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THE QUANTAMENTAL REVOLUTION

**FACTOR INVESTING IN THE AGE OF MACHINE
LEARNING**

Milind Sharma

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I have personally mentored well over 150 MFE students over the past 16 years who are now gainfully employed at the top Wall Street firms ranging from Goldman Sachs, Morgan Stanley, BlackRock and Pimco to the top quant hedge funds. Many were from Carnegie Mellon's MSCF program, but some were from Columbia's MSBA not to mention UCLA and the other top MFE programs, where I have directed a variety of Capstone course projects. Many MFE students have collaborated with us on numerous QuantZ white papers and QMIT blogs based on our proprietary data. Some of those ideas made the cut and eventually found their way into topics discussed herein. I will acknowledge as many contributors as I can recall: Anthony Yip, Gautam Wahi, Brian MacSweeney, Lorena Rodriguez Pineda, Quang Viet Tran, Sendoh Xu, Shih-hung Wang, Xinyi Xu, Kathy Zhang, Boyu Fang, Yongkang Zhu, Junze Hu, Zixu Yang, Aravind Ganesan, Yakun Deng, Danila Sitnikov and Pratik Sharda.

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1. A QUANTAMENTAL WALK DOWN WALL STREET

1.1. A RANDOM WALK DOWN WALL STREET

It was in the bitter cold of an upstate New York winter in 1994 that I stepped onto the Track-35 bound Metro North train from Poughkeepsie. Somehow that train and track 35 always reminded me of a scene from Superman. On this particular day, there was no time for idle chatter about movies or pop culture references. I had just watched Michael Douglas in “Wall Street”¹ exhorting an entire generation to go out on a capitalistic rampage. We were going to be the “Greed is Good”² generation I figured - even though I could barely spell out LBO as yet. “Let’s hope they don’t talk about that or Anacott Steel”, I said to myself. I barely knew debt from equity but felt strangely empowered by virtue of watching the movie and flipping through *Liar’s Poker*³. Had never set foot in the Economics department. Never bought a share of any stock. Never came within spitting distance of any trading floor. At the time, it would have been anathema for any respectable liberal arts college to teach anything particularly useful in terms of finance or too close to the real world. The level of finance awareness was low. The term “investment banking” was bandied about at cocktail parties in a vague and nebulous sense to refer to everything from the sell-side or buy-side to the red-headed stepchild (commercial banking) or God forbid even private banking. We were supposed to be utility maximizing automatons according to the economists, except that most liberal arts undergraduates had little cognizance of CARA, HARA, CRRA, Epstein-Zin⁴ or the various formulations of highly unrealistic utility functions that academics were mysteriously obsessed with. I had a couple of

¹ Michael Douglas starred as Gordon Gekko in the 1987 movie *Wall Street*, where he delivered the famous line "Greed, for lack of a better word, is good." This speech became iconic and is often referenced in discussions about the excesses of Wall Street in the 1980.

² The phrase captures the ethos of the time, influenced by real-life Wall Street figures such as Ivan Boesky, who in 1986 said, "Greed is all right, by the way. I want you to know that. I think greed is healthy".

³ *Liar's Poker* is indeed a semi-autobiographical book by Michael Lewis, published in 1989. It details his experiences as a bond salesman on Wall Street during the 1980s.

⁴ Epstein-Zin Preferences - a class of utility functions used in economics and finance to model intertemporal choice and risk.

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papers in Astronomy and dabbled in just enough Physics, Philosophy, and Mathematics to be offered teaching/ research assistantships at some of the top PhD programs in the country. Fake it till you make it is now the advice du jour (courtesy of the Amy Cuddys⁵ of the world). But there was no point in faking it on that day. I simply did not have the vernacular. Unlike rising seniors who already had a couple of Wall Street internships under their belt (often through family or fraternity connections) and had relevant majors, I never had any interest in being gainfully employed. This was merely an afterthought. Since I had already secured the coveted scholarships and assistantships, it gave me the freedom to interview without a care in the world. Unlike my peers - I had no interest in the job, hence no downside. While it felt like a pure call option, it really was a psychological hedge against a future of poverty, destitution and unsung glory.

