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HOW EVOLUTION, STORIES, AND IRRATIONALITY INFLUENCE DECISION MAKING IN FINANCIAL MARKETS: ANALYZING WHETHER WE CAN LEVERAGE OUR INNATE TRAITS AND HEURISTICS TO IMPROVE OUTCOMES

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Abstract

One of the most commonly asked questions in investing is whether or not it is possible to achieve excess returns in the financial markets. To give a somewhat simple answer, for most investors a basic low-fee passive ("static") index fund portfolio is the best investment strategy since it outperforms nearly all advanced active indexing methodologies, such as "dynamic indexing," over the long-term due to factors such as high fees, high turnover, and poor asset selection (McCarthy and Tower, 2020b). Yet, even so, it does appear that it is possible to beat the market on a single trade through skill or luck as there are real inefficiencies and mispricings that occur among different investment vehicles at certain points in time (Lo, 2017; Malkiel, 2012; Ellis, 2017). This is especially evident in a number of endowment models, such as Yale's under David Swensen, which have successfully embraced risk through alternative investments – e.g., private equity – by focusing on longer time horizons and subsequently achieved very impressive results (Chambers, Dimson, and Kaffe, 2020; "Lessons from the endowment model," 2020). However, the fact that the financial markets are a zero-sum game with so many highly intelligent and highly informed investors constantly competing against one another makes it exceptionally difficult, and rare, to achieve excess returns over the long-term (Lo, 2017; Malkiel, 2012; Ellis, 2017). Indeed, the only way to truly beat the market on a regular basis is to constantly adapt your strategy in order to prevent your competitors from mimicking your successful techniques and thereby diluting your overall alpha (Lo, 2017; Malkiel, 2012; Ellis, 2017). Yet, even if we are able to consistently modify our approach as required, there are natural human biases relating to our evolutionary development; our collective stories; and our rationality / irrationality that can influence our decision making. In the following paper, I intend to provide an in-depth analysis of these three areas, and subsequently share a series of current best practices and frameworks from Behavioral Decision Theory (BDT) and Judgement and Decision Making (JDM) fields – e.g., "The Good Judgment Project" and "The Wisdom of Select Crowds" (Mannes, Soll, and Larrick, 2014; Mellers et al., 2014) – which if properly applied in a thoughtful and deliberate manner could offer a meaningful improvement in analysis, forecasting, decision making, and outcomes for both leaders and their organizations in the investing arena.
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"It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so" (Anonymous).

**Chapter One: Introduction**

**Reconciling Rational Expectations and Behavioral Economics**

The above quote is one of my favorites both for its folksy yet elegant simplicity and for its reminder to remain cautious, humble, and skeptical in whatever type of analysis or research you might perform. However, it's also highly relevant here for a research paper examining the influence of evolution, stories, and human irrationality / rationality on decision making and financial markets, as it has been falsely credited to Mark Twain – among others – over the years despite the fact that it never appears in any of his work ("It ain't what you don't know that gets you into trouble. It's what you know for sure that just ain't so.", 2018). This is a simple example of what Nobel-prize winning psychologist Daniel Kahneman called, "theory-induced blindness," and of how stories evolve and can anchor us on a particular belief without any factual basis. Yet, beyond the incorrect attribution of quotations, the stories that we tell; our potential for irrational decisions; and our baseline evolutionary traits can have a profound impact on our political policies, our religious beliefs, and our outcomes in the financial markets.

To this point, an interesting question is whether it is possible to leverage our irrationality and our innate heuristics in order to improve outcomes in investments and financial markets. The choice of this topic for my master's project was inspired by a series of lessons and insights from classes on economics, investment strategies, behavioral decision theory, human evolution, and marketing. However, the primary

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1 **Theory-Induced Blindness:** "once you have accepted a theory and used it as a tool in your thinking, it is extraordinarily difficult to notice its flaws. If you come upon an observation that does not seem to fit the model, you assume that there must be a perfectly good explanation that you are somehow missing. You give the theory the benefit of the doubt, trusting the community of experts who have accepted it" (Kahneman, 2011, p. 277).

2 Daniel Kahneman and Amos Tversky's **anchoring effect** is also very relevant in getting us to believe that this quotation was actually derived from Mart Twain: "It [the anchoring effect] occurs when people consider a particular value for an unknown quantity before estimating that quantity" (Kahneman, 2011, p. 119). This heuristic is highly influential in much of human behavior. Essentially we assign a greater value to what we hear first (especially when it comes from sources perceived as credible), and therefore, when we are initially told that the quote is from Twain we're primed to associate it with him moving forward making it difficult to disbelieve he was the source even after being definitively shown otherwise (Tversky and Kahneman, 1974).
driver spurring my interest in this arena is a curiosity as to whether it's possible to reconcile the quantitatively focused Rational Expectations (New Classical) branch of economics – and to a slightly lesser extent the New Keynesian School – with the more qualitative social psychology-focused Behavioral Economics school of thought. Indeed, resolving the differences between these two branches has become one of the main challenges for the economics profession, with the goal being to develop more realistic and adaptable econometric models that incorporate human irrationality into increasingly dynamic and complex systems with one of the primary techniques, at present, being the utilization of Dynamic Stochastic General Equilibrium Models (DSGE).

**Appropriate Level of Granularity**

In his 2013 textbook, *Macroeconomics*, Harvard economist N. Gregory Mankiw opens up his chapter on dynamic modeling of aggregate supply and demand – which serves as a primer for DSGE models – with a quote from physicist William Bragg: "The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them" (Mankiw, 2013, p. 429). He then goes on to share his high level thoughts on modeling in economics: "Economists develop models to provide new ways to think about these familiar facts. A good model is one that not only fits the facts but also offers new insights about them" (Mankiw, 2013, p. 429). Indeed, this seems like a sound and humble way forward to bridge the gap between the qualitative and quantitative arenas of economics and finance. He then offers a nice simple explanation of how DSGE models work.

These models are dynamic because they trace the path of variables over time. They are stochastic because they incorporate the inherent randomness of economic life. They are general equilibrium because they take into account the fact that everything depends on everything else. In many ways they are the state-of-the-art models in the analysis of short-run economic fluctuations. (Mankiw, 2013, p. 460).

There is obviously real value in utilizing these types of advanced methods to analyze policies and potentially also to improve financial forecasting by marrying up mathematical and behavioral decision theory techniques in an efficient and effective manner; yet, it's also important to note that there is an ongoing
debate between thought leaders in the economics community regarding the effectiveness of DSGE models, primarily stemming from their failure to predict the Global Financial Crisis (GFC) in 2008.

One of the more prominent discussions on the viability of DSGE models took place in 2017 between Nobel-Prize winning Columbia University economist Joseph Stiglitz and Northwestern / Freie Universitat economists Lawrence Christiano, Martin Eichenbaum, and Mathias Trabandt. In his 2017 NBER Working Paper "Where Modern Macroeconomics Went Wrong," Stiglitz argues that DSGE models fell short during the GFC because they "failed to incorporate key aspects of economic behavior, e.g. incorporating insights from information economics and behavioral economics" (Stiglitz, 2017, p. 1). He also argued that the models targeted the wrong things based on their assumptions: i.e., "inflation" versus "financial stability" (Stiglitz, 2017, p. 21). However, his biggest issue with these DSGE models pertains to "the treatment of uncertainty" and "assumptions concerning risk management," which weren't appropriately incorporated into their design (Stiglitz, 2017, p. 22). He further shares that "There were several economists (Such as Rob Shiller) who, using less fully articulated models, could see that there was clear evidence of a high probability of a housing bubble," who were able to predict the GFC because they didn't fall victim to the risk management tunnel vision so prevalent in many DSGE models (Stiglitz, 2017, p. 23). Ultimately, Stiglitz maintains that even with modifications and updates DSGE models will not be able to make up for their deficiencies, and instead advocates for the use of "benchmark models," of progressive sophistication, which he believes will afford us with better explanatory power regarding the actual state of the economy (Stiglitz, 2017, p. 23).

On the other end of the spectrum Christiano et al., writing for the Journal of Economic Perspectives later in 2017, come out in strong support of enhanced and revised DSGE models, applying (reshaping) economist Robert Lucas' axiom to explain their value in empirical analysis in the social science field: "The only place that we can do experiments is in dynamic stochastic general equilibrium (DSGE) models" (Christiano, Eichenbaum, and Trabandt, 2017, p. 1). They acknowledge the deficiencies of DSGE models prior to the GFC, and then go on to highlight "the progress that has been made incorporating financial
frictions and heterogeneity into DSGE models," which has included the additional behavioral aspects not properly covered in earlier versions (Christiano, Eichenbaum, and Trabandt, 2017, p. 21). Christiano et al. assert that DSGE models are clearly the best empirical methodology we have at present to make sense of markets and economics; yet, they recognize the need to utilize both models and people in order to obtain the best outcomes: "We'd rather have [former Federal Reserve Vice Chair] Stanley Fischer than a DSGE model, but we'd rather have Stanley Fischer with a DSGE model than without one" (Christiano, Eichenbaum, and Trabandt, 2017, p. 21). Christiano and his colleagues appear to show valuable evolutions in the DSGE ecosystem; yet, Stiglitz also shares a highly effective analytical tool with his enhanced "benchmark model(s)" (Christiano, Eichenbaum, and Trabandt, 2017; Stiglitz, 2017).

Both of these techniques are highly sophisticated and can potentially offer strong explanatory value to short-term macroeconomic analysis, while also merging valuable sub-elements from constructs such as the "Efficient Market Hypothesis" and "Prospect Theory," and while they're designed more so to analyze aggregated supply and demand, business cycles, labor, capital, consumption, and goods there is also some connective tissue that they share with the investment ecosystem (Mankiw, 2013; Stiglitz, 2017; Christiano, Eichenbaum, and Trabandt, 2017; Kahneman, 2011; Lo, 2017). However, there is another recent theory – along with associated modeling – put forward by MIT financial economist Andrew Lo, called the "Adaptive Markets Hypothesis" that could offer new ways of looking at existing facts more specifically inside of the investing space (Lo, 2017).

**Adaptive Markets Hypothesis**

In his 2017 book, *Adaptive Markets: Financial Evolution at the Speed of Thought*, Lo makes the argument that evolutionary theory is the proper lens that we should utilize when viewing financial markets (Lo, 2017). He came to this determination by analyzing the work of thinkers in various disciplines (e.g., economics, sociology, psychology, anthropology, philosophy, evolutionary biology, mathematics, physics, etc.), along with his own empirical research to make sense of the strengths and weaknesses of
mathematically elegant theories such as the "Efficient Market Hypothesis"\(^3\) of Paul Samuelson and Eugene Fama (Lo, 2017, p. 16) and the social psychology focused "Prospect Theory"\(^4\) of Amos Tversky and Daniel Kahneman, along with the concepts of "satisficing" and "bounded rationality"\(^5\) from Carnegie Mellon behavioral economist / political scientist Herbert Simon (Lo, 2017, p. 180; Kahneman, 2011, pp. 281-284).

He then studied and incorporated the work of evolutionary biologists and sociobiologists such as Charles Darwin, Alfred Russell Wallace, Theodosius Dobzhansky, Ernst Mayr, E.O. Wilson, J.B.S. Haldane, and Bill Hamilton into his research, which opened up his eyes to the similarities between evolutionary theory and the manner in which markets function (Lo, 2017).

This led him to observe that "most real world economic phenomena simply look more like biology than physics; it's very rare to find any economic ideas that conform perfectly to elegant mathematical derivations" (Lo, 2017, p. 214), and ultimately guided him to the development of his "Adaptive Markets Hypothesis" (Lo, 2017, p. 2). Lo shares a nice synopsis of why he believes his theory fits so well with the actual functioning of the markets.

The Adaptive Markets Hypothesis is based on the insight that investors and financial markets behave more like biology than physics, comprising a population of living organisms competing to survive, not a collection of inanimate objects subject to immutable laws of motion. This simple truth has far-reaching implications. For one thing, it implies that the principles of evolution – competition, innovation, reproduction, and adaptation – are more useful for understanding the inner workings of the financial industry than the physics-like principles of rational economic analysis. (Lo, 2017, p. 2)

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\(^3\) \textit{Efficient Market Hypothesis}: "in an efficient market, the price of an asset fully reflects all available information about that asset" (Lo, 2017, p. 16). Additionally, there are three forms of market efficiency that Eugene Fama cites: \textit{weak market efficient} (reflects historical prices), \textit{semi-strong form market efficiency} (reflects historical prices and public information), and \textit{strong form efficiency} (reflects all information – historical prices, public information and private information) (Brealey, Myers, and Allen, 2014, pp. 324-325).

\(^4\) \textit{Prospect Theory}: 1) "Evaluation is relative to a neutral reference point, which is sometimes referred to as an 'adaptation level'" (Kahneman, 2011, p. 282); 2) "A principle of diminishing sensitivity applies to both sensory dimensions and the evaluation of changes of wealth" (Kahneman, 2011, p. 282); and 3) "The third principle is loss aversion. When directly compared or weighted against each other, losses loom larger than gains" (Kahneman, 2011, p. 282).

\(^5\) "When individuals make decisions, we calculate toward the best solution until we reach a breakeven point, where any additional benefits from the calculation are balanced by the cost of getting there. Simon coined the term \textit{satisficing} (a mix of "satisfy" and "suffice") to refer to this behavior. Individuals didn't optimize – they satisfied, making decisions that weren't always optimal, but were good enough. Simon called this the theory of \textit{bounded rationality}" (Lo, 2017, p. 180).
Indeed, it seems almost obvious in hindsight that evolutionary biology is the best way to interpret and analyze financial markets given human irrationality and the influence that our emotions tend to have on our decision making. To this point, Lo quotes Caltech physicist Richard Feynman who said, "Imagine how much harder physics would be if electrons had feelings" (Lo, 2017, p. 10). Supported by the value and ingenuity of his research and the intuitions provided through the "Adaptive Markets Hypothesis," Andrew Lo then proceeded to develop his own models to capitalize on these evolutionary tendencies, which he called *dynamic indexes*⁶ (Lo, 2017, p. 267).

Lo founded AlphaSimplex Group LLC in 1999 to take advantage of his research cited above and over the course of the past two decades he and his team built out four core funds based on the model of dynamic indexing (AlphaSimplex – Andrew Lo, 2020; AlphaSimplex (NATIXIS), 2020). In addition to its basis on the "Adaptive Markets Hypothesis" this strategy is also a nod to Andrew Lo’s dichotomous view of investing and the markets. He believes that it is possible to beat the market through luck or skill (e.g., James Simons of Renaissance Technologies); however, because investing is a zero-sum game, to do it continuously requires exceptional talent combined with constant adaptation (Lo, 2017). This view is paralleled by his deep respect for Vanguard founder Jack Bogle, and his strategy advocating for a low-fee passive index fund approach based on Bogle’s own "Cost Matters Hypothesis," which asserts that the general efficiency of the markets means that keeping fees low is probably the best way for most investors to achieve success⁷ (Lo, 2017, p. 265). Lo’s *dynamic indexing* essentially combines these two techniques in conjunction with advanced technology and evolutionary biology style thinking to enhance risk management and performance results by utilizing the best aspects of passive and active investing; taking advantage of

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⁶ In his 2015 working paper, "What is an Index," Andrew Lo more specifically defines what he means by *dynamic index*: "any portfolio strategy that satisfies three properties should be considered an index: (1) it is completely transparent; (2) it is investable; and (3) it is systematic, i.e., it is entirely rules-based and contains no judgment or unique investment skill. Portfolios satisfying these properties that are not market-cap weighted are given a new name: 'dynamic indexes'" (Lo, 2015, p. 1).

⁷ This is further supported by the research of Duke master’s student Joseph McCarthy and Duke University economics professor Edward Tower who have identified that tactical asset allocation funds significantly underperformed both their benchmarks and a basic Vanguard static indexing portfolio, "Even gross of expenses" (McCarthy and Tower, 2020b, p. 1).
behavioral irregularities in the market; and managing volatility and risk exposure with a series of carefully
developed rules (Lo, 2017, pp. 267-274). Interestingly, despite the sophistication of his models and the
exceptional mathematical and financial economics expertise that he brings to the table, Lo's funds have
underperformed a simple Vanguard three-fund portfolio since 2010 as demonstrated by Duke master's
McCarthy and Tower show that the elegant strategies employed by the four AlphaSimplex funds (even
though they're based on Lo's convincing "Adaptive Markets" research) show poorer performance in
practical application in both returns and standard deviation (volatility) than a simple passive index fund
portfolio (McCarthy and Tower, 2020a). At a high level this can be viewed as similar to the lackluster
performance of some of the DSGE models mentioned above, and possibly Stiglitz' "alternative benchmark
models" as well – once they're studied in application. This then leads to the question, "Why do such
incredibly granular and advanced models fail despite such refined and thoughtful construction?"

Environmental, Psychological, and Methodological Influences on Prediction

In replying to that question, one of the simplest answers is probably that financial markets are what
Oxford historian Yuval Harari calls "Level Two Chaotic Systems": "Level two chaos is chaos that reacts to
predictions made about it, and therefore it can never be predicted accurately" (Harari, 2015, p. 240). These
are in contrast to "Level One Chaotic Systems," which don't respond to forecasts made about them – e.g.,
weather (Harari, 2015, p. 240). Building on this point is the fact that the investing ecosystem is situated in
what Barcelona GSE psychologist Robin Hogarth and his colleagues calls a "wicked" environment with poor
cues and unproductive feedback as opposed to a "kind" environment such as weather\footnote{In his 2019 book \textit{Range: Why Generalists Succeed in a Specialized World}, journalist David Epstein gives a nice summary of Robin Hogarth's "\textit{kind}" and "\textit{wicked}" environments: "[In \textit{kind} environments] Patterns repeat over and over, and feedback is extremely accurate and usually very rapid ... In \textit{wicked} domains, the rules of the game are often unclear or incomplete, there may or may not be patterns and they may not be obvious, and feedback is often delayed, inaccurate, or both" (Epstein, 2019, pp. 20-21).} (Hogarth, Legarrage and Soyer, 2015; Keren and Wu [Larrick and Feiler], 2015). Yet, paradoxically I think that part of the
problem can be explained by Lo's own research. If a model becomes too complex or overfitted to the data that it's analyzing or interpreting, it's very possible to encounter confounding variables, omitted variable bias, and/or spatial and temporal autocorrelation, among other possible issues (Lo, 2017; Albright, 2019, October 16; Albright, 2019, October 28).

Building on this point, Lo, in describing the current state of the financial system, cites the work of Yale sociologist Charles Perrow who argued "that the twin conditions of complexity and tight coupling were recipes for disaster in a variety of industry contexts" (Lo, 2017, p. 321). Lo then proceeds to explain the dangers of "tight coupling" and "complexity" with clear examples and articulates the risks that they pose in terms of potentially causing financial crises (Lo, 2017, pp. 321-329). However, I think that the valid points that Lo makes regarding this issue are somewhat analogous to the reasons why AlphaSimplex's dynamic index funds underperformed and why so many DSGE models failed during the GFC: They are too narrowly focused missing out on correlations and additional variables that might influence results. This in turn relates to what University of Pennsylvania psychologist Phil Tetlock calls "Aleatory uncertainty [which] is something you not only don't know; it's unknowable" (Tetlock and Gardner, 2015, p. 143). Models and mutual funds that become too granular or develop "tunnel vision" are inherently unstable and risk missing out on key linkages and critical variables, which can potentially lead to inaccurate assessments, poor forecasts, or negative outcomes.

This seems to lend credence to more high-level models such as those employed by Robert Shiller to predict financial downturns in the "Tech Bubble" and the "Global Financial Crisis"; although it's important to note that Shiller made his predictions sometimes so far in advance that they may not necessarily be

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9 Tetlock argues that "An awareness of irreducible uncertainty is the core of probabilistic thinking, but it's a tricky thing to measure" (Tetlock, 2015, p. 143). Tetlock borrows the terms of "epistemic" and 'aleatory" uncertainty from the philosophy community with "aleatory" [defined above] being the opposite of "epistemic" uncertainty: "Epistemic uncertainty is something you don't know but is, at least in theory, knowable" (Tetlock, 2015, p. 143).

10 In an interview with NPR's Madeleine Brand on June 3, 2005 Yale economist Robert Shiller predicted correctly that the U.S. housing market bubble would burst; however, he made his prescient forecast over two years prior to it occurring (Brand, 2005), which begs the question: "How valuable is a correct prediction if it lacks the timeliness to be actionable?"
useful\textsuperscript{11} (Brand, 2005). Evidently there seems to be a tradeoff between the ability to reasonably forecast a probabilistic event and how complex a model can get before it becomes useless or dangerous. A great example of a complex model in contrast to Shiller's technique is Wall Street quant David X. Li's "Gaussian copula function," which has been credited with a good part of the improper risk management of investment banks, mortgage lenders, and hedge funds leading up to the GFC (Salmon, 2009). In his 2009 \textit{Wired} article, reporter Felix Salmon explains how Li's "elegant mathematical formula [analyzing the correlation of mortgage defaults] ... allowed hugely complex risks to be modeled with more ease and accuracy than ever before"; yet, "it assumed that correlation was a constant rather than something mercurial," which ran in contrast to finance consultant Paul Wilmott's assessment "that correlations between financial quantities are notoriously unstable" (Salmon, 2009).

The perception that it was possible to accurately measure and manage risk led to a rapid expansion of Credit Default Swaps (CDS) and Collateralized Debt Obligations (CDO), with the belief that pooling risk of these products using Li's formula would offset correlations and reduce the overall risk of the instruments (Salmon, 2009). Indeed, the risks surrounding this process were pointed out in 2006 by credit derivatives expert Janet Tavakoli who said, "Correlation trading has spread through the psyche of the financial markets like a highly infectious thought virus" (Salmon, 2009). Indeed, the "Gaussian copula function's" incorrect assessment of correlations between default probabilities (especially with increasing scale) combined with Wall Street banker's improper application of Li's formula for pricing and assessing derivatives risk led to the spectacular and tragic implosion of the "Housing Bubble" and the subsequent "Global Financial Crisis" in 2008 (Salmon, 2009). This seems to tie back very closely with Andrew Lo's concerns about "tight coupling" and "complexity" in financial markets and their effects when correlation and "aleatory uncertainty"

\textsuperscript{11}In his 2013 Nobel Prize lecture for winning the economics award jointly with Robert Shiller and Lars Peter Hansen, Eugene Fama (founder of the \textit{Efficient Markets Hypothesis}) explains that if he had heeded Shiller's call to get out of the market during the Dot-com bubble of the late 1990's he would have missed out on several years of excellent returns (Fama, 2013). This alludes to the fact that an accurate prediction made too early might not necessarily be of value.
combine at scale, which are not necessarily new fears; however, the risks associated with these two factors seem to be growing with the rise of digitization and the increased interconnectedness of the global economy and financial markets\textsuperscript{12} (Lo, 2017).

To this point, McCarthy and Tower reference Lo's own assessment of the benefits and risk associated with his development of dynamic indexes (Lo, 2015): "He [Andrew Lo] likens the replacement of static indexing by dynamic indexing to the replacement of the handsaw by the chainsaw: a productive tool, but a dangerous one" (McCarthy and Tower, 2020). This seems to clearly show that Andrew Lo understands the potential risks that increasingly complex quantitative models might have on markets given their inherent instability and the likelihood that they might over-explain variance or miss out on influential variables. There is a balance that must be achieved between broadness and granularity for a model to be of actionable use without guiding you down the wrong path; yet, even today – despite the cautionary tales of Long-Term Capital Management, the "Gaussian copula function," and pre-GFC DSGE models – there is a constant battle in the highly competitive ecosystem of international finance to achieve a meaningful advantage over the competition: e.g., J.P. Morgan's "Volffe Index\textsuperscript{13}" (Alloway, 2019). Given this fast-paced and adaptive contest between highly sophisticated and intelligent entities and actors it seems difficult if not impossible to sustain a true measurable advantage, with the risks of false positives and true negatives ever present.

**Behavioral Approaches to Develop Better Outcomes in Financial Markets**

In approaching this master's project, I was initially planning to conduct a time series econometric analysis evaluating the statistical impact of posts, searches, and narratives on social media and in search

\textsuperscript{12} A good example of this being the collapse of Wall Street super-quant firm Long-Term Capital Management in 1998, so brilliantly captured by Roger Lowenstein in his 2000 book *When Genius Failed: The Rise and Fall of Long-Term Capital Management* (Lowenstein, 2000).

\textsuperscript{13} Bloomberg reporter Tracy Alloway explains that J.P. Morgan's "Volffe Index" has identified that Donald Trump's tweets have a "statistically significant impact on Treasury yields"; however, Citigroup (who has also developed their own instrument to measure Trump's tweets) cautions that "The ramifications of @realDonaldTrump's market aren't so definitive to be of use in the design of systemic strategies" (Alloway, 2019).
engines regarding financial markets to see if they had a measurable affect – and hopefully determine causation. However, after conducting extensive research in this arena, it's become abundantly clear (to put it lightly) to me that I can't match the mathematical elegance and quantitative skill of Greg Mankiw, Joseph Stiglitz, Edward Tower, Lawrence Christiano, James Simons, Robert Shiller, and the J.P. Morgan "Volfefe" team, among others, which leads me to believe that the most relevant contribution that I might be able to offer would be in performing a qualitative evaluation of how our innate traits and heuristics, and our collective interactions, shape markets, and then look into what we might do to enhance our decision-making in the investing ecosystem. To this point, in the following paper I intend to examine: our baseline evolutionary characteristics; our collective tendency to utilize stories to share both useful and harmful information; and our propensity for both rationality and irrationality in an increasingly complex world, and then share potentially useful techniques that we might be able to employ to improve our decision making and to deliver better outcomes in the financial markets. I think that there are very valuable insights to be gleaned from fields such as behavioral decision theory, narrative economics, judgment and decision making, social psychology, English literature, philosophy, neurology, and evolutionary biology, which could have a substantive influence on our analyses of decisions and outcomes in the investing arena.

In returning to how deep to go with financial, statistical, and economic modeling I think that a quote from Duke University biologist Jonathan Shaw (referring to digitization, but very much applicable in this arena as well) is apt: "The difference between a medicine and a poison is dosage. It's how much you take and how you use it. It's not inherently bad in and of itself" (Shaw, 2019). This really speaks again to the need to achieve balance between Rational Expectations and Behavioral Economics and broad based models (e.g., CAPE Shiller P/E Ratio) and in-depth models (e.g., Gaussian copula function) in order to achieve optimal outcomes. Indeed, I think that the best way to view modeling, given what we know about human nature, is to add in a degree of flexibility to the greatest extent possible. Along these lines I believe that the advice of University of Chicago economics and behavioral science professor Sendhil Mullainathan (suggesting how to prepare for technological change, though very relevant in the investing space) is
valuable as well: "The safest prediction is that reality will outstrip our imaginations. So let us craft our policies not just for what we expect but for what will surely surprise us" (Mullainathan, 2017). This speaks to the need to be adaptive in both our thinking and our analysis (similar to many of Lo's assertions), given the fact that the future is unknowable.

Yet, built into our evolutionary biology is a proclivity for pattern recognition and a desire to make sense of the world with an aspiration to know "Why things are the way that they are now?" and "How things will turn out in the future?" Going back to the quote at the beginning of the section, falsely attributed to Mark Twain, it is a great example of how a pithy aphorism full of colloquialisms from a world renowned literary expert can develop a life of its own as it spreads broadly throughout society. To be sure, there is real value in the knowledge that it shares; however, it probably wouldn't have reached such a wide audience had it not been credited to Mark Twain in the first place. Yet, even though Mark Twain never wrote this phrase it still remains aligned with him in the public psyche due to the anchoring heuristic. The anchoring and adjustment effect, first identified by renowned Israeli psychologists Amos Tversky and Daniel Kahneman, is one of many heuristics that are built into our personalities (likely through some combination of genetics and experience), which can have a profound impact on how we make decisions (Kahneman, 2011). At our core, through these conscious and subconscious strategies, we are essentially pattern recognition machines. However, maybe even more important than our ability to discern patterns is our imagination, which enables us to generate the aforementioned quote in the first place, realize its value, tie it to a popular figure to enhance its spread, and continue to link it to him even after being proven otherwise. As we look into how our biology and psychology influence our decision making and analytical abilities, it's critical that we remain keenly aware of all of these internal and external factors in order to ensure that we develop objective, balanced, and flexible models and processes in order to improve our outcomes in financial markets.
"It is rather a shock for some biologists to learn that natural selection, taken strictly, is not a selection process at all, but rather a process of elimination and differential reproduction. It is the least adapted individuals that in every generation are eliminated first, while those that are better adapted have a greater chance to survive and reproduce" – Ernst Mayr (Mayr, 2004, p. 31).

Chapter Two: Human Evolutionary Development

Evolution and Natural Selection

In analyzing how human evolutionary development impacts our decision-making in financial markets, the most influential factor to focus on is our imagination; however, before delving into that line of research, it is wise to give a little background on the theory of evolution, natural selection, and Sapiens’ physiological development. The theory of evolution by natural selection was uncovered by Charles Darwin and Alfred Russell Wallace in the mid-19th century and announced to the world in 1858 followed by the publication of Darwin's *On the Origin of Species* in 1859 (Mayr, 2000). It offers a clear scientific explanation of how life evolved on Earth from our earliest common ancestor approximately 3.8 million years ago (Harari, 2015; Nowak 2011). Biologist Ernst Mayr shares a nice summary of Darwin's four critical contributions to scientific thought through his founding of evolutionary biology: 1) nonconstancy of species, 2) branching evolution (common descent from a single origin), 3) gradual evolution with no major breaks or discontinuities, and 4) the mechanism of evolution is natural selection (Mayr, 2000, p. 80). In terms of understanding what natural selection really means, Duke biologist Jon Shaw shares a nice clear summary:

"Some individuals have higher fitness due to certain phenotypic traits – Nature is selecting some individuals based off of this fitness. Differences in reproductive success across individuals occurs because of their characteristics, and individuals differ in their success because of their traits" (Shaw, 2018).

14 A separate, but fascinating topic is how life actually started on here on Earth with two of the main theories being panspermia (life was brought here from somewhere else at the beginning of the galaxy and solar system) and abiogenesis (life developed independently on Earth). Mathematical biologist Martin Nowak argues more for the latter concluding through his research that life evolved here on Earth through cooperation between prelife molecules: "Ultimately, life gnaws away the scaffold of prelife molecules that got it going in the first place. In this way, life is an infection of prelife, one that eventually destroys its molecular ancestor. Or to put it in an anthropomorphic way, life exploits prolife" (Nowak, 2011, p. 123).

