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Michael Milken's Spreadsheets: Computation and Charisma in Finance in the Go-Go '80s

To begin: a story about an infamous financier and a famous piece of software. The financier is Michael Milken, whose pioneering “junk bond” operation at the investment bank Drexel Burnham Lambert in the 1980s funded many of the corporate raids and hostile takeovers that characterized that “go-go” era in American financial history. Contemporaries labeled him the most important American financier since J. P. Morgan and his name featured regularly on lists of the decade’s most influential people.¹ Indicted on ninety-eight criminal counts in 1989, including securities fraud and racketeering, he was sentenced to ten years in prison and \$600 billion in fines—he ultimately served twenty-two months—and banned for life from the securities industry. His estimated net worth today is \$3.7 billion.² The computer program is VisiCalc (the “Visible Calculator”), the first personal computer spreadsheet program. Launched in 1979 by Dan Bricklin and Bob Frankston and purportedly inspired by one of Bricklin’s Harvard Business School assignments, VisiCalc became a defining triumph of the early PC era, the “killer app” for the Apple IIe.³ The two characters were precise contemporaries, each receiving their first major national media profiles—*Forbes* for Milken, *Harper’s* for VisiCalc—in November 1984.⁴

I first heard this story from a chance acquaintance well-apprised of VisiCalc’s history. It goes like this: asked to explain the unprecedented financial turmoil of the 1980s, Milken once claimed the true culprits were the creators of VisiCalc. Versions of this story appear in multiple print sources. Management researcher J. Christopher Westland describes how “Michael Milken once commented that Bricklin’s invention had single-handedly paved the way for the 1980s corporate megadeals.” Innovation guru Michael Schrage recounts how “Michael Milken... has privately credited spreadsheet software with making it possible to model and market so swiftly

‘high-yield’—aka junk—bonds he pioneered at Drexel Burnham Lambert.”⁵ In trying to explain the immense transformations in American finance and business in the 1980s, transformations to which he contributed greatly, Milken invoked a blunt technological determinism: the spreadsheets did it! And Milken was not alone in this assessment. The idea that spreadsheets made Wall Street as we know it has become a somewhat common story.⁶

The financial upheavals of the 1980s are hard to overstate. The period saw the emergence of substantially new financial technologies and practices—junk bonds, leveraged buyouts, hostile takeovers—that profoundly altered the day-to-day activities of Wall Street firms and shook businesses nationwide. One major effect was a radical transformation in the volume, pace, and style of mergers and acquisitions (“M&A”), the business of companies and other investors buying other companies. Between 1980 and 1988, the volume of M&A activity increased fivefold.⁷ Over that period, “corporate raiders” like T. Boone Pickens and Carl Icahn and young “private equity” firms like Kohlberg, Kravis, Roberts (“KKR”) scoured corporate America for companies that could be profitably bought up and taken over. While in previous decades M&A was driven by operating businesses buying other businesses for strategic reasons, the ‘80s takeover craze was propelled by financial prospecting, as buyout artists looked for undervalued companies that could be exploited for financial gain—for example by dismantling the company and selling components, replacing underperforming managers, or laying off workers. Many of these takeovers were “hostile”; the acquirers sought to buy a company whose management did not wish to be bought, or at least threaten a takeover and then sell that stock back at an extortive profit (“greenmailing”).

To do this, raiders used piles of borrowed money, raised primarily by selling junk bonds—Milken’s specialty. Those junk bonds were a high-risk/high-reward financial technology

that exposed investors to dramatic swings of fortune—like those of First Executive Corporation, once the largest life insurer in California and also a massive purchaser of junk bonds, whose spectacular collapse in April 1991 was then the largest insurance company failure ever. The volatile mix of buyouts and junk bonds opened up new opportunities for criminality, as unscrupulous operators used illicit private information about takeover activity to speculate on public stocks. That practice burst into view in 1986 in high-profile prosecutions led by U.S. Attorney Rudolph Giuliani, ensnaring celebrity arbitrageur Ivan Boesky, several of Milken’s Drexel colleagues, and ultimately Milken himself.⁸

This new pattern of financial action had widespread economic, social, and cultural ramifications.⁹ Every reasonably-sized company in America became a conceivable target. A 1996 study found that half of the companies in a representative sample of 1,064 firms were subject to a takeover bid between 1982 and 1989; nearly half of those (23% overall) faced a hostile bid.¹⁰ Some of America’s most storied businesses fell prey to raiders, including Revlon, TWA, and most famously RJR Nabisco, bought by KKR in 1988 in a staggering \$25 billion deal. This reshaping of American business hit workers too. A typical large hostile takeover in the mid-1980s cost 500 jobs, or 5.7% of a company’s workforce.¹¹ In some cases the toll was much greater, as in the 1986 buyout of supermarket chain Safeway, which yielded \$7 billion in profits to KKR but forced more than half of Safeway’s 2,300 stores to close and left 63,000 unemployed.¹² Finance simultaneously earned unprecedented attention in journalism, art, and popular culture, exemplified by Oliver Stone’s *Wall Street* (1987), where fictional raider Gordon Gekko (Michael Douglas) and his mantra “greed is good” became the icon of the age. Karen Ho has shown how the go-go 1980s would become an “ideological and temporal marker” in the

“collective memory” of Wall Street, remembered by subsequent generations of financiers as a founding moment when bankers “rescued American business.”¹³

What explained this surge in new and unsettling modes of financial action during the “Deal Decade”? Many answers have been ventured. Economists explain the oddities of the ‘80s as financial markets’ response to structural inefficiencies in American business. For Michael Jensen, the leading academic advocate for takeovers, the ‘80s represented a long-needed effort by investors to discipline irresponsible corporate executives, triggered by mismanagement epidemic in the ‘70s.¹⁴ This would subsequently become the dominant narrative of the ‘80s among Wall Street professionals.¹⁵ Other economists offered slightly different explanations, pointing out that debt-fueled acquisitions were rational responses to the tax code, which permitted companies to deduct interest payments from taxable income, or a backlash against the longstanding dominance of large, diversified conglomerates in American business.¹⁶ Sociologists have pointed in other directions, arguing the ‘80s fervor was symptomatic of structural transformations in how corporations were organized and controlled and a broader “financialization” of the American economy. These political-economic shifts were substantially shaped by public policy and state action, including the rollback of New Deal-era financial regulations.¹⁷ Other scholars call attention to cultural and intellectual forces, notably an emergent ideology about the nature of business—what Marion Fourcade and Rakesh Khurana call “the neoliberal common sense of capital”—that envisioned companies as generators of “cash flow” and posited that managers’ key responsibility was “maximizing shareholder value.”¹⁸

Amidst all of these forces, Milken blamed spreadsheets. How was this a reasonable, or even plausible, explanation for Wall Street’s remaking in the 1980s? Why might Milken have offered it? This paper begins to unpack Milken’s techno-determinist story, in a couple ways.

