



A THEORY OF BEHAVIORAL FINANCE

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Introduction

This document is born of a many year's fascination with behavioral finance dating back to my collegiate education (1989-1993). I recall clearly sitting in an economics class and listening to my professor Dr. Barbara J. Robles discuss economists' view that human decision making was based on rationality. As I sat there, I was thinking of the real people, not the homo-economici, I knew. I raised my hand to challenge the status quo that all people at all times make rational decisions. Barbara's response was that there was a growing number of economists and researchers that were exploring a different assumption; that people were actually irrational and motivated by other factors when making a decision. And from that moment I felt that economics might actually have something important to say about the world. That said, over three decades have passed and in my chosen avocation of finance we still clutch to the demonstrably false assumption that economic actors act rationally. Worse still, behavioral finance still lacks an overarching theory; something that would guide the adherent on how to better understand their decisions, as well as how to improve them.

Hence, this work before you and that is the culmination of many years exploring the topic as: an economics student, an investor, the behavioral finance Content Director at CFA Institute, an author, and now as a consultant advising investors on how to improve their philosophy, process, and execution. My hope is that the publication of A Theory of Behavioral Finance is the beginning of a conversation and exploration of a theory, and not the end of it. I do not have all of the answers, and I am happy to be wrong. Behavioral finance deserves our attention and our risking personal reputations to improve it. Now, let's get to it!

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26 January 2021

Behavioral Finance is Missing a Theory

A criticism of behavioral finance is that it lacks an overarching theory.ⁱ Namely, that it is just a long list of quirks and oddities logged by scientists about human behavior, but without an explanation for why they exist, or what to do with the insights revealed through the many experiments done in service to behavioral finance. Furthermore, a lack of a theory limits behavioral finance from making specific predictions about future outcomes. In turn, this means that behavioral finance is just short of being a science. This work seeks to rectify this situation, as well as to have behavioral finance replace the failed investment paradigm of Modern Portfolio Theory (MPT).

What constitutes a theory?

Theories are analytical tools for understanding, explaining, and making predictions about a given subject matter.ⁱⁱ In science a theory must have the following characteristics:ⁱⁱⁱ

1. It makes falsifiable predictions with consistent accuracy across a broad area of scientific inquiry.
2. It is well-supported by many independent strands of evidence, rather than a single foundation.
3. It is consistent with preexisting experimental results and at least as accurate in its predictions as are any preexisting theories.

In the above list, note the importance of predictions to the necessary conditions for an analytical tool to be considered a theory. The dominant paradigm framing investing currently is Modern Portfolio Theory. But despite a deep investigation it is not clear what MPT is supposed to be predicting.

Based on our experience we can posit that MPT's primary predictions are:

- That investors construct investment portfolios rationally to maximize expected returns relative to expected price fluctuations.
- Changes in the prices of securities within financial markets are rational responses to new information that affects expected returns and expected price fluctuations.

Does this summation seem reasonable? Assuming you agree that these are reasonable predictions for MPT then we can reject it as a theory because its assumptions are unsupported

by data. However, we can also reject it because its prediction of rationality is also not supported empirically.

A Theory of Behavioral Finance Overview

If we reject MPT then important questions include: What is the next paradigm? What are the new paradigm's assumptions? What are the new paradigm's predictions?

Assumptions

1. Human behavior is a complex combination of multiple primary factors that must be considered in total to glean causal insights about it. These primary factors are:
 - a. Biological, with energy and time conservation being the drivers of these factors.
 - b. Psychological, with the level of self-awareness being the driver of these factors.
 - c. Sociological, with the level of social pressures and the level of self-awareness being the drivers of these factors.
 - d. Immediacy of decision making, with time horizon preferences being the driver of this factor.
2. Biological secondary factors affecting human behavior include:
 - a. Human biology evolved with a preference to conserve energy and time.
 - b. Instinctual and habitual behaviors are efficient relative to energy conservation.
 - c. Working memory resources are, for practical purposes, fixed.
 - d. Self-awareness is energy inefficient in the short-term.
 - e. Intellectual thought is energy inefficient in the short-term.
3. Psychological secondary factors affecting human behavior include:
 - a. Behaviors and habits form based on:
 - i. Goals/needs being attained, but relative to energy conservation. Needs include, but are not limited to:
 - Physiological needs
 - Safety needs
 - Belongingness and love
 - Esteem
 - Self-actualization
 - ii. Decisions driven by a desire that the benefits of outcomes exceed their costs, including energy and time conservation.
 - iii. Positive feedback for courses of action from the environment, the self, and/or from others.
 - b. When behaviors and habits are automatic, they become energy efficient.
 - c. Behaviors and habits are typically learned and formed at a young age when self-awareness and self-determination are less.

- d. New behaviors and habits require an initial energy investment to develop strong neural pathways and are energy inefficient.
4. Sociological factors affecting human behavior include:
 - a. Safety and a desire to attain and preserve it.
 - b. Group feedback of individual decisions that is either positive or negative about attitudes, behaviors, and choices.
5. Behavior is biased away from self-aware and intellectual responses due to energy and time conservation, as well as working memory constraints.
6. Changes in the prices of securities within financial markets are the aggregate of individual investor behavior.

Predictions

1. People, even when there is a rationally correct answer, overwhelmingly engage in instinctual, irrational behavior. Said another way, people are predominately behaviorally biased.
2. Changes in the prices of securities within financial markets are overwhelmingly instinctual, irrational, and larger than would be predicted by rational models (e.g., modern-portfolio theory, discounted cash flow valuation, and so on). Also, given the automaticity of the behavioral biases, securities prices are likely more volatile annually than the annual change in the accounting value of total assets. This is true even when a company has a high proportion of “fair market value of assets” in its balance sheet.

Importantly, each of the above behavioral finance assumptions are verified empirically, as are its predictions. It is for this reason that we posit that behavioral finance *as a theory* is superior to modern portfolio theory.

What is Unique About Our Theory?

First, many theories in science are siloed and limited in context to the scientific domain in question. Our theory above recognizes behavioral finance as a combination of biological, psychological, and sociological factors that collide with time preferences. We believe to fully understand human decision-making requires an appreciation of each of these factors. This systemic view of the problem is unique, to our knowledge.

Second, the above theory constrains the concerns of behavioral finance. One of the complaints about behavioral economics is that because its emphasis is on the ex post facto effects of decisions, rather than on the ex-ante causes, that it can explain any observation.

That is, when we witness bias in decisions, we can always find a behavioral cause. But when we work in this bottom-up fashion, we avoid the gorilla-in-the-room (inside joke) question of: what caused these biases in the first place? In other words, behavioral finance is largely a diagnosis after the fact, without an apparent cause before the fact. Above, we have named what we believe are the causal factors. In turn, if as investors we are able to mitigate these causal factors then it changes behavioral finance from a mere diagnosis into a possible suite of prescriptions for how to overcome the biases.

Third, unlike Modern Portfolio Theory, the assumptions and predictions above meet the strict criteria for what constitutes a scientific theory.

Exploration of the Assumptions

Next, we explore the predictions of A Theory of Behavioral Finance, taking each in turn.

Assumption 1 – A Combination of Factors

Recall that Assumption 1 posits that human behavior is a complex combination of multiple primary factors that must be considered in total to glean causal insights about it. These primary factors are:

- a. Biological, with energy and time conservation being the drivers of these factors.
- b. Psychological, with the level of self-awareness being the driver of these factors.
- c. Sociological, with the level of social pressures and the level of self-awareness being the drivers of these factors.
- d. Immediacy of decision making, with time horizon preferences being the driver of this factor.

Above, we stated that one of the things making our Theory unique is the recognition that multiple sciences must be invoked in order to explain something as complex as behavioral bias. Previous proposed models of behavioral bias have tried to describe too much with too little, in our opinion. But that is not the only thing missing from other attempts to explain behavioral bias.