15 Dr. Shaw additionally cites the three types of selection methods: 1) Stabilizing Selection, 2) Directional Selection, and 3) Diversifying Selection (Shaw, 2018).
Building on this, biologist Ernst Mayr refers to evolution as a "process of elimination and differential reproduction" (Mayr, 2004, p. 31) meaning that "Even very slight differences in reproductive success can lead to a genetic trait becoming common in an evolutionarily small period of time" (Lo, 2017, p. 146). It is essentially a process of "trial and error" where the organisms that are least fitted to an environment are eliminated over time, while those that are best adapted multiply (Lo, 2017, p. 141). In referencing the randomness and luck involved in the evolutionary process, biologist Stephen Jay Gould states that “The history of life is not necessarily progressive; it certainly is not predictable. The earth’s creatures have evolved through a series of contingent and fortuitous events” (Gould, 2004, p. 92). It’s also important to note that "there’s no intention in natural selection" (Lo, 2017, p. 143), or for that matter no fairness as well: i.e., "A species can become so well adapted to an environment through natural selection that it fails to survive a change to that environment" (Lo, 2017, p. 148). To summarize this point, Andrew Lo cites an aphorism from the physics community, which states that "nature abhors an undiversified bet" (Lo, 2017, p. 195). In contrast to many other species, Human beings have proven remarkably adaptable to different environments throughout the planet, which has given them a unique survival advantage; yet, as Dr. Gould points out, the randomness and complexity that underpin evolution should arm us with a great degree of humility in the luck that got Sapiens to this point (Gould, 2004).

At present, depending on which expert you ask, Homo sapiens is estimated to have developed into a unique species in eastern Africa roughly 200,000 to 300,000 years ago and is the last surviving group of humans following the extinction of Homo floresiensis roughly 12,000 to 13,000 years ago (Harari, 2015; Wong, 2012). Understanding the branches of the human ancestral tree is still somewhat tentative; however, Kate Wong writing for Scientific American in 2012 (“First of Our Kind: Sensational fossils from...”)

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16 A good example of this is the current struggle of polar bears to adapt to changes in the arctic due to climate change because of their deep specialization.
17 Interestingly around 100,000 years ago there we six different species of humans: Homo denisova, Homo neanderthalensis, Homo erectus, Homo floresiensis, Homo soloensis, and Homo sapiens (Wong, 2012; Harari, 2015). However, likely through a combination of hybridization / interbreeding and replacement Homo sapiens wiped out all of the remaining humans over the next 90,000 years (Harari, 2015).
South Africa spark debate over how we came to be human") charts a generally accepted path linking us to our ancestors from about 4 million years ago (mya): *Australopithecus anamensis* > *Australopithecus afarensis* > *Australopithecus africanus* > *Homo habilis* > *Homo ergaster* > *Homo erectus* > *Homo heidelbergensis* > *Homo sapiens* [along with *Homo neanderthalensis* and *Homo denisova*] (Wong, 2012, pp. 36-37). It's important to note that this tree is very likely nonlinear (i.e., hybridization) and experts still debate many of the linkages (i.e., the placement of Australopithecus sediba and whether Homo antecessor was a linkage between ergaster / erectus and heidelbergensis); however, this loose framework gives us a general understanding of where *Homo sapiens* came from and broadly how we're connected to our relatives in the genus *Homo* (Wong, 2012; Harari, 2015). This leads to the question of how the biological, physiological, and behavioral traits and characteristics of our ancestors evolved over time and ultimately afforded Sapiens with the tools to quickly jump to the top of the food chain.

In helping us understand the biological, physiological, and behavioral traits that set Sapiens apart historian Yuval Noah Harari does a nice job of summarizing the current research from modern evolutionary biology and anthropology in his 2015 book *Sapiens: A Brief History of Humankind* (Harari, 2015). He cites three critical factors that proved highly influential on our baseline development: 1) our brain size, 2) our ability to stand on two legs, and 3) our mastery of fire (Harari, 2015, pp. 8-13). Harari explains that our brain size is remarkable compared to most other creatures: "Mammals weighing 130 pounds have an average brain size of 12 cubic inches … Modern Sapiens sport a brain averaging 73-85 cubic inches" (Harari, 2015, p. 8). This enhancement afforded us with an increase in cognitive capacity that was incredibly valuable in enhancing our survival on the east African Savanna. However, there are tradeoffs that come with a larger brain size, mainly because big brains require a great deal of energy in comparison to other organs: "Archaic humans paid for their large brains in two ways. Firstly, they spent more time in search of food. Secondly, their muscles atrophied" (Harari, 2015, p. 9). Additionally, Harari explains that "Another singular human trait is that we walk upright on two legs" (Harari, 2015, p. 9). This new attribute served to free up our hands for a multitude of tasks and to enable us to develop and utilize many new tools (Harari,
2015, pp. 9-10). Yet, as with big brains there were tradeoffs that came from standing on two feet, with one example coming in the form of numerous spinal issues; however, the most significant impacts were those that affected women since "An upright gait required narrower hips," which created significant complications in childbirth (Harari, 2015, p. 10). This in turn "favoured earlier births," which created a remarkably long dependency period for human children compared to other species (Harari, 2015, p. 10). Fascinatingly, "This fact has contributed greatly both to humankind's extraordinary social abilities and to its unique social problems" (Harari, 2015, p. 10). However, there was one final core behavioral / physiological step that helped propel humans to the next level up the evolutionary ladder: the mastery of fire (Harari, 2015, p. 12).

The regular utilization and control of fire was a major enhancement in human evolutionary development (Harari, 2015). It afforded humans with "a dependable source of light and warmth" as well as a solid protective mechanism against predators; however, "the best thing that fire did was cook" (Harari, 2015, p. 12).

Whereas chimpanzees spend five hours a day chewing raw food, a single hour suffices for people eating cooked food. The advent of cooking enabled humans to eat more kinds of food, to devote less time to eating, and to make do with smaller teeth and shorter intestines. Some scholars believe there is a direct link between the advent of cooking, the shortening of the human intestinal track, and the growth of the human brain. Since long intestines and large brains are both massive energy consumers. (Harari, 2015, pp. 12-13)

This was an exceptional leap forward, which provided humans with a tool that no other species in the animal kingdom possessed: "When humans domesticated fire, they gained control of an obedient and potentially limitless force" (Harari, 2015, p. 13). Fire was an immensely powerful tool and potentially paved the way for Sapiens most critical attribute: Imagination.

Imagination and Language

There are a number of theories put forward as to why Homo sapiens has been so successful compared to other animals – and other extinct humans: e.g., opposable thumb, ability to cook food, complex tool use, and the ability to stand on two legs (Wong, 2012; Stix, 2014; Harari, 2015). However, the
general consensus at this point in time seems to center around a uniqueness in our imagination and creativity: i.e., the creation of "legal fiction," "human rights," and "limited liability companies" (Harari, 2015, pp. 29-32; Pringle, 2013; Hermann et al., 2007; Stix, 2014). Economist Andrew Lo argues that "The human capacity to create complex scenarios, pure figments of our substantial imagination, is the most important evolutionary advantage we've developed, and it seems to be unique to our species" (Lo, 2017, p. 163).

These imagined myths and shared narratives enable Homo sapiens to cooperate at a scale and complexity unmatched by any other species in the animal kingdom18 (Harari, 2015; Pringle, 2013).

The ability to create an imagined reality out of words enabled large numbers of strangers to cooperate effectively. But it also did something more. Since large-scale human cooperation is based on myths, the way people cooperate can be altered by changing the myths – by telling different stories. (Harari, 2015, p. 32)

For most animals, their behavior is a function of their genes and their environment; however, with Homo sapiens, ever since the "cognitive revolution"19 they have been able to change and modify their behavior in an amazingly rapid manner through "cultural evolution" without the requirement for genetic and environmental change (Harari, 2015, pp. 33-34). Yuval Harari believes that the "cognitive revolution" was the turning point for Sapiens rapid ascent up the evolutionary ladder citing three new abilities that it afforded us.

1) The ability to transmit larger quantities of information about the world surrounding Homo sapiens,
2) The ability to transmit larger quantities of information about Sapiens social relationships, and
3) The ability to transmit information about things that do not really exist, such as tribal spirits, nations, limited liability companies, and human rights (Harari, 2015, p. 37)

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18 As an example of scale in other species, "Under natural conditions, a typical chimpanzee troop consists of about twenty to fifty individuals. As the number of chimpanzees in a troop increases, the social order destabilizes, eventually leading to a rupture and the formation of a new troop by some of the animals" (Harari, 2015, p. 26).
19 Yuval Harari argues that "The Cognitive Revolution [which likely occurred somewhere between 50,000 and 70,000 years ago] is accordingly the point when history declared its independence from biology" (Harari, 2015, p. 37).
These new abilities, specifically the enhanced creativity and the capacity to produce fiction, enabled *Homo sapiens* to innovate and to transmit information between generations and cooperate in a manner and scale that none of our close relatives, even the Neanderthals, could match (Harari, 2015, pp. 34-37).

In terms of why and how human imagination developed, it appears as though it was due to a mix of genetic and sociological factors that caused its occurrence over the course of thousands of years. One particular line of research – cognitive archaeology – blends environmental, cultural, and genetic factors to offer an interesting set of hypotheses surrounding the development of the human mind (Smith, 2006, p. 72). The two main frameworks from this field come from cognitive neuroscientist Merlin Donald and archaeologist Steven Mithen, which Cameron McPherson Smith describes in his 2006 *Scientific American* article, "Rise of the Modern Mind" (Smith, 2006, pp. 70-77). "[Merlin] Donald proposed that the evolution of the mind was fundamentally about the ways it represented its experiences. His model ... outlines several revolutions in how the mind managed the information stored in the brain, with each change yielding, a new state of consciousness" (Smith, 2006, p. 72). Donald further separates the levels of consciousness into four categories: 1) episodic, 2) mimetic, 3) mythic, and 4) theoretical (Smith, 2006, pp. 72-75). To give an explanation of the two extremes of Donald’s levels of consciousness, episodic consciousness is the simplest (recognizable in chimpanzees), which essentially deals with events happening right now, while the most advanced, theoretical consciousness, deals with innovation, critical thinking, and correlation practiced by modern humans (Smith, 2006, pp. 72-75). On a slightly different track, Steven Mithen has suggested that "cognitive fluidity" was most critical in the evolution of the modern mind, which deals with "the degree to which different kinds of intelligence communicate with one another" (Smith, 2006, p. 75). He focuses on the "'modular' domains of intelligence," and "explains the mind's evolution as an increasing level of interaction among these domains" (Smith, 2006, p. 75). Mithen further recognizes four principal forms of intelligence, which are possessed only by modern *Homo sapiens*: 1) linguistic (production and comprehension of language), 2) social (managing interpersonal relationships), 3) technical (manipulation of objects), and 4) natural history (understanding cause and effect in the natural world) (Smith, 2006, p. 75).
In turn, he also contends that "cognitive fluidity" and the communication between these different modular domains likely occurred due to the development of language sometime roughly around 50,000 years ago (Smith, 2006, p. 76).

Language has had a powerful impact on the evolutionary development of modern humans and their ability to process, analyze, and share information. Indeed, historian Yuval Harari claims that "Homo sapiens conquered the world because of its unique language" (Harari, 2015, p. 19). Additionally, mathematical biologist Martin Nowak maintains that language development is one of the most important events since the creation of life (Nowak, 2011, p. 171). He further asserts that the origins of language came from the complexity of our societal structures and our development of politics, stating that "Language allows people to work together to exchange their ideas, their thoughts, and their dreams. In this way, language is intimately linked with cooperation" (Nowak, 2011, p. 171). Nowak in turn elaborates on the evolution of language and its impacts on human development.

Thanks to the gift of gab, humans now occupy a unique place in the 4-billion-year story of life on Earth. Before they arrived, the most significant way that information was transmitted between living things was in the form of the chemicals of heredity, DNA or RNA. Then along came language, an ever-growing repertoire of signals that had evolved from ancient regions of the primate brain that were once only used to decipher sounds and control facial muscles. In this way, language propelled human evolution out of a purely genetic realm, where it still operates, into the realm of culture. Language offers a way to take the thoughts of one person, encode them, and insert them into the minds of others ... Language became a spur for evolution. Those who had brains that were most receptive to these new ideas, and could make best use of them, were more likely to thrive ... Language, in effect, helped bootstrap the development of our powerful and flexible brains ... Language created us ... Language had to evolve with cooperation, since individuals are not going to bother to learn new ways to communicate with each other unless they are already working together to some extent ... In this way, language and cooperation coevolved. (Nowak, 2011, pp. 172-173)

The critical nature of language in human cooperation then leads us to hypothesize about how this particular skill set was fostered in different cultures and what sociological features were necessary to enable more advanced cooperative and innovative behaviors that furthered the success of Homo sapiens.

One of the more prominent sociological theories that helps explain the development of human creativity is the "cultural intelligence hypothesis," which argues that specialized skills of human cognition
are "mainly due to a species-specific set of social-cognitive skills, emerging early in ontogeny, for participating and exchanging knowledge in cultural groups" (Herrmann et al., 2007, p. 1360). A 2007 study by Max Planck Institute biologist / developmental psychologist Esther Herrmann and her colleagues published in *Science* ("Humans Have Evolved Specialized Skills of Social Cognition"), compared human infants to chimpanzees and orangutans and afforded strong support for the "cultural intelligence hypothesis" (Herrmann et al., 2007, p. 1365). Their results suggested that "human beings have evolved some specialized social-cognitive skills (beyond those of other primates in general) for living and exchanging knowledge in cultural groups: communicating with others, learning from others, and 'reading the mind' of others in especially complex ways" (Herrmann et al., 2007, p. 1365). Additional recent findings from psychologists and neuroanthropologists Liane Gabora, Dean Falk, and Katerina Semendeferi, summarized by Heather Pringle in her 2013 *Scientific American* article "The Origins of Creativity," seem to lend credence to the critical nature of social skills in human development, but also reference the importance of a big brain with more neurons, and maybe more critically the ability to "make use of all that extra grey matter" (Pringle, 2013, p. 42). Martin Nowak also believes that "as evolution selected individuals who could communicate with improved language, it selected for bigger brains at the same time," which in effect suggests that language and the higher fitness that it inferred was a significant reason for enhanced human brain development (Nowak, 2011, p. 177). Pringle also cites support for "cultural ratcheting" from Lewis Dean, which involves "the ability to pass on knowledge from one individual to another, or from one generation to the next, until someone comes along with an idea for an improvement" (Pringle, 2013, p. 43). This insight is reinforced by work from Mark Thomas, who states that "It's not how smart you are ... It's how well connected you are" emphasizing the importance of population density in fostering innovation\(^\text{20}\) (Pringle, 2013, p. 43).

\(^{20}\) This is backed up by the research of Nobel-Prize winning Harvard economist Michael Kremer who "has suggested that world population growth is a key driver of advancing economic prosperity. If there are more people, Kremer argues, then there are more scientists, inventors, and engineers to contribute to innovation and technological
In a 2014 *Scientific American* piece "The 'It' Factor," Gary Stix cites further research from Michael Tomasello – who first identified the "cultural ratchet" – arguing that "what separated modern humans from the hominin pack was an evolutionary adaptation for hypersociality" (Stix, 2014, p. 76). Tomasello additionally suggests that "shared intentionality," which is the "capacity to engage with another person to play a game or achieve a common goal," was another unique human adaptation (Stix, 2014, p. 77). He contends that this small attribute is "rooted in an inherited predisposition for a degree of cooperative social interactions that is absent in chimps or any other species" (Stix, 2014, p. 77). Tomasello and his colleagues also maintain that "humans have a special capacity for engaging in figurative 'mind reading' of another person's thoughts. They use these deductions to make plans for achieving a joint goal – whether it be carrying a log or building a skyscraper" (Stix, 2014, p. 77). It is important to mention that despite the positive reception that Michael Tomasello, Esther Herrmann, and their team have received on their research, they still have influential critics on both sides of the debate (Stix, 2014, p. 78). Primatologists Catherine Crockford, Christophe Boesch (also members of the Max Planck Institute), and Frans de Waal, believe that chimpanzees are much more cooperative than Tomasello gives them credit for, while anthropologist Daniel Povinelli thinks that Tomasello, "overstates chimps' cognitive capacities" (Stix, 2014, p. 79). Indeed, there is still much debate and much more to be learned about why human intelligence developed in the way that it did, but it does appear that imagination, social skills, and the ability to cooperate in a dynamic manner played a reasonable role in getting humans to their current state.

**Cooperation**

Over the past several decades there have been numerous research studies which have proven the criticality of cooperation between cells, organisms, and animals (especially social species) in determining their ultimate success in evolutionary terms (Mayr, 2000; Nowak, Tarnita, and Wilson, 2010). These new progress" (Mankiw, 2013, p. 230). Kremer essentially argues that "having more people induces more technological progress" (Mankiw, 2013, p. 230).

21 One of the most important findings relating to this arena was biologist Lynn Margulis' discovery of "symbiogenesis," which occurred when one bacterium occupied another bacterium approximately 1.8 billion years ago leading to the
findings have diminished the prominence of social Darwinism – i.e., Herbert Spencer's famous quote "survival of the fittest" – and shown how truly vital cooperation is in evolutionary development (Mayr, 2000, pp. 80-82). Biologist Ernst Mayr shares a nice summary of the current thinking on cooperation in the evolutionary biology field in his 2000 Scientific American article "Darwin's Influence on Modern Thought" (Mayr, 2000).

We now know, however, that in a social species not only the individual must be considered—an entire social group can be the target of selection. Darwin applied this reasoning to the human species in 1871 in The Descent of Man. The survival and prosperity of a social group depends to a large extent on the harmonious cooperation of the members of the group, and this behavior must be based on altruism. Such altruism, by furthering the survival and prosperity of the group, also indirectly benefits the fitness of the group's individuals. The result amounts to selection favoring altruistic behavior. Kin selection and reciprocal helpfulness in particular will be greatly favored in a social group. Such selection for altruism has been demonstrated in recent years to be widespread among many other social animals. One can then perhaps encapsulate the relation between ethics and evolution by saying that a propensity for altruism and harmonious cooperation in social groups is favored by natural selection. The old thesis of social Darwinism—strict selfishness—was based on an incomplete understanding of animals, particularly social species. (Mayr, 2000, p. 82)

As expressed by Mayr in the above quote, the criticality of cooperation in human development (and the development of most organisms) is now generally accepted in the scientific community; however, the reasons for its importance and the fragile advantage that it maintains over competition (and selfishness) are both interesting and complex.

In the most straightforward terms one of the main reasons for the centrality of cooperation in human development is the concept of fairness. Indeed, primatologists / ethologists Sarah Brosnan and Frans de Waal have demonstrated – in a 2003 study published in Nature ("Monkeys reject unequal pay") – that fairness and cooperation played an exceptionally important role in the evolutionary development of non-human primates as well due to the fact that individuals continuously compare themselves to each other and have an "aversion to inequity" based off of perceived unfair return distributions (Brosnan and de

formulation of "higher cells, known as Eukarya" (Nowak, 2011, p. 138). This cooperation event led to the development of complex multicellular organisms "known as eukaryotes, [which] are the building blocks of [all] plant and animal bodies, including our own" (Nowak, 2011, p. 139).
Waal, 2003, pp. 297-298). In a subsequent study published in *Neuropsychologia* ("Capuchin cognitive ecology: cooperation based on projected returns") the same year, Frans de Waal and biologist Jason Davis discovered another more subtle insight into how capuchin monkeys managed cooperation and fairness when encountering the possibility of future rewards: "the monkeys based decisions about cooperation on anticipated pay-offs, taking into account both the possibility and likelihood of competition with their partner. In tolerant relationships, as found among kin, monopolization opportunities were largely ignored, but not in the more competitive relationships among nonkin" (de Wall and Davis 227). What's fascinating about the findings of these studies is that they are strikingly similar to the way that humans utilize fairness and unfairness to deal with inequity.


The sociologists say that, when transactions are not fair, the person on the short end of the transaction will be angry. The impulses released by that anger force exchanges to be fair. The social psychology theory of exchange is called equity theory. It holds that on either side of an exchange the inputs should equal the outputs. (Akerlof and Shiller, 2009, pp. 23-24).

Akerlof and Shiller's assessment of fairness and unfairness essentially boils down to the fact that people expect fairness and will readily take action if they perceive things as being unfair. They further articulate a nice summary of their findings:

We have shown that a great deal of what makes people happy is living up to what they think they should be doing. In this sense most of the time people want to be fair. They consider it an insult if others do not think they are fair. At the same time, people also want others to live up to what they think those others should be doing. People get upset (think of Fehr’s experimental subjects and their desire to punish) when they think others are not being fair. (Akerlof and Shiller, 2009, p. 25).
The concept of fairness is also context dependent based on nuances relating to perception and environment; yet, it is remarkably robust and can have a profound impact on the way that we interact on both the individual and group level.

Building upon this principle in an applied setting, University of Pennsylvania social psychologist Adam Grant has discovered a fascinating dynamic regarding fairness and its implications for success in the real world by classifying people into three groups: 1) givers, 2) takers, and 3) matchers (Grant, 2013). Grant has found that in general most of us are "matchers," but in terms of overall career (and personal) success "givers" occupy both the very top and the very bottom of the scale (Grant, 2013). This is because "givers" are always at risk of detrimental actions from selfish "takers," who can potentially cause them significant damage; however, "takers" are largely kept in check by "matchers" whose aversion to inequity and unfairness will cause them to take action against individualistic or manipulative people (Grant, 2013). The key differential in whether "givers" can rise to the top of the ladder or remain at the bottom is how they are able to defend against exploitation by "takers" (Grant, 2013). If they are able to prevent "takers" from causing harm, "givers" have the opportunity to become incredibly successful, which is largely a function of the way that humans broadly view fairness, cooperation, and altruistic actors (Grant, 2013). Interestingly, Grant's insights tie in well with recent findings from a group of Harvard, Oxford, and Princeton researchers on the delicate advantage that cooperation holds over competition.

Biologists Corina Tarnita, Hisashi Ohtsuki, E.O. Wilson, Bob May, Martin Nowak, and Karl Sigmund have recently proven mathematically that cooperation was one of the most essential elements of human development. They have also shown that J.B.S. Haldane and Bill Hamilton's "kin selection" and "inclusive fitness theory," while still valid mechanisms for cooperation, have serious mathematical shortfalls that limit their applicability as a stand-alone driver in evolutionary biology (Nowak, Tarnita, and Wilson, 2010, pp. 1057-1061). Additionally, they have determined five specific mechanisms that enable cooperation, with the presence of just one being enough to allow for its development within a group or population (Nowak, 2011, p. 270).
Cooperation Mechanisms:
1. **Repetition (Direct Reciprocity):** "I'll scratch your back and you scratch mine."
2. **Reputation (Indirect Reciprocity):** "I scratch your back and someone will scratch mine."
3. **Spatial selection:** "cooperators can prevail by forming networks and clusters in which they help each other."
4. **Multilevel selection:** "in some circumstances selection acts not only on individuals but also on groups."
5. **Kin selection:** "I recognize my kin and I behave accordingly, so I cooperate with close kin and I defect with strangers." (Nowak, 2011, pp. 270-272)

These discoveries are an important step forward in understanding the conditions that are required for cooperation to succeed; yet, a pair of elegant mathematical proofs by Hisashi Ohtsuki and Corina Tarnita offer even more granular explanatory power.

Ohtsuki uncovered a rule which holds that "if the benefit-to-cost ratio is greater than the degree of the graph [network], then cooperators are more abundant than defectors" – expressed as $b/c > k$ [k = graph, b = benefit, and c = cost] (Nowak, 2011, p. 250). His finding can be more clearly stated as follows:

... defectors always beat cooperators when they encounter each other in a well-mixed population. But on a graph, cooperation can thrive when cooperators huddle together to form clusters ... we can see that it is easier to form a cluster if each individual is only connected to a few others. The fewer the neighbors, k, means the smaller the benefit-to-cost ratio that is required for cooperation to thrive. (Nowak, 2011, p. 250)

Building on this line of research, Corina Tarnita has discovered another brilliant proof, which is universally applicable in any evolutionary process and can be summed up rather simply: "the more sets there are, the better it is for cooperation. The reason is that when there are more sets, cooperators have more opportunities to escape. It is easier for them to find sets that are free of the troublesome defectors that could exploit them" (Nowak, 2011, p. 262). At an even more granular scale Tarnita discerned that there were also optimal levels of "choosiness" and "mobility" for cooperators to ensure that they identified prime sets with like-minded individuals and then stayed long enough to offer a mutual benefit, but at the same time were granted the opportunity to leave if the set became toxic with defectors beginning to dominate (Nowak, 2011, pp. 262-263). Essentially the ideal environment is a balance between "mobility" and "choosiness" that gives the cooperators an opportunity to attract each other to a specific set, but also the chance to exit in search of a new set if defectors become too numerous: i.e., cooperative sets attract
cooperators and majority defector sets decline and expire (Nowak, 2011, pp. 262-263). Tarnita's theorem was in turn built off of Martin Nowak's variant of "Tibor's Constant," which included the insertion of an additionally parameter $\sigma$ (Nowak, 2011, p. 265). Through her research Tarnita had "found a way to calculate $\sigma$ for sets," which she refers to as "divine Tit for Tat" (Nowak, 2011, p. 266). The nature of how $\sigma$ operates in her theorem is surprisingly easy to explain.

If $\sigma$ is greater than one, then like associates with like: what we call positive assortment or clustering. If $\sigma$ is less than one, then the opposite strategies interact more frequently. Hence there is negative assortment. For the well-mixed population $\sigma$ is equal to one. So if we want cooperators to thrive in the Prisoner's Dilemma we need positive assortment and thus need $\sigma$ to exceed one. (Nowak, 2011, p. 266)

Tarnita's elegant solution is an exceptionally valuable tool for understanding the nature of cooperation and how it thrives in different sets and different environments, but what's most powerful about it is the fact that, as Martin Nowak says, "It applies to any and every game in the cosmos [literally]" (Nowak, 2011, p. 266).

Tying this mathematical biology research on cooperation back to "game theory" and its relevance in the financial markets, numerous researchers in the biology, mathematics, statistics, and physics realms have come up with fascinating insights into the optimal strategies to employ in "game theory," which began with the evolutionary game theory tournaments of University of Michigan political scientist Robert Axelrod (Nowak, 2011, pp. 29-31). The original approach that won the first game theory tournament was employed by Russian mathematical-psychologist Anatol Rapoport called "Tit for Tat," which "starts with a cooperative move and then always repeats the co-player's previous move" (Nowak, 2011, p. 30). However, an even more sophisticated strategy was developed roughly a decade later by Karl Sigmund and Martin Nowak

22 "This coefficient [\sigma] specifies the relative rate at which like-minded players meet: in other words, the relative rate at which cooperators team up with other cooperators, and defectors gang up with other defectors" (Nowak, 2011, p. 265).
23 Nowak also shares another simple way of understanding Tarnita's proof: "In evolving populations, cooperation withers, shrivels, and dies when the structure coefficient, $\sigma$, is less than one. Equally, when $\sigma$ is greater than one, cooperation takes root and flourishes" (Nowak, 2011, p. 266).
24 Just to share a list of some of these important researchers in the "game theory" and mathematical biology realm: Robert Axelrod, Anatol Rapoport, Karl Sigmund, John Maynard Smith, Bob May, Manfred Milinski, John Krebs, David Kraines, Vivian Kraines, Eric Maskin, Martin Nowak, and Drew Fudenberg.
called "Generous Tit for Tat," which leveraged forgiveness to enhance outcomes: "Generous Tit for Tat" Strategy – "always meet cooperation with cooperation and when facing defection, cooperate for one in every three encounters [specific parameters can be varied depending on the game]" (Nowak, 2011, p. 36).

Yet, while "Generous Tit for Tat" works well in alternating move games another modulating strategy called "Win Stay, Lose Shift" was optimal for simultaneous move games: "Win Stay, Lose Shift" Strategy – "If I am doing well, I will repeat my move. If I am doing badly, I will change what I am doing" (Nowak, 2011, pp. 43-47).

Yet, even the sophistication and elegance arising from the protective randomness of these strategies ("Generous Tit for Tat" and "Win Stay, Lose Shift") doesn't last forever, as over time the niceness of the group creates conditions that "allow [for] a resurgence of defectors" (Nowak, 2011, p. 48). Martin Nowak sums up this research explaining how it informs our understanding of evolutionary game theory: "No Strategy is really stable and thus successful for eternity. There is constant turnover. Fortune does not smile forever on one person. A heaven of cooperation will always be followed by a defective hell. Cooperation's success depends on how long it can persist and how often it reemerges to bloom again" (Nowak, 2011, p. 49). As we will see this is an incredibly powerful insight not just for the mathematics and biology arenas, but also for the financial markets as well since they operate as a zero-sum game and are perpetually influenced by our imagination, our language, and our cultural evolution and behavioral development.

**Cultural Evolution, Behavioral Development, and Financial Markets**

In tying together all of the reasons why *Homo sapiens* is special, its probably best summarized by University of Virginia strategy professor Alec Horniman: “We are the only animals who can intentionally learn and intentionally evolve” (Venkataraman and Horniman, *Leadership Failure – Strategic Success*, 2014).

Yuval Harari argues that the cerebral changes and specific abilities pertaining to "cultural evolution" began

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25 Oxford zoologist John Krebs helped Sigmund and Nowak further refine their understanding of the "Win Stay, Lose Shift" strategy and its application in "game theory" by explaining its prevalence throughout the animal kingdom, especially among mammals (Nowak, 2011, p. 43). Separately, Duke and Meredith University mathematicians David Kraines and Vivian Kraines have developed a strategy to fend off selfish actors similar to "Win Stay, Lose Shift," which they called "Pavlov" (Nowak, 2011, p. 44).
after the Cognitive Revolution [likely due to alterations in our prefrontal cortex] and allowed for our rapid run up the evolutionary ladder (Harari, 2015).

... ever since the Cognitive Revolution, Sapiens have been able to change their behaviour quickly, transmitting new behaviours to future generations without any need of genetic or environmental change. ... In other words, while the behaviour patterns of archaic humans remained fixed for tens of thousands of years, Sapiens could transform their social structures, the nature of their interpersonal relations, their economic activities and a host of other behaviours within a decade or two. (Harari, 2015, pp. 33-34)

Andrew Lo likes to refer to this advantage as "Evolution at the Speed of Thought" (Lo, 2017, p. 162), which he ties in with our imagination: "The ability to engage in abstract thought, to imagine counterfactual situations, and to predict the consequences is uniquely human" (Lo, 2017, p. 183). Lo elaborates further on how he views this concept and its relevance in the modern world:

Evolution has shaped our brains, but our brains shape ideas. Even in the realm of ideas, however, evolution still has a role to play ... We can use our brains to test our ideas in mental models, and to reshape them if they're found lacking. This is still a form of evolution, but it's evolution at the speed of thought ... Unlike Darwinian evolution, evolution at the speed of thought can recombine ideas from many different sources, past and present, living and dead ... Natural selection applies to narratives as well as to genes ... Just as in nature, the evolution of ideas doesn't play favorites ... To someone who's convinced that he knows the answer, there's no hope of any further enlightenment ... The evolution of ideas, accomplished at the speed of thought, is at the heart of what separates us from other species and allows us to dominate our world. (Lo, 2017, pp. 164-168)

He then uses these concepts relating to "cultural evolution" and "evolution at the speed of thought" to develop his "Adaptive Markets Hypothesis," which he utilizes to interpret financial markets and the investment ecosystem.

