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AUTO CORRECT

What Driverless Cars Can Teach Us About Behavioral Finance

By Omar Aguilar, PhD

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Technology and behavioral science have made for a powerful combination. Across a diverse range of applications, from medicine to aviation to finance, there is growing recognition that automomous systems generally result in faster, more disciplined decision-making than humans alone. However, the road to full autonomy is a long one, potholed with complications. As a result, interim solutions integrate autonomous technology with human intervention and oversight. Yet therein resides another problem: Humans are generally terrible emergency backup systems.

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In the autonomous vehicle field, this challenge is known as the "Level 3 problem." For years, auto industry executives approached self-driving cars as a long-term mission that would be achieved in distinct stages, much like the moon landing. Then car companies realized that the same human traits that triggered the need for driverless technologies in the first place—inattention, slowness to respond, the tendency to overreact in a crisis—become compounded in a quick handoff from an autonomous system to human control. Therefore, many developers of autonomous vehicles have largely abandoned systems that control the car under domain-specific scenarios but rely on people to take over in a crisis (regulators generally refer to this as "Level 3 conditional automation"). These companies are moving straight from Level 2 driver-assist packages to Level 4, in which a car is fully autonomous under most driving conditions.

The investment industry has its own Level 3 problem. More than three decades of behavioral finance research, combined with major advancements in computing power, have generated a robust toolkit for helping to create portfolios aligned with investors' specific goals and objectives. For example, there are programs to help ensure that investors save more for retirement and target-date funds to assist them in taking the appropriate level of risk for each stage along the way. There are also low-cost strategic beta strategies that can complement market cap-weighted index strategies, potentially enabling better overall portfolio diversification. In addition, there are robo-advisory platforms that use behavior-based algorithms to tactically optimize performance based on market conditions and each investor's individual behavioral risk profile.

All these advances have helped to shield millions of investors from their own worst impulses. However, just as with self-driving vehicles, we must be careful not to be lulled into believing these innovations provide more protection than they do.

If behavioral finance is to realize its full potential as a force for better client outcomes, we must think through how behavioral insights can inform the entire investment and portfolio construction process. We need to engineer solutions that operate on multiple levels and conform to each individual investor's habits. These solutions must include reality checks, client training, and mission-critical feedback loops that guard against an inopportune response from behind the wheel.

THE CLASSICAL FINANCE MODEL

Once upon a time, investors had a thorough, all-encompassing system called classical finance theory. Born of the hyper-rationalist 1950s and early 1960s, classical finance describes market participants as rational investors acting in their own best interests. Classical finance holds little room for biases that color decisions or utility functions such as seeking downside protection. Harry Markowitz (1952) codified these ideas into modern portfolio theory (MPT), under which each optimally constructed portfolio can be designed along an efficient frontier representing optimal tradeoffs between risk and return. Later, William Sharpe (1970) connected this theoretical framework to portfolios with the capital asset pricing model (CAPM), showing that all differences in expected returns are determined by differences in risk. Eugene Fama (1965) and others bolstered the evidence for the efficient market hypothesis by espousing the concept that prices fully reflect all available information.

As elegant as these theories and models appeared, however, some of the core assumptions on which they rely proved questionable. Starting in the late 1970s, Daniel Kahneman and Amos Tversky conducted a series of experiments that exposed these holes. They studied how people often view tradeoffs based on mental heuristics and feel greater emotional impact associated with losses compared to equivalent gains. Kahneman and Tversky (1979) found that the tradeoffs between risk and return follow more of an S-curve, with people attaching far greater weight to the prospect of losses than to the prospect of incremental gains.

This "prospect theory" later formed the basis of other behavioral observations. For example, people tend to anchor on a specific point of reference—such as a portfolio's past high—when measuring performance (anchoring bias). Individuals also can place too much emphasis on experiences freshest in their memories (recency bias). A desire to copy the actions of others and follow the herd (herding bias) represents yet another behavioral observation. People also make errors in mental accounting: They overestimate their abilities (overconfidence bias), tend to seek evidence to confirm preexisting beliefs (confirmation bias), and attach far greater value to items already in their possession (the endowment effect).

In other words, many of the choices made by investors are not unbiased at all. In systems as complex and laden with emotional triggers as the financial markets, investors use mental filters and shortcuts to process information. Some of these may be cognitive biases stemming from defective thinking or memory. Others may be emotional biases rooted in the most primitive parts of our brains. The point is, in no case do they ever fit neatly into a framework that attributes every decision to the rational optimization of monetary gain.