Behavioral Bias Examples

To demonstrate that multiple scientific disciplines are needed to explain behavioral bias it is helpful to consider situations in which the evidence of the bias defies any one science's ability to fully describe its effects. For example, Biological factors affecting behavioral bias tend to focus on things like energy conservation where quick, instinctual thinking reduces the energy drain that is key to deep thought. In other words, our biology seems adapted to survival of the quickest and fittest. Sociological reasons likely have a large overlap with biological ones. Namely, the reason we make personal sacrifices in a group setting is that we are more likely to survive if we are part of a group of people rather than operating solo. Psychological factors, also major contributors to behavioral biases, are also frequently characterized by too much energy inefficient mental deliberation.

Let us look at the classic behavioral biases one-by-one in brief to demonstrate that a more holistic view is necessary to fully explain their effects on people and their decisions.

Loss Aversion

Here, people feel the pain of loss approximately twice as great as the pleasure from gain. Biology serves as a strong explanation for this bias. In the ancient world when confronted with uncertainty it was better to run first and think about what happened second, lest that sabre-tooth tiger eat you at the watering hole.

However, we have worked with firms that believe that they make most of their money by preserving capital, first, and by earning excess returns, second. In other words, they are risk averse, long-term compounding investors and probably the victims of the biology underlying the behavioral bias of loss aversion. We have also seen closeted risk-takers at these firms who, nonetheless, have become practiced at executing the firm's sociological norms and their accompanying language. For example, "Boss, I am pitching this stock because it has a wide moat, is liquid, and pays a dividend; all of which provides ample downside protection." Here sociological factors are also likely contributing to loss aversion. Stranger still, is that a desire to fit in can actually lead to behavioral changes on the part of staff. In fact, "a good cultural fit" is one of the things that many investment firms hire for. But is the fit real, or do people just know how to fake it, until they make themselves a good fit? Last, once these sociological considerations are inculcated by a member of the group, they then can and likely do become part of the psychological make up of the investment pro.

Overconfidence

This bias strongly violates a purely biological explanation. What overconfidence seems to be preserving is not exclusively energy, but a person's fragile ego, clearly a psychological factor. Ego, for our purposes here, is defined as the preferences we have formed about how others perceive us and becomes a filter for how we evaluate reality. Further, if a person's reputation within a group is that they are a risk-taker, then they are likely to prefer making decisions with little deliberation and with the puffery that is a hallmark of overconfidence, not because of energy conservation but because of reputation conservation. Again, there are likely closeted risk averse investors at event-driven hedge funds, at small cap growth shoppes, and at venture capital firms. The biological basis for overconfidence might be that sans this bias we might not venture out to forage for life-preserving food. That is, we need a kind of hope and confidence in our abilities to confront uncertainty and make decisions. Again, though, a full explanation of the bias requires more than a single factor.

Confirmation

Here people look for evidence that affirms a belief that they hold, and discount evidence that does not. There is a biological case to be made here that treating situations as similar, which is at the heart of confirmation bias, allows for energy conservation because a person does not need to reconsider held beliefs, or new evidence. However, confirmation bias also psychologically allows us to say to a chief investment officer that our view of that credit still holds given the evidence we continue to examine. In other words, ego is being preserved again. Confirmation bias also defers having to admit mistakes, which is unpalatable to the ego, and in many social situations where we do not want to be seen as a faulty thinker.

Herding

Mass movement in a single group direction clearly has a psychological and sociological component. This explains fashion and music trends, among many things. A biological explanation though, is that when we move in a herd there is “strength in numbers.” However, a full unraveling of the factors that lead to herding cannot be had by looking at just one branch of science.

Anchoring

Those anchored are stuck on a thought. Manifestations of this bias include the first number uttered in a sequence, the dominant idea in a group discussion, the losses suffered on investments in the Great Recession, and so on. Yes, it conserves energy to not consider other points of view – the biological explanation of anchoring – but it is also the case that “going with the flow” in a group discussion is sociologically more beneficial. However, psychologically the benefit to anchoring is again most likely about ego protection. The reason we are waiting for that stock to get back up to its cost basis before selling is that we do not want to admit that we made a mistake because our self-image is that we are capable investors.

Availability

Overemphasizing information that is easily within reach resource-wise is the hallmark of availability bias. Because something is easily available, we prefer it. Clearly this is energy efficient from a biological point of view. However, it is also the case that when speaking to a reporter and asked to describe our investment process that our firm’s investment philosophy is likely to spring to mind and what we feed to the media. This is true even if we have tweaked

the firm's investment process a bit to better deliver alpha for the product we manage. Despite this, we quote the firm's investment process because we know this is the "correct" answer sociologically.

State changes are one of investing's hardest problems to deal with. Here, our readily available mental models must adjust on the fly if we are to comprehend what is happening in real time. Psychologically, this may be more difficult than intellectually. For example, if we are a value investor circa 2020, it is hard for us to defend our last decade's worth of returns, so we invoke readily available stories about large rises in inflation being a likely future outcome from too much monetary stimulus. Again, the factor involved here is psychological – we are defending our beloved investment philosophy with a readily available theory.

Representativeness

Making decisions based on stereotypes is energy efficient, though frequently these representations are incorrect. However, stereotypes also typically form within group settings. Hedge funds and investment banks only recruit from the "best" schools because they want only the "best" employees. The result is an overbiased sample based on sociological factors – we hire from there because that is where we come from, too – and psychological factors, too. Namely, we may have failed to deliver competitive investment returns but it is because of bad luck, not because all of us were educated by the same professors spouting the same uniformly acceptable ideas and that are likely foundational to our thinking.

Mental Accounting

The two biases that map most neatly to solely biological factors are loss aversion and mental accounting. Due to the limitations of working memory and its inability to consider too many ideas simultaneously, it is certainly efficient biologically to parse different ideas into different categories and apply different decision rules to them. For example, apportioning our investment portfolios to a group of "room to grow" securities, "do no harm to our returns, likely to go sideways" securities, and "income paying" securities. Here, the money is all fungible, but we treat it differently because we have mentally accounted for the securities differently.

In summary, to fully explain the manifestations of behavioral bias we need to invoke biology, psychology, and sociology. Without these three sciences we end up leaving key descriptive

aspects of each behavioral bias out of our understanding. Next, we consider other things missing from the current work on behavioral finance and its biases.

A Proposed System 3

Amos Tversky and Daniel Kahneman's groundbreaking research was a significant portion of the wind in the sails of behavioral finance that got the boat moving in the early 1970s. More recently, Kahneman's highly influential book, *Thinking, Fast and Slow*,^{iv} has pushed the ship further along its journey. But we believe the ship needs updating.

For those not familiar with Kahneman's work he says that human decision-making is best summarized by two systems, System 1, and System 2. More specifically they are:

1. System 1 is fast thinking, characterized by instinctual reactions, snap assessments of situations, subconscious thinking, and centered in the brain's amygdala region.
2. System 2 is slow thinking, characterized by intellectual responses, deep analysis, and centered in the brain's pre-frontal cortex region.

This model, that many mistakenly believe was postulated by Daniel Kahneman,^v is incomplete. Certain ways of thinking, like intuition, defy this oversimplification of the mind into two systems. Among what we believe are Kahneman's mistakes, he uses the word "intuition" as a simile for System 1 – a subject covered at length by us elsewhere. This is a mistake, for example, among the Oxford English Dictionary's definitions of intuition is:

Immediate apprehension by the intellect alone; a particular act of such apprehension.^{vi}

Note the combination of "the intellect" – System 2 – and "immediate apprehension" – System 1, in the OED's definition. We have proposed elsewhere that there is clearly a System 3 which is supported by neuroscientists that explore and research intuition/insight. For example, a meta-analysis^{vii} (i.e., a study of studies) by Sprugnoli, et al. (2017)^{viii} found the following neural correlates for intuition:

- A complex network composed of the anterior cingulate cortex, prefrontal and parietal lobes, claustrum, temporo-occipital regions, middle-temporal gyrus, and insula.
- Both hemispheres of the brain involved.

- In the left-hemisphere, regions active are precentral gyrus, middle temporal gyrus, precuneus, cingulate gyrus, claustrum, middle occipital gyrus, uvula (inferior vermis - cerebellum) and insula.
- In the right-hemisphere, regions active are superior frontal gyrus, insula, precuneus and middle temporal gyrus.