In his efforts to bridge the gap between the Rational Expectations Branch and the Behavior Economics school of thought, Andrew Lo has developed the "Adaptive Markets Hypothesis" by drawing on evolutionary biology and natural selection due to the similar complexities that they share with economics: "Economic concepts translate naturally to their biological counterparts, and vice versa, such as the allocation of scarce resources and the measurement of diversity in a population" (Lo, 2017, p. 214). Lo
argues that "We're neither entirely rational nor entirely irrational, hence neither the rationalists nor the
Behavioralists are completely convincing" (Lo, 2017, p. 186).

We aren't rational actors with a few quirks in our behavior – instead, our brains are
collections of quirks. We're not a system with bugs; we're a system of bugs. Working
together under certain conditions, these quirks often produce behavior that an
economist would call "rational." But under other conditions, they produce behaviors
that an economist would consider wildly irrational. These quirks aren't accidental, ad
hoc, or unsystematic; they're the products of brain structures whose main purpose isn't
economic rationality, but survival. (Lo, 2017, pp. 186-187)

The similarities that he finds between evolution and financial markets are striking and seem to begin to
offer a new way to understand that a particular behavior may only be "irrational" because it isn't well-
adapted to the environment that it is being employed in: i.e., "There may be a compelling reason for the
behavior, but it's not the most ideal behavior for the current environment" (Lo, 2017, p. 189).

This in turn leads into how natural selection modified our behaviors over time and how we utilize
its principles to better grasp financial market dynamics. Lo shares his thoughts on natural selection's
impacts on our development and how it relates to his concept of "evolution at the speed of thought" (Lo,
2017, p. 162).

Natural selection, the primary driver of evolution, gave us abstract thought, language,
and the memory-prediction framework, new adaptations in human beings that were
critically important for our evolutionary success. These adaptations have endowed us
with the power to change our behavior within a single lifespan, in response to
immediate environmental challenges and the anticipation of new challenges in the
future. Natural selection also gave us heuristics, cognitive shortcuts, behavioral biases,
and other conscious and unconscious rules of thumb – the adaptations that we make at
the speed of thought. Natural selection isn't interested in exact solutions and optimal
behavior, features of Homo economicus. Natural selection only cares about differential
reproduction and elimination, in other words life or death. Our behavioral adaptations
reflect this cold logic. However, evolution at the speed of thought is far more efficient
and powerful than evolution at the speed of biological reproduction, which unfolds one
generation at a time. Evolution at the speed of thought has allowed us to adapt our
brain functions across time and under myriad circumstances to generate behaviors that
have greatly improved our chances for survival. (Lo, 2017, pp. 187-188)

These insights on natural selection relate back to "cultural evolution" and how we can rapidly change our
behaviors based on experience and information sharing, with perhaps the most critical method to facilitate
this process being the manner in which we choose to learn.
University of Virginia strategy professors Sankaran Venkataraman and Alec Horniman suggest that being a constant learner is one of the most important factors in achieving success and that "How we choose to learn is perhaps the most important process that we engage in" (Venkataraman and Horniman, Change as Evolution, 2014). They also offer a high level strategy for how to approach learning in the modern world.

There is a general template for a learning strategy, which babies tend to do the best: 1) **Observe**, 2) **Digest**, 3) **Imitate**, 4) **Design Independence**, and 5) **Innovate**. We must develop a deliberate learning strategy and focus on achieving a balance between learning and evolution. (Venkataraman and Horniman, Change as Evolution, 2014)

These insights from Venkataraman and Horniman are incredibly profound and link back to learning in the context of "conceptual evolution" that Andrew Lo explores to develop his theory (Lo, 2017, p. 183). Lo, together with his fellow researcher Tom Brennan explain the principles of learning and optimizing as they relate to Herbert Simon's "satisficing" in contrast to the "Efficient Market Hypothesis" (Lo, 2017, p. 182).

You develop rules of thumb by trial and error. You usually don't know whether a decision is truly optimal. Over time, however, you experience positive and negative feedback from your decisions, and you alter your decisions in response to this feedback. In other words, you learn and adapt to the current environment. Our ability to learn from experience, and to adapt one's behavior in light of new circumstances, is one of the most powerful traits of *Homo sapiens* and is the main mechanism that can transform us over time and through experience into *Homo economicus*, at least while the environment is stable. Learning is a form of conceptual evolution. We begin learning a new behavior using a heuristic – our rule of thumb – that may be very far from optimal. If we receive negative feedback from applying that heuristic, we change the heuristic. We don't even have to do this consciously. We reproduce the original behavior, but make a variation on it. If this change yields positive feedback, we keep using the new heuristic; if the feedback is still negative we change it again. (Lo, 2017, pp. 182-183)

Lo argues that this informs the key differentiator in the power behind our methods of learning and their influence on our behaviors: "our heuristics can evolve at the speed of thought" (Lo, 2017, p. 183).

Andrew Lo ultimately comes to define the philosophy behind his "Adaptive Markets Hypothesis" through the theories of "cultural evolution," "conceptual evolution," and "evolution at the speed of thought," which lead him to five different principles that summarize his hypothesis (Lo, 2017, p. 188).
Adaptive Markets Hypothesis:
1. We are neither always rational nor irrational, but we are biological entities whose features and behaviors are shaped by the forces of evolution.
2. We display behavioral biases and make apparently suboptimal decisions, but we can learn from past experience and revise our heuristics in response to negative feedback.
3. We have the capacity for abstract thinking, specifically forward-looking what-if analysis; predictions about the future based on past experience; and preparation for changes in our environment. This is evolution at the speed of thought, which is different from but related to biological evolution.
4. Financial market dynamics are driven by our interactions as we behave, learn, and adapt to each other, and to the social, cultural, political, economic, and natural environments in which we live.
5. Survival is the ultimate force driving competition, innovation, and adaptation. (Lo, 2017, p. 188)

This is an incredibly nuanced and well-researched hypothesis, and indeed, it seems like an obviously effective way to view and interpret the markets. However, there are exceptional complexities at play here that are backed up by Lo's own assertions, which make forecasting and prediction in the markets remarkably difficult. For example, Lo believes that it is possible – though extremely difficult – to beat the market by taking advantage of small inefficiencies that occur from time to time; however, these opportunities tend to be fleeting as other investors will quickly recognize your strategy and imitate it until your excess returns disappear (Lo, 2017). Similarly to the "game theory" and "evolutionary biology" strategies mentioned earlier, the financial market environment necessitates a constantly changing adaptive strategy to even hope for the possibility of generating consistent alpha²⁶, since everything is always in flux and what worked in one environment or time period will likely not be successful in another. Yet, interestingly a significant factor governing the behavioral traits and trends within the financial markets is how critical information is shared and at what speed it is disbursed, which ultimately comes down to five different core theories, concepts, and models: e.g., "imagination," "language," "cultural evolution," "conceptual evolution," and [particularly] "stories."

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²⁶ **Alpha** is the excess investment return achieved above the market or a predetermined comparison benchmark.
"A man is always a teller of tales, he lives surrounded by his stories and the stories of others, he sees everything that happens to him through them; and he tries to live his life as if he were recounting it" – Jean Paul Sartre (Shiller, 2017, p. 8; Sartre, 1938).

Chapter Three: Stories

Background on the Evolution of Stories

Stories are the most powerful method of transmitting information between human beings. It's not too much of a leap to say that, following imagination and language, they are one of the key reasons for Sapiens' evolutionary success. They enable the sharing of useful knowledge and can galvanize us to believe in a cause and spur us to take action. Why they are so powerful is summed up very clearly by Alec Horniman's insight that "We live our lives in story," which means that we assess and interpret every experience and interaction that we have in the world through the lens of a story – and its importance may also have biological underpinnings as well (Venkataraman and Horniman, Leading Change – A Turnaround, 2014).

Indeed, Robert Shiller in his 2019 book Narrative Economics: How Stories Go Viral and Drive Major Economic Events, cites research suggesting that our brains may be hardwired to be particularly receptive to stories (Shiller, 2019). Referencing work from literary scholars, Shiller explains that they "have found that certain basic story structures are repeated constantly, though the names and circumstances change from story to story, suggesting that the human brain may have built-in receptors for certain stories" (Shiller, 2019, pp. 15-16). In one such example journalist Christopher Booker "argues that there are only seven basic plots": "overcoming the monster, rags to riches, the quest, voyage and return, comedy, tragedy, and rebirth" (Shiller, 2019, p. 16). Additionally, it appears as though metaphor and analogy have a powerful influence over us as well, possibly because of the ease with which they link to previous experiences or knowledge.

Contagious narratives often function as metaphors. That is, they suggest some idea, mechanism, or purpose not even mentioned in the story, and the story becomes in effect a name for it. The human brain tends to organize around metaphors. For, example we freely incorporate war metaphors in our speech. We say an argument was "shot down" or is "indefensible." The human brain notices these words' connection to
war narratives, although the connection is not always a conscious one. The connection enriches the speech by suggesting other possibilities. So when we speak of a stock market "crash," most of us are reminded of the rich story of the 1929 stock market crash and its aftermath. (Shiller, 2019, p. 17)

This is further supported by research from neuroscientist Oshin Vartanian who observes that particular regions of the brain are consistently stimulated when introduced to these types of stories: i.e., "the human brain seems wired to respond to stories that lead to thinking in analogies" (Shiller, 2019, p. 17).

Neuroeconomist Paul Zak has also found that "narratives with a 'dramatic arc' increase levels of the hormones oxytocin and cortisol in the listener's bloodstream, as compared with more 'flat' narratives" (Shiller, 2019, p. 54).

Building on this point, stories and narratives are made possible by language, which appears to have evolved in the human brain over time, allowing us to leverage our imagination and to cooperate at a level that no other species can match. Part of the reason that this feat doesn't occur in other animals is because both the creation of syntax and the employment of a big brain are large energy drains, which are only useful if they are able to confer some sort of survival advantage, as they do in humans (Nowak, 2011, pp. 185-186). Explaining exactly why this happened in people is challenging, but in effect, it appears as though over time "as evolution selected individuals who could communicate with improved language, it selected for bigger brains as the same time," meaning that the two genetic changes appear intertwined; however, the specificity of language may have meant that it was slightly more influential in brain development (Nowak, 2011, p. 177). Mathematical biologist Martin Nowak, further articulates how this evolutionary development plays out over time.

There is a payoff for individuals who successfully communicate with each other. The payoff improves their fitness, with more genetic or cultural offspring. The biological

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27 Interestingly, German astronomer / mathematician Johannes Kepler was famous for using analogies to develop solutions and explanations for problems that were "outside the bounds of previous thought": e.g., "laws of planetary motion" and "that the moon influenced tides on Earth" (Epstein, 2019, pp. 100-101). Additionally, there is a fascinating critical thinking process championed by Northwestern University psychologist Dedre Gentner called analogical thinking, which might be value added to explore in the investment ecosystem: "Deep analogical thinking is the practice of recognizing conceptual similarities in multiple domains or scenarios that may seem to have little in common on the surface" (Epstein, 2019, pp. 102-103).
payoff is that they reproduce faster; they are more efficient at getting mates, for example. In a cultural payoff, they are more likely to pass along their grammar to listeners/learners. Children are not born with a language but with a mechanism for learning language. (Nowak, 2011, pp. 190-191)

This mechanism is what allows us to learn, process, and employ language through the utilization of grammar.  

To this point, philosopher / cognitive scientist Noam Chomsky argues "that all languages have a common structural basis, a set of rules ... called 'universal grammar,' a plan common to each and every grammar that we know of" (Nowak, 2011, p. 179). In searching to understand how the brain encodes and decodes these sequences of random signals, "He [Chomsky] found that an elegant mathematical underpinning can generate a code to speak and understand infinite meanings" (Nowak, 2011, p. 179). To give a better understanding of what this means exactly, Nowak summarizes the science behind the work of Chomsky and others in the field.

Learning theory shows that this set of potentially learnable languages must be restricted, so the brain cannot pick up every conceivable grammar. The brain is not a blank slate that can infer the rules of any grammar. Instead it is restricted to learn a particular set of grammars. This restricted set of grammars that can be learned by the human brain is characterized by what Chomsky calls universal grammar. (Nowak, 2011, p. 190)

Building on this Nowak and his colleagues Natasha Komarova and Partha Niyogi discovered the reasoning and mechanism that gives rise to universal grammar in the first place, which is a "linguistic coherence threshold" that they articulated in their 2001 Science article, "Evolution of Universal Grammar" (Nowak, Komarova, and Niyogi, 2001). What they uncovered was a "law of nature" identifying "that for a given amount of information (number of sample sentences) we [Nowak and his colleagues] could specify how specific a universal grammar had to be for coherent grammar to evolve in a population of speakers" (Nowak, 2011, p. 191). Essentially, there is a set mutation in the gene architecture of the brain that enables

28 “Grammar ... enables words to cooperate to form new meanings. Grammar is what gives rise to the unlimited expressibility of language” (Nowak, 2011, p. 178).

29 Another example of a "law of nature" is Manfred Eigen and Peter Schuster's genetics discovery that "for a given mutation rate there is a maximum genome length for genetic evolution to be possible" (Nowak, 2011, p. 191).
just the right "search space" of grammars without it becoming too big that it creates confusion due to contradictory data (Nowak, 2011, p. 191). This provides an interesting background on the underpinnings of how grammar and language evolved; however, the impacts of their development were even more remarkable.

Martin Nowak explains that "Language allows people to work together, to exchange ideas, their thoughts and their dreams" and it additionally supports the cooperative mechanism of "indirect reciprocity" (along with "gossip"), which enables reputation and altruistic acts to enhance productivity among groups (Nowak, 2011, p. 171). Nowak further articulates the game changing effects of language.

... the emergence of language led to an extraordinary range of social interactions and discussions about who did what to whom and why. As a result of language, social life became ever more sophisticated. Our brains did too. Big brains are costly in terms of food and child birth, and the development of our extraordinary encephalon could only be justified by making us adept at the complex social politics that come with a sophisticated language. Down the generations, as human society expanded and became ever more elaborate, the gossip that lubricated the mechanism of indirect reciprocity also made us smart. (Nowak, 2011, p. 198)

Yet, language by itself is still just a mechanism to facilitate communication. Its integration into stories and shared narratives enables even more profound impacts on the way that humans interact, impart information, and collaborate together as a whole.

Indeed, it appears as though most of "human knowledge" arose largely because of stories (Akerlof and Shiller, 2009, p. 51). Robert Shiller and George Akerlof share a nice summary of the human brain and its dependence on stories.

The human mind is built to think in terms of narratives, of sequences of events with an internal logic and dynamic that appear as a unified whole. In turn, much of human motivation comes from living through a story of our lives, a story that we tell to ourselves and that creates a framework for motivation. Life could be just "one damn thing after another" if it weren't for such stories. (Akerlof and Shiller, 2009, p. 51)

Akerlof and Shiller go on to cite the work of social psychologists Roger Schank and Robert Abelson regarding the critical linkage between memory and stories.

People's memories of essential facts are, they argue, indexed in the brain around stories. Facts that are remembered are attached to stories. Other facts may enter
short-term memory. But such memories tend not to be influential, and they are eventually erased ... Yet we keep in mind a story of those memories, a story that helps define who we are and what our purpose is ... Human conversation ... tends to take the form of reciprocal storytelling. One person tells a story. This reminds the other of a related story. That in turn reminds the first person of a story, and so on and on in a long sequence. We take a deep-seated delight in telling a story that provokes a response from another person. Conversation tends to move along, seemingly randomly, from one topic to another. But the process has an underlying design that is key to human intelligence. It not only serves to communicate information in a form that is readily absorbed, it also serves to reinforce memories related to stories. We tend to forget stories that we do not repeat to others. (Akerlof and Shiller, 2009, p. 51)

These relationships between stories, conversation, and memory are very powerful, and they illustrate the criticality of storytelling at both a biological and cultural level. Along these lines, Akerlof and Shiller point out that "The confidence of a nation, or of any large group, tends to revolve around stories"; yet, even at the individual level stories are remarkably influential for a number of reasons.

Sankaran Venkataraman and Alec Horniman of the University of Virginia explain that everyone has a story where they think that they're the hero30 (Venkataraman and Horniman, Personal Leadership through Engagement, 2014). We are always the central character (protagonist) in our story, and there are typically recurring patterns of behavior surrounding this narrative, which tend to repeat if left unexamined (Venkataraman and Horniman, Personal Leadership through Engagement, 2014). We choose our story unknowingly in the first three years of our life, and we created this story, that then becomes the integrator for all of our habits, based on very little information (Venkataraman and Horniman, Personal Leadership through Engagement, 2014). Duke University social psychologist Richard Larrick echoes these insights from Venkataraman and Horniman, observing that our core personality is generally shaped during early childhood, and although we can make adjustments to it over time through changes to our habits and our environments, this baseline character is largely fixed from a young age (Larrick, Learning from Experience, 2018).

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30 This is backed up by Daniel Kahneman's assertion that "we all care intensely for the narrative of our own life and very much want it to be a good story, with a decent hero" (Kahneman, 2011, p. 387).
As mentioned above, a significant part of the development of our personalities is based on these stories that we create in early childhood, and if you have a robust story your story typically determines the rest of your life (Venkataraman and Horniman, Personal Leadership through Engagement, 2014). Yet, change is possible, and knowing our stories and taking charge of them can dramatically impact our outcomes. The more that we understand our story the more options and choices it affords us. (Venkataraman and Horniman, Personal Leadership through Engagement, 2014). One helpful way of doing this is to incorporate the "Key Elements of a Classical Story"\(^{31}\) when managing our story to help guide our meaning and purpose: 1) A protagonist the listener cares about, 2) A catalyst compelling the protagonist to take action, 3) Trials and Tribulations, 4) A turning point, and 5) A resolution\(^ {32}\) (Ibarra and Lineback, 2004, p. 3). Indeed, this is just one of many techniques that can be utilized to understand and develop our stories, which can be of profound importance when trying to alter our habits and behaviors. As organizational behavior professors Herminia Ibarra and Kent Lineback observe, the types of stories that we tell and the way that we tell them can have a significant impact as well: "The kinds of stories we tell make an enormous difference in how well we cope with change" (Ibarra and Lineback, 2004, p. 1). Understanding our story and its influence on our lives can be incredibly powerful in helping us shape our path at the individual level; however, marketers, corporations, and governments can also leverage stories for a wide variety of purposes ranging from convincing people to purchase their products to buying into their political agendas.

**Stories, Marketing, and Propaganda**

George Akerlof and Robert Shiller argue that "Stories are like viruses," and that their spread could potentially be modeled along the lines of a viral epidemic (Akerlof and Shiller, 2009, p. 56). Indeed, it is this

\(^{31}\) In their 2004 *Harvard Business Review* article "What is your story?" Herminia Ibarra and Kent Lineback explain that "This is the classic beginning-middle-end story structure defined by Aristotle more than 2,300 years ago and used by countless others since. It seems to reflect how the human mind wants to organize reality" (Ibarra and Lineback, 2004, p. 3).

\(^{32}\) Another important storytelling technique is the similarly designed "Classic Play Structure" shared by Jenn Chambers of Duke University: **Classic Play Structure** – 1) Prologue, 2) Conflict, 3) Rising Action, 4) Climax, 5) Falling Action, and 6) Denouement [Conclusion/Resolution] (Chambers, Dramatic Spectacle, 2019)
attribute that tends to make stories so influential, and while they may arise organically, such as a crisis of confidence, they might also be developed intentionally by marketers or politicians to shape perception and to achieve their goals (Akerlof and Shiller, 2009). Along these lines it's probably helpful to share a little bit of background on the embedded psychological principles that underpin our susceptibility to the power of stories from Arizona State marketing professor Robert Cialdini. In his seminal 1984 book *Influence: The Psychology of Persuasion*, Cialdini outlines six principles that govern the way that people can be manipulated and swayed by messaging, environments, and framing, all of which are related back to our core psychological makeup.

**Principles of Persuasion:**

1. **Reciprocity:** People feel the need to return a favor or give back when they receive something.
2. **Commitment and Consistency:** When people make a commitment they typically hold to it.
3. **Social Proof:** People looks to others for cues on what actions that they should take, and tend to replicate them.
4. **Authority:** The majority of people show a deference to authority.
5. **Liking:** We are more easily influenced by people who we find likeable.
6. **Scarcity:** When there is a limited supply of something we tend to value it more.

(Cialdini, 1984)

The almost universality of these principles is incredibly fascinating, and it's likely due to the way that the social nature of our species has modified the wiring of our brain over thousands of years.

However, for our purposes here, what is also interesting is that embedded within each of these guidelines is a small story that makes it relevant or potentially useful. For example, with **social proof** we often look for cues based on what is acceptable in a particular environment so that we adhere to the generally accepted norms that the group has deemed appropriate, such as seeing a barista's tip jar almost full, which might indicate that at this coffee shop generous tipping is the norm (Cialdini, 1984). However, despite the evolutionary advantages that this trait might have conferred at both the individual and group level, it can also be easily manipulated to influence behavior: e.g., "Bartenders often 'salt' their tip jars with a few dollars at the beginning of the evening ... to give the impression that tipping with folding money is proper barroom behavior" (Cialdini, 1984, p. 117). The micro-stories related to each of these principles give
us a glimpse of how they might afford an opening for influence and exploitation, which marketers and politicians are fully aware of and readily use for both positive and negative ends.

In beginning the dive into the marketing realm it's best to build off of Akerlof and Shiller's contentions on the virality\(^{33}\) of stories (Akerlof and Shiller, 2009) by analyzing the work of University of Pennsylvania marketing professor Jonah Berger in his 2013 book *Contagious: Why Things Catch On* (Berger, 2013). Berger argues that "Social influence and word of mouth" are two of the largest determinants of what becomes popular for a fairly simple reason: "People love to share stories, news, and information with those around them" (Berger, 2013, p. 7). He further explains that the reason that "word of mouth" is so effective basically boils down to two factors: "First, it's more persuasive. ... Our friends ... tend to tell it to us straight ... [and] Second, word of mouth is more targeted. ... [It's] naturally directed towards an interested audience" (Berger, 2013, pp. 8-9). Berger states that "Word of mouth is the primary factor behind 20 percent to 50 percent of all purchasing decisions" (Berger, 2013, p. 7) and that the key driver in spreading information is not necessarily the messenger, but instead "the message" (Berger, 2013, p. 14). He additionally argues that "Virality isn't born, it's made," and articulates six principles that determine whether or not "content" becomes "contagious" (Berger, 2013, pp. 21-22).

Six Principles of Contagiousness:
1. **Social Currency**: We share things that make us look good
2. **Triggers**: Top of the mind, tip of the tongue
3. **Emotion**: When we care, we share
4. **Public**: Built to show, built to grow
5. **Practical Value**: News you can use
6. **Stories**: Information travels under the guise of idle chatter (Berger, 2013, p. 207)

\(^{33}\) One of the more powerful concepts governing the viral spread of information is the "**Strength of the Weak Ties**" discovered and articulated by sociologist Mark Granovetter in the *American Journal of Sociology* in 1973: Information travels fastest through weak links (Granovetter, 1973). Essentially people spread the most relevant and useful information possible between weak connections in order to build up their credibility (Granovetter, 1973). Ironically, a great example of the "Strength of the Weak Ties" is telling people about the "Strength of the Weak Ties."
These are exceptionally valuable guidelines with applicability across a broad spectrum of arenas. Yet, despite the relation that each of the six principles have to narrative's influence on marketing, it's likely wise to focus on stories because they are embedded within each of the other principles.

A great example of this comes from the New York City Department of Health (DOH) advertisement called, "Man Drinks Fat" (Berger, 2013, p. 87). In this ad the DOH tries to illustrate the amount of fat that you absorb through sugary drinks by showing a visualization of a man drinking congealed chunks of fat in the equivalent amount of a regular soda (Berger, 2013, p. 87). The clip closes with the statement, “Drinking one can of soda a day can make you 10 pounds fatter a year” (Berger, 2013, p. 88). In analyzing this ad, Jonah Berger points out that “Man Drinks Fat” does a great job of tapping into triggers (Berger, 2013). In this case the trigger is opening a can of soda; every time a consumer opens a can of soda, they will immediately draw back to the repulsive visualization of the man drinking fat globules (Berger, 2013). Yet, even though the trigger is the primary principle in this instance there is still a micro story contained underneath the surface: that people who drink soda regularly will become unnecessarily fatter because of it.

Berger explains that the reason why stories are so powerful is "because people don't think in terms of information. They think in terms of narratives. But while people focus on the story itself, information comes along for the ride" (Berger, 2013, p. 181). Additionally, it's critical to remember that "Stories are the original form of entertainment" (e.g., the Trojan horse in The Odyssey), and "Narratives are inherently more engrossing than basic facts" (Berger, 2013, p. 181). Essentially, stories communicate useful information in a manner that makes us more receptive to internalize it. Jonah Berger articulates more of the why behind the value of stories, especially in the marketing world.

Stories carry things. A lesson or moral. Information or a take-home message. ... [They] act as vessels, carriers that help transmit information to others. ... Stories are an important source of cultural learning that help us make sense of the world. ... [They] save time and hassle and give people the information they need in a way that's easy to remember. You can think of stories as providing proof by analogy. ... People are also less likely to argue against stories than against advertising claims. ... First, it's hard to disagree with a specific thing that happened to a specific person [and] ... Second, we're
so caught up in the drama of what happened to so-and-so that we don’t have the
cognitive resources to disagree. (Berger, 2013, pp. 183-187)

In Berger’s contentions you can see a repetition of many of the key scientific insights regarding why stories
are so valuable to human beings, such as the importance of analogy and the way that our brains are
designed to be receptive of it; however, his big contribution to stories, specifically in the marketing realm, is
the concept of "valuable virality" (Berger, 2013, p. 196).

When trying to generate word of mouth, many people forget one important detail. They focus so much on getting people to talk that they ignore the part that really matters: \textit{what people are talking about}. ... The key, then is to not only make something viral, but also make it valuable to the sponsoring company or organization. Not just virality, but \textit{valuable virality}. ... Virality is most valuable when the brand or product benefit is integral to the story. ... That means making the idea or benefit a key part of the narrative. ... Make sure your desired information is so embedded into the plot that people can't tell the story without it. (Berger, 2013, pp. 195-201)

Berger ultimately advocates that advertisers create their own viral Trojan Horse style narrative with a
hidden idea or lesson embedded inside it to guarantee its spread to the widest possible audience (Berger, 2013).

Yet, while making a story go viral is important to marketers, it's also critical to make it sticky as well.
In addition to virality, marketers also strive to make their ideas and concepts stick so that they remain top
of mind for their consumers long after hearing the initial message. Along this line of research social
psychologists Chip and Dan Heath have uncovered a series of principles that enable notions and
impressions to stay with your desired audience long after internalizing the original communication.

\textbf{Six Principles of Sticky Ideas:}

1. \textbf{Simplicity}: We must strip an idea down to its core, we must be masters of exclusion. We
must relentlessly reprioritize. Proverbs are the ideal. We must create ideas that are both simple and profound.
2. \textbf{Unexpectedness}: We need to violate people’s expectations. For our idea to endure it
must generate interest and curiosity. We can engage people’s curiosity over a long
period of time by systematically “opening gaps” in their knowledge – and then filling
those gaps.
3. \textbf{Concreteness}: We must explain our ideas in terms of human actions, in terms of
sensory information. Speaking concretely is the only way that we can ensure that our
idea will mean the same thing to everyone in the audience.
4. \textbf{Credibility}: Sticky ideas carry their own credentials. We need ways to help people
test our ideas for themselves – a "try before you buy" philosophy for the world of ideas.
5. **Emotions**: We make them feel something. We are wired to feel things for people, not abstractions.

6. **Stories**: Hearing stories acts as a kind of mental flight simulator, preparing us to respond more quickly and effectively. (Heath and Heath, 2008, pp. 16-18)

To give an example of how to tie all of these principles together with a sticky message the Heath brothers cite the work of Art Silverman at the Center for Science in the Public Interest (Heath and Heath, 2008, p. 6).

Silverman was trying to explain to people how unhealthy a medium bag of movie theater popcorn with coconut oil was, given that its 37 grams of saturated fat was 17 grams above the United States Department of Agriculture's (USDA) daily maximum (Heath and Heath, 2008, p. 6). The problem is that most people can't really conceptualize what 37 grams of fat really means in order to understand the ramifications, so Silverman refined the message into something that was more understandable and sticky: “A medium-sized ‘butter’ popcorn at a typical neighborhood movie theater contains more artery-clogging fat than a bacon-and-eggs breakfast, a Big Mac and fries for lunch, and a steak dinner with all of the trimmings – combined!” (Heath and Heath, 2008, p. 7). His message was an immediate success and went viral throughout print and television media outlets, and significantly modified consumer behavior pertaining to movie theater popcorn (Heath and Heath, 2008, pp. 7-8). This is a great example of employing the Heath principles effectively to achieve success with an honest positively intentioned message; however, there are also many examples of fabricated stories and harmful messages being spread through this framework as well, both intentionally and unintentionally: e.g., The unproven rumor of razor blades in Halloween candy, which went viral all over the U.S. in the 1970's and 1980's and significantly altered the way that the holiday is approached (Heath and Heath, 2008, pp. 8-14).

The Heath brothers use this story of Art Silverman and his improved messaging to articulate how to get an idea to stick in people’s minds; however, they further articulate that the real power of stories is their ability to get people to take action: "a credible idea makes people believe. An emotional idea makes people care. And ... the right stories make people act" (Heath and Heath, 2008, p. 206).

Stories illustrate causal relationships that people hadn't recognized before and highlight unexpected, resourceful ways in which people have solved problems ... The story's
power, then, is twofold: It provides simulation (knowledge about how to act) and inspiration (motivation to act). Note that both benefits, simulation and inspiration, are geared to generating action. (Heath and Heath, 2008, p. 206)

People take action based on stories because they can relate to them, easily remember them, and use them as a guide for what actions to take in the future: "This is the role that stories play – putting knowledge into a framework that is more lifelike, more true to our day-to-day existence" (Heath and Heath, 2008, p. 214). The Heath brothers further argue that there are three basic plots34 which are utilized for most stories: The Challenge Plot (e.g., David and Goliath), The Connection Plot (e.g., Good Samaritan), and The Creativity Plot (e.g., MacGyver Plot) (Heath and Heath, 2008, pp. 226-230). Each of these different plot frameworks empowers the listener to take on a challenge, draw inferences, and develop solutions; however, embedded within all of them is the primary power of stories: "to simulate and to inspire" (Heath and Heath, 2008, p. 237).