First, how were PCs and especially spreadsheets actually used in financial practice in the '80s, particularly by Milken, his colleagues, and clients? Drawing upon the extensive journalistic coverage of Milken's operation plus biographies and published oral histories, this paper offers a preliminary reconstruction of part of the mundane technical infrastructure of '80s finance.¹⁹ This paper takes up Nathan Ensmenger's call to examine the "digitization of modern society" by tracing how computation entered the "day-to-day activities and material practices" of specific workplaces.²⁰ It also will contribute to a growing body of research that seeks to understand how the incorporation of information and computing technologies has affected financial markets, financial regulation, and the embodied experience of financial actors.²¹ In doing so, it builds on a rich body of literature in the "social studies of finance" (SSF) that has explored how technical devices and infrastructures—computational instruments, analytical models, price displays, communications networks, marketplace architectures, and so on—enable economic action, constitute markets, and shape the outcomes of exchange.²²

Viewed from within Milken's financial empire, there was more than a kernel of truth in his assessment. Spreadsheets were an essential component of his junk bond operation and the takeover business with which it was symbiotically dependent. Finance in the '80s would have looked different without them. But this is not to ratify the determinism of Milken's remark. Spreadsheets came to thrive in '80s high finance because firms like Drexel provided a hospitable environment in which those technologies could embed. Picked up by human users with preexisting instincts, needs, and ambitions, spreadsheet software like VisiCalc and Lotus 1-2-3 became a durable augmentation for financial agents.²³ With spreadsheets, Milken and his team *accomplished* new financial capacities.²⁴

They accomplished three kinds of augmented capacity in particular, all with visual dimensions.²⁵ First, they achieved new capacities of *surveillance*. With the help of computers, Milken and his team were able to keep precise track of the movement and location of junk bonds, giving Drexel unrivaled command over the market. Second, they achieved capacities of *valuation*. High-yield bonds neatly complemented the affordances of off-the-shelf spreadsheet software. Capitalizing on this congruity, Milken’s team incorporated spreadsheet-aided analyses into their minute-to-minute sales and trading activity, using those valuations to help make junk bonds legibly valuable to others.²⁶ Third, ‘80s financiers achieved augmented *imagination*. Adapting the “what if?” powers of spreadsheets, buyout artists like KKR—among Milken’s most important clients—built hypothetical models about potential buyout transactions and used them to scan for takeover targets. Forward-looking spreadsheets models generated and concretized “fictional expectations” about the economic future, which became the foundation for action in the present.²⁷

Milken’s accusation against spreadsheets was not simply a dispassionate description of financial practice; it was a rhetorical gambit, aimed at shifting responsibility from humans to machines. This points to a second set of questions. How did financiers like Milken use computers *discursively*—to promote certain financial opportunities, legitimate their financial activities in public spheres, and fashion financial selves? Milken’s own rhetorical engagement with computing technology was complex and seemingly contradictory. At some moments, Milken and associates played up the importance of computing in framing their own activities, part of a broader portrayal of Milken’s junk bond operation as an innovative financial “machine.” At others, Milken and his allies distanced themselves from dependence on technology, fashioning a mystique around Milken as a financial visionary whose genius

exceeded mere rational calculation. Instead of a machine, Milken's junk bond operation was presented as a religious movement, a "gospel."

Milken and his spreadsheets offer an instructive case for thinking through a central debate in SSF, about what Arjun Appadurai has called "the ghost in the financial machine." In a bold 2011 article, Appadurai contends that the keen focus on technical devices that defined early SSF scholarship has led scholars to overlook the cultural values or Weberian "spirit" animating contemporary financial capitalism. Appadurai notes that the most in/famous figures in recent Wall Street history, those most responsible for generating change and turmoil, hardly accord with Weber's picture of modern capitalist rationality. "Plainly, when we look at the heroes and (demons) of the past forty years in global finance, especially in the United States (individuals such as *Michael Milken*, Ivan Boesky, and Bernard Madoff), we cannot see in them much of the spirit of the ascetical Calvinist businessman..." Appadurai writes. "Rather, the typical 'master' of the financial universe is not a dull or nerdy accountant or lawyer but a gaudy, adventurous, reckless, amoral type." The exorbitant wealth and power these figures come to control derives not from their superior calculative rationality nor command over a previously "undiscovered set of proprietary databases, screens, tools, or models," Appadurai suggests, but from personal charisma and an attendant confidence in "their capacity to channel the workings of uncertainty." The task for scholars of contemporary financial capitalism is to explicate this "disjuncture... between hypercharismatic leaders and hypermethodical devices," a task which "requires us to admit the gap between the 'ghost' and the 'machine'" in modern finance.²⁸

The interplay between computation and charisma—machine and ghost—was indeed a constitutive feature of Milken and his operation. But the relationship between the two was not the "disjuncture" Appadurai describes. Milken as an individual and his broader operation at

Drexel had both computational and charismatic aspects, both essential to the junk bond enterprise. Those two facets were mutually co-dependent; charisma required computation, and vice versa. The unique success of Milken and his team lay in how they capitalized on this dual constitution.

Junk Finance

In 1969, Michael Milken took a summer position at the investment bank Drexel Harriman Ripley in Philadelphia, while a student at the Wharton School of Finance and Commerce. He continued full-time at Drexel's Wall Street office following his M.B.A. in 1970. (Following a series of mergers, the firm would be rebranded Drexel Burnham Lambert in 1973). In the early 1970s, Milken began to build a small group devoted to certain high-risk corporate bonds.²⁹ Bonds are small tradeable units of debt. An entity wishing to borrow money (the "issuer") might sell bonds to raise upfront cash, promising to pay regular interest ("coupon") payments to the bonds' purchasers ("bondholders") until the bond reaches maturity, when the original capital is paid back. Compared to stocks, corporate bonds are generally lower risk for investors—because the issuing company is legally obligated to pay the interest and principal—and lower reward—because the income to bondholders is fixed and cannot rise with the company's profits. Investment banks like Drexel "underwrite" bond issues, advancing the upfront capital to the borrower and then selling the bonds to investors (including individuals, institutional investors like pension funds, and insurance companies), charging a fee for the service.

Bonds are typically evaluated by ratings agencies like Standard & Poor's (S&P) and Moody's, who assess the financial health of the borrower and the likelihood the company will be able to make the promised interest and principal payments. The most financially secure issuers,

like Microsoft today, earn the highest ratings: AAA; riskier issuers receive lower ratings AA, A, BBB, and so on down through C and D (bonds in default). These ratings govern the interest rates borrowers have to pay on new bonds and guide which bonds certain investors are willing or able to buy. Many “institutional investors,” like pension funds, have traditionally been restricted to purchasing bonds rated “investment-grade,” BBB or higher. BB-rated bonds and below are “high-yield” or, colloquially, “junk.” When Milken began at Drexel, investment banks would only underwrite bonds for the roughly 800 large companies deemed investment-grade. So the only “junk” bonds existing were “fallen angels,” formerly investment-grade bonds that had been downgraded when the issuing companies entered financial distress. Because the price of fallen angels would have fallen considerably from their original price, investors could buy them cheaply and earn a high yield if—a big “if”—the issuers repaid them fully. A 1958 study on *Corporate Bond Quality and Investor Experience* by economist W. Braddock Hickman—which Milken reputedly discovered as an undergraduate—found that such downgraded bonds were actually a good investment, yielding higher returns on average than other assets.

