What Works and Why!

LIVING OFF YOUR MONEY

The Modern Mechanics of Investing During Retirement with Stocks and Bonds

MICHAEL H. MCCLUNG

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For my dear wife, Sheila,
whose support never wavered through
what appeared to be a never-ending book,
and to my children,
Craig, Sheldon, Honor, and Jadzia,
who add to the meaning of it all.

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I want to acknowledge Yale's Robert Shiller, who for many years has posted and updated his US market data from his own research. Access to his dataset was an invaluable asset to this book, especially in the early days when the initial soundness of ideas and approaches were being tested.

Special thanks also go to Sheila, my wife, whose finance degree came in handy when she was the first reader of each chapter, sometime multiple times. I appreciate Debra Murray, my sister, providing helpful advice for the introductory chapters. I also appreciate the expertise and support from Bob Rich, my copyeditor, as well as Liz Dexter, my proofreader, whose remarkable attention to detail provided an exceptional last line of defense against my many mistakes. Finally, I want to thank my book designer, Stephanie Anderson of Jera Publishing, who not only helped make up for my slipped schedule, but exceeded my design expectations.

Contents

I have too many unread books on my shelves, so why should I buy yours?

Walter E. Goh

What's Good To Know First

This preface distinguishes what's different about this book compared to others on investing during retirement. In doing so, it introduces the purpose, the problem, and the approach. Most importantly, it helps you decide if this book is right for you.

The Purpose

It's common knowledge few Americans save enough for retirement. The surprising part is, those who do then rarely invest it well *during* retirement. This is unfortunate. To a degree, it squanders what has been diligently saved. Why does this happen? Investing during retirement is more difficult for sure, but that's not the root of the problem

Our brain doesn't deal well with ambiguity, conflicting opinions, and a constant bombardment of misleading information…the domain of investing during retirement. Ultimately, there is too much wrong guidance and not enough right guidance, and it's difficult to discern which is which. No wonder so many get it wrong.

Adding to the problem, the investing landscape has changed significantly over the past 20 years, outdating practices once considered correct. Financial economics has been and still is in a state of transition. Old theories are known to be lacking, but there is no consensus on what should take their place. Without clear unified guidance from economists, many retirees stick to what was deemed best in the past; unfortunately, this seemingly conservative stance is not a good one.

This book consolidates exactly what you need to know to invest well in retirement. It provides an updated set of best practices. There is no ambiguity or incomplete answers. All recommendations are supported with proper evidence to understand not only what works but why, including side-by-side comparisons of alternatives. Today's retirees can do appreciably better than previous generations by applying these updated practices—this means more income with less risk.

What kind of numbers are we talking about? It's impossible to provide guarantees, but I'll estimate adhering to this book's recommendations will increase your retirement income by 15% to 50%, depending on previous practices. Of course it also depends on what is happening in the markets, but the recommendations are generally most valuable during poor to moderate markets…when it matters most. At the extreme end, when all this book's recommendations

are combined (as shown in Chapter 10), the average annual income under a global benchmark increased 87% over specific practices still used by some retirees.

Be clear this book is not about tricks and wishful thinking, but about applying rational evidence-based practices. Considering the magnitude of the payoff, investing well in retirement is a rare life opportunity.

The Scope of the Problem

Anyone aiming to create a top-performing plan for investing during retirement quickly encounters a host of barriers, making the task extremely difficult.

The literature varies in its usefulness. On topics like risk the discussion rarely provides objective help for the hardest decisions to be made. Other well-covered topics, like asset allocation, generally apply but without retirement specifics (e.g., what fund combinations are most suitable; what are the appropriate stock-bond ratios; what are the tradeoffs). Specialized topics, like income-harvesting and variable-withdrawal strategies (explained later in depth), have reasonably good coverage if you can find it, but no means to compare alternatives — performance comparisons are difficult or impossible to make. When precise studies and comparisons can be found, the assumptions* don't support the needs of today's retirees.

Unsubstantiated claims are perhaps hardest to deal with. Outside academic studies, conclusions and advice are frequently handed out with minimal supporting data. When evidence is provided, even in academic studies, it's typically based either on one set of United States historical data, or computer simulations lacking a resemblance to true markets. This isn't enough.

It's also important to understand academic standards aren't aimed at the pragmatic needs of retirees. Early on I believed academic research set the highest standard for retirement guidance: a combination of scientific method, mathematical rigor, logical analysis, and peer reviews. As my own research progressed, I became aware of the extent academia's goals for original research differed from my need for pragmatic guidance. To begin with, fundamental truths aren't always practical and practical solutions don't always lead to fundamental truths. I also found caveats are a well-honed tool within academic writings, often used to address ambiguities that are crucial to the pragmatist, or to equivocate on practical implications. Completeness is also not a criterion, given the research goal is often narrow, independent from how it might be applied. However, this is not a critique of academia but a reality for investors to understand — the goals of academia within financial economics are generally its own, with too rare of focus on pragmatic guidance.

This book is concerned with real people investing their savings in real markets, tangibly affecting their lives for better or worse. Proper guidance in this context must sort through the ambiguities, deal with what's lacking, verify assumptions, and compare alternatives, all to arrive at balanced judgments. For anyone publishing retirement guidance, there is an implicit obligation to provide one's best — incomplete coverage accompanied by caveats or equivocating, whether in a conclusion or a footnote, cannot soften poor outcomes.

Another problem is biases are pervasive within the investing domain. Again, this isn't a critique, but an acknowledgement of the effects incentives have on human nature. Biases aren't from intent, but from a lack of self-awareness. Biases arise out of the subtle influences incentives exert on our thoughts and actions. The magnitude of a bias generally correlates to the magnitude of the incentive, even when unconscious.

Strong incentives contribute to biases in the retirement industry. The financial media is generally biased towards investment news that best captures an audience. Financial planners and money managers are generally biased towards

* Common assumptions are a US-based market portfolio, annual rebalancing, and inflation-adjusted fixed withdrawals.

investment strategies that aid their business, either through simplifying their operations or generating more revenue. Financial authors are generally biased for a diversity of reasons — it may stem from their business or career interests, or a mindset that reinforces their actions, reputation, or esteem. Some professionals are much more objective than others, some admirably so, but no one is totally immune.

Luigi Zingales, an economist as well as a professor at the Chicago Booth School of Business, wrote a revealing paper[1] on how economics as a profession has pervasive biases. He discusses how economists who support business interests have better career opportunities, resulting in biases. From the opposite side, some economists are rewarded for being anti-business, forming an opposing set of biases. Zingales also describes* how papers supporting certain research conclusions are more likely to be published in leading journals due to editor bias (driven by a different set of incentives). This implies biases even play a role in deciding who is awarded university tenure. The implications of this are sobering. While we can expect economists to be more objective than the average person, their incentives to varying degrees shape the financial industry.

I can easily say this book is freer than most from biases. I'm not exposed to industry incentives. My aim isn't to grow a financial business or attract new clients. My dominant goal is to write a worthwhile book, and sell enough to write another worthwhile book; however, avoiding biases is not that straightforward. I'm not bias free. While researching this book I noticed a subtle predisposition to favor concepts and strategies I originated or supported. I found it necessary to deliberatively counterbalance these natural biases by focusing on the data, continually questioning the results, and giving attention to proper research methods.

We can't eliminate our biases, as a producer or a consumer, but we can substantially reduce them with conscious effort and discipline. The best advice I can give for reading this book is to temporarily put all investing mindsets on hold, taking a careful look at the data presented, only then forming your conclusions.

The Target Audience

This book is for those living off their money, planning to, or helping others to do so. It applies to individual investors from non-financial careers as well as financial advisors or investment managers, basically anyone interested in taking a careful look at the data and the best practices it implies.

The common investing scenario is a retiree drawing annual income from a combination of retirement accounts (e.g., 401Ks, IRAs), taxable brokerage accounts, and perhaps other investments like annuities or individual bonds. Additional income may come from a pension, Social Security, or other sources; however, to apply this book's guidance a significant portion of income must stem from market assets directly controlled.

Unfortunately, this book cannot be considered a proper guide for beginning investors. It too often digs into topics with the depth and pace to satisfy more experienced investors. Also, a substantial portion focuses on the supporting evidence, which tends to be more difficult to understand than the recommendations. Less experienced investors can still profit from this book if they are dedicated readers, but it will take extra effort and occasional Internet queries to fill in background knowledge.

Fortunately, once understood investing well during retirement is not difficult. This brings us to the challenge this book presents.

* Luigi Zingales talks about his paper in an October 20, 2014 interview on EconTalk, economist Russ Roberts' excellent and readily available podcast series.

The Reader's Challenge

This book is best approached by setting aside some time. The coverage is pragmatic, but a complete reading takes a level of involvement beyond what most books on investing require.

Only a small percentage of retirees are motivated enough to actively seek how to invest well in retirement. If you fall into this group, this book will be easier to read, perhaps even providing an enjoyable foray through what the data shows. However, many more retirees are sitting on the fence—they want to invest well but find it burdensome and formidable. If you fall into this larger group, consider the following: there's a large payoff for investing well in retirement (remember the earlier numbers!) and you can take advantage of it.

The average lifetime includes 2000 work weeks—I estimate it'll take one week of studying this book to substantially magnify the benefits of what you've worked long and hard to save. It's all doable: *if you had the forethought and discipline to save well for retirement, you have what it takes to benefit from this book***.** You don't have to be a genius or have a degree in economics. What you need is a strong dose of emotional intelligence—that's what sustains our motivation to follow through when our best interests are at stake.

It's been said there is more benefit from reading one good book five times, than from five average books once. It takes an uncommon amount of effort to gain the full benefits of a good book. I believe this is a good book. You needn't read it multiple times, but there may be parts requiring more than one read to fully gain the benefit. I suggest you start by flipping through the book a time or two to orient yourself before settling into a more serious read.

Despite the challenge, you can take shortcuts if you want to substantially reduce your effort. Conceptually, there are two books here: a 75-page how-to book wrapped in a much larger why-it's-so book. A Chapter Guide before the start of each chapter explains what is essential (i.e., the how-to portion) versus the broader explanations more suitable to in-depth readers. To profit, a reader need only understand the recommendations, even though the essence of the book is in the why-it's-so parts.

Fortunately, very little ongoing effort is needed once a plan is put in place, with the benefits continuing throughout retirement.

A Companion Spreadsheet

Despite the reader challenge, there is no need for retirees to do their own calculations to follow the recommendations. Applying the recommendations doesn't even require a lot of calculations, but it's still better to avoid the possibility of errors. As an aid, a downloadable spreadsheet is provided for free on the book's website: www.livingoffyourmoney.com.

The Investing Assumptions

A set of assumptions underlie every approach to the market. This book's primary assumptions are listed below.

a. Complex investment instruments rarely make good investments; they are usually created to benefit the industry, not investors.

b. Low-cost index funds are generally the best instruments for stocks and bonds, although managed funds are sometimes a reasonable choice.

c. Retirees want their investments to perform well during retirement, but only at a level of risk they are comfortable with.

d. Top retirement plans don't need frequent attention, typically annual or semi-annual maintenance is sufficient.

An Evidence-Based Guide — Applying Science to Data

It has already been said the recommendations in this book are supported by proper evidence. Now is the time to clarify what this means, but a quick story will set the stage.

Recently, a bestselling author on investing told financial advisors they lose potential clients by providing too much data. He explained, clients make their decisions based on emotional connections; the data only clutters up the process. Regrettably, this reflects the prevailing norm: emotions, sound bites, and sales pitches drive key financial decisions more than knowledge. This book takes an opposing approach, emphasizing the power of data and the knowledge it conveys.

The market data we have in hand is an excellent guide, showing what works and what doesn't investing during retirement. This data spans long periods of time, multiple countries, and different asset classes. Properly used it provides the best possible answers. However, we must tread carefully through the data to reach correct conclusions.

Campbell Harvey, a Duke professor of economics and expert on data mining, argues along with his coauthors[2] that "most claimed research findings in financial economics are likely false" due to improper data techniques — this is especially startling considering he is talking about experienced researchers.

This book applies the science of analyzing data* to form answers, following an approach known as evidence-based research. Wikipedia defines evidence-based research in the following words:

> Evidence is comprised of research findings derived from the systematic collection of data through observation and experiment. All practical decisions made should be based on research studies selected and interpreted according to some specific norms. Typically, such norms disregard theoretical studies and qualitative studies and consider quantitative studies according to a narrow set of criteria of what counts as evidence.

Wikipedia continues with the definition of an evidence-based practice.

> An evidence-based practice develops individualized guidelines of best practices to inform the improvement of whatever professional task is at hand. Evidence-based practice is a philosophical approach that is in opposition to rules of thumb, folklore, and tradition. Examples of a reliance on "the way it was always done" can be found in almost every profession, even when those practices are contradicted by new and better information.[3]

* The word *data science* is avoided due to its overuse and broader connotations. Certainly data science is applied in this book, but its better known facets, including machine learning and Bayesian analysis, are less applicable to investing during retirement compared to more classical statistical approaches.

The above definitions, along with a skeptical mindset, capture the approach and philosophy of this book. The only thing missing is a clear statement of the specific norms for proper evidence within the domain of investing during retirement.

The following four criteria define the norms to comply with for all recommendations in this book— if for some reason a recommendation cannot fully comply with these norms then it's clearly stated.

1. Recommendations must be verified with real market data (i.e., market simulations alone are not sufficient… we don't know how to fully model markets).
2. Recommendations must be based on methods supporting independent confirmation by other researchers (i.e., results that cannot be replicated are not sufficient).
3. All recommendations must be verified using at least one independent data source but preferably several; testing with independent data is the only way to insure correct results, preventing a data-mining bias (which is thoroughly defined later).
4. All recommendations must hold up to robust testing, designed to seek out counterevidence or identify weaknesses. Typically this requires a diversity of tests, cross-verifying conclusions across multiple contexts and datasets. Only by consciously seeking to identify flaws in favored strategies can the natural biases in research be counterbalanced.

A brief example makes the above clearer. A new strategy, Prime Harvesting, is recommended in Chapter 3; however, before it's recommended it has to satisfy the norms of evidence-based research. For this particular case, it means showing satisfactory performance (compared to its peers) under the following diverse conditions: multiple real markets (US, UK, and Japan), varying withdrawal rates, varying retirement lengths, several thousand randomly-generated portfolios, several thousand simulated markets, and varying risk metrics (e.g., worse-case scenario, top-90% performance, average performance). These tests are explained later, but as a whole they reflect the primary premise: a strong dose of due diligence, applied according to the norms of evidence-based research, produces exceptionally strong answers.

The Modern Mechanics — What's New Here?

Modern Mechanics in the title of this book corresponds to the best practices that will be identified. *Modern* fits because the recommendations are mostly based on research from the last 20 years. *Mechanics* fits because the recommendations are detailed and complete, delving into the nuts and bolts of all it takes to invest well in retirement.

So what's new? For a start, very few retirees apply anything close to the ideas covered, mostly because they have not been systemically sorted through and presented with sufficient data. It's like all the parts have been lying around but never assembled — certainly there is no up-to-date evidence-based retirement plan circulating in the general literature. More specifically, several new strategies are recommended, ones you won't find elsewhere, plus a couple of existing strategies are enhanced to perform better. Additionally, new metrics are introduced to help compare alternatives…the most important supports comparing which portfolios are best suited for retirement.

Finally the form of the book is new. This book follows the data, directly compares alternatives, and delivers a complete set of step-by-step recommendations.

It's safe to say there are no comparable books focusing on data. It may be due to timing, the lack of author incentives, or publishers not believing there are enough savvy readers to justify books like this. Whatever the reason, providing pragmatic in-depth well-verified complete answers for investing well during retirement is new.

The Past Versus the Future

We are all familiar with some form of the common investment disclaimer: past performance does not guarantee future results. This disclaimer is certainly true, but it's also true (and will be shown) that the historical data is the best guide we have to future markets.

The market exhibits fundamental behavior in the form of real returns. Although real returns vary greatly year to year, they also maintain some forms of consistency across diverse conditions over long time periods. I call these consistent behaviors *market invariants*. Market invariants have influenced real market returns throughout history. Just as important, there is no reason to believe these invariants will cease to exert their influence in the future.

Market invariants play a role in financial economics. Fama and French's three-factor model of the market is based on invariants. Shiller's valuation work based on price-earnings ratios (i.e., CAPE-10) is also based on invariants. There appears to be consensus that momentum is an invariant.

The existence of market invariants support the rationale of defining a set of best practices for the future, based on what has been observed in the past. Certainly not all market influences are invariants and invariants can be difficult to directly leverage; nevertheless, the data makes clear invariants persist across extremely diverse circumstances, exerting their influence to keep the markets as a whole within certain boundaries. The outcome is past market characteristics, when prudently considered, provide the best approximation we have of future market characteristics.

On the other hand, acknowledging and considering the influence of market invariants doesn't preclude planning for extreme scenarios never encountered before; however, this type of planning, based on speculation beyond known bounds, is best served by supplementing with guaranteed income…the topic of the last chapter.

Systemic Withdrawals and the Retirement-Income Philosophy

This final topic before officially starting the book concerns the philosophy taken towards retirement income.

Jeremy Cooper and Wade Pfau in their paper, *The Yin and Yang of Retirement Income Philosophies*, explain that retirement strategies fall into two main camps: probability-based and safety-first. The probability-based camp focuses on a portfolio of volatile stock and bond funds to meet income needs. The safety-first camp focuses on a portfolio of guaranteed-income (e.g., annuities, bond ladders) to meet income needs. Neither of these camps is pure, though: the probability-based camp often supplements with guaranteed-income in a secondary role; the safety-first camp often supplements with stock and bond funds in a secondary role. Nevertheless, the differences are major.

Philosophically, the safety-first camp makes complete sense; however, this book fits squarely into the probability-based camp for several reasons outlined below.

First, the data shows by using an updated set of probability-based best practices (the topic of this book) there is significantly lower risk than traditionally estimated — most retirees will find the risk acceptable and the reward worthwhile.

There's another reason, often overlooked. The risk of insufficient income can come from poor markets *or unexpected expenses*. In both cases the result is not enough income to meet expenses. When stocks make up a substantial portion of the portfolio, there is typically surplus value from the stocks (over 90% of the time historically). This frequent surplus value from stocks can help or fully cover unexpected expenses, essentially providing an extra hedge.

In contrast, a safety-first solution often costs significantly more than traditionally estimated because of longer life spans — low returns from guaranteed-income solutions rarely support long retirements well. Also, a safety-first solution doesn't generally have the built-in hedge for unexpected expenses —the bulk of the portfolio is more likely to be allocated to guaranteed income, limiting both the stock allocation and the potential for surplus value to cover any unexpected expenses.

Ultimately, it will become clear that many retirees can't afford a pure safety-first approach, or if they can, they aren't willing to pay the price, or sacrifice the loss in flexibility, or accept the exposure to unexpected expenses. Guaranteed income still has an optional role, but it must be a balanced one.

From within the probability-based camp, this book focuses on what is called *systemic withdrawals*[*]…a conglomerate of strategies generating sustainable income from a portfolio of stock and bond funds. The first 10 chapters identify and verify the best practices for systemic withdrawals. The last chapter, almost a book in itself, shows how guaranteed income can supplement systemic withdrawals to handle cases worse than we've seen in the past.

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Once you've completed this book, you'll be well prepared to form your own plan and put it into action. The downloadable spreadsheet will aid you, plus the book's website can keep you abreast of updates, but everything you have to have is here.

* A similar term, systematic withdrawals, is commonly used in the literature, but its definitions vary and sometimes misalign with the solutions covered.

The One-Page Reference Guide
for Investing Well During Retirement

The downloadable spreadsheet supports this guide.

- Form a plan by iterating through the following steps until satisfied.
  1. Pick your target retirement length based on life expectancy, typically 30 to 40 years. Websites such as https://personal.vanguard.com/us/insights/retirement/plan-for-a-long-retirement-tool can identify the age where the life-expectancy probability is between the recommended amounts of 1% to 5%.
  2. Make sure you are comfortable with income-harvesting in Chapter 3, specifically Prime Harvesting (or Alternate Prime as an alternative).
  3. Make sure you are comfortable with variable withdrawals in Chapter 4, specifically EM (or ECM as an alternative).
  4. Pick your initial stock percentage. See Chapter 7 recommendations.
  5. Pick one of the portfolios from the recommendations in Chapter 8. Or optionally, define your own well-diversified portfolio using the Harvesting Ratio (defined in Chapter 5 and applied in Chapter 8).
  6. Identify your initial withdrawal rate, following the example in Chapter 9.
  7. Consider Figure 141 in Chapter 10 to make any needed adjustments to the stock percentage or withdrawal rate based on your primary retirement parameters.
  8. Optionally consider using guaranteed income, based on Chapter 11's recommendations and the following steps.
     i. Determine your essential-income rate (factoring in all income sources)
     ii. Compare GI options (i.e., TIPS ladders, I Bonds, inflation-adjusted SPIAs) and their payouts
     iii. Choose a GI strategy, considering the essential-income rate, stock-valuation level, bequest motivation, and the various payout rates for different options
     iv. Calculate and consider the total income rate from combining the guaranteed-income plan and systemic-withdrawal plan.

- At the start of retirement:
  1. For systemic-withdrawals
     i. Start Prime Harvesting (or the alternative) to manage income harvesting, following the step-by-step example in Chapter 3.
     ii. Start EM (or the alternative) to determine annual withdrawal amounts, following the step-by-step example in Chapter 4.
  2. Begin the guaranteed-income plan (if any), possibly purchasing bonds and annuities.

- Once a year, do plan maintenance, which is essentially adhering to Prime Harvesting and EM, plus any guaranteed-income requirements.

- Every 5 to 10 years, reevaluate your goals and outlook. For major changes, reiterate on the plan if needed. If merited, review the guidance on restarting systemic withdrawals in Chapter 10. Also consider reviewing the examples in the last chapter.

CHAPTER 1 GUIDE

This chapter explains why investing during retirement requires new concepts and strategies. Advances in financial economics are described as the underpinnings for the modern mechanics of investing during retirement. The mechanics are introduced, essentially outlining the core contents of this book.

Less interested readers can skim the chapter focusing on the "The Modern Mechanics".

Our financial descendants will look back to this time and wonder, "What were they thinking?"

Walter E. Goh*, 1991
National Conference of Academic Retirement Planners

CHAPTER 1

Investing During Retirement is Different

The top priority for investing during retirement must be to provide sufficient, if not ample, income for as long as we live. Running out of money late in life, when our earnings potential has dwindled, certainly qualifies as a financial disaster — recovery would be difficult if not impossible. Retirement is not a time to learn from investment mistakes.