Yet, there is a specific pitfall surrounding stories – and the other sticky principles – that we must always be cognizant of: "The Curse of Knowledge" (Heath and Heath, 2008, p. 20). The "Curse of Knowledge" is particularly nefarious and can act as an impediment to get us to efficiently and effectively share information with others (Heath and Heath, 2008, p. 20). The "Curse of Knowledge" essentially boils down to the fact that "Once we know something, we find it hard to imagine what it was like not to know it. Our knowledge has 'cursed' us. And it becomes difficult for us to share our knowledge with others, because we can't readily re-create our listeners' state of mind" (Heath and Heath, 2008, p. 20). Yet, stories in particular are very effective at avoiding the "Curse of Knowledge" because they enable even complex or abstract information to be delivered in a manner that can be easily understood and received by your audience. (Heath and Heath, 2008). For example, David Hume's "Problem of Induction" could possibly be simplified down to saying that, when you haven't seen something before you don't think it's possible; however, it can be made even more memorable and easy to understand with the use of story and analogy.

34 Interestingly, "Aristotle believed there were four primary dramatic plots: Simple Tragic, Simple Fortunate, Complex Tragic, and Complex Fortunate" (Heath and Heath, 2008, p. 226).
by relating it to swans: Everyone thought that swans were only white because they had only seen white swans until they traveled to Australia and observed their first black swan (Taleb, 2004, pp. 116-120). Along these lines, the Heath brothers explain how strategies, which are guides to how a business will realize its objectives, are often not necessarily good or bad, but instead "inert" (Heath and Heath, 2008, p. 255). This is because the wording and messaging used is typically academic and engineered, which doesn't necessarily resonate with employees or inspire them into action (Heath and Heath, 2008). This is where stories can assist the company in developing a shared consciousness and motivating action.

Stories that speak to an organization's strategy have two parts. There's the story itself, and there's the moral of the story. It's nice to have both. If you have to choose between the two, though, choose the story. Because the moral is implicit in the story, but the story is not implicit in the moral. And the story – with its concrete language, specific protagonists, and real-world setting – is more likely to guide behavior. Both stories and concrete language help leaders dodge the Curse of Knowledge, and everyone in the organization benefits from a shared understanding of the strategy. (Heath and Heath, 2008, p. 258)

It starts to become obvious that stories can be highly beneficial in motivating organizations, firms, and governments to achieve their goals; however, there is also a related concept that can be somewhat malicious and manipulative, which can serve to push people in non-beneficial directions: Propaganda.

Propaganda generally refers to influential communications from political entities designed to shift public sentiment and can come in many different variants (Propaganda, 2020). However, its primary meaning in modern times tends to revolve around manipulated messaging put forth by political, corporate, or religious organizations to sway people to a certain point of view (Propaganda, 2020). It can run the gamut from television advertisements, to national anthems, and even to posters and memes; yet, at its core there is a need to tell a story to convince the people of a country or organization to take on a particular perspective. There are many different countries and activist groups that have utilized, and are utilizing, these techniques; however, one of the best examples of highly effective propaganda is the Chinese Communist Party's (CCP) elimination of the country's memory of the massacre at Tiananmen Square in 1989: i.e., "The Great Forgetting" (Lim, NPR, 2014). To this point, Duke University romance studies
professor Martin Eisner notes: "Myths either create memories and history or erase them ... You need a shared myth and narrative in order to bring everyone together" (Eisner, The Republic's Militia, 2019). In this case the CCP has been able to almost completely wipe out the collective memory of events that day through a campaign of nationalist indoctrination and targeted repression focusing on instilling consequentialism and utilitarianism as the underlying societal ethics in China.

Journalist, Louisa Lim reporting for NPR in 2014 shares a nice explanation of the CCP's policies to stamp out the memory of Tiananmen and develop a nationalist myth.

This two-decade-long campaign [patriotic education classes] — one of the largest ideological campaigns in human history — was born out of paramount leader Deng Xiaoping's conviction that the 1989 movement occurred due to a lack of ideological and political education. In seeking to reassert its legitimacy, nationalism was the best – perhaps the only – tool available to China's Communist leaders ... Nationalism, rather than politics, is the force that drives young Chinese onto the streets. It's no coincidence that the largest protests permitted since 1989 were anti-Japanese marches in 2012, which took place in about 80 cities across the country. It's proof of the success of the Communist Party's strategy to wipe clean the past – and direct anger outside the country, rather than within. (Lim, NPR, 2014)

This combination of suppression of dissent with the careful and deliberate implementation of patriotic political education classes – i.e., classes surrounding "Xi Jinping Thought" – has proven remarkably effective. Indeed, based on the narrative that the CCP has created, young Chinese citizens born after 1989 often believe that the events that occurred at Tiananmen Square in June of that year didn't actually happen, and instead they are merely devious western propaganda.

In some ways, indoctrinating China's young people with a utilitarian view of history is an even more powerful tool than censorship itself. When people accept that history must serve the interests of the state, they become closed off to the spirit of academic inquiry or even idle curiosity ... While all countries construct their own national narratives, few manage to rival the power of China's deeply emotive patriotic nationalism and its unquestioned ability to punish those who publicly question the official version of history. (Lim, New York Times, 2019)

What the CCP has accomplished in terms of patriotic education, political indoctrination, narrative management, and repression of dissent is both remarkable and disturbing. It is a very clear example of the
power of stories, narratives, and myths, and how both corporate entities and nation states can leverage them in manipulative ways to consolidate control and maintain power.

**Narrative Economics**

Yet, moving away from the influence of stories on the political ecosystem, there is another arena where the thoughts and ideas that we share can have a profound impact on our daily lives: Narrative Economics. All of these insights and findings regarding stories and their influence on human beings ultimately leads to *narrative economics* and the effects that popular narratives can have on financial markets (Shiller, 2017). In terms of research in this arena two of the top thought leaders are Robert Shiller and Andrew Lo, with the former dedicating much of his work over the past four years to determining how narratives can influence market outcomes and the latter focusing on utilizing stories to resolve the differences between the quantitative and qualitative branches of economics (Shiller, 2017; Lo, 2017; Shiller, 2019). To illustrate how important narratives are in general, Lo references current research in neuroscience regarding what intelligence actually means, which ultimately leads to a relatively simple answer: Intelligence is "the ability to construct good narratives" (Lo, 2017, p. 128). This boils down to "if then analysis" to understand events and their casual factors, which Lo summarizes succinctly: "Intelligence is the ability to generate accurate cause-and-effect descriptions of reality" (Lo, 2017, p. 128). Shiller further makes the argument that the way forward in economics at the present point in time is to incorporate narrative economics more broadly and deeply throughout the field (Shiller, 2019). In terms of defining narrative economics\(^\text{35}\) Shiller offers a nice summary of its meaning in his 2017 *NBER Working Paper*, "Narrative Economics": "By narrative economics I mean the study of the spread and dynamics of popular narratives, the stories, particularly those of human interest and emotion, and how these change through time"\(^\text{36}\) (Shiller, 2017, p. 3). He explains that he tends to focus on two elements in this arena: "(1) the word-

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\(^{35}\) Shiller also cites the definition of the word "*narrative*" from the *Oxford English Dictionary*: "a story or representation used to give an explanatory or justificatory account of a society, period etc." (Shiller, 2019, p. xi).

\(^{36}\) In his 2019 book *Narrative Economics: How Stories Go Viral and Drive Economic Events*, Shiller shares a more in-depth definition of this new area of research: "*Narrative economics*, the study of the viral spread of popular narratives.
of-mouth contagion of ideas in the form of stories and (2) the efforts that people make to generate new contagious stories or to make stories more contagious" (Shiller, 2019, p. xi).

Shiller argues that "We have to consider the possibility that sometimes the dominant reason why a recession is severe is related to the prevalence and vividness of certain stories, not the purely economic feedback or multipliers that economists love to model" (Shiller, 2017, p. 3). However, the challenge in this arena is the fact that it's incredibly difficult to prove quantitatively how and to what extent a particular narrative has an effect on economic outcomes due to the ever present possibility of simultaneous causality (Shiller, 2017). Yet, the relevance of narratives on almost all aspects of the social sciences is undeniable as they are one of the primary mechanisms that we use to make sense of the world, with evolutionary biologist Stephen Jay Gould arguing that it would not be unreasonable to refer to human beings as Homo narrator since our ability to tell stories is one of the key differentiating characteristics between us and other species (Shiller, 2017; Gould, 1994).

Despite the profound influence that narratives have had on Homo sapien’s overall development, they can also have very significant impacts on economic movements due many of our innate heuristics: e.g., "framing," "representativeness heuristic," "availability bias," and "affect heuristic" among others (Shiller, 2017; Thaler, 2015; Kahneman and Tversky 1973; Tversky and Kahneman 1974). To illustrate this point, Shiller shares some of the research that he has conducted with William Goetzmann and Dasol Kim, which finds that "people generally have exaggerated assessments of the risk of a stock market crash, and that these assessments are influenced by the news stories, especially front page stories, that they read. One intriguing finding was that an event such as an earthquake "could influence estimations of the likelihood of a stock market crash" (Shiller, 2017, p. 13; Goetzmann, Kim, and Shiller, 2016). This detailed empirical analysis from academics at Yale School of Management and the U.S. Treasury Department demonstrates

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that affect economic behavior ... An economic narrative is a contagious story that has the potential to hire a worker or wait for better times, to stick one’s neck out or to be cautious in business, to launch a business venture, or to invest in a volatile speculative asset" (Shiller, 2019, p. 3).
that people's probabilistic perception of economic shocks and stock market crashes can be readily impacted by the stories that they read or hear in the media (Goetzmann, Kim and Shiller, 2016). The interesting thing to note in the research of Goetzmann et al. is that the stories can be completely uncorrelated and unrelated to investment returns; yet, they can still have an effect on people's subjective interpretation of risk (Goetzmann, Kim and Shiller, 2016). This can be readily seen in the general risk aversion of the generation that lived through the Great Depression as compared to the post-WWII "baby boomer" generation, who didn't experience any comparable economic events until recently.

Yet, interestingly it's not just unrelated stories that can effect economic perceptions and public discourse; completely fabricated stories can have a meaningful impact as well: e.g., "The Laffer Curve" (Shiller, 2017, pp. 20-23). The "Laffer Curve" is a great example of a story that went on to significantly influence public discourse (especially among the republican establishment) regarding taxation, "supply-side" economics, and governmental structure from the 1980's onward. As Shiller explains, the story is centered on a 1974 dinner that economist Art Laffer had with Dick Cheney, Donald Rumsfeld, and journalist Jude Wanniski at an expensive restaurant in Washington D.C., where they were having a discussion about tax policy (Shiller, 2017, pp. 20-23). Laffer reportedly went on to describe tax efficiency by drawing a U-shaped curve on a napkin and explaining that if the tax-rate is zero percent the government wouldn't collect any revenue; however, if the tax-rate is 100 percent it wouldn't collect any revenue either because the population simply wouldn't work (Shiller, 2017, p. 23). This relatively simple anecdote was used to show the inefficiency of high taxes and to justify tax cuts to push the country to the left side of the curve (Shiller, 2017, p. 23). In a 1978 article in National Affairs recounting the experience, Jude Wanniski described the underlying premise behind Laffer's assertion: "there are two tax rates that will generate this U shape, one at the left with a high-income level and low tax rates, the other at the right with a low-income level and high tax rates" (Shiller, 2017, p. 23). It was this sticky phrasing in the piece by Wanniski that

37 "The term supply-side economics went viral around the same time the Laffer curve did" (Shiller, 2019, p. 48).
seems to have made the story go viral despite the fact that the interaction happened four years earlier and had been largely forgotten by the attendees (Shiller, 2017, p. 23). In recounting Laffer's argument "Wanniski suggested, without any data, that we are on the inefficient side of the Laffer Curve ... [and that] the Laffer Curve seems to suggest that cutting taxes would produce a huge windfall in national income" (Shiller, 2017, p. 23).

Mainstream economists at the time argued that we were definitively not on the inefficient side of the curve, but they were not able to combat the catchiness of the concept to people outside of the economic arena (Shiller, 2017, p. 23). Additionally, Laffer’s view was not anything close to a new idea as economist / philosopher Adam Smith had articulated the effects that taxes might have on income, labor, and incentives back in the 1700's and “trickle down” economics was previously attributed to Treasury Secretary Andrew Mellon and President Calvin Coolidge in the 1920's (Shiller, 2017, p. 22). Even more, years later Laffer himself discounted the story that he had drawn the curve on a napkin since "the restaurant used cloth napkins and my mother had raised me not to desecrate nice things" (Shiller, 2019, pp. 44-45). Shiller’s use of this story to explain how economic narratives – even false and fabricated narratives – can go viral is a good example of how even simple stories can go on to have a dramatic impact on public discourse and national policy. Shiller further explains that "Contagious stories are largely creative and innovative, not simply a logical reaction to economic events," which in turn ties into the fact that causality, and more specifically reverse causality is ever present in narrative economics: i.e., "new contagious

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38 Interestingly, this pattern of narratives and quotations mutating and adapting over time repeats consistently, which can result in misattribution of the original author, with the message or statement becoming widespread only when a person of influence utters the phrase in a way that makes it go viral (Shiller, 2019, p. 128). A great example of this is the phrase "the only thing that we have to fear is fear itself" from President Franklin Roosevelt at his 1933 inauguration speech, which is a well-known quotation; however, it was previously made by Thomas Mullen (assistant to the Mayor of Boston) in 1931 and it bears striking resemblance to economist Irving Fisher’s words in 1930: "My only fear is the fear of fear" (Shiller, 2019, p. 128). Shiller describes the reasoning behind why Roosevelt ultimately got credit for this quote: "Thomas Mullen was not a celebrity, but President Roosevelt was. So Roosevelt went viral as the originator of the idea, taking credit for an idea that sounded right because it had already been repeated many times" (Shiller, 2019, p. 128).

39 A key point from a stickiness perspective is that "when authors want their audience to remember a story, they should suggest striking visual images [in this case a napkin]" (Shiller, 2019, p. 46). And, at the same time a number of articles in academic journals have found that "bizarre mental images do serve as memory aids" (Shiller, 2019, p. 46).
narratives cause economic events, and economic events cause changed narratives" (Shiller, 2019, p. 71).

Shiller makes this point regarding causality by building on the research of Milton Friedman and Anna J. Schwartz in their 1963 book *Monetary History of the United States* pertaining to difficult to model scenarios: "quasi-controlled experiments" (Shiller, 2019, p. 73). One of the challenges that economists often face is that it's difficult for them to establish causality for many events because they are unable to formulate precise experiments that replicate the episode at scale (Shiller, 2019, p. 72). However, Shiller argues that given new breakthroughs in economic simulation "it is indeed possible to infer causality even when controlled experiments are impossible" by interpreting "New narratives as exogenous ... [allowing] us [to] identify additional quasi-controlled experiments," which ties back to and builds on Schwartz and Friedman's research from 1963 (Shiller, 2019, p. 73).

To be sure, the complexities involved in narratives in the finance and economic arenas still make this type of modeling and experimentation particularly challenging even in the current technological environment. Yet, narratives do simplify things, provide meaning behind actions, and allow for memory of key elements in a problem, which leads Shiller to develop "Seven Propositions of Narrative Economics" that guide our understanding of how they impact the world around us in practice (Shiller, 2019, p. 87).

**Seven Propositions of Narrative Economics:**

1. **Epidemics can be fast or slow, big or small.** The timetable and magnitude of epidemics can vary widely.
2. **Important economic narratives may comprise a very small percentage of popular talk.** Narratives may be rarely heard and still economically important.
3. **Narrative constellations have more impact than any one narrative.** Constellations matter.
4. **The economic impact of narratives may change through time.** Changing details matter as narratives evolve over time.
5. **Trust is not enough to stop false narratives.** Truth matters, but only if it is in-your-face obvious.
6. **Contagion of economic narratives builds on opportunities for repetition.** Reinforcement matters.

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40 This framework offer by Shiller affords the social science community with an excellent tool to develop *consilience*, which was "coined by philosopher of science William Whewell in 1840 and popularized by biologist E.O. Wilson in 1994": "[Consilience] means the unity of knowledge among the differing academic disciplines, especially between the sciences and the humanities" (Shiller, 2019, p. 12).

This framework that Shiller has created is an excellent way of looking at the world and beginning to develop a grasp of how they might influence market outcomes. Interestingly, these propositions also offer a lens to discern linkages between narratives and how their combinations can impact major events through constellations and confluence: 1) "[constellation] large-scale economic narratives are often composed of a constellation of many smaller narratives," 2) "[confluence] a group of narratives that are not viewed as particularly associated with one another but that have similar economic effects at a point in time and so may explain an exceptionally large economic event" (Shiller, 2019, pp. 28-29). This in turn leads to the more subtle explanations of how narratives surrounding panic, confidence, and bubbles can develop, spread, and influence societal thought.

Shiller states that "Economically, the most important stories are those about other people's confidence and about efforts to promote confidence" (Shiller, 2019, p. 114). Inevitably, panic and confidence are intertwined with a crisis of confidence, which can lead to banks runs and other potentially seemingly irrational behaviors – e.g., hoarding toilet paper during a pandemic – with three primary confidence narratives repeating over and over again: 1) financial panic narrative, 2) business confidence narrative, and 3) consumer confidence narrative (Shiller, 2019, pp. 114-115). Shiller articulates the evolution of these different narratives and how they can impact both perception and action:

All of these slow-moving narratives have shown growth paths that span lifetimes. Financial panic came first, followed by narratives about crisis in business confidence, followed by narratives of crisis in consumer confidence. As narratives spread about the dangers of business losses and decreased consumer confidence, increasing self-censorship of narratives may, and sometimes does, encourage panic. Because people are aware that others self-censor, they increasingly try to read between the lines of public pronouncements to determine the "truth." (Shiller, 2019, p. 115)

He goes on to give a nice example of how these narratives can influence behavior by sharing some history regarding "saving."

In the eighteenth and nineteenth centuries, most people did not save at all, except maybe for some coins hidden under a mattress or in a crack in a wall. In economic
terms, the Keynesian marginal propensity to consume out of additional income was close to 100%. That is, most people, except for people with high incomes, spent their entire income. ... The idea that the poor should be taught to save grew gradually over the nineteenth century, the result of propaganda from the savings bank movement. But contemporary thought was miles away from the idea that a depression might be caused by ordinary people heeding the propaganda and trying to save too much. (Shiller, 2019, pp. 116-117)

This is an excellent illustration of how a particular story can build up in society and adjust the behavior of a broad population on a massive scale, without a true understanding of the consequences of how certain specific actions might actually affect the economy. This links to the power of "crowd psychology,"⁴¹ which was brought into the academic lexicon by Charles MacKay in 1841 and again by Gustave Le Bon in 1895, and describes how people think together at scale (Shiller, 2019, p 119). This concept is in turn closely tied to "suggestibility," which refers to the idea that individual human behavior is subconsciously imitative of and reactive to others" (Shiller, 2019, p. 119). Interestingly, these intuitions of how humans operate at scale also give us a reasonable understanding of the causes behind the Great Depression.

Robert Shiller states that "people today tend to identify the causes of the Great Depression as fear and of loss of confidence related to bank failures" (Shiller, 2019, p. 132). To Shiller’s point, at present there are essentially three major theories surrounding the causes of The Great Depression: 1) "The Spending Hypothesis," 2) "The Money Hypothesis," and 3) "The Gold Standard / Gold Hoarding" (Mankiw, 2013; Irwin, 2010; Eichengreen and Temin, 1997). Fascinatingly, embedded in all three of these theories are elements of crowd psychology both at the community and governmental levels.

The first of the three general explanations for the Great Depression is the "spending hypothesis," which "places primary blame for the Depression on an exogenous fall in spending on goods and services" (Mankiw, 2013, p. 343). This theory suggests a number of different reasons for the fall in spending, ranging

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⁴¹ Another tangentially related topic called the "wisdom of the crowds," which we'll cover later, is scientist Sir Francis Galton's discovery of the accuracy of aggregating group estimates at a 1906 fair in Britain: "hundreds of people individually guessed the weight that a live ox would be after it was 'slaughtered and dressed.' Their average guess – their collective judgment – was 1,197 pounds, one pound short of the correct answer, 1,198. It was the earliest demonstration of a phenomenon popularized by – and now named for – James Surowiecki’s bestseller The Wisdom of the Crowds" (Tetlock and Gardner, 2015, pp. 72-73).
from the stock market crash of 1929 causing people to save rather than spend; to the bust of the housing bubble of the 1920's; to the bank failures of the 1930's, which mitigated the distribution of capital that businesses needed to grow; and to the contractionary fiscal policy in the early 1930's in the form of reduced government spending combined with increases in taxes (Mankiw, 2013, pp. 343-344). The "spending hypothesis" is supported by strong evidence and research that contractionary shocks to the IS curve can have real negative impacts on the economy (Mankiw, 2013).

The second major theory is the "money hypothesis," which is argues that the primary causal factor was a "shock to the LM curve" (Mankiw, 2013, p. 344). The contractionary shift of the LM curve was likely a significant influencer in the Great Depression: "From 1929 to 1933 the price level fell 25 percent. Many economists blame this deflation for the severity of the Great Depression" (Mankiw, 2013, pp. 344-345). Yet, there is another related hypothesis tied into the contractionary LM curve called Debt-deflation theory, which might also help in determining the causality of the downturn (Mankiw, 2013, p. 345). The reason for this is that debt-deflation theory suggests that "unexpected deflation enriches creditors and impoverishes debtors" (Mankiw, 2013, p. 346). Falling investment reduces capital expenditures and that in turn reduces the amount of money available to workers (Mankiw, 2013, p. 346). Subsequently, "The fall in income reduces the demand for money, and this reduces the nominal interest rate that equilibrates the money market. The nominal interest rate falls by less than the expected deflation, so the real interest rate rises" (Mankiw, 2013, p. 346). Economist N. Gregory Mankiw argues that "Because a deflation of the size observed from 1929 to 1933 is unlikely except in the presence of a major contraction in the money supply, these first two explanations assign some of the responsibility for the Depression – especially its severity – to the Fed" (Mankiw, 2013, p. 347).

The third mainstream theory surrounds the impact of the "gold standard" and the deflationary effects that it had on countries throughout the world following the stock market crash of 1929 and the subsequent crises that followed. "Economic historians Barry Eichengreen and Peter Temin ... have shown that countries that abandoned the gold standard earlier recovered better" (Shiller, 2019, p. 132) and that
the ideology and affinity for the gold standard among some other governments prevented them from taking the steps necessary to mitigate the crisis (Eichengreen and Temin, 1997). Additionally, economist Douglas Irwin argues that gold hoarding and sterilization by France – and to a lesser extent the United States – was a significant causal factor in the economic contraction (Irwin, 2010). Irwin proposes that that France's increase in its gold reserves "from 7 percent to 27 percent between 1927 and 1932 [and sterilization of this accumulation] ... created an artificial shortage of reserves and put other countries under enormous deflationary pressure" (Irwin, 2010, p. abstract). He then asserts that "France was somewhat more to blame than the United States for the worldwide deflation of 1929-1933" and "The deflation could have been avoided if the central banks had simply maintained their 1928 cover ratios" (Irwin, 2010, p. abstract). Initially, both "the United States and France contributed to the effective reduction in the world's gold stock in 1929 and 1930, [however], France was almost entirely responsible for the effective reduction in 1931 and 1932 ... [with such a large sterilization explaining] half of the massive worldwide deflation in 1930 and 1931" (Irwin, 2010, pp. 4-5). The main issue behind this sterilization and hoarding was that the U.S. and France were not monetizing their gold and thereby inducing a monetary contraction rather than a monetary expansion, with detrimental effects for the rest of the global economy (Irwin, 2010, pp. 5-13).

In terms of explaining financial crises more generally, N. Gregory Mankiw offers an anatomy of their causal factors in his 2013 textbook *Macroeconomics* noting that "Financial crises are not all alike, but they share some common features" (Mankiw, 2013, p. 576). He further defines a financial crisis as "a major disruption in the financial system that impedes the economy's ability to intermediate between those who want to save and those who want to borrow and invest" (Mankiw, 2013, p. 576). Mankiw then proposes six basic elements that form the core of most financial crises: 1) Asset-Price Booms and Busts, 2) Insolvencies at Financial Institutions, 3) Falling Confidence, 4) Credit Crunch, 5) Recession, and 6) A Vicious Cycle (Mankiw 576-579). His high-level analysis of economic crises reveals connective tissue between all three theories articulating the potential causes of The Great Depression and shows that they all contain a piece of explanatory power behind this colossal economic downturn, despite the fact that they each argue for a
different central premise. However, what's interesting is that there are features of narrative economics embedded within all three of them, demonstrating Shiller's point that narratives can have a profound effect on large scale economic events. Yet, there is also another tangentially related area that exemplifies the power of narratives on financial market outcomes that is very useful to study as well: stock market bubbles.

Stock market bubbles are an excellent example of a speculative bubble, which are surprisingly common, can have dramatic effects on market outcomes, and can come in a variety of different forms: e.g., "The Dutch Tulip Bubble Craze" (Malkiel, 2012, pp. 38-41), "The South Sea Bubble" (Malkiel, 2012, pp. 41-47), "The Dot-Com Bubble" (Malkiel, 2012, pp. 98-107), and "The Housing Bubble of 2008" (Malkiel, 2012, pp. 98-107). They essentially build around "excitement and risk taking" that could result in tremendous financial gains, and "are [largely] driven by social comparison" (Shiller, 2019, p. 228). However, stock market bubbles are not quite similar to some of the narratives mentioned earlier because "the stock market is different from the economy as a whole" (Shiller, 2019, p. 228). This differentiation is mainly because investors are attempting to buy securities and assets that they hope will gain in value and then sell them for a profit, so the stock market is essentially a collective guess on how public companies will perform in the future (Shiller, 2019). The difficulty is that unlike weather forecasting, stock picking involves a process where the market can respond to predictions made about it, and although there might be certain cues that are relevant during one period of time they might not have any value in the next one – i.e., a high price-to-earnings ratio indicating the higher probability of a downturn (Shiller, 2019, pp. 231-232). Another key influencer in stock market bubbles involves the narratives that develop and the vivid language that is used to disseminate them – e.g., "boom" and "crash" (Shiller, 2019, p. 229). When coupled with the media, it's easy to see how this language can exacerbate social comparison trends given the fact that

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42 Robert Shiller notes that real estate bubbles are also largely a function of social comparison (Shiller, 2019).
43 Interestingly, Shiller also shares that the words "boom" and "crash" really didn't enter the lexicon until after the stock market drop in October 1929: "The word crash was not commonly attached to stock market movements before 1929, and the new use of the word became a name for a different view of the economy, that economic growth depends heavily on the performance of the overall stock market, so that the stock price indexes are taken as oracles. ... After 1929, boom and crash went viral and usually described the stock market" (Shiller, 2019, p. 229).
"newspapers are very focused on records" and are often driven by the aphorism "if it bleeds it leads," which can bring booms and busts top of mind to the general population (Shiller, 2019, p. 233; Heath and Heath, 2007).

Yet, professional investors are also not immune to the effects of these stories that develop regarding market conditions, and they will make similar bracketing errors due to heuristics and biases such those stemming from Prospect Theory, where we view everything from a relative reference point (Kahneman, 2011). A famous example of this is Citigroup CEO Chuck Prince's comments to the Financial Times in July 2007 – several months before the start of the Global Financial Crisis (GFC) – that Citigroup was going to stay invested despite bubblish conditions in the U.S. subprime mortgage market.

When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing. ... The depth of the pools of liquidity is so much larger than it used to be that a disruptive event now needs to be much more disruptive than it used to be ... At some point the disruptive event will be so significant that instead of liquidity filling in, the liquidity will go the other way. I don't think we're at that point. – Chuck Prince (Nakamoto and Wighton, 2007)

When the market turned downward a few months later in the fall of 2007 Citigroup ended up taking major losses as a result of the positions they maintained in the subprime and credit default markets and were only able to survive as a going concern due to bailouts and injections of capital from the federal government. This illustrates the fact that even the leader of one of the top investment banks in the world can get caught up in the story right up to the end of a bubble with negative consequences for both himself and his firm.

In trying to share prescriptive methods for how to avoid the booms and busts that narratives might cause or exacerbate, Shiller urges that we look deeper to decipher the true meaning behind the stories.

Policymakers might take a lesson from both the real estate bubble narratives and the stock market crash narratives: during economic inflections, there is real analytical value to looking beyond the headlines and statistics. We should also consider that certain stories that recur with mutations play a significant role in our lives. Stories and legends from the past are scripts for the next boom or crash. (Shiller, 2019, p. 238)

He then goes on to explain how leaders and politicians can fight back and counter false and potentially destructive narratives.
Leaders must lean against false or misleading narratives and establish a moral authority against them. Their first step is to understand the dynamics of the narratives. Their second step is to design policy actions that take account of narrative epidemics. Policymakers should try to create and disseminate counternarratives that establish more rational and more public-spirited economic behavior. Even if the counternarratives are slower to take effect than a more contagious destructive narrative, they can eventually be corrective. (Shiller, 2019, p. 278)

Yet, even then there are difficulties that can come into play in the economic arena, as human emotions can have a significant impact on how people make decisions both individually and collectively (Shiller, 2019). Indeed, this emotionality and the complexity of behaviors that it can generate in humans at scale makes it difficult to truly quantify the narratives that develop and their effects on financial markets at this point in time. However, there is still real value in conducting research in this area even if we’re unable to empirically determine causality since in the future with better data, artificial intelligence, and machine learning, we might be able to make significant discoveries similar to those in the social psychology realm over the past 70 years, which have helped us gain a much better understanding of our rationality, our irrationality, and our decision making processes.
"The situation has provided a cue; this cue has given the expert access to information stored in memory, and the information provides the answer. Intuition is nothing more and nothing less than recognition" – Herbert Simon (Simon, 1992, p. 155).

Chapter Four: Rationality, Irrationality, and Decision Making

Rational or Irrational?

As mentioned earlier, human beings are first and foremost pattern recognition machines. We are consistently trying to make sense of the world by looking for linkages and causation through an "if-then" and "means-ends" style of thinking (Lo, 2017, Simon, 1992). This analysis is supported by the frameworks that we’ve developed through our imagination and creativity, which we utilize to discover new lessons and insights that we then share with each other through our special language capability. Yet, we are still prone to make mistakes when we confuse correlation with causation, or incorrectly interpret signals based on previous experiences. This then leads to the debate about whether humans are rational or irrational; however, Nobel-prize winner Daniel Kahneman, in his seminal 2011 book *Thinking, Fast and Slow*, explains that this deliberation about human decision-making capacity is actually much more complicated than a simple binary argument between these two possibilities.