First, notice that Sprugnoli found intuition to be a network of interconnected brain activity, neither centered in the amygdala or pre-frontal cortex. In fact, the amygdala is not believed a part of the functioning of intuition. Second, Sprugnoli found that both hemispheres of the brain are involved, meaning that intuition is a whole-brained activity. Also, for those who research intuition they all note that insights spring into consciousness unannounced rather than after a slow deliberative process.

So, clearly there is a well-known and universal mental experience – intuition – that is not well described by System 1 and System 2. It is for this reason that we propose there is at least one other decision-making system: System 3. This system describes the effects of intuition on that perennial human activity: innovation.

A Model of the Brain

Our discussion of Assumption 1 needs a good model of the brain from a neuroscience point of view that helps to explain the convergence of biology, psychology, and sociology in behavioral biases. A model proposed by Vartanian and Mandel (2011)^x is such a model and is similar to those proposed by others.^x Here are the elements of their model:

1. The brain has both serial and parallel processes working simultaneously in cognitive tasks. To test this idea, subjects in their experiments were given two tasks to complete. While involved in completing the tasks there were sensory interruptions. Seeing how the brain responded to the interruptions allowed Vartanian and Mandel to verify their hypothesis that the brain has both serial (i.e., linear) and parallel modes working simultaneously.
2. They found using fMRI and EEG that the brain uses both serial and parallel processes with a cognitive task.
3. They also discovered that working through a complex cognitive task has three distinct brain phases:
 - a. A perceptual component (P)
 - b. A central component (C)
 - c. A motor component (M)

4. Vartanian and Mandel found that only the central component (C) establishes a bottleneck; that is a slowing down of task completion. The thought is that both the perceptual (P) and motor (M) components are able to act in parallel but that the central component can only work in a serial fashion.

In short, they propose that every decision has an initial component where the problem requiring a decision is perceived either by the senses or through meta-cognition (i.e., self-awareness). Then the perception moves on to the parts of the brain that consider a course of action; the (C) central component. After the decision is made then action is taken, the (M) motor component.

Both of the first two stages of the Vartanian and Mandel model, perceptual (P) and (C), central, have ramifications for explaining why behavioral bias manifests. Briefly, we believe that behavioral bias manifests due largely to an underdeveloped metacognition/self-awareness in the (P)erceptual stage of decision-making. That is, we fail to recognize or consider the correct thinking mode needed to solve a problem that we are confronted with. Instead, overwhelmingly, we default to existing reactions and responses to stimuli.

Within the (C)entral part of decision-making, the brain first does a check in with memory. If a problem is familiar or similar, then we tend to default to System 1 thinking. If, on the other hand, it is unfamiliar then we tend to default to System 2 thinking. The reason that System 2 thinking is so slow is that deliberate thinking must be done serially and because working memory bandwidth is biologically constrained. System 3 thinking on the other hand is fast but ends up taxing multiple parts of the brain simultaneously, and not just the prefrontal cortex. All decisions require evaluation by people and trigger hormonal/physiological reactions that we experience as either pleasure or pain. This feedback mechanism is exactly where the biases arise. A decision made years ago that was a success triggered pleasurable hormones, became a pleasant memory, and when a similar decision is made again, it also feels good to us. To improve our thinking – that is, to unwind a bias and create a new habit – requires interrupting this feedback loop, experiencing physical discomfort, and is time and energy inefficient in the short-run.

Understanding the steps above well is the subject of subsequent sections of A Theory of Behavioral Finance, and it puts us on track to fully explain the effects we see in behavioral bias. In turn, this allows for predictions to be made based on the Theory. It also has the benefits of implying prescriptions for overcoming these biases.

In conclusion, explaining and understanding behavioral biases requires multiple branches of science. Importantly, the biological, psychological, sociological, and temporal factors all converge in our brains and are well understood with the Vartanian and Mandel PCM model.

Assumption 2 – The Biological Factors

Now we explore with some depth the biological factors that contribute to the arising of behavioral biases. Our Theory says of Assumption 2:

Biological secondary factors affecting human behavior include:

- a. Human biology evolved with a preference to conserve energy and time.
- b. Instinctual and habitual behaviors are efficient relative to energy conservation.
- c. Working memory resources are, for practical purposes, fixed.
- d. Self-awareness is energy inefficient in the short-term.
- e. Intellectual thought is energy inefficient in the short-term.

The Biological Component of Behavioral Bias

Multiple authors have sought to explain behavioral bias via biology and primarily as the artifact of humans evolving with a preference to conserve energy to better ensure our survival. However, it is also the case that time is something that the brain conserves.

Energy Conservation

Among the authors that explain behavioral bias as a problem of energy conservation is Daniel Crosby. He simply and cleverly summarizes brains as old, hungry, and impatient.^{xi} It turns out that our most important of organs has evolved little over the last 150,000 years. So, modern people are walking around with a brain built for survival in a world dominated by sabre-tooth tigers; 1,000-pound, 10 feet tall orangutans; packs of 300-pound cave hyenas; and 23 feet long monitor lizards. Run!

In other words, in the time before civilization and when people are believed to have been hunter-gatherers, calories were hard to come by and were available only inconsistently. Consequently, energy conservation was a matter of survival. Ergo, we conserve scarce energy resources. But why would this affect the brain so radically, which is such a differentiated and advantageous organ of homo sapiens?

Our brain represents only 2% by weight, yet it consumes 20% of our daily energy. This is equivalent to the calories burned during 30 minutes of skiing, hiking, or swimming. So, for many of us, our brain consumes the same amount of energy each day as we expend in our daily exercise routine. The brain is easily the hungriest organ in our body. For this reason, it is forever looking for short cuts, referred to as heuristics, to minimize energy consumption while making thousands of decisions each day. The unintended consequence of the brain's bias

toward conserving energy is an overuse of System 1, instinctual, processes because it is fast and energy efficient/conserving.

Time Conservation

We believe it is indisputable that behavioral bias is partially explained by a preference to conserve energy. However, this is not the only biological factor being conserved. As Vartanian and Mandel's PCM model from Assumption 1^{xii} proves, time is also a factor in our ability to make decisions. This is because the (C)entral component in decision making can only be done in a serial fashion. That is, one step must follow another linearly which creates a temporal choke point, slowing down decision-making. Their work also demonstrates that when there are interruptions in our decision-making that our thinking slows down even further.

To avoid this time bottleneck, one of the first operations in that central component is the brain's quick check in with memory to see if the problem/situation currently (P)erceived is similar to previous decisions that have been made. Problems believed to be similar typically activate brain regions associated with memory (i.e., we recall a similar problem), and the course of action followed previously is invoked quickly. This was, of course, essential for survival in the ancient world. This is analogous to problem-solving via System 1.

If, on the other hand, there are multiple similar problems, or if the problem is unique and has no memory associated with it, the evidence shows that there is then a check in with the pre-frontal cortex (System 2) and its slow, energy draining, serial methods of working and problem-solving.

Additionally, the exceptionally limited in bandwidth and energy hogging working memory is invoked so that multiple courses of action may be considered. Vartanian and Mandel's model and its evidentiary support demonstrates that our brains switch back and forth between the possibilities when evaluating multiple competing courses of action. This is energy and time taxing and may reduce our ability to survive when confronted with an imminent threat. Interestingly, there are many reports of people "freezing" into catatonia when confronted with violence.^{xiii} This is especially true for those unaccustomed to these situations.

Other research done by psychologists shows that the maximum number of ideas and their permutations that can be held in working memory at any one time is approximately 7,^{xiv} with an ideal number being around 3 competing ideas. The various courses of possible action are then evaluated *emotionally* with the parts of the brain associated with different releases of hormones involved. Because the brain's evolution largely took place in historical periods

where survival was dependent on having enough food/energy and where quickly avoiding catastrophe meant survival, it is likely that the brain conserves, not just energy, but also time.

