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Chaos and Retirement Income

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When the media, academics, and politicians tout investment strategies such as indexing as universal truths without distinguishing between wealth accumulation and distribution, they promote strategies that are dangerous to retirees' life savings. Accumulating wealth is a linear process, but taking withdrawals from a portfolio injects nonlinearity, and "nonlinearity means that the act of playing the game has a way of changing the rules" (Gleick 1987). Trying to solve retirement income using rules for accumulating wealth is dangerous. Because three-fourths of financial assets belong to people of or near retirement age (Srinivas and Goradia 2016), dangerous investment advice is a widespread problem. Chaos theory, which focuses on nonlinear processes such as retirement income, is key to understanding why and how the rules of portfolio management change from pre- to post-retirement. This understanding is the basis for creating safer portfolios for retirees. Chaos theory is also the basis for making retirement income simpler and more personalized because it allows us to see what to pay attention to and what to ignore.

This paper explains why accumulating wealth is a linear process and distributing wealth is a nonlinear process governed by the principles of chaos. It then focuses on four principles and their impacts on portfolio management for retirees. First, nonlinear relationships are unpredictable, so retirement income is about preparing rather than predicting. Second, for nonlinear relationships, even small, early changes can have significant long-term effects and worst-case risk may have catastrophic impact, so retirees should prepare for the worst and then adapt. Third, averages mask nonlinearity and therefore should be ignored—except for erosion rate, because it facilitates adaptation. Fourth, nonlinear problems require nonlinear thinking that leads to multiple solutions, which provides retirees with choices and the personalized solutions they desire. This problem-solving process allows advisors to differentiate themselves as well. Given the importance of nonlinear thinking, it is important to understand the biases that impede it.

CHAOS AND RETIREMENT INCOME

Edward Lorenz trained as a weather forecaster at MIT, then earned a doctorate in meteorology there and spent his career at his alma mater. He was interested in weather forecasting at a time when most meteorologists scorned forecasting and mistrusted computers (Gleick 1987). But by the late 1950s, Lorenz was using a computer to run simulations of weather models to evaluate forecasting techniques. In 1961, he was repeating a simulation when he rounded a variable from 0.506127 to 0.506 and was surprised when that seemingly insignificant change dramatically altered the output from the earlier simulation. This result seemed to challenge classical physics, which holds that, given the initial state of a system, you can calculate all possible future states; and that approximately accurate inputs lead to approximately accurate outputs. This result also became the foundation of chaos theory, the area of mathematics that focuses on complex, nonlinear systems that are very sensitive to slight changes in inputs.

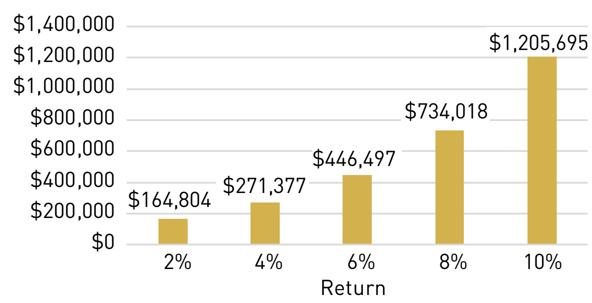
In linear systems, inputs are proportional to outputs, so outcomes are easily and accurately predicted. For example, if every shelf holds fifty books, you can accurately forecast that ten shelves will hold 500 books. The input (one shelf) is proportional to the output (fifty books). The relationship plots on a graph as a straight line (in this case sloping upward) and can be accurately projected into the future. Wealth accumulation is a linear process and given the initial state of that process (present value), you can predict all possible future states (future value).

Figure 1 shows the value of $100,000 after accumulating for twenty-five years assuming different rates of return. As the return increases by 2 percent, each bar increases by approximately 64 percent from the previous bar (e.g., $271,377 is 64 percent greater than $164,804). Because the input (2-percent increase in return) is proportional to the output (64-percent increase in wealth), it is a linear relationship, and as such is predictable.

Figure 1

RETURNS AND WEALTH

Value of $100,000 after Accumulating 25 Years at Different Rates of Return



Similarly, if you pay an annual portfolio fee that is 0.25 percent per year less than I do when accumulating wealth, you should finish the twenty-fifth year with approximately 6 percent more principal than I have. The input (0.25-percent fee reduction) is proportional to the output (6-percent increase in wealth), meaning it is a linear relationship and is predictable. Figure 2 illustrates this by showing that each additional 0.25-percent reduction in fees increased ending values by an additional 6 percent during the period 1966 through 1990.

Figure 2

FEES AND WEALTH

Ending Accumulation Values with Different Fees, 1966–1990

$1 Million Investment, 50/50 Allocation

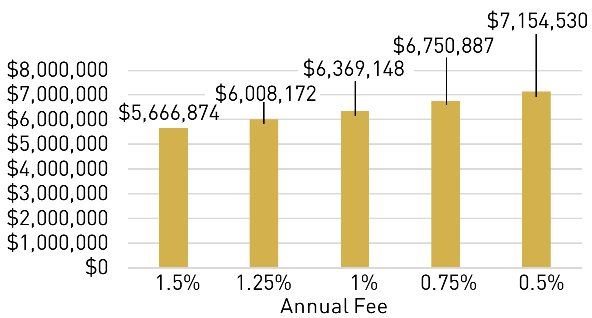


Figure 3

NONLINEARITY AND RETURNS

Year-by-Year Account Values

$1 Million Investment, 50/50 Allocation, 5% Withdrawal Increased 3% Annually

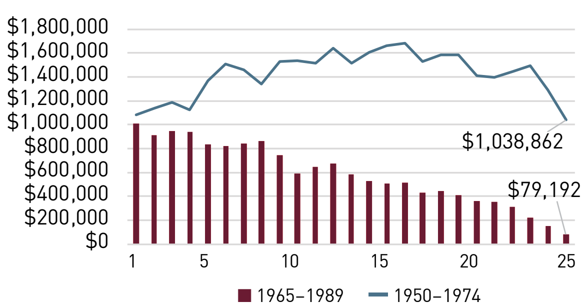
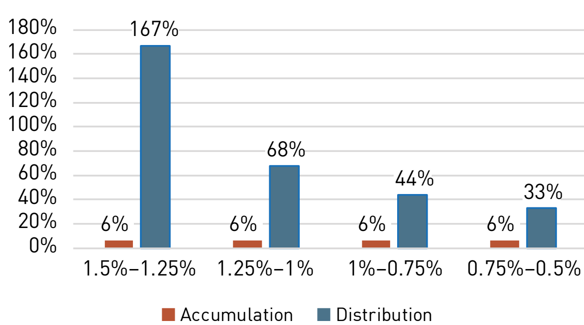


Figure 4

NONLINEARITY AND FEES

Incremental Increase in Ending Values with Each Subsequent 0.25% Fee Reduction, 1966–1990



The linearity of these relationships is key to classical portfolio management and makes accumulation financial planning predictable. As classical science taught that knowing the initial state of a system allows you to predict all possible future states, classical portfolio management teaches that knowing the present value of a portfolio allows you to predict all future values.