The only test of rationality is not whether a person’s beliefs and preferences are reasonable, but whether they are internally consistent. A rational person can believe in ghosts so long as all her other beliefs are consistent with the existence of ghosts. A rational person can prefer being hated over being loved, so long as his preferences are consistent. Rationality is logical coherence – reasonable or not. Econs\(^{44}\) are rational by this definition, but there is overwhelming evidence that Humans cannot be. An Econ would not be susceptible to priming, WYSIATI, narrow framing, the inside view, or preference reversals, which Humans cannot consistently avoid. The definition of rationality as coherence is impossibly restrictive; it demands adherence to rules of logic that a finite mind is not able to implement. Reasonable people cannot be rational by that definition, but they should not be branded as irrational for that reason. *Irrational* is a strong word, which connotes impulsivity, emotionality, and a stubborn resistance to reasonable argument. I often cringe when my work with Amos [Tversky] is credited with demonstrating that human choices are irrational, when in fact our research only showed that Humans are not well described by the rational-agent model. (Kahneman, 2011, p. 411)

\(^{44}\) Econ is a term coined by Nobel-prize winning economist Richard Thaler, which refers to the "fictional creature called homo economicus" (Thaler, 2015, p. 4). Thaler explains that economists often make their models based on Econs who tend not to misbehave as normal humans do in the real world, which often leads to “a lot of bad predictions” – i.e., the failure to predict the Global Financial Crisis of 2008 (Thaler, 2015, p. 4).
Kahneman's insights help us to understand that it's not necessarily a binary answer as to whether or not we're irrational: "when we observe people acting in ways that seem odd, we should first examine the possibility that they have a good reason for what they do" (Kahneman, 2011, p. 412).

Andrew Lo supports Kahneman and Tversky's findings on the rational choice model with his "Adaptive Markets Hypothesis," which suggests that past experiences, natural selection, and evolutionary biology have guided the development of our intuition and that poor decisions are not necessarily irrational when viewed in the appropriate context (Lo, 2017).

If we want to understand current behavior, we need to understand the past environments and selective pressure that gave rise to that behavior over time and across generations of trial and error. ... Our theory offers conditions that give us rationality as well as irrationality, and both can coexist for a period of time as natural selection works its magic. (Lo, 2017, p. 198)

In further sharing his perspective on this balance between the balance between rationality and irrationality Lo ties it back to our evolution and to our interpretation of the world through stories.

_This ability to construct a narrative is central to what we mean by "intelligence."_45

Remember, we humans are not so much the "rational animal" as we are the rationalizing animal. We interpret the world not in terms of objects and events, but in sequences of objects and events, preferably leading to some conclusion, as they do in a story. Our ability to choose an optimal behavior appears related to our ability to come up with the most plausible sounding explanation of the world: the best narrative. It turns out that we may have Homo economicus in our brains after all – acting as a literary critic. (Lo, 2017, p. 117)

Essentially Lo argues, similarly to Kahneman and Tversky, that we are constantly striving to make our "best guess" as situations and decision points arrive; however, the heuristics that we employ at the current time have been developed through previous experiences and may not be optimal for the current environment: "If the environment changes, the heuristics of the old environment might not be suited to the new one.

This means that the behavior will look 'irrational'' (Lo, 2017, pp. 188-189). Lo's "Adaptive Markets

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45 Kahneman also shares his view on what intelligence means at a high level: "Intelligence is not only the ability to reason; it is also the ability to find relevant material in memory and to deploy attention when needed" (Kahneman, 2011, p. 46).
Hypothesis” views these types of suboptimal behaviors as “maladaptive” rather than “irrational,” since “There may be a compelling reason for the behavior, but it’s not the most ideal behavior for the current environment” (Lo, 2017, p. 189).

To further explore rationality and irrationality, Daniel Kahneman employs terms from psychologists Keith Stanovich and Richard West: System 1 and System 2 (Kahneman, 2011, p. 20).

- **System 1** operates automatically and quickly, with little or no effect and no sense of voluntary control.
- **System 2** allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice, and concentration. (Kahneman, 2011, pp. 20-21)

In articulating these systems more clearly, System 1 is rapid, involuntary, and intuitive, while System 2 is deliberate, slow, and logical (Kahneman, 2011, pp. 20-21). This can be made even more concise by saying that System 1 is the "automatic system" and System 2 is the "effortful system" (Kahneman, 2011, p. 29). System 1 is trained over time to react quickly to familiar situations and it is incredibly effective at what it does (e.g., stepping on the brake in a car); however, its reactions can lead to biases or errors when it correlates a specific response that is not properly fitted for a particular situation⁴⁶ (Kahneman, 2011, pp. 21-25). System 2 is more focused on deliberate thought (e.g., multiplication) and acts as the control center working "to overcome the impulses of System 1" (Kahneman, 2011, pp. 22-26). This is critically important because System 1 is never turned off so our System 2 must always be on guard to defend against errors or misattributions of System 1 ((Kahneman, 2011, p. 28).

It is this self-control function of System 2 that counteracts negative tendencies of System 1; however, this requires a lot of effort, which creates an inherent laziness where "System 2 protects the most important activity, so it receives the attention it needs" (Kahneman, 2011, pp. 33-35). System 1 on the other hand "takes over in emergencies and assigns total priority to self-protective actions," which has been

⁴⁶ Of note also, relating back to last chapter, is that “The mind – especially System 1 – appears to have a special aptitude for the construction and interpretation of stories about active agents, who have personalities, habits, and abilities” (Kahneman, 2011, p. 29).
honored throughout our evolution to "improve the chance of survival" (Kahneman, 2011, p. 35). Yet, beyond this survival function System 1 also encodes newly learned skill sets, which eventually become intuitive when performed enough times: "As you become skilled in a task, its demand for energy diminishes" (Kahneman, 2011, p. 35). This essentially means that the more you perform a task the less of your conscious mind you need to execute it and the more instinctual it becomes: e.g., an Olympic wrestler performing a single-leg takedown or a chess grandmaster seeing her next set of moves.  

There is always a tradeoff in the energy required to balance "self-control and cognitive effort" (Kahneman, 2011, p. 41), and as Chip and Dan Heath note, "What looks like laziness is often exhaustion." (Heath and Heath, 2010, p. 12). Yet, the difficulty that arises here is that "System 1 has more influence on behavior when System 2 is busy" and "People who are cognitively busy are also more likely to make selfish choices, use sexist language, and make superficial judgments in social situations" (Kahneman, 2011, p. 41). Psychologist Roy Baumeister likes to refer to this type of exhaustion due to the exercise of self-control as "ego depletion" (Kahneman, 2011, p. 42). Kahneman shares a nice synopsis of Baumeister and his colleague's discoveries regarding "ego depletion."

The evidence is persuasive [regarding "ego depletion"]: activities that impose high demands on System 2 require self-control, and the exertion of self-control is depleting and unpleasant. Unlike cognitive load, ego depletion is at least in part a loss of motivation. After exerting self-control in one task, you do not feel like making an effort in another, although you could do it if you really had to. (Kahneman, 2011, p. 42)

This means that multitasking or engaging in exhaustive assignments can put System 1 in the driver's seat, which can cause problems because when "System 1 is involved, the conclusion comes first and the

47 These can be understood also in Mikhaly Csikszentmihalyi's concept of flow or "optimal experience" where individuals through experience and deliberate practice can separate the control of their attention in order to devote all resources to the specific task that they are performing: Flow: "a state of effortless concentration so deep that they lose their sense of time, of themselves, of their problems" (Kahneman, 2011, pp. 40-41).

48 A great example of this was the 1998 study conducted by Baumeister et al., where they placed radishes and freshly baked cookies in front of college students and instructed each group to eat one, but not the other (Baumeister, Bratslavsky, Muraven, and, Tice, 1998). Immediately afterwards both groups were given a series of complicated tasks; the individuals who were instructed to eat cookies spent twice the amount of time on solving the problems than those who were told to eat radishes, because the latter had become mentally exhausted and "ran out of self-control" (Heath and Heath, 2010, p. 10; Baumeister, Bratslavsky, Muraven, and, Tice, 1998).
arguments follow" (Kahneman, 2011, p. 45). Kahneman goes on to cite the research of Keith Stanovich and Richard West who argue that "high intelligence does not make people immune to biases" and that System 2 can be broken down into two "separate minds": algorithmic and rational (Kahneman, 2011, pp. 48-49).

Kahneman further shares Stanovich's assessment of the latter "mind" (Kahneman, 2011, p. 49).

The core of his [Stanovich's] argument is that rationality should be distinguished from intelligence. In his view, superficial or "lazy" thinking is a flaw in the reflective mind, a failure of rationality. (Kahneman, 2011, p. 49)

This distinction between intelligence and rationality is indeed an interesting area to study in the future; however, getting back to how our System 1 and System 2 relate to our rationality, irrationality, and decision making, it's important to understand that our brains are also association machines (Kahneman, 2011).

The associative nature of our brains and our memory more specifically can often lead to confirmation bias, which is largely a function of System 1 and its failure to search for alternatives; in contrast to System 2, which is responsible for doubt and objective analysis (Kahneman, 2011, pp. 79-81).

Indeed, this ties into our propensity to jump to conclusions based on previous experiences, which can have benefits, but can also be highly detrimental when our assessments are not properly fine-tuned for the environment or situation that we are encountering.

Jumping to conclusions is efficient if the conclusions are likely to be correct and the costs of an occasional mistake acceptable, and if the jump saves much time and effort. Jumping to conclusions is risky when the situation is unfamiliar, the stakes are high, and there is no time to collect more information. These are the circumstances in which intuitive errors are probable, which may be prevented by a deliberate intervention of System 2. (Kahneman, 2011, p. 79)

This in turn ties into Daniel Kahnemen's concept of "What You See Is All There Is" (WYSIATI), which "facilitates the achievement of coherence and of the cognitive ease that causes us to accept a statement as true" and allows us to "think fast, and ... make sense of partial information in a complex world" (Kahnemen, 2011, pp. 86-87).

The combination of a coherence-seeking System 1 with a lazy System 2 implies that System 2 will endorse many intuitive beliefs, which closely reflect the impressions generated by System 1. ... System 1 is radically insensitive to both the quality and the
quantity of the information that gives rise to impressions and intuitions. (Kahneman, 2011, p. 86)

These insights make it easy to see how these valuable tools embedded in the genetic make-up of our brains can afford us with great benefits, but also significant determinants when we apply intuitive System 1 assessments to situations that we haven't encountered previously. It also demonstrates how traders at hedge funds and investment banks can be incredibly skilled for a particular environment, but fail to adapt when market conditions change, due to core biological principles regarding how our brain works. This reaffirms Kahneman, Tversky, and Lo's claim that we are not necessarily rational or irrational, rather we have been conditioned based on previous experiences and when we apply these frameworks in new environments that they're not designed for it can lead to errors, biases, and suboptimal decisions. Yet, it's likely also useful to incorporate an analysis of how our emotions play into our decision making processes as they offer both the potential for value and risk in our assessments; however, they are also absolutely vital to our ability to function in a hyper-complex world.

**Emotion and the Ventromedial Prefrontal Cortex**

Our emotions are a critical factor in our decision-making processes; indeed, they are actually essential to our rationality and without them we cannot approach problem solving in an effective manner (Lo, 2017, pp. 102-103). Contrary to many people's beliefs, emotions are a very valuable piece of our pattern recognition machine, and they help guide our evaluations and assessments. To illustrate this point, Andrew Lo summarizes the research and findings of neurologist Antonio Damasio who came to the "conclusion that the role of emotion in human cognition is central to rationality": "In other words, to be fully rational, we need emotion" (Lo, 2017, p. 103). Research by neurologists and psychologists over the past 30 years has uncovered some key insights into the function that emotions play in humans and in other animals as well: "Emotion is a tool for improving the efficiency with which animals – including humans – learn from their environment and their past. We're more efficient learners with emotions than without" (Lo, 2017, p. 103). It seems almost obvious when you think about it more deeply, but emotions such as joy,
anger, fear, and sadness all help us learn and can influence our judgements and the way that we perceive risk, with fear being a particularly important mechanism.

Damasio’s first understanding of the importance of emotion came through studies with a patient named "Elliot" in the 1970’s who had successful surgery to remove a brain tumor; however, the procedure also took out some healthy tissue from his prefrontal cortex (Lo, 2017, p. 102). Following the operation everything was back to normal for him; however, "he would spend the day obsessing over unimportant details" and "Deciding what clothes to wear in the morning or what restaurant to visit at night consumed hours" (Lo, 2017, p. 102). "Elliot" was otherwise fully functional; however, he lacked the ability to feel emotions – essentially "everything was all the same to Elliot" (Lo, 2017, pp. 102-104). This in turn prevented him "from making rational judgments," which can create major impediments when evaluating situations (Lo, 2017, p. 104). More specifically along these lines, fear can be a valuable and vital teacher when it comes to assessing risk; yet, it can also overwhelm our rational side in certain situations as well.

... emotions help to form an internal reward-and-punishment system that allows the brain to select an advantageous behavior. From an economic perspective, emotions help provide a basic currency or standard of value for animals – again, including humans – to engage in a cost-benefit analysis of the various options open to them. ... Neuroscientists have shown that emotion, especially fear and the fight-or-flight response is our "first responder." ... Extreme emotional reactions can short-circuit rational thought altogether. There’s a neurological reason for this. A strong stimulus to the amygdala seems to suppress activity in the prefrontal cortex, the region of the brain associated with logical deliberation and reasoning ability. ... From a biological standpoint, this makes sense. Very strong emotions are a physiological call-to-arms that should be heeded immediately because personal survival may depend on it. ... [When this happens] your higher brain functions such as language and logical reasoning are suppressed until the threat is over. ... Subjectively, it can feel as though emotion and reason are warring against each other; neurophysiologically, that’s exactly what’s happening. (Lo, 2017, pp. 104-105)

This "gift of fear," along with other related emotions, allows humans to fine tune their behaviors and develop optimal strategies for a given environment (Lo, 2017, p. 106).

Related to this is another fascinating study conducted by Antoine Bechara, Hanna Damasio, Daniel Tranel, and Antonio Damasio called, "Deciding Advantageously Before Knowing the Advantageous Strategy" was published in Science in 1997 (Bechara, Damasio, Tranel, and Damasio, 1997). Their research evaluated
how nonconscious biases can guide our decision making before we are consciously aware of the optimal strategy. Bechara and his team utilized two groups of test subjects, one with damage to their ventromedial prefrontal cortex (emotion and decision making portion of the brain) and one with normal individuals without brain damage, and then had them perform a gambling task for monetary rewards with four decks of cards – two stacked disadvantageously and two stacked advantageously – in which they would pull cards from the decks, with the end goal being to win the largest possible amount of money. (Bechara, Damasio, Tranel, and Damasio, 1997). All participants were hooked up to Skin Conductance Response (SCR) kits to evaluate their reactions as they played the gambling game (Bechara, Damasio, Tranel, and Damasio, 1997). As the subjects pulled from the decks the normal participants were able to discern a "hunch" about which decks were stacked by roughly card 50 on average and began avoiding the bad decks, but couldn't explain why until around card 80 (Bechara, Damasio, Tranel, and Damasio, 1997, pp. 1293-1294). However, the participants with damage to their ventromedial prefrontal cortex continued to pull from the disadvantageous decks even after they could explain conceptually which decks were bad (Bechara, Damasio, Tranel, and Damasio, 1997, pp. 1293-1294). This in turn led Bechara and his fellow researchers to conclude that “In normal individuals, nonconscious biases guide behavior before conscious knowledge does. Without the help of such biases, overt knowledge may be insufficient to ensure advantageous behavior” (Bechara, Damasio, Tranel, and Damasio, 1997, pp. 1294-1295). This discovery was important for two reasons: 1) It demonstrated that our brain gives us signals, that guide us to the best possible decision before we’re aware of it, and 2) Without these signals we will not execute the optimal behavior.

Tying this back into the financial markets, Andrew Lo explains how emotions relate to our behaviors and decision making: "When the ability to experience emotions is removed, human behavior becomes less rational. ... But these imbalanced behaviors aren't random. They're merely inappropriate for the environment in which they are exhibited" (Lo, 2017, p. 108). Specifically relating to financial markets, the behaviors investors and traders exhibit are definitively influenced by their emotions, which are responsive to both internal and external factors.
Therefore, it shouldn’t be a surprise to learn that the lack of sunlight in during the winter months tends to depress stock market prices ... [and] traders who exhibit too little or too much emotional response tend to be less profitable than those in the happy medium, or that traders tend to make more money on days when their levels of testosterone are higher than average. (Lo, 2017, p. 108)

All of this research regarding emotions and their significance shows us that they are vital to our decision making processes; however, it is important to keep them in balance to avoid "irrational" behaviors as we perform our analysis of equities, fixed income, and derivatives. Yet, beyond emotions there are a number of other heuristics and biases that we should familiarize ourselves with to prevent suboptimal decisions in our investments.

**Biases and Heuristics**

As mentioned earlier our brains are constantly looking for shortcuts or heuristics to both conserve energy and improve efficiency in our behaviors. These heuristics allow us to rapidly handle simple tasks and operate effectively in a hyper-complex world, and they are honed over the course of our lives based on our experiences. However, the nature of their development means that they can be prone to bias especially when they are applied incorrectly or in the wrong setting, and they can also leave us open to manipulation by marketers, politicians, and competitors who understand how to leverage them. Interestingly though, there are a number of universal heuristics and biases, which are important to be aware of when trading in the financial markets in order to prevent ourselves from making suboptimal decisions. And, while there are an exceptionally large number of heuristics that have been identified by the social psychology community there are eight specifically that I believe are valuable to familiarize ourselves with in the investing arena.⁴⁹

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⁴⁹ Another very helpful resource is the "List of cognitive biases" on Wikipedia, which gives a nice summary of all of the cognitive biases and heuristics that have currently been discovered and verified by social psychology researchers: [https://en.wikipedia.org/wiki/List_of_cognitive_biases#Social](https://en.wikipedia.org/wiki/List_of_cognitive_biases#Social) ("List of Cognitive Biases," 2020).
The first is "base-rate neglect," which is tied to Kahneman and Tversky's representativeness heuristic, and describes how forecasters often fail to give appropriate weight to historical statistical data pertaining to probabilities and instead focus more on specific descriptive regarding the individual case being analyzed (Tversky and Kahneman, 1974; Kahneman and Tversky, 1973; Kahneman, 2011). A great example of this comes from Phil Tetlock's "superforecasting" work regarding President Obama's nomination of Chuck Hagel for Secretary of Defense (SECDEF) (Tetlock and Gardner, 2015). Tetlock describes how because of a poor confirmation hearing and other related controversies, defense analyst Tom Ricks predicted that the odds of Hagel withdrawing were "50-50 ... But declining by the day" (Tetlock and Gardner, 2015, p. 170). However, one of Tetlock's "superforecasters" Jay Ulfelder instead began with the base-rate by analyzing how often SECDEF nominees had been rejected by the Senate: "Ulfelder wrote. 'Since the establishment of the [secretary of defense] position soon after World War II, it looks like only one of 24 nominees has been rejected by the Senate, and none has withdrawn.' So the base rate is 96%" (Tetlock, 2015, p. 170). Ulfelder then performed an analysis utilizing Bayes Theorem looking into how often poor hearing nomination performances resulted in a withdrawal of the nominee, which caused him to reduce his forecast from 96% to 83%; however, it nevertheless predicted that "Hagel was still very likely to be confirmed ... [which] he was, two weeks later" (Tetlock and Gardner, 2015, p. 171). Ulfelder's technique is an excellent example of how to overcome base-rate neglect, as he begins with the historical base-rate and then modifies his forecast in light of other pertinent information.

However, the next bias, David Hume's "Problem of Induction," is important to be cognizant of as it can cause havoc if we only look at historical data and experiences (Taleb, 2004, pp. 116-117). Regarding

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50 A tangentially related heuristic, which is useful to note in the markets is "regression to the mean" where assets, events, and actions tend to return back to the historic average over time (Kahneman, 2011, pp. 175-176). A great example of this is Daniel Kahneman's experience teaching flight instructors in the Israeli Air Force (Kahneman, 2011, pp. 175-176). The flight instructors believed that when they yelled at the students for a poorly performed maneuver it improved their performance on the next iteration; however, in reality the students better execution the next time around was just a result of "regression to the mean" and the instructors aggressive critiques had no impact on their improved performance (Kahneman, 2011, pp. 175-176).
the second bias, Nassim Taleb does an exceptional job of explaining the criticality of incorporating David Hume's "Problem of Induction" into financial market analysis, which ties in closely with Daniel Kahneman's WYSIATI (Taleb, 2004, pp. 116-117; Kahneman, 2011). Hume's insight essentially states that because we haven't seen something before we don't believe that it's possible, which is illustrated by John Stuart Mill's example regarding Black Swans: "No amount of observations of white swans can allow the inference that all swans are white, but the observation of a single black swan is sufficient to refute that claim"51 (Taleb, 2004, p. 117). A great contemporary example of this is the quote by former Goldman Sachs Chief Financial Officer David Viniar to the Financial Times during the beginning of the GFC in August of 2007: "We were seeing things that were 25-standard deviation moves, several days in a row. ... There have been issues in some of the other quantitative spaces. But nothing like what we saw last week" (Larsen, 2007, August 13). A 25-standard deviation event is essentially something that shouldn't be possible; however, it was only thought not to be possible because no one had ever seen anything like it before. Indeed, its occurrence was due to inappropriate assessments of fat-tail risks and a failure by many Wall Street firms to incorporate the possibility of correlation between all of the different mortgage-backed securities (MBS), Collateralized Debt Obligations (CDO), and Credit Default Swaps (CDS). Taleb believes that the failure to incorporate previously unseen or unknown variables into risk models is one of the fundamental flaws of investors on Wall Street (Taleb, 2004).

The third heuristic is the "anchoring effect," which is the fact that people have a tendency towards "giving disproportionate weight to the first information you [we] receive" (Hammond, Keeney, and Raiffa, 2003, p. 1). This particular heuristic is one of the most powerful and reliable of all of our biases, with Duke University professor Rick Larrick noting that "Anchoring effects are one of the truest things in psychology" (Larrick, Introduction, 2018). Kahneman and Tversky note that part of the reason for anchoring's robustness is the fact that it's embedded in both System 1 and System 2: "Two different mechanisms

51 Referencing Nassim Taleb's work, Phil Tetlock states that "The 'black swan' is therefore a brilliant metaphor for an event so far outside of experience we can't imagine it until it happens" (Tetlock and Gardner, 2015, p. 238).
produce anchoring effects – one for each system. There is a form of anchoring that occurs in a deliberate process of adjustment, an operation of System 2. And there is anchoring that occurs by a priming effect, an automatic manifestation of System 1" (Kahneman, 2011, p. 120). To illustrate what the anchoring effect looks like in practice, psychologists John Hammond, Ralph Kenney, and Howard Raiffa shared an example with two questions in their 2003 Harvard Business Review piece "The Hidden Traps in Decision Making" (Hammond, Keeney, and Raiffa, 2003).

**Anchoring Question:**
Is the population of Turkey greater than 35 million?
What's your best estimate of Turkey's population? (Hammond, Keeney, and Raiffa, 2003, p. 3)

Hammond et al. point out that for "most people, the figure of 35 million cited in the first question ... [influences] your answer to the second question" (Hammond, Keeney, and Raiffa, 2003, p. 3). Interestingly, they point out that in the studies that they have conducted over the years, the estimates of Turkey's population in the second question are always significantly higher if the number in the first question is increased as well – i.e., 100 million will give a bigger estimate than 35 million (Hammond, Keeney, and Raiffa, 2003, p. 3). Hammond and his colleagues emphasize that it's critical to "Always view a problem from different perspectives. ... [and to] Be open minded. ... Seek[ing] information and opinions from a variety of people to widen your frame of reference and to push your mind in fresh directions" (Hammond, Keeney, and Raiffa, 2003, p. 4). The "anchoring effect" is incredibly strong when it comes to markets, which makes it critical to be cognizant of its influence on us when analyzing financial ratios, charts, and statistics.

The fourth that I believe is important to look into is "confirmation bias," which shares some similar qualities with anchoring. This bias involves our tendency to "develop a quick belief about a situation and then seek out information that bolsters our belief" (Heath and Heath, 2013, p. 11). In their 2013 book Decisive: How to Make Better Choices in Life and Work, Chip and Dan Heath explain that much of the reasoning behind the confirmation bias is that "deep down, we never really want to hear ... negative information" (Heath and Heath, 2013, p. 112). A great example of this effect at work is Kodak's invention of
the digital camera in the 1970's, followed by its failure to implement and embrace the technology out of a belief that "Film is simply superior to digital" (Heath and Heath, 2013, pp. 223-224). This ultimately resulted in the company going bankrupt in January 2012 after decades of market dominance (Heath and Heath, 2013, pp. 224-225). To counteract the "confirmation bias" the Heath brothers propose a three step process that can be implemented by both individuals and teams: "One, we can make it easier for people to disagree with us. Two, we can ask questions that are more likely to surface contrary information. Three, we can check ourselves by considering the opposite" (Heath and Heath, 2013, p. 113). Indeed, being open to new information and different points of view is very helpful in avoiding "confirmation bias" along with many other decision traps as well.

The fifth heuristic to be cognizant of is the "status quo" bias. This trap essentially boils down to the fact that "Decision makers display ... a strong bias towards alternatives that perpetuate the status quo" (Hammond, Keeney, and Raiffa, 2003, p. 4). Hammond, Keeney, and Raiffa explain that the reasoning behind the "status quo" trap is based on our innate tendency for risk aversion and "our desire to protect our egos from damage": "Breaking from the status quo means taking action, and when we take action, we take responsibility, thus opening ourselves to criticism and to regret. Not surprisingly, we naturally look for reasons to do nothing" (Hammond, Keeney, and Raiffa, 2003, p. 4). A nice example of this bias in action is the tendency of acquiring firms to avoid "taking swift action to impose a new, more appropriate management structure on the acquired firm" following a merger, out of a fear of disrupting the "status quo," which often results in a failure to generate accretive value (Hammond, Keeney, and Raiffa, 2003, p. 4). To avoid the "status quo" trap Hammond et al. suggest that we should consider many alternatives and to make certain that your current state doesn't act as an impediment to your long-term goals (Hammond, Keeney, and Raiffa, 2003, pp. 4-5).

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52 Daniel Kahneman further articulates that the "status quo" bias is very strong due to loss aversion and our desire to maintain stability relative to a certain reference point, which is often beneficial; however, it can be problematic in arenas such as negotiation and investing when it prevents us from readjusting our frame of reference and/or making changes when the status quo is no longer sound (Kahneman, 2011, pp. 304-305).
The sixth decision trap involves "sunk costs," which essentially means "Making choices in a way that...
[justify] past flawed choices" (Hammond, Keeney, and Raiffa, 2003, p. 1). At the core this involves chasing good money after bad, or failing to cut your losses despite a value depletion in a particular investment (Hammond, Keeney, and Raiffa, 2003, p. 5). Daniel Kahneman further defines the "sunk-cost fallacy" as "The decision to invest additional resources in a losing account, when better investments are available" (Kahneman, 2011, p. 345). A simple example of this bias is refusing "to sell a stock or a mutual fund at a loss, [and thereby] forgoing, other more attractive investments" (Hammond, Keeney, and Raiffa, 2003, p. 5). To counteract this tendency, Hammond et al. suggest that we listen to opposing views, introspectively and honestly analyze our mistakes, and avoid creating a "failure-fearing culture" in our organizations (Hammond, Keeney, and Raiffa, 2003, p. 5). Avoiding this specific trap is of particular importance in trading and financial markets as failure to acknowledge and admit to our mistakes can result in significant monetary losses.

The seventh heuristic to be aware involves "framing effects," which relate to the fact that it's possible to present similar information in different ways in order to stimulate different emotions (Kahneman, 2011, p. 88). Hammond et al. emphasize that "The way a problem is framed can profoundly influence the choices that you make" (Hammond, Keeney, and Raiffa, 2003, p. 7). Daniel Kahneman illustrates this principle by discussing the probability of survival from a particular surgical procedure: "The statement that 'the odds of survival one month after surgery are 90% is more reassuring than the equivalent statement that 'mortality within one month of surgery is 10%'" (Kahneman, 2011, p. 88). It's easy to see how this sort of frame might significantly alter your decision on whether or not to undergo this type of surgical procedure. In order to prevent framing from negatively impacting your choices and decisions, Hammond et al. suggest that we "Always try to reframe the problem" and that we "Try posing problems in a neutral, redundant way that combines gains and losses or embraces different reference points" (Hammond, Keeney, and Raiffa, 2003, p. 8). This heuristic is a powerful example of how our
emotions can be significantly influenced simply by the way in which we are presented information, which subsequently impacts how we make decisions.

The eighth bias that we should analyze is the "availability heuristic," which Daniel Kahneman describes as "the process of judging frequency by 'the ease with which instances come to mind'" (Kahneman, 2011, p. 129). Essentially, when making predictions we often use recent events or the most impressionable events in our memory53 to complete our forecasts (Hammond, Keeney, and Raiffa, 2003, pp. 8-9; Kahneman, 2011, pp. 129-136). To give an example of this bias at work Hammond et al. cite how "Corporate lawyers often get caught in the recallability trap when defending liability suits": i.e., "Because the media tend to aggressively publicize massive damage awards ... lawyers can overestimate the probability of a large award for the plaintiff. As a result, they offer larger settlements than are actually warranted" (Hammond, Keeney, and Raiffa, 2003, p. 9). In order to offset the possibility of the "availability heuristic" impacting your forecasts, John Hammond and his colleagues recommend that we "Test estimates over a reasonable range to assess their impact"; "carefully examine all your assumptions to ensure they’re not unduly influenced by your memory"; and "Get actual statistics whenever possible" (Hammond, Keeney, and Raiffa, 2003, pp. 9-10). The "availability heuristic" in its numerous forms can significantly impact our estimations and forecasts in finance and investing, making it critical to counteract it utilizing objective data analysis and thoughtful introspection; however, there is one more bias that we should examine, which is arguably the most important to be aware of out of all of them: overconfidence.

53 Related to how our memories form from experiences and interactions is Daniel Kahneman's concept of the "experiencing self" versus the "remembering self," along with the fact that we remember peak intensity and what happens last more than anything else (Kahneman, 2011, p. 381). "The experiencing self is the one that answers the question: "Does it hurt now?" The remembering self is the one that answers the question: "How was it, on the whole?" Memories are all we get to keep from our experience of living, and the only perspective that we can adopt as we think about our lives is therefore that of the remembering self. The experiencing self does not have a voice. The remembering self is sometimes wrong, but it is the one that keeps the score and governs what we learn from living, and it is the one that makes decisions. What we learn from the past is to maximize the qualities of our future memories, not necessarily of our future experience. This is the tyranny of the remembering self" (Kahneman, 2011, p. 381).
**Overconfidence**

Indeed, overconfidence is such a significant influencer in our decision making process that Daniel Kahneman dedicates almost one-fifth of his book, *Thinking, Fast and Slow*, to this specific topic. Much of the reason for our evaluation of it here relates to how important it is in forecasting and how dangerous it can be if we fail to account for it when determining our portfolio allocations and investment selections. Our emotionality, our ego, and our implicit biases all give us an innate inclination towards overconfidence, overplacement, and overprecision in decision making, which needs to be counteracted at all costs to achieve sustainable excess returns in the markets (Keren and Wu [Moore, Tenney, and Haran], 2015). What's particularly interesting about overconfidence as a bias is how pervasive it is, and how often it's detached from reality. As Duke social psychologist Rick Larrick states, "When people express 90% confidence, they're right about 50% of the time" (Larrick – "Introduction," 2018).