Investing *during* retirement is different from investing during the accumulating years. Periodically selling stocks and bonds to support sustainable income add a new dimension to the problem. A strained duality is created: while our money must never run out, it must continually fund our standard of living. This duality creates a different investment dynamic, one requiring checks and balances beyond investing in the accumulating years.

Regrettably, investing during retirement in the media or practical literature is too often reduced to tactical planning for IRAs and 401Ks, a dose of annuities, and boosting bond levels to cut "risk" — all followed by a return to investing as usual with no strategic changes. Usually, there is little or no emphasis on the differences stemming from the portfolio withdrawals that provide income.

A plan for investing during retirement should answer several key questions, all revolving around withdrawals. What asset allocation is most likely to support sustainable withdrawals? What assets should be sold each year to fund withdrawals? When and how should the portfolio be rebalanced to minimize risk from withdrawals? How might future unknowns be hedged to protect withdrawals? And of course, how much can be safely withdrawn each year? The correctness of these answers strongly correlates to financial success in retirement.

A tenet of this book is the global market data provides the answers, showing us how to invest well during retirement. Alone, though, the data isn't enough. As outlined in the preface, evidence-based practices ensure correct answers are pulled from the data. Likewise, the science of data plays a part, leveraging what has been learned before to properly analyze and interpret the data in hand. Done right, this combination produces exceptionally good answers, directly aligned to the needs of retirees.

* A quote from Walter E. Goh introduces each chapter. You can find out more about Walter on the book's website.

What about financial economics? By itself, it hasn't gone far enough in supporting the needs of retirement investors. This lack is in part because financial economics is in a state of transition, reforming its core theories. It may also be the pragmatic needs of retirees extend too far beyond theory and narrow empirical research. Whatever the reasons, it's clear from the data, better solutions are possible than now proposed by financial economics alone. This should change as the field evolves, but probably not for this generation of retirees.

Nevertheless, the rigor of financial economics can ultimately provide a depth to investment answers that is not obtainable otherwise. This is why investors care about financial economics. It's also why it's reassuring when retirement guidance (even when derived from the data) can be mapped back to a defendable position within financial economics. In other words, financial economics can't provide complete answers yet, but we should still pay attention, gleaning what we can from what it does well. Before looking more at financial economics, it's helpful to first consider the landscape of investing during retirement.

The Landscape

During the accumulating years preceding retirement, especially early on, time is greatly on the side of the investor's portfolio. The long-term compounding of investment returns provides powerful fuel for portfolio growth. When ill markets are significantly down, holding fast eventually provides the cure. With proper diversification and enough time, good market performance follows the bad. The ability to wait through bear markets and global crises is the great simplifier for the long-term investor saving for retirement.

In retirement with periodic withdrawals, we can no longer fully depend on compound investment growth or the restoration of our portfolio value from market recoveries. The underlying characteristics are still at play, but not with enough power to eliminate the additional risk from withdrawals. Withdrawals can erode portfolio value during down markets. When depressed stocks are sold to support withdrawals, losses are permanently locked in, even during normal market cycles. Said another way, a market recovery cannot return value to assets that had to be sold at reduced prices to fund living expenses. Sells at depressed prices increase the odds of running out of money and necessitate a defensive posture for making withdrawals.

The right asset allocation combined with careful management of the overall portfolio (explored in depth later) can provide a buffer to selling at depressed prices to support withdrawals, adding time for losses to recover before being locked in though sells. Still, there is a limit for how long poor performance in retirement can be handled without adverse retirement effects — 10 to 15 years may be around the maximum. In contrast, during the accumulating years, 20 to 30 years of poor performance might be handled with no ill effect on starting retirement.

Another distinction stems from starting with a lump sum under varying market conditions. Investing during the accumulating years is typically based on dollar-cost-averaging over many years, but retirement kicks off under specific market conditions managing a lump sum. The initial market valuation of the shares held at the start of retirement can significantly affect the expected rate of safe withdrawals. When valuations are attractive (i.e., stocks are cheap), then the outlook for a high income rate is excellent. When valuations are unattractive (i.e., stocks are expensive), then a low income rate is more probable. History shows the sustainable withdrawal rate varies depending on when stocks are cheap versus expensive, such as 8% annual withdrawals versus 4%. To some extent, the starting portfolio value will balance the expected rate (when stocks are expensive, the portfolio value is typically higher to help compensate), but this income-balancing effect is often incomplete and unpredictable. Ultimately, we can't reliably predict future markets, or time markets well, but modest adjustments based on market conditions can improve overall results.

Although the average lifespan is now in the upper seventies, the probability of a 65 year old living into their nineties is now 20% for males and 31% for females[4]. There is even an 18% chance that one member of a retiring couple will live beyond 95. These percentages make it prudent to plan for a long life, which comes with unexpected expenses and often a growing reliance on savings.

The longer we live, the more income we need and the less flexibility we have to obtain it. We need income at a minimum to cover essentials and unforeseeable expenses. Shortfalls may occur due to our personal affairs, our health, or our income sources. Before retirement, shortfalls could be alleviated by saving more or working longer. In retirement, although some retirees work part-time, we must assume this ability to earn income eventually disappears with waning health.

Restating the above, during the accumulating years, risks could be alleviated outside the investment portfolio (again, such as saving more or retiring later); however, in retirement, as life-options narrow with age, risk must be alleviated from within the portfolio — there must be a reliable income stream with no outside aid. This implies risk must be kept very low in retirement.

The adage "form follows function" applies here. During the accumulating years, what matters most is increasing portfolio value safely for retirement. In retirement, what matters most is generating income safely throughout retirement. Different aims require solutions of different forms. The result is investing during retirement requires more forethought and distinct strategies, extending well beyond what was required for the accumulating years.

With this in mind, let's return to financial economics for a moment.

The Revolution in Financial Economics

"The last 15 years have seen a revolution in the way financial economists understand the investment world." This statement was made in 1999 by Professor John Cochrane, a leading financial economist from the University of Chicago, in his succinct appraisal of where the field stood.[5] The revolution Cochrane refers to is still in progress; however, a line can now be drawn between the old pre-revolutionary thinking in financial economics and the new post-revolutionary thinking. This division is important for retirement planning: the old thinking led to weak retirement plans while the new thinking opened the door to better performing and safer plans.

Below is an outline of the old thinking: how most financial economists understood the investment world before the revolutionary shift Cochrane describes.

a. In compliance with the capital asset pricing model (CAPM), all investors should operate from a two-fund world. One fund is composed of risk-free assets (e.g., treasury bills); the other fund is made up of risky assets (e.g., stocks), approximating the market portfolio (i.e., a portfolio proportionally invested across all the risky assets in the market).

b. The "market portfolio" is the optimal portfolio for risky assets — no additional risky asset can be added to the market portfolio to improve the return-to-risk ratio (as defined by the Sharpe Ratio). This means the market portfolio is the safest possible allocation of risky assets for all investors, including retirees.

c. An investor's risk aversion determines how little or much of the risky fund (the market portfolio) should be held. For example, an investor with a high risk aversion holds more of the risk-free bond fund; an investor with a low risk aversion holds more of the risky total-market fund.

d. Return should be increased only by raising the allocation to the risky fund (the market portfolio). To increase return above what 100% in the risky fund can deliver, money is borrowed at the risk-free rate and invested in the risky fund, essentially buying more total-market funds on margin.

e. Stock and bond market prices (from the risky market) are independent from earlier years, forming a sequence of random returns (i.e., a random walk). Likewise, stock and bond prices are unpredictable in the short and long-term. Stock market valuations tell us nothing about future market performance.

f. Periodic rebalancing maintains the correct portfolio, realigning the stock-bond ratio to match the investor's risk aversion.

Few investors today adhere to a pure form of the above thinking, but there is no doubt these old thoughts still have an influence on what "good" investing during retirement looks like. Exactly how this old thinking manifests in retirement plans is periodically explored throughout this book, but in short, the market portfolio with annual rebalancing performs poorly in retirement.

Below is an outline of the new thinking: how most financial economists now see the investment world *after* the revolutionary shift Cochrane references. This thinking is much more conducive to strong retirement planning. Most important here, it properly aligns to the long-term global market behavior observed in the data.

a. Multiple factors explain portfolio returns, meaning the two-fund portfolio (i.e., the risk-free fund and the total-market fund) is insufficient. There are many factors, although the best known are size, value, and momentum.

b. In a multi-factor world, retirees should operate in a multi-fund world (e.g., value stocks, small stocks) beyond the capital asset pricing model's recommendations. Likewise, "riskier" high-return funds may be on a retirement portfolio's efficient frontier (i.e., the optimal allocation for a targeted return rate).

c. Stock-market prices are not independent from earlier years. While prices remain unpredictable over the short term, they have a component of predictability over long periods. Market valuations do tell us something about the future — high valuations are on average followed by low stock returns and low valuations by high stock returns.

d. Since stock prices aren't totally random, there is no longer a single static asset allocation to cover all situations. For example, the best stock-bond ratio can shift over time. Likewise, periodic rebalancing is no longer a simple conclusion; when and how to rebalance the portfolio can depend on portfolio conditions and market conditions.

e. The time horizon for the investor does make a difference. Short-term and long-term investors usually shouldn't hold the same portfolio.

Although notable critics of the above new thinking can be found, relatively few economists now dispute these market characteristics in their most basic form. Nevertheless, a major dispute continues around the why, the extent, and the implications. The result is, surprisingly little relevant pragmatic advice has trickled out to retirees.

Fortunately there is no need to wait for a consensus around a new encompassing theory. Some of the most pragmatic results coming out of financial economics in the last 25 years stem from Fama and French's work on the value and size effect on stock returns. Notably, this work is essentially empirical without a strong theoretical foundation — it's based on the data. Recommendations for investing during retirement can progress in the same

way, focusing on the data to update retirement strategies while the debates are being resolved and the theory catches up.

Keep in mind, investing during retirement isn't possible without following a set of strategies, whether old or new, whether implicit or explicit. Even doing only the minimal is a strategy. Living off your money requires decisions for each step of the process — these decisions form your strategies. The question is what strategies will you choose, and if you don't actively choose, then most likely the choice is being made for you based on tradition...doing what has "always" been done with at best mediocre results.

Every one of the strategies recommended in this book is shown to have a long-standing verifiable track record along with rational underpinnings. More specifically, the recommendations come from well-established market patterns found in the global data when applying the science of data, adhering to evidence-based research. In addition, wherever applicable, the recommendations are well-rooted in new economic thinking.

The Modern Mechanics

Modern mechanics are simply the working pieces of the best practices for systemic withdrawals. (As a reminder, the term *systemic withdrawals* refers to the complete set of strategies for generating sustainable income from a portfolio of stock and bond funds.) The mechanics are defined with a pragmatic level of precision, including the hands-on steps retirees must follow to enact their retirement plan. These mechanics might be organized several ways, but here they are grouped into the following components:

1. An Income-Harvesting Strategy
2. A Variable-Withdrawal Strategy
3. A Baseline Market and Portfolio
4. A Retirement-Portfolio Metric
5. A Strategy for Setting the Initial Withdrawal Rate

As mentioned in the preface, these mechanics are new to most retirees, rarely put into practice and then only partially. Acceptance in investment circles of the better known aspects has been slow in part due to the lasting debates surrounding the new economic thinking, coupled with a lack of sufficient verification. The lesser or unknown aspects, like the retirement-portfolio metric or a Baseline Market, haven't before been adequately addressed for retirement planning.

Each component of the new mechanics is outlined below. The mechanics are generally independent from each other — each can be used without the others — although only together do they form a complete plan.

1. An Income-Harvesting Strategy

An income-harvesting strategy defines exactly how to manage the portfolio during retirement to minimize the impact of periodic withdrawals.

Every retirement investor has an income-harvesting strategy, most just don't realize it. Traditional rebalancing, the default, is one of the simplest of strategies. The problem is, traditional rebalancing doesn't perform well in retirement. It's not the worst strategy, but far from efficient.

There are a diverse set of existing income-harvesting strategies to choose from in the literature. All strategies, at least implicitly, define rebalancing rules (how and when to rebalance) and what assets are sold to fund withdrawals. Some affect the stock-bond ratio, others affect the broader asset allocation. Setting the withdrawal rate, though, is outside the domain of an income-harvesting strategy.

The new thinking in financial economics reflects the need for a smart income-harvesting strategy. When retirement performance is simulated using old market assumptions, the smart income-harvesting strategies have a much smaller advantage over annual rebalancing (although still an advantage). In contrast, when performance is simulated using new market assumptions, the advantages of smart income-harvesting strategies are substantially boosted. More importantly, this boost from smart harvesting consistently shows up in real historical data, outperforming all forms of traditional rebalancing.

Chapter 3 covers income-harvesting strategies in depth.

2. A Variable-Withdrawal Strategy

A variable-withdrawal strategy determines how much can be withdrawn annually. It can increase withdrawals during strong markets and lower withdrawals during poor markets. Ideally, the portfolio never runs out of money, with rates lowered as much as necessary to handle market shortfalls.

Despite the flexibility of variable-withdrawal strategies, a fixed, inflation-adjusted withdrawal rate is the de facto standard within the industry and the retirement literature: the same inflation-adjusted amount is withdrawn every year. Certainly, a fixed rate is easier to discuss, compare, and plan with, but it matches neither retirees' true spending patterns nor the reality of changing market conditions. Fixed withdrawals force a low rate to handle the worst possible case, almost always resulting in income lower than necessary (with a large portion of assets left untouched throughout retirement). More dramatic, fixed withdrawals will run out of money during an unforeseeably poor market—a retiree would almost certainly compensate if required by lowering the rate, but a fixed-rate strategy ignores the possibility and provides no guidance for effectively doing so.

The best known variable-withdrawal strategies vary significantly, but overall their performance is strong. Every strategy has its own metric to monitor the retirement state and adapt accordingly. A higher withdrawal rate is specified when there are signs the portfolio is strong, and a lower withdrawal rate when there are signs the portfolio is weak. Often, floor and ceiling amounts are used to set boundaries on the annual amount withdrawn. While these strategies don't directly depend on the new thinking in financial economics, they must be verified with the real market data (embodying the new thinking).

Chapter 4 covers variable-withdrawal strategies in depth.

3. A Retirement Portfolio Metric: The Harvesting Ratio

Post-revolutionary thinking in financial economics indicates retirees are not limited to the market portfolio, but how can a retiree know what asset allocation works well in retirement?

There are obstacles to looking in the literature to find the right portfolio for retirement. First, who are you going to believe? Expert advice is very diverse. Much of it's subjective, not meeting the standard for evidence-based guidance, again making the right answers difficult to discern from the wrong ones. Also, the overwhelming majority of portfolio advice revolves around the accumulation phase of investing, with relatively little distinction made for investing during retirement.

What the new mechanics contribute is help in identifying strong retirement portfolios. The Harvesting Ratio, a new portfolio metric, measures the suitability of a portfolio to support a specific withdrawal rate. The higher

a portfolio's Harvesting Ratio for a specified withdrawal rate, the more likely the portfolio will be successful in retirement.

The Harvesting Ratio works by measuring the correct balance between portfolio return and volatility necessary to support a specific withdrawal rate. While this simple relationship might not appear sufficient, it is. Matching the portfolio allocation to retirement withdrawals substantially pays off in safety and income.

The evidence is carefully reviewed in Chapter 5, showing the Harvesting Ratio as a reliable metric for comparing retirement portfolios. Chapter 8 applies the Harvesting Ratio to a well-known set of "Lazy Portfolios", bringing to light the strong (as well as weak) portfolios for retirement. These same results are then used to create a new set of specific portfolio recommendations for retirement.

The Harvesting Ratio is not intended to supplant the fundamentals of asset allocation (all retirement portfolios should first be composed of a well-diversified mix of low-cost funds of high-quality assets), but it aids asset selection by removing most of the arbitrary decision-making from the process.

4. A Baseline Market and Portfolio

Virtually all results from retirement research are either relative, or only valid within a specific market context. This is acceptable for testing and comparing strategies, but at some point a retiree wants to know the income and risk levels to expect for his or her own retirement. A baseline market and a baseline portfolio are defined in the new mechanics to provide realistic estimates of income and risk for retirement planning.

A baseline market acts as a proxy for future markets. To be effective, it must have certain characteristics: it must be globally oriented; it must support a variety of asset classes for proper diversification; it must include a sufficiently long history encompassing the best and worst market periods. It should also be based on real market data, insuring it conforms to the new thinking in financial markets. Unfortunately, no existing dataset meets these criteria and we don't know how to properly model markets.

The solution taken is to fabricate a baseline market by starting with the best real data available and scaling it to align with long-term global stock and bond returns. The process and rationale for this are fully explained later, but for now accept the resulting baseline market will satisfy the criteria, providing an appropriate proxy for future markets.

A baseline portfolio is also needed, representing an average retiree's portfolio when following best practices. A simple but effective baseline portfolio can be composed using the Harvesting Ratio. The result is a portfolio representative of what most retirees should use for their retirement portfolio.

The combination of a baseline market with a baseline portfolio provides realistic estimates of the performance and risk retirees can expect using a globally diversified portfolio. There is no crystal ball, but prudently using these baselines fills an existing gap in retirement planning.

Chapter 6 covers the Baseline Market and Baseline Portfolio.

5. A Strategy for Setting the Initial Withdrawal Rate

Most variable-withdrawal strategies must be seeded with an initial rate, or baseline rate, which affects how well the strategy performs. Withdrawals typically revolve around this initial rate, moving above it during good times and below it during bad times. When the initial rate is properly set, the demands on the variable-withdrawal strategy are lowered and the results better.

The new thinking in financial economics acknowledges that long-term stock prices have an element of predictability. The problem is the data shows a strong reliance on market predictions is risky; however, the data also shows long-term predictions can be *moderately* applied to improve the selection of the initial withdrawal rate.

This aspect of the new mechanics deploys a moderate but effective approach by modestly tilting the initial withdrawal rate based on long-term market predictions. The result is much better than sailing blind, with a worthwhile boost in both performance and risk avoidance.

Chapter 9 covers the complete rationale and steps for seeding the initial withdrawal rate using market valuations.

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These five components of the modern mechanics will form a complete solution to the systemic withdrawals problem. Their exact makeup is determined in later chapters by what reliably works and what is essential, filtering out lots of invalid or extraneous investment trends, opinions, and techniques. The final result is an updated set of best practices for systemic withdrawals.

The Point

Investing during retirement is different, requiring new strategies. Financial economics alone doesn't provide enough guidance, but it's evolving and should still be considered. The data is now our best guide. Following the data, adhering to evidence-based research, this book defines a new set of best practices. Compared to traditional approaches, these best practices lower risk while increasing income.

CHAPTER 2 GUIDE

This chapter defines risk during retirement, how it's estimated, how it's broken down, and how it's applied. The factors causing risk are also identified.

There is latitude in how well the reader should understand this chapter before moving forward. While it's essential from the investigative perspective (i.e., what, why, how), much less is essential for carrying out an individual plan. Less interested readers may skim the chapter for highlights, although a careful reading is worthwhile.

This chapter completes the foundation, with the rest of the book more directly oriented toward defining a retirement plan.

Some investors are entangled in their study of risk whereas the purpose of studying risk is to keep investors out of entanglements.

Walter E. Goh

CHAPTER 2

Understanding Risk During Retirement

Risk has a strong tendency to stay opaque. It's one of those rare topics we can easily grasp intuitively, but quickly becomes obscure when trying to comprehend at a deeper level. To make matters worse, the financial media bombards retirees with risk-related assertions that are ill-suited for retirement planning.

There are many well-studied discussions of risk in the literature, coming from many perspectives. While risk discussions can be engaging and thought-provoking, they can also be distracting and difficult to apply. Each outlook depends on perspective, goals, and starting assumptions. To avoid becoming bogged down, it's important here to methodically refine what is known about the risk of investing during retirement, which is a lot, and then focus on applying it.

An appropriate starting place is to define exactly what investing risk means during retirement. Or more specifically, what risk means within the context of systemic withdrawals.

Defining the Risk

Generally, risk is defined as exposure to danger, but in the context of investing, risk is usually defined by economists as exposure to loss. This exposure to loss is measured as the volatility in an asset's return. (Volatility resulting in a negative return is a loss, hence the equating of investment risk to volatility.)

Volatility as it's typically measured is oriented to short-term market happenings and a type of investing style no retiree should depend on. Investing during retirement extends decades into the future, where the short-term spikes and troughs gauged by volatility aren't always relevant. In retirement, it's best to put aside discussions on what might happen to portfolio value. It's not the loss of portfolio value retirees should care most about; it's the loss of retirement income. This distinction between value and income is important because tests show portfolio values often rise and fall (incur paper gains and losses) with no effect on retirement income.

The real risk in retirement is insufficient income to cover living expenses, with the extreme case being running out of money. However, insufficient income is cumbersome to meaningfully estimate—it's less intuitive and, depending on how it's defined, might vary between retirees. The extreme case, the probability of running out of money, turns out to be the best working definition for risk during retirement. It's easy to understand and can be precisely estimated (with caveats). Also, the risk of running out of money generally correlates well with the risk of insufficient income, making the simpler definition adequate for retirement planning.

This risk of running out of money is determined by several factors. For example, the withdrawal rate is a fundamental factor. Without withdrawals there is virtually no risk (the portfolio cannot run out of money). Increasing withdrawals always increases risk; lowering withdrawals always lowers risk. Likewise, retirement length is another fundamental factor for similar reasons. This is why the retirement literature contains many statements like "there is a 90% chance of retirement success (i.e., the probability of not running of money) for a 4% withdrawal rate for 30 years." Still, other factors affect risk, as the next section will show.

In summary, a simplified pragmatic definition for risk is the probability of running out of money before the end of retirement. A complete breakdown of what drives risk is covered in the next few sections. The discussion afterward turns to measuring risk, and finally to effectively monitoring and controlling risk.

Breaking Down Risk

Risk can be broken down to into different facets and the factors that determine it. The aim of this breakdown is to align with retirement planning, identifying those areas essential to specific decision points. What is defined is conceptual; however, this is not an academic exercise. Retirement planning depends on an exploration of the underlying risk.

Figure 1 shows a breakdown of the elements of risk during retirement using systemic withdrawals. This breakdown is the focus of the rest of the chapter, but to start off, a quick summary is given below.