In his early years at Drexel, Milken founded a small unit focused on fallen angels. He would identify promising bonds, buy them at bargain prices, and sell them at a mark-up to Drexel clients looking for exciting, high-return investment opportunities. Milken worked zealously to teach investors about the virtues of these shadowy assets and to recruit new high-yield enthusiasts. His operation grew rapidly. In 1977, Milken’s operation took a bold step and began underwriting new issues of high-yield bonds, creating bonds “born” as junk. Though speculative bonds had been a staple of financing in earlier periods, as in nineteenth-century railroad finance, new issues of non-investment-grade bonds were basically unheard of in American finance when Drexel started, widely seen as a taboo business akin to loan-sharking.

Because they had so few competitors, Drexel could charge much higher fees for issuing high-yield bonds than they could for investment-grade issues.³⁰ Around the same time, Milken's team began to create new high-yield bond retail funds, enabling smaller investors to buy into a diversified bundle of junk bonds.

In 1978, Milken relocated his twenty-person team from New York to Los Angeles, returning to his hometown and gaining considerable autonomy over his operation within Drexel. There he continued to cultivate a powerful network of loyal investors, including Fred Carr of the First Executive life insurance company and Thomas Spiegel the Columbia Savings and Loan Association, who provided Milken access to massive reservoirs of institutional capital. From its new California base, Milken's Drexel team solidified its dominance in the high-yield debt market. In 1978, the firm issued fourteen junk offerings worth \$439.5 million, almost triple their nearest competitor.³¹ The high-yield debt business boomed through the mid-'80s; in 1986 alone Drexel issued over \$14 billion of high-yield bonds. Drexel's high-yield market share regularly topped 50% and sometimes approached 70%.³² Drexel and its employees reaped massive profits, none more than Milken himself, whose annual compensation reached a mindboggling \$550 million in 1987.

Driving this junk bond boom was a new use Milken and his team fashioned for that financial technology: for financing corporate buyouts. In 1981, Drexel members proposed the idea of issuing junk bonds to fund management-led "leveraged buyouts," transactions in which the executives of a publicly-traded company and allied investors used borrowed money to purchase all of a company's public stock and "take the company private." Initially Milken's team only underwrote bonds for "friendly" buyouts, where the company's management was amenable. In 1984 Drexel announced that they would begin backing hostile deals as well. Milken's junk

bonds became the pivotal source of capital fueling the boom in buyouts, raids, and takeovers that defined Wall Street in the Deal Decade.

The Computational Milken

One way to tell the story of Milken's high-yield "revolution" is as a technical triumph, the development and promulgation of an ingenious new financial technology by an industrious engineer. In that version of the story, Milken's defining features were "methodical" ones.

Although Appadurai lists Milken among those master financiers who bore little resemblance to Weber's "ascetical Calvinist businessman," many of Milken's contemporaries saw him as precisely that. His work ethic was legendary. He was known for arriving at the L.A. office by 4:30 or 5:00, supposedly "to work a 14-hour day... and still get home in time to have dinner and spend time with the family." By the standards of '80s finance, his manner was notably modest, reserved, and sober. He dressed plainly and without ostentation, save perhaps for an "ill-fitting toupee," and was never particularly eager to cultivate public fame. He apparently never drank alcohol, caffeine, or even carbonation. Milken *was* "a dull or nerdy accountant" type.³³

From a young age growing up in Encino, California—his father was actually an accountant—Milken's path to a financial career was paved by technical curiosity and technical talent. He reputedly showed a gift for numbers at an early age. As an undergraduate at the University of California, Berkeley, he began as a mathematics major, switched to business administration, and reportedly spent much of his time at a stockbroker's office on Shattuck Avenue. One of his successful early stock picks was "a computer software company that made a program for accountants."³⁴ After graduating in 1968, Milken worked at the accounting firm Touche Ross before beginning his M.B.A. at Wharton, where he earned a competitive Joseph

Wharton fellowship. At Wharton he reputedly signed up for three majors—information systems, operations research, and finance—and earned straight As, while conducting significant research on corporate finance with Wharton faculty.³⁵

In 1969, Milken began his M.B.A summer at Drexel Harriman Ripley working with director Anthony Buford, Jr. on Drexel's planning and operations. Drexel was in the midst of overhauling the back-office systems it used to process transactions and track the money and securities it circulated. The firm was attempting to switch to a computer-based system to address a mounting "paper crunch"—part of a broader crisis hitting Wall Street in the late 1960s.³⁶ Creating a new digital infrastructure for financial operations was thus the first endeavor in Milken's banking career. His precocity earned him a position working on other special projects as an assistant to the firm's president, including a project reforming the firm's system for physical delivery of securities credited with saving \$500,000 annually. Drexel's co-director of research Ernest Widmann recalled his early impression of Milken "using mathematics to solve all kinds of organizational or business problems."³⁷

Milken's early career was built on his acumen as a financial technician. Those talents would carry over into his high-yield enterprise, as he steadily built a potent machine for monitoring, manufacturing, and mobilizing junk-bond. The physical and symbolic nexus of this complex was an X-shaped constellation of desks on Drexel's Beverly Hills trading floor. Milken sat at the vertex, "holding six conversations at once."³⁸ The configuration was established so that "there's no place that you can sit on that desk where you can't really look at somebody in the eye," recalled Lorraine Spurge, once Milken's executive assistant and later a top Drexel executive.³⁹ Few images are better for visualizing the notion of a "socio-technical assemblage" so central to SSF research. Contemporaries did not use the language of assemblages to describe

Milken's operations, of course, but they did very commonly call it a *machine*—a “marvelous money machine,” as a November 1984 *Forbes* cover labelled it.⁴⁰

Spreadsheets in Milken's Marvelous Money Machine

Personal computers, and spreadsheets in particular, were integral components in Milken's high-yield machine. Spurge recalled how she used to pick Milken up early in the morning and he would spend the drive to work “looking at the spreadsheets, the trading sheets.”⁴¹ The famed X-shaped desk in Beverly Hills was “lined with personal computers loaded with spreadsheets.” “If VisiCalc was the ‘killer application’ for the new PC,” writes Christopher Westland, “then Milken certainly must have to be considered the killer applicant.”⁴² Personal computing technologies appear to have shaped the working practices of Milken and his broader network in three crucial ways: surveillance, valuation, and imagination.

The first—*surveillance*—concerned Milken's management, oversight, and indeed construction of the market for high-yield debt. The success of the Drexel junk bond operation depended on the vast matrix of investors, insurance and banking executives, corporate raiders, arbitrageurs, and other clients that Milken had assembled, upon whom he could depend to buy or sell bonds, invest in deals being proposed by other members of the network, absorb Milken-backed securities that other clients needed to sell, and so on. Critically, only Milken and his team could comprehend who was included within this network, where various securities were owned, and the prices they could sell for. It was a “vast, interlocking machine of which he alone would know all the parts.”⁴³ Because other participants had so little information about the rest of the high-yield market, they were forced to transact business through the Drexel nexus.