But there is something else that we preserve that is lurking in the background, and to our knowledge not explored by behavioral finance researchers. Namely, if a decision works out and we survive a situation, then hormones associated with pleasure – dopamine and opioids^{xv} – are released into the brain and body.^{xvi} Our memory of the result is therefore associated with pleasure. This gives preference to these solutions when similar problems are encountered in the future. These emotions, these physiological responses, are a part of what makes changing behaviors so difficult. Effectively, we must undo something that brings us physical pleasure. Therefore, we are conserving pleasure when engaging in habits.

Here is the problem with that: because many solutions to problems were arrived at many years ago before we had attained greater and deeper knowledge, it means that our preferred modes of reacting/responding/thinking are outdated intellectual technologies even if they are energy and time efficient; and worse, they also feel good. Ouch! In fact, the work of Van Hoek, et. al (2015)^{xvii} demonstrates that to undo a thought requires the work of many brain regions and is time consuming. Specifically, the regions involved are:

- Medial temporal lobe and pre-frontal cortex, to simulate different outcomes.
- Fronto-parietal and cingulo-opercular network, to provide cognitive control.
- Limbic regions and ventro-medial pre-frontal cortex, to provide motivation and the power to evaluate possible outcomes.

Invoking this many brain regions is energy and time inefficient.

Self-Awareness is Energy Inefficient

We argued above that a lack of self-awareness – which science formally calls metacognition – in the (P)erceptual stage of decision-making is responsible for all of the behavioral biases. Below we discuss the psychological aspects of metacognition more fully, but there is a biological phenomenon which needs consideration here, too. Specifically, meta-cognition appears to be primed by prior expectations:^{xviii}

“...perceptual decisions which are congruent with valid perceptual expectations lead to increased metacognitive sensitivity, independently of attentional allocation.”

What this means is that to overcome behavioral biases is made even more difficult because the primary mechanism for undoing them – metacognition – is itself biased toward energy and time conservation. Biologically speaking then it is very costly energy and temporal-wise to

change how you think. Additionally, the pleasurable feelings generated by engaging in biased thought must also be overcome. Not surprisingly, this is very difficult to do and for most decisions it is impractical.

Assumption 3 – The Psychological Factors

Now we describe in greater detail the Psychological Factors that contribute to behavioral biases. In the overview of A Theory of Behavioral Finance from above we said of Assumption 3:

Psychological secondary factors affecting human behavior include:

- a. Behaviors and habits form based on:
 - i. Goals/needs being attained, but relative to energy conservation. Needs include, but are not limited to:
 - Physiological needs
 - Safety needs
 - Belongingness and love
 - Esteem
 - Self-actualization
 - ii. Decisions driven by a desire that the benefits of outcomes exceed their costs, including energy and time conservation.
 - iii. Positive feedback for courses of action from the environment, the self, and/or from others.
- b. When behaviors and habits are automatic, they become energy efficient.
- c. Behaviors and habits are typically learned and formed at a young age when self-awareness and self-determination are less.
- d. New behaviors and habits require an initial energy investment to develop strong neural pathways and are energy inefficient.

How Habits and Behaviors Form

Here again we make use of Vartanian and Mandel's decision-making model and its three components:

1. (P)erceptive: Information provided through either the senses or metacognition.
2. (C)entral processing: The brain sorts the stimuli from the Perceptive stage and if familiar it invokes a habit, and if unfamiliar it triggers more deliberation.

3. (M)otor: A decision is made, and a course of action taken that triggers a physical, hormonal response that reinforces or dissuades the same course of action being taken again depending on the quality of the outcome.

Other researchers refer to this sequence as a “cortico-basal ganglia loop.”^{xix} While still other researchers refer to this same brain functionality as a “habit loop.”^{xx} Only the nomenclature is different among these different versions of the model, with the three PCM components becoming: a cue, a routine, and a reward. Relative to our discussion about the psychological factors contributing to behavioral bias, we use this additional nomenclature [sorry, in advance, for any confusion].

Recall, that once initiated by a prospective decision, the outcome of the above PCM model is the creation of a cause-and-effect chain that directly associates stimuli (the causes) with actions (the effects). When the outcome of executing this chain is positive then this is reinforced with hormones that really make us feel good. This, in turn, biases us to execute this routine the next time, too. If this routine is done enough then it creates a habit.

The reason that some researchers call this the “cortico-basal ganglia loop” is that the basal ganglia is directly implicated in the creation of, storage of, and execution of habits. In fact, people with damaged basal ganglia often become mentally paralyzed and cannot form new habits.

Our outward behaviors are usually the net result of a large number of habits operating shockingly unconsciously rather than being the result of a deliberative process or a conscious choice. This is called “chunking” by the researchers that refer to the sequence of mental events as a “loop.”

Psychologically speaking, though, what directs our decision-making in the first place? That is, why are we compelled to decide anything non-life threatening when its consideration is optional? We think you will agree that it is not just energy and time conservation affecting decision-making. In short, our motivations are crucial to decision-making, too. For example, if we are hungry, we develop habits and behaviors – habit loops – associated with our need for energy. But we also develop habits and behaviors affiliated with a nearly infinite number of possible stimuli, such as: walking, sitting, sleeping, relieving our boredom, tackling math problems, relating well to our coworkers, finding mates, learning, and so on. Thus, to understand behavioral bias more fully we need to understand psychology and motivations.

Researchers interested in psychology throughout time have theorized about motivation.^{xxi} We are largely indifferent about which theory is superior to the others. Instead, we find value in each of the major theories of motivation. Among those you may have heard of are:^{xxixxxii}

- Herzberg's *Two-Factor Theory*
- Hull's *Formalized Drive*
- Maslow's *Hierarchy of Needs*
- Thorndike's *Law of Effect*
- Skinner's *Operant Conditioning*

As an example of possible motivations for actions let us look at Maslow's *Hierarchy of Needs*. He specifically theorized that there were five basic needs/motivations:

1. Physiological needs, such as finding food, reproduction, and sleep.
2. Safety needs, such as shelter, homeostasis, access to capital, and absence of violence.
3. Belongingness and love, such as groups and people that create affiliation.
4. Esteem and achievement, such as recognition for our contribution to the collective.
5. Self-actualization, such as achieving our full potential or enlightenment.

Maslow also believed that people focus at fulfilling their initial needs before evolving to those higher up the hierarchy. This part of his theory has largely been debunked. Researchers have found, for example, that the boundaries between the hierarchy needs are blurred, and that people have varying degrees of the hierarchy in place and not sequentially. In fact, many self-actualization traditions hold that the most evolved should take vows of poverty and shun all but the most basic material concerns, and as well that a sense of self-esteem and achievement is counter-productive to development.

Nonetheless, we like Maslow's framework because it shows the different categories of psychological motivations. Further, it creates distinctions between biological, psychological, and sociological factors. Each of these are recognized as causes for behaviors and habits.

Habits and Behaviors Conserve

One of the reasons habits and behaviors are difficult to change is that once they are formed, the brain regions needed to execute an action are reduced. Additionally, the amount of energy needed to come up with a reaction to a familiar pattern is also reduced. Just as we related above when considering the biology of behavior, habits form because the brain is looking to conserve energy and time. Dunhigg says in his *The Power of Habit*, "When a habit emerges, the brain stops fully participating in decision making." However, an important observation supported by science below, is that this statement leaves open the possibility of the brain partially participating in decision making when habits are present. That partial

participation is the wedge in which we can insert and assert ourselves anew and change habits.

Importantly, we do not just conserve energy and time in service to our biology when making decisions. We also conserve our self-esteem and relationships, which is why we are more tolerant of those with whom we have strong bonds, than those we have just met. Furthermore, and in rough accord with Maslow's *Hierarchy of Needs* once a person has established physical, mental, and spiritual health in accord with their motivations then they tend to live their lives strongly in accord with the habits that led to these preferred outcomes. Why?