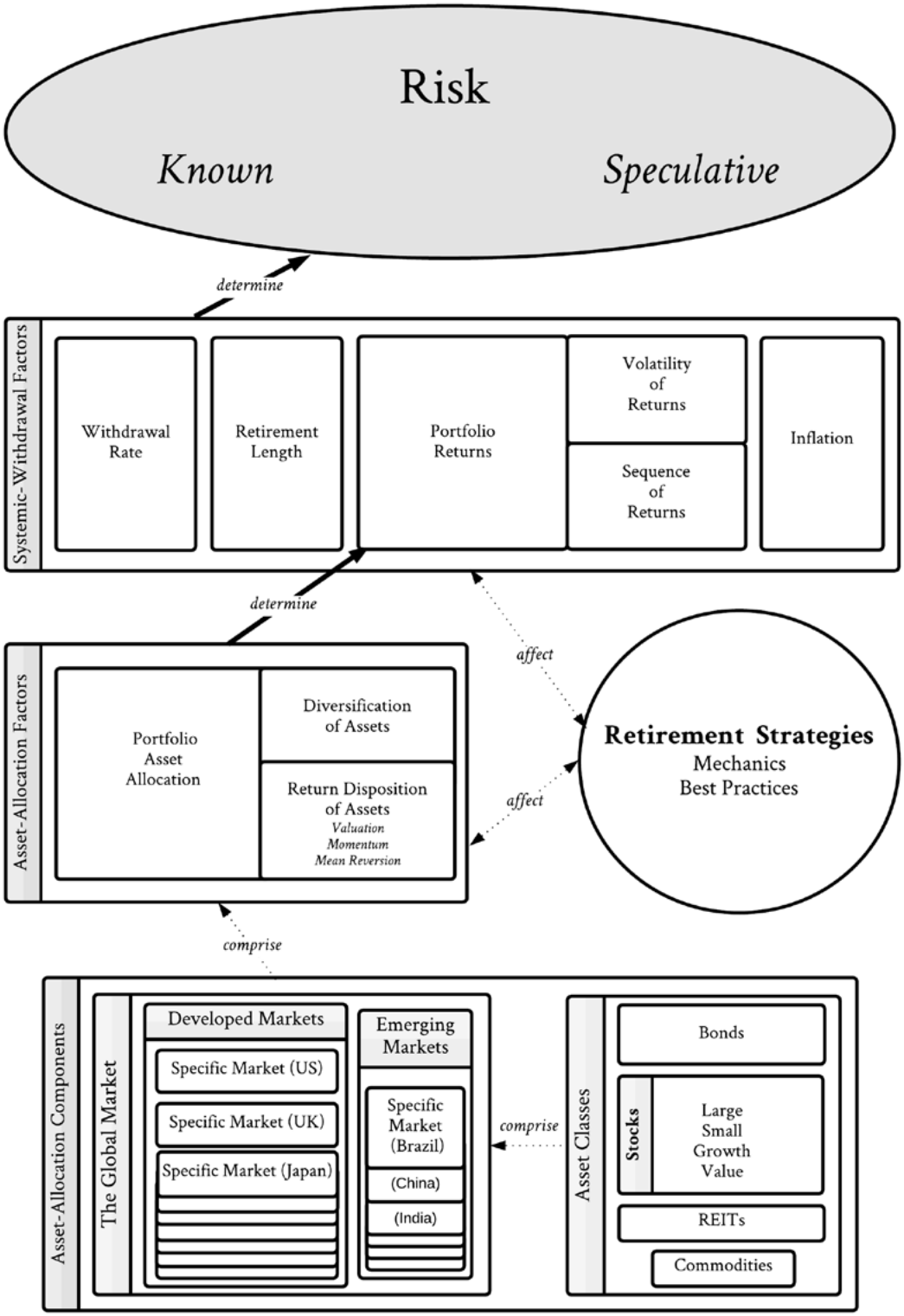

FIGURE 1

Risk during retirement using systemic-withdrawals, including the factors, components, and strategies that affect it.

There are two facets to systemic-withdrawal risk: known risk and speculative risk. Known risk is what retirees commonly face. It's based on the historical data, measurable, well understood, and at the center of retirement planning. In contrast, speculative risk corresponds to the possibility of markets worse than we've ever seen. It's rare and hopefully will never be encountered. It's unmeasurable, ill understood, and can only be planned for in an indirect manner.

Moving down a level, six interrelated factors drive all retirement risk: the withdrawal rate, the retirement length, portfolio returns, return volatility, the sequence of returns, and inflation. The factors are not equal in their importance — their potency in affecting risk varies as well as their ability to be manipulated.

One more level down, three asset allocation factors also have a major effect on retirement risk, but only indirectly by affecting the three return factors. The pragmatic reality at this level is a retiree's global asset allocation drives portfolio returns, volatility of returns, and the sequence of returns, which in turn partially drive retirement risk.

Notice in the same diagram how retirement strategies affect and are affected by the direct and indirect factors of retirement risk. Conceptually, the retirement strategies of the new mechanics are a set of rules for monitoring and manipulating the risk factors (in varying degrees), all with the aim of generating a sufficient amount of income for the least risk. The same can be said of investing during retirement as a whole — it's about the proper monitoring and manipulation of the risk factors affecting income.

Known and Speculative Risk

As mentioned earlier, all retirement risk can be subdivided into two facets: known risk and speculative risk. Known retirement risk encapsulates everything we know from the historical market data. Conversely, speculative retirement risk is outside the boundaries of what has been seen in market history and thus can only be discussed in speculative terms.

From another perspective, speculative risk can be said to pick up where known risk leaves off. Consider this case: in the US market the known risk of failure for a 3% withdrawal rate is 0% — there is no instance of failure anywhere in the US data for such a low withdrawal rate. Does this mean it's impossible to run out of money withdrawing 3% annually? Yes, if based on known risk within the US, but not based on speculative risk, where the possibility of a failure always exists. Speculative risk extends indefinitely beyond what has been experienced in the past, although we can say the more extreme the case, the lower the risk (i.e., speculative risk for a 1% withdrawal rate has to be lower than for a 2% withdrawal rate, even though neither is measurable). The logical existence of this speculative risk is very clear: virtually anything can happen in the future, but always keep in mind it's truly speculative without a clear foundation for estimating or planning.

There are important but subtle reasons for distinguishing known risk from speculative risk. The line separating what we know about markets (known risk) from what we don't know (speculative risk) is too often blurred in discussions. This blurring can cause risk to be treated as if it has no distinct characteristics, leading some to conclude there is very little market behavior we can plan on, with the extreme opinion being markets are too risky for retirement. With well over 100 years of global market data, speculative risk becomes an anomaly that should not obscure what is known about the markets. Speculative risk is indeed speculative and should be classified as such. Quite distinctly, known risk can be methodically measured, based on our substantial historical record. Planning can be based on it.

This concept of speculative risk parallels the following thoughts on uncertainty made by University of Chicago economist Frank Knight in his 1921 book *Risk, Uncertainty, and Profit*:

> Uncertainty must be taken in a sense radically distinct from the familiar notion of Risk, from which it has never been properly separated. […] The essential fact is that 'risk' means in some cases a quantity susceptible of measurement, while at other times it's something distinctly not of this character. […] It will appear that a measurable uncertainty, or 'risk' proper, as we shall use the term, is so far different from an unmeasurable one that it's not in effect an uncertainty at all.

Similar to Knight's thoughts above, known risk is the measureable uncertainty or "risk" proper in retirement. Compared to speculative risk, known risk provides a level of understanding that is not uncertain at all, with clear boundaries drawn by historical markets. Known risk forms the basis for most of the retirement planning in this book. In contrast, speculative risk is the unmeasurable uncertainly in retirement, and as such is difficult to plan for except generally. Speculative risk is also the source of most disagreements surrounding retirement risk, and as such is better separated — we can only speculate on its future magnitude and frequency.

Nevertheless, speculative risk as defined must be small — the risk's existence starts beyond the market events of the last 100 years, spanning depressions, recessions, world wars, market bubbles, and high inflation. Known risk is bad enough and big enough to encompass all but the most extreme cases the future can throw at our retirements. Still, speculative risk is real and will periodically be given separate attention, distinct from the methodical focus best applied to known risk.

Risk going forward generally refers to the known risk of systemic withdrawals.

The Risk Factors

Distinguishing a risk factor from risk itself is the starting point for learning how to effectively control risk.

Figure 1 shows that six direct factors and three indirect factors determine retirement risk. Some of these factors can only be observed or monitored, while others can be manipulated to our advantage, lowering retirement risk. Most factors have established metrics for measurement, but a few do not. Some factors are distinct, affecting risk on their own, and some act in combination. Some only have meaning in terms of others.

The analysis of risk factors, which will be ongoing throughout this book, is not meant to be complete, but sufficient enough to serve the needs of retirement planning.*

The Direct Factors

The six direct factors of risk are described below, each in its most common form.

1. **Withdrawal Rate**

   The withdrawal rate refers to the percentage of the portfolio periodically pulled out for income. Typically, the withdrawal is made annually. For example, a 4.2% annual withdrawal rate for a $500,000 portfolio is $21,000.

   The withdrawal rate is the single most important factor of retirement risk. A low rate can push risk down to zero and a high rate can push it up to 100%. This is the only direct factor a retiree may claim to completely control. For this reason, a variable-withdrawal strategy plays a crucial role within a strong retirement plan, dynamically keeping risk in check by adjusting the withdrawal rate.

* As defined and broken down, retirement risk could be calculated as a single formula based on the six direct factors of retirement risk. While this approach would be interesting and insightful, the data is not readily available, plus it doesn't serve the needs of investing during retirement as well as historical simulations. However, the Harvesting Ratio in Chapter 5 does define a single formula with four factors to aid asset allocation, especially where the historical data is insufficient.

2. **Retirement Length**

Retirement length is the number of years a retiree lives in retirement. For a couple (e.g., husband and wife) the longer-living person determines the length of retirement. As the length increases, retirement risk increases, because sustainable withdrawals must last longer. Generally, retirement length is a secondary factor of retirement risk, in part because the total length is fixed for planning and in part because its effect on risk doesn't change substantially between longer retirement plans.

Over 30 years, the risk stemming from the retirement length flattens out. For example, where a 30-year retirement can support a 4.3% sustainable withdrawal rate, a 40-year retirement supports 4.0%—a 7% decrease in sustainable income for a 33% increase in retirement length. Somewhere above 45 years, the effect on known risk becomes completely flat (e.g., a 45 year, 50 year, and 55 year retirement plan all support a 3.8% sustainable withdrawal rate).

Occasionally, the length of retirement has an indirect impact on retirement planning. For example, some income-harvesting and variable-withdrawal strategies take into account the years remaining in retirement; for these strategies the retirement length has a substantial indirect effect on annual income later in life. Also, when using guaranteed income, outside of systemic withdrawals, the impact of planning for a 30-year versus a 40-year retirement is much larger.

The retiree's part concerning the retirement length is relatively simple: the retirement length is picked once at the start of retirement roughly based on the maximum remaining life expectancy, with planning then proceeding accordingly.

3. **Portfolio Returns**

Portfolio returns correspond to the total return of all assets in the systemic-withdrawal portfolio. Portfolio returns make up the second most important factor of retirement risk, behind the withdrawal rate. Low portfolio returns increase retirement risk; high portfolio returns decrease retirement risk.

The retiree has no direct control over returns, but a substantial amount of indirect control through asset allocation (as shown in Chapter 5). Referring back to Figure 1, returns and its related factors are determined by the three indirect factors of asset allocation. Also, income-harvesting strategies affect asset allocation in order to increase portfolio return.

Return can be measured in different forms. When using historical datasets, return is in annual terms and nominal (i.e., no inflation adjustment). This simple form is most often used discussing return values. It's also the form commonly used to measure volatility (the next factor). Portfolio return is commonly stated as an average (i.e., arithmetic mean), such as the 10-year average, a 30-year average, or a complete dataset average. Although less common and therefore less practical, the return metric with the highest direct correlation to retirement risk is the annualized real return (the geometric mean after inflation).

The effects of asset allocation on return and how it maps to retirement risk is discussed in depth in Chapter 5's coverage of the Harvesting Ratio.

4. **Volatility of Returns**

The volatility of returns refers to the variance of the portfolio returns (the previous factor). Volatility is typically measured as the standard deviation using nominal annual portfolio returns over a long time period, like 20 years or more. No doubt, higher volatility generally increases retirement risk; however, volatility is not one of the dominant factors of retirement risk.

Consider the following two sets of retirement returns:

Annual Returns for Retirement 1: 10% 10% 10% 10%...10% 10% 10% 10%
Annual Returns for Retirement 2: 20% 0% 20% 0%...20% 0% 20% 0% 20% 0%

The average annual return for both cases above is identical at 10%, but the volatility for the first case is zero, and 10% for the second case. Nevertheless, both cases have the exact same sustainable withdrawal when using an appropriate income-harvesting strategy.

Also, one of the most volatile periods in the US market began in 1929 at the start of the Great Depression; however, a 30-year retirement starting in 1929 didn't do too poorly, with a sustainable rate of 4.6% using annual rebalancing.

Short-term volatility has little effect on retirement risk, especially using a smart income-harvesting strategy. Nevertheless, a significant amount of long-term volatility will always increase retirement risk, just not by as much as returns.

Like with returns, the retiree has no direct control over volatility, but a substantial amount of indirect control through asset allocation. These two factors share the same relationship to the three factors of asset allocation.

It's also well-known that return and volatility are coupled: the more return, the higher the volatility. Less known is the right mix of portfolio return and volatility, to reduce retirement risk. Again, this is covered in depth in Chapter 5's coverage of the Harvesting Ratio.

For now, keep in mind that retirees often pay too much attention to volatility.

5. **Sequence of Returns**

The sequence of returns factor is based on the order in which returns occur during retirement. Generally, lower returns early in retirement have more risk than lower returns later in retirement. To be clear, the same set of returns with identical levels of volatility can have a different level of risk due only to the sequence of returns. The following two sets of retirement returns illustrate the point well.

Annual Returns for Retirement 1: 1% 2% 3% 4% 5%...26% 27% 28% 29% 30%
Annual Returns for Retirement 2: 30% 29% 28% 27% 26%...5%, 4%, 3%, 2%, 1%

The return and volatility are identical, but the first retirement period sustains a withdrawal rate of 7.7%, while the second a withdrawal rate of 9%, only because of the difference in the sequence of returns.

The sequence of returns is the only direct factor of risk that has no established metric, which is unfortunate since its effects are difficult to discern by looking at a series of return numbers, especially with all the other risk factors at play.

Although this factor is defined in terms of portfolio returns, sequencing effects may come from inflation too. Ultimately, it's the sequence of the real return that matters. It doesn't matter if poor real returns are due to low nominal returns or high inflation.

Although the sequence of returns is emphasized for its negative effects, a good sequence of returns (lowering retirement risk) is just as probable as a poor sequence of returns (raising retirement risk).

To some degree, the sequence of returns is a random event depending on short-term market happenings; however the sequence of returns can be partially affected by asset allocation, since high volatility has more potential for a poor sequence of returns. It's notable in the historical data that a poor sequence of returns coupled with high volatility doesn't overpower the advantages of high returns, but it comes close to nullifying the advantages. This is in part due to the ability of an efficient income-harvesting strategy.

Based on US data back to 1928, the sequence of returns had a noticeably negative affect on retirement risk in less than 10% of the retirement periods, but in none of these periods did the sequence of returns dominate retirement results. Still, even without dominating, a poor sequence can contribute to distorted retirement results. The worst retirement periods in US history, starting in the late 1960s, were partly due to poor sequencing.

The sequence of returns can only be classified as a secondary factor of return risk. It can't be controlled, and its effects are generally limited, although in rare cases it has the potential to distort retirement results for better or worse. For planning purposes, it demands no special attention, given best practices handle it.

6. **Inflation**

Inflation determines the purchasing power of retirement income. As inflation increases, the purchase power decreases, requiring a higher withdrawal rate to cover the same amount of expenses. Depending on perspective, inflation can erode portfolio value or it can inflate the withdrawal rate (to maintain equivalent value), but the outcome is identical. This makes inflation equivalent to the withdrawal rate in affecting retirement risk; however it remains a secondary factor of retirement risk in terms of planning.

There are three reasons inflation requires little direct focus when planning for systemic withdrawals. First, a retiree has no direct control over the inflation rate, except perhaps to a small degree through discretional spending. Second, its effects are automatically accounted for by inflation-adjusting the withdrawal rate. Third, stocks as an essential component of systemic withdrawals provide an excellent long-term hedge against inflation. The result is that a systemic withdrawal plan naturally balances out and incorporates the worst effects of inflation with no special attention from the retiree. (In contrast, inflation is a dominant factor affecting guaranteed-income planning.)

Inflation is typically measured by annual changes in the US Consumer Price Index (CPI)*, or its equivalent outside the US.

Summarizing, the withdrawal rate and portfolio returns are the two dominant factors for retirement planning. The withdrawal rate can be fully controlled, and returns are partially controlled indirectly through asset allocation. Volatility and sequence of returns are less important due to their smaller impact, but they are still significant and partially controlled indirectly through asset allocation. Retirement length is usually set once at the beginning of retirement to its maximum value, and then treated as a constant with little attention afterward. Inflation can have a potent effect, but it's typically handled indirectly through annual income adjustments plus hedged by stock returns.

The Indirect Factors

Three asset-allocation factors indirectly affect portfolio returns, volatility of returns, and sequencing of returns. As such, they become the indirect factors of retirement risk and important levers for controlling it. Retirees for the most part are very familiar with the asset-allocation factors, although they might not think of them of in such terms. They are described below.

1. **The Portfolio Asset Allocation**

The portfolio asset allocation determines exactly what assets make up the portfolio and in what proportion. Asset allocation has a dominant effect on portfolio returns. It's also completely under the control of the retiree. This makes it a key factor, albeit an indirect one, for controlling retirement risk. As such, a significant portion of this book focuses on controlling the asset allocation to reduce retirement risk.

* More specifically, Consumer Price Index-All Urban Consumers (CPI-U) is used.

2. **The Diversification of Asset Allocation**
   Diversification simply means that the asset allocation is partitioned across multiple markets and asset classes. There are no well-established metrics for measuring or evaluating retirement diversification, but it's relatively simple to adjust for. Diversification should span a significant number of developed markets and emerging markets. It should also span a significant number of asset classes. The details are covered thoroughly under portfolio construction in Chapter 8.

3. **The Return Disposition of Asset Allocation**
   Return disposition is the state of the market that affects future returns. It runs hand in hand with return predictability. With a positive disposition, a higher than average portfolio return is more likely; with a negative disposition, a lower than average portfolio return is more likely. It directly depends on the specific asset allocation. It can be a potent factor of return risk; nevertheless, it's difficult to efficiently leverage.

   Mean reversion, market valuations, and momentum are all forms of return disposition. Financial economists have yet to agree on the extent and reliability of these forms of return disposition, only their existence to some degree. At any particular moment, the market can be positively or negatively predisposed. Return disposition pulls market behavior back from extreme positions in either direction.

   Some forms of return disposition, such as market valuations, have accepted metrics and will be discussed later, but generally there is no well-established metric for measuring return disposition.

   Return disposition cannot be controlled for a given asset allocation, only monitored. It can however be indirectly controlled through the makeup of the asset allocation. This indirect control and monitoring enables it to be leveraged, although without precision. Because it's imprecise, return disposition in many ways should be ignored in retirement, but with proper care it can be considered in certain contexts (topics covered in Chapters 9 and 11).

Figure 1 also shows the components which comprise the asset allocation. As already mentioned, these components include many markets (e.g., developed and emerging) and many asset classes. There are index funds for every component shown, whether by market or asset class or both. The proportions of these components and how they operate as a whole are more important than the individual components. Over half of the retirement problem is solved if a retiree knows how to allocate and maintain assets in the proper portions (indirectly balancing return with volatility to minimize risk).

Measuring the Risk

Measuring risk is at the heart of retirement planning. It means estimating the probability of running out of money before the end of retirement. Measuring risk enables the direct comparison of retirement strategies. For example, if strategy A has less retirement risk than strategy B for a specific amount of income, then it's a better retirement strategy (all other things being equal). Measuring risk supports the definition of a set of best practices across the spectrum of retirement mechanics. Then, with best practices in place, measuring risk optimizes final planning—ultimately a retiree wants to know how much income to expect for a minimum amount of risk, given selected parameters.

Risk measurements are well suited to computer simulation. There are generally two simulation approaches: backtesting simulations and Monte Carlo simulations, with bootstrapping simulations providing a composite third approach (see sidebars for each). Backtesting simulations fully rely on historical market data; Monte Carlo

simulations randomly create data using by modeling markets; bootstrapping randomly resamples the historical data to create new data.

Backtesting is the primary method of simulation used in this book, and the focus here, because it's based on real market data. Jim Otar in his book *Unveiling the Retirement Myth*[6] makes this point well: "A man-made simulator is still a man-made simulator. It's still not the real thing. Do yourself a favor; use the actual history." General Monte Carlo techniques are not used because the underlying models to create the data are either not sophisticated enough or have no agreed standards for modeling markets in a realistic way. However, bootstrapping is used occasionally when needing to broaden the results past what backtesting can provide.

In a nutshell, backtesting uses *past* retirements to provide a risk estimate for the future. Here's the general rationale: if a percentage (e.g., 5%) of past retirements failed over the last 100 years for a given portfolio, withdrawal rate, and market (e.g., the US), then the same percentage can be used as an estimate for future failures with the same portfolio, withdrawal rate, and market.

Backtesting is sometimes criticized or undervalued because it can be used improperly (discussed later as a data-mining bias). The problem stems from drawing too many conclusions from too little data (against the norms of evidence-based research). Today the best datasets usually contain from 80 to 140 years of data for their specific markets, with varying levels of detail. More data would be ideal, but what's in hand is sufficient (for comparing risk) because backtesting can be applied to *multiple* independent datasets, cross-validating the results. Fortunately, in the past 20 years the number of historical datasets has greatly increased, expanding beyond US markets into many international markets.

Figure 2 shows backtesting results using different withdrawal rates within the US market. For example, the risk estimate for a 4.5% inflation-adjusted withdrawal rate (e.g., $45,000 the first year for a $1 million portfolio) is a 20% probability of failure (i.e., running out of money), or the equivalent 80% probability of success (having money left over). To arrive at this estimate, backtesting found 11 of the 53 retirement periods failed by running out of money prematurely and 42 succeeded. Every risk measurement is always within the context of a specific set of strategies and parameters. This time, it's annual rebalancing with a 60% stock percentage and a fixed inflation-adjusted withdrawal rate. Note this single backtesting estimate of retirement risk is not enough to draw conclusions from, but when coupled with other risk estimates, it becomes part of a complete answer.