A fascinating observation with overconfidence is that even experts aren't immune to it; although, their judgments may tend to be more accurate than average people in their domain of expertise their confidence in their abilities will cause them to develop a similar calibration error leading them to narrowly bracket the ranges for outcomes, which leads them to make prediction errors similar to non-experts. (Keren and Wu [Larrick and Feiler], 2015, p. 712). Building upon this understanding, the Heath brothers explain that "The future isn't a point; it's a range": "Even if we have a pretty good guess about the future, the research on overconfidence suggests that we'll be wrong more often than we think" (Heath and Heath, 2013, p. 201). For this reason, they suggest to "bookend the future" with an estimated top and bottom range where we brainstorm why we might be successful and why we might fail in order to determine both high and low extremes while also using a safety factor to prepare for the unknowns (Heath and Heath 2013, p. 217). It's critical to implement strategies such as this to mitigate our myopic tendencies when forecasting because this particular bias is so widespread and so powerful.

Psychologists Don Moore, Elizabeth Tenney, and Uriel Haran suggest that overconfidence is the "mother of all biases" because it is so pervasive (as with the example of experts above) and because of the
supportive base that it gives to many other biases (Keren and Wu [Moore, Tenney, and Haran], 2015, p. 182). Moore et al. further share the three different kinds of overconfidence: "1) Overestimation – thinking that you’re better than you are, 2) Overplacement – an exaggeration of the degree that you are better than others, and 3) Overprecision – the excessive faith that you know the truth" (Keren and Wu [Moore, Tenney, and Haran], 2015, p. 183). Much of the root cause of these three categories of overconfidence comes from our ego and our belief that we know what the future will bring (Heath and Heath, 2013). This in turn can lead us to develop stories that might reinforce our confidence that we knew how something was going to turn out, especially when we have little truly relevant information (Kahneman, 2011).

You cannot help dealing with the limited information you have if it were all there is to know. You build the best possible story from the information available to you, and if it is a good story, you believe it. Paradoxically, it is easier to construct a coherent story when you know little, when there are fewer pieces to fit into the puzzle. Our comforting conviction that the world makes sense rests on a secure foundation: our almost unlimited ability to ignore our ignorance. (Kahneman, 2011, p. 201)

This ties into research of psychologists Baruch Fischhoff and Ruth Beyth that uncovered the "hindsight bias," which relates to the fact that we tell ourselves that we really knew how things would were going to happen when looking back on it: "The tendency to revise the history of one's beliefs in light of what actually happened produces a robust cognitive illusion" (Kahneman, 2011, pp. 202-203). Nassim Taleb likes to point out that "Everything makes sense in hindsight" (Kahneman, 2011, p. 218) and that "Things appear to be more predictable after the fact" (Taleb, 2004, p. 192). Indeed, the stories that we tell ourselves about how we knew how things would transpire creates serious impediments to our ability to forecast accurately in the future (Kahneman, 2011, p. 218).

54 The "hindsight bias" is also referred to as the "'I-knew-it-all-along' effect" (Kahneman, 2011, p. 202).
55 Kahneman explains that the hindsight bias also significantly affects the way that we assess and evaluate decisions, and not for the best: "It ["hindsight bias"] leads observers to assess the quality of a decision not by whether the process was sound but by whether its outcome was good or bad. ... We are prone to blame decision makers for good decisions that worked out badly and to give them too little credit for successful moves that appear obvious only after the fact. There is a clear outcome bias" "Kahneman, 2011, p. 203).
In the investing world these types of overconfidence can develop into the "narrative fallacy," introduced by Taleb, which explains how "flawed stories of the past shape our view of the world and our expectations of the future" (Kahneman, 2011, p 199). We often simply fail to grasp how limited our understanding is and at times willfully ignore how much of a factor luck has in everything\(^{56}\) (Kahneman, 2011, p 218).

The explanatory stories that people find compelling are simple; are concrete rather than abstract; assign a larger role to talent, stupidity, and intentions than to luck; and focus on a few striking events that happened rather than on the countless events that failed to happen. (Kahneman, 2011, p 199)

These biased tendencies relating to overconfidence are good examples of the aforementioned "What You See Is All There Is" (WYSIATI) from Daniel Kahneman (Kahneman, 2011, pp. 85-88). Richard Larrick articulates this concept by explaining some of the limitations in our judgment process.

We don't do a great job of drawing on a wide variety of evidence. We are generally not calibrated to what we don't know and assume that the future will be like the present [Representativeness], and there are social pressures that push us to give an answer instead of saying that we don't know. There is a lot of noise in the world and even researchers may not realize when "regression to the mean" is sneaking into their data. This in turn can lead us to cherry pick the strategy and framework that we use to get a specific result. (Larrick – "Judgment under Uncertainty II," 2018)

The reason for this particularly hazardous form of overconfidence [WYSIATI] is that because when we haven't seen something before we believe that it's not possible: e.g., A black swan, which is "something literally inconceivable before it happens" (Taleb, 2004, p. 117; Tetlock and Gardner, 2015, p. 238). Tetlock shares that Nassim Taleb has a "more modest definition of a black swan as a 'highly improbable consequential event'"; however, Taleb also "insists that black swans, and black swans alone, determine the course of history" (Tetlock and Gardner, 2015, pp. 238-239).

\(^{56}\) One of the keys to identifying skill versus luck is the presence of "**persistent achievement,**" which tends to be lacking among nearly all professional investors (Kahneman, 2011, p. 214). Ironclad, one of the big problems for many traders comes down to the fact that investing is a zero-sum game with so many highly intelligent actors operating in the same arena – i.e., Market efficiency: "In highly efficient markets ... educated guesses are no more accurate than blind guesses" (Kahneman, 2011, p. 215).
This underappreciation of uncertainty can be dangerous in many arenas, but particularly in the markets, where Taleb argues that "inadequate appreciation of uncertainty of the environment inevitably leads economic agents to take risks that they should avoid" (Kahneman, 2011, p. 262). Indeed, Taleb believes that "fat-tail risks" are substantially more prevalent in financial markets than most people think, which "means that our world is vastly more volatile than most of us realize and we are at risk of grave miscalculation" (Tetlock and Gardner, 2015, pp. 246-249; Taleb, 2004). This means that we tend to be more confident in the range of potential future outcomes than the historical data say we should be, which can lead to significant issues when attempting to make predictions. And, while overconfidence can cause many different potential problems, such as Daniel Kahneman's, "theory-induced blindness" (Kahneman, 2011, p. 277), those surrounding WYSIATI are particularly nefarious and can in some cases lead to catastrophic outcomes, such as the "Housing Bubble" and "Global Financial Crisis" of 2007-2009. To add to the danger of overconfidence is the fact that "nobody really knows where they are, and where they stand relative to others in terms of their level of skill" (Larrick – "Judgment under Uncertainty II," 2018).

Overconfidence in our skills, abilities, and talents is incredibly dangerous and surprisingly pervasive, especially in financial markets; however, recent research in the Judgment and Decision Making (JDM) and Behavioral Decision Theory (BDT) realms of the social psychology field has shown that there are empirically backed approaches that may provide value in resolving our biases and our flawed heuristics. One potentially curative strategy could be the integration of a Bootstrapping Model in the mold of Robin Hogarth and Natalie Karelaia's updated "Lens Model" (Hogarth and Karelaia, 2007); while another to explore might be the incorporation of a framework based on a modified "Weighted Additive Rule" (Shah and Oppenheimer, 2008) into the decision process. In terms of specifically debiasing overprecision, Moore, Tenney, and Haran, offer three generally accepted mainstream methods: 1) encouraging the consideration of more information and possible alternatives, 2) decomposing the response set or alternatives into smaller

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57 Fat-tail distributions (and the risks that they represent) are essentially distributions with a higher probability of extreme events in contrast to a normal Gaussian distribution (Tetlock and Gardner, 2015).
components and considering each one of them separately, and 3) providing feedback (Keren and Wu [Moore, Tenney, and Haran], 2015, p. 195). In a more broadly focused debiasing solution, social psychologists Jack Soll, Katherine Milkman, and John Payne advocate for following the framework of "Modify the Person and Modify the Environment" (Keren and Wu [Soll, Milkman, and Payne], 2015).

Modify the Person:
1) **Education**: teach rules and principles such as statistics
2) **Cognitive Strategies**: how to think
3) **Use models to decide**: replace the human with an equation, linear models typically exceed humans in forecasting accuracy (Keren and Wu [Soll, Milkman, and Payne], 2015, pp. 930-934)

Modify the Environment:
1) **Incentives**: bonuses and rewards, increased accountability
2) **Choice Architecture**: how information is presented (Keren and Wu [Soll, Milkman, and Payne], 2015, pp. 934-940)

These techniques are all supported by empirical research showing that they can be effective at combating overconfidence and other biases.

However, another important challenge to address on investment analyst and forecasting teams relates to people's perceptions of each other. Generally speaking, taking a logical and probabilistic approach to making decisions is very sound and the best way to enhance overall prediction accuracy; however, that particular way of thinking is not what most of the population typically views as strong and credible leadership (Tetlock and Gardner, 2015; Keren and Wu [Moore, Tenney, and Haran], 2015; Klayman et al., 1999). Moore et al. explain that "People and organizations do want unbiased experts who appreciate uncertainty, but people are nevertheless drawn to the confident experts, especially when they believe that high confidence is a signal of high performance" (Keren and Wu [Moore, Tenney, and Haran], 2015, p. 200). They further share some of Daniel Kahneman's advice on how to approach this dilemma (Keren and Wu [Moore, Tenney, and Haran], 2015, p. 200).

You should not take assertive and confident people at their own evaluation unless you have independent reason to believe that they know what they are talking about. Unfortunately, this advice is difficult to follow: overconfident professionals sincerely believe they have expertise, act as experts, and look like experts. You will have to
struggle to remind yourself that they may be in the grip of an illusion. (Keren and Wu [Moore, Tenney, and Haran], 2015, p. 200).

The challenges associated with this are that it's often difficult to truly identify competence and expertise, given factors such as luck or the "treatment effect" (Larrick – "Judgment under Uncertainty II," 2018).

One way that we typically gauge expertise is by who talks the most and who's the most confident, but those are usually pretty week cues (Larrick and Soll – "Group Decision Making and the Wisdom of Crowds," 2018). Along this line, Joshua Klayman, Jack Soll, Claudia Gonzalez-Vallejo, and Seme Barlas cite concerns about the ability to separate competence from confidence and what that means in application (Klayman et al., 1999, p. 243).

If there are real differences among people in their proneness to overconfidence, that has interesting implications for the real world. In a world in which competence is hard to measure, confidence often wins the day. This is troubling if, as our results suggest, the most confident people are also the most overconfident. (Klayman et al., 1999, p. 243).

This in turn could be a major impediment when trying to build and develop teams of experts to better improve forecasting and prediction accuracy in financial markets, or in selecting the right fund manager. Yet, despite these challenges there are still very effective methods from the Behavioral Decision Theory (BDT) and Judgement and Decision Making (JDM) arenas that focus largely on process and can potentially be very helpful at improving investment analysis and portfolio management: 1) High-Level Decision Making

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58 Munich business school professor Jack Nacher echoes the insights of Moore et al. in his 2019 Harvard Business Review article "To Seem More Competent, Be More Confident." (Nasher, 2019). Nacher reiterates the assertions of Moore and his colleagues that people often look to confidence as one of the key indicators of competence: "if you project confidence, others tend to believe you know what you're talking about, and they will then filter ambiguous information (like how much luck may have helped or hurt you) to fit their initial impression" (Nasher, 2019). He additionally shares the findings from a 1982 study by psychologists Barry Schlenker and Mark Leary on perceptions of confidence and competence in order to explain why people often discount modesty in the workplace and many other settings as well: "people tend to penalize humble actors by deciding against them and choosing the confident ones. Modesty is regarded as hedging against possible failure, an attempt to take the wind out of critics' sails" (Nasher, 2019; Schlenker and Leary, 1982).

59 The "treatment effect" occurs when you select a group of people for an initiative such as an accelerated development program at a corporation and provide them with extra support, mentoring, and guidance, which improves their performance (Larrick – "Judgment under Uncertainty II," 2018). If the group's members are successful it could lead senior leadership to believe that they selected the right individuals; however, in reality most employees would have been just as successful if given all of the additional support that the accelerated development group received (Larrick – "Judgment under Uncertainty II," 2018).
"The fundamental cause of the trouble is that in the modern world the stupid are cocksure while the intelligent are full of doubt" – Bertrand Russell (Russell, 1933, pp. 203-204).

Chapter Five: BDT and JDM Techniques to Improve Processes and Outcomes in the Markets

Can You Beat The Market?

In terms of whether or not it is possible to achieve excess returns in the financial markets, I believe that Andrew Lo’s assessment is the most accurate at this point in time. Lo asserts that it is possible to beat the market; however, it's exceptionally difficult to do consistently because it's a zero-sum game with many intelligent and skilled actors competing, which means that you must constantly adapt your strategy in order to achieve success60 – e.g., David Shaw, Warren Buffett, Jim Simons, Peter Lynch, David Swensen, and George Soros (Lo, 2017, p. 277 and p. 6; "Lessons from the endowment model," 2020). Lo argues that genuine mispricings and inefficiencies do occur and can be exploited; however, when you identify them you need to quickly flood the trade and take advantage of the opportunity before other investors recognize the opening and jump in, thereby diluting the potential alpha (Lo, 2017).

This in turn leads to the "Lucas critique" of Nobel-prize winning economist Robert Lucas: According to Taleb, Lucas states that "if people were rational then their rationality would cause them to figure out predictable patterns from the past and adapt, so that past information would be completely useless for predicting the future" (Taleb, 2004, p. 114). An example of this in practice would be the employment of superior trading techniques by analysts at a particular hedge fund, which potentially offer a meaningful improvement in the fund's performance and returns. However, if their application of these investing strategies is successful, it will undoubtedly be replicated again and again by multiple other entities until the initial firm's performance edge disappears. Paradoxically, this could turn all participants in the investing ecosystem into superior traders and, because the marketplace is a zero-sum game no one firm will have an

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60 Investment consultant Charlie Ellis argues that "The only way active investment managers can beat the market, after adjusting for market risk, is to discover and exploit other active investors' mistakes" (Ellis, 2017, p. 23).
advantage over another. Ironically this hyper-competitive process could cause a perpetual Knightian uncertainty\textsuperscript{61} loop making it virtually impossible to achieve reasonable forecasting accuracy, with the sole result being limited to increasing the overall efficiency of the market without any true gains in predictive skill.

This would in turn necessitate a consistently adaptive strategy to stay ahead of other traders and firms that might mirror your approach, as has been previously accomplished by D.E. Shaw \& Co and Renaissance Technologies (Lo, 2017). Indeed, Lo believes that it is possible to beat the market as illustrated by the examples he shares; yet, he also acknowledges the immense difficulty associated with accomplishing this feat (Lo, 2017). This is exemplified by the cognitive dissonance / paradox of two of Lo's favorite investment thought leaders: Jack Bogle (Vanguard) and Jim Simons (Renaissance Technologies) (Lo, 2017, p. 6). Lo expresses strong support for Vanguard founder Jack Bogle's "Cost Matters Hypothesis"\textsuperscript{62} and low-fee passive index fund approach; however, he also believes in mathematician and Renaissance founder James Simons' quantitative strategy, since he and his firm have beaten the market by quite a bit for a very long period of time (Lo, 2017, pp. 224-225 and pp. 263-265). Yet, the exceptional difficulty and rarity of Renaissance's success really speaks to the fact that low-fee passive index funds, or similar low-fee target date funds, are probably the best approach to investing for many, probably most, investors; however, by employing superquants with sophisticated and continuously evolving strategies it might very well be possible to beat the market as Simons has done (Lo, 2017). Yet, the ability to achieve this comes down to having the necessary expertise for a particular trade – e.g., currencies, forwards, futures, and swaps – at a

\textsuperscript{61} "Knightian Uncertainty" is named for University of Chicago economist Frank Knight who differentiated quantifiable risk from "true uncertainty" (Dizikes, 2010). Peter Dizikes of the MIT News Office shares a concise explanation of Knight's thoughts on "uncertainty" and "risk": "'There is a fundamental distinction between the reward for taking a known risk and that for assuming a risk whose value itself is not known,' Knight wrote. A known risk is 'easily converted into an effective certainty,' while 'true uncertainty,' as Knight called it, is 'not susceptible to measurement'" (Dizikes, 2010).

\textsuperscript{62} This is backed up by the research of McCarthy and Tower who determined that a simple Vanguard low-fee index fund portfolio outperforms more complex active tactical asset allocation (TAA) funds by a wide margin, and that "the superiority of Vanguard's index ETFs to the TAAs is explained by the lower reported expenses and the lower costs that lower turnover bestows" (McCarthy and Tower, 2020b, p. 11).
very granular level and knowing how and when to enter and exit the position, while also being ready to continuously modify your strategy.

In terms of explaining what exactly "expertise" is, social psychologists Richard Larrick and Daniel Feiler build on Swedish psychologist Anders Ericsson's definition: For them, "the possession of domain-specific knowledge that is acquired through experience or training and that leads to superior reproducible performance in the domain-related tasks" (Keren and Wu [Larrick and Feiler], 2015, p. 697). Larrick and Feiler further clarify the "three key elements" that underpin "expertise" (Keren and Wu [Larrick and Feiler], 2015, p. 697).

**Three Key Elements of Expertise:**
1) First, expertise is *domain* specific.
2) Second, expert knowledge is *acquired from experience and training*.
3) Third, expertise leads to *superior, reproducible performance*. (Keren and Wu [Larrick and Feiler], 2015, p. 697)

Larrick and Feiler further cite Ericsson's findings that achieving "expertise" requires a great deal of practice: "approximately 10 years of experience, or 10,000 hours" (Keren and Wu [Larrick and Feiler], 2015, p. 700; Ericsson, 2006). Additionally, "deliberate practice" is also "key to achieving the highest levels of expertise," which has two essential factors: "(a) it is initially done with awareness and intention, and (b) it is focused on a specific task that is designed to be different from what is familiar but is relevant to future challenges" ((Keren and Wu [Larrick and Feiler], 2015, pp. 701-702).

Yet, a lot of the determination as to whether or not expertise is possible in a particular arena comes down to whether the environment is "kind" (immediate accurate feedback) or "wicked" (delayed unreliable feedback) (Keren and Wu [Larrick and Feiler], 2015; Epstein, 2019; Hogarth and Soyer, 2011). This means that – in certain fields with clear, accurate, and opportune responses – expertise is very possible, such as weather forecasting and bridge playing (Keren and Wu [Larrick and Feiler], 2015); however, in other arenas – such as law enforcement and political punditry – it is incredibly elusive due to the lack of timely reliable feedback, which inhibits learning, though not overconfidence (Tetlock and Gardner, 2015). Indeed, Larrick and Feiler tend to group financial investment into the latter category.
where true "expertise" is not possible because while trading does "depend on expertise to assess fundamental values ... it is [also] an arms race in which all parties acquire expertise to stay even with other parties," which makes it almost impossible to remain ahead of competitors on a consistent basis (Keren and Wu [Larrick and Feiler], 2015, p. 706).

Ironically though, I think that by employing decision processes such as those proposed by Larrick and Feiler, along with techniques advocated for by other social psychologists like Barbara Mellers, Phil Tetlock, Don Moore, Jack Soll, Al Mannes, Chip Heath, and Dan Heath, it may be possible to beat the market in a replicable manner – if other investors don't fully copy the successful empirical methodologies that you and your team develop. To be sure, this will require an exacting execution of Larrick et al.'s decision frameworks along with an ability and willingness to consistently adapt using elegant quantitative strategies in a similar manner to Renaissance Technologies; however, if an investor or investment team is able to achieve these two goals it might be possible to realize sustainable and replicable alpha – again still exceptionally difficult.

For our purposes in this paper I will focus specifically on the former, since I lack the mathematical expertise to uncover specific market inefficiencies and because of the fact that many investment arenas are incredibly granular and domain-specific. I also believe that sharing a series of best practices in decision making and team building for forecasting is more universally applicable throughout the investment world. In terms of how to approach this framework I think that the best way forward is to begin with the methodologies proposed by Chip and Dan Heath in their 2013 book _Decisive: How to Make Better Choices in Life and Work_ (Heath and Heath, 2013).

**Decision Making Strategies**

To this end, Chip and Dan Heath, who have taught at Stanford Business School and Duke University, have identified what they call "the four villains of decision making," which inhibit our ability to make optimal decisions: 1) Narrow framing, 2) Confirmation bias, 3) Short-term emotion, and 4) Overconfidence. (Heath and Heath, 2013, p. 29). They also offer a core philosophical insight into making good decisions as
well: "Sometimes the hardest part of making a good decision is knowing that there's one to be made" (Heath and Heath, 2013, p. 28). To counter the four villains, the Heath brothers have developed a fascinating four-stage process for making decisions, which incorporates many important findings that have been discovered recently in the social psychology arena.

Their simplified process is summarized as WRAP: 1) Widen your options, 2) Reality-test your assumptions, 3) Attain distance before deciding, and 4) Prepare to be wrong (Heath and Heath, 2013). In their book *Decisive*, they offer a detailed overview of their methodology along with a number of key examples. (Heath and Heath, 2013).

**WRAP Process:**

1. **Widen your options**
   a. Avoid a narrow frame
   b. Multitrack
   c. Find someone who's solved your problem

2. **Reality-test your assumptions**
   a. Consider the opposite
   b. Zoom out, zoom in
   c. Ooch – build out small empirical tests

3. **Attain distance before deciding**
   a. Overcome short-term emotion
   b. Honor your core priorities

4. **Prepare to be wrong**
   a. Bookend the future
   b. Set a tripwire
   c. Trust the process (Heath and Heath, 2013)

Much of the problem with our biases is the fact that we only take into account what is directly in front of us, which falls in line with Daniel Kahneman's WYSIATI (Heath and Heath, 2013, p. 2). This can also be described through the "spotlight effect," which is one of the key impediments to "good" decision making: "What's in the spotlight will rarely be everything we need to make a good decision, but we won't always remember to shift the light. Sometimes, in fact, we'll forget there's a spotlight at all, dwelling so long in the tiny circle of light that we forget there's a broader landscape beyond it" (Heath and Heath, 2013, p. 3). The Heath brothers' framework is basically a methodological approach that allows us to overcome these
ingrained heuristics and "deactivate our biases" so that we can improve our overall decision making and enhance our outcomes in the financial markets (Heath and Heath, 2013, p. 22).

Indeed, in looking at human decision making as a whole I think that frameworks such as the Heath brothers' WRAP process are likely the most useful for us on a normal daily basis; yet, an empirically designed model such as this can also be incredibly valuable in the investment world. The reason why a sound process, such as WRAP, is necessary is because as the Heath brothers note, just knowing our biases is not enough to overcome them, we need to apply appropriate guardrails to manage our decision making (Heath and Heath, 2013). This is backed up by research from Dan Lovallo and Olivier Sibony of the University of Sydney and McKinsey & Company, which determined that process is more important than analysis in making good decisions: "they [Lovallo and Sibony] found that ‘process mattered more than analysis – by a factor of six’" (Heath and Heath, 2013, p. 5). To this end, it's worthwhile to evaluate each step of the WRAP process, along with Daniel Kahneman's choice models, in order to determine best practices for making decisions in the financial markets.

The first step of the WRAP process is "Widen Your Options," which starts off with the need to "avoid a narrow frame" (first sub-step), and essentially boils down to thinking outside of the box and realizing that "our options are more plentiful than we think" (Heath and Heath, 2013, p. 49). Too often we limit our choices, which can ultimately prevent us from taking the best course of action; instead, we should be thinking more along the lines of "Can I do this And that?" rather than "Whether or not"63 (Heath and Heath, 2013, pp. 29, 42). Additionally, there are techniques that can be employed in the investing arena such as analyzing the "opportunity cost" of a particular investment and where you might have been able to put the money to work had you not bought a particular asset (Heath and Heath, 2013, p. 42). This in turn can be related back to Nobel Prize winning economist Harry Markowitz' "Modern Portfolio Theory," where you make investments with offsetting correlations to diminish risk while achieving the similar returns – and

63 It's also useful to have someone or perhaps several people arguing that we shouldn't take a particular action (Heath and Heath, 2013).
potentially leaving yourself open to make a small investment in a risky asset with a high potential return (Heath and Heath, 2013; Perold, 1984). The Heath brothers further offer that it's value added to employ a "Vanishing Options Test," which involves saying to yourself if these particular assets were no longer available where would we employ our capital: i.e., Where would we move our "spotlight"? (Heath and Heath, 2013, pp. 47-49).

The second sub-step is to "Multitrack," which involves pursuing multiple options at the same time (Heath and Heath, 2013, p. 67). This pursuit of different options simultaneously can enable us to "learn the 'shape' of the problem" while also keeping "egos in check" (Heath and Heath, 2013, p. 67). The Heaths also argue that it's critical to understand that "Not all choices are equal" (Heath and Heath, 2013, p. 58).

To get the benefits of multitracking, we need to produce options that are meaningfully distinct. We must be careful, too, to avoid sham options, which only exist to make the "real" option look better. (Heath and Heath, 2013, p. 58).

A great example of this would be a "Seed" or Venture Capital firm that presents a potential investor with opportunities to invest in its lower level or poorer quality start-ups to make the one that they want them to invest in look more attractive. It's also important to maintain a "Prevention Focus" of "avoiding negative outcomes" while at the same time balancing that against a "Promotion Focus" more targeted towards "pursuing positive outcomes" (Heath and Heath, 2013, pp. 60-61). Both of these attention styles are valuable; however, balancing the two can better enable you to moderate your risk-seeking and risk-averse choices in your portfolio allocation decisions.

The third sub-step of "Widen Your Options" is to "Find Someone Who's Solved Your Problem," which is somewhat self-explanatory (Heath and Heath, 2013, p. 69). This can be accomplished in a number of different ways, but perhaps one of the easiest is to "Look inside" of your organization and "Find your bright spots" (Heath and Heath, 2013, p. 89). Simply looking inside your different departments and analyzing

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64 It's important to note also that the Heath brothers are only advocating for the pursuit of a couple options simultaneously in order to avoid psychologist Barry Schwartz' "choice overload" where we undergo decision paralysis when faced with too many selections (Heath and Heath, 2013, pp. 56-57).
which trading techniques and team structures work best can often glean a series of valuable insights. However, another method that's also very effective is to "Look outside" of your firm in order to determine whether methods that your competitors are utilizing can be implemented as solutions in your own company (Heath and Heath, 2013, p. 89). The Heath brothers share a great example of this in Sam Walton's competitive analysis approach when he was building Walmart up from a small variety store in Bentonville, AR (Heath and Heath, 2013). They describe how "Walton constantly scoured other stores for good ideas," and when he found a more advanced practice he would swiftly enact it in his shops (Heath and Heath, 2013, pp. 68-69). On one occasion Walton traveled 600 miles to witness a new centralized checkout model being employed by Ben Franklin variety stores up in Minnesota; "Convinced Franklin's process was superior, Walton quickly implemented the idea in his stores, and Walmart continues to use the same model today" (Heath and Heath, 2013, p. 69). Looking around the investment world for best practices among your competitors can likely have an equally valuable impact on your enterprise.

Yet, another technique that can be utilized under this sub-step is "analogy," which is incredibly well utilized inside the scientific community and can likely be transitioned into the financial arena as well (Heath and Heath, 2013). Indeed, psychologist Kevin Dunbar argues that "The use of analogies is one of the main mechanisms for driving [scientific] research forward" (Heath and Heath, 2013, p. 81). Dunbar discovered that scientists would benefit from a "local analogy" when analyzing a "very similar experiment with a similar organism"; however, when there was a more complex or dynamic problem they would turn to a "regional analogy," which involves larger more complex problems that are not as similar as yours and typically further off in the distance (Heath and Heath, 2013, pp. 80-81). Through his research "Dunbar found that granular problems benefit from local analogies, and conceptual problems lend themselves to regional analogies" (Heath and Heath, 2013, p. 82). He suggested that the best way to leverage these techniques would be by "laddering up," which means starting with the local analogies similar to yours and then build to the regional analogies in different domains that will give you more options, "but those options will require leaps of imagination" (Heath and Heath, 2013, p. 82). A good example of this would be starting off with a "local
analogy" by utilizing a modified Dupont Analysis from an equity researcher at a rival firm in order to evaluate tech stock returns in a recessionary environment, and then "laddering up" by looking into whether the behavior of competing chimpanzee groups in a drought might offer insights into how technology companies react under stress (Heath and Heath, 2013).

Once you have expanded your view of potential options, the second step of the WRAP process is to "Reality-test your assumptions," meaning check to make certain that the premises underlying your analysis are sound and not influenced by "confirmation bias" (Heath and Heath, 2013, p. 23). One of the best ways to accomplish this is with the first sub-step "Consider the Opposite," which is a remarkably straightforward and valuable technique, but often underutilized (Heath and Heath, 2013, p. 114). It's been widely shown in academic studies that acquisitions made by public firms rarely generate real value with synergies, likely because "the average premium paid in an acquisition is 41%," which means that in most cases the acquiring company significantly overpays (Heath and Heath, 2013, p. 92). In terms of why this happens, the Heaths cite fascinating research from Columbia business school professors Matthew Hayward and Donald Hambrick, which argues that CEO hubris is the primary culprit (Hayward and Hambrick, 1997; Heath and Heath, 2013). Hayward and Hambrick "found that for every favorable article written in a major publication about the CEO, the acquisition premium paid went up by 4.8%" (Heath and Heath, 2013, p. 94; Hayward and Hambrick, 1997). Yet, Hambrick and Hayward also discovered "that CEO's paid lower acquisition premiums when they had people around them who were more likely to challenge their thinking" (Heath and Heath, 2013, p. 94; Hayward and Hambrick, 1997). This illustrates how critical it is have people on our team who are prepared to disagree with us when we're considering a potential risky investment decision.

The reason that this is so critical is because "confirmation bias" often leads us to go "hunting for information that confirms our initial assumptions" (Heath and Heath, 2013, p. 114). Indeed, it's exceptionally important to establish a culture that rewards "constructive disagreement" to mitigate this tendency (Heath and Heath, 2013, p. 114). One potential technique is to have a team member specifically tasked with playing "devil's advocate," such as the Catholic Church's previously utilized promotor fidei,
whose "role was to build a case against sainthood" during the canonization process, or the U.S. military's use of "murder board[s] ... [which they employ] to try to kill ill conceived missions" (Heath and Heath, 2013, p. 96). The Heaths also explain the value of "disconfirming questions" as advocated for by former University of Toronto Rotman School of Management Dean Roger Martin (Heath and Heath, 2013, pp. 97-100). Martin argues that asking questions such as "What would have to be true?" allows people "to back away from their beliefs and allow for exploration by which they give themselves the opportunity to learn something new" (Heath and Heath, 2013, p. 100). Indeed, these types of "disconfirming questions" can be incredibly valuable; however, they can work against us in asymmetric power situations such as a principal or managing director speaking with a junior analyst (Heath and Heath, 2013, pp. 104-107). In these types of situations it can be better to ask "open-ended questions" to avoid inhibiting the insights that could be offered by the lower ranking employee (Heath and Heath, 2013, pp. 104-107). To be sure, there is much complexity and nuance involved in taking the opposite point of view; yet, it is very clear how vital it is in order to avoid making investment decisions with little accretive value.