Because these desired outcomes are reinforced hormonally, and they feel incredibly good. Said another way, our habits ask of us "if it ain't broke, why fix it?" The answer, of course, is that our behaviors and habits may not be the best ones available to us. In short, due to conservation, most of us are content with our behaviors, even if upgrades are available. Consequently, most of us are walking around with outdated and unexamined behaviors that were enshrined many years in the past.

Behaviors and Habits Largely Form in Youth

Once the umbilical cord is cut between us and our mothers, satisfying our own needs becomes front and center in our motivations. At that moment of emergence into the world, the mechanism of the PCM model also kicks into gear. We begin perceiving things, and slowly over many years, reacting and responding to them. Each time the outcome of our decisions is a good one, that decision is positively reinforced chemically.

In time, if that "chunk" delivers positive outcomes with high probability then it becomes a habit loop. Last, it has as an unwanted side effect the creation of unawareness around our habits and behaviors. The reason, of course, is conservation.

Thus, long before we arrive at the moment when we need to respond thoughtfully to a massive decline in the price of one of our investments (i.e., avoid loss aversion bias), we have an entire lifetime of habits developed out of domain, and out of time with a confronting-us-now event. In this circumstance, we stand a low chance of breaking old habits.

Psychologists that study habit formation have long recognized that most of our habits and behaviors are near permanently minted when we are children. For example, a recent gigantic study of 50,000 families found that most of our key behaviors and habits are in place by age 9.^{xxiv} These habits include things like our ability to complete tasks, such as household chores, and our willingness to take on responsibility. Sadly, and as we explore below, most of us do not have enough self-awareness at a young age to ensure that our behaviors are the best

ones. In short, they are just the ones that worked in the past and our behavioral technologies are typically those of a 9-year-old.

Changing Habits is Expensive

It should come as no surprise that to change habits is exceptionally difficult due to conservation. But there is another factor that is just as important and regrettably it is largely ignored. Namely, our lack of self-awareness in most decisions. As we learned with the PCM model, in the (C)entral processing component, if something is familiar our brains invoke default habits. So, if a habit is sub-optimal, but still serves us, we have no hormonal indication that it needs fixing. In other words, a major contributor to behavioral biases is our lack of self-awareness and near total absence therefore of self-improvement. The remedy, as we have written many times is: self-awareness. Self-awareness is known formally as metacognition.

At about age 6 we develop the ability to recognize that “something is wrong” in our environment. However, at that age we typically are ill-equipped to know what is wrong, or to understand different points of view that might lead to different decisions. Sadly, metacognition researchers believe that until about age 11-12 most of us do not have strong metacognition.^{xv} In other words, one of the causes of behavioral biases is that the capability needed to unwind them – metacognition – is not sufficiently formed until years after the habits themselves are formed.

What this means is that to overcome behavioral bias requires that we have a way to observe the cues that trigger our habit loops, and a way to interrupt them. Hormonally, none of this feels good. It is work. What this means is that if you are an investor and you can overcome your behavioral biases, then you can be certain you have a difficult-to-compete-against edge over those that do not.

Assumption 4 – Sociological Factors

Next up, let us turn our attention to the sociological factors that lead to our errors in judgement.

Sociological factors affecting human behavior include:

- a. Safety and a desire to attain and preserve it.
- b. Group feedback of individual decisions that is either positive or negative about attitudes, behaviors, and choices.

Why Sociology is Important for Understanding Bias

It should come as no surprise that most people care about what others think of them. Most people also are concerned with how well they fit in with groups. Why?

It is easy to imagine a time in the distant past when people survived the rigors of nature – unpredictable weather, finding food, defending against violence – because of safety in numbers. Standing alone against the world was nigh impossible in our ancient past. Surely affiliation with a group of people increased the likelihood of survival. While seemingly obvious, this idea remained hidden in the shadow cast by the light of Darwin’s evolutionary theory for almost a hundred years. Why would we cooperate when we need to be selfish to survive?

That cooperation is important for survival is supported by evolutionary biologists who have demonstrated this idea mathematically. Pioneering work in 1964 by Hamilton provided key insights as to why individuals’ ideas of survival of the fittest was not solely a selfish impulse.^{xxvi} Specifically, his work found that organisms do not reproduce, genes do. Genes that are shaped by a need to survive can do so in two ways: 1) an organism can reproduce itself by passing its genes to its offspring; or 2) it can help other organisms that share its genes, such as its relatives. Subsequent researchers over the decades continue to affirm these findings, as well as that cooperation is key to survival.

A modern investing education usually includes a short detour into game theory. Typically, what people remember after this diversion is the Prisoners’ Dilemma. Here, co-conspiring criminals facing prosecution “win” by selling out their partner in crime and labeling them as the primary instigator. Thus, they receive a lighter criminal sentence from prosecutors grateful for their witness testimony. Yet, as we have written elsewhere this strategy only holds in a limited set of circumstances and that cooperation is almost always a better strategy.^{xxvii} Other game theorists have researched and found the same thing. For example, Nowak and Sigmund found that, “Cooperation pays because it confers the image of a valuable community member to the cooperating individual.”^{xxviii} Their work with computer simulations finds, “the emergence of indirect reciprocity was a decisive step for the evolution of human species.”^{xxix}

In summary, the survival of the species depends, in part, on how well groups perform vs. nature. Group performance, in turn, depends on how well the members of the group work together and how they fit together.

Finally, that belonging to a group is important to people is also made obvious when you consider the way that we punish people for violating the laws or norms of a group. In short, we punish people by pushing them further away from the group. A violation of family norms can result in being “sent to our room,” or if the violation is worse, in “grounding.” Here the

misbehaving child is cleaved off from the group temporarily. Within society people who violate the law severely enough are carved out from society altogether and sent to prison. Violations within prison can lead to solitary confinement, which many consider a truly severe punishment. Some even label solitary confinement as inhumane which is strong evidence that group affiliation is important to people.

Proof that we are social creatures is that solitary confinement has profound effects on our biological and psychological health. Solitary confinement is associated with a 26% increased risk of premature death stemming from our stress response which dumps cortisol into our system and increases blood pressure and inflammation.^{xxx} It is also well-known that increased isolation increases our risk for suicide.^{xxxi} Long-term solitary confinement leads to very strange effects such as the inability to recognize faces, and to learn new things due to the damage it does to the hippocampus.^{xxxii} Note: again, the hormonal influence on the way our behaviors.

Closer to home, and here we are talking about within investment firms, those that fail to thrive within the culture of their firms either leave or are eventually fired. Many investment organizations spend large amounts of time trying to identify the type of culture they want at their firms, and then they actively hire people in conformity with their culture. This is verified by a perusal of one of the investment industry's leading consultancies Focus Consulting Group's "Writings" section of its website.^{xxxiii} Their site features 5 whitepapers on culture, as well as 13 articles just on its main page. Additionally, the titles of these writings are telling, too:

- "Linking Strong Culture to Success."
- "Managing Culture: Leaders as Shapers of Reality."
- "Culture as a Strategic Advantage"
- "Commercial Success and Culture"
- "Good Cultures Don't Scare People."

In other words, groups functioning well sociologically are a key concern of investment organizations. We can also conclude then that to succeed in investment organizations partially requires that we:

1. Are fluent with our group or organization's norms.
2. Behave in accordance with our group or organization's norms.

As described in our other works on behavioral biases,^{xxxiv} they arise when we fail to understand reality for what it is, and instead respond reflexively to situations. Group norms are the very definition of reflexive responses to reality.

For example, how easy is it for a research analyst to pitch a waste management business to a portfolio manager if the firm has been hurt by the performance of waste management companies in the past? Or, how easy is it for a research analyst serving on a value-style investing product to stretch the valuation norms when pitching a stock? How easy is it for a member of an investment committee to ignore a group decision and purchase a stock on her own?

We are not arguing that we ignore the sociological expectations of our organizations to avoid behavioral bias. Instead, we are arguing that sociology and the anxiety of being rejected by the group is a powerful incentive to behave in very particular ways. We are using strong examples to indicate that sociology does bias our possible decision sets by limiting our available decisions. Consequently, to fully understand behavioral bias, we need to consider the group setting, too.