Contemporaries like Joseph DiMartino, a bond portfolio manager at Chase Manhattan,

appreciated that informational control was key to Milken's dominance: "No one could touch his ability to know where things were."⁴⁴ Though it likely began largely in Milken's own memory, this remarkable surveillance of the high-yield market came to depend on new techniques of digital information management. As biographer Connie Bruck described it, Milken and the Drexel team set up a "supercomputer system" to map and manage the high-yield matrix. Milken "knew, with his phenomenal memory augmented by his computer system in Beverly Hills, where nearly every bond was.... As one junk aficionado put it in a frequently uttered refrain, 'Michael is the market.'"⁴⁵

This surveillance capacity was largely independent of the specific assets Milken's operation traded. But PCs, and spreadsheets in particular, also helped Milken and his team achieve a second capacity—*valuation*—distinctly tied to the nature of junk bonds. Among financial securities circulating at the time, high-yield bonds were arguably the ones for which PCs offered the most decisive analytical benefits. Investment-grade bonds were comparatively uninteresting analytically, as their prices moved in lock-step with macroeconomic benchmarks. Stocks posed a much more open-ended (and less tractable) analytical puzzle, but they were already the subject of a wide array of competing valuation techniques; spreadsheets just added one more tool to an already-crowded arsenal. Many derivative securities, like options or mortgage-backed securities, required much more specialized forms of modeling and were often the province of "Ph.D.'s in math, economics, and/or physics."⁴⁶ Compared to these other securities, junk bonds were well-suited for analysis on personal computers with flexible, ready-made software. They were complicated enough that PCs offered huge advantages over pen-and-paper methods, but not so much that they demanded esoteric models, specialty software, or doctoral-level mathematics. They could be analyzed using nimble spreadsheet models with a

manageable number of variables (like principal value, market price, interest payments, and default risk).

Because bonds involve streams of fixed payments, the central challenge of analysis is making an array of payments across future time periods commensurable to one another. Generally, this is done by reducing all future payments into present terms—calculating what a payment two or ten or fifty years in the future is worth *today*—using a technique called *net present value (NPV)*.⁴⁷ This was an ideal task for a computer spreadsheet: the series of payments could be slotted into sequential cells and the present value of each calculated and then summed using standard arithmetical and exponential operators. Early spreadsheet software even came pre-programmed with an *NPV* function.⁴⁸ A 1985 *Wall Street Journal* article highlighted precisely this function in explaining the effect of spreadsheets in business: “Thousands of MBAs, relieved of the drudgery of financial calculations, turned into what [Mitch] Kapor [creator of Lotus 1-2-3] refers to as ‘net-present-value machines.’”⁴⁹

These two critical uses of PCs, surveillance and valuation, complemented each another. Westland describes how these digital tools augmented the capacities of Milken’s Drexel team, notably the salespeople responsible for marketing junk bonds. Previously, salespeople had to wait days for separate research departments to provide information and analysis on securities. “With PCs, spreadsheets and data on inventories, market prices and customers at their fingertips, bond salespeople were no longer reliant on... a distant research department,” Westland writes. “Instantly tying numbers to their telephone narrative, salespeople could buy and sell, restructure deals and process new market information while they were speaking to customers.”⁵⁰

The third augmentation enabled by spreadsheet software—imagination—was potentially the most decisive in empowering new forms of financial action. Spreadsheets proved essential

for modelling the buyout transactions that drove demand for high-yield bonds. In a leveraged buyout (LBO), the purchaser acquired a company's existing stock from shareholders by taking on heavy amounts of debt—frequently, Milken's junk bonds—using the assets of the to-be-acquired company as collateral. (The buyer would contribute only a small fraction of the purchase price in cash). Because the company's own revenues would cover the sizeable interest payments, the best targets for LBOs were companies generating high “free cash flow” relative to their stock price. For buyout artists, the goal was to saddle the target company with as much debt as its cash flow could sustain. Higher “leverage” also magnified the returns to the buyer and decreased how much of their own money they had to risk. Interest was also tax-deductible, so higher debt meant lower taxes.

Assessing a potential leveraged buyout required forecasting the future finances of the target business under different assumptions about the potential transaction structure (like the amount of debt raised or the interest rate). “The backbone of any successful LBO is a set of projections: profits, sales, and, most important, cash flows,” wrote the authors of *Barbarians at the Gate*, a 1990 exposé on the RJR Nabisco buyout. “Because they dictate the amount of debt a company can safely repay, projections are the key to formulating a bid.”⁵¹ Creating financial projections were one of the foundational uses for computer spreadsheets from the very beginning. In one 1984 manual on *Spreadsheets on the IBM PC*, the very first example in the chapter on “Getting the Most Out of What If... Analysis” was a “projected cash flow statement” in which the bottom line showed “FREE CASH FLOW” after “Repayment of Debt.”⁵² Clever modelers could easily adapt the forecasting templates taught in spreadsheet manuals into tools for experimenting with LBO transactions and scanning for buyout targets. As one critic

reminisced in 2013: “Financiers could run endless fantastical scenarios (Lever the bank 40 to 1? Lotus [1-2-3] says it could work!) without picking up a pencil.”⁵³

One institution that eagerly seized upon these fantastical capacities was KKR, a vital node in Milken’s network. KKR relied on Milken-backed high-yield bonds in financing thirteen of its biggest buyouts between 1984 and 1989, including a massive \$5 billion from Milken for the RJR Nabisco deal.⁵⁴ According to business journalist George Anders, KKR executive Donald Herdrich stopped by a Manhattan electronics store in 1980 to purchase a personal computer as entertainment for his children. While there, an enterprising sales associate offered Herdrich a demonstration of VisiCalc. “Enthralled” by VisiCalc’s ability to recalculate projections instantaneously upon changing one cell, Herdrich purchased KKR’s first Apple IIe. It proved a “decisive advantage.” “In the 1970s, KKR couldn’t rapidly stalk several companies at once, because its financial blueprints required weeks of calculations by hand,” Anders explained. “Then microchips came to Wall Street.... All of a sudden, giant companies’ finances could be picked apart in an afternoon.”⁵⁵

Buyout firms began investing heavily in computing technology, upgrading hardware and shifting to more sophisticated packages like Lotus’s 1-2-3 and Symphony. *Wall Street Journal* advertisements touted “\$99 ‘LBO software packages’ that let even a neophyte race through the types of calculations that had once taken Herdrich and Kravis weeks.” This ability to “stalk” buyout targets through spreadsheets empowered upstart firms. As Ander put it: “the personal computer accomplished for Wall Street’s buyout boutiques what the advent of gunpowder did for Mongol warriors.”⁵⁶ Like gunpowder, spreadsheets proved to be potent tools of persuasion, used by buyout artists to help others—lenders, managers, shareholders—see the future the buyers wanted. “The subtext of the takeover of RJR/Nabisco....,” writes Schrage of KKR’s biggest deal,