THE MARKET IS US

Of course, the market is not one person. It represents the collective actions of individuals, each potentially experiencing various behavioral biases that may be more or less dominant depending on unique experiences.

The fact that many biases may operate on the market at the same time raises the question of whether they somehow could cancel one another out. Proponents of classical finance theory clung to this possibility as part of the defense of MPT and the CAPM: Even if investors are biased, prices still can be rational as the "invisible hand" of a competitive market magically does its work. In his book *Misbehaving*, behavioral economist Richard Thaler (2015) spoofs this argument: "Suppose there were people doing silly things like the subjects in your experiments, and these people had to interact in competitive markets, then ..." Thaler calls this the "invisible hand wave," because, he tells us, no classical economist has ever been able to finish the sentence with both hands remaining still.

As bubbles and busts have unfolded over the past three decades, the alternate explanations of market behavior provided by behavioral finance have become harder to brush aside. First, even if prices are rational and investors are not, that still leaves a huge potential source of friction. Absent some framework for managing the disconnect, rationalizing investors' expectations with their actual needs becomes a perpetual challenge. Second, the past 30 years of fear- and greed-driven market cycles, not to mention extensive research—on everything from the small-cap bias (Banz 1981) to the value effect (Latif et al. 2011) to price momentum (Jegadeesh and Titman 1993)—point to prices not being entirely rational.

Today, most economists likely would agree that the classical models remain useful, but only as a starting point. Most now seem to recognize it is likely better to think of markets as generally efficient over the long term. However, it is clear that some anomalies exist and help drive asset prices at the specific security level. In addition, there are periods where one or another set of anomalies can dominate and drive the market as a whole.

WHERE IT GETS TRICKY

In many cases, investors may not be aware of the behavioral biases embedded in their portfolios. For example, in the short run, a market cap-weighted index can experience significant price distortions—winning stocks often become more heavily weighted within an index while losers get even less-weighted by comparison. For many investors, resisting the pull of this momentum effect can be difficult. Their reactions may not even be conscious. However, there are also investors for whom portfolio biases are foreign and incidental.

We refer to these as "implicit biases." Take the example of an investor who has long kept the majority of his portfolio's equity exposure in a product benchmarked against a market cap-weighted index such as the S&P 500®. This investor may simply view the choice as a solid, cost-effective approach to investing, reflecting assumed best practices regarding diversification and the difficulty of beating the market. Each month when this investor views his statement and sees healthy gains, he is disinclined to delve too deeply into what is really going on.

Therefore, when the market finally corrects, the investor isn't just disappointed at the results—he's shocked. As shown in table 1, at one point in mid-2018 more than 75 percent of the S&P 500's year-to-date gains had become concentrated in just five stocks that represented large weights in the index. Anyone with equity holdings benchmarked against the index and seeking to own the market essentially had become part of a giant momentum play in a handful of high-profile companies, likely driven in no small measure by the overconfidence and availability biases of millions of investors.

Table 1

IN THE UNITED STATES, FAANG* STOCKS REPRESENTED 78 PERCENT OF THE S&P® INDEX'S FIRST-HALF 2018 RETURNS

	Year-to-Date Returns (%)	Contribution to S&P Year-to-Date Returns (%)
Facebook	10.1	0.19
Amazon	45.4	0.91
Apple	10.3	0.42
Netflix	103.9	0.37
Google**	7.2	0.10
Google	6.6	0.09
		2.08 (78%)
S&P 500 Index Total Return	**2.65**	

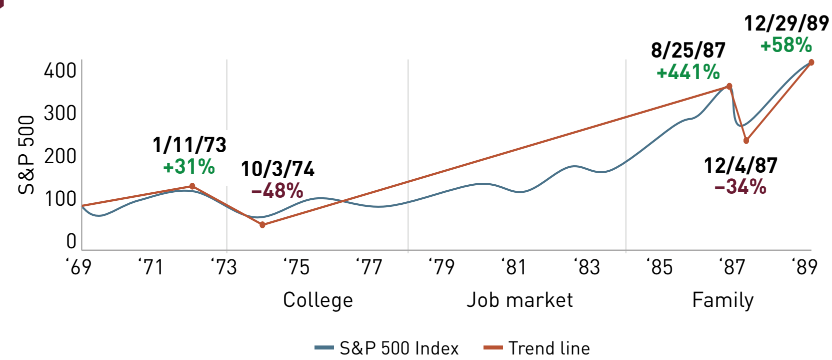
**FAANG is the weighted average price of Facebook, Amazon, Apple, Netflix, and Google stocks.*
***Google results above reflect two different share classes.*
Sources: Charles Schwab Investment Management; Bloomberg attribution analysis, using total returns index; data from December 31, 2017, to June 30, 2018. Illustrative research sample. Past performance is no guarantee of future results. Indexes are unmanaged, do not incur management fees, costs, and expenses, and cannot be invested in directly.