However, taking withdrawals injects nonlinearity into portfolio management. In the nonlinear world of retirement income, inputs (returns) are not proportional to outputs (wealth), average returns are not predictors of success, neither higher returns nor lower fees guarantee better financial outcomes, and averages mask nonlinearity. Figure 3 shows the year-by-year values when I applied the same retirement income methodology to two different twenty-five-year periods. The account represented by the line earned an average annual return of 7.2 percent, less than the 9.3 percent annual return earned by the account represented by the bars, yet it finished with considerably more wealth ($1,038,862 versus $79,192).

Similarly, figure 4 shows the percentage increase in wealth generated by each 25-basis-point reduction in fees. The tall bars show that the input of fees is not proportional to the output of wealth when taking withdrawals because reductions in fees did not generate a consistent incremental increase in wealth. Compare this with the short bars, which illustrate the consistent 6-percent increases during accumulation. When applied to different periods, the accumulation bars always reflected approximately 6-percent increases but the distribution bars showed different percentage increases than those here. However, distribution bars always followed the pattern seen in figure 4, with the first fee reduction showing the largest percentage increases in wealth (first bar), and each subsequent fee reduction resulting in smaller percentage increases in wealth.

The third key relationship that becomes nonlinear post-retirement is the one between the inflation rate and wealth. If inflation increases 3 percent when you are accumulating wealth, your wealth also must increase 3 percent to maintain your standard of living. That is not the case when taking withdrawals from a portfolio, and to assume that it is the case is a major flaw in much of the research around many of the calculators of retirement income. Assumptions create boundaries that limit creative insight. Assuming that in retirement cash flow must increase at the historical 3-percent inflation rate to maintain your standard of living has led the industry to struggle to develop innovative retirement income solutions. Challenging assumptions is the genesis of creative thinking.

Because the relationships between returns and fees to wealth are linear when accumulating wealth, some media, academics, and politicians promote the idea that portfolio management is simply about maximizing returns and minimizing fees. Because many of those parties believe portfolio managers cannot

VOLUME 8
NUMBER 1
2019

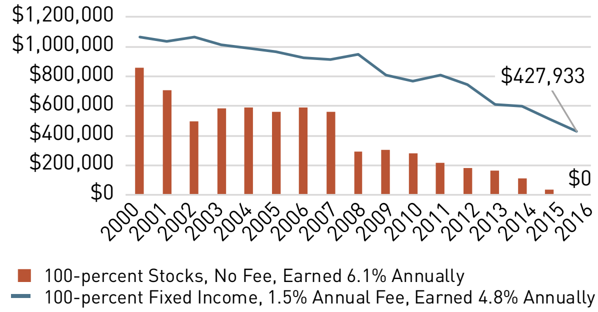
generate a higher return than the S&P Index, they encourage investors to minimize fees by not paying for investment advice (*The Economist* 2014). Figures 3 and 4 show that when distributing wealth, the relationships of returns and fees to wealth become nonlinear and are no longer predictors of financial success. Working with a professional who understands how nonlinearity changes the rules of portfolio management post-retirement is vital to safer retirement income portfolios. Below, I explore four principles of chaos that are keys to safer, simpler, and more personalized retirement income solutions.

Figure 5

SHIFT HAPPENS

Year-by-Year Account Values, 2000–2015

$1 Million Investment, 5% Initial Withdrawal, 3% Annual Increases



UNPREDICTABILITY

Chaos was the third scientific revolution of the twentieth century, after quantum mechanics and relativity. Chaos theory was revolutionary because it challenged the assumption of classical science that we lived in a perfectly predictable universe, and challenging that required a paradigm shift. Thomas Kuhn popularized the concept of a paradigm shift in his landmark book *The Structure of Scientific Revolutions* (1962) and noted that such a shift begins when people identify anomalies that the old paradigm cannot account for. Just as classical science could not account for the nonlinearity of weather, classical portfolio management cannot account for anomalies due to the nonlinearity of retirement income, as shown in figure 5.

The two retirement income portfolios in figure 5 both begin with $1 million in the year 2000 and take 5-percent initial withdrawals with the dollar value of those withdrawals increased 3 percent annually. The line is half T-bills and half long treasuries, earned 4.8 percent annually, and assumed the investor paid a 1.5-percent annual fee. The bars are 100-percent S&P 500 Total Return Index, earned 6.1 percent annually, and assumed the investor paid no fee. Under classical portfolio theory, the higher returns and lower fees that accompany the bars predict greater wealth long-term, but the portfolio with a lower return (4.8 percent versus 6.1 percent) and higher fees (1.5 percent annually versus no fee) generated more wealth ($427,933 versus $0).

Expected returns, a cornerstone of the efficient frontier of modern portfolio theory, are not predictors of success for retirees, even if they are higher returns. The line in figure 5 delivered a superior result despite the fact that it cost more and did not beat the S&P Index as represented by the bars. When distributing wealth, trying to beat a long-term average such as the S&P Index or the inflation rate is an irrelevant distraction you should avoid, yet I have never seen the media make that distinction when promoting indexing.

Volatility, the other cornerstone of the efficient frontier, is not a predictor of success for retirement income and retirees cannot make assumptions about the optimal long-term risk allocation. The most fundamental rule of classical portfolio management is that you must accept greater risk to earn a higher return with a goal of generating more wealth long-term. However, nonlinearity changes the rules and the less volatile portfolio was optimal long-term for the retiree in figure 5. In other periods, a more volatile portfolio was optimal for retirees. This lack of predictability makes any pre-planned risk allocation such as a glide path or static rebalance potentially dangerous and places a premium on active management and adapting to the environment.

Although beating a long-term average is irrelevant post-retirement, beating the index in negative return years is very important. After the first three years the bars, which represent the S&P Index, had lost half their value due to the poor stock market of 2000–2003 and never recovered, but the line had increased its value after three years. Indexing a retirement income portfolio guarantees you will not beat the index in negative years. That the line in figure 5 also cost more but still generated a better financial outcome shows that retirees who build their retirement portfolio strategy strictly around indexing and low fees could find themselves going broke cheaply, like the bars.

Although the defining feature of chaotic systems is their unpredictability, the desire to predict the unpredictable persists with retirement income in the form of probability forecasting or Monte Carlo-style calculators. Uncertainty is aversive (Bar-Anan et al. 2009) and people are strongly motivated to diminish or avoid uncertainty (Whitson and Galinsky 2008), causing them to employ an illusion of control to mitigate those feelings (Danzig 2011). This aversion and desire for control leads to an unjustifiable reliance on prediction (Danzig 2011). It's unjustifiable because researchers have shown that as you receive more information about a topic, your confidence in your forecasts grows faster than the accuracy of your forecasts, even if the information is flawed, leading to overconfidence (Hall et al. 2007).

As Kahneman (2011) notes:

> *The idea that the future is unpredictable is undermined every day by the ease with which the past is explained. As Nassim Taleb points out in* The Black Swan, *our*

tendency to construct and believe coherent narratives of the past makes it difficult for us to accept the limits of our forecasting ability. We cannot suppress the powerful intuition that what makes sense in hindsight today was predictable yesterday. The illusion that we understand the past fosters overconfidence in our ability to predict the future.

Kahneman's observation that the image of the "march of history" implies order and direction is consistent with the belief of classical physics that we live in a "clockwork universe" that includes perfect predictability. Kahneman continues, "The illusion of valid prediction remains intact, a fact that is exploited by people whose business is prediction—not only financial experts but pundits in business and politics, too."