“is that the ultimate purchase depended less on the charm or deep pockets of any particular investor than on the combined analytical and operational persuasiveness of their spreadsheets.”⁵⁷

From one perspective, the story of Milken-era finance is a story about the disruptive effects of computing technology and the triumph of a new forms of methodical rationality in a realm dominated by elite sociality. For some this change was salutary, even democratizing. Because of Milken, wrote Peter Passell in the *New York Times* in 1989, “sharp elbows and a working knowledge of computer spreadsheets suddenly counted more than a nose for dry sherry or membership in Skull and Bones.” Milken himself touted the fact that “junk bonds allow entrepreneurs outside the system to get capital and realize their dreams.” For others, including many “white shoe” bankers displaced by Milken and the buyout artists, new computational methods enacted a fanciful and reckless form of finance. “Buyout fund after buyout fund plunged into the market, buying up lackluster companies at grossly inflated prices,” wrote *Los Angeles Times* columnist Charles R. Morris. “Twenty-five year-olds made millions playing computer games with their Lotus spreadsheets.”⁵⁸

The Charismatic Milken

Yet to tell the history of Milken and the go-go ‘80s as a story of method and mechanism is to leave the story partially untold. What of Appadurai’s “ghost” in Milken’s machine? There is a second narrative that was commonly told of Milken and his junk bonds, centered not on computation but charisma. According to many participants and observers, Milken’s operation was much more a social and even cultural achievement than a technical one. Milken’s power lay in his ability to construct around him an ever denser network of investors, entrepreneurs, executives, and raiders who were personally beholden to him—what Milken called “matrixing.”

“Because he controlled so much of the market...,” wrote a 1990 *Newsweek* feature, quoting a contemporary attorney, “Milken had the influence to get people to take a deal they wouldn’t have otherwise.” “A lot of these institutions would buy just on Milken’s say-so,” recalled John Sorte, co-head of corporate finance at Drexel in the Milken era. “They didn’t do their own analysis.” While Milken’s operations used computing to visualize and manage this matrix, it also relied heavily on Milken’s personal skills in recruiting new members, identifying beneficial interlinkages, and convincing others to believe in his “junk bond gospel.”⁵⁹

One of the most striking patterns in the discourse in and around Milken was the prevalence of religious language. Milken was labelled a “prophet,” “guru,” or even “God,” his clients as “devotees,” his employees “disciples.”⁶⁰ Milken’s promotion of high-yield finance was “evangelizing,” a “sermon,” a “crusade,” while his conflict with the American financial and business “establishment” was a “holy war.”⁶¹ (The metaphor of religious conflict took on extra poignancy given the anti-Semitism that Milken, who is Jewish, and the Jewish members of his network faced.)⁶² Drexel employees embraced this religious language fervently. Drexel investment banker Stephen Weinroth had a framed quotation in his office which read that “Drexel is like a god.” In 1986, Drexel banker Leon Black admitted: “I’m not much given to hero worship, but I have to tell you I never thought there would be a Michael Milken.” Ned Kennan, a psychologist brought in by Drexel chief Fred Joseph to consult in the mid-1980s, diagnosed that “Drexel wasn’t a business, it was a religion. Milken was God, Joseph was his prophet, and the Corporate Finance and High-Yield departments were his disciples.” According to a contemporary banker, most of Milken’s clients and investors also “thought he was the Messiah... The theory was that he could turn lead into gold.” Critics invoked religious language

too. The powerful CEO of Salomon Brothers, John Gutfreund, once remarked that “Milken thought he was in the church business.”⁶³

Milken was frequently described as having mystical powers that transcended the normal order of finance—the “grand sorcerer of finance” and “a dream-maker... [able] to turn fantasies into realities.” Among the powers frequently ascribed to Milken was a kind of superhuman vision. Visionary language pervaded depictions of Milken. “There are plenty of brilliant people in the world,” noted friend Neal Kassel in 1988. “What separates [Milken] is he has a vision.” “Like a champion chess player,” described a 1986 *Forbes* piece, “Milken sees not only today’s deal but several moves ahead.” As Leon Black put it, “He’s someone who sees the big picture all the time—and also the small picture.” Some thought Milken could see into the future. In April 1992, *Forbes* published a large collection of readers’ letters responding to an earlier (sympathetic) interview with Milken post-conviction. One reader wrote that “Milken’s crime against society is that he... could correctly see into the future and used that ability to exploit his issuer clients, his investors and even his own firm.”⁶⁴

Milken’s numinous persona was partly the product of media coverage and Wall Street rumor, but Milken also actively worked to construct it through his self-presentation, social tactics, and managerial policies. Drexel employee Don Engel recalled that “he would speak in parables. ... It became almost like mystical.” In interacting with others he exhibited unflinching confidence in his financial mission and his own rectitude. “He only cared about bringing the truth,” reported a Drexel executive. “If Mike hadn’t gone into the securities business, he could have led a religious revival movement.” Milken cast his development of high-yield finance as a higher cause, which he elevated above his own personal reward. “The example Milken set must have done much to bind his people to him—,” wrote Connie Bruck, “an example of sublimation

of all things personal, and utter consecration to his mission, which was framed not just as money-making but challenging the prevailing misconceptions of the financial world.”⁶⁵ Milken’s charismatic image was further advanced by a “compulsion for secrecy which bordered on the fanatical.” He “shielded his deals in secrecy,” avoided excessive personal publicity, and even left his name off the Drexel annual report, all of which burnished his mystique. Obscurity prevailed within Drexel too. “Throughout the Milken *monastery*, money was shrouded in mystery and intrigue,” wrote a 1992 *Harvard Business Review* feature. Milken’s own employees never knew exactly how their compensation was calculated or how much they were worth in Milken’s eyes, uncertainty that helped Milken maintain sway over his disciples.⁶⁶

Milken actively stoked the mystical air around him. He was fascinated by the work of business writer and popular futurologist John Naisbitt and drew upon those idea to imbue his high-yield mission within a futuristic spirit. Milken believed the essence of business success was “recognizing what people want and need in the future,” and the power of high-yield bonds came in enabling those with forward-looking ideas to realize those dreams. “Traditionally, lenders have found the future more risky than the past,” Milken explained. “Future-oriented lenders, however, have a different perspective... Future, not past, performance, after all, was going to pay off the loan.” Milken’s champions, like economist Glenn Yago, cited this as Milken’s grand idea: the “concept that a company should be judged on its potential rather than what it has previously accomplished.” Milken reportedly began meetings with new entrepreneurs and dealmakers by asking them: “Tell me your dreams.”⁶⁷