With regard to the classic behavioral biases themselves, some firms have established risk averse cultures where loss aversion is more likely to express itself. While still other cultures may prefer cocksure thinkers and have a “survival of the fittest” environment where analysts fight for their ideas to end up in investment portfolios. Here overconfidence is more likely to be present sociologically. And so on. In our work as a consultant working with organizations, the very hallmarks of a firm’s investment culture are also frequently the sources of institutionalized behavioral bias.

Group Feedback Matters

The discussion above strongly indicates that bias is likely to be reinforced, if not outright created by the social milieus in which we work. But there are even biological effects caused moment-to-moment by the feedback we receive – positive or negative – from our groups.

Again, referring to the Vartanian and Mandel PCM model, the final step of the decision-making loop is “feedback.” That is, after we make a decision, we observe the consequences of our choice. If the result of our decision is a favorable outcome, then our brains release hormones that feel good to us. Whereas, if the outcome is poor then hormones that do not feel good are released. This feedback mechanism reinforces the development of our behaviors, habits, reactions, and so on.

But how does the brain treat feedback from the groups in which we partake? “[T]he brain transforms socially constructed rewards into the same ‘common currency’ [i.e., hormonal neurotransmitters] as ‘natural rewards.’”^{xxxv} In other words, at the level of our brains there is no difference. Furthermore, researchers have found, “If positive expected value is somehow coded by activity in these ‘reward regions,’ then investigators should be able to predict

participants' choice behavior based on activation of these regions. This idea was recently explored by Kuhnen and Knutson (2005) who hypothesized that an increase in gain anticipation would promote risky choices, whereas an increase in loss anticipation would instead promote riskless choices." This is direct evidence that our social interactions contribute to our behavioral biases.

Assumptions 5 and 6 – Impedances & Market Prices

Assumptions 5 and 6 can be combined into a single section, and here is how they are described by the Theory:

5. Behavior is biased away from self-aware and intellectual responses due to energy and time conservation, as well as working memory constraints.
6. Changes in the prices of securities within financial markets are the aggregate of individual investor behavior.

Assumption 5 – Impedances to Unbiased Behavior

In each of the preceding assumptions the details of Assumption 5 – the impediments to unbiased thinking – have arisen as a natural consequence of the discussion. Summarized they are:

- The evolutionary advantages of conservation of energy and time.
- Hormonal responses that essentially make us addicts to decisions that work, even if sub-optimal and there are superior ways of responding to a situation.
- Our psychological motivations, including the need to like ourselves, companionship, preservation of our self-concept of ourselves; self-expression; and so on.
- Our need for survival predisposes us to habits that conform us to group sociological norms.

But there is another important thing at work here that we only discussed in passing previously. There seems to be a biological constraint on the number of independent thoughts that we can hold in working memory. Specifically, most of us can only accurately hold 3 independent thoughts in working memory.^{xxxvi} While some outstanding people do better than this, even they seem tapped out at 5 items. Still others can only hold 2 separate thoughts front of mind. Note: meditators are able to expand their working memory, as well as to task switch much better than non-meditators; a subject discussed more in-depth below.

Assumption 6 – Market Prices are Driven by Behavior

The final assumption of A Theory of Behavioral Finance is that financial market prices are the aggregate of the behaviors of individual market participants. We take this as self-evident, and you probably do, too. But researchers note the same thing. For example, Kurz (1998) advanced a theory of market prices called Rational Belief Equilibria in which he stated, “The conclusion of the paper is that the main cause of market volatility is the distribution of beliefs and expectations of agents.”^{xxxvii}

However, Kurz’s work still assumes rationality on the part of investors. In other words, it is based on the failed paradigm of Modern Portfolio Theory that assumes that investors are rational. Whereas, the work of many researchers, even from the mid-1970s, shows that investors are not rational and that MPT does not describe reality. Criticism of MPT came early and often and from heavy hitters. Richard Roll stated of MPT in a takedown that should have been the end of the theory:

“Testing the two parameter asset pricing theory [i.e. CAPM] is difficult (and currently infeasible). Due to a mathematical equivalence between the individual return/‘beta’ linearity relation and the market portfolio’s mean-variance efficiency, any valid test presupposes complete knowledge of the true market portfolio’s composition. This implies inter alia, that every individual asset must be included in a correct test.”

In other words, MPT does not have falsifiable predictions, and so cannot constitute a theory.

Still other MPT naysayers, include Nobel Laureate, Robert J. Shiller, who demonstrated in 1980 that stock prices were much more volatile than they should be relative to the business fundamentals of those same companies.^{xxxviii} In other words, investors are behaviorally biased and irrational. In fact, behavioral finance as a discipline demonstrates that people routinely make biased and irrational decisions even when mathematically correct answers are available.

Behavioral finance researchers also believe markets are the result of the aggregate interaction of market participants. Szyszka states, “The paper presents the Generalized Behavioral Model that describes how asset prices may be influenced by various behavioral heuristics and how the prices may deviate from fundamental values due to investors’ irrational behavior.”^{xxxix} In other words, markets are the net result of the interactions of its behaviorally biased actors.

Summary of Assumptions

In summary, behavioral biases arise due to multiple factors – biological, psychological, sociological – whose influences often occur in combination and impede unbiased decision-making. Each of these factors bias decision-making toward habitual reactions and away from self-aware responses. In turn, this results in aggregate securities price movements driven by behavior much more so than by rationality.

Predictions of a Theory of Behavioral Finance

In the overarching A Theory of Behavioral Finance described above we said that there were two broad predictions. However, there are also multiple sub-predictions. Importantly, for a theory to be considered A Theory it needs falsifiable predictions. That means that other researchers can evaluate the veracity of a theory. Here are those falsifiable predictions based on the assumptions of the Theory:

1. People, even when there is a rationally correct answer, overwhelmingly engage in instinctual, irrational behavior. Said another way, people are predominately behaviorally biased.
2. Changes in the prices of securities within financial markets are overwhelmingly instinctual, irrational, and larger than would be predicted by rational models (e.g., modern-portfolio theory, discounted cash flow valuation, and so on). Also, given the automaticity of the behavioral biases, securities prices are likely more volatile annually than the annual change in the accounting value of total assets. This is true even when a company has a high proportion of “fair market value of assets” in its balance sheet.

Prediction 1

In our discussion of the Theory’s assumptions there were both major and minor factors identified as contributing to behavioral biases. They are:

1. Energy conservation, because food is hard to come by;
2. Time conservation, time, because reacting quickly to threats was the difference between life and death;
3. Working memory is constrained, such that people can hold, on average, only 3 competing thoughts in our minds at once; and,
4. Group connectedness, because membership in a collective increased the likelihood our genes would survive.

Each of these major factors are also therefore, the basis of a series of testable predictions. Namely:

- a. Those with more time constraints will be more subject to the biases; and those with fewer time constraints will be less subject to the biases.

- b. Those with less energy – those that are tired – will be more subject to the biases; and those with more energy – those that are not tired - will be less subject to the biases.
- c. Those groups with less cognitive diversity will be more subject to the biases; and those groups with greater cognitive diversity will be less subject to the biases.
- d. Those groups with less psychological safety will be more subject to the biases; and those groups with greater psychological safety will be less subject to the biases.
- e. Those individuals with lower levels of metacognition will be more subject to the biases; and those with higher levels of metacognition will be less subject to the biases.
- f. Those less able to change their habits will be more subject to the biases; and those with a demonstrated greater ability to change their habits will be less subject to the biases.

Notice that each of these are framed on a continuum from more biased to less biased. This means that research based on these continuums allows researchers to test the causal nature of each key factor relative to biases.

More practically, this also means that as an investment practitioner, if you seek to mitigate the behavioral biases to improve your decision-making, that you need simply to counter the factors. That is, your research staff: need more time and energy; should have higher levels of cognitive diversity and psychological safety; and they should be hired, in part based on their ability to change their habits and their level of self-awareness. In fact, we would argue that if these considerations are satisfied that another prediction is that the investment results of such individuals and teams is higher than that of average individuals and teams.