LEVEL 3 BREAKDOWN

However, it gets even more complicated. Beyond all the biases reflected in the markets and in individual portfolios, there are also important demographic and social influences.

Figure 1

BOOMERS' MARKET EXPERIENCE (1969–1989)



Sources: Charles Schwab Investment Management; Bloomberg. Indexes are unmanaged, do not incur management fees, costs, and expenses, and cannot be invested in directly. Past performance is no guarantee of future results.

We have observed this particularly in two of today's largest wealth management demographic cohorts: baby boomers and millennials.

As the generation that planned to change the world, baby boomers are fertile ground for overconfidence and confirmation biases. Figure 1 shows that although the baby-boomer generation has experienced its share of bull and bear markets, it has repeatedly seen the market recover and trend higher. This has added to baby boomers' sense of decision-making invincibility. At a stage in their lives when textbook risk optimization would have them moving down the curve toward a more conservative asset mix, many have remained heavily invested in high-beta growth stocks.

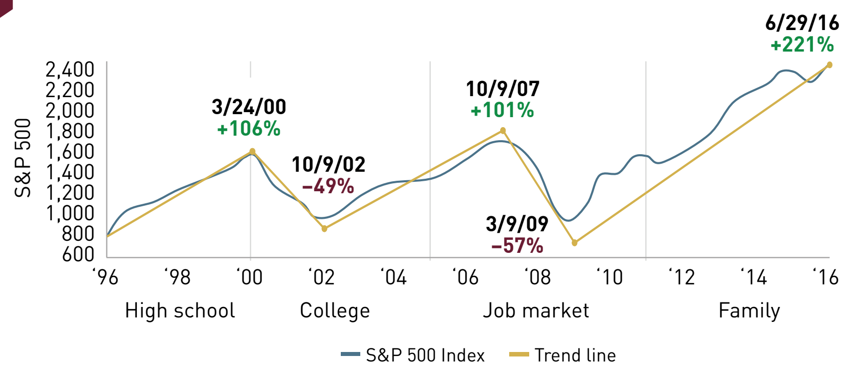
We have seen this pattern on full display over the past 18 months. Early in 2018, after the first wave in many years of extreme market volatility, a number of advisors with significant assets under management commented that their baby-boomer clients seemed to be treating the selloff as a buying opportunity to increase technology exposures. The market's return to new heights since then has meant that the overconfidence of baby boomers once again has been rewarded. Yet it also has left many even more exposed to a potential crash—one that they may not be as quick to recover from as they rapidly approach retirement.

Millennials suffer from opposite patterns. Their lengthy investment horizons and surfeit of human capital should put these young investors at the most aggressive end of the risk spectrum, yet in many cases they project even older than their parents (see figure 2). A childhood spent in the shadow of the dot-com bust and early working years spent weathering the financial crisis have embedded a heightened desire for loss aversion in the minds of millennials. Cognitive biases around illusion of control further cloud their judgment, just as they do with the baby boomers. For millennials, though, these biases center more on an exaggerated sense of the protective power of cash and an underestimation of the risk this poses to growing assets sufficiently over time to reach financial goals. A herding bias fed by social media adds additional layers of complexity.