Withdrawal Rate	Risk Estimate (Positive Form): Percentage of Backtesting Successes	Risk Estimate (Negitive Form): Percentage of Backtesting Failures
3.0%	100%	0%
3.5%	100%	0%
4.0%	93%	7%
4.5%	80%	20%
5.0%	63%	37%
5.5%	52%	48%
6.0%	39%	61%
6.5%	32%	69%
7.0%	20%	80%

FIGURE 2

Backtesting risk estimates for 53 30-year retirement periods spanning from 1928 through 2010 in the US market.

Distinct from measuring probability, another form for measuring risk is the Maximum Sustainable Withdrawal Rate (MSWR). MSWR represents the highest inflation-adjusted fixed withdrawal rate that can be used without running out of money during a retirement period. For example, if backtesting a specific 30-year retirement period fails (i.e., runs out of money) with a 4.4% withdrawal rate, but succeeds with a 4.3% withdrawal rate, then the MSWR is 4.3%.

A more enhanced form of MSWR combines multiple measurements across all the retirement periods in a dataset. For example, MSWR-100% is the MSWR across all the retirement periods, where 100% of the backtested retirement periods in the dataset are successful. Likewise, MSWR-80% is the MSWR across periods where at least 80% of the periods are successful.

Figure 3 graphs 54 MSWR values for 30-year retirements starting from 1928 to 1981 using the US dataset. For example, a retirement starting in 1930 supports a 5.1% MSWR, meaning a maximum of 5.1% (of the starting portfolio value with inflation adjustment) can be withdrawn each year of retirement (from 1930 to 1959) without running out of money. A retirement starting in 1949 supports a 7.5% MSWR, meaning a maximum of 7.5% can be withdrawn each year of retirement (from 1949 to 1978) without running out of money.

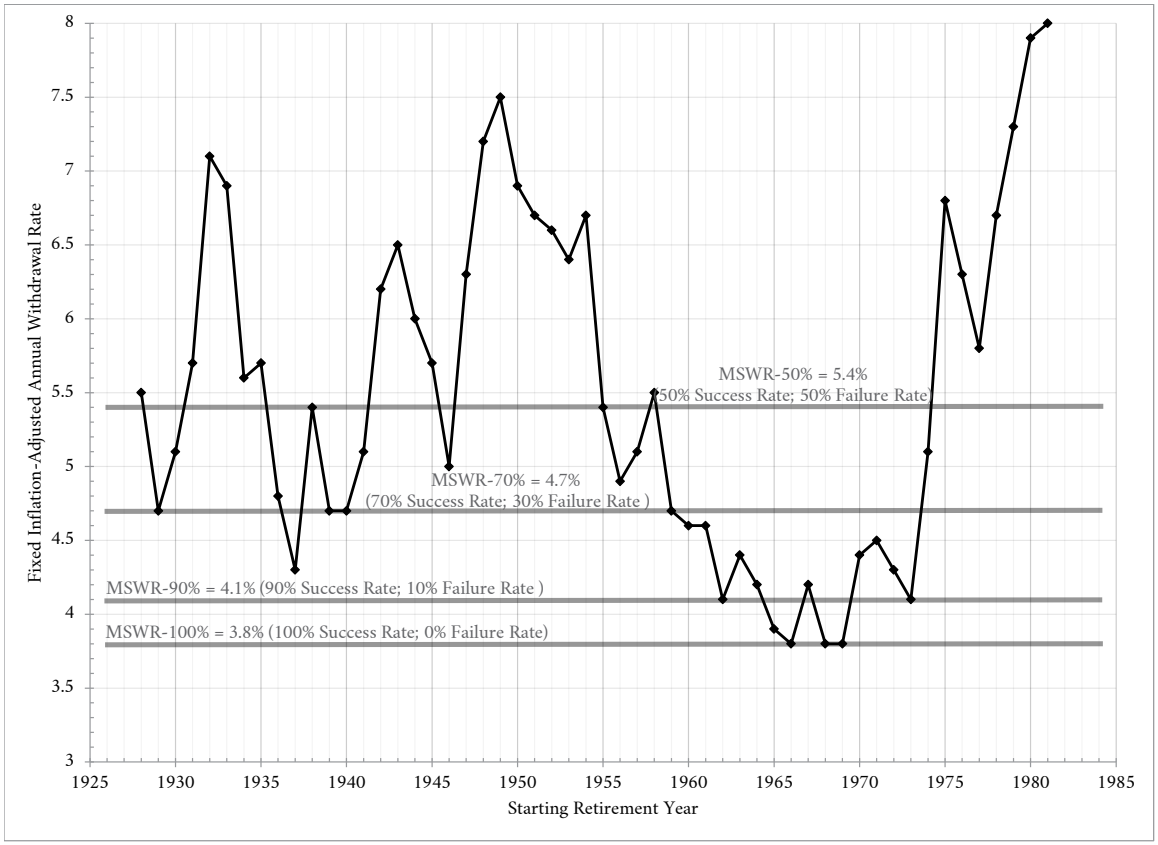

FIGURE 3

Maximum Sustainable Withdrawal Rates for the US Market. Annual rebalancing is used for a portfolio with 55% in a total-market stock fund and 45% in an intermediate-treasury bond fund. The retirement length is 30 years.

Figure 3 also shows the enhanced form of MSWR, with measurements spanning the complete dataset. For example, MSWR-100% equals 3.8% because all the retirement periods (i.e., 100%) ranging from 1928 to 1981 have a MSWR of at least 3.8%. MSWR-90% equals 4.1%, because 90% of the retirement periods have a MSWR of at least 4.1%. MSWR-70% equals 4.7%. MSWR-50%, representing half the backtested retirements, equals 5.4%. This nomenclature is used throughout the book.

Few conclusions, based on one set of parameters for a single dataset, can be drawn from any of these numbers yet. Just understanding how the risk estimates are made, their intent, and their nomenclature is the aim for now.

Backtesting Simulation

Backtesting shows exactly how a strategy performs when set in the past. The historical market data, primarily annual returns from stock and bond indexes, drive backtesting by encapsulating the market behaviors most cared about. While some of these behaviors are reasonably well understood, others are not, giving backtesting the great advantage of side-stepping the need to model that which is not well understood, instead using the real data factors in everything (e.g., asset allocation, return disposition, sequence of returns, volatility, inflation).

Backtesting works as if the retiree had gone back in time to start retirement in a specific year, such as 1928. Each year of the retirement thereafter (e.g., 1929, 1930, 1931, etc.) is based on the corresponding historical data. The portfolio's value grows and shrinks according to the historical returns as annual withdrawals are simulated. If the portfolio value lasts through the complete retirement period (i.e., the money does not run out), then the test is marked as "successful" for the year the retirement began in; if the portfolio value drops to zero before the end of retirement period, then the test is marked as "failed".

After the completion of one retirement period, the starting year is bumped up by one (e.g., 1928 to 1929) and the complete sequence is restarted for the new period with the result again recorded as either a success or failure. This continues for every retirement period up to the one ending at the last year of the dataset (e.g., 2010). The percentage of successful retirements across all the retirement periods measures the known risk.

For example, using historical data from 1928 through 2010, the following 53 retirement periods can be backtested assuming a 30-year retirement, with the final pass-fail statistics forming the risk measurement.

Period 1: 30-Year Retirement from 1928-1957
Period 2: 30-Year Retirement from 1929–1958
Period 3: 30-Year Retirement from 1930-1959
. . .
Period 51: 30-Year Retirement from 1979–2008
Period 52: 30-Year Retirement from 1980–2009
Period 53: 30-Year Retirement from 1981–2010

As just illustrated above, the historical data from 1928 to 2010 supports 53 30-year test periods starting with the 1928-1957 period and ending with the 1981-2010 period. If every one of the test cycles completed without running out of money, then the success rate is 100%. If 10 of the cycles failed, leaving 43 successful, the success rate is 81% (i.e., 43/53). If half the cycles failed, the success rate would be 50%. This final measure provides a quantitative metric for evaluating and comparing the performance of investment strategies.

Monte Carlo Simulation

An alternate approach to estimating risk is using a Monte Carlo simulation. A Monte Carlo simulation uses randomization to generate an unlimited amount of test data according to the model of choice as defined by the researcher. Although this technique is a valuable tool for certain classes of problems, for retirement it's only as good as the underlying model of the markets. Building a complete model of the market is problematic, given there are gaps in our understanding of how markets function.

A simple model might include only inflation and return data within the confines of historical averages and volatility. A more advanced model might include correlation between assets. An even more advanced model may include mean reversion and momentum. How far to go is up to the researcher, but this ad hoc nature of Monte Carlo modeling makes it hard for others to confirm or interpret the results of all but the simplest models.

Until a standardized model for markets is defined and agreed on, general Monte Carlo simulations are not attractive for estimating retirement risk.

Bootstrapping Simulation

There is one limited but well-defined form of Monte Carlo simulation, bootstrapping, which randomly resamples the historical data. Bootstrapping has a few advantages: its results are repeatable, it maintains the correlation between assets, and it produces an almost unlimited amount of data through resampling. Unfortunately, bootstrapping also strips out all forms of return disposition (i.e., autocorrelation) and produces return and volatility characteristics far beyond the historical market boundaries. Still, as long as its shortfalls are considered, bootstrapping can add another dimension to testing retirement strategies.

A modified bootstrapping technique called simple-block bootstrapping helps to partially preserve return disposition while maintaining return and volatility characteristics. Instead of randomly resampling return data from the complete dataset, returns are instead randomly permutated within multi-year blocks (e.g., 5-year). For example, using SBBI data starting in 1928, the returns are randomly scrambled for years 1928-1932, then for years 1933-1937, and so on to generate a new unique set of market data while bounding the degree of reordering.

Specific Markets versus the Global Market

Before going further, a quick review is helpful. The concept of known (measurable) risk was introduced and distinguished from speculative (unmeasurable) risk. This known risk can be measured using backtesting. In addition, known risk is typically represented in one of two forms: 1) the measured probability of success (i.e., not running out of money) for a given withdrawal rate; or 2) the measured maximum sustainable withdrawal rate for a given success rate, such as MSWR-100% (the sustainable rate with 100% success) or MSWR-90% (the sustainable rate with 90% success).

What hasn't been emphasized yet is that known risk varies, depending on the specific dataset used for backtesting or the specific strategy being backtested. For example, MSWR-100% for a total-market portfolio with 60% stocks in the US using annual rebalancing is 3.7%, but the same in the UK is only 3.0%. Likewise, the same case using

a smart income-harvesting strategy is 3.8% in the US and 3.7% in the UK. Again, the risk measured depends on the market and the strategy.

Measuring specific-market risks is important for testing and comparing strategies; however, global-market risk is also important. What ultimately matters most to retirees is their own retirement plan's performance. Assuming best practices, retirees should be investing globally, which implies the most realistic estimate of future retirement performance comes from measuring known global-market risk. (Comprehensive estimates of future retirement performance are one of this book's deliverables, covered in Chapter 10.)

An important implication of the above is final planning should not be distracted by extreme examples of specific-market risk. Consider that Austria's real stock market return for the last 113 years is only 0.6%. Such low returns will translate to extremely poor retirement results (i.e., MSWR-100% is under 1.5%); however, this case can be removed from final consideration. Retirement planning does not and should not depend on the risk of any specific market in isolation — this benefit comes with global investing.

The above doesn't eliminate a pragmatic dependency on specific-market risk. The historical datasets are almost all based on specific markets. As mentioned, these datasets support independent domains for verifying retirement strategies. More specifically, the independent datasets of specific markets are needed to reduce the chance of a data-mining bias, which is explained in the next section.

This book uses the following four specific-market datasets* for backtesting.

1. United States Market from 1928 through 2010, based on 2011 Ibbotson's Stocks, Bonds, Bills, and Inflation (SBBI) Yearbook
2. United States S&P Market from 1871 through 2010, based on Robert Shiller's dataset at Yale
3. United Kingdom Market from 1923 through 2010, based on Global Financial Data's FTSE and T-Bill datasets
4. Japan Market from 1950 through 2010, based on Global Financial Data's Topix and T-Bill datasets

Also used is the small but significant global market data from 1972 through 2010, based on Simba's spreadsheet of international mutual-fund returns.

A couple of caveats are now necessary. First, although all retirees should invest globally, it's also reasonable to give some tilt to the US market (more on this later), so the US is one specific market deserving extra attention. Also, as discussed earlier, data is lacking for a sufficiently complete long-term global dataset to measure global-market risk, so a Baseline Market must be created (fusing real market data from other sources) as a substitute for the global market (exactly why and how are covered in detail in Chapter 6).

For now, it's only important to keep in mind that known risk depends on its context: it may be for specific markets to compare strategies, or for the global market for final planning using best practices.

The Hazard of a Data-Mining Bias

Data mining is extracting patterns from data. This book mines the data using backtesting and to a lesser extent using bootstrap simulations. Used well, data mining leads to new understandings of market behavior and better strategies

* The historical datasets are fully described in Appendix A.

(i.e., more income for less risk); used improperly, it leads to a data-mining bias where wrong conclusions are drawn and poor strategies recommended (with less income or more risk). Following the norms of evidence-based research, with ample cross-validation, greatly reduces the hazard of a data-mining bias.

A data-mining bias stems from mistaking random or temporary patterns in the market data as fundamental ongoing market characteristics, causing risk to be incorrectly measured. A data-mining bias always underestimates risk—a dangerous thing because a strategy looks better than it really is. The process of iteratively backtesting and tuning a specific strategy for a specific market always has a risk of a data-mining bias. The way to reduce the risk is by verifying results using an independent dataset (i.e., out-of-sample data) without tuning the strategy. Going further, testing with multiple independent datasets can nearly eliminate the risk of a data-mining bias.

Here's a simplistic example of a data-mining bias. Let's assume all the retirement periods across a dataset were backtested. A close examination of the measured risk for each period shows retirements starting in odd years on average support a higher MSWR than those starting in even years. It could then be accurately stated that according to the data, retiring in odd-years improves retirement results (i.e., it's a good strategy). While this "truth" holds for the specific dataset, it's no doubt due to random behavior (a data-mining bias) as opposed to market fundamentals that will reliably hold true in the future. Testing with other datasets, distinct from the dataset used to form the strategy, will show retiring in odd years isn't a reliable strategy to improve performance.

In practice, a data-mining bias is much less obvious. Here's a more realistic example. Let's assume a new income-harvesting strategy is being tested. The strategy rebalances the portfolio only when annualized 30-year trailing returns are above 12%. Backtesting with a 5% withdrawal rate shows a success rate of 72% compared to annual rebalancing's 63% success rate. Encouraged by the results, a researcher tunes the new strategy to instead rebalance when trailing returns are above 11%. This improves the backtesting success rate to 74%. The researcher continues tuning and backtesting the trailing return value until the optimal trailing return is found at 7.6%, producing an 81% success rate. Next, the researcher starts tuning the length of the trailing-return interval. Starting at a 30-year trailing returns and moving downward, the researcher finds a 23-year trailing-return interval produces the best backtesting results, boosting performance to an 86% success rate. The researcher then publishes a paper showing that rebalancing when 23-year trailing returns exceed 7.6% is a strong retirement strategy.

The above approach by the researcher almost certainly contains a data-mining bias and underestimates the risk of the strategy. The strategy tested is better than annual rebalancing for the given dataset, but it remains unclear how the strategy will perform with an independent dataset (one the strategy wasn't tuned for). It's fair to tune a strategy to improve empirical results, especially when based on an underlying rationale or theory, but turning for optimal performance almost always introduces some bias for the dataset used.

The above examples illustrate why independent datasets are critical for verifying strategies. Many retirement strategies developed in the last 20 years were originally backtested and tuned with either the US SBBI or US Shiller dataset (described in the next section). For this reason, whenever possible, I also verify strategies using UK and Japan datasets. If a strategy is a top performer across the US, UK, and Japan markets, it's likely to be a top performer for a future retirement in a global market (everything else being equal). Going further using simulated data, a bootstrapping simulation of many different markets is also used when deemed necessary to provide one more layer of protection against a data-mining bias.

In addition, the following supplementary guidelines are followed to further reduce the chance of a data-mining bias.

1. Ensure a strategy is consistent across different asset allocations.
2. Favor methods with underlying theories, or at least a firm rationale.

3. Keep It Simple — complex strategies with many parameters are more prone to overtuning.
4. Distrust unstable strategies whose results are sensitive to minor parameter changes.

Putting Risk Factors to Use

It's worth coming back to why we should bother with identifying the factors of risk. Any factor that can be controlled is a potential lever for affecting risk; any factor that can be monitored is a potential guide for controlling other risk factors. Retirement strategies both monitor and control risk factors to affect risk, then backtesting indicates how well different strategies perform when doing so. Best practices are essentially those strategies and parameters known to most reliably leverage the risk factors to lower risk while generating sufficient income.

The risk factors vary substantially in their usefulness though — some are more effective and reliable than others. Also, there are innumerable ways to raise risk though inappropriate choices that adversely affect the risk factors. Investing during retirement is not an easy puzzle to figure out, but understanding the risk factors makes the path more coherent.

The following provides a sampling of how the risk factors are understood and applied throughout the rest of the book. This is in part a recap and in part a preview of what is to come.

a. There is a fundamental tradeoff between the risk of running out of money and the level of income generated. If income is lowered enough, risk will eventually drop to zero. Likewise, if income is raised enough, risk will eventually rise to 100%...certain failure. A goal is to identify the income levels with a small enough level of risk to satisfy most retirees without needlessly sacrificing income.

b. Known specific-market risk can be high even at low income levels, but diversification is able to mute specific market risk. Known global-market risk can be kept reasonably small for an acceptable level of income. It turns out, known global-market risk roughly aligns with known US market risk, but is a little higher (i.e., supports a little lower amount of income).

c. Of all the factors, the withdrawal rate (the level of income) is the most accessible and powerful factor affecting retirement risk. To exploit this advantage, it's prudent to let withdrawals vary with the state of the portfolio and markets — this is the focus of the variable-withdrawal strategies.

d. Portfolio returns, volatility of returns, and sequence of returns are all factors of risk that cannot be directly controlled, but they can be indirectly controlled through their own underlying factors…the asset-allocation factors. After the withdrawal rate, asset allocation (i.e., the asset allocation factors) provides the best path to reducing retirement risk.

e. The retirement length can't be controlled directly or indirectly. As such, it's treated more as a constant of investing during retirement. However, some strategies effectively monitor an estimate of the remaining retirement length to reduce risk.

f. The inflation factor can't be controlled, and there is little advantage to monitoring it independently. Inflation is most easily handled by incorporating it into the withdrawal rate (i.e., working with an inflation-adjusted withdrawal rate), then letting the variable-withdrawal strategy compensate for it.

g. The volatility of returns is important, but still a secondary factor of risk. Correctly done, asset allocation creates the optimal balance between return and volatility, keeping risk low while supporting sufficient income. This relationship is captured and applied by the Harvesting Ratio in Chapter 5.

h. The makeup of the stock allocation (e.g., small, value, emerging markets) provides a powerful asset-allocation level for controlling risk, again considered by the Harvesting Ratio in Chapter 5.

i. The stock percentage is a weaker asset-allocation lever than usually realized. The most effective stock percentage is typically limited to relatively narrow boundaries around 50% — a too high or too low percentage will usually increase risk. Lowering the stock percentage below its optimal point lowers risk only when the withdrawal rate is correspondingly lowered, but keep in mind guaranteed-income is often a better approach to reducing overall risk (known and speculative) than lowering the stock percentage along with the withdrawal rate.

j. Return disposition as an indirect factor is difficult to use, but also too important to ignore. Market valuations as a measure of return disposition are used to set the initial withdrawal rate, and also discussed in the last chapter on planning with guaranteed income. Beyond these limited uses, there is insufficient evidence to support putting return disposition to more direct use, despite its broad potential. However, there are indirect methods of using return disposition that can safely reduce risk, such as smart rebalancing within the income-harvesting strategies.

k. Beyond the identified factors, retirement risk can only be affected outside the domain of systemic withdrawals*.

* The most common investment during retirement that falls outside systemic withdrawal is guaranteed-income (e.g., bond ladders, annuities), addressed in the last chapter. Another common alternative, completely outside this book's scope although viable in the right markets, is direct real-estate ownership with rental income.

The Point

Breaking down risk identifies the facets and the factors useful for understanding and controlling risk during retirement. Speculative risk is unmeasurable, but known risk based on the data can be measured to find the right strategies, the right portfolios, and suitable initial withdrawal rates. Known specific-market risk supports comparing strategies and avoiding a data-mining bias. However, only known global-market risk (measured from a baseline market) can provide realistic estimates of future retirement performance.

Considering the specifics, retirees usually pay too much attention to volatility; the withdrawal rate and portfolio returns are the two dominant factors affecting risk in retirement; half the systemic-withdrawal problem is solved by knowing how to allocate and maintain assets in their proper portions, indirectly balancing returns with volatility.

CHAPTER 3 GUIDE

This chapter covers income-harvesting strategies: what these strategies do, and how various strategies perform relative to each other. The outcome is one recommended strategy, Prime Harvesting, with precise instructions for applying it.

Less interested readers need only skim the chapter, carefully focusing on the Prime Harvesting section in the introductory survey, the recommendation section, and the example at the end.

If I'm confident I could entrust you with raising my children, and I'm dazzled by your brilliance, then I might trust your investment strategy without seeing your data.

Walter E. Goh

CHAPTER 3

Surveying and Selecting an Income-Harvesting Strategy

Income-harvesting strategies manage the retirement portfolio to minimize the impact of periodic withdrawals. They specify what's sold to fund withdrawals, what triggers rebalancing, and how rebalancing takes place. Some strategies also affect the stock-bond ratio, although usually not directly. Income-harvesting strategies may not be natural attention-getters for investors, but don't mistake them as mere accounting details—the effects can be considerable, perhaps even making or breaking a retirement plan in certain circumstances.

This chapter surveys a dozen income-harvesting strategies, including side-by-side performance comparisons under diverse conditions. More than 30 strategies were originally tested before narrowing the list. The survey aims to provide a representative sampling of all strategies*, including the best performing and best known. The final outcome is to reduce the set of strategies down to a single income-harvesting recommendation.

Consistently strong strategies appear to be relatively rare, so don't expect better choices to show up each year in the literature. To avoid gambling with retirement assets, retirees should not change from one strategy to another without solid evidence of better performance, preferably shown by direct comparison adhering to evidence-based research. Chasing strategies can be almost as bad as chasing returns.