Prediction 1a – Time Constraints – Evidence

A comprehensive review of the literature exploring the relationship between time available and decision-making quality is provided in Ordóñez (2015).^{x1} Among the major findings, there is a distinction between time constraints and time pressures. Constraints refer to externally imposed limitations on our ability to take time to make a higher quality decision. Whereas time pressure refers to the psychological reaction that a person has when she or he believes the amount of available time is less than the amount she or he believes is necessary to perform a task. Germane to Prediction 1a, an entire body of research finds:

“Research suggests that people have strategies, if limited, for coping with time constraints and, presumably, with any resulting sense of time pressure. For example,

they process information more quickly, become more energetic and anxious, and become more or less conservative in their risk-taking proclivity. Decision-makers under time constraint have been shown to switch to simpler strategies, stay with the same strategy if switching strategies would incur a cognitive cost, or simply fall back to old habits.”

Furthermore, they also state:

“Payne et al. provided strong evidence of the ‘adaptive decision maker,’ who selects from a set of strategies that trade effort for accuracy... [I]f time constraints are imposed or information costs are high, decision makers will switch to simpler, non-compensatory strategies... in which they consider only the most important variables and truncate a decision quickly, devoting less time and cognitive effort.”

So, Prediction 1a is supported by an entire body of scientific evidence.

Prediction 1b – Energy Constraints – Evidence

Research evaluating the causal relationship between a lack of energy/fatigue and behavioral bias was conducted by Hirshleifer, et al. (2020).^{xli} They tested whether decision fatigue – the tendency for decision quality to decline after an extensive session of decision-making – causes stock market analysts to be more heuristic in their forecasting. Net: “We find that forecast accuracy declines over the course of a day as the number of forecasts the analyst has already issued increases. Also consistent with decision fatigue, we find that the more forecasts an analyst issues, the higher the likelihood the analyst resorts to more heuristic decisions by herding more closely with the consensus forecast, by self-herding (i.e., reissuing their own previous outstanding forecasts), and by issuing a rounded forecast.”

Again, there is evidence in support of Prediction 1b.

Prediction 1c – Cognitive Diversity – Evidence

Multiple researchers link higher levels of cognitive diversity with better group decision-making. That said, there are limits as discussed above in the review of our theory’s assumptions. For example, because of energy conservation, time conservation, a need for psychological safety, and above all, working memory constraints, group decision making is best when done in a safe space where the group members are small in number.

That said, if people join in groups to increase the chance our genes propagate into the future, then the greater the cognitive diversity of these groups the better the decision-making

must be. Deloitte^{xiii} recently found in a large-scale survey of 105 business leaders found that: “an increase in individuals’ feelings of inclusion translates into an increase in perceived team performance (+17%), decision-making quality (+20%), and collaboration (+29%).”

Meanwhile, consultancy Cloverpop states, “Our research shows inclusive decision-making drives better company performance and gives a decisive competitive advantage. Inclusive decision-making leads to better business decisions up to 87% of the time. Business teams drive decision making twice as fast with half the meetings. Decision outcomes can improve by 60 percent.”^{xliii}

While these quotations are from consultancies, scientific journals have also featured research evaluating the importance of cognitive diversity to decision-making quality. It is for future researchers to directly test increases in group cognitive diversity leading to less behavioral bias. Until that occurs, we believe this prediction is not quite conclusively demonstrated as evidence for A Theory of Behavioral Finance.

Prediction 1 d – Psychological Safety – Evidence

Google’s well-known study that circulated like wildfire in the business community several years back found their highest performing teams all shared only one critical factor: psychological safety. This is logical because the main reason for participating in a group is for an improved chance of survival. Therefore, those that have the highest levels of psychological safety likely also have better survivability and decisions made under uncertainty.

More recently Zhou et al. (2020) found, “empirical evidence that individual EI [emotional intelligence] is positively related to individual influence on team decisions. Team-level EI improves team decision-making performance through increases in psychological safety.”^{xliv} In 2001 Edmondson stated of her research, “Results of a study of 51 work teams in a manufacturing company, measuring antecedent, process, and outcome variables, show that team psychological safety is associated with learning behavior...As predicted, learning behavior mediates between team psychological safety and team performance.”^{xlv}

Again, researchers to our knowledge have not directly tested and thus connected causally increases in psychological safety reducing behavioral biases. That said, increases in the quality of decision-making and outcomes coming from psychological safety likely involves a reduction in biases. However, for now, this is an inference and remains to be tested.

Prediction 1 e – Metacognition – Evidence

Recall that in our discussion of Assumption 1 – A Combination of Factors, that we quibbled with the claim made by many behavioral finance researchers that behavioral biases cannot be overcome. Our confidence in making this statement stems from pioneering research done by Kirk et al.^{xlvi} where behavioral biases have been directly tested against meditators. Many researchers of meditation find two primary improvements in practitioners’ abilities: increases in metacognition and top-down control. Therefore, it is no surprise that those with increased metacognition, like meditators, are able to make less biased decisions and are less susceptible to behavioral bias.^{xlvii}

Of the predictions of the Theory, this is the one that has been directly tested.

Prediction 1f – Changing Habits – Evidence

Assuming that a person has some level of metacognition, they should be able to more effortlessly change their habits and decision-making. After all, it is that self-awareness that allows people the realizations needed to give themselves more time to make a decision, to ensure they are not fatigued, to better modulate their behavior in groups, to check to see if they are feeling safe emotionally, and so on.

Recall in our exploration of Assumption 3 – The Psychological Factors, we discussed at length the difficulty of changing habits. Specifically, Dunhigg says in his *The Power of Habit*, “When a habit emerges, the brain stops fully participating in decision making.”^{xlviii} Habit loops form to conserve time and energy, and very typically most habits are in place before age 9. But that does not mean that people do not change. In fact, we do.

We believe this is self-evident, but more research needs to be done to test whether or not behavioral biases are more easily overcome by those with greater metacognition and top-down control, as Kirk’s work above demonstrated.

Prediction 2

The second major prediction of A Theory of Behavioral Finance is that a company’s securities’ prices are more volatile than would be expected when examining the operating performance of the same company, and that this is due to the behavioral biases of investors. Stated more directly, securities prices are volatile due to investor emotions.

In *Return of the Active Manager*, the following chart is offered in support of this prediction:^{xlix}

S&P 500 Average Level Volatility (January 1, 1950 thru May 31, 2020)

