracle that will raise living standards around the world.[20]

In the era of second nature, fact follows science fiction. Economic theories and the institutions they elicit come to shape the pathways of life on planet Earth, altering everything from the cobblestones to the continents. In 1993, when Friedman wrote, maquiladora plants had already overtaken tourism as Mexico's largest source of foreign exchange. Twenty years later, as I write, the largest part of the American industrial working class lives in China and speaks Chinese. An entire industrial geography has been transformed by the massive extension of foreign direct investment (what economists call FDI), along with crucial risk-insurance role played by futures and other derivatives. In this way, the city of Chicago has become the heart of a global economic construct called "Chimerica."[21]

If you get in a car in the thoroughly gentrified downtown Loop and drive southwest for perhaps an hour and fifteen minutes you will reach the BSNF multimodal port, located in a so-called "Foreign Trade Zone" (FTZ) near the exurban city of Joliet. Consumer goods shipped from China arrive at container ports in Los Angeles, are transshipped to short-haul trucks and then to transcontinental trains, before finally arriving here. Then they are again transshipped, this time to the immense complex of CenterPoint warehouses, also located on a nearby FTZ.[22] The seemingly endless double nave of the WalMart warehouse – whose subcontracted workers recently won an improbable labor-conditions strike – is one of six such installations in the United States. From its innumerable loading bays the goods are shipped to local logistics hubs, and thence to the big-box stores. WalMart is the largest employer in America (and perhaps in all of Chimerica), but its employees require food stamps and other archaic state subsidies just to make it through the working day. If we could see through the pulsating fiber-optic cables of the global derivatives exchanges, maybe their kitchens would come into view.

Dick Bryan and Michael Rafferty are the authors of a book titled *Capitalism with Derivatives*.[23] What they explain in this remarkable volume is the role of derivatives contracts in the epochal shift from the Gold Standard to the Information Standard, and the consequences of this shift on the human underlier. The central claim of the financial markets, they maintain, is that derivatives – that is, dynamic hedging operations serving as insurance against risks – can be bought and sold as commodities, like any other widget. These particular commodities, however, are conceived both as values in themselves and as guarantees for other values, whether industrial, commercial or financial. Thus they serve to replace gold as a stabilizing anchor for a vast system of credit money (the kind used for home loans, capital investments, leveraged buy-outs of corporations, short-selling of stocks, etc). Derivatives are claimed as the backstop for global capital circulation: a privately controlled way to manage risks. The claim is still made today. Yet all this private risk insurance is propped up by the US Fed, which has held interest rates below inflation for six years, while creating some $2 trillion in new bank reserves (so-called "quantitative easing") and providing a staggering $16 trillion in short-term loans to transnational banks, all in order to stabilize the financial crisis that began in 2007.[24] The government remains the ultimate risk manager, and the "free international market in currencies" is in reality the creation of public central bankers serving private ends.

What Bryan and Rafferty point out is that derivatives always imply an underlier – not only an underlying paper asset or basket of such assets, but an underlying process of consumption, distribution or use, upon which value can ultimately be based. The particular characteristics of the underlier then become extremely important. It must be scrutinized by a thousand analysts, it must be compared to everything of a similar category or class, and it must be made to conform to a common standard of efficiency and profitability, failing which it cannot be part of the economic equation. Far from closing its eyes, therefore, the "system of derivatives" projects a normalizing gaze on everything that comes within its field of vision and calculation. It standardizes both the products sold by an enterprise like WalMart and the labor-hours of its employees, forcing both of them down to the lowest possible price. The underlier then becomes the real anchor of value, a rock-bottom benchmark serving to justify the wildest flights of speculative risk. The spaceships take off for the stars; but in the last instance, the underlier is always a human being. Endless monetary expansion is rocket fuel for the CME; but a worker's food

stamps are what ultimately puts the champagne on the algo-traders' tables.

Consider this as you look again at the photographs of the empty rooms. These interiors became values in an enormous speculative pyramid *because* they were the containers of people's lives. They represented an income stream because they were a vitally necessary place of rest, of sleep, of nourishment, of play, of extra-economic activity. People only struggle to earn a salary and to pay off a debt for something other than the receipt of that salary and the quittance of that debt. Now flip the coin again. The empty desks of the high-frequency traders and the vacant architecture of the financial exchanges reveal an abstract machinery that lures people into debt, then sells that debt to other people who will demand that it be paid. The same logic that produced the subprime collapse in the United States was repeated, on comparable scales, in countries like Spain and Ireland. There, and throughout Europe, the circuitous process that transfers unpayable debt from hand to hand and from market to market has ultimately resulted in a demand, from the bond markets, for the institutional transformation of both national governments and the European Union. In the US, we have not heard such pressing demands. That's because the privatization of government was accomplished long ago, by the forces described in this essay.