Philip Tetlock conducted a landmark twenty-year study that tested the business of political and economic "experts" and published the results in his 2005 book, *Expert Political Judgment: How Good Is It? How Can We Know?* He gathered more than 80,000 geopolitical and economic predictions from 284 people who made their living "commenting or offering advice on political and economic trends." He asked them to rate the probabilities of three alternate outcomes for each prediction. Kahneman described the results: "People who spend their time, and earn their living, studying a particular topic produce poorer predictions than dart-throwing monkeys who would have distributed their choices evenly over the options." Tetlock also used the dart-throwing monkey analogy and noted that while the forecasters with the biggest reputations were no more accurate in their predictions than non-specialists, they exhibited the greatest degree of overconfidence in their forecasts. He also identified "dogmatism" as the most distinguishing characteristic of a bad and overconfident forecaster (Dubner 2016). As Kahneman added, "The person who acquires more knowledge develops an enhanced illusion of her skill and becomes unrealistically overconfident."

That wealth accumulation is very predictable undoubtedly contributes to the unrealistic overconfidence of experts in predicting retirement income. Lorenz felt that one reason people had unrealistic confidence on the long-range predictability of weather was because of the ability to forecast certain real physical phenomena such as celestial mechanics and tides far into the future. You could forecast comets and eclipses years in advance with such precision that people took it as fact, rather than the predictions that they were, and incorrectly assumed the same applied to weather (Gleick 1987).

Similarly, accumulation is predictable but the nonlinearity of wealth distribution, coupled with the psychology of investors and the methodology of many retirement income calculators, severely limits the practical application of those calculators. As we will see below, the static portfolio coupled with a systematic withdrawal employed by probability forecasting software is likely to overstate the risk of running out of money because it understates the potential positive impact of actively managing risk and cash flow.

In addition, people make decisions and evaluate risk through an experiential system based on narrative, images, and associations to emotion that Kahneman (2011) calls "system 1" and an analytic system based on normative rules such as probability that he calls "system 2." Prospect theory and the certainty effect (Kahneman and Tversky 1979), the affect heuristic (Slovic et al. 2007), risk as feelings (Lowenstein et al. 2001), and probability neglect (Sunstein 2001) show that laypeople are fairly insensitive to probabilities and ignore them completely when facing a particularly vivid risk, such as running out of money.

When subjects of a study heard there was a probability that they would receive an electric shock, their emotional response did not change based on different probabilities of shock, but it did change when told to expect different magnitudes of shock (Rottenstreich and Hsee 2001). When faced with a low-probability high-magnitude risk, retirees ignore the probability and focus on the magnitude, and advisors should too.

Finally, the words "Monte Carlo analysis" are likely to have a negative priming effect that causes investors to think of gambling—not a good association when asking for someone's life savings—yet many firms display those words prominently on their websites or in their literature.

Although wealth accumulation is predictable, nonlinear processes such as retirement income are unpredictable, so advisors should not predict but prepare, by focusing on the magnitude of risk rather than the probability, then adapting to the journey. Cornerstones of classical portfolio management such as expected returns and volatility are not predictors of financial success post-retirement and strategies that assume they are, such as indexing, are potentially dangerous for retirees. Advisors should challenge all of the assumptions around modern portfolio theory when working with retirees; never use words with a negative priming effect and always focus on beating the index in negative return years. Retirees should be skeptical of any media that makes blanket recommendations around investment strategies without distinguishing between wealth accumulation and distribution.

THE BUTTERFLY EFFECT

A classical science corollary to the assumption of perfect predictability is the belief that approximately accurate inputs lead to approximately accurate outputs. But the butterfly effect, the most familiar principle of chaos, challenged this assumption. The butterfly effect gets its name from the idea that a butterfly flapping its wings in Brazil could trigger a sequence of events that culminate in the formation of a tornado in Texas. In other

VOLUME 8
NUMBER 1
2019

words, small differences early in a nonlinear process potentially can result in big differences later.

Consider the case of the investor who has $500,000 and expects to retire in eight years. If this investor can achieve the targeted rate of return of 8 percent, he would retire with $925,465. If he earns only 7.75 percent, he would retire with $908,465. Thus, when accumulating wealth, earning approximately what you intended (7.75 percent instead of 8 percent) leads to the approximate amount of wealth targeted.

However, the butterfly effect leads to every seemingly insignificant change to input in a nonlinear process resulting in a potentially significant change to output. Figure 6 gives year-by-year account values for investors who retired with $1 million one year apart using the same retirement income strategy, and it illustrates the butterfly effect. One person retired in 1966 (bars) and the other in 1967 (line). Despite the fact that the two investors shared the same returns in the exact same sequence for twenty-four of their respective twenty-five years, the later retiree finished the twenty-fifth year with $768,588 more ($863,120 versus $94,532). That was the impact of the line avoiding the -2.9-percent return that was the first year for the bars. Even if you extended the analysis for the earlier investor (bars) one year so that it included all twenty-five years of the line, the bars would have finished the twenty-sixth year with $8,501. Incurring the small loss early almost depleted the portfolio after twenty-five years.

Einstein famously looked for the most simplifying axiom of a problem and Lorenz employed similar reductionist thinking to see chaos. One simplifying axiom of retirement income is losses hurt more financially and psychologically when distributing wealth than when accumulating wealth. Figure 6 shows the potential outsized impact of even small losses and psychologists have shown that for most people losses have twice the emotional impact as gains (Kahneman and Tversky 1979), but for retirees they may have ten times the emotional impact (Johnson 2010). Thus, withdrawals exacerbate the impact of market losses at a time when investors are more sensitive to losses.

Much of the industry focuses on sequence of returns risk. But I did not have to change the sequence of all returns in figure 6—I altered one—to have a dramatic impact on long-term values. Furthermore, figure 7 compares the year-by-year account values for two $1-million retirement portfolios applying the same retirement income approach. When I applied those methodologies to the period 1980–1999 (bars) I finished the twentieth year with 536 percent of my original investment intact compared to 543 percent when I reversed the sequence of returns (line). In this period, the sequence of returns was inconsequential to the outcomes because the portfolio had only one negative year during which it lost just 0.2 percent.

Figure 6

THE BUTTERFLY EFFECT

Year-by-Year Account Values

$1 Million Investment, 50/50 Allocation, 5% Initial Withdrawal, 3% Annual Increases

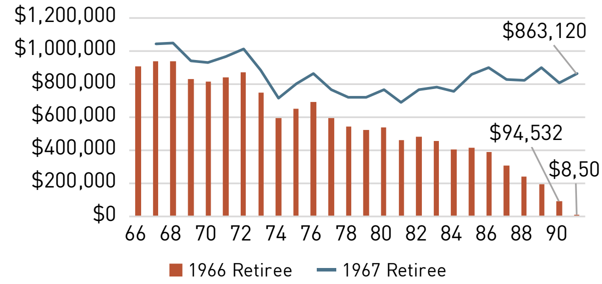
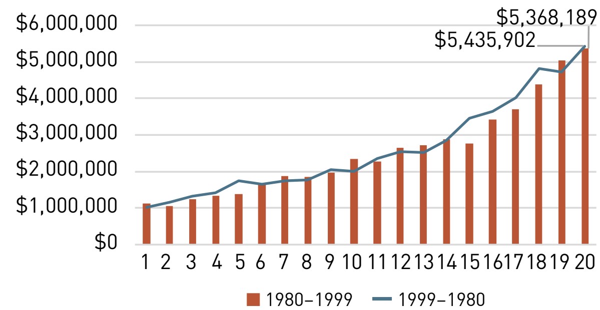


Figure 7

WHAT SEQUENCE RISK?