Transcending the Technical

Essential to Milken's charisma was the impression that his capacities transcended the mere technicalities of finance. In his own self-presentation, Milken persistently sought to fashion finance as something more than just the pragmatics of deal-making, and to fashion himself as more than a financier. In a speech Milken once made to high-school students at the "American Academy of Achievement" in Washington, D.C., Milken declared: "Finance is an art. Not yes or no, right or wrong. It is an art form, an understanding of who should be the companies of the future, and how to structure transactions."⁶⁸ In both private and public interactions, Milken routinely cast himself as a higher intellectual with expertise beyond finance. He reputedly often claimed to have graduated from Berkeley with a degree in mathematics rather than business "He wanted to make himself look more brilliant," recalled a childhood friend, "to look as if he was both a whiz at business and also able to get into those ivory-tower, more academic areas like higher mathematics." He pulled this trick on at least one *New York Times* reporter, who credited Milken as a mathematics major in a 1978 profile. In a controversial interview with *Forbes* in 1992, after his conviction, he declared: "I think of myself as a social scientist.... I mean not just looking at financial figures—looking at society." An especially striking example of Milken's intellectual self-aggrandizement came in a November 1988 *Washington Post* feature, as the legal heat around Milken was intensifying. "Milken said he has had several conversations with his sons about the situation," wrote reporter David Vise. "One of his boys, he said, compared him with the Greek philosopher Socrates, who was persecuted for his unconventional views even though he had devoted himself to the pursuit of truth and goodness."⁶⁹

Vital to Milken's sage-like persona was the sense that his financial vision was more-than-just calculation. While many acknowledged that he had an "an excellent onboard computer" in

his head, for Milken and his disciples his greatness resided in accessing a realm of insight and imagination beyond rational computation.⁷⁰ A remarkable testament to Milken's *supra-rationality* came courtesy of Drexel CEO Fred Joseph:

I used to sit with a company and say, "What do you want?"... All the other firms didn't have the confidence of having a Milken would could sell this paper... So they had to look at spread sheets [*sic*], figure out what had been done, and do one just like it. But we could just sit there with our minds wide open and smoke pot—he laughs—daydream, and say, "What do you want?"⁷¹

For fierce defenders like Yago, this ability to transcend the technical was both a competitive advantage and a social virtue. "Interesting, in a world of finance characterized by quantitative methods, numerical minutiae, and concrete business plans," wrote Yago in 1991, "the first question Milken was to ask entrepreneurs and managers seeking to raise money... [was] 'What are your hopes and dreams?'"⁷² Some of Milken's harshest critics like Ben Stein also attributed his extraordinary influence to some essentially non-technical genius. In scathing articles for *Barron's* and a 1992 book, Stein assailed the notion that Milken's high-yield operation was technical ingenious and that Milken was a great financial engineer. Yet Stein conceded that Milken had some distinct abilities—just not technical ones. "His understanding of how to make things happen, how to make the world go his way, how to wheel and deal and control was stupendous..." Stein wrote in *License to Steal*. "If one considers what he accomplished, even for ill, he must be some sort of genius, a real magician in his understanding of the human spirit."⁷³

Between Computation and Charisma

Two metaphors dominated how Drexel's high-yield operation was understood, by participants, observers, and critics alike. One saw Milken as the engineer and chief operator of a technically

innovative “money machine”; the other saw him as the charismatic leader of a pseudo-religious order built on interpersonal devotion and superhuman “vision.” In contrasting the “hypermethodical” and “hypercharismatic” conceptualizations of modern finance, Appadurai formalizes a distinction already at the heart of ‘80s financial culture. Appadurai is right to ask how Milken’s financial heroics depended on forms of charisma and “strategies of divination” that diverged from the technics of “databases, screens, tools, or models.”⁷⁴ But to suggest that Milken’s power was essentially charismatic *rather* than methodical is to miss a profound fact of financial capitalism in the period: those two modes were constitutively interdependent.

As a matter of financial practice, many of the exceptional capacities that comprised Milken’s mystique were assembled together with an emerging technical apparatus: his gift for “matrixing” was achieved in conjunction with the information-management capacities of PCs; his future-oriented conception of American business arose in concert with spreadsheet tools that dramatically eased “present value” calculations; his ability to make dreams come true for entrepreneurs and investors was facilitated by spreadsheet models that helped isolate what transactional variables to adjust in order to realize those economic dreams.⁷⁵ At the same time, the mechanics of Milken’s money machine only functioned because of the personal devotion Milken attracted in his followers—from the Drexel disciples who manned the X-desk, to the network of faithful investors who would buy whatever he offered, to the entrepreneurs and raiders with faith Milken could deliver the high-risk deals they dared to dream.

The interdependent relationship between the mechanical-computational and mystical-charismatic aspects of Milken’s agency is also essential to understanding the culture of ‘80s finance. This dyad was central to how Milken and his disciples promoted and justified their activities to broader publics and to how they fashioned their financial selves. Milken and his

closest advocates pivoted between emphasizing the mechanical and the mystical. Before more hostile audiences, for whom Milken's individual artifice indicated the illicit character of his enterprise, it was shrewd to embrace the technicality of Milken's machine. Taken to the extreme, this might entail adopting a kind of technological determinism, suggesting that the junk bond revolution and takeover frenzy it fueled were the inevitable consequence of evolving computational and financial technology, not the designs of profit-seeking individuals. This is how to understand this paper's opening quip, when Milken blamed VisiCalc for the '80s' financial ills. Milken's accusation against spreadsheets sits in a longer lineage of arguments by market advocates, from libertarian theorists like Friedrich Hayek to modern economists of "mechanism design," analogizing markets to machines for achieving social ends.⁷⁶

At other times, it was empowering for Milken and associates to downplay the machine-like character of their enterprise and seize upon its super-rational dimensions instead. Before generous audiences, like potential investors and readers of the business press, it was empowering to cast Milken's project as a visionary mission to refashion the future of American business and society. Milken's vision was so potent precisely because it entailed a disruption—a transcendence—of the mundane mechanics of power and capital on Wall Street. One group especially eager to embrace the ghost in Milken's money machine were Drexel team-members, who commonly spoke of their high-yield mission in religious terms. It is illuminating to read this spiritual idiom in the light of the technological intensity of Milken's operation. The fact that the junk bond machine was so dependent on new technological devices was, I propose, a key reason why the human components of that system wished to understand their achievement as beyond technical. The machine vision had alienating implications for Milken's people, perhaps even Milken himself, who risked being reduced to cogs in the financial machinery.