Some of the strategies tested are documented in retirement books; others in financial journals; a few on the Web. Most are defined by financial professionals. A few perform rather well; most moderately well; a few poorly.

Why bother with a survey? Why not just tell the best strategy and move on? A survey is useful for several reasons:

a. It documents the performance of the poor strategies, helping to reduce their use in retirement. Some have long-standing and dedicated advocates.

b. Broad coverage helps reduce the likelihood that some retirees will later be diverted (from what works well) in search of greener pastures.

* Valuation-based strategies are not included in the survey, but are discussed later in the chapter.

c. The "best" income-harvesting strategies are the ones which perform well *relative* to the alternatives. This is realized only through side-by-side comparisons.

It's also helpful to understand upfront what this chapter does *not* do. It does not recommend a safe withdrawal rate or a retirement portfolio. These are independent topics covered in later chapters.

The Backtesting Details

Given this survey revolves around backtesting, the default parameters and how to interpret the results are best explained first.

The Default Parameters and Assumptions

There will be a diversity of tests; however, every backtesting simulation uses the following default parameters unless otherwise noted.

1. A 30-year retirement period.
2. An initial allocation of 60% stocks and 40% bonds. Some strategies override this initial allocation and others use it as the starting point, varying it as needed throughout retirement.
3. Fixed-rate inflation-adjusted withdrawals.
4. A default market based on the US SBBI dataset spanning from 1928 to 2010.
5. A default portfolio using the following allocation (intended to be somewhat representative of what today's retirees often use):
    - For bonds, 100% intermediate-term treasuries
    - For stocks, a moderately diversified allocation:
        - 70% Total Market Stocks
        - 10% Small Company Stocks
        - 10% Large Value Stocks
        - 10% Small Value Stocks
6. Reinvested dividends—the focus is always on total return throughout this book.

No special consideration is given to taxes. Taxes differ depending on circumstances; nevertheless, the behaviors of the top-ranked strategies are reasonable when it comes to tax considerations (i.e., taxes are unlikely to affect the ranking).

Interpreting the Results

A Maximum Sustainable Withdrawal Rate (MSWR) graph, as described in Chapter 2 (Figure 3), is shown for each surveyed strategy. This graph provides a snapshot of a strategy's performance. Keep in mind when comparing strategies, the performance during the poorest retirement periods (i.e., the lower MSWR values) is what matters most for bounding risk—during strong retirement periods, virtually every strategy is a winner.

When results are listed in tabular form, the following values are included (depending on the specific table and the strategy):

a. **Withdrawal Rate** — the annual withdrawal percentage (fixed rate, inflation-adjusted).

b. **Stock** — the initial percentage of the portfolio held in stocks.

c. **Average Remaining** — the average, in millions of dollars, remaining at the end of the backtested retirement periods (i.e., at the end of 30 years) based on a starting portfolio value of $1 million dollars; however, the relationship of the starting value to the "average remaining" applies to any starting portfolio value.

d. **Average Year of Failure** — for the retirement periods that fail, the average retirement year when the failure occurred out of a 30-year retirement period.

e. **Lowest-Bond Average** — the average of the lowest bond percentage reached for each retirement period. For example, if during one 30-year retirement period the percentage of bonds in the portfolio ranged from 15% to 55%, the lowest percentage, 15%, goes into the average for all the retirement periods backtested. This value provides an indication of how low the bond percentage drops during a typical retirement period.

f. **Highest-Bond Average** — the average of the highest bond percentage reached for each retirement period. For example, if during one retirement period, the percentage of bonds in the portfolio ranged from 15% to 55%, the highest percentage, 55%, goes into the average for all the retirement periods backtested.

g. **Bond Average** — the overall average percentage of bonds for all retirement years over all retirement periods backtested.

h. **Success Rate** — the percentage of retirement periods ending successfully with assets remaining.

Required Caveats

A few caveats are required to fairly set the stage for this survey, as well as the one in the next chapter.

a. The aim of modeling each strategy is to accurately and faithfully match the originator's intent. A large amount of retesting and crosschecking was done to reinforce this aim. Also, the core software infrastructure was calibrated by comparing traditional rebalancing results with FireCalc[7], a popular retirement calculator on the Web. While I believe all results are correct, with proper due diligence taken, there is no path to complete confidence when writing software to interpret the ideas of others.

b. A couple of strategies explicitly state a financial advisor or money manager should be monitoring performance and making adjustments as needed. This aspect of any strategy is too open-ended for modeling. Whenever there were ambiguities or incompleteness in a strategy, I chose an interpretation that performed well with the sample portfolio using the SBBI dataset, making a best effort to provide a fair representation of each strategy.

c. For each of the referenced strategies, I use the same sources I believe retirees are using; however, these sources may not represent the originators' latest thinking. Also, some of the strategies that are not top performers today may have been innovative and the best in their class when they were introduced. Hindsight provides an enormous research advantage.

d. Ultimately, this survey (and the next) can only claim to compare my interpretation and modeling of the strategies defined in the referenced sources. It's not intended to judge how well any particular money manager or financial advisor might have fared with their own interpretations, latest thoughts, or custom adjustments to a specific client's portfolio.

e. Finally, throughout the survey and the rest of the book, the numbers sometimes show a decimal-point precision that can't apply to the future. The data is our best guide, but it's never a precise guide to the future.

Traditional Rebalancing — The Baseline Income-Harvesting Strategy

When surveying income-harvesting strategies, it's helpful to have a known reference point for comparison. Traditional rebalancing provides this reference point as a baseline strategy, given its use by most investors. In the introductory survey, the performance of every strategy will be compared to traditional rebalancing's performance.

Traditional rebalancing is simply restoring asset values back to their target percentages at periodic intervals by buying and selling as needed. Traditional rebalancing brings to mind the old computer sales adage, "no one gets fired for buying IBM". No advisor, portfolio manager, or financial writer can be faulted for assuming or advocating traditional rebalancing during retirement. Traditional rebalancing is so dominant, it's not considered a strategy, but a part of "good" portfolio maintenance. Nevertheless, its use in retirement makes it an income-harvesting strategy by default. As will be shown, it does not compare well with the top-performing alternatives. It's not a bad strategy, but also not a good one. Annual rebalancing fits the assumptions of pre-revolutionary economics outlined in Chapter 1, but not the assumptions of post-revolutionary economics.

Push-back against traditional rebalancing is rare though, making it understandable that many retirees consider it the safest option and are hesitant to veer from it; however, evidence against traditional rebalancing does exists in the literature. For example, Duke University economist Campbell Harvey and his coauthors in their 2014 paper, Rebalancing Risk[8], show traditional rebalancing increases risk during sharp market downturns. The authors explain that traditional rebalancing becomes a kind of "anti-momentum" strategy during these poor markets, where under-performing assets are bought and outperforming assets are sold. They point out that other factors (momentum in their study) can better guide rebalancing to lower risk. The point is, traditional rebalancing should not be assumed to be the safest retirement choice.

Traditional rebalancing comes in several forms, although annual rebalancing is the dominant form. Rebalancing over longer periods of several years is common, as well as rebalancing when the portfolio values drift outside a specific range. Generally, the evidence isn't clear for favoring one form of traditional rebalancing over another. For example, backtesting using US SBBI data from 1928 to 2010 shows rebalancing every four or five years improves retirement performance, but the improvements disappear when backtesting with Shiller's US data as well as with UK and Japan data. Longer rebalancing periods usually result in a higher average percentage of stocks and therefore a higher return, but don't always map to the best retirement performance. Throughout this survey, as well as the rest of the book, annual rebalancing is used to represent all the forms of traditional rebalancing.

The income-harvesting steps below describe precisely how annual rebalancing works in retirement when making annual withdrawals. Following the complete set of steps, annual rebalancing's initial backtesting results are then shown. (This same form — a set of implementation steps followed by initial backtesting results — is used throughout the survey for each income-harvesting strategy.)

Income-Harvesting Steps with Annual Rebalancing

1. Sell enough portfolio assets to fund the next withdrawal (which assets don't matter in theory, because the portfolio is rebalanced at the end).

2. Withdraw the annual living expenses from the portfolio's cash.

3. Buy and sell as needed to rebalance back to target values:
   a. The stock and bond percentages are restored to their target percentages.
   b. Individual stock assets are rebalanced to their target values within the stock allocation.
   c. Individual bond assets are rebalanced to their target values within the bond allocation.

In the above steps (for annual rebalancing as well as other harvesting strategies), selling assets to withdraw funds is listed as a step distinct from selling assets to rebalance. In practice, only one step is used with all transactions taking place in conjunction to reduce fees. Both ways, the resulting portfolio allocation is the same.

Backtesting Results

Figure 4 shows annual rebalancing's Maximum Sustainable Withdrawal Rate (MSWR) for 54 30-year retirement periods, the first period starting in 1928 (extending to 1957) and the last starting in 1981 (extending to 2010).

Figure 5 shows the results for various withdrawal percentages and stock ratios.

None of these results are very interesting by themselves, but they form the baseline for comparing other strategies.

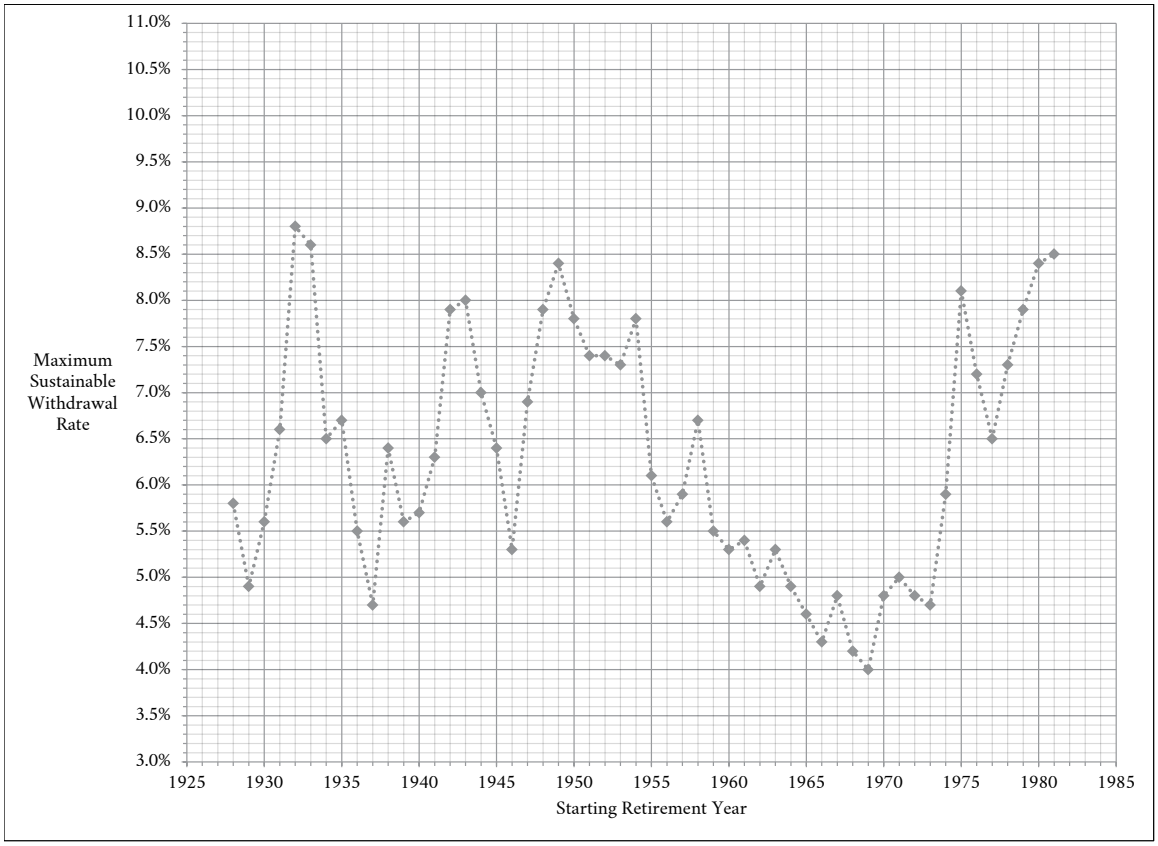

FIGURE 4

Maximum Sustainable Withdrawal Rates with annual rebalancing.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	0.6M	26.2	90.00%	90.00%	90.00%	42.60%
4.0%	20%	1.2M	27.1	80.00%	80.00%	80.00%	77.80%
4.0%	30%	2.1M	29.7	70.00%	70.00%	70.00%	94.40%
4.0%	40%	3.4M	NA	60.00%	60.00%	60.00%	100.00%
4.0%	50%	4.8M	NA	50.00%	50.00%	50.00%	100.00%
4.0%	60%	6.6M	NA	40.00%	40.00%	40.00%	100.00%
4.0%	70%	8.8M	NA	30.00%	30.00%	30.00%	100.00%
4.0%	80%	11.3M	29	20.00%	20.00%	20.00%	98.10%
4.0%	90%	14.2M	26.5	10.00%	10.00%	10.00%	96.30%
4.5%	10%	0.4M	23.4	90.00%	90.00%	90.00%	24.10%
4.5%	20%	0.6M	25.1	80.00%	80.00%	80.00%	42.60%
4.5%	30%	1.2M	26.2	70.00%	70.00%	70.00%	68.50%
4.5%	40%	2.2M	26.9	60.00%	60.00%	60.00%	87.00%
4.5%	50%	3.5M	25	50.00%	50.00%	50.00%	94.40%
4.5%	60%	5.1M	25.3	40.00%	40.00%	40.00%	94.40%
4.5%	70%	7.0M	25.3	30.00%	30.00%	30.00%	94.40%
4.5%	80%	9.3M	25	20.00%	20.00%	20.00%	92.60%
4.5%	90%	12.0M	21.3	10.00%	10.00%	10.00%	94.40%
5.0%	10%	0.2M	21.2	90.00%	90.00%	90.00%	14.80%
5.0%	20%	0.4M	22.9	80.00%	80.00%	80.00%	22.20%
5.0%	30%	0.7M	24.2	70.00%	70.00%	70.00%	40.70%
5.0%	40%	1.4M	24.9	60.00%	60.00%	60.00%	59.30%
5.0%	50%	2.4M	24.6	50.00%	50.00%	50.00%	75.90%
5.0%	60%	3.7M	25.5	40.00%	40.00%	40.00%	77.80%
5.0%	70%	5.5M	24.6	30.00%	30.00%	30.00%	83.30%
5.0%	80%	7.6M	22.7	20.00%	20.00%	20.00%	87.00%
5.0%	90%	10.1M	21.6	10.00%	10.00%	10.00%	87.00%

FIGURE 5

Annual rebalancing results for varying withdrawal rates and stock percentages.

Annual rebalancing's withdrawals are funded each year from the asset classes with the highest growth, or if there is no growth, then from the asset classes with the least loss. At the same time, the higher performing assets supplement the lower performing assets, bringing all back to their target percentage. While this buy-low and sell-high approach seems reasonable, there is more to a strong income-harvesting strategy. (It's also the basis for the anti-momentum effect previously mentioned.) The general problem with annual rebalancing is lack of consideration of what is happening to the overall portfolio over time — the target allocation is adhered to, no matter what.

Again, annual rebalancing isn't a poor solution, it just isn't strong. Later comparisons show it performs somewhere in the upper-middle range of the surveyed strategies.

An Introductory Survey of Income-Harvesting Strategies

This section surveys the selected incoming-harvesting strategies, showing how each works, with a preliminary look at performance. Each strategy is introduced, its rules for portfolio management broken down into precise individual steps, then its backtesting results shown. Following the introductory survey, the strategies are more thoroughly compared side-by-side.

When describing the steps for implementing a strategy, the most straightforward explanation is given to accomplish what it requires. For simplicity, no attention is given to minimizing the number of buy or sell transactions to reduce broker expenses.

Most of these strategies manage the portfolio at the highest asset-class level (e.g., stocks, bonds, cash) as opposed to the finer-grain subclass levels (e.g., large value stocks, small stocks, growth stocks). One may wonder if strategies operating at this higher level may be unnecessarily inefficient, but tentative results show this doesn't appear to be the case. Finer-grain management was backtested for a couple of cases without finding a substantial improvement in performance.

Bonds-First Strategy

Spitzer and Singh, professors of economics and finance respectively, published a paper[9] comparing strategies in the June 2007 issue of the Journal of Financial Planning. While the goal of their paper was to explore the effects of rebalancing on a retirement portfolio, in a broader sense they were comparing a set of income-harvesting strategies.

Here's their description of the four strategies examined in their paper:

1. Withdraw money from the asset that had the highest return during the year and do not rebalance. This will be referred to as "High First."
2. Withdraw money from the asset that had the lowest return during the year and do not rebalance. This will be referred to as "Low First."
3. Take withdrawals from bonds first and do not rebalance. This will be referred to as "Bonds First."
4. Take withdrawals from stocks first and do not rebalance. This will be referred to as "Stocks First."

Spitzer and Singh found the Bonds-First strategy (the third strategy above) performed best of the four strategies, making it an attractive choice for this survey.

The Steps

1. Sell enough bond assets to fund the next withdrawal; if bonds are depleted, sell from stocks.
2. Withdraw the annual living expenses from the portfolio's cash (from the previous sell).
3. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).
4. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

Backtesting Results

Figure 6 shows the strategy's MSWR values compared to annual rebalancing. Bonds-First does significantly better in almost every retirement period. Only during the most difficult periods starting in the mid-1960s did Bonds-First merely tie with annual rebalancing.

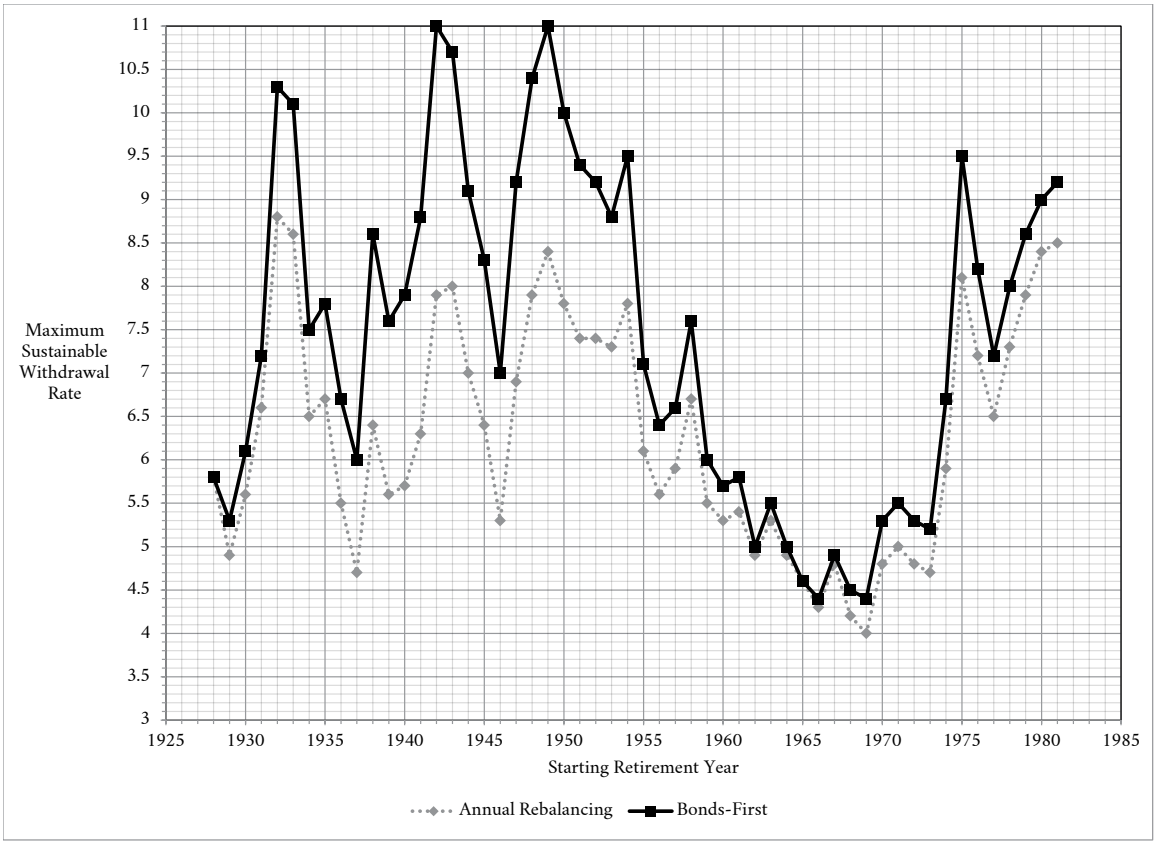

FIGURE 6

Bonds-First Strategy compared to annual rebalancing.

Figure 7 shows the results for various withdrawal percentages and stock ratios. Not only is the performance strong (again in relation to annual rebalancing), but also, the average remaining portfolio value at the end of retirement is high…actually the highest for all the strategies included in the survey.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	2.1M	29	2.10%	89.80%	47.10%	96.30%
4.0%	20%	4.8M	NA	0.30%	79.60%	33.00%	100.00%
4.0%	30%	7.4M	NA	0.00%	69.30%	23.80%	100.00%
4.0%	40%	9.8M	NA	0.00%	59.00%	17.00%	100.00%
4.0%	50%	11.9M	NA	0.00%	48.60%	11.80%	100.00%
4.0%	60%	13.8M	NA	0.00%	38.00%	7.60%	100.00%
4.0%	70%	15.4M	NA	0.00%	27.40%	4.40%	100.00%
4.0%	80%	16.5M	NA	0.00%	16.50%	2.10%	100.00%
4.0%	90%	17.3M	26	0.00%	5.90%	0.60%	96.30%
4.5%	10%	1.3M	26.5	0.70%	89.40%	44.40%	66.70%
4.5%	20%	3.5M	27.1	0.00%	79.30%	30.40%	87.00%
4.5%	30%	5.8M	28.3	0.00%	68.80%	21.80%	94.40%
4.5%	40%	7.9M	29	0.00%	58.50%	15.60%	98.10%
4.5%	50%	9.9M	30	0.00%	48.00%	10.70%	98.10%
4.5%	60%	11.7M	28	0.00%	37.40%	6.90%	96.30%
4.5%	70%	13.1M	26.3	0.00%	26.70%	4.00%	94.40%
4.5%	80%	14.2M	24.3	0.00%	15.90%	1.90%	94.40%
4.5%	90%	14.9M	20	0.00%	5.40%	0.60%	94.40%
5.0%	10%	0.7M	23.7	0.00%	89.40%	44.20%	44.40%
5.0%	20%	2.5M	24.8	0.00%	78.70%	29.30%	66.70%
5.0%	30%	4.4M	25.8	0.00%	68.60%	20.60%	77.80%
5.0%	40%	6.3M	24.7	0.00%	58.30%	14.70%	87.00%
5.0%	50%	8.1M	25.1	0.00%	47.80%	10.10%	87.00%
5.0%	60%	9.7M	23.4	0.00%	37.20%	6.50%	90.70%
5.0%	70%	11.0M	23.8	0.00%	25.90%	3.70%	88.90%
5.0%	80%	12.0M	21.2	0.00%	15.10%	1.80%	90.70%
5.0%	90%	12.6M	19.8	0.00%	4.80%	0.50%	88.90%

FIGURE 7

Bonds-First Strategy results for varying withdrawal rates and stock percentages.