Year-by-Year Account Values

$1 Million Investment, 50/50 Allocation, 5% Initial Withdrawals, 3% Annual Increases



The sequence of returns is relevant to the essence of the problem when it includes negative returns, illustrating that negative returns are the simplifying axiom to focus on, and due to the butterfly effect, negative returns that happen early in retirement are particularly pernicious.

Furthermore, because small losses can have big impact, large losses can have catastrophic impact, as illustrated by the bars in figure 5. For this reason, retirees and their advisors should prepare for the worst case or black swan type of stock market initially, then adapt.

The butterfly effect makes active management of portfolios more important, as illustrated by figure 8, which compares ending values after twenty-five years of a passive versus active approach to creating retirement income. The first bar assumes a 50/50 portfolio rebalanced annually, with a 5-percent initial withdrawal increased 3 percent annually. This passive, systematic, or autopilot approach left $94,000 of your original $1-million investment.

The second bar did everything the same as the first except it employed a 30-percent stocks/70-percent fixed income risk allocation the first year, then a 50/50 mix in all remaining

Figure 8

PASSIVE VERSUS ACTIVE MANAGEMENT

Ending Account Value, 1966–1990

$1 Million Investment

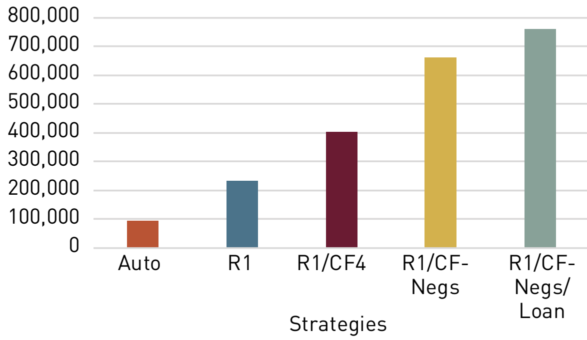


Figure 9

NO SECOND CHANCES

Accumulation vs. Distribution, 2000–2016

100% Stocks

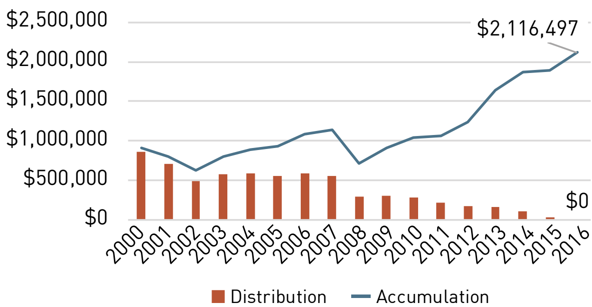
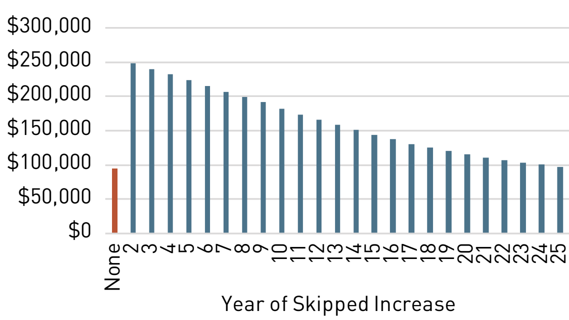


Figure 10

SKIPPING ONE CASH-FLOW INCREASE

Impact of Skipping Cash Flow Increase One Year, 1966–1990

$1 Million Investment, 5% Initial Withdrawal



years. This small adjustment improved the first-year return from −2.9 percent to −0.04 percent and increased the ending value to $232,000. The third bar applied the same methodology as the second but did not increase cash flow in the fourth year, a year in which the portfolio had a negative return. This small difference increased the ending value to $401,000. Although the third bar finished the twenty-fifth year with four times as much as the first ($401,000 versus $94,000), the dramatic impact of these adjustments was not so obvious in the short-term, because the first and third bars finished the fourth year with $830,529 and $863,292, respectively.

The fourth bar did everything the same as the third, except it did not increase cash flow in the eighth, ninth, or twelfth years, pushing the ending value to $660,000. The fifth bar followed the approach of the previous bar but also assumed you had an outside source of funds, which you took withdrawals from instead of from the portfolio in negative return years, then repaid that loan with 4-percent interest in the next positive return year. This "loan strategy" increased your ending value to $758,000.

Monte Carlo-style retirement income calculators that employ the same type of systematic approach as the first bar significantly overstate the risk of running out of money because they understate the potential positive impact of actively managing risk and cash flow. In the example in figure 8, actively managing risk and cash flow increased the ending value from $94,000 to $758,000. This illustrates the value of active management and how even small, seemingly insignificant changes to a retirement income portfolio can have significant impact long-term.

Importantly, the wrong seemingly insignificant changes can have significant negative impact long-term. For this reason, it is particularly important for retirees to avoid those who offer investment advice without distinguishing between accumulating and distributing wealth, and to work with professionals who understand how both risk and psychology change post-retirement, especially considering there are no second chances in retirement income.

The bars in figure 9 are the same as those in figure 5, but the line shows what those values would have been without taking distributions—that you finished the seventeenth year with more than twice as much as you began with. One of the most important ways the rules of portfolio management change post-retirement is you have always been able to count on time to recover from market losses when accumulating wealth, but withdrawals exacerbate losses and take away time as a dependable risk management tool. This creates a smaller margin for error and puts a premium on getting the risk allocation right, and you cannot put that on autopilot, you must actively manage it.

The impact of the butterfly effect on the short-term, especially the early years of a process, is particularly important to retirement income. Figure 8 showed the potential positive impact of small changes to a portfolio, but figures 5 and 6 showed that small negative inputs potentially cause significant negative impact and worst-case inputs (figure 5) can result in catastrophic outcomes. That is why I focus here on the worst-case type of historical environments, that is, environments with large or multiple negative years early in the portfolio.

VOLUME 8
NUMBER 1
2019

Figure 10 illustrates the importance of early years and the potential positive impact of skipping one increase in cash flow for someone who retired in 1966. The first bar (red) shows that if you increased cash flow by 3 percent annually beginning the second year you finished the twenty-fifth year with $94,532. The second bar shows that if you skipped an increase the second year, beginning increases the third year, you finished with $248,200, a significant increase for a seemingly small adjustment. The third bar assumes you increased cash flow the second year but skipped an increase the third year, then resumed annual increases the fourth year. The impact of skipping one cash-flow increase declines with time. This is especially important when the long-term impact of those adjustments may not be obvious in the short-term.

Skipping increases early is a particularly effective strategy when you can skip multiple years. Figure 10 showed the effect of skipping a single cash-flow increase; figure 11 shows the impact of skipping multiple years by delaying the first increase.