The next sub-step under "Reality test your assumptions" is to "Zoom Out, Zoom In" (Heath and Heath, 2013, pp. 115-133). This relates to the importance of being able to look at your problem at a granular level ("inside view"), but arguably more importantly looking at it through a broader more realistic perspective as well ("outside view"), which "is more accurate – it's a summary of real-world experiences, rather than a single person's impressions" (Heath and Heath, 2013, pp. 116-117). The Heath brothers share a nice description of both the "inside view" and "outside view" (Heath and Heath, 2013, pp. 116-117).

The inside view draws from information that is in our spotlight as we consider a decision – our own impressions and assessments of the situation we’re in. The outside view, by contrast, ignores the particulars and instead analyzes the larger class it’s part of. (Heath and Heath, 2013, pp. 116-117)

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65 Martin also advocates using other questions along a similar line that enable a productive counterpoint conversation: e.g., "What if our least favorite option were actually the best one?" or "What data might convince us of that?" (Heath and Heath, 2013, p. 100).
One of the critical reasons that the "outside view" is so powerful is because it incorporates "base rates," as we discussed in Chapter Four, which are one of the best starting points for making a decision or a prediction: i.e., Before starting your restaurant it would be important to know that "60% of restaurants fail in their first three years," and to then assess what might make our experience different (Heath and Heath, 2013, p. 117). However, it's also valuable to zoom back in once we have done our initial outside view assessment because it will allow us to "take a close-up of the situation ... [enabling us to look] for 'color' that could inform our decision" (Heath and Heath, 2013, p. 133). Indeed, this is well illustrated by the example on page 71 of "superforecaster" Jay Ulfelder beginning his prediction of Chuck Hagel's SECDEF confirmation probability with the base rate and then adjusting it downward after incorporating situation specific dynamics (Tetlock and Gardner, 2015, pp. 170-171).

The third sub-step under "Reality Test Your Assumptions" is "Ooch," which is kind of a funny slang name, but it essentially means "to construct small experiments to test one's hypothesis": i.e., A/B testing (Heath and Heath, 2013, p. 135). The reason why "ooching" is so effective is because it allows you to "Dip a toe in before you plunge headfirst" (Heath and Heath, 2013, p. 140). It's also similar to the strategy advocated for by consulting researchers Jim Collins and Morten Hansen called, "firing bullets then cannonballs": i.e., "running small experiments and then doubling down on the ones that work best" (Heath and Heath, 2013, p. 140). It additionally bears resemblance to the technique employed by most successful entrepreneurs called "effectual reasoning," which was uncovered by University of Virginia Darden business school professor Saras Sarasvathy: "Effectual reasoning, however, does not begin with a specific goal. Instead, it begins with a given set of means and allows goals to emerge contingently over time from the varied imagination and diverse aspirations of the founders and the people they interact with".

66 The Heath brothers suggest that you should reach out to an expert for guidance if you can't find base rates yourself; however, it's important to approach the interaction thoughtfully because "experts are pretty bad at predictions. But they are great at assessing base rates" (Heath and Heath, 2013, p. 120).
67 Sarasvathy also identified that these successful entrepreneurs tend to adhere to the motto of "Ready-fire-aim," which again lends itself to experimentation in order to see what works (Sarasvathy, 2005, p. 6).
Sarasvathy has determined that "effectual reasoning" starts with a given means and works through experimentation in order to determine where opportunities can be found (Sarasvathy, 2005, p. 4).

**Effectual Reasoning Principles:**
1. Effectual reasoning is **means-driven**
2. Effectual reasoning emphasizes **affordable loss**
3. Effectual reasoning is built upon a **growing network of partnerships**
4. Effectual reasoning stresses the **leveraging of contingencies and being open to surprises**
5. Effectual reasoning argues that opportunities can be "made" as well as found **through human action** (Sarasvathy, 2005, p. 4).

Her assessment of how these successful entrepreneurs operate comes down to a testing based logic where they believe that "To the extent that we can control the future, we do not need to predict it" (Sarasvathy, 2005, p. 6).

The last important insight relating to "ooching" is the "interview illusion," which builds on the first few guidelines and elucidates the importance of testing even when we intuitively feel that we know the right decision (Heath and Heath, 2013, p. 150). This is critically important when we are trying to hire the appropriate people for our investment team because, contrary to popular belief, research by social psychologist Robyn Dawes has determined that "interviews seemed [seem] to correlate with nothing other than, well, the ability to interview" (Heath and Heath, 2013, p. 150). Expanding on this, Chip and Dan Heath share social psychologist Richard Nisbett's (who discovered the "interview illusion") example of the graduate school admissions process to illustrate the uselessness of interviews in determining success (Heath and Heath, 2013, p. 150).

The absurdity, he [Nisbett] says, is that "you and I, looking at a folder or interviewing someone for a half hour, are supposed to be able to form a better impression than one based on three-and-a-half years of the cumulative evaluation of 20 to 40 different professors." (Heath and Heath, 2013, pp. 150-151)

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68 University of Michigan social psychologist Richard Nisbett explains that the "interview illusion" relates to "our certainty that we’re learning more in an interview than we really are" (Heath and Heath, 2013, p. 150).
In terms of how to identify who best to hire at your boutique investment bank or hedge fund, in addition to GPA, "work samples, job-knowledge tests, and peer ratings of past job performance" are all significantly better predictors of success than a baseline behavioral interview (Heath and Heath, 2013, p. 149).

This then leads into the third step in the WRAP Process "Attain Distance Before Deciding" (Heath and Heath, 2013, p. 155). The first sub-step under this decision category is to "Overcome Short-Term Emotion," which is critical in order to avoid making subjective decisions based on what we are feeling in the moment (Heath and Heath, 2013, pp. 156-174). As mentioned in Chapter Four our emotions are a critical part of our biological decision making apparatus; yet, they can also lead us astray due to our innate hard coded biases. The Heaths explain that "Our decisions are often altered by two subtle short-term emotions: 1) mere exposure – we like what's familiar to us; and 2) loss aversion: losses are more painful than gains" (Heath and Heath, 2013, p. 174). Indeed, these two particular short-term emotions can lead us towards the aforementioned "status-quo bias," which could prevent us from making a potentially valuable trade or investment (Heath and Heath, 2013, pp. 164-165). This necessitates pulling back and working to achieve greater objectivity when faced with a difficult choice; possibly looking at it from the perspective of another person, which could be accomplished by asking the question, "What would I tell my best friend to do in this situation?" (Heath and Heath, 2013, p. 172). The reason that this specific type of question is particularly valuable is because "when we're giving advice, we find it easier to focus on the most important factors": i.e., "When we think of friends, we see the forest. When we think of ourselves, we get stuck in the trees" (Heath and Heath, 2013, pp. 171-172). Along this track, another useful line of decision support questions is the 10/10/10 framework developed by business writer Suzy Welch: "How will we feel about it 10 minutes from now? How about 10 months from now? How about 10 years from now?" (Heath and Heath, 2013, p. 160). Indeed, these types of questions are very constructive and helpful in allowing us to step back and avoid "mere exposure," "loss aversion," and "status-quo bias"; however, there is one other tool that we should employ in order to "attain distance before deciding" (Heath and Heath, 2013, p. 174).
This last sub-step under "Attain Distance Before Deciding" is to "Honor Your Core Priorities," which enables a focus on your "long-term emotional values, goals, and aspirations" (Heath and Heath, 2013, p. 192). This comes down to identifying a set of principles to govern your decision making processes and "honor the emotions that count" (Heath and Heath, 2013, p. 192). As with some of the other sub-frameworks, questions can also be very valuable in this one as well: i.e., In the medical field having the core of every decision focused on, "What's best for the patient here?" (Heath and Heath, 2013, p. 183). In the equity investing arena it could also involve defining the key factors that underpin all of your stock selections: i.e., Hedge Fund manager Joel Greenblatt's Magic Formula, which focuses on 1) Return on Capital (EBIT / (Net Working Capital + Net Fixed Assets)) and 2) Earnings Yield (EBIT / Enterprise Value) (Greenblatt, 2010, pp. 166-172). This focus on the core is very powerful in guiding you and your team to prioritize choices and decisions appropriately, which also enables you to save valuable time by not lingering on minor priorities.

Yet, there is one final step in the WRAP Process that is critically important in order to operate effectively inside of the world of financial markets: "Prepare to Be Wrong" (Heath and Heath, 2013, p. 193). This fourth and final step of the WRAP Process inoculates us against our tendency to believe that there is one definitive right answer: "The future is not a 'point' – a single scenario that we must predict. It is a range. We should bookend the future, considering a range of outcomes from very bad to very good" (Heath and Heath, 2013, p. 217). This leads to the first sub-step under "Prepare to Be Wrong": "Bookend the Future" (Heath and Heath, 2013, p. 194). This "bookending" principle is particularly valuable in investing and can help give you a more realistic, and thus potentially more accurate, range for how your positions might turn out in the future (Heath and Heath, 2013, p. 196). The Heath's cite investment banker Byron Penstock's "bookending" strategy in particular. (Heath and Heath, 2013, p. 196). Penstock estimates

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69 Along these lines another great question proposed by productivity guru Peter Bregman is to ask yourself, or your team, "Am I [Are we] doing what I [we] most need to be doing right now?" (Heath and Heath, 2013, p. 190).
70 On a slightly simpler level Greenblatt's formula can also be broken down into focusing on equities with a high ROA and low P/E Ratio as a first filter (Greenblatt, 2010).
“two different scenarios: a dire scenario (the lower bookend), where things go badly for a company, and a rosy scenario (the upper bookend), where the company gets a lot of breaks” (Heath and Heath, 2013, p. 196). It’s important to note that these "bookends" are not the most maximum possible results; they are instead "just very negative and very positive outcomes with real-world assumptions," which are based on Penstock’s granular evaluations of the company’s potential performance in the current environment (Heath and Heath, 2013, p. 196). Penstock calls his strategy "low-IQ investing" and explains that he thinks it’s more realistic and accurate than attempting to compute a "precise target stock price" (Heath and Heath, 2013, pp. 198-199).

It’s my job as an investor to think about the future, but the future is uncertain, so my investments can’t hinge on knowing the future. I look for situations where the bookends suggest that I can invest wisely without knowing exactly what the future holds. (Heath and Heath, 2013, p. 199)

Chip and Dan Heath argue that Penstock’s "Humility about his predictive abilities is [...] what enables him to make] a good decision" (Heath and Heath, 2013, p. 199).

Interestingly, Penstock’s technique is strongly backed up by research from Duke and Chicago social psychologists Jack Soll and Joshua Klayman who determined that "people's estimates grew much more accurate when they were asked to explicitly consider the high and low ends of the range" (Heath and Heath, 2013, p. 200; Soll and Klayman, 2004). Much of the reasoning behind this is because "When we think about the extremes, we stretch our sense of what's possible, and that expanded range better reflects reality" (Heath and Heath, 2013, p. 200). This focus on the future and potential outcomes as a range mitigates our propensity for overconfidence and works to manage our egos; yet, it's also important to conduct a "premortem"71 for the lower bound and a "preparade" for the upper bound in order to ready us for what might happen if we reach the extremes of our prediction model (Heath and Heath, 2013, pp. 202-208). Ironically, these types of extremized thought experiments not only teach us how to respond to the

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71 The concept of a "premortem" was proposed by social psychologist Gary Klein and it focuses on envisioning "the future 'death' of a project and asks, 'What killed it?'" (Heath and Heath, 2013, pp. 202-203). This is an incredibly valuable technique that can be utilized to forecast and prepare for potential negative outcomes.
limits of our range if we hit them, but in the case of the "premortem" it also allow us to plot "ways to avoid ending up there" in the first place (Heath and Heath, 2013, p. 202-208). In addition, once we have conducted this thought experiment, we add value by utilizing a "safety factor" or "buffer factor" in order to prepare, just in case the outcomes end up occurring outside of our presupposed range limits, which can also serve as a tripwire (Heath and Heath, 2013, pp. 208-209).

"Set a Tripwire" is the second sub-step of "Prepare to Be Wrong," and it focuses on making us "realize that we have a choice" and pulling us out of our complacency (Heath and Heath, 2013, p. 238). It can be especially valuable in overcoming the "sunk cost fallacy" where we often chase good money after bad, or demonstrate the tendency to sell winning stocks too early and hold on to loosing stocks for too long (Kahneman, 2011; Heath and Heath, 2013; Hammond, Keeney, and Raiffa, 2003). A great example of this would be buying a stock in a firm like Citigroup while the GFC is unfolding and holding it for years afterwards, potentially also adding to the investment, with the hope that it will generate a significant return because it is undervalued. However, in essence you are locking up capital at a loss when you could simply cut your gains and invest in another more profitable equity in a different sector. By emplacing a specific loss amount or percentage loss as a point to divest the asset you can save yourself from doubling down on poor investment decisions. Chip and Dan Heath additionally argue that "Tripwires can actually create a safe space for risk taking" since "They: 1) cap risk; and 2) quiet your mind until the trigger is hit" (Heath and Heath, 2013, p. 238). At the core "tripwires" provide exceptional value because they let you know that there is a decision to be made and that "I have a choice" (Heath and Heath, 2013, p. 237).

The third and final sub-step under "Prepare to Be Wrong" is to focus on "Trusting the Process" (Heath and Heath, 2013 p. 239). Indeed, as mentioned at the beginning of this section the process is the most important thing in any decision making model, and it is critical to follow it in order to make your best possible decisions as the Heath brothers share.

"Process isn't glamorous. But the confidence it can provide is precious. Trusting a process can permit us to take bigger risks, to make bolder choices. Studies of the elderly
show that people regret not what they *did* but what they *didn't do.* (Heath and Heath, 2013, p. 253)

Yet, when building out the process for a team-based decision model, it's important to ensure that all stakeholders are involved in the "bargaining" stage so that everyone comes to agreement on its design and its overall fairness (Heath and Heath, 2013, p. 240). This aligns with a "procedural justice" based approach, where "the procedures used to make a decision were [are] just" (Heath and Heath, 2013, p. 243).

Interestingly, the importance of this type of framework has become even more strongly supported recently by research from legal proceedings showing that "Losers who perceive procedural justice are almost as happy as winners who don't" (Heath and Heath, 2013, p. 253). Therefore, "It's not just the outcome that matters; it's the process" as well (Heath and Heath, 2013, p. 243). Indeed, a strong and well-designed process not only helps you make better decisions, it also develops more trusting and collaborative teams that can withstand significant challenges.

"Superforecasters"

Before delving deeper into the development of teams, I think it's important to look further into how best to make individual predictions and forecasts by looking at the "The Good Judgment Project" and "superforecasting" work of University of Pennsylvania and UC Berkeley social psychologists Phil Tetlock, Barbara Mellers, and Don Moore. Their work in identifying "superforecasters" was spawned by "The Good Judgment Project," which was a geopolitical forecasting tournament sponsored by the CIA's Intelligence Advanced Research Projects Activity (IARPA) Aggregative Contingent Estimation (ACE) tournament in 2011 (Mellers et al., 2015; "The Good Judgment Project," 2018). The tournament consisted of five research groups from various universities throughout the country with the goal of attempting to determine the most accurate probabilistic predictions of specific idiosyncratic events over the course of a two-year period—later extended out to four years (Mellers et al., 2014; "Good Judgment: From Theory to Practice," 2018). The general format involved recruiting forecasters, gaining their predictions, and then aggregating their results in an effort to forecast the occurrence of finite outcomes using the Brier Score to assess accuracy.
(Tetlock and Gardner, 2015; Mellers et al., 2014). Over the course of the tournament "The Good Judgment Project," led by Barbara Mellers, Philip Tetlock, and Don Moore of The University of Pennsylvania and The University of California Berkeley ("IARPA: The Good Judgment Project," 2018), emerged as the clear winner with IARPA Program Manager Steven Rieber stating that "Team Good Judgment ... beat the control group by more than 50%. This is the largest improvement in judgmental forecasting accuracy observed in the literature" ("Good Judgment: From Theory to Practice," 2018). In fact the predictions of the superforecasters identified by Tetlock and his team were "reportedly 30 percent better than intelligence officers with access to actual classified information" ("So You Think You're Smarter Than A CIA Agent," 2014, NPR – Online edition). To accomplish this Mellers, Tetlock, and Moore utilized an empirical approach based on three key concepts: 1) Training, 2) Teaming, and 3) Tracking (Mellers et al., 2014).

Yet, before going into the team development aspect of forecasting it's important to understand what makes individual forecasters successful and what is so special about "superforecasters," and to conceptualize how the techniques that they employed in the geopolitical forecasting tournament can be applied by analysts in the investing space. In their 2015 book, *Superforecasting: The Art and Science of Prediction*, Philip Tetlock and Dan Gardner do an excellent job of summarizing the traits and qualities of superforecasters, and maybe just as importantly they point out that ordinary people can train themselves to enhance or even acquire these characteristics to improve their day-to-day decision making (Tetlock and Gardner, 2015). One of the things that they reveal is the criticality of employing an empirically sound process such as those incorporated by meteorologists, central bankers, and marketers: "Forecast, measure, revise. Repeat" (Tetlock and Gardner, 2015, p. 15). This style of thinking and analysis is exemplified in the work of meteorologist, Edward Lorenz (Tetlock and Gardner, 2015, pp. 8-10), whose research inspired

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72 For our purposes in this section, I focus on sharing high-level explanations of the traits and qualities that "superforecasters" possess based on the geopolitical forecasting research of Mellers, Moore, and Tetlock, in order to illustrate the understanding that all of these characteristics are, learnable and, readily applicable within the investment ecosystem.

73 Lorenz wrote a famous piece in 1972 called, "Predictability: Does the Flap of a Butterfly's Wings in Brazil Set Off a Tornado in Texas?" (Tetlock and Gardner, 2015, p. 8). This work gave rise to the phrase the "butterfly effect," and
"chaos theory" by demonstrating the limits of predictability and Dr. Archie Cochrane\textsuperscript{74} (Tetlock and Gardner, 2015, p. 66), who helped introduce evidence-based medicine into the field of healthcare with a focus on determining the actual effectiveness of techniques and treatments (Tetlock and Gardner, 2015, pp. 30-33). Drawing from his 2005 book, *Expert Political Judgment: How Good Is It? How Can We Know?*, Tetlock explains that "The critical factor [in differentiating the forecasting success of one group over another] was how they thought" (Tetlock and Gardner, 2005, p. 68).

He subsequently utilizes the analogy composed by Isaiah Berlin – drawn from Archilochus – of the fox and the hedgehog: "The fox knows many things but the hedgehog knows one big thing" (Tetlock and Gardner, 2005, p. 69). Tetlock likes to equate "superforecasters" to foxes, in that foxes have a diverse skillset and lots of different tools in their kitbag to help them solve problems (Tetlock, 2005; Tetlock and Gardner, 2015; Mellers et al., 2015). He illustrates this concept by citing the famous example of financial commentator, Larry Kudlow – a hedgehog – who in December 2007 stated that "There was no recession," despite the fact that one of the biggest recessions in U.S. history was unfolding right before his eyes; yet, he couldn't see it or didn't want to see it (Tetlock and Gardner, 2015, p. 70). This leads to another interesting concept, which is the "inverse correlation between fame and accuracy: the more famous an expert was, the less accurate he was" (Tetlock and Gardner, 2015, p. 72). In contrast to the hedgehogs, the foxes "deploy not one analytical idea but many and seek out information not from one source but many. Then they synthesize it all into a single conclusion. In a word, they aggregate" (Tetlock and Gardner, 2015, p. 74). Tetlock explains that the reason that foxes don’t do as well in the public eye is largely related to their successful forecasting process: "They're less confident, less likely to say something is 'certain' or

\textsuperscript{74} After witnessing what he called "the God complex" (Tetlock and Gardner, 2015, p. 31) among many physicians in Britain during the 1950's and 1960's, Archie Cochrane worked tirelessly to develop evidence-based medicine focused on "scientific validation" (Tetlock and Gardner, 2015, p. 30) with a clear mantra: "don't believe until you test" (Tetlock and Gardner, 2015, p. 86).
'impossible,' and are likelier to settle on shades of 'maybe.' And their stories are complex, full of 'howevers' and 'on the other hands,' because they look at problems one way, then another, and another" (Tetlock and Gardner, 2005, p. 72). He adds to this, describing the ability of "superforecasters" not only to act as foxes, but also to see the world through a "dragonfly eye" analyzing and aggregating multiple different perspectives at the same time (Tetlock and Gardner, 2005, p. 77). Indeed, this mode of thinking is similar to the style that Andrew Lo identified among investors who are able to continuously beat the market, and is indicative of both their brainpower and their humility (Lo, 2017; Tetlock and Gardner, 2015).

In terms of intellect "superforecasters" demonstrated higher levels of fluid (logic) and crystalized (skill employment) intelligence (Mellers et al., 2014; Mellers et al. 2015); however, maybe just as critical they possessed what Tetlock's colleague Jonathan Baron called "active open-mindedness" (Tetlock and Gardner, 2015, p. 126; Mellers et al., 2015), meaning that they have a "tendency to evaluate arguments and evidence without undue bias from one's own prior beliefs – and with recognition of the fallibility of one's judgment ... They avoid the 'myside bias' – the tendency to bolster one's own views and dismiss contradictory evidence" (Mellers et al., 2015, p. 3). Mellers and her colleagues summed up their profile of "superforecasters" in their 2015 paper in the Journal of Experimental Psychology, "The Psychology of Intelligence Analysis: Drivers of Prediction Accuracy in World Politics" (Mellers et al., 2015).

... they were better at inductive reasoning, pattern detection, cognitive flexibility, and open-mindedness. They had greater understanding of geopolitics, training in probabilistic reasoning, and opportunities to succeed in cognitively enriched team environments. Last but not least, they viewed forecasting as a skill that required deliberate practice, sustained effort, and constant monitoring of current affairs. (Mellers et al., 2015, p. 1)

These types of individuals routinely engaged in an aggregation of many different perspectives (Tetlock and Gardner, 2015, pp. 72-74). In terms of the "Big Five Personality Traits" – 1) Agreeableness, 2) Conscientiousness, 3) Openness to experience, 4) Extroversion, and 5) Neuroticism (Larrick – "Expertise and Individual Differences in Decision Making," 2018) – they seemed to show a propensity for "openness to experience" (Tetlock and Gardner, 2015, p. 125), which lends itself towards being a constant learner with
what Carol Dweck refers to as a "growth mindset" – "believing that your abilities are largely the product of effort – that you can 'grow' to the extent that you are willing to work hard and learn" (Tetlock and Gardner, 2018, p. 174). Building on this they also tended to concentrate on the "how" questions which "focus on causation and probabilities" rather than the "why" questions which relate more to "metaphysics" (Tetlock and Gardner, 2015, pp. 148-150). Indeed, this probabilistic viewpoint was a critical attribute that enabled them to successfully employ Daniel Kahneman's "outside view," and as would be expected "the more a forecaster embraced probabilistic thinking, the more accurate she was" (Tetlock and Gardner, 2015, pp. 151-152). Additionally, Barbara Mellers has "shown that granularity predicts accuracy" in probabilistic forecasting: i.e. utilizing ones (e.g., 42%, 43%) generates meaningfully more accurate forecasts than using tens (e.g., 60%, 70%) (Tetlock and Gardner, 2015, p. 145).

However, as Tetlock explains it's not just a specific trait that sets "superforecasters" apart, it's more of a mode of thinking that "beliefs are hypotheses to be tested, not treasures to be guarded" (Tetlock and Gardner, 2015, p. 127). And because of this they tend to "update much more frequently, on average, than regular forecasters" (Tetlock and Gardner, 2015, p. 154) and "they [also] update in smaller increments"75 (Tetlock and Gardner, 2015, p. 169). This style of thinking can be thought of more succinctly by the superforecasters' use of the core insight of "Bayes Theorem"76: A focus on "gradually getting closer to the truth by constantly updating in proportion to the weight of the evidence"77 (Tetlock and Gardner, 2015, p. 171). However, even with this highly effective mindset, they need to be allowed the opportunity to develop and improve in what Robin Hogarth called a "kind" feedback environment (mentioned earlier in Chapter One and Chapter Four), where they can receive "clear, immediate feedback, which allows effective

75 Tetlock explains that "the forecaster who carefully balances the old and the new captures the value in both – and puts it into her new forecast. The best way to do that is by updating often but bit by bit" (Tetlock and Gardner, 2015, p. 169).
76 Phil Tetlock summarizes "Bayes Theorem" qualitatively by explaining that "the theorem says that your new belief should depend on two things – your prior belief (and all the knowledge that informed it) multiplied by the 'diagnostic value' of the new information" (Tetlock and Gardner, 2015, p. 170).
77 This was well illustrated by the earlier example of "superforecaster" Jay Ulfelder successfully predicting the confirmation of Chuck Hagel for SECDEF by continuously updating and reweighting his base-rate probabilities as he was presented with new evidence (Tetlock and Gardner, 2015, pp. 170-171).
learning (Keren and Wu [Larrick and Feiler], 2015, p. 703; Hogarth, Lejarrage and Soyer, 2015; Hogarth and Soyer, 2011). In illustrating this intersection of mindset with training and environment in their cultivation of superforecasters, Mellers and her colleagues cite observations by Daniel Kahneman and Gary Klein:

Kahneman and Klein argued that for any type of skill to develop, two conditions must be present: (a) an environment with sufficient deterministic stability to permit learning, and (b) opportunities for practice. Skill development occurs to the extent that people care enough to engage in deliberative rehearsal. Our forecasters received constant feedback in the form of Brier scores and leaderboard rankings. They had many chances to learn; there were 199 questions over a period of 2 years, and, on average forecasters made predictions for 121 of them. These conditions enabled a process of learning-by-doing and help to explain why some forecasters achieved far-better-than-chance accuracy. (Mellers et al., 2015, p. 12)

In terms of improving prediction performance, a focus on combining a growth mindset with thoughtful criticism and experience is invaluable (Tetlock and Gardner, 2015). It's also highly beneficial to enable the opportunity to learn from mistakes, with immediate and clear feedback as mentioned above, since it allows us to know that we failed, understand why, and learn from it (Tetlock and Gardner, 2015, p. 181).

These insights on learning are additionally supported by one of the 20th century's greatest economists, John Maynard Keynes (Tetlock and Gardner, 2015). Keynes' mindset was that "failure was an opportunity to learn – to identify mistakes, spot new alternatives, and try again" (Tetlock and Gardner, 2015, p. 177). Keynes always believed that growth was possible and employed a process of continuous improvement similar to that of superforecasters: "Try, fail, analyze, adjust, and try again" (Tetlock and Gardner, 2015, p. 178). Superforecasters typically employ this strategy successfully, but they also have a

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78 Tetlock also points out that "research shows that judgement calibrated in one context transfers poorly, if at all, to another" (Tetlock and Gardner, 2015, p. 185). Therefore, "To get better at a certain type of forecasting, that is the type of forecasting you must do – over and over again with good feedback telling you how your training is going, and a cheerful willingness to say, 'Wow, I got that one wrong. I'd better think about why'" (Tetlock and Gardner, 2015, p. 185).

79 Duke economist Edward Tower likens this to Steven Landsberg's assertion that "one of the best things that can happen to you is to lose an argument, because when you lose an argument, that's when you've learned something" (Conan [Interviewing Steven Landsberg] NPR, 2009; Landsberg, 2009).

80 This technique employed by Keynes and the "superforecasters" bears strong resemblance to Archie Cochrane's guidance to the medical community: "Quit pretending you know things you don't and start running experiments" (Tetlock and Gardner, 2015, p. 89).
propensity to break down questions into more granular and digestible parts in the style of physicist, Enrico Fermi: "What Fermi understood is that by breaking down the question, we can better separate the knowable and the unknowable" (Tetlock and Gardner, 2015, pp. 110-111).

By taking this approach and asking good questions while continuously updating highly granular predictions, superforecasters are able to achieve superior results with consistent improvements (Tetlock and Gardner, 2015). In summing up the composite portrait of a model "superforecaster" Tetlock offers the following illustration: (Tetlock and Gardner, 2015, pp. 191-192)

**Philosophical Outlook**
1) **Cautious**: Nothing is certain
2) **Humble**: Reality is infinitely complex
3) **Nondeterministic**: What happens is not meant to be and does not have to happen

**Abilities and Thinking Styles**
1) **Actively Open-Minded**: Beliefs are hypotheses to be tested, not treasures to be protected
2) **Intelligent and Knowledgeable, with a "Need for Cognition"**: Intellectually curious, enjoy puzzles and mental challenges
3) **Reflective**: Introspective and self-critical
4) **Numerate**: Comfortable with numbers

**Methods of forecasting**
1) **Pragmatic**: Not wedded to any idea or agenda
2) **Analytical**: Capable of stepping back from the tip-of-your-nose perspective and considering other views
3) **Dragonfly-eyed**: Value diverse views and synthesize them into their own
4) **Probabilistic**: Judge using many grades of maybe
5) **Thoughtful Updaters**: When facts change, they change their minds
6) **Good Intuitive Psychologists**: Aware of the value of checking thinking for cognitive and emotional biases

**Work Ethic**
1) **A Growth Mindset**: Believe it's possible to get better
2) **Grit**: Determined to keep at it however long it takes (Tetlock and Gardner, 2015, pp. 191-192)

These traits, characteristics, and processes are also supplemented by a desire to continuously improve and a feeling that they are never done (Tetlock and Gardner, 2015). Borrowing a term from computer
programming, Tetlock states that "superforecasters are in 'perpetual beta,'" meaning that they are "a program that is not intended to be released in a final version but will instead be used, analyzed, and improved without end" (Tetlock and Gardner, 2015, p. 190). Indeed, this propensity for "perpetual beta" seems to again fall in line with the consistently adaptive strategies of investors like James Simons, D.E. Shaw, David Swensen, and Peter Lynch, who Andrew Lo has identified as truly capable of beating the market (Lo, 2015; "Lessons from the endowment model," 2020). Yet, reliably outperforming your benchmark is not just an individual effort: it also requires developing sound processes and, more importantly, building effective and collaborative teams who can execute those processes.

**Team Development and Strategic Execution**

In terms of team development, one of the most important places to start is by determining who you should bring onboard your team. Indeed, in his seminal 2001 book *Good To Great* business strategist Jim Collins dedicates a whole chapter to "First Who ... Then What," meaning that it's best to first hire the correct people on your team before determining what your strategy is and where you're going (Collins, 2001, p. 41). To explain this concept in a memorable way Collins uses the analogy of a bus.