Bonds-First's strength stems from giving stocks years of insulated growth before starting to withdraw from them, as many as 15 years. Another factor is the average stock percentage during retirement is very high, contributing both to strong performance and the large remaining balance at the end of retirement.

However, Bonds-First has several limitations. Later when other data sets are backtested, its performance isn't as consistent as desired. Just as important, the portfolio will always end with 100% in stocks. This creates an uncomfortable exposure to speculative risk for most retirees. Also, like annual rebalancing, there is no consideration for what is occurring to the portfolio, limiting flexibility in extreme markets.

While Bonds-First works surprisingly well, the smarter strategies do better.

Age-Based Strategies: 100-Age, 120-Age, and Glidepath

Outside annual rebalancing, age-based strategies may be the best known. They are certainly often recommended in the media. While they are not described as "income-harvesting strategies", their use in retirement again makes them just that.

These strategies determine each year's stock percentage by using the retiree's current age. Here's the general idea: as we age, we cannot handle as much investment risk, so we should progressively lower our portfolio's stock ownership. To some extent, the underlying idea might also be, we need less growth from stocks as we age because our remaining life is shorter.

The most common age-based strategy is 100-Age, where the retiree's age is subtracted from 100 to determine the stock percentage. For example, if you are 65 years old, you would have 35% (i.e., 100 - 65) invested in stocks with the balance in bonds. When you turn 66, your stock allocation should drop to 34% (i.e., 100 - 66) and so on.

A 30-year retirement using 100-Age would have the following stock percentages from the beginning to the end of retirement.

35%, 34%, 33%, 32%, 31%, 30%...10%, 9%, 8%, 7%, 6%, 5%

Over the last decade or two, 120-Age* has surfaced as an alternative to 100-Age. Here, the stock percentage is 120 minus the retiree's age as seen in the following percentages for a 30-year retirement for a 65 year old retiree.

55%, 54%, 53%, 52%, 51%, 50%...30%, 29%, 28%, 27%, 26%, 25%

Another age-based strategy is Glidepath[10], where the stock percentages taper off slowly at the beginning of retirement and accelerate at the end†. A 65 year old retiree's 30-year retirement would have the following series of annual stock percentages using Glidepath.

54%, 53%, 52%, 51%, 49%, 48%, 46%, 45%, 43%, 41%, 40%, 38%, 6%, 34%,
32%, 30%, 28%, 26%, 23%, 20%, 18%, 15%, 11%, 8%, 4%, 0%, 0%, 0%, 0%, 0%

The irony is, while age-based strategies appear conservative and sensible, they have the distinction of being the poorest performing income-harvesting strategies. The dichotomy between recommendation and result is so large that the term "urban myth" is appropriate for the attractiveness of these strategies in retirement.

The source of these strategies is not clear, although Jack Bogle, former CEO and founder of Vanguard, has for many years been a proponent of putting your age in bonds (i.e., age = percentage) as a rough guide for retirement. Mr. Bogle's advice is heeded by many for good reason: perhaps more than anyone else in the twentieth century, he greatly aided individual investors with innovation, fair dealings, and straight talk (his sterling reputation is well deserved). At the same time, his recommendation illustrates how apparently sensible, well-intentioned advice from an industry expert can falter when the criteria for evidence-based guidance are not met.

The Steps

1. Sell enough portfolio assets to fund the next withdrawal.
2. Withdraw the annual living expenses from the portfolio's cash.
3. Buy and sell as needed to rebalance according to the following rules:
   a. Total stock and bond allocations are set to the current year's age-based percentage.
   b. Individual stock assets are rebalanced to their target stock values (without modifying the portfolio's stock percentage).
   c. Individual bond assets are rebalanced to their target bond values (without modifying the portfolio's bond percentage).

* Recently I've also noticed more references to 110-Age.

† The Glidepath function for the stock percentage is Log_{10} (100 – current-age) – 1.

Backtesting Results

Figure 8 shows the MSWR values for the age-based strategies, compared to annual rebalancing. The age-based strategies perform significantly worse than annual rebalancing—the graph lines for each of the age-based strategies fall significantly under the line for annual rebalancing. For example, annual rebalancing in the 30-year retirement period starting in 1937 supported a withdrawal rate of 4.7% annually, where 100-Age only supported a rate of 3.4% (28% less income), 120-Age a rate of 4.1% (13% less income), and Glidepath a rate of 4% (15% less income).

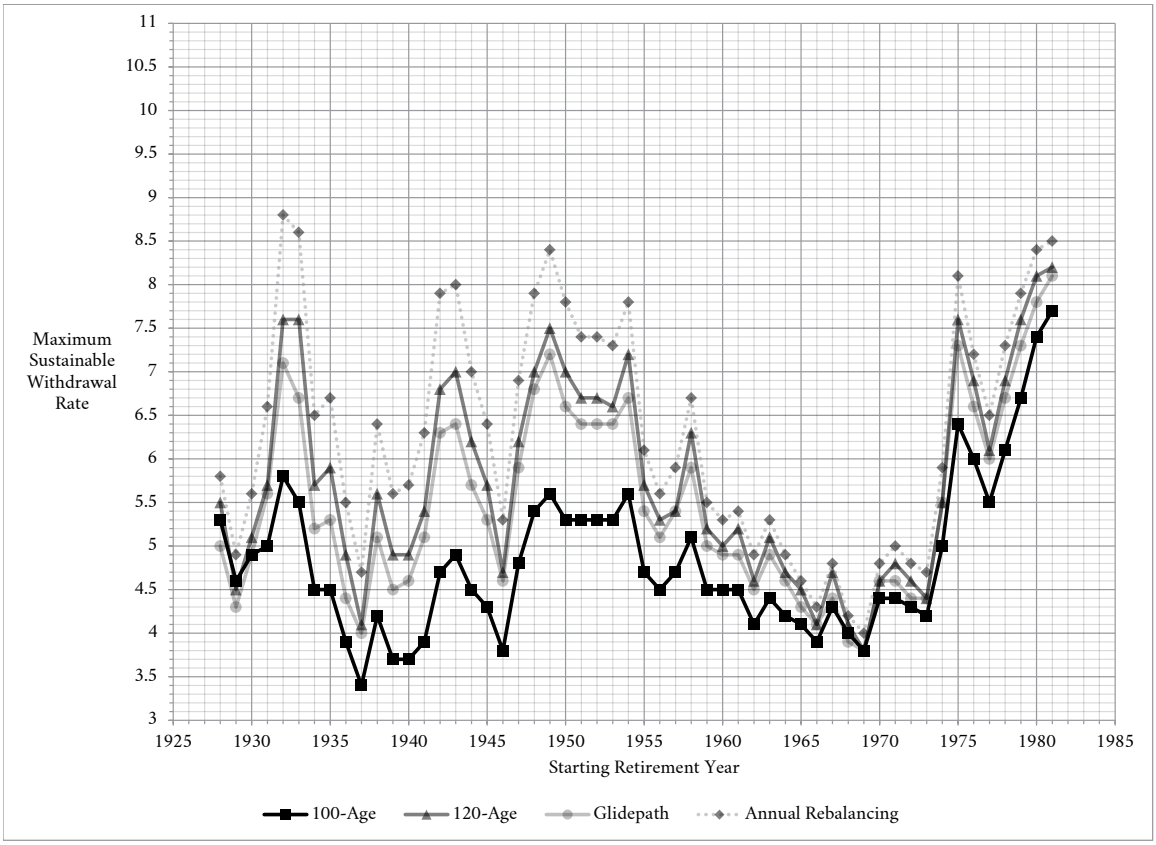

FIGURE 8

Age-based Strategies compared to annual rebalancing.

Figure 9 shows the results for various withdrawal percentages and stock ratios. Except for the lowest withdrawal rates, the performance is poor compared to other strategies. (Backtesting results using different stock percentages are not included, since the age-based strategies control the stock-bond ratio.) Advocates may still claim the age-based strategies are safer as long as the withdrawal rate is kept appropriately low; however, the evidence does not support this claim. Exceptionally poor markets can stress any withdrawal rate, making an efficient income-harvesting strategy always important.

Age-Based Strategy	Withdraw Rate	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
Age-100	4.0%	1.8M	28.5	65.00%	94.00%	78.30%	85.20%
Age-120	4.0%	4.2M	28	45.00%	74.00%	58.30%	98.10%
Glidepath	4.0%	3.0M	29	45.60%	100.00%	70.40%	96.30%
Age-100	4.5%	1.0M	26	65.00%	94.00%	77.70%	63.00%
Age-120	4.5%	3.0M	25.2	45.00%	74.00%	58.20%	90.70%
Glidepath	4.5%	2.0M	26.8	45.60%	100.00%	70.00%	83.30%
Age-100	5.0%	0.6M	24.1	65.00%	94.00%	76.80%	37.00%
Age-120	5.0%	2.1M	24.9	45.00%	74.00%	57.70%	68.50%
Glidepath	5.0%	1.4M	24.9	45.60%	100.00%	68.70%	61.10%

FIGURE 9

Age-based Strategies results for varying withdrawal rates.

Why do these strategies perform so poorly? The main reason is, they all overweight the allocation to bonds. Also, selling stocks each year according to an age formula is blind to the market's behavior and the overall performance of the portfolio.

It turns out the optimal age-based formula is around "140 Minus Age" (for the default portfolio using the SBBI dataset). While this extreme age-based strategy is much better than the others in its group, often surpassing traditional rebalancing, it still underperforms annual rebalancing in the most difficult retirement periods…when a strategy counts the most.

The Guyton PMR Strategy

Jonathan Guyton, principal of Cornerstone Wealth Advisors, is well known for his early innovative work on income-harvesting and variable-withdrawals strategies (under different terminology).

Guyton's PMR Strategy for income-harvesting* is defined in the 2004 issue of the *Journal of Financial Planning*[11], and then refined in a follow-up paper in 2006 co-authored with William Klinger[12].

Below are Guyton's words describing PMR:

- Following years in which an equity asset class has a positive return that produced a weighting in excess of its target allocation, the excess allocation is "sold" and the proceeds invested in cash to meet future withdrawal requirements.
- Portfolio withdrawals are funded each year on January 1 using assets in the following order: (1) cash from rebalancing any over-weighted equity asset classes from the prior year-end, (2) cash from rebalancing any over-weighted fixed income assets from the prior year-end, (3) withdrawals from remaining cash, (4) withdrawals from remaining fixed income assets, (5) withdrawals from remaining equity assets in order of the prior year's performance.
- No withdrawals are taken from an equity asset class following a year in which it had a negative return so long as cash or fixed income assets are sufficient to fund the withdrawal requirement.

Guyton's PMR strategy is reframed into the below steps for backtesting.

* Guyton combines income-harvesting with variable-withdrawals, but in this survey and the next the strategies are broken apart for comparison.

The Steps

1. If an individual stock or bond asset has a positive return for the year, move the excess return to cash. Excess return is the amount that exceeds the asset's target allocation based on each year's total portfolio value.

2. Withdraw first from cash (i.e., as much as possible), then from bonds, and lastly from stocks. No withdrawals are taken from bonds if sufficient cash is available; likewise, no withdrawals are taken from stocks if sufficient cash or bonds are available.

There is no direct rebalancing of stocks and bonds; rebalancing occurs indirectly only though selling to transfer excess value to cash.

Backtesting Results

Klinger, Guyton's co-author, in a later 2007 paper[13] essentially states PMR is not significantly better than annual rebalancing, but backtesting using SBBI historical data does show a modest improvement over traditional rebalancing*. Still, the improvement is moderate and not consistent across all the datasets.

Figure 10 shows the strategy's MSWR values compared to annual rebalancing, with moderate gains in almost all the retirement periods. Figure 11 shows the results for various withdrawal percentages and stock ratios, also an improvement compared to traditional rebalancing.

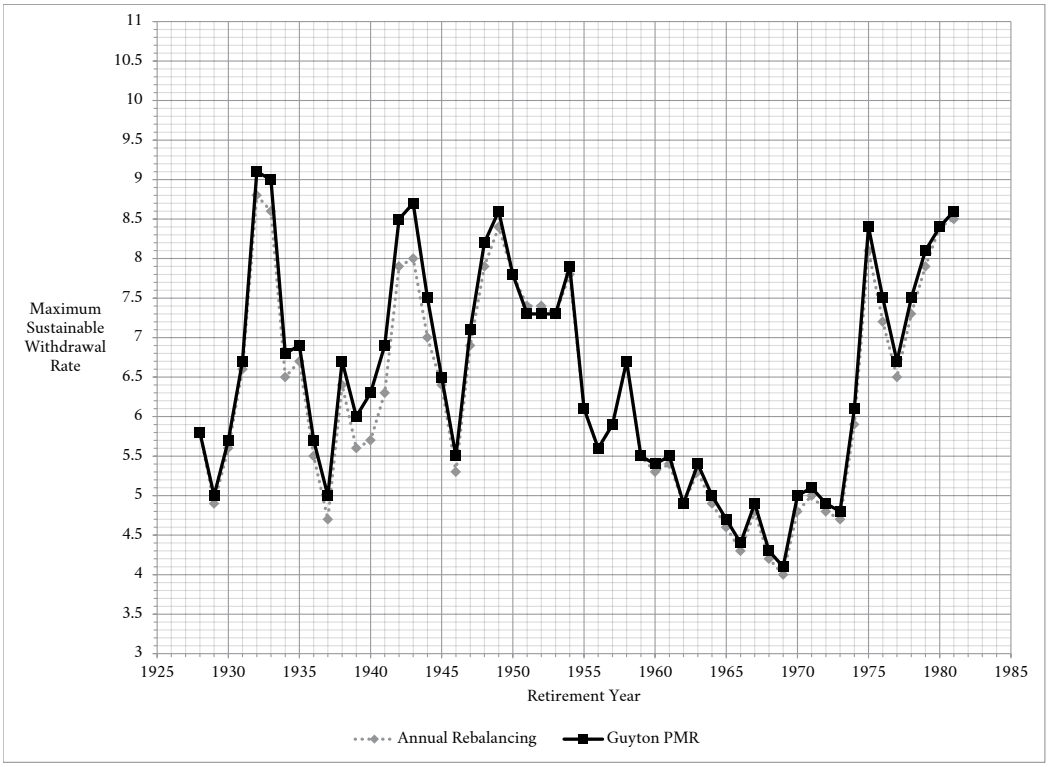

FIGURE 10

Guyton PMR Strategy compared to annual rebalancing.

* It's unusual for backtesting performance to exceed an author's estimation.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	0.6M	26.5	66.40%	93.40%	85.60%	44.40%
4.0%	20%	1.1M	27.9	58.40%	85.80%	76.50%	83.30%
4.0%	30%	1.8M	NA	55.30%	77.30%	68.30%	100.00%
4.0%	40%	2.4M	NA	49.80%	69.00%	58.10%	100.00%
4.0%	50%	2.8M	NA	38.80%	59.70%	46.90%	100.00%
4.0%	60%	3.3M	NA	27.70%	49.20%	35.50%	100.00%
4.0%	70%	3.9M	NA	17.40%	36.30%	24.10%	100.00%
4.0%	80%	4.7M	28	8.60%	22.10%	13.00%	98.10%
4.0%	90%	6.6M	25.5	1.70%	8.20%	3.40%	96.30%
4.5%	10%	0.4M	23.7	64.80%	94.00%	84.40%	24.10%
4.5%	20%	0.6M	26	57.60%	85.70%	73.20%	42.60%
4.5%	30%	1.0M	27.1	50.80%	76.90%	65.10%	70.40%
4.5%	40%	1.6M	26.6	43.80%	68.40%	56.30%	90.70%
4.5%	50%	2.2M	25.3	37.10%	59.30%	45.90%	94.40%
4.5%	60%	2.6M	26	27.10%	49.00%	34.70%	94.40%
4.5%	70%	3.2M	24	16.80%	36.00%	23.20%	96.30%
4.5%	80%	3.9M	25	8.10%	21.40%	12.10%	94.40%
4.5%	90%	5.8M	20.3	1.50%	7.60%	2.90%	94.40%
5.0%	10%	0.2M	21.6	66.00%	93.40%	82.90%	14.80%
5.0%	20%	0.4M	23.7	57.40%	87.30%	71.60%	22.20%
5.0%	30%	0.6M	24.2	43.40%	77.10%	62.40%	50.00%
5.0%	40%	1.1M	26	44.00%	67.80%	53.40%	61.10%
5.0%	50%	1.6M	25	32.60%	58.70%	43.90%	79.60%
5.0%	60%	2.0M	25.5	24.50%	48.60%	32.90%	85.20%
5.0%	70%	2.5M	24.3	15.00%	35.60%	21.90%	88.90%
5.0%	80%	3.2M	24.3	7.10%	21.10%	11.00%	87.00%
5.0%	90%	5.0M	22	1.30%	7.10%	2.50%	85.20%

FIGURE 11

Guyton PMR Strategy results for varying withdrawal rates and stock percentages.

PMR is essentially a three-pool strategy, dividing assets between cash, bonds, and stocks. The cash and bonds provide a buffer to volatility in stocks. Also, past performance is indirectly considered by comparing the current asset allocation to the target allocation. Then why doesn't the strategy perform better?

The problem is, comparing current allocation to target allocation does not reflect well how stocks are doing over a multi-year period, causing stocks' "excess returns" to be shifted to cash during periods when stocks as a whole are still actually underperforming, ultimately lowering the portfolio's return.

In the end, PMR is not a top performer in this survey, but it appears better than annual rebalancing. To Guyton and Klinger's credit, their total strategy was both innovative and well tested, using Monte Carlo techniques.

The Parker Strategy

Zachary Parker is Vice President of Income Distribution & Product Strategy at Securities America. In 2011, he received the Practitioner Thought Leadership Award from the Retirement Income Industry Association. His income-harvesting strategy surveyed here is described in the August 2008 issue of the *Journal of Financial Planning*[14]. The original study defining his strategy was a Judge's Grant winner in the 2007 Financial Frontiers Award competition.

Parker's strategy is the most complex in this survey. He divides the portfolio into four accounts, each playing a part in the harvesting strategy:

1. The Income Guarantee Account is invested in bonds. This account is the source of all annual withdrawals.
2. The Equity Harvest Account is invested in stocks. This account annually transfers a percentage of its growth to the Income Guarantee Account.

3. The Equity Withdrawal Account is also invested in stocks. This account annually transfers a percentage of its total value to the Income Guarantee Account.
4. The Derivative Protection Account is also invested in bonds. This account has a one-time purpose…if there is ever a drastic drop in equity values, transfer all of this account to the Equity Harvest Account.

As with most studies, some adaptation from Parker's study is necessary for this survey. Parker assumes 3% inflation with adjustments every 5 years, where this survey adjusts inflation every year based on CPI. Parker's asset allocation is different; nevertheless, what is used in this survey is comparable. Also, Parker assumes a fixed growth rate for bonds, where this survey uses historical returns. Finally, Parker states as a key assumption that an advisor periodically reviews the strategy and adjusts the portfolio as necessary to stay with the philosophy; here backtesting uses only the explicitly defined steps for the strategy as described below.

The Steps

Initially fill the strategy's four accounts to match their target values. Parker's most aggressive, but best performing, parameters are approximated: allocate 26% of the portfolio to bonds in the Income Guarantee Account, 30% to stocks in the Equity Withdrawal Account, 34% to stocks in the Equity Harvest Account, and finally 10% to bonds in the Derivative Protection Account.

1. If the Equity Withdrawal Account's underlying value did not decline by 5% during the year, transfer a portion of the account's assets to the Income Guarantee Account. The portion to be transferred is 7.5% of the account's assets if a transfer was made the previous year; if no transfer was made the previous year, then transfer the higher of two numbers: 7.5% of the account's assets or the amount of the most recent transfer.
2. If the Equity Harvest Account's underlying value grew over the last year, transfer a portion of the growth to the Income Guarantee Account. The portion to transfer is 60% of growth up to the Income Guarantee Account's target value; otherwise, 25% of the growth is transferred.
3. If the Equity Harvest Account's underlying value declined 30% or more over the previous two years, do a one-time transfer of all the assets in the Derivative Protection Account to the Equity Harvest Account.
4. Sell enough bonds from the Income Guarantee Account to fund the next withdrawal. If the account does not have sufficient funds, make up the shortfall by selling from the Equity Harvest Account. If the Equity Harvest Account is short, make up the shortfall by selling from the Equity Withdrawal Account.
5. Withdraw the annual living expenses from the portfolio's cash.
6. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).
7. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

Backtesting Results

Figure 12 shows the strategy's MSWR values compared to annual rebalancing. Figure 13 shows the harvesting results for different withdrawal rates using five different portfolio makeups defined in Parker's paper, ranging from aggressive to conservative.

FIGURE 12

Parker Strategy compared to annual rebalancing.

Parker's Adjusted Models	Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
Aggressive	4.0%	63%	8.0M	NA	24.70%	42.90%	36.30%	100.00%
Moderate Aggressive	4.0%	56%	6.9M	NA	30.20%	46.00%	40.70%	100.00%
Moderate	4.0%	52%	6.3M	NA	32.50%	49.30%	43.10%	100.00%
Moderate Conservative	4.0%	49%	5.9M	NA	33.60%	50.60%	44.40%	100.00%
Conservative	4.0%	45%	5.4M	NA	35.90%	53.50%	47.30%	100.00%
Aggressive	4.5%	63%	6.7M	NA	21.80%	39.40%	33.40%	98.10%
Moderate Aggressive	4.5%	56%	5.7M	NA	26.40%	42.70%	37.50%	98.10%
Moderate	4.5%	52%	5.2M	24	27.60%	45.90%	39.20%	98.10%
Moderate Conservative	4.5%	49%	4.8M	25	27.60%	48.00%	40.20%	98.10%
Conservative	4.5%	45%	4.3M	26	28.40%	51.30%	42.70%	98.10%
Aggressive	5.0%	63%	5.5M	23.7	17.60%	36.10%	29.90%	92.60%
Moderate Aggressive	5.0%	56%	4.6M	26	21.10%	39.80%	33.40%	92.60%
Moderate	5.0%	52%	4.1M	25.8	20.70%	43.50%	34.80%	92.60%
Moderate Conservative	5.0%	49%	3.9M	25.4	20.00%	45.90%	35.60%	92.60%
Conservative	5.0%	45%	3.4M	25	20.80%	49.80%	37.80%	88.90%

FIGURE 13

Parker Strategy results for varying withdrawal rates and models.