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We have reached the close of a long journey, from Chicago to Chicago, from nature to second nature and back again. At stake here, perhaps, is the provision of a set of empathic organs for a cyborg adrift on a cosmic sea. In the empty real-estate photographed by Geissler & Sann, I have sought to make you, the all-seeing eye, feel the presence of absent human beings. As those who have been banished know all too well, not the high-speed traders alone, but instead, a total social process causes the wild violence of the financialized economy. That economy promises something like the ownership and use of a home, then jerks it away again at the moment of crisis, "when human equals alien."

To be sure, the empty rooms themselves have always been bits of second nature, like the cyborgs and everything else created by human beings. The question is, how do we take responsibility for what we have created?

1 William Cronon, *Nature's Metropolis: Chicago and the Great West* (New York: W.W. Norton, 1991). Anyone seeking to understand the development of Chicago's financial markets can begin with this superb book.

2 Walter B. Wriston, *The Twilight of Sovereignty* (New York: Charles Scribner's Sons, 1992), p. 58.

3 Leo Melamed, *For Crying Out Loud* (Hoboken, NJ: John Wiley and Sons, 2009), p. 128.

4 The proposal was reprinted in Leo Melamed, ed., *The Merits of Flexible Exchange Rates* (George Mason University Press, 1988).

5 Milton Friedman, "The Case for Flexible Exchange Rates," in: *Essays in Positive Economics* (University of Chicago Press, 1953), p. 174.

6 Leo Melamed, *For Crying Out Loud,* op. cit., p. 235.

7 Donald MacKenzie, *An Engine Not a Camera: How Financial Models Shape Markets* (Cambridge, Mass.: MIT Press, 2006), p. 142.

8 Walter B. Wriston, "Dumb Networks and Smart Capital," *The Cato Journal* 17/3 (Winter 1998), pp. 329-40.

9 The opposition of veridiction and jurisdiction has been borrowed from Michel Foucault, *The Birth of Biopolitics* (New York: Palgrave MacMillan, 2008), lesson 2.

10 Leo Melamed, *The Tenth Planet* (Chicago: Bonus Books, 1987).

11 Warren Weaver, "Science and Complexity," in: *American Scientist* 36 (1948), p. 536.

12 Philip Mirowski, *Machine Dreams: Economics Becomes a Cyborg Science* (Cambridge University Press, 2002), p. 171.

13 On Black's tenure at Goldman, see the biography by Perry Mehrling, *Fischer Black and the Revolutionary Idea of Finance* (Hoboken: John Wiley and Sons, 2005), chapter 10.

14 Sarah Collins, "Leo Melamed tells us how his sci-fi novel led to e-trading at the Merc," Chicago Grid (undated online publication), available at: http://www.chicagogrid.com/people/leo-melamed-sci-fi-merc-cme.

15 For a reading of Black Monday in its relation to the generalization of Black-Scholes type models, see Donald MacKenzie, *An Engine Not a Camera*, *op. cit.* ch. 7 and *passim*.

16 On the efficient or rational market hypothesis, see Justin Fox, *The Myth of the Rational Market: A History of Risk, Reward, and Delusion on Wall Street* (New York: Harper Collins, 2009).

17 Manfred E. Clynes and Nathan S. Kline, "Cyborgs and Space," *Astronautics* (September 1960), reprinted in: Charles Hables Gray, ed. *The Cyborg Handbook* (New York: Routledge, 1995), p. 29.

18 For an idea of what this kind of corporation consists of, see Luis Suarez-Villa, *Technocapitalism: A Critical Perspective on Technological Innovation and Corporatism* (Philadelphia, PA: Temple University Press)

19 James Owen Weatherall, *The Physics of Wall Street* (New York: Houghton Mifflin Harcourt, 2013), pp. 150-51.

20 Milton Friedman, "Foreword," in: Leo Melamed, *Leo Melamed on the Markets* (New York: John Wiley and Sons, 1993), p. ix.

21 For the first, thoroughly uncritical use of this geo-economic concept, see Niall Ferguson, "'Chimerica' and the Global Asset Market Boom," *International Finance* 10/3 (December 2007).

22 For an introduction to Chicagoland FTZs in their relation to migrant labor, see Rozalinda Borcila, "Riding the Zone," in: Compass Collaborators, *Deep Routes: The Midwest in All Directions* (White Wire, 2012).

23 Dick Bryan and Michael Rafferty, *Capitalism with Derivatives: A Political Economy of Financial Derivatives, Capital and Class* (Basingstoke/New York: Palgrave MacMillan, 2006), see esp. part II, chapters 5-7.

24 For the figures see, among others, the July 2012 speech by John C. Williams, President and CEO of the Federal Reserve Bank of San Francisco, "Monetary Policy, Money, and Inflation" (http://www.frbsf.org/our-district/press/presidents-speeches/williams-speeches/2012/july/williams-monetary-policy-money-inflation/john-williams-0702.pdf) and the first-ever Government Accountability Office audit of the Federal Reserve System, *GAO-11-696*
, released in July 2011 (http://www.gao.gov/products/GAO-11-696), p. 144.