Burton Malkiel's book - "A Random Walk Down Wall Street"⁶ - was perfect fodder for one who needed to sound vaguely intelligent about a novel topic. Thumbing through the book I could see that if I guided the conversation toward Brownian motion and away from the rather topical debt financing of LBOs, I had a chance of not being shown the door. As luck would have it, the esteemed Professor was suggesting one need not worry too much about the details given that no one could beat the market. The market was a random walk so why worry about picking stocks, bonds or star fund managers when you could just buy the index and do better? Simple and elegant. And so, I strode into the lobby of 345 Park Avenue, twitching uncomfortably in an ill-fitting suit. For a geek who only ever wanted to be an astronomer, then a physicist, then a philosopher, and eventually a logician, this was really just about forcing oneself out of one's comfort zone.

⁵ Amy Cuddy - a social psychologist known for her research on body language and the "fake it till you make it" philosophy.

⁶ An investing bestseller that popularized the idea that one cannot consistently outperform market averages.

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1.2. ON THE WAY TO \$12 TRILLION

Having a near perfect GPA and a host of academic accolades and past scholarships meant that one could secure the obligatory 1st round at a Morgan, McKinsey or the like. Most of us did not understand the pecking order or which department was interviewing us for what job. It just felt nice to be in demand without any skills per se. But this firm was different. This was no J.P. Morgan or Merrill Lynch. They only had a few dozen employees on half of the floor. What was the point of talking to some firm that my mother would have never heard of? There were no bragging rights even if you had the vacuous offer. The MIT PhD in charge of Risk and his acolytes was surprisingly friendly and amenable to taking the random digression down the garden path. After a few rounds, Ben Golub⁷ rhetorically asked if I could “swim with the sharks in the cesspool”? Clearly the answer was – nyet or at least not yet. I was Pittsburgh-bound and incredibly excited about a place that would spawn the future CEO of Renaissance Technologies not to mention that it was also the birthplace of A.I., Robotics, and the pioneering Computational Finance program. The firm that sounded like a Rock or a Stone got filed into the outer the recesses of my memory until around 2006 when Larry Fink made a bid for my future employer (Merrill Lynch IM⁸) and my one-time boss (Bob Doll, President and CIO of MLIM) decided to sell the company. 30 years later I could be forgiven for not having foreseen that BlackRock was someday going to manage over \$12 trillion in assets and rule the world (according to every misguided conspiracy theorist). While I’m at it, I should also confess to being among the first few on a certain mailing list that had hyperlinked books for sale. I got the vision but never bought a share of the company. I’d heard of Jeff Bezos from friends at D.E. Shaw. I’m not sure they knew that he was destined for world domination either. You see, prediction is always hard – especially when it’s about the distant future. Backtests are - by construction - always rosy. Ever

⁷ Ben Golub was the founding chief risk manager of BlackRock and now has a center named after him at MIT.

⁸ Merrill Lynch Investment Management, a subsidiary of Merrill Lynch, was acquired by BlackRock in 2006.

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seen a p-hacked negative Sharpe ratio? Out-of-sample rarely lives up to in-sample and live – well fuhgeddaboutit.

So here we are 30 years later. I know a bit more about Brownian motion, LBOs, derivative pricing, risk-premia and taming the factor zoo. And so does much of Wall Street. Bachelier's Brownian motion⁹, stochastic calculus, arbitrage pricing, statistical arbitrage and all such manner of mumbo jumbo has taken central stage on Wall Street in a manner that no one could have imagined back when I was fumbling around with spelling debt and equity. When I accidentally stumbled into that interview at BlackRock, there was no legacy of rocket scientists on Wall Street. There were the legacy kids from the Ivies. There were the frat boys and the would-be ditch diggers who had stumbled into obscene wealth as Michael Lewis had profiled in "Liar's Poker". To the old-timers, today's Wall Street – one of fully automated execution and a fully systematic or Quantamental investment paradigm would be an alien concept. Where are the frat boys and the high-fiving, back-slapping monkeys our algos were designed to pick off? Now everyone has an MBA or an MFE with a CFA or a PhD to boot. There are no widows or orphans in the institutional world no more. It's my HFT algorithm against yours just like it was my copula against yours in the heyday of credit correlation trading. Even retail buys the dips now.

How did we get here? What are the forces and the visionary figures who brought us here today as we stand on the precipice of AGI, ASI and Quantum Computing where the yellers and screamers on the floor wouldn't survive a picosecond with their hand gestures against "colo and lola"¹⁰. I figured it was time to take stock. To rant and to ruminate as we take this Quantamental walk down Wall Street in a fitting nod to the Princeton professor's great insights about market

⁹ Bachelier's Brownian motion - Refers to the mathematical description of random motion, foundational in financial mathematics.