Figure 11

DELAYING INCREASES

Ending Values Based on Year of First Cash-Flow Increase, 1957–1981

$1 Million Investment, 50/50 Allocation, 5% Initial Withdrawal

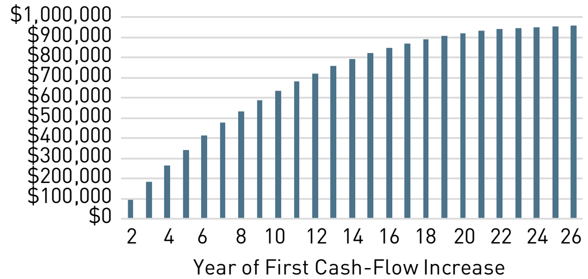


Figure 12

PERCENTAGE IMPACT OF DELAYING INCREASES

Incremental Increase of Ending Value for Each Year Delaying First Cash-Flow Increase, 1957–1981

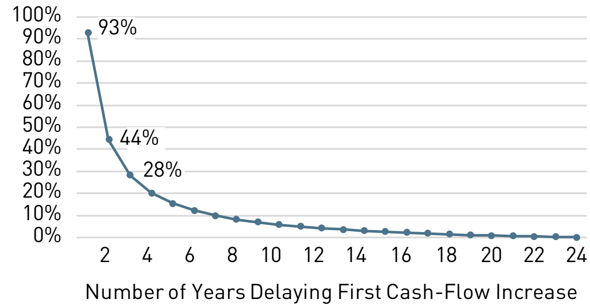
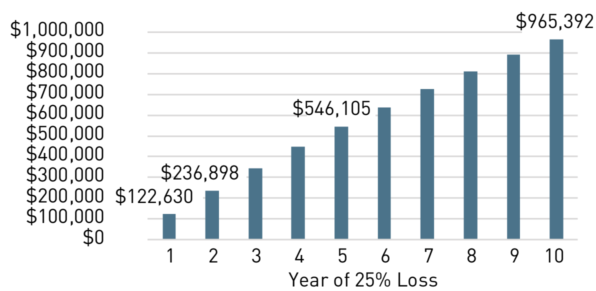


Figure 13

IMPACT OF DELAYING LOSSES DISTRIBUTION

Ending Value after 25 Years Based on Year of 25% Loss

$1 Million Investment, 5% Initial Withdrawal, 3% Annual Increases



Skipping increases early is a particularly effective strategy when you can skip multiple years. Figure 10 showed the effect of skipping a single cash-flow increase; figure 11 shows the impact of skipping multiple years by delaying the first increase. Figure 11 shows that if someone retired in 1957, withdrew 5 percent the first year and increased cash flow 3 percent annually beginning the second year, they finished the twenty-fifth year with $95,865. The second bar shows that if they delayed an increase one year, they finished with $184,786, and each subsequent bar shows the impact on ending values of delaying the first increase by an additional year.

Each delay obviously increases absolute wealth, but figure 12 shows the declining incremental impact of each additional year of delay. The second bar in figure 11 is 93 percent bigger than the first, and the third is 44 percent bigger than the second, and so forth. Figure 12 again illustrates the nonlinear nature of retirement income. Retirees should delay increasing withdrawals as long as possible, because the longer they delay the more aggressive they can be with their initial withdrawal.

The butterfly effect also makes delaying market losses more important post-retirement. In figure 13, I assumed a twenty-five-year period in which a retiree withdrew 5 percent initially, increased that dollar amount 3 percent annually, and earned 10 percent every year but one in which they lost 25 percent. The bars show account values after twenty-five years depending on which one of the first ten years you suffered a 25-percent loss. If you incurred the loss the first year, you finished the twenty-fifth with $122,630. Delaying the loss by one year (bar 2) increased ending wealth to $236,898, a 93-percent increase (figure 14). Delaying that loss to the fifth year left more than 50 percent of the original investment, and delaying the loss until the tenth year left you with almost your original $1 million investment intact after twenty-five years. Conversely, if the investor had been accumulating wealth, he finished with the same dollar amount regardless of the year of the loss.

VOLUME 8
NUMBER 1
2019

Figure 14

PERCENTAGE IMPACT OF DELAYING LOSSES

Incremental Percentage Increase in Ending Value with Each Additional Year Delaying 25% Loss

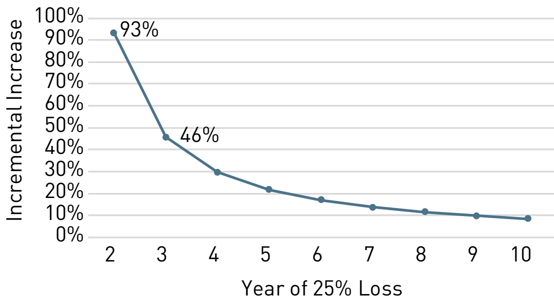


Figure 15

DELAYING FIRST INCREASE AND LOSS

Years Delaying First Increase and 25% Loss

$1 Million Investment

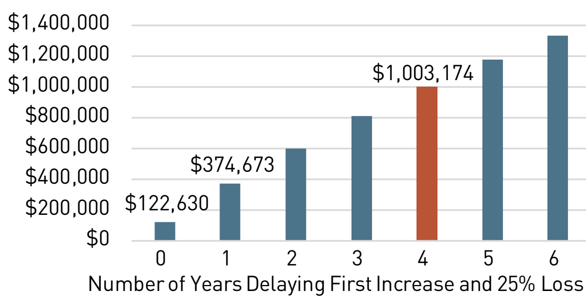


Figure 16

PERCENTAGE IMPACT DELAYING FIRST INCREASE AND LOSS

Incremental Percentage Increase Ending Value by Delaying Both First Increase and 25% Loss

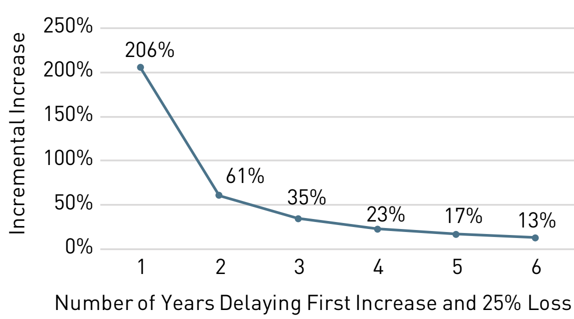


Figure 14 shows the incremental percentage increase in ending value that accompanied each additional year delaying the loss, and illustrates the nonlinearity of retirement income and the importance of minimizing early losses. Delaying the loss until the second year increased the ending value by 93 percent, and delaying it to the third year increased wealth an incremental 46 percent.

Figure 15 continues my hypothetical scenario but shows the impact of delaying the first cash-flow increases in conjunction with delaying the 25-percent market loss. If you suffered the loss the first year and increased cash flow the first possible year (the second year), then you finished the twenty-fifth year with $122,630 of your original $1 million investment. Delaying each by one year increased your ending value to $374,673, which is a 206-percent increase. Note delaying both by four years (red bar) left more principal than you began with, compared to when I only focused on losses (figure 13) and delaying them ten years left me close to my original investment.

Figure 16 reflects the incremental percentage increase of delaying both the market loss and the first cash-flow increase. As adaptive distribution theory (Sandidge 2016) showed, retirees should take a conservative approach to both risk and cash flow in the early years of retirement, then adapt.