Ironically, these influences recently had jarring impacts at a number of the robo-advisory platforms popular with millennials. Although the behavioral-based algorithms and programmed rebalancing of these platforms are designed to insulate users

Figure 2

MILLENNIALS' MARKET EXPERIENCE (1996–2016)

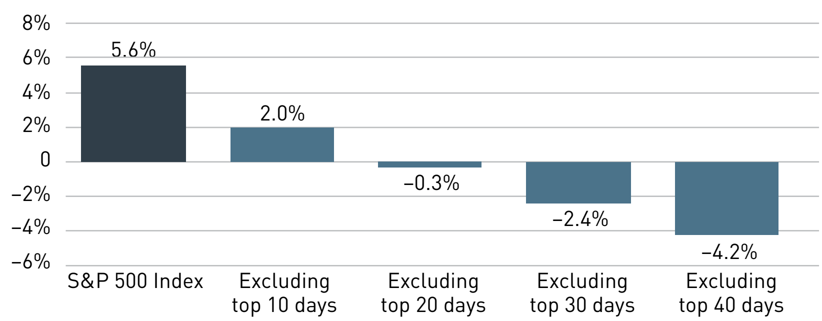


Sources: Charles Schwab Investment Management; Bloomberg. Indexes are unmanaged, do not incur management fees, costs, and expenses, and cannot be invested in directly. Past performance is no guarantee of future results.

Figure 3

TIME IN THE MARKET IS MORE IMPORTANT THAN TIMING THE MARKET

Index annualized total return (1999–2018)



Sources: Schwab Center for Financial Research™ with data provided by Standard and Poor's. Return data is annualized based on an average of 252 trading days within a calendar year. The year begins on the first trading day in January and ends on the last trading day of December, and daily total returns were used. Returns assume reinvestment of dividends. When out of the market, cash is not invested. Market returns are represented by the S&P 500® Index which represents an index of widely traded stocks (dark blue bar). Top days are defined as the best-performing days of the S&P 500 during the 20-year period. Indexes are unmanaged, do not incur fees or expenses, and cannot be invested in directly. Past performance is no guarantee of future results.

from market spasms, users can override the system and liquidate assets at any time—the prototypical Level 3 solution for resolving a driving crisis. During the February 2018 selloff, a handful of wealth management websites became overwhelmed by heightened volume during a frenetic two days of trading. As the Dow plunged 1,175 points, its largest single-day point drop in history, millennials wanted access to their money (Allocca 2019).

LEVEL 4

What might a Level 4 system for constructing and managing client portfolios look like? Given that most investors can be their own worst enemies in a market crash, how might we design a system that fully accounts for the necessary complexity without relying on the weakest link as the fallback? Even if, technologically speaking, true driverless portfolios are not a practical solution, can we use technologies and our increasingly evolved understanding of investor behavior to mitigate the biases hardwired in our brains?

I think the answer is to take a page out of classical finance and approach this design project as holistically, and ambitiously, as possible. To stick to the car analogy, we must reconceive the entire portfolio construction process as a behavioral exercise. In the process, we can use the following four basic tenets to guide our thinking.

Accept that markets are not entirely efficient and find innovative ways to diversify. As evidenced by the cyclical patterns of booms and busts, market inefficiencies tend to wax and wane. These cycles, in turn, are characterized by biases and certain related factors (value, growth, momentum, etc.) that go in and out of favor. Rather than trying to time the market for a specific factor outperformance, which is hard to predict, investors should consider investing in well-balanced and diversified portfolios, which could help smooth their ride through the market cycles and help investors stay invested over the long term (see figure 3).

Strategic (or smart) beta is one of the important innovations that has emerged in recent years. Available at relatively low costs, investment vehicles focused on these strategies can be combined with traditional market cap-weighted index strategies for additional portfolio diversification, and to help offset some of the embedded implicit biases in cap-weighted indexes. For example, traditional market cap-weighted indexes potentially can neglect some of the smaller-capitalization firms that look promising in favor of better established, larger-capitalization companies that already may have reached their growth potential. Complementing investment products in market cap-weighted indexes with investments focused on alternatively weighted strategies (e.g., active management, strategic beta, etc.) may provide more opportunities for exposure to small-company equities, as well as risk reduction by decreasing momentum exposure in certain market environments. Where cost considerations for actively managed products represent a concern, smart beta strategies may provide less-expensive alternatives.

Consider risk-optimization methods beyond mean-variance optimization. Portfolio construction is about balancing client wants with client needs to meet their investment objectives. Utility functions differ from investor to investor and may change over time, and portfolio construction should reflect this. Other types of risk optimization beyond classic mean-variance optimization may be required to get the asset mix right. The standard risk profile is still the foundation for most sound portfolio construction efforts, but it is not enough on its own, for the simple reason that investors have different definitions of risk. A more effective approach incorporates elements of both traditional risk profiling and investor-specific utility functions. For example, changing utility functions could drive the allocations at the sub-asset class level and set the ultimate portfolio weights. If growing wealth is the primary utility function, the portfolio could tilt much more toward riskier but potentially higher-growth segments. Alternatively, if downside protection is the ultimate objective, some of these riskier sub-asset classes might be extracted from the mix entirely. The approach is all about achieving the right balance between client wants and client needs to create a more robust solution.