The height of Milken's power coincided with increasing public attention to the incursion of PCs into the financial industry. In a series of articles in the *New York Times*, David E. Sanger captured a murmuring anxiety among financial professional that humans had "become captive to computers," that certain traditional functions like full-service brokerage would be displaced, and that markets would become increasingly unstable as they were "virtually run by machines."⁷⁷ Social-scientific studies of financial practice have explored how the incursion of new technologies can powerfully destabilize financial actors' identity and sense of agency. As Donald MacKenzie notes, financial cultures feature a lexicon of epithets for those who have become captive appendages to calculative devices—like a "sheet monkey" or "F9 monkey." "Pressing the F9 key when using a spreadsheet instructs the program to perform the calculations implemented in the spreadsheet," MacKenzie explains, "and an 'F9 monkey' is someone who allows the resultant number of numbers to determine their actions."⁷⁸ Conversely, financiers valorize those who exhibit independence from calculation. He notes how senior bankers make a point of hiring "confident" junior analysts, capable of seeing the "real big picture situation" rather than "running another five hundred worksheets, spreadsheets" and "being sure all of the numbers are perfectly correct."⁷⁹ These specific concerns about becoming captive to mechanistic calculation are one aspect of a broader anxiety on the part of financial actors that they might lose their agential selves within the ruthless efficiency of the market.⁸⁰

The power of Milken's high-yield operation thus derived from both the outstanding mastery of a novel configuration of technical components and a common confidence that the mission was more than the sum of those mechanical parts. For Milken and his disciples, these were not conflicting identities but complementary ones. Milken's ability to nurture and perform these dual constitutions was the foundation of his anti-/heroic status within '80s finance. Some

people who knew Milken saw such malleability as one of his defining features. In discussing how Milken used to pretend he had majored in mathematics, a childhood friend offered a fitting description of Milken. “He wanted to have it every possible way,” that friend explained, “to look good from whatever angle people were looking at him.”⁸¹

¹ For example, Paul E. Steiger, “Ten for the Textbooks,” *The Wall Street Journal* (Jun. 23, 1989), B1a.

² Milken’s net worth as of Nov. 1, 2019, per *Forbes*: <https://www.forbes.com/profile/michael-milken/>.

³ On VisiCalc and other early spreadsheet programs, see the special issue of *IEEE Annals of the History of Computing* 29, no. 3 (Jul.-Sep. 2007), ed. Paul Ceruzzi and Burton Grad, esp.: Martin Campbell-Kelly, “Number Crunching without Programming: The Evolution of Spreadsheet Usability” (6-19); Grad, “The Creation and Demise of VisiCalc,” (20-31). See also: Melissa Rodriguez Zynda, “The First Killer App: A History of Spreadsheets,” *interactions* 20, no. 5 (Sep.-Oct., 2013): 68-72; Campbell-Kelly, “The Rise and Rise of the Spreadsheet,” in *The History of Mathematical Tables: From Sumer to Spreadsheets*, ed. M. Campbell-Kelly, M. Croarken, R. Flood, and E. Robson (Oxford: Oxford University Press, 2003), 323-348.

⁴ Allan Sloan and Howard Rudnitsky, “Taking in Each Other’s Laundry,” *Forbes* (November 19, 1984), 207-222; Steven Levy, “A Spreadsheet Way of Knowledge,” *Harper’s* (Nov. 1984), at <https://www.wired.com/2014/10/a-spreadsheet-way-of-knowledge/>.

⁵ Chris Westland, *Global Innovation Management: A Strategic Approach* (Basingstoke, UK: Palgrave Macmillan, 2008), 79; Michael Schrage, *Serious Play: How the World’s Best Companies Simulate to Innovate* (Boston: Harvard Business School Press, 2000), 40.

⁶ “Spreadsheets: Broken Link: Computing Power, like Political Power, Corrupts,” *Financial Times* (Aug. 30, 2013); “Episode 606: Spreadsheets!” *Planet Money* podcast (Feb. 25, 2015), <https://www.npr.org/sections/money/2015/02/25/389027988/episode-606-spreadsheets>; Janet Burns, “How the Invention of Spreadsheet Software Unleashed Wall Street on the World,” *Gizmodo* (Aug. 14, 2019), <https://gizmodo.com/how-the-invention-of-spreadsheet-software-unleashed-wal-1837177232>.

⁷ Data from Marcel Kahan and Edward B. Rock, “How I Learned to Stop Worrying and Love the Pill: Adaptive Responses to Takeover Law,” *University of Chicago Law Review* 69 (2002): 871-915, on 874.

⁸ This legal drama was vividly recounted in James Stewart, *Den of Thieves* (New York: Simon & Schuster, 1991).

⁹ For a useful economic overview: Bengt Holmstrom and Steven N. Kaplan, “Corporate Governance and Merger Activity in the United States: Making Sense of the 1980s and 1990s,” *Journal of Economic Perspectives* 15, no. 2 (Spring 2001): 121-144.

¹⁰ Mark L. Mitchell, “The Impact of Industry Shocks on Takeover and Restructuring Activity,” *Journal of Financial Economics* 41 (1996): 193-229, esp. 198-199.

¹¹ Sanjai Bhagat, Andrei Shleifer, and Robert Vishny, “Hostile Takeovers in the 1980s: The Return of Corporate Specialization,” *Brookings Papers on Economic Activity. Microeconomics* (1990): 1-72, esp. 22-25

¹² Susan C. Faludi, “The Reckoning: Safeway LBO Yields Vast Profits but Exacts a Heavy Human Toll,” *The Wall Street Journal* (May 16, 1990). On private equity and its social consequences: Daniel Souleles, *Songs of Profit, Songs of Loss: Private Equity, Wealth, and Inequality* (Lincoln: University of Nebraska Press, 2019).

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- ¹³ Karen Ho, *Liquidated: An Ethnography of Wall Street* (Durham, NC: Duke University Press, 2009), 129-150.
- ¹⁴ Michael C. Jensen, "Takeovers: Their Causes and Consequences," *Journal of Economic Perspectives* 2, no. 1 (Winter 1988): 21-48.
- ¹⁵ Ho, *Liquidated*, 132-134.
- ¹⁶ Alan J. Auerbach and David Reishus, "The Impact of Taxation on Mergers and Acquisitions," in *Mergers and Acquisitions*, ed. Alan J. Auerbach (Chicago: University of Chicago Press, 1987), 69-86; Andrei Shleifer and Robert W. Vishny, "The Takeover Wave of the 1980s," *Science* 249, no. 4970 (Aug. 17, 1990): 745-749.
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- ¹⁹ I hope to inspire further archival study, notably in the Drexel Burnham Lambert papers at the Museum of American Finance: https://www.moaf.org/publications-collections/museum-collection/dbl_finding_aid. The MOAF is currently closed following a 2018 flood.

²⁰ Nathan Ensmenger, “The Digital Construction of Technology: Rethinking the History of Computers in Society,” *Technology and Culture* 53, no. 4 (Oct., 2012), 753-776, on 753, 757.

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²⁴ See Janet Vertesi’s notion of *software accomplishments*: “From Affordances to Accomplishments: PowerPoint and Excel at Nasa,” in *digitalSTS: A Field Guide for Science and*

Technology Studies, ed. Janet Vertesi and David Ribes (Princeton, NJ: Princeton University Press, 2019), 369-392.

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²⁸ Arjun Appadurai, “The Ghost in the Financial Machine,” *Public Culture* 23, no. 3 (2011): 517-540, on 520, 524, 532, 533, 536. *Emphasis* mine.

²⁹ For details of Milken’s life and career, see: Bruck, *Predators’ Ball*, 23-102; Jesse Kornbluth, *Highly Confident: The Crime and Punishment of Michael Milken* (New York: William Morrow, 1992), 31-91.

³⁰ Kornbluth, *Highly Confident*, 48.

³¹ Bruck, *Predators’ Ball*, 48.