	High	Low	Avg. Level	Spread	Volatility	Decade Avg.
1950	20.43	16.66	18.40	3.77	20.5%	
1951	23.85	20.69	22.32	3.16	14.2%	
1952	26.59	23.09	24.50	3.50	14.3%	
1953	26.66	22.71	24.72	3.95	16.0%	
1954	35.98	24.80	29.72	11.18	37.6%	
1955	46.41	34.58	40.50	11.83	29.2%	
1956	49.64	43.11	46.64	6.53	14.0%	
1957	49.13	38.98	44.42	10.15	22.8%	
1958	55.21	40.33	46.20	14.88	32.2%	
1959	60.71	53.58	57.42	7.13	12.4%	
1960	60.39	52.20	55.85	8.19	14.7%	20.7%
1961	72.64	57.57	66.27	15.07	22.7%	
1962	71.13	52.32	62.32	18.81	30.2%	
1963	75.02	62.69	69.86	12.33	17.6%	
1964	86.28	75.43	81.37	10.85	13.3%	
1965	92.63	81.60	88.16	11.03	12.5%	
1966	94.06	73.20	85.18	20.86	24.5%	
1967	97.59	80.38	91.96	17.21	18.7%	
1968	108.37	87.72	98.38	20.65	21.0%	
1969	106.16	89.20	97.77	16.96	17.3%	
1970	93.46	69.29	83.15	24.17	29.1%	20.7%
1971	104.77	90.16	98.32	14.61	14.9%	
1972	119.12	101.67	109.13	17.45	16.0%	
1973	120.24	92.16	107.44	28.08	26.1%	
1974	99.80	62.28	82.78	37.52	45.3%	
1975	95.61	70.04	86.18	25.57	29.7%	
1976	107.83	90.90	102.04	16.93	16.6%	
1977	107.00	90.71	98.18	16.29	16.6%	
1978	106.99	86.90	96.11	20.09	20.9%	
1979	111.27	96.13	103.00	15.14	14.7%	
1980	140.52	98.22	118.71	42.30	35.6%	23.6%
1981	138.12	112.77	128.04	25.35	19.8%	
1982	143.02	102.42	119.71	40.60	33.9%	
1983	172.65	138.34	160.47	34.31	21.4%	
1984	170.41	147.82	160.46	22.59	14.1%	
1985	212.02	163.68	186.83	48.34	25.9%	
1986	254.00	203.49	236.39	50.51	21.4%	
1987	336.77	223.92	287.00	112.85	39.3%	
1988	283.66	242.63	265.88	41.03	15.4%	
1989	359.80	275.31	323.05	84.49	26.2%	
1990	368.95	295.46	334.63	73.49	22.0%	23.9%
1991	417.09	311.49	376.19	105.60	28.1%	
1992	441.28	394.50	415.75	46.78	11.3%	
1993	470.94	429.05	451.61	41.89	9.3%	
1994	482.00	438.92	460.42	43.08	9.4%	
1995	621.69	459.11	541.72	162.58	30.0%	
1996	757.03	598.48	670.49	158.55	23.6%	
1997	983.79	737.01	873.43	246.78	28.3%	
1998	1,241.81	927.69	1,085.50	314.12	28.9%	
1999	1,469.25	1,212.19	1,327.33	257.06	19.4%	
2000	1,527.46	1,264.74	1,427.22	262.72	18.4%	20.7%
2001	1,373.73	965.80	1,194.18	407.93	34.2%	
2002	1,172.51	776.76	993.93	395.75	39.8%	
2003	1,111.92	800.73	965.23	311.19	32.2%	
2004	1,213.55	1,063.23	1,130.65	150.32	13.3%	
2005	1,272.74	1,137.50	1,207.23	135.24	11.2%	
2006	1,427.09	1,223.69	1,310.46	203.40	15.5%	
2007	1,565.15	1,374.12	1,477.18	191.03	12.9%	
2008	1,447.16	752.44	1,220.04	694.72	56.9%	
2009	1,127.78	676.53	948.05	451.25	47.6%	
2010	1,259.78	1,022.58	1,139.97	237.20	20.8%	28.5%
2011	1,363.61	1,099.23	1,267.64	264.38	20.9%	
2012	1,465.77	1,277.06	1,379.35	188.71	13.7%	
2013	1,848.36	1,457.15	1,643.80	391.21	23.8%	
2014	2,090.57	1,741.89	1,931.56	348.68	18.1%	
2015	2,130.82	1,867.61	2,061.07	263.21	12.8%	
2016	2,271.72	1,829.08	2,094.65	442.64	21.1%	
2017	2,690.16	2,257.83	2,449.08	432.33	17.7%	
2018	2,930.75	2,351.10	2,746.21	579.65	21.1%	
2019	3,240.02	2,447.89	2,913.36	792.13	27.2%	
2020	3,386.15	2,237.40	2,969.49	1,148.75	38.7%	21.5%

22.8% Avg. Vol.
9.7% Std. Dev.
42.6% CV

By Decade
22.8% Avg. Vol.
2.9% Std. Dev.
12.5% CV

This chart shows a simple metric regarding the components of the S&P 500 stock index: the annual 52-week high, less the annual 52-week low, divided by the average annual level of the index. That these spreads, even when averaged over long periods of time are so large is evidence of behavioral bias driving stock prices. This is especially true when compared with the likely very stable operating performance of the components of the S&P 500 over these same time periods. Is it rational, for example, that the actual value – say as measured by total assets – of a very stable business such as Proctor and Gamble would fluctuate by an average of 22.5% over this same time period? We think it is not rational. Examining this point in greater depth is the following chart:

Q1 2009 through 4Q2019

	Avg. Stock Price Growth/ Avg. B/S Growth	Avg. Std. Dev. Price/ Avg. Std. Dev. B/S	Total B/S Growth	Total Price Growth
AAPL	152.1%	186.7%	687.8%	2521.0%
AXP	396.0%	292.9%	63.7%	513.6%
BA	291.8%	287.8%	141.5%	950.7%
CAT	941.6%	446.1%	21.7%	411.5%
CSCO	377.4%	288.4%	39.8%	205.1%
CVX	252.1%	392.6%	48.9%	142.1%
DD	107.2%	52.6%	57.2%	226.4%
DIS	143.6%	55.9%	218.8%	633.4%
GS	1187.8%	419.6%	7.3%	114.0%
HD	1338.5%	212.6%	17.1%	1026.7%
IBM	192.3%	223.7%	49.3%	92.9%
INTC	183.9%	328.9%	181.8%	464.9%
JNJ	240.2%	315.1%	83.2%	293.9%
JPM	690.6%	396.1%	29.3%	416.0%
KO	196.1%	90.0%	100.4%	317.0%
MCD	285.5%	85.3%	70.8%	459.8%
MMM	231.7%	256.6%	83.5%	264.9%
MRK	166.9%	40.4%	81.3%	417.7%
MSFT	179.3%	243.3%	310.7%	985.1%
NKE	329.5%	226.0%	110.5%	951.7%
PFE	361.1%	89.9%	36.2%	315.5%
PG	-883.5%	225.2%	-15.6%	253.8%
TRV	1435.7%	552.3%	-0.3%	317.0%
UNH	240.0%	202.6%	210.0%	1252.4%
RTX	173.8%	177.5%	155.0%	349.3%
V	298.4%	118.7%	134.0%	1226.1%
VZ	454.9%	148.6%	28.6%	252.4%
WBA	68.1%	114.0%	265.8%	105.5%
WMT	321.5%	309.1%	45.9%	197.4%
XOM	75.1%	211.2%	63.0%	31.0%
	347.6%	233.0%	110.9%	523.6%

What the above graphic of the DJIA components shows in the second column is the average quarterly growth in each company's stock price, divided by the average quarterly growth in their total assets. As you can see, with the exception of WBA and XOM (PG's total assets just barely shrank), every company's quarterly growth in stock price grew much faster than did the balance sheets. How much? 347.6% faster. Not only that, but the standard deviation of the quarterly stock price growth as compared to the total assets growth is 233.0% as shown in the third column. This means that the stock price series is much more volatile, too.

A complaint might be that stock prices are marked-to-market, but that balance sheets are not. Fair enough, but as we can see in columns 4 and 5, the balance sheets, on average more than doubled over the time period, yet the stock price growth was in excess of that amount. In other words, the balance sheets are not stagnant. Not only that, but firms like GS where their balance sheet is almost entirely marked-to-market show little growth as compared with the growth in their stock price. Ditto: JPM. No, instead, the conclusion must be that stock market prices are more volatile, and this is likely due to misestimations of value caused by emotions and behavioral biases.

Research conducted by Hirshleifer and Siew (2002),¹ states the following in the conclusion of their analysis: "This paper has examined the consequences of limited attention for disclosure, financial reporting policy and market trading...Owing to limited attention, such choices can affect investor perceptions and market price. In our approach, investors sometimes neglect relevant aspects of the economic environments they face, such as strategic incentives of firms to manipulate investor perceptions." In other words, time constraints lead to limited attention, which in turn leads to neglect of crucial information.

Conclusion

We have offered multiple assumptions in support of A Theory of Behavioral Finance. Unique in our approach is that we postulate that behavioral biases have multiple causes, and that to understand and mitigate the biases, we need to rely on multiple scientific disciplines. These multiple causes include biological, psychological, and sociological. The Theory also, to our knowledge, for the first time, advances a number of falsifiable predictions that if tested and confirmed would support the Theory. Most of these predictions already show strong indirect evidence, if not direct evidentiary support. This stands in stark contrast to Modern Portfolio Theory whose assumptions are unrealistic (i.e., people are not 100% rational), and its predictions are not borne out by the data (e.g., see Basu or Shiller).

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