In the nonlinear world of retirement income, approximately accurate inputs do not lead to approximately accurate outputs, because seemingly insignificant changes to portfolios can have significant impact long-term. By creating a smaller margin of error for retirees, the butterfly effect makes every adjustment to a portfolio important, demanding increased focus on the short-term and in particular on losses in the early years of retirement. It puts a premium on active management of risk and cash flow, and on working with an advisor who understands that the rules of retirement income are different from those for wealth accumulation. Advisors should focus on delaying losses as well as initial increases in cash flow, even though the impact of those adjustments may not be obvious in the short-term.

AVERAGES

That averages mask nonlinearity is the third important principle of chaos that retirees should bear in mind. Lorenz understood: "Weather had a flavor that could not be expressed by talking about averages … Those were statistics. The essence was the way patterns in the atmosphere changed over time" (Gleick 1987). Averages are about the long term, but the short term is the essence of nonlinear processes.

We already have seen that trying to beat a long-term annualized rate such as an index or the inflation rate is an irrelevant distraction to avoid. But one annualized rate that advisors should include in their retirement income discussions is the annualized erosion rate.

As discussed in Sandidge (2016), advisors should prepare for the worst then adapt as the actual environment becomes clear. That means initially taking a conservative approach to risk and cash flow, with the possibility of becoming more aggressive if the environment supports that. Monitoring the annualized erosion rate facilitates that transition.

If investors finish the first year of retirement with less money than they retired with, it is human nature for them to project

VOLUME 8 NUMBER 1 2019

that erosion into the future (availability heuristic). If they have 3-percent erosion year one and maintain that rate, their portfolios would last thirty-three years. Investors already are making this calculation, so advisors should manage to an annualized rate projecting to a number of years acceptable to the retiree.

Figure 17 shows the year-by-year annualized erosion rate for a retirement income portfolio that increased cash flow only every other year instead of annually. After overcoming a market loss in the first year, the portfolio had minimal erosion through twelve years and finished the twenty-fifth year with less than 2-percent annualized erosion and more than 50 percent of original principal remaining. At the twelve-year point, if not sooner, the retiree may have chosen to take a more-aggressive approach to cash-flow increases, such as increasing three out of four years. Figure 17 represents the worst twenty-five years for stocks since 1940 (1957–1981), so this exercise illustrates the focus on short term and worst case.

Figure 17 also illustrates the need to prepare investors for the possibility of portfolio erosion in the initial years. The portfolio was down 9.2 percent the first year, which would project to a possibly unsettling eleven years of longevity, despite the fact that the market loss was only 2.7 percent. The 5-percent withdrawal and 1.5-percent fee assumptions exacerbated the market loss.

Figure 18 shows how much erosion 30/70 and 50/50 portfolios experienced (including a 5-percent withdrawal and 1-percent fee) when applied to all years from 1940 through 2016, knowing that each of those years could have been the first year of retirement for someone. The fourth set of bars show that more than 20 percent of years for either allocation had erosion of at least 5 percent, projecting to twenty years of longevity, which some retirees may find uncomfortable. The fifth and sixth sets of bars show that the more-aggressive allocation was considerably more likely to have first-year erosion of at least 7 percent and 10 percent, and the butterfly effect can make those larger losses devastating. The 30/70 allocation had 10-percent erosion or more 1.3 percent of the time compared to 9.1 percent of the time for the 50/50 mix. Overallocating to stocks early to hedge premature erosion of principal creates the conditions most likely to lead to the kind of losses that cause premature erosion of principal.

The more-aggressive allocation was more likely to have significant principal erosion the first year and figure 19 shows how much erosion different allocations had in the worst-case years 1974 and 2008. The literature of financial services firms seems to view a 60/40 allocation as "moderate" or "balanced" on the risk spectrum without distinguishing between accumulation and distribution. However, figure 19 shows that retirees using that allocation with a 5-percent withdrawal and 1-percent fee could have seen a panic-inducing 20 percent of their life savings disappear in the first year of retirement if they retired in 1974 or 2008. Because losses may feel ten times as bad as gains feel good for retirees (Johnson 2010), the unfortunate retirees who see one-fifth of their life savings disappear the first year are not likely to feel exposed to "moderate" risk, especially if they understand the potential impact of the butterfly effect and worst-case losses.

Just as the essence of weather is how patterns in the atmosphere change on a daily basis, the essence of retirement

Figure 17

ANNUALIZED EROSION RATE

Annualized Erosion Rate, 1957–1981

5% Initial Withdrawal, Increased 3% Every Other Year, 50/50 Allocation

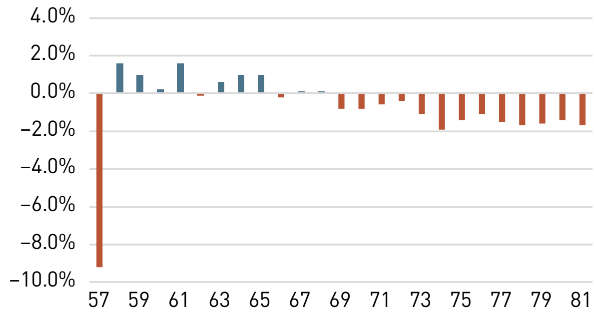


Figure 18

FIRST YEAR EROSION

Erosion First Year of Retirement, 1940–2016

5% Withdrawal, 1% Fee

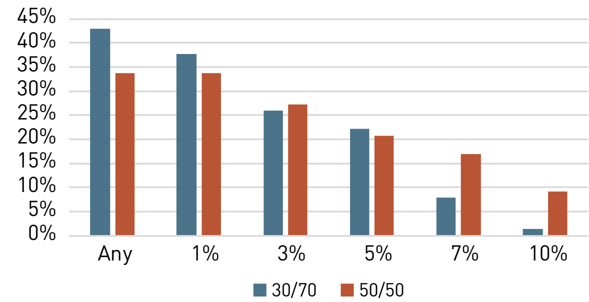
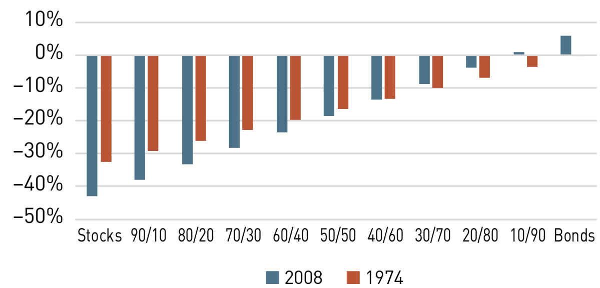


Figure 19

WORST-CASE FIRST YEAR EROSION

Worst Case First Year Erosion

5% Withdrawal, 1% Fee



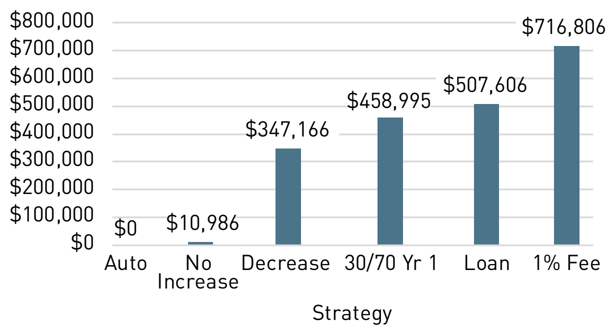
VOLUME 8
NUMBER 1
2019

Figure 20

DECLINING WITHDRAWALS

Ending Value, 1957–1981

$1 Million Investment, 7% Initial Withdrawal



income is about short-term changes rather than long-term average returns. Advisors should prepare for the short-term worst-case scenario, as illustrated by figure 19, then adapt to the environment. That means focusing on an annualized erosion rate that is acceptable to the investor and preparing for the possibility of principal erosion the first year of retirement.