Develop a disciplined and systematic implementation approach. Rebalancing may be the easiest part of the portfolio construction process to automate, but it can prompt additional behavioral biases. Therefore, a rigorous yet practical process needs to be adopted to ensure against rebalancing misfires. Most disciplined rebalancing systems include some pre-set trigger points for when and how decisions are made to bring the portfolio back to its strategic weights. Yet this is often precisely where many Level 3 systems start to break down. Consider the situation where a market drawdown reduces the value of equity holdings and upsets the balance with bonds. The rebalancing algorithm may call for buying into the teeth of the selloff to bring portfolio weights back into equilibrium. But if the algorithm does this without consideration of how the risk-averse investor will react, it may amplify this investor's overreaction. Similarly, a call to pull profits off the table in the midst of a powerful market rally could frustrate an investor at the opposite end of the behavioral risk spectrum. In either scenario, a safety function designed to keep a portfolio motoring on a smoother path could turn into a catalyst for an investor override that short-circuits the whole process. That's why when designing a rebalancing program it's important to think in terms of broad bands rather than binary yes-or-no, hard-and-fast triggers, to giving investors more time to acclimate and reorient rather than simply reacting.

Incorporating behavioral finance supports strong advisor–client relationships. Integrating behavioral aspects into portfolio construction goes a long way toward building strong and longstanding relationships between advisors and clients. Incorporating behavioral modification into portfolio construction cannot be static—continual touchpoints and feedback loops are critical. In the design of driverless vehicles, a critical early step always involves putting an experienced driver behind the wheel to train the system how to drive. Only in this way does the system begin to recognize that when the onboard cameras capture one set of pixels moving at a certain speed and direction there is a small animal crossing the road but that another combination of pixels is only a shadow. When an image doesn't compute, the system also learns to alert the person to take more direct control of the vehicle, giving itself another input to perform more autonomously in the future. The same continuous feedback loop holds for investment professionals on the front lines of techno-behavioral applications. Wealth management isn't yet able to incorporate artificial intelligence as thoroughly as the Level 4 systems in some other fields, so our portfolio construction systems must continually solicit input from the humans they serve. In this way, the machine learning of the system is continuous. As advisors learn more about the behavioral impulses of their clients, they should consider employing a series of bias-mitigation tactics. Think of these as a last line of defense against investor overreactions, and as a standing touchpoint for advisors to check their client-related assumptions. For one type of investor, this could mean putting the person on a media diet to prevent bingeing on news when the investor's loss-aversion and recency biases are on full alert, or a mutually agreed-upon waiting period before pressing the panic button or advisor's phone number. For another client, it could mean a reality checklist that appears in the investor's email inbox whenever the market reaches a new high. By the Level 4 standards of some fields, these mitigation tactics aren't terribly high tech. Fortunately, to counter the effects of some of our most primordial impulses and thought processes, they don't need to be.

THE ROAD AHEAD

Behavioral finance has done much to add to our understanding of investing and markets. Investors are people with varied assortments of emotional reactions and faulty thought patterns that can negatively influence decision-making. Although classical models remain useful as starting points for portfolio construction, the ability to design evolved solutions can help counter investors' biases and potentially produce portfolios that better align client wants with their needs to achieve investment objectives.

However, as we carve out a larger role in the investment process for systems programmed to correct for investor behaviors, we must continually be aware of the awkward marriage we are creating. As in other fields being transformed by technology and decision science, we must recognize that there is little room for partial solutions or systems that operate in a vacuum. Instead, we should use behavioral insights to inform the entire portfolio construction and investment process.

This article has provided suggestions for shoring up weak points in the ever-evolving techno-behavioral wealth management landscape. One important byproduct of these efforts should be a potential strengthening of long-term advisor-client relationships. Investing always will involve unpredictability, but advisors who better-know their clients can mitigate that unpredictability with enduring communication and trust. Contrary to the popular belief that the new wealth management robots are coming for advisors' jobs, I believe that advisors are critical for the new systems to succeed.

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