> If we get the right people on the bus, the right people in the right seats, and the wrong people off the bus, then we'll figure out how to take it to someplace great. (Collins, 2001, p. 41).

Embedded in this point, though not explicitly stated, is the fact that it's critical to hire the right people rather than the best people. Collins goes on to state that "people are not your most important asset. The right people are" (Collins, 2001, p. 51). This essentially means finding the people who have the right skillset, are a good culture fit, and are passionate about the work that you're doing in order to guarantee that they'll make a strong contribution. In terms of determining how to find these "right people" there are a number of different techniques that can be utilized.

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81 The "beta" that Tetlock cites here is a term from the programming world referring to draft software that is essentially complete but just needs to be checked for bugs and glitches; as opposed to "beta" in the investing world, which indicates the amount of risk that a fund manager is taking relative to the market.
One methodology advocated by retired Army General Stanley McChrystal at his consulting company, McChrystal Group, is to put junior-level hires through an internship program to evaluate their skills and fit prior to extending an offer; while with senior-level hires he only onboards applicants who he and his executive team know personally, whose performance and competencies they have seen first-hand (McChrystal et al., 2015). This technique that McChrystal utilizes for high-level hires is very effective and may be of use for smaller and more selective investment teams; however, for larger entities it may be better to assign a contract project to see how the individual performs or to bring people in on a conditional basis to test them out in a similar manner to McChrystal's junior-level hiring process (McChrystal et al., 2015, Heath and Heath, 2013). It's advisable to take your time to make certain that you don't inadvertently hire the wrong person (Collins, 2001), but if you need to build out your team quickly it's worthwhile to employ the techniques advocated for by Robyn Dawes, Richard Nisbett, and the Heath brothers: i.e., evaluate GPA, peer evals, or technical skill project assessments (e.g., ANOVA and econometric modeling of a real-world big data problem) (Heath and Heath, 2013, pp. 149-151). These strategies are all much more effective than behavioral interviewing and will give you a higher probability of bringing a strong teammate onboard. Yet, once you add an additional team member, you must also focus on indoctrinating her into your culture.

Indeed, culture is another exceptionally important aspect to be cognizant of when building your team. In their 2003 California Management Review article "Leading by Leveraging Culture," organizational behavioral professors Jennifer Chatman and Sandra Cha define culture as "a system of shared values (defining what is important) and norms (defining appropriate attitudes and behaviors)" (Chatman and Cha, 2003, p. 21). Cha and Chatman additionally argue that "by actively managing culture, an organization will be more likely to deliver on its strategic objectives over the long run"82 (Chatman and Cha, 2003, p. 20). To

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82 Chatman and Cha promote the utilization of three tools to "Manage and Change Organizational Culture": 1) Recruiting and Selecting People for Culture Fit; 2) Managing Culture through Socialization and Training; and 3) Managing Culture through the Reward System (Chatman and Cha, 2003, pp. 26-31).
give an idea of the value of culture, University of Virginia Darden business school professor Ming-Jer Chen likes to cite former IBM CEO Lou Gerstner's perspective when analyzing strategy: “I [Gerstner] came to see, in my time at IBM that culture isn’t just one aspect of the game – it is the game. In the end, an organization is nothing more than the collective capacity of its people to create value.” (Chen, Inside Chinese Business: A Strategic-Cultural Perspective, 2014). To further elaborate on the importance of culture, Ming-Jer has developed the "Culture-Strategy-Execution Trio" to share an analogy of how to understand its place in team development and strategy execution (Chen, Inside Chinese Business: A Strategic-Cultural Perspective, 2014; Chen, Chan, and Tucker, 2019).

**Culture-Strategy-Execution Trio – Ming-Jer Chen**

1) Culture is the Heart, the Value, and focused on the Long-Term
2) Strategy is the Brain, the Method, and focused on the Short-Term
3) Execution is the Hand, the Practice, and focused on the Even Shorter Term (Chen, Inside Chinese Business: A Strategic-Cultural Perspective, 2014).

Professor Chen’s framework is valuable in giving us a way to think about culture in a practical sense, and leads into Cha and Chatman's assertions that "Strong cultures are based on ... high levels of agreement among employees about what's valued and high levels of intensity about these values" and that "Culture 'works' when it is clear, consistent, and comprehensive"83 (Chatman and Cha, 2003, p. 32).

They additionally argue that strong cultures "improve performance by energizing employees" and "by shaping and coordinating employees' behavior" (Chatman and Cha, 2003, pp. 23-24). However, in some cases culture can inadvertently develop into "warring factions" which are "characterized by high levels of intensity but low levels of agreement" or "vacuous cultures" where "members agree about what's important, but they don't much care and ... are unwilling to go the extra mile" (Chatman and Cha, 2003, pp. 23-24). These two types of culture are incredibly unproductive and often result in failures to properly

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83 Chatman and Cha also argue that leaders should be cognizant of two specific potential "pitfalls" if employees perceive that they are not "walking the talk": 1) "Hypocrisy attribution dynamic" – "When we detect potential inconsistencies between stated values and observed actions our cognitive tendency to judge others harshly kicks in." 2) "Actor observer bias" – "The human tendency to explain one’s own behavior generously and to explain other’s behavior unsympathetically" (Chatman and Cha, 2003, p. 29).
execute strategic objectives; interestingly though, they are exactly the opposite of the norms that developed among the "superforecasting" teams (Chatman and Cha, 2003, p. 24; Tetlock and Gardner, 2015). Specifically, the teams of "superforecasters" worked to achieve "constructive confrontation" by always attempting to "disagree without being disagreeable" (Tetlock and Gardner, 2015, p. 199). The reason that this is so important is because a failure to challenge incorrect assumptions can lead to poor forecasts and poor decisions; however, an excessively confrontational team or an overly dominant leader might equally prevent people with valuable information from speaking up. This is best summed up by Duke social psychology professor Richard Larrick.

If teams share the same experience, information, and biases it can degrade the accuracy of their forecasts. Additionally, there is a danger that people who interact together often tend to think alike, which necessitates a focus on ensuring that people are inaccurate in different ways when forming a team. Discussion and dissent can be valuable tools to combat groupthink and the risk of inaccurate redundancy – where everyone agrees but they’re all wrong, so they perform badly in a confident manner. Conversely, dissent is great if the team has the wrong answer, but if they’re right it could lead them away from the correct answer; that said, if dissent creates more confidence it can be a valuable tradeoff. Typically, the more that teams disagree, the better that they do. (Larrick and Soll – "Group Decision Making and the Wisdom of Crowds," 2018)

This very much echoes the findings of Tetlock and his colleagues who argue that "If forecasters can keep questioning themselves and their teammates, and welcome vigorous debate, the group can become more than the sum of its parts" (Tetlock and Gardner, 2015, p. 198). This emphasis on diversity of thought is very valuable and can meaningfully improve prediction accuracy; however, it's also important to take into account how highly intelligent traders and investment professionals might influence organizational dynamics.

This last significant cultural consideration for leaders in the investment arena is the fact that their analysts and team members, like "superforecasters," will probably be highly intelligent and clever people, which necessitates a slightly modified management style as advocated for by London Business School professors Rob Goffee and Gareth Jones. In their 2007, Harvard Business Review article, "Leading Clever
People," Goffee and Jones acknowledge that in certain arenas leaders may be required to manage direct reports who are substantially smarter than them or potentially more skilled in a particular domain (Goffee and Jones, 2007). In order to leverage the value of your "clever people" while preventing them from leaving or damaging your culture they share five principles, which will enable you to make the most of their talents: 1) Reduce administrative distractions, 2) Maintain diversity of ideas, 3) Make it safe to fail, 4) Let clever people pursue private efforts, and 5) Demonstrate you’re an expert in your own right (Goffee and Jones, 2007, p. 1). These techniques are very valuable and can make the most of your talented crew members while at the same time leveraging your culture. Once you have optimized your culture the next important step in building out your organization is strategy development.

In their 2001 Academy of Management Executive piece, "Are you sure you have a strategy?," Columbia business school professors Donald Hambrick and James Fredrickson share a clear definition of strategy: A strategy is "a central, integrated, externally oriented concept of how the business will achieve its objective" (Hambrick and Fredrickson, 2001, p. 49). They also explain that one of the dangers involved with strategy development is simply using the term too frequently: "When executives call everything strategy, and end up with a collection of strategies, they create confusion and undermine their own credibility" (Hambrick and Fredrickson, 2001, p. 49). This then leads to the question, "What is a "Good" strategy?" To answer this, it's best to turn to University of Virginia Darden business school professor

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Goffee and Jones additionally share "Seven Things You Need to Know About Clever People": 1) They know their worth, 2) They are organizationally savvy, 3) They ignore corporate hierarchy, 4) They expect instant access, 5) They are well connected, 6) They have a low boredom threshold, and 7) They won't thank you" (Goffee and Jones, 2007, p. 4).

University of Virginia Darden business school professor, Lynn Isabella, strongly backs the need to allow your employees to make mistakes because they are one of the best ways to facilitate learning; however, at this same time she cautions that it’s also very important to prevent them from making the big mistakes that might cause real harm to your team or organization (Isabella, 2014). To explain her philosophy on mistakes in more detail Isabella shares the analogy of a ship, stating that you can allow hits to the sail, the deck, and even the bow, but you can't allow hits below the water-line that might sink the boat (Isabella, 2014).

Hambrick and Fredrickson also explain that the word strategy "is derived from the Greek strategos, or 'the art of the general' (Hambrick and Fredrickson, 2001, p. 49). They share that "The general's challenge ... is in orchestration and comprehensiveness. Great generals think about the whole," and they further argue that "business generals" (e.g., CEO's and managing directors) must adhere to similar principles when developing their organization's strategy (Hambrick and Fredrickson, 2001, p. 49).
Sankaran Venkataraman who shares that "A strategy is a set of decisions and choices, and having a strategy is when your decisions and choices align with your missions and goals" (Venkataraman, Wilcox, and Freeland, 2015). Venkat goes on to explain what constitutes a "good" strategy.

"Good" Strategy:
1. Walk equals talk
2. Different choices, activities, and values support each other. It’s internally consistent and aligned, and it’s simple and shared
3. “Focused” – attuned to internal and external signals
4. Something at which you can be the best at
5. Potentially creates meaningful “Value”

He also shares that "Mission and Goals are just a strategy of what you want to achieve. A strategy is how you are going to achieve it" (Venkataraman, Wilcox, and Freeland, 2015). Professor Venkataraman further affirms that the "strategy is the thing that you return to when you make a decision" and even though "you can't win at everything, you can still win at some things" (Venkataraman, Wilcox, and Freeland, 2015). Your strategy is ultimately what enables you to leverage your people, your culture, and your capabilities to get you where you want to go. Yet, there is one last step in your organizational development that you must master as well: execution and process application.

In terms of bridging the gap between strategy and execution, University of Virginia strategy professor Ming-Jer Chen recommends that we should focus on becoming "strategic thinkers and disciplined executors" (Chen, Thinking Strategically, 2014). The disciplined execution that Ming-Jer advocates for is particularly important given the increasing complexity of the digital age, and it’s echoed in the team development guidance of retired Army General Stanley McChrystal. McChrystal was the commanding general of Joint Special Operations Command (JSOC) from 2003-2008 where he led the most elite special operators in the world (McChrystal et al., 2015). At the beginning of his command his organization was operating at an incredibly rapid pace taking out key Al Qaeda and Taliban targets; however, no matter how quickly they worked they couldn't execute fast enough and there were always more missions then they had time to accomplish (McChrystal et al., 2015). They were doing good work, but they simply couldn't keep up
with the scale; this led McChrystal and his leadership team to conduct an in depth analysis of the entirety of their operations (McChrystal et al., 2015). What they determined was that the enemy threat that they were facing – counter-insurgency – and the dynamics associated with it made their mission not just "complicated," but "complex" (McChrystal et al., 2015, p. 74). As opposed to "complicated" problems, which are difficult, but at least in theory solvable, "Complex systems [and complex problems] are fickle and volatile, presenting a broad range of possible outcomes, [with] the type and sheer number of interactions preventing us from making accurate predictions" (McChrystal et al., 2015, p. 67). This ultimately led them to develop a framework involving "trust, common purpose, shared consciousness, and empowered execution" to streamline their operations and get ahead of the complex counterinsurgency that they faced – with a heavy focus on the last two principles (McChrystal et al., 2015, p. 7). It was the development of "shared consciousness" and "empowered execution" that ultimately delivered McChrystal and his team the organizational structure and cohesive culture that they needed in order to succeed in this hyper complex operating environment (McChrystal et al., 2015, p. 7).

While there were a lot of adjustments that JSOC made during this time period, they can essentially be summarized as a "systems management" approach focused on extensive cooperation and information sharing along with a decentralization of decision making to improve responsiveness and speed of execution (McChrystal et al., 2015). McChrystal and his leadership team painstakingly selected individuals for the right positions in a manner similar to Jim Collins putting people in the "right seats" and they ceaselessly worked to break down barriers and walls inside of their organization to make it more flat (McChrystal et al., 2015, Collins, 2001, p. 41). They also worked to build networks and partnerships with entities outside of JSOC – e.g., CIA, FBI, DIA, NSA – in order to enhance information sharing and speed up the delivery of actionable intelligence to their teams and while also disclosing sensitive site exploitation information back with those same partners to help build strong relationships (McChrystal et al., 2015). Additionally, McChrystal had a two-hour meeting each day with every member of JSOC in order to share information, develop cohesion, enhance cooperation, and build common purpose (McChrystal et al., 2015). All of these...
process actions afforded him and his leadership team the ability to decentralize decision making and facilitate rapid cooperation and coordination, which dramatically improved their outcomes (McChyrstal et al., 2015). The success of their organizational redesign was remarkable and led to the elimination or capture of many senior Al Qaeda and Taliban leadership targets, including the head of Al Qaeda in Iraq Abu Musab al-Zarqawi (McChyrstal et al., 2015). Interestingly though, one of the main inspirations for McChrystal's organizational redesign was the National Aeronautics and Space Association (NASA) Apollo project (McChyrstal et al., 2015).

NASA's Apollo team is generally considered to be one of the greatest teams ever assembled and their undertakings and achievements are widely regarded "as one of the greatest technological endeavors in the history of humankind" (McChyrstal et al., 2015, p. 145). There are obviously many key actors who led to the success of this project such as James Webb, Thomas Paine, Robert Seamans, Frederick Ordway, Hugh Dryden, Gene Kranz, and Wernher von Braun, among others; however, the individual most responsible for the conceptualization and development of the team was electrical engineer George Mueller (McChyrstal et al., 2015, p. 147; Epstein, 2019, p. 258). Mueller was brought in to develop the organizational structure and systems design of the Apollo program with a unique goal that "NASA director Wernher von Braun" called the creation of a "managerial 'nervous system'": "His [Mueller's] vision for NASA was that of a single interconnected mind – an emergent intelligence like the 'joint cognition' that defines extraordinary teams" (McChyrstal et al., 2015, p. 147). Among the most prolific systems engineering and organizational design initiatives that Mueller undertook was the creation of an immense "teleservices network" that facilitated the immediate sharing of information, and break down walls and barriers, among the Apollo engineering teams and field centers – it could be described as "the Internet before the Internet" (McChyrstal et al., 2015, p. 148). Many engineers initially pushed back against Mueller's initiatives, including von Braun himself; however, once they realized how much these organizational design changes improved problem solving and enhanced efficiencies they quickly came onboard (McChyrstal et al., 2015). Indeed, citing the
keys to Apollo's success Wernher von Braun stated that "The real mechanism that makes [NASA] 'tick,' is ... a continuous cross-feed between the right and left side of the house" (McChyrstal et al., 2015, p. 149).

NASA has a famous mantra that often functions as a lodestar for their processes and problem solving ("In God We Trust, All Others Bring Data"); however, in the Apollo program there was also a valuable informal information sharing ethos fostered by Mueller's system management programs, which was best exemplified by Wernher von Braun's "Monday Notes" (Epstein, 2019, p. 258). While leading the Marshall Space Flight Center during the Apollo program, von Braun initiated a process called "Monday Notes" where "every week engineers submitted a single page of notes on their salient issues" (Epstein, 2019, p. 258). Once he received notes from all of the teams "von Braun handwrote comments in the margins, and then circulated the entire compilation" (Epstein, 2019, p. 258). This enabled good situational awareness among all divisions while at the same time fostering a culture that allowed problems to be brought to the forefront to uncover solutions, rather than hide them away (Epstein, 2019, p. 258).

Separately, Apollo flight director Gene Kranz continuously sought out information and feedback outside of formal channels to make sure that he wasn't missing something: "[Kranz] made a habit of seeking out opinions of technicians and engineers at every level of the hierarchy. If he heard the same hunch twice, it didn't take data for him to interrupt the usual process and investigate" (Epstein, 2019, p. 258). This open, collaborative, and cooperative culture was one of the most critical keys to the Apollo Programs' success, and was effectively replicated by McChrystal in his reorganization of JSOC into an integrated and dynamic information sharing enterprise. All of these best practices regarding personnel selection, culture formulation, strategy development, and empowered execution are exceptionally valuable; however, in terms of putting them all together to create optimal teams of investors, traders, and forecasters there are

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87 You can see the parallels in Wernher von Braun's "Monday Notes" and Stanley McChrystal's daily meetings as a means of keeping the entire organization informed and focused on collectively solving problems and achieving their objectives.
really two major methodologies that are at the forefront today in modern academia: "Select Crowds" and "The Good Judgement Project."

"Select Crowds" vs "The Good Judgment Project"

At the present time there are two main methodologies that have been proven to deliver strong results in the forecasting and prediction world: "The Wisdom of Select Crowds" framework created by Al Mannes, Jack Soll, and Richard Larrick and "The Good Judgment Project" designed by Phil Tetlock, Barbara Mellers, and Don Moore (Mannes, Soll, and Larrick, 2014; Mellers et al., 2014). Both techniques involve building small teams of experts with offsetting strengths and weaknesses to make forecasts and predictions about specific domains, with the only major difference being that "The Good Judgment Project" researchers have their groups of experts communicate together and share information before making their individual decisions, while the "Select Crowds" researchers have each expert make their forecast independently of one another without conversing (Mannes, Soll, and Larrick, 2014; Mellers et al., 2014). Interestingly though, the outcomes for both strategies are equally robust, which seems to indicate that small groups of experts carefully assembled together can make reasonably accurate predictions over the short-term. While this gives a nice concise high-level summary of how both methodologies work, it's probably value-added to share a slightly more granular look at each of their techniques.

Starting with "The Good Judgment Project"88 of Mellers, Tetlock, and Moore, their main focus is on training, teaming, and tracking "superforecasters in order to achieve optimal prediction results in the geopolitical arena (Mellers et al., 2014). In terms of training, Mellers' team focused on scenario training and probabilistic-reasoning training to facilitate debiasing among their forecasters (Mellers et al., 2014, p. 1107). This enabled them to gain a greater understanding of how to employ techniques such as decision trees to produce new potential futures, while at the same time avoiding decision traps such as

88 The background surrounding the tournament that spawned the Mellers et al. work is shared earlier in Chapter Five under the "Superforecasters" section.
overconfidence and base-rate neglect\textsuperscript{89} (Mellers et al., 2014, p. 1107). The teeming aspect involved grouping together individuals in order to aggregate their results and take advantage of the wisdom of the crowds (Mellers et al., 2014). Additionally, as teams were selected there were several important considerations that were taken into account, such as the potential for groupthink and free-rider problems, which were analyzed over the course of the tournament to determine the optimal team-based strategy (Mellers et al., 2014). The final element involved tracking, which evaluated forecaster performance while providing responsive feedback, thus enabling the participants to consistently revise their strategies and refine their techniques to improve their accuracy (Mellers et al., 2014).

Mellers and Tetlock then leveraged these three techniques, combining the top 2% of forecasters from year one into elite select teams for year two, with even more impressive results: "These superforecasters outperformed all other groups by a wide margin. There was no evidence of Year 2 regression to the mean; political forecasting appeared to be at least somewhat skill based, and the acquisition of skill accelerated when top performers worked together" (Mellers et al., 2014, p. 1111). The Brier scores allowed the researchers to analyze the variability, calibration, and resolution of the forecasters, with an emphasis on the latter two characteristics due to their correlation with skill (Mellers et al., 2014, p. 1111). Analysis of a forecaster's calibration enabled assessment of humility, while resolution supported measurement of ability to decipher signals from the noise; in the case of these two metrics "superforecasters" outperformed regular participants and "calibration and resolution both benefited from training, teaming, and tracking" (Mellers et al., 2014, pp. 1111-1113).

Ultimately, the results of the research of Mellers, Tetlock, and their colleagues demonstrated that the three techniques of training, teaming, and tracking "significantly reduced forecasting errors" (Mellers et

\textsuperscript{89} The methods that "The Good Judgment Project" used to train their forecasters also bear a strong resemblance to suggested best practices for modifying individual biases as articulated by Jack Soll, Katherine Milkman, and John Payne: education, generating alternatives, tempering optimism, improving judgmental accuracy, assessing uncertainty, and incorporation of models (Keren and Wu [Soll, Milkman, and Payne], 2015, pp. 930-934).
al., 2014, p. 1113). There were also a series of fascinating empirical insights about how individual forecasting, teaming, and the wisdom of the crowds compare to each other.

Results strongly disconfirm the expectations of pro-independence theorists. Team forecasters were more accurate than crowd-belief forecasters, and crowd-belief forecasters outperformed independent forecasters. Team communication produced enlightened cognitive altruism: sharing of news articles and exchange of rationales. Finally, the pooling of top performers into elite teams with the exalted title of "superforecasters" was the equivalent of a "steroid injection." Communication, effort, and engagement reached levels that far exceeded our wildest expectations. (Mellers et al., 2014, p. 1113)

The results achieved by "The Good Judgment Project" and their "superforecasters" are unequivocally impressive; however, it's a little early to say definitively that their findings disprove the viability of small groups of independent experts – as stated above by Mellers et al. – since Mannes et al. have achieved similarly impressive results.

The grouping of the best participants into "superforecasting" teams bears strong resemblance to the "Select Crowds" strategy put forth by Albert Mannes, Richard Larrick, and Jack Soll, which advocates for averaging the estimations of the top five judges independently without allowing them to communicate with one another, thereby leveraging both expert opinion and the wisdom of the crowds (Mannes, Soll, and Larrick, 2014). Indeed, the training, teaming, and tracking method of Mellers, Tetlock, and Moore demonstrates similar robustness to the "Select Crowds" strategy, with the two approaches typically outperforming both individual experts and general crowds of forecasters (Mellers et al., 2014; Mellers et al. 2015; Mannes, Soll, and Larrick, 2014). The difference in the "Select Crowds" strategy is this aggregation of independent predictions of their experts without collective discussion, which tends to prevent group heuristics and biases from becoming an issue in the aggregated forecasts (Mannes, Soll, and Larrick, 2014).

Duke professor Richard Larrick explains that teams of experts are an incredibly valuable resource to improve analyses, forecasts, and decision making; the exchange of diverse insights and knowledge along with constructive conversations that they enable are highly beneficial and in most cases lead a team to outperform even the best individual in prediction accuracy – e.g., "The Good Judgment Project" (Larrick and
Soll – "Group Decision Making and the Wisdom of Crowds,” 2018). However, with "Select Crowds" of independent experts it is possible to achieve similarly impressive and accurate forecasting results (Mannes, Soll, and Larrick, 2014). By selecting teams of around five people – in some cases up to ten may be value-added, but too many judges will reduce accuracy (Mannes, Soll, and Larrick, 2014) – at the higher end of accuracy and having them make separate objective forecasts it allows for a cancelation of larger errors and leverages the benefits of averaging from different experiences, perspectives, and sides of the truth (Larrick and Soll – "Group Decision Making and the Wisdom of Crowds," 2018). This strategy as opposed to that of "The Good Judgment Project" altogether bypasses the pitfalls of groupthink and Garrett Hardin’s "Tragedy of the Commons" – i.e., free-rider problems (Larrick and Soll – "Group Decision Making and the Wisdom of Crowds," 2018; Nowak, 2011, p. 201). It is this ability to avoid groupthink and other collective biases mentioned earlier in the paper that makes the "Select Crowds" strategy particularly valuable, and perhaps why it delivers equally impressive results to "The Good Judgment Project."

Both methodologies can be readily applied in the investment analysis and financial market forecasting arena with specific modifications to the strategies based on the domain or asset class that your team or firm is trading. However, it's difficult to say how much further we might be able to improve prediction accuracy – or how far out into the future we might be able to forecast – as there will inherently be some level of uncertainty that cannot be discerned (Mellers et al., 2014). Despite the potential theoretical limit of financial market prediction, the insights from the research of Mellers et al. and Mannes et al. have provided an empirically tested series of guidelines to improve decision making and forecasting outcomes by implementing sound frameworks and techniques at both the individual and team level. The results of "The Good Judgment Project" and the "Select Crowds" studies are incredibly exciting and offer new hope for the possibility of more accurately predicting future events. However, in the financial markets arena it will necessarily require a constant adaptation by investors and traders in order to stay ahead of competitors who might copy their techniques and dilute potential alpha.
**Planck's principle**: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it" – Max Planck (Planck, 1949, pp. 33-34).

**Chapter Six: Conclusion**

Throughout the course of this paper I have made a concerted effort to adhere to the guidance of physicist William Bragg: "The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them" (Mankiw, 2013, p. 429). Indeed, my goal with this project was to take an interdisciplinary approach by analyzing topics that are only recently being empirically linked to the fields of investing and economics – human evolutionary development, narrative economics, and behavioral decision theory (rationality/irrationality) – in order to see if there are best practices from the social psychology and judgment and decision making arenas which can be implemented to improve outcomes in the financial markets. On top of this, I also looked at what the appropriate level of granularity is to develop an optimal explanatory model that provides accurate forecasts which are actionable without becoming overwhelmed by tight coupling and complexity: i.e., Robert Shiller's prediction of the GFC two years early versus DSGE models and David Li's "Gaussian Copula Function," which were incredibly granular, but missed out on correlations and additional casual factors that proved highly influential (Lo, 2017; Salmon, 2009; Brand, 2005; Fama, 2013). Regrettably, there is no simple solution to the question of how specific is too specific for a model since there is a perpetual balancing act between obtaining actionable explanatory power and failing to account for significant variables, which likely makes the best answer to this question, "It depends." However, a good place to start would probably be by utilizing the "superforecaster" strategy of beginning with base rates and then employing a probabilistic framework that rapidly adjusts to changing market conditions in real-time as influential factors and events reveal themselves (Tetlock and Gardner, 2015).

Related to this point, I am confident that there are hedge funds and other investing teams who are already employing elegant state of the art algorithmic analyses of social media, viral stories, industry trends, and derivative positions in an attempt to beat the market. It's also reasonable to assume that some
of these firms are able to utilize these complex object oriented programming techniques, developed by computer science, mathematics, physics, and engineering PhD's, to beat the market -- though the entities who have accomplished this are probably doing their best to keep it quiet. However, I also think that because of the competitive zero-sum nature of the financial markets it's likely that over time, or possibly very quickly, the "Lucas Critique" will come into play with other actors copying these strategies and models until the available excess returns all but disappear⁹⁰ (Taleb, 2004, p. 114). Thus, as with all other previous successful techniques in the markets it will require a consistently adaptive approach in order to stay ahead of competitors who continuously imitate efficacious methods.

To be sure, I believe that this approach of constantly modifying your method and consistently looking for inefficiencies and mispricings -- as advocated for by Andrew Lo -- is the best way to increase your chances of beating the market: e.g., D.E. Shaw, James Simons, Warren Buffett, Peter Lynch, and David Swensen (Lo, 2017). However, I also believe that utilizing the best practices from Judgement and Decision Making (JDM) and Behavioral Decision Theory (BDT) for individual analysis, team development, and group decision making will enable you to stay ahead of the curve and the tactical changes of your opponents.

Indeed, I think that these frameworks along with the incorporation of insights from evolutionary theory, mathematical biology, sociology, anthropology, history, English literature, and social psychology can enable investors to meaningfully improve their results because they will minimize the impacts of negative heuristics and biases while facilitating an agile culture that can rapidly shift to take advantage of changes in the environment and exploit inefficiencies.⁹¹ One of the reasons why I believe that these frameworks can be so successful is because they can help firms overcome the "knowing-doing gap" of Jeffrey Pfeffer and Robert Sutton, which is the fact that knowing what you should do -- both individually and organizationally --

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⁹⁰ Charlie Ellis shares a very clear assessment of the why behind this: "To achieve better-than-average results through active management, you must depend directly on exploiting the mistakes of others" (Ellis, 2017, p. 8).
⁹¹ A separate issue of course is whether a firm which is able to consistently beat the market decides to charge fees so high that it will prevent potential clients from taking advantage of the excess returns from these market beating strategies, which would make it more prudent for these investors to simply place their capital in low-fee passive index funds as advocated for by Jack Bogle.
is more difficult than actually enacting it in practice\textsuperscript{92} (Pfeffer and Sutton, 2000). Ironically, it's probably much easier to develop sophisticated quantitative models and advanced algorithms than it is to create a smart collaborative organization with a shared consciousness that is free of ego, overconfidence, and bias. The ability to do both will undoubtedly afford a meaningful advantage.

Yet, even then there's still a strong element of luck that will play into everything, which leads us to Daniel Kahneman's favorite equation which he shared with *Edge* magazine over a decade ago (Kahneman, 2011, pp. 176-177).

Daniel Kahneman's Favorite Equation:

\textbf{Success} = talent + luck  
\textbf{Great Success} = a little more talent + a lot of luck (Kahneman, 2011, p. 177)

This I think is ultimately the most accurate assessment of what all of investing comes down to: The goal is to increase skill as much as possible while hopefully putting yourself in position for luck to take you the rest of the way. However, even then, in the active investing world it really just comes down to staying ahead of your competitors, which necessitates the implementation of sound strategies and creative solutions\textsuperscript{93} in a hyper-complex and ever-changing environment. Breaking everything down to the simplest level, the implementation of these BDT and JDM frameworks throughout your investing team might allow you to make fewer mistakes, which may be just enough – with constant adaptation and a good bit of luck – to realize consistently above average returns. As Admiral Samuel Elliot Morrison said, "Other things being equal [it's] the side that makes the fewest strategic errors [that] wins the war" (Ellis, 2017, p. 4).

\textsuperscript{92} A related insight from the great management expert Peter Drucker is also very valuable to share in this arena: "Working efficiently ... means knowing how to do things the right way, but working effectively means doing the right things" (Ellis, 2017, p. 8).

\textsuperscript{93} Along these lines it's valuable to be aware of Nobel prize-winning physicist Richard Feynman's guidance on how to start the path towards creativity: "Genuine doubt ... is the necessary first step towards creativity" (Ellis, 2017, p. 243). This relates back very well to the Tetlock et al. and Mannes et al. work on prediction and forecasting.


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