NONLINEAR THINKING: THINK DIFFERENT

That the nonlinear thinking needed to "solve" nonlinear problems is about finding multiple solutions is the fourth important aspect of nonlinearity that advisors should understand. But cognitive biases make nonlinear thinking difficult for most people. An awareness of those biases is the best defense against them and overcoming them affords advisors the opportunity to have discussions that resonate with investors and create a brand of original thinking that differentiates.

Linear thinking is about following a process to arrive at the "right" answer, but nonlinear thinking is about finding multiple answers rather than one, and you need multiple solutions to offer investors the choices required for personalized solutions. Much of the industry literature around retirement income offers investors a single solution—some version of the 4-percent rule—but Sandidge (2016) showed that by staggering annual cash-flow increases you create hundreds of ways to manage the distribution of wealth.

Figure 20 shows that a willingness to decrease cash flow expands that universe even more. Banarjee (2014) showed that on average people reduce spending as they age. Using his numbers as a template, I created a cash-flow model that paid the same distribution for ten years, reduced it by 4 percent per year for five years, then by 2 percent per year for ten years.

The first bar (Auto) used a 50/50 allocation, withdrew 7 percent the first year, increased that 3 percent annually, and depleted the asset base in the eighteenth year. The second bar did all the same except never increased the initial withdrawal, leaving $10,986 after twenty-five years. The third bar applied the decreasing cash-flow strategy discussed above and left $347,166, which is 34 percent of the original investment. At that pace of erosion, the portfolio would last a total of almost thirty-eight years. The fourth did everything the same as the third, except it used a 30/70 risk allocation the first year. The fifth did everything as the fourth except it also employed the loan strategy, where I took withdrawals from an outside source of funds in negative return years, discussed earlier with figure 8. Finally, the sixth bar mirrored the fifth bar except I reduced the fee from 1.5 percent to 1 percent, pushing the ending value to $716,806. In summary, that sixth bar shows I withdrew 8 percent the first year (1 percent was fee) in the worst twenty-five years for stocks in the past seventy-five years and finished the twenty-fifth year with 71 percent of my original investment still intact.

Just as solution providers typically offer six to eight different model portfolios differentiated by levels of risk for accumulating wealth, they also should offer different cash-flow models based on different combinations of initial withdrawal and frequency of increasing subsequent withdrawals (Sandidge 2016). Investors understand they cannot get a tailor-made suit at a store that only carries one size, and they cannot get a personalized cash-flow plan from a firm that only promotes a version of the 4-percent rule.

Research has shown that humans favor choice over nonchoice, even when that choice affords no improvement in outcome, and removal of choice can be very stressful (Leotti et al. 2010). A threat to or elimination of a behavioral freedom arouses people ("psychological reactance")—including a freedom to choose. An awareness that certain products or services exist to choose from creates freedoms (Brehm 1989). Advisors can create freedoms by making clients or prospects aware that multiple solutions exist, in contrast to those who would offer only some version of the 4-percent rule.

The paradox of choice is that, although people like to have choices, giving them too many (say, more than five) can cause them to struggle to make a decision (Iyengar and Lepper 2000). Older adults prefer to have fewer choices (Reed et al. 2008). Therefore, you should make investors aware of the many solutions available, explain that you will help guide them through the selection process to a handful of final candidates, and contrast the process to those who would limit choice to a single solution.

Unfortunately, the nonlinear or creative thinking needed to see multiple solutions does not come naturally and advisors should be aware of the cognitive biases that cause difficulties for most people. The human brain likes simple straight lines and struggles to understand nonlinear relationships (de Langhe et al. 2017), and counterintuitively, "experts" in particular may be the least capable of creative thinking. That is because they are

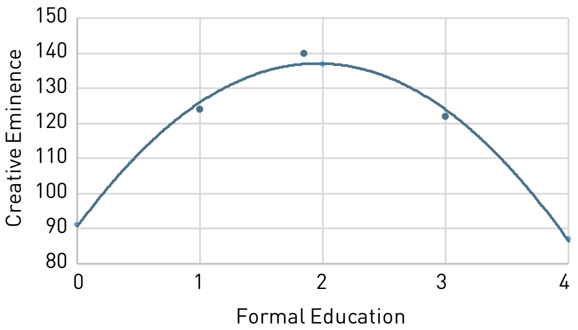
VOLUME 8
NUMBER 1
2019

particularly susceptible to the biases of the Einstellung effect, narrow framing, and assumptions, which are described below.

THE EINSTELLUNG EFFECT

In a study of 300 creative people of history, Simonton (1983) showed that the relationship of formal education to creative eminence is nonlinear. In figure 21, the numbers on the horizontal axis correspond to levels of education. One is a high school degree, two a bachelors, three a masters, and four a doctorate. The inverted U-shaped line (curvilinear) shows that as you add formal education you tend to become more creative to a point, which Simonton found to be short of a college degree; education beyond that point is negatively correlated to creativity.

Figure 21 **EDUCATION AND CREATIVITY**



In a companion study comparing education to flexibility in thought (dogma) of political and military leaders, Simonton found the curves for eminent creativity and dogmatism virtually mirror images, with people who had doctorates and experience teaching at a college being the most dogmatic. He noted, "The over-trained student may overconform to conventional viewpoints on central artistic and scientific problems and thereby become less apt to revolutionize their disciplines." The more information you receive on a topic the greater your confidence grows in your opinions or forecasts regarding that subject, even if the information is flawed. As Dorothy Parker (Drennan 1990) observed, "You can't teach an old dogma new tricks." This bias where knowledge blocks imagination, known as the Einstellung effect, is well-documented (Luchins 1942; Kuhn 1962; Weisberg 1999).

A study of visual recognition illustrated the difficulty of forgetting initial opinions. Subjects viewed pictures of common objects coming slowly into focus. Participants who saw a less-blurred initial picture eventually recognized it at a greater level of blur. The greater or more prolonged the initial blur, the clearer the picture had to become for eventual recognition. The slower recognition times were at least partly due to the difficulty of rejecting an initially formed incorrect hypothesis about what the picture was (Bruner and Potter 1964). Learning new solutions is easy compared to forgetting old ones.

NARROW FRAMING

Theories of creativity agree that creative insight occurs in a mental state marked by defocused attention and associative thought (Martindale 1999), but humans by nature are narrow framers (Kahneman 2011) and experts in particular are narrowly focused (Taleb 2010). Narrow framing is the second bias that impedes creative thought.

Associative thought is about combining elements that appear disparate in a useful way. For example, Steve Jobs often ended his product-launch presentations with a slide that depicted Apple sitting at the intersection of technology and liberal arts (Isaacson 2012). The more remote the elements, the more creative the process or solution. People can only make associations between what they know, and creative people often have broad interests (Andreasen 2005) with many famous creators (e.g., Piaget, Freud, and Darwin) practicing a professional marginality by purposely moving from one field to another (Runco 2014). People who revolutionize a domain often do so by drawing on a breadth of knowledge across multiple domains. Experts tend to have a narrow focus that limits the breadth of elements available to connect.