The strategy's MSWR values and success rates are high, the bond averages are reasonable, and the average remaining dollars are solid; overall the strategy's performance is excellent using the US data. Unfortunately, it isn't as strong with non-US datasets.

As a preview of what's ahead, when the broader results (e.g., UK, Japan) are considered at the end of this chapter (e.g., Figure 30 and Figure 31), one may wonder if Parker's results include some amount of an unintended data-mining bias. Keep in mind a data-mining bias is hard to discern, but its risk is ever present when developing investment strategies, especially strategies with several parameters tuned for optimal performance. If there is a bias, the strategy's full strengths will not carry into the future.

Parker does address the risk of overtuning in the following caveat for a particular parameter: "Although this optimal point was based on historical performance, there is no reason to assume it will remain optimal into the future; but the assumption can be made that this optimal point would remain fairly stable and could be adjusted throughout the life of the plan." I believe his point is that a financial planner or money manager could dynamically adjust the parameters throughout the plan to counter any weaknesses, although how to do this is not clear.

Even if there is some bias to US data, the strategy is still a strong performer. As such it provides another benchmark to compare other strategies against.

The Weiss Strategy

Gerald Weiss is a Certified Financial Planner, heading his own firm, Weiss Financial Planning. He outlined his harvesting strategy in a 2001 paper, "Dynamic Rebalancing"[15], published in the *Journal of Financial Planning*. This older strategy is a solid performer, as is Weiss' paper, identifying many of the core issues concerning income harvesting.

Weiss' strategy is simple but effective. In up years when stocks perform well, traditional annual rebalancing takes place as normal with withdrawals mainly coming from stocks. However, in down years when stocks underperform, no rebalancing occurs, with withdrawals coming only from bonds until the market improves. "Up Years" are those where the cumulative return from the start of retirement is above the expected average; "Down Years" are those where the cumulative return is below the expected average. The strategy also rebalances annually if bonds are completely depleted, or if stocks are underrepresented in the portfolio due to a bear market.

Cumulative real return is the trigger for rebalancing during up markets — it's calculated as the inflation-adjusted geometric mean from the start of retirement. Weiss did not specify what the expected cumulative return should be, but 5% is used given it performs best with backtesting, although up to 7% performs almost as well.

The Steps

1. Sell enough bond assets to fund the next withdrawal; if bonds are depleted, sell from stocks.

2. Withdraw the annual living expenses from the portfolio's cash.

3. Buy and sell as needed to rebalance according to the following rules:
    a. Rebalance back to target stock and bond ratios if any of the following criteria are true:
        i. If stocks are under their target allocation (i.e., a low percentage of the portfolio).
        ii. If cumulative stock returns from the start of retirement are greater than 5%.
        iii. If the bonds are depleted.
    b. Individual stock assets are rebalanced to their target stock values (without modifying the portfolio's stock percentage).
    c. Individual bond assets are rebalanced to their target bond values (without modifying the portfolio's bond percentage).

Backtesting Results

Figure 14 shows the strategy's MSWR values compared to annual rebalancing. The figure illustrates how the strategy matches annual rebalancing during strong retirement periods, but boosts performance during the worst years by using bonds to buffer the sale of stocks.

Figure 15 shows the results for various withdrawal percentages and stock ratios.

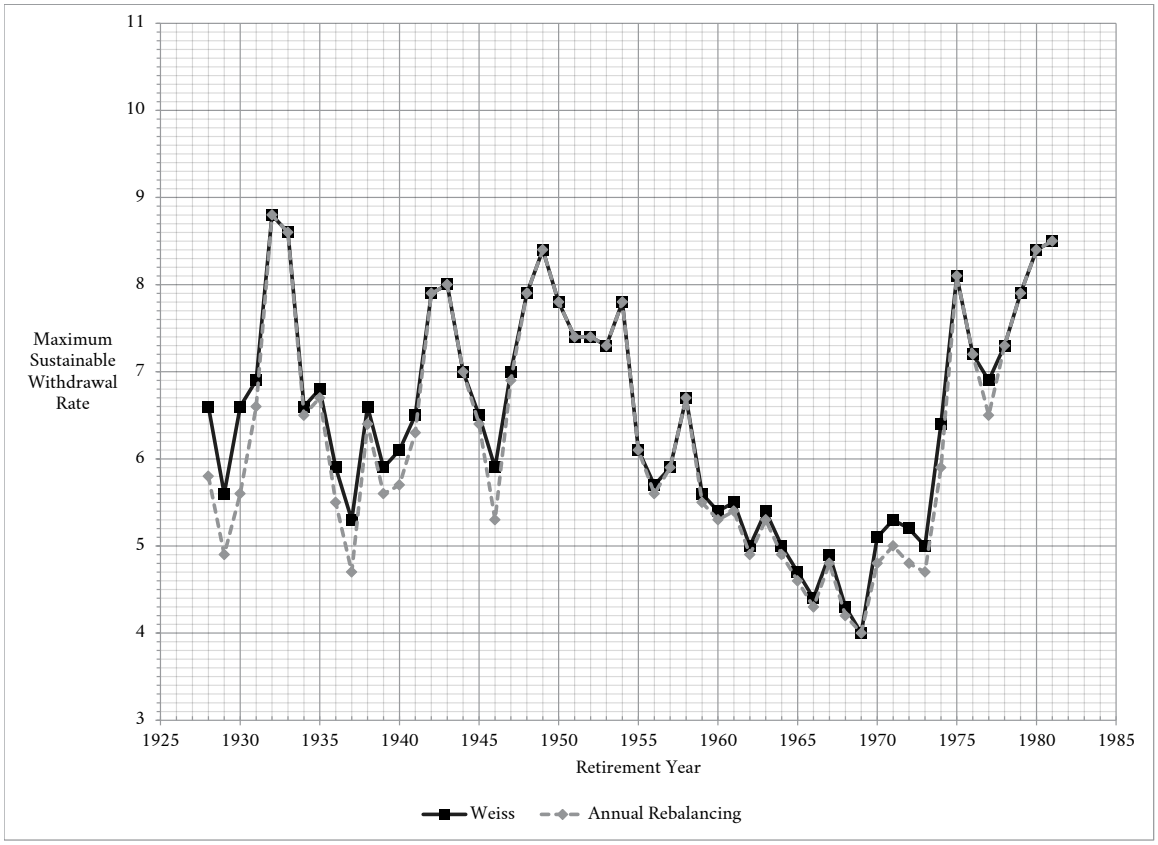

FIGURE 14

Weiss Strategy compared to annual rebalancing.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	0.8M	26.1	70.50%	90.00%	86.90%	51.90%
4.0%	20%	1.6M	27.8	54.70%	80.00%	76.20%	83.30%
4.0%	30%	2.7M	NA	46.60%	70.00%	66.10%	100.00%
4.0%	40%	4.0M	NA	38.00%	60.00%	56.50%	100.00%
4.0%	50%	5.6M	NA	30.30%	50.00%	47.10%	100.00%
4.0%	60%	7.5M	NA	23.00%	40.00%	37.60%	100.00%
4.0%	70%	9.5M	NA	16.30%	30.00%	27.80%	100.00%
4.0%	80%	11.7M	25	10.60%	20.00%	18.70%	98.10%
4.0%	90%	14.5M	28	4.90%	10.00%	9.50%	96.30%
4.5%	10%	0.4M	24	77.40%	90.00%	86.50%	25.90%
4.5%	20%	0.8M	26	61.40%	80.00%	75.90%	50.00%
4.5%	30%	1.5M	27.6	47.80%	70.00%	66.30%	83.30%
4.5%	40%	2.7M	29	38.80%	60.00%	56.80%	96.30%
4.5%	50%	4.2M	26.3	31.20%	50.00%	47.20%	94.40%
4.5%	60%	5.8M	26.3	23.80%	40.00%	37.30%	94.40%
4.5%	70%	7.5M	24	16.70%	30.00%	27.90%	96.30%
4.5%	80%	9.8M	23	10.70%	20.00%	18.70%	92.60%
4.5%	90%	12.3M	21	4.90%	10.00%	9.60%	94.40%
5.0%	10%	0.2M	21.6	76.70%	90.00%	86.60%	16.70%
5.0%	20%	0.5M	23.8	66.50%	80.00%	76.20%	24.10%
5.0%	30%	0.9M	26.2	56.40%	70.00%	66.70%	44.40%
5.0%	40%	1.6M	27.2	43.30%	60.00%	56.90%	75.90%
5.0%	50%	2.9M	25.4	33.00%	50.00%	47.20%	87.00%
5.0%	60%	4.2M	24.7	24.50%	40.00%	37.40%	88.90%
5.0%	70%	5.9M	22.8	17.40%	30.00%	28.10%	90.70%
5.0%	80%	7.9M	20.4	11.00%	20.00%	18.90%	90.70%
5.0%	90%	10.2M	22	5.10%	10.00%	9.70%	87.00%

FIGURE 15

Weiss Strategy results for varying withdrawal rates and stock percentages.

While Weiss' strategy is not a top performer in this survey, it does well and is consistently better than annual rebalancing. Weiss' early paper and analysis is a significant contribution to the income-harvesting literature.

The OmegaNot Strategy

David Lee developed the OmegaNot Strategy[16] around 2001. He derived it while trying to interpret and backtest columnist Scott Burns' Omega strategy. Here are Lee's words describing it:

> Scott [Burns] was not specific about how this strategy would be implemented and (to my knowledge) no one has ever done any back-testing on this approach. This was intended to be the subject of this chapter. The truth is that I ended up (partly through my own misinterpretations) simulating a strategy that is fundamentally different than what Scott was trying to describe, although at a high level it matches his description as I stated it above.

David Lee's resulting strategy, OmegaNot, is a strong performer…one of the best. Its downside, fully realized by Lee, is the strategy's low bond average. Like the Bonds-First strategy, bonds are never replenished; however, withdrawals come from bonds only when the inflation-adjusted stock growth is insufficient to support them.

Lee's approach to using the inflation-adjusted target stock value as a metric for real growth is both simple and effective. A variation is successfully put to use later in the Prime Harvesting Strategy.

The Steps

1. Each year, adjust the targeted stock value by the inflation rate. The first year's targeted stock value is set to the initial stock allocation (e.g., 60% of the portfolio value, given 60% is initially allocated to stocks).
2. If the current stock value is greater than the targeted stock value, sell enough from the excess to fund the annual withdrawal. If the stock's excess value does not fully fund the withdrawal, sell bonds to make up the shortfall. If bonds become depleted, sell stocks to complete the amount needed for the withdrawal.
3. Withdraw the annual living expenses from the portfolio's cash.
4. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).
5. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

Backtesting Results

Figure 16 shows the strategy's MSWR values compared to annual rebalancing. The figure shows OmegaNot significantly outperforming annual rebalancing for every backtested retirement period.

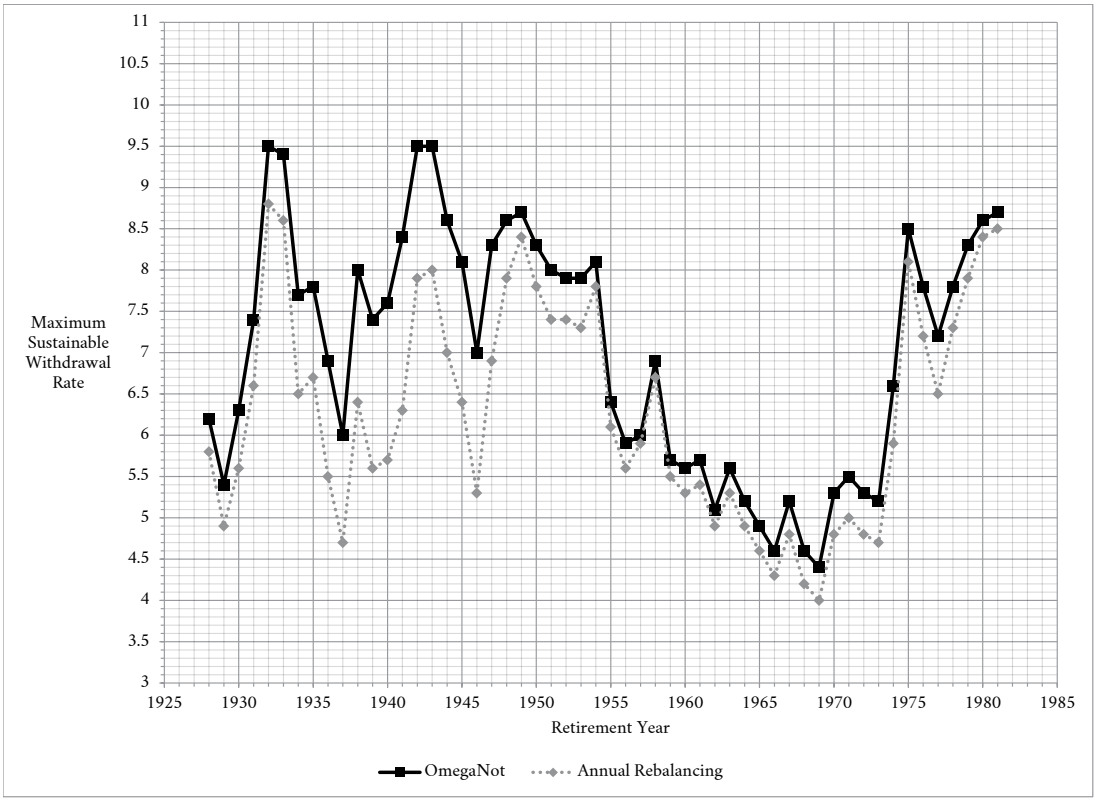

FIGURE 16

OmegaNot Strategy compared to annual rebalancing.

Figure 17 shows the results for various withdrawal percentages and stock ratios. Again, performance is strong, but bond averages are generally low. For example, a 5% withdrawal rate with an initial stock allocation of 60% has a 92.6% success rate, but the overall bond average is only 20.7% with the low-bond average 4.9%. Higher averages are seen with lower withdrawal rates though: a 4.5% withdrawal rate with a 50% initial stock allocation produces a 98.1% success rate with an overall bond average of 30.4% and a low-bond average of 14%.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	0.7M	27.6	41.80%	93.30%	76.60%	57.40%
4.0%	20%	1.6M	NA	41.00%	84.70%	68.60%	100.00%
4.0%	30%	2.8M	NA	40.70%	77.40%	58.30%	100.00%
4.0%	40%	4.8M	NA	25.40%	66.50%	43.80%	100.00%
4.0%	50%	7.3M	NA	15.70%	54.60%	31.60%	100.00%
4.0%	60%	9.9M	NA	9.40%	43.10%	21.90%	100.00%
4.0%	70%	12.4M	NA	5.60%	31.50%	14.20%	100.00%
4.0%	80%	14.6M	NA	3.00%	19.70%	7.90%	100.00%
4.0%	90%	16.5M	26	1.10%	8.40%	2.90%	96.30%
4.5%	10%	0.4M	24.9	59.60%	94.00%	74.60%	25.90%
4.5%	20%	0.8M	27.7	27.10%	84.60%	62.00%	70.40%
4.5%	30%	1.7M	28	33.90%	76.80%	54.50%	90.70%
4.5%	40%	3.3M	29.5	22.30%	66.80%	42.20%	96.30%
4.5%	50%	5.6M	30	14.00%	54.80%	30.40%	98.10%
4.5%	60%	8.0M	27	8.40%	43.10%	21.00%	98.10%
4.5%	70%	10.3M	24	5.20%	31.00%	13.60%	98.10%
4.5%	80%	12.5M	22.5	2.70%	19.50%	7.40%	96.30%
4.5%	90%	14.2M	20.3	0.90%	8.20%	2.70%	94.40%
5.0%	10%	0.2M	22.2	46.90%	93.40%	73.80%	18.50%
5.0%	20%	0.4M	25.6	37.80%	86.00%	59.20%	33.30%
5.0%	30%	1.0M	26.1	28.30%	75.60%	51.90%	66.70%
5.0%	40%	2.2M	25	23.40%	67.10%	41.30%	87.00%
5.0%	50%	4.1M	23.8	13.50%	55.50%	30.00%	92.60%
5.0%	60%	6.2M	24.3	8.30%	43.00%	20.70%	92.60%
5.0%	70%	8.4M	21	4.90%	30.80%	13.20%	94.40%
5.0%	80%	10.4M	19.8	2.60%	19.10%	7.20%	92.60%
5.0%	90%	12.0M	17.3	0.80%	7.90%	2.60%	92.60%

FIGURE 17

OmegaNot Strategy results for varying withdrawal rates and stock percentages.

Although OmegaNot is not recommended, it's a top-performing strategy with consistent performance across multiple datasets. The downside is that its low bond averages carry a higher exposure to speculative risk; nevertheless, if there weren't better alternatives, it would still be worth considering.

The Three-Bucket Strategy

The best known three-bucket strategy is Ray Lucia's, described in his *Buckets of Money* books. The Three-Bucket Strategy surveyed here tries to adhere to Lucia's description as much as possible.

Mr. Lucia has a Wikipedia page[17], containing the following snippets:

> Raymond Joseph Lucia, Sr. is an American former Certified Financial Planner, former Registered Investment Advisor, author, radio personality and television host. He is host of The Ray Lucia Show, a nationally syndicated radio and television financial talk show on the Global American Broadcasting Radio Network and the Biz Television Network.
>
> On July 8, 2013, The United States Securities and Exchange Commission (SEC) banned him from associating with an investment adviser, broker or dealer, revoked his license and that of his former company, and slapped both with a fine—$50,000 to Lucia and $250,000 to his former firm.

The Buckets of Money strategy was promoted for over ten years before the SEC accused Mr. Lucia of misleading investors by portraying his strategy as successfully backtested when it was not. Here, the backtesting data is explored.

Although Mr. Lucia goes into considerable details on asset allocation, I found his income-harvesting ideas less clear in his books. I could not find precise guidance for handling unexpected situations, such as prematurely running out of a bucket's assets. I was also unable to find backtesting performance data in any of Mr. Lucia's publications, although a previous version of his website indicated his strategy was successfully backtested for the bear market of 1973-74. However, I could not recreate the performance described.

The Bucket of Money Strategy uses the following division of assets into three "buckets".

1. The first bucket contains safe-money investments, enough to fund seven years of withdrawals.
2. The second bucket contains moderately safe investments, enough to refill bucket one for another seven years when it empties.
3. The third bucket contains higher risk assets, typically equities, to refill the first two buckets when they are both depleted after approximately fourteen years.

The essential idea is to live off the first bucket for seven years while the second and third grows, then shift the second bucket to the first, living off it while the third keeps growing for a second seven years, finally starting all over again after a total of fourteen years with the accumulated assets of the third bucket used to refill the first two buckets.

The historical datasets contain good data for assets to fill bucket one and bucket three, but there is not good data for assets going into bucket two. Corporate bonds generally fulfill Lucia's criteria for bucket two (and are listed as a possible bucket two asset in his third book), but their poor backtesting results make their exclusive use questionable for a fair test of the strategy. To get past this barrier, bucket two's contents are simulated, essentially guaranteeing a solid bucket-two return during backtesting. Using simulated data, bucket two's return is annually set to 3% over the T-bill rate. This is a generous return for "moderately safe" investments during the worst of markets, given the return is derived from the safest asset, T-bills. From 1926 to 2010, adding 3% to the T-bill rate provides an annual return ranging from 2.98% to 17.71%, with the average of 6.67% and an annualized return of 6.01%. For those years where there is no T-Bill Rate (e.g., before 1926 for US data), Shiller's long interest rate is substituted for the T-bill rate.

The generous simulation of bucket two's return is emphasized so that any poor backtesting results cannot be a side effect of how bucket two is simulated; however, stronger than should be expected backtesting results are likely a side effect in extremely poor markets.

The Steps

To start, allocate to bucket one the withdrawal amount times seven (i.e., years), allocate to bucket two the withdrawal amount times six, and to bucket three allocate the remaining money. (This allocation for buckets one and two works as well as any in the 5-7 year ranges when backtesting with the US SBBI data.)

1. Each year, sell assets from bucket one to fund the withdrawal, and then pull the annual living expenses from the resulting cash. If there is not enough in bucket one to cover the withdrawal, then refill bucket one using all the contents of bucket two.
2. When bucket one and bucket two are depleted, refill them from the contents of bucket three using the starting guidelines, but this time use the updated inflation-adjusted withdrawal amount when calculating bucket sizes. If bucket three cannot refill buckets one and two, then divide the assets between bucket one and bucket two (and bucket three disappears).
3. Individual assets are rebalanced annually within their buckets.

Backtesting Results

Figure 18 shows the strategy's MSWR values compared to annual rebalancing. Figure 19 shows the results for various withdrawal percentages and bucket sizes.