³² For data, see John R. Emshwiller, “Milken’s Pursuit of Business Opportunity Built a Personal Fortune, Brought Drexel to the Fore,” *The Wall Street Journal* (Sep. 8, 1988), 7A.

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³⁴ Benjamin J. Stein, *A License to Steal: The Untold Story of Michael Milken and the Conspiracy to Bilk the Nation* (New York: Simon & Schuster, 1992), 20; Howard Rudnitsky, Allan Sloan, and Richard L. Stern, with Matthew Heller, “A One-Man Revolution,” *Forbes* 138, no. 4 (Aug., 1986): 34-49, on 48; O’Reilly, “Midas Touch”; Bruck, *Predators’ Ball*, 28.

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³⁶ Kennedy, “Machine in the Market,” 898-902.

³⁷ Bruck, *Predators’ Ball*, 24-26; O’Reilly, “Midas Touch.”

³⁸ O’Reilly, “Midas Touch.”

³⁹ Max Abelson, Jason Kelly, and David Carey, “Renegades of Junk: The Rise and Fall of the Drexel Empire,” *Bloomberg* (Apr. 1, 2015), <http://www.bloomberg.com/graphics/2015-drexel-burnham-oral-history/>.

⁴⁰ See the cover of *Forbes* (Nov. 19, 1984); Bruck, *Predators’ Ball*, chap. 12. Relatedly: Sarah Bartlett, *The Money Machine: How KKR Manufactured Power & Profits* (New York: Warner, 1991).

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- ⁴¹ Abelson et al., “Renegades.”
- ⁴² Westland, *Global Innovation*, 79.
- ⁴³ Bruck, *Predators’ Ball*, 14.
- ⁴⁴ Rudnitsky et al., “One-Man Revolution,” 44.
- ⁴⁵ Bruck, *Predators’ Ball*, 68, 95.
- ⁴⁶ Donald MacKenzie, *An Engine, Not a Camera: How Financial Models Shape Markets* (Cambridge, MA: MIT Press, 2006), chaps. 5-6; Michael Lewis, *Liar’s Poker: Rising through the Wreckage on Wall Street*, later ed. (New York: Norton, 2010 [1989]), 16.
- ⁴⁷ The “present value” of \$100 in five years is however much you have to save today to have \$100 in five years, assuming compound interest.
- ⁴⁸ Andrew T. Williams, *What If?: A User’s Guide to Spreadsheets on the IBM PC* (New York: Wiley, 1984), 50.
- ⁴⁹ William M. Bulkeley and Bob Davis, “1-2-3, Go: Lotus Has a Program for Software Primacy, But Bugs Aren’t Out,” *Wall Street Journal* (May 15, 1985).
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- ⁵² Williams, *What If?*, 56-57.
- ⁵³ “Spreadsheets: Broken Link.”
- ⁵⁴ George Anders, *Merchants of Debt: KKR and the Mortgaging of American Business* (Washington: Beard, 1992), 83; Westland, *Global Innovation*, 64.
- ⁵⁵ Anders, *Merchants of Debt*, 40-41; Schrage, *Serious Play*, 45.
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⁵⁷ Schrage, *Serious Play*, 46.

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⁶⁰ Bruck, *Predators' Ball*, 86, 252, 266; Sloan and Rudnitsky, "Taking in," 207; O'Reilly, "Midas Touch."

⁶¹ Kornbluth, *Highly Confident*, 44, 66, 119; Rudnitsky et al., "One-Man Revolution," 34; Sloan and Rudnitsky, "Taking in," 207.

⁶² Bruck, *Predators' Ball*, 29, 205, 331; Kornbluth, *Highly Confident*, 98-99.

⁶³ Bruck, *Predators' Ball*, 68, 244-245; Kornbluth, *Highly Confident*, 80, 89.

⁶⁴ Emshwiller, "Milken's Pursuit"; Vise, "Dream-Maker"; Rudnitsky et al., "One-Man Revolution," 48; O'Reilly, "Midas Touch"; Bruck, *Predators' Ball*, 245; Richard Lehmann, in "The Milken Letters," *Forbes* (Apr. 12, 1992), 66-67, on 67.

⁶⁵ Abelson et al., "Renegades"; Bruck, *Predators' Ball*, 25, 88.

⁶⁶ Kornbluth, *Highly Confident*, 88; Rudnitsky et al., "One-Man Revolution," 34, 40; Bruck, *Predators' Ball*, 32, 69, 84; William Taylor, "Crime? Greed? Big Ideas? What Were the '80s About?" *Harvard Business Review* (Jan.-Feb., 1992): 32-45, on 41. *Emphasis mine.*

⁶⁷ Yago, *Junk Bonds*, vii, 25-26; Rudnitsky et al., “One-Man Revolution,” 40; Robert Sobel, *Dangerous Dreamers: The Financial Innovators from Charles Merrill to Michael Milken*, reprint ed. (Washington: Beard, 2001 [1993]), 70; Vise, “Dream-Maker.”

⁶⁸ Rudnitsky et al., “One-Man Revolution,” 40.

⁶⁹ Stein, *License to Steal*, 34; Sharon Johnson, “Mohammed and the Mountain,” *New York Times* (Jan. 29, 1978), sec. 3, p. 5; Michael Milken, with James W. Michaels and Phyllis Berman, “My Story,” *Forbes* (Mar. 16, 1992), 78-100, on 95, 98, 100; Taylor, “What Were the ‘80s About?” 41; Vise, “Dream-Maker.”

⁷⁰ Kornbluth, *Highly Confident*, 45.

⁷¹ Bruck, *Predators’ Ball*, 72.

⁷² Yago, *Junk Bonds*, 25.

⁷³ Stein, *License to Steal*, 203.

⁷⁴ Appadurai, “Ghost in the Financial Machine,” 532.

⁷⁵ Bruck, *Predators’ Ball*, 72.

⁷⁶ Philip Mirowski, *Machine Dreams: Economics Becomes a Cyborg Science* (Cambridge: Cambridge University Press, 2001); Philip Mirowski and Edward Nik-Khah, “Command Performance: Exploring What STS Thinks It Takes to Build a Market,” in *Living in a Material World*, ed. Pinch and Swedberg, 89-128; Pardo-Guerra, “Creating Flows,” 84-86.

⁷⁷⁷ David E. Sanger, “Brokerage by Computer Grows,” *New York Times* (May 19, 1985), sec. 12, p. 32; Sanger, “Wall Street’s Tomorrow Machine,” *New York Times* (Oct. 19, 1986), sec. 3, pp. 1, 30; Sanger, “New Reliance on Computers Is Altering Investors’ Tactics,” *New York Times* (Dec. 15, 1987), A1, D6.

⁷⁸ MacKenzie, *Material Markets*, 21; Zaloom, *Out of the Pits*.

⁷⁹ Ho, *Liquidated*, 102.

⁸⁰ Hirokazu Miyazaki, *Arbitraging Japan: Dreams of Capitalism at the End of Finance*

(Berkeley, CA: University of California Press, 2013); Preda, *Noise*.

⁸¹ Stein, *License to Steal*, 34.