Mednick (1962) proposed an associative hierarchy as a representation of creative thought. For example, on a word association task how would you respond to the word "table"? Someone limited to the most common responses such as "chair" has a steep (vertical) associative hierarchy. When they get past the most common responses, their associative strengths to other words falls quickly. For someone with a flat (horizontal) associative hierarchy, the most common responses are not as dominant and they are more likely to get to the more remote associations that are the basis for creative ideas. Gardner (1997) viewed vertical thinkers as experts, and horizontal thinkers as visionaries.

Advisors wishing to explain narrow framing to investors may find the famous Monty Hall problem helpful. On *Let's Make A Deal*, participants choose among three curtains, a new car behind one and a goat behind each of the other two. After you choose, they open one curtain to reveal a goat and ask if you want to switch your choice between the two remaining curtains. Participants typically struggle with this decision because they frame the choice as between two curtains and believe they have a 50/50 probability of success. The reality is when they were initially presented with three curtains they only had a one in three chance, or a 33-percent probability, of choosing the winning curtain. Thus, the odds are that when faced with three curtains they chose a losing curtain and when given the choice of staying with their original choice or switching to the only other unopened curtain, they should switch. Framing the second decision too narrowly, as between two curtains, instead of broadly, as between three curtains, one of which was open already, can cause them to make a suboptimal decision.

ASSUMPTIONS

Challenging assumptions is the genesis of creative insight but the tendency to make assumptions is universal, and here again, a bias to which experts are particularly prone (Runco 2014).

Worse, failing to challenge assumptions, especially your own, can lead to overconfidence and intellectual sloth. A key element of overconfidence is failure to recognize that one's assumptions—including those of experts—may be tenuous (Slovic et al. 1982). Overconfidence can create an illusion of safety, and the one thing more dangerous than a clear threat is the illusion of safety.

Max Planck, father of quantum mechanics, said, "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it."

I see job postings that use "expert" and "thought leader" interchangeably, but experts may be among the least likely to have the original thoughts needed to be a thought leader. The education and focus that served them so well in becoming an expert and solving linear problems makes them prisoners of their own devices when it comes to creativity. Because the cognitive deck is stacked against experts embracing, much less originating, new thinking, most scientific revolutions meet resistance or indifference. It was four years after the publication of his seminal paper that Einstein was asked to speak at a major conference and six years before it was included in a textbook (Gardner 2011). In the ten years after publication, Lorenz's paper was cited by only three researchers from outside the field of meteorology (Gleick 1987). Max Planck, father of quantum mechanics, said, "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it" (Kuhn 1962). Given the fierce resistance transformative thinkers frequently meet from contemporaries, it is not surprising that several theories of creativity include a persuasion component in their definition of creativity (Simonton 1983; Csikszentmihalyi 1999; Sternberg and Lubart 1999).

MENTAL DAZZLE

Mental dazzle is a fourth bias that obstructs creative insight and impedes persuasion and communication. Suppose you must transport an adult across a river and the only means to do so is a small boat belonging to two boys. The boat can carry no more than two children or one adult. How can the adult get across the river without stranding the children from their boat? The solution is that the two boys cross the river. One gets out on the far bank while the other rows back. When he lands on the original bank, the boy in the boat trades places with the adult who then rows across the river alone. Upon reaching the far side, the adult exits the boat and the boy on that bank rows back to join the other boy waiting on the original bank.

Because the boat only holds one adult, the number of adults to be transported should be immaterial to the essence of the problem, which is how to get one adult across; then if there are multiple adults to be transported you repeat the process as often as needed. However, a group that was told that one adult needed to cross the river took an average of one and a half minutes to solve the problem, and a second group that was told that six adults needed to cross took approximately twice as long to solve the problem (Katz 1950). Raising the number of adults transported produced "mental dazzle"—the tendency for superfluous information to distract from the essence of a problem, making it more difficult to solve.

Limiting superfluous information is also critical to communicating because most people can hold only three to five chunks of information in their working memory, and any more than that creates confusion (Cowan 2010). As Simon (1971) noted, "What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention." The risk is that in their desire for robust solutions, advisors may feel compelled to give investors more information, when filtering out distracting information is the key to problem-solving and communication. With subtraction comes clarity. Distracting terms that advisors should avoid include: expected returns or return risk, indexing, inflation risk (talk about lifestyle risk instead), efficient frontier, predictions, probabilities, Monte Carlo analysis, sequence of returns risk, and standard deviation.

Although superfluous information can limit working memory, nonlinear or creative thinking can stimulate it. Neuroscientists monitoring brain activity of subjects viewing online ads found that ads stressing functional elements of a product, such as what it is, how it works, or features and benefits, stimulate less-complex areas of the brain that deal with recognition. Conversely, ads that stressed the experiential element of imagination stimulated more-complex brain areas associated with working memory, sustained attention, and creativity (Couwenberg et al. 2017). They also motivated subjects to seek more information about the product by clicking on a link that was included as part of the ad. Researchers found that consumers value innovation for itself, and not just features and benefits innovation. Thus, nonlinear or creative thinking resonates with consumers, motivates them to pay more attention and seek out more information, and, because it is not easy, it differentiates advisors.

The nonlinear thinking needed for nonlinear problems such as retirement income is about finding the kind of multiple strategies that consumers crave for personalized solutions. Advisors must guard against habitual thinking (the Einstellung effect) and narrow framing, and they must challenge assumptions. By challenging the assumption that everyone must increase cash flow 3 percent annually in retirement, advisors can create multiple solutions by pairing different initial withdrawals with different ways of increasing (or decreasing) cash flow. Avoiding mental dazzle by limiting superfluous information that distracts from the essence of the problem is also critical for problem solving and communication. In addition to creating multiple solutions, nonlinear thinking engages consumers' attention and differentiates advisors.

SUMMARY

Chaos is the key to safer, simpler, and more personalized retirement income portfolios that resonate with and motivate retirees and differentiate advisors.

Gleick (1987) noted, "Where chaos begins classical science stops." And where retirement income begins classical portfolio management stops, because trying to solve retirement income with rules that worked for wealth accumulation is dangerous. Yet, much of the media as well as some politicians, academics, and automated advisors promote strategies such as indexing as if they are universal law. But trying to beat an index is an irrelevant and even dangerous distraction for retirees. The key to safer retirement income portfolios is to focus on beating the index in negative-return years and ignoring those who give blanket investment advice without distinguishing between accumulating and distributing wealth. Most important, retirees should work with an advisor who understands how the rules of portfolio management change post-retirement.

As Gleick also noted, "Analyzing the behavior of a nonlinear equation is like walking through a maze whose walls rearrange themselves with each step you take." Nonlinear systems are unpredictable, so retirement income is about preparing rather than predicting. Because the butterfly effect makes downside risk more important, advisors should prepare for the worst and adapt. Adapting is much more about the journey than the destination, and active management of each step of the journey takes on greater importance. To monitor how that journey is progressing, advisors should focus on the annualized erosion rate.

Advisors should create multiple solutions by challenging assumptions and by being aware of the biases that block creative insight, such as habitual thinking, narrow framing, making assumptions, and mental dazzle. These biases mean the cognitive deck is stacked against those willing to think differently. But overcoming these biases is the key to creating a brand that differentiates, for one thing in shorter supply than people who are able to think different is people who are willing to do so.

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