¹⁰ By Colo and Lola, I mean co-location (colo) and low-latency (lola) in the context of high-frequency trading (HFT)

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efficiency. Of course, had I really imbibed the gospel of efficient markets, I would not have spent decades designing better factor models to beat the market.

This book is largely aimed at MFE students¹¹. Hence the anecdotes and the historical perspective for the uninitiated who may not have the big picture inkling as to how we got from the buttonwood tree¹² to co-locating in Weehawken. The stories in this first chapter are part-memoir and part-allegory. The rest of the book is written in the style of academic journal papers but watered down to the level of an industry quant. Michael Lewis meets Fama French¹³ would be aspirational but blasphemous to suggest. I hope that academics, industry quants and even some factor investing experts may find some interesting tidbits from this comprehensive survey and roadmap of Quantamental investing. The central premise of this book is that one can deploy a spanning set of smart betas to express any linear view on Equities. Systematizing the investment universe via such Lego building blocks (or atomic units of “risk-premia”) demystifies what the star managers and divas of yesteryear claimed to do in their heads except that a Quantamental process does it much better, more methodically, more transparently, with fewer errors and without bias or emotion. The logical progression from firm characteristics (factors) to Enhanced Smart Betas (or ESBs as aided by ML ensembles); from ESBs to MFMs (multi-factor models) or combination signals and then to portfolio risk and construction should make the entire investment process workflow and the lifecycle of quant investing clear to the neophyte (which often takes decades of experience to crystallize). Many students find the anecdotal big picture roadmap far more beneficial to managing their careers than the incremental tinkering of yet another Cholesky-like decomposition.

¹¹ MFE students - Refers to students enrolled in a Master of Financial Engineering program.

¹² Buttonwood tree - Refers to the origin of the New York Stock Exchange, where traders initially met under a buttonwood tree in the late 18th century.

¹³ Michael Lewis meets Fama French - A comparison combining the narrative style of Michael Lewis with the academic finance models developed by Eugene Fama and Kenneth French.

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While I aim to present the state of the art (qua factor investing) and be comprehensive in doing so (after all there are seminal papers but no books that do justice to that) – not everything in this book is (of competitive necessity) necessarily cutting edge. It presents the arc of evolution; of quants coming of age on Wall Street (an industry which used to be openly hostile to propeller heads); and critically the rationale for how we got here. There are cutting edge results on factor momentum not to mention our framework of ML enhanced factor investing. That said, I am not trying to replace refereed journal articles but present an insider’s realistic view as to how and what techniques actually tend to be deployed in the industry as opposed to what one might politely call the “mental masturbation” of many far-fetched academic treatises (and curricula) that bear no resemblance to live trading or investing. One must also acknowledge that this book is being written against the backdrop of an AI revolution that will likely soon disintermediate all knowledge work and potentially disrupt university education in short order. That said, we make the case that there isn’t all that much for AI to disrupt in the mid to low frequency Quantamental world. For long-term investors - the question remains - would Buffett or Munger do things any differently tomorrow?

The fact that the specifics of our QMIT framework presented herein have had some measure of live success over 6.5 years should be reassuring to the reader but is largely incidental and not central to the thesis. Along the way, we derive many side benefits that emerge from this factor framework such as Risk, Attribution, Style Analysis, Sector Rotation, Crash Baskets, Regime tilting, etc. We extend the literature on Factor momentum, provide an exposition and rebuttal of the Causal critique, track an archetypal market neutral hedge fund construct, explore a novel liquid proxy for private equity, combine it with NLP sentiment, indulge the Agentic AI future with specific examples like LLM based sentiment and much more. While we focus purely on Equities, this framework is being extended to other asset classes as we speak. We conclude with

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a chapter on the impending Singularity and Agentic (AI) future and its ramifications as it pertains to factor investing.

The metaphor of BlackRock's exponential growth to over \$12 Trillion over the past 30 years is emblematic of the magic of geometric compounding and capitalism at its best. It is also a uniquely American story – one that we will hopefully see repeated via American ingenuity driving exponential innovation in the age of AI-driven abundance – that is if AI does not destroy humanity en route.