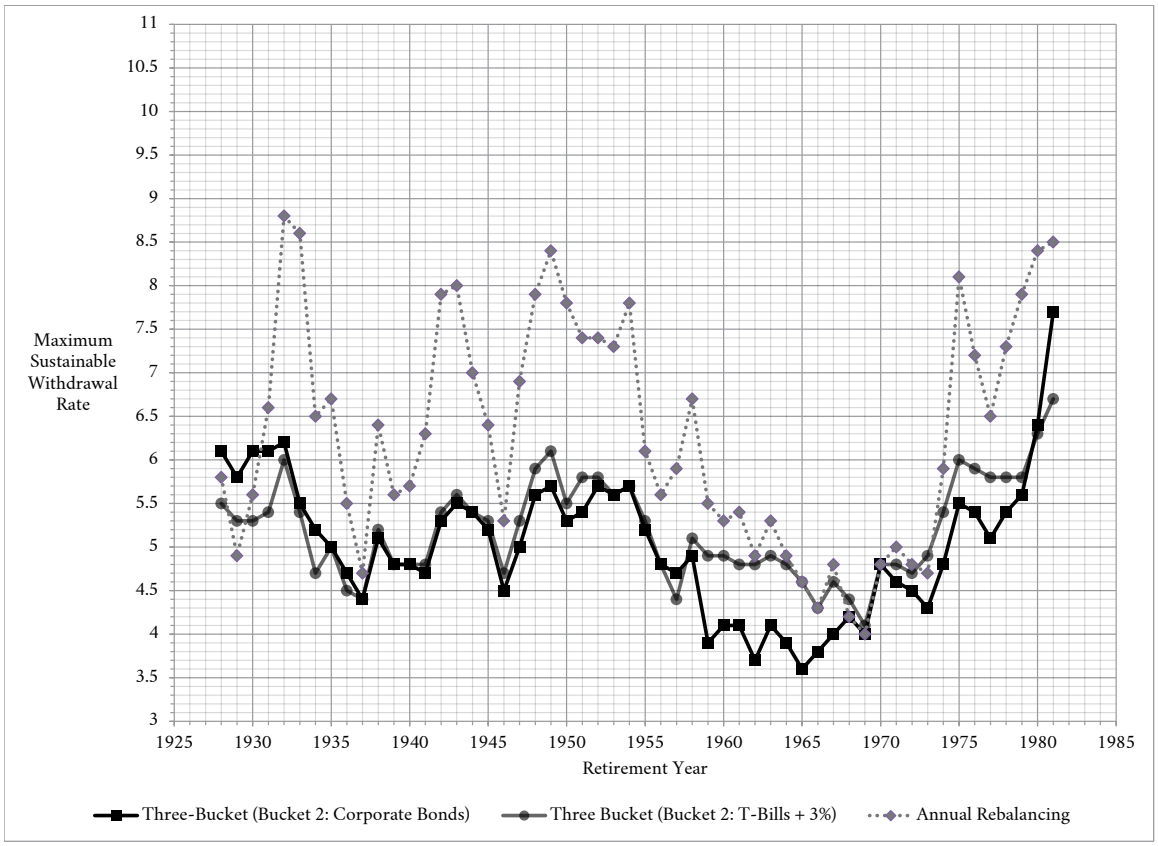

FIGURE 18

Three-Bucket Strategy with 7-year bucket sizes compared to annual rebalancing. Bucket two is shown with two different assets: 1) corporate bonds; 2) a simulated asset with a return rate equal to the current T-Bill rate plus 3%.

Withdraw Rate	Bucket Size	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	7 Years	8.3M	NA	1.60%	65.10%	32.20%	100.00%
4.0%	6 Years	10.0M	NA	1.10%	56.70%	25.50%	100.00%
4.0%	5 Years	11.4M	NA	0.80%	46.80%	19.60%	100.00%
4.5%	7 Years	4.9M	28.6	2.40%	75.50%	43.40%	90.70%
4.5%	6 Years	6.7M	26.8	1.40%	64.30%	33.70%	88.90%
4.5%	5 Years	8.4M	27	1.10%	52.70%	25.80%	90.70%
5.0%	7 Years	2.3M	26.4	2.50%	79.60%	54.70%	55.60%
5.0%	6 Years	4.0M	25.4	1.50%	68.20%	43.70%	66.70%
5.0%	5 Years	5.7M	23.4	1.10%	57.00%	32.10%	77.80%

FIGURE 19

Three-Bucket results (using a simulated bucket 2) for varying withdrawal rates and bucket sizes.

Overall the performance is weak, even with a generous return for bucket two. More is needed in a strategy than simply bucketing to effectively insulate stock volatility from withdrawals. Specifically, using "years" to calculate bucket sizes can cause imbalances during difficult markets by resulting in too many bonds—as previously stated, using a percentage of the overall portfolio performs better than "years". Also, blindly refilling the buckets when they are depleted does not perform well; a smarter rebalancing trigger is needed to raise the performance.

The Enhanced Two-Bucket Strategy

The Enhanced Two-Bucket Strategy (ETBS) tries to leverage the ideas from the Grangaard Strategy™. Paul Grangaard is an author and consultant on retirement planning. His harvesting strategy is outlined in his book[18] along with papers on his website[19]. To be clear, ETBS isn't Grangaard's strategy, because there are too many differences (described below); however, ETBS is a strategy an individual retiree might come up with by reading the book and making the necessary changes to adapt it to an income-harvesting strategy based wholly on index funds.

Grangaard recommends allocating to a "bond bucket" enough to fund 10 years of withdrawals; the rest of the portfolio is allocated to stocks. Grangaard's core idea is for the bond bucket to fund all withdrawals for 10 years, insulating the withdrawals from the volatility of stocks (i.e., the risk of having to sell low). As has been seen before, insulating stocks is generally good advice, but the details matter greatly. The book also suggests bonds might be replenished before 10 years (e.g., at 5 years) if the return objectives are met—also generally good advice as reflected in Weiss' work.

ETBS veers from Grangaard's recommendation primarily by how the bond bucket is formed. For ETBS the bond bucket is always composed of an intermediate-treasury bond index (as opposed to a ladder), matching the assumptions of this survey to enable direct comparison with the other strategies. In contrast, Grangaard recommends bond ladders* for the bond bucket. Briefly, the advantage of ladders is that the income rate is locked in during difficult markets and the income is guaranteed; however, what is lost is the negative correlation between bond funds and stock funds during those same difficult markets (i.e., the extra returns from a bond fund can help compensate for poor stock returns).

Grangaard's goals as well as his characterization of the problems of investing during retirement are clear at a high level, but implementing the concept using bond funds raises several questions. Also, like a few other strategies,

* Using bond ladders with systemic withdrawals is explored in Appendix B. There is significant added complexity and the historical results appear mixed, but it can sometimes improve results. I didn't find the case for ladders compelling though.

Grangaard leaves some details fluid for the investor or investment advisor (which he recommends) to customize and adjust as needed. To complete ETBS, the following interpretations are necessary.

The first interpretation requires deciding how much should be allocated to bonds to cover withdrawals for a 10-year period. The simplest approach is to multiply the current year's withdrawal amount by 10. This is reasonable, given high-quality bonds often do little more than keep up with inflation; in fact, with the SBBI data, this approach with intermediate treasury bonds resulted on average of around 10.5 years of withdrawals.

The next interpretation is exactly how to manage the bonds earmarked to fund 10 years of withdrawals. Questions arose such as what to do if bonds are depleted before 10 years, or what to do if significant bonds are left at the end of the 10 years. Backtesting performance did not show a substantial difference between various options, so the simplest choice is used: replenish bonds from stock sells when there is not enough to fund the next annual withdrawal, whether or not more or less than 10 years have elapsed. This means a shortfall in the bond fund (due to low returns or high inflation) will trigger early selling of stocks to replenish bonds in as few as 7, 8, or 9 years; likewise a surplus in the bond fund due to strong returns and low inflation may delay replenishing up to 15 years.

The last interpretation is, if and when to replenish bonds early because the portfolio's return objective has been met. The following criterion is used: replenish bonds when the real stock return (i.e., inflation adjusted geometric return) from the start of retirement is greater than 7%, and at least 5 years have passed since the last replenish. The long-term market average of 7% is used as the trigger because it's known to perform relatively well (although 6% or 8% also perform relatively well). A minimum 5-year period is used because Grangaard suggested it, plus it also performs relatively well.

All these interpretations are included in the following steps defining ETBS.

The Steps

Initially fill the bond bucket with 10 years of withdrawals (i.e., 10 times the initial withdrawal amount).

1. If there are not enough bonds to fund the current year's withdrawal, sell enough stocks to replenish bonds with another 10 years of withdrawals (i.e., 10 times the current year's withdrawal amount).
2. If 5 years have elapsed since bonds were replenished and the real return for stocks (since the start of retirement) is greater than 7%, sell enough stocks to replenish bonds early for another 10 years (using the bonds already in place).
3. Withdraw from bonds.
4. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).
5. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

Backtesting Results

Figure 20 shows the strategy's MSWR values compared to annual rebalancing. Figure 21 shows the results for varying withdrawal percentages. It's clear that ETBS consistently underperforms annual rebalancing.

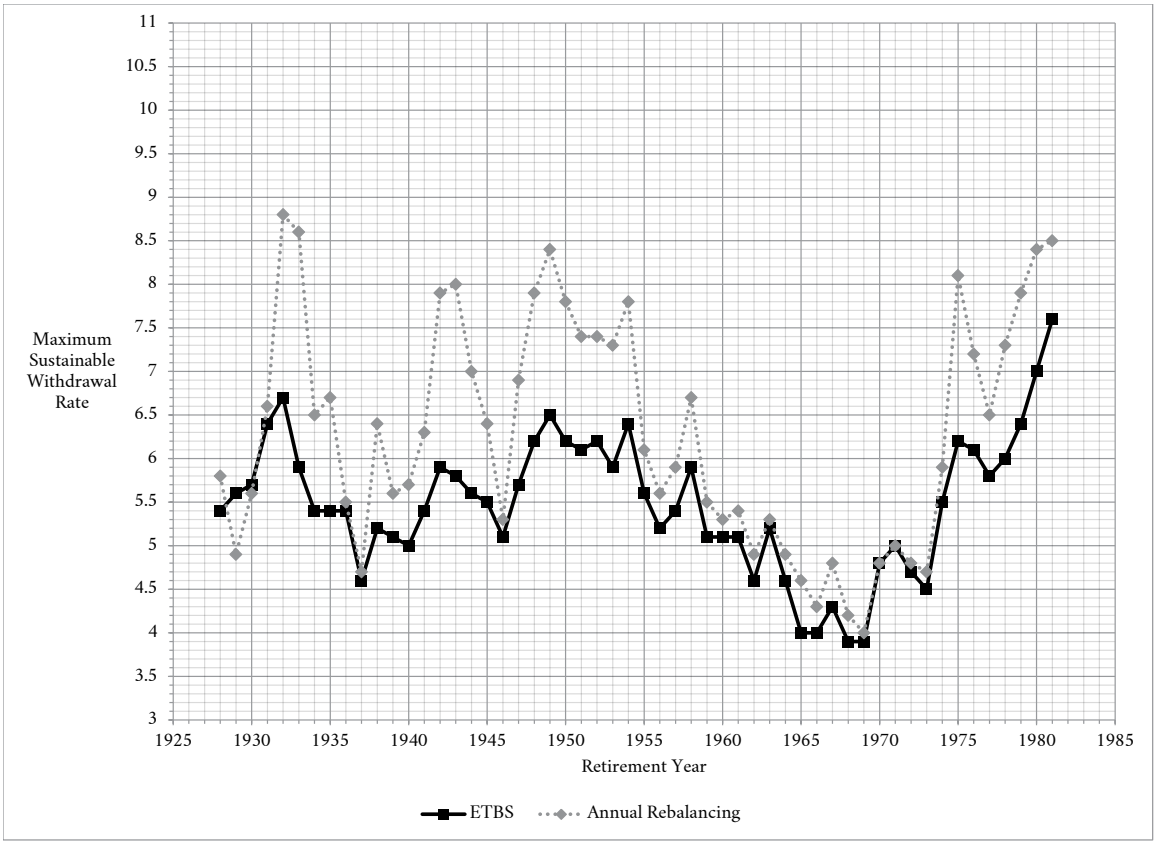

FIGURE 20

ETBS compared to annual rebalancing.

Withdraw Rate	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	9.9M	29.5	3.50%	46.20%	23.60%	96.30%
4.5%	6.7M	23	5.20%	54.90%	30.40%	90.70%
5.0%	4.0M	21.8	9.80%	63.20%	40.00%	79.60%

FIGURE 21

ETBS results for varying withdrawal rates.

Although ETBS has strong points (e.g., using bonds to insulate stocks; setting a return goal), the results when compared to traditional rebalancing indicate that the strategy's weaknesses overpower its strengths. The weaknesses stem from two interrelated problems:

- Calculating the bond allocation using years is less efficient than using the percentage of the portfolio. In some markets, the 10-year allocation for bonds can become a disproportionately large part of the overall portfolio, possibly even driving the stock percentage to zero. Varying the number of years in bonds by a couple of years in either direction did not result in significantly better performance.

- Replenishing bonds when they are depleted causes a large portion of stocks to be immediately sold independently of what is happening in the market—selling at a bad time can drive the portfolio to failure.

What can be learned from this exercise? Good general ideas don't necessarily translate to effective income-harvesting strategies—the details greatly matter. Also, it can be difficult to translate high-level goals into well-specified individual plans. Finally, it appears difficult to squeeze strong harvesting performance out of a bucket strategy based on time intervals (versus portfolio percentage).

The Rational Strategy

The Rational Strategy covers another set of income-harvesting steps circulating within the literature, although it may be known under different names and includes variations. As the name I give to it implies, the strategy is based on rational ideas that are individually sound, although again the results show this is not enough.

The following overlapping concepts guide the makeup of the strategy:

- Stocks fuel portfolio growth.
- Stocks should not be sold when they are down if at all possible.
- Bonds buffer stocks during bad years by funding withdrawals.
- Bonds are replenished from stock sales during good years.

More specifically, bonds support withdrawals but they are only replenished from nominal stock growth. All the concepts are realized in the following steps defining the Rational Strategy.

The Steps

Initially calculate the bond allocation by multiplying the initial withdrawal amount by a target number of years (5 to 7 years are recommended, but 5 is used as the best-performing); the rest of the portfolio is allocated to stocks.

1. Each year, recalculate the targeted bond allocation by multiplying the current annual withdrawal amount by the targeted years in bonds (e.g., 5).
2. Sell enough bond assets to fund the next withdrawal; if bonds are depleted, sell from stocks.
3. Withdraw the annual living expenses from the portfolio's cash.
4. Buy and sell as needed to rebalance according to the following criteria:
   a. If stocks are up for the year and bonds are less than their target allocation, then make up as much as possible of the bonds' shortage from the year's stock growth (by selling stocks to buy bonds).
   b. Individual stock assets are rebalanced to their target stock values (without modifying the portfolio's stock percentage).
   c. Individual bond assets are rebalanced to their target bond values (without modifying the portfolio's stock percentage).

Backtesting Results

Figure 22 shows the strategy's MSWR values compared to annual rebalancing. Figure 23 shows the results for various withdrawal percentages and years set aside in bonds (i.e., the target bond allocation).

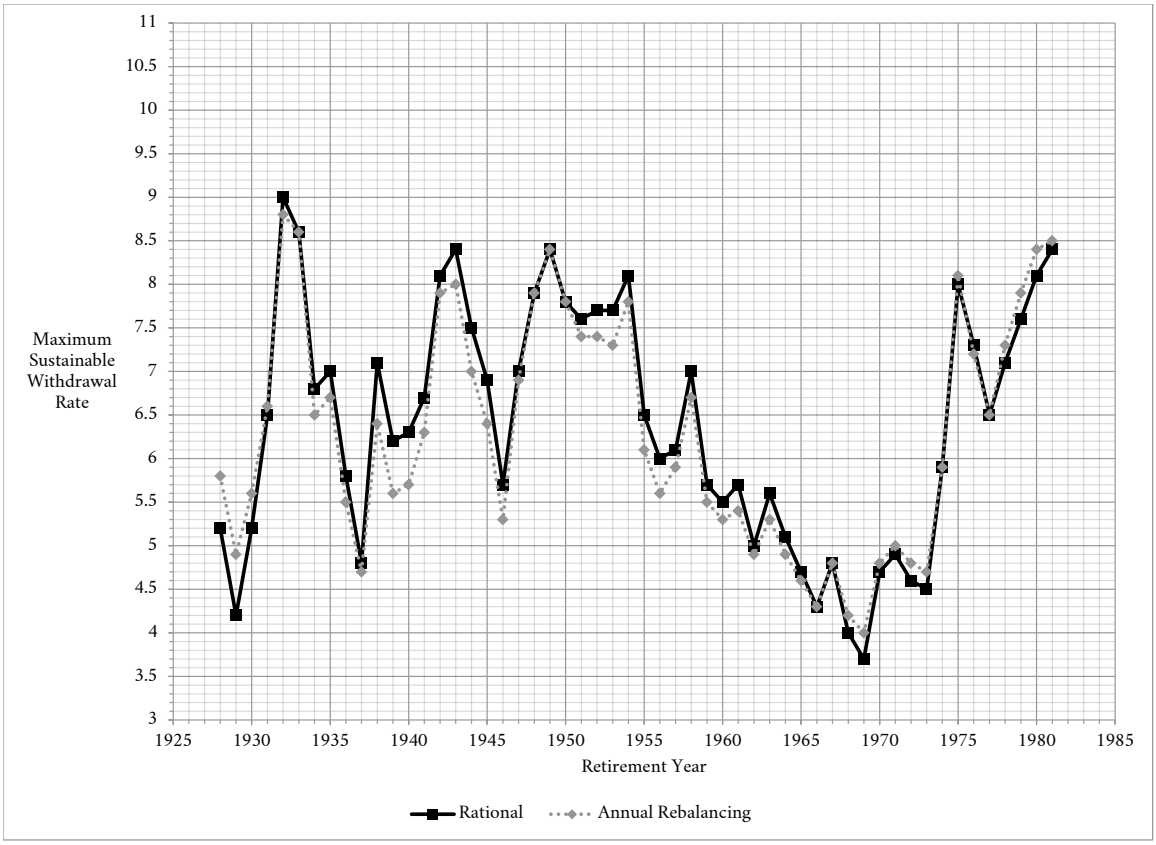

FIGURE 22

Rational Strategy compared to annual rebalancing.

Withdraw Rate	Bond Target	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	5 Years	12.6M	25	6.20%	25.20%	14.90%	98.10%
4.0%	6 Years	11.5M	25	8.70%	30.40%	18.60%	98.10%
4.0%	7 Years	10.4M	25	11.30%	35.60%	22.50%	98.10%
4.5%	5 Years	9.8M	24.3	7.50%	29.10%	18.40%	92.60%
4.5%	6 Years	8.7M	25.4	10.00%	34.50%	22.70%	90.70%
4.5%	7 Years	7.6M	25.6	12.10%	40.30%	26.90%	90.70%
5.0%	5 Years	7.5M	23.9	7.10%	30.20%	19.60%	79.60%
5.0%	6 Years	6.4M	23.5	10.70%	36.50%	24.60%	77.80%
5.0%	7 Years	5.3M	23.4	15.50%	42.80%	30.00%	75.90%

FIGURE 23

Rational Strategy results for varying withdrawal rates and bond-target years.

Overall, the results are not strong. For some retirement periods, the performance is better than annual rebalancing, but during difficult periods (e.g., retirements starting in 1929, 1968, and 1969) when it matters most, the strategy underperforms. What's surprising is the similarity between this strategy and some top performers (e.g., OmegaNot, Prime Harvesting)—it seems like this strategy should perform much better than it does.

The strategy's weakness is primarily due to measuring stock growth without considering inflation. The result is that cumulative stock performance isn't accurately measured, and stocks are sometimes sold at a loss in real terms. In addition, the immediate sells from nominal stock growth can sometime lose out on momentum (compared to alternatives). It's also notable that although allocating bonds by years (instead of percentage) typically results in too many bonds, this time there were on average too few bonds because of how they were replenished.

The details and how they interoperate matter greatly, making it very difficult to anticipate how a strategy will perform without a complete verification. Good concepts combined with rational thinking and individually sound rules aren't enough.

The Prime Harvesting Strategy – A New Strategy

Prime Harvesting is formed out of the top-performing characteristics of the preceding strategies. However, as already shown it's the composite behavior that ultimately matters. Picking and choosing what works best together, the following characteristics (i.e., what works) are included in Prime Harvesting:

1. Withdrawals are always funded by bonds, providing a buffer from stock volatility.
2. The bond allocation is based on a percentage of the total portfolio, as opposed to setting aside a fixed number of years of income.
3. Bonds are replenished from stock sells only when the total market is up (i.e., stocks are never sold at a loss if possible).
4. A comprehensive metric is used to identify when the market is up, covering multiple years as opposed to the most recent performance.

The comprehensive metric for identifying when markets are up is adapted from Dave Lee's OmegaNot Strategy. This metric is an essential part of Prime Harvesting: if stock values are greater than 120% of their inflation-adjusted initial value, then the market is considered "up" and a portion of stocks are transferred to bonds. Triggering off 120%, instead of 100%, takes more advantage of market momentum.

Another distinguishing characteristic is, once the initial stock percentage is set, additional stocks are never purchased throughout retirement (the only exception is dividend reinvestment within funds). The stock percentage can only rise passively by stock growth, or indirectly by lowering bonds (by selling to fund withdrawals). Again, stocks are only sold to replenish bonds and then bonds are only sold to fund withdrawals. This means, the original stock allocation fuels growth throughout retirement with no potential for anti-momentum (i.e., continuing to buy stocks as prices drop over multiple years).

Prime Harvesting is very simple, but effective. It's also the strategy recommended in this book for income-harvesting. The reason will eventually become clear. The strategy comes in two forms: Prime Harvesting and Alternate-Prime Harvesting. Both forms are defined in the following steps. The only difference between the two strategies is highlighted in bold in Step 1.

The Steps with Prime Harvesting (With Spreadsheet Support)

1. If stock assets are greater than 120% of their initial value after annually adjusting for inflation, **sell 20% of stocks to buy additional bonds**.
2. Sell enough bond assets to fund the next withdrawal; if bonds are depleted, sell enough from stocks to cover the withdrawal.

3. Withdraw the annual living expenses from the portfolio's cash.

4. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).

5. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

When stocks are doing well, Prime Harvesting captures the gain, transferring stocks to bonds. As stocks continue to increase in value, more gain is captured and the bond percentage increases. With Prime Harvesting, there is no limit to the bond percentage. This sometimes loses out on extra return, but it reduces risk.

When stocks are underperforming, Prime Harvesting waits for the market to recover before selling. As long as bonds are available, this prevents stocks from ever being sold while they are down (locking in a loss).

The Steps with Alternate-Prime Harvesting (With Spreadsheet Support)

1. If the stock assets are greater than 120% of their initial value after annually adjusting for inflation, then **sell enough stocks to replenish the target bond allocation (i.e., the initial bond percentage)**.

2. Sell enough bond assets to fund the next withdrawal; if bonds are depleted, sell enough from stocks to cover the withdrawal.

3. Withdraw the annual living expenses from the portfolio's cash.

4. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).

5. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

When stocks are doing well, Alternate-Prime always replenishes bonds back to their target level, no more or less. This typically increases income for a small increase in risk.

Both forms of Prime Harvesting work with any initial stock percentage.

Backtesting Results

Figure 24 and Figure 25 show the Prime and Alternate-Prime strategies' MSWR values respectively with each compared to annual rebalancing. Figure 26 and Figure 27 show the Prime Harvesting and Alternate-Prime results respectively for various withdrawal percentages and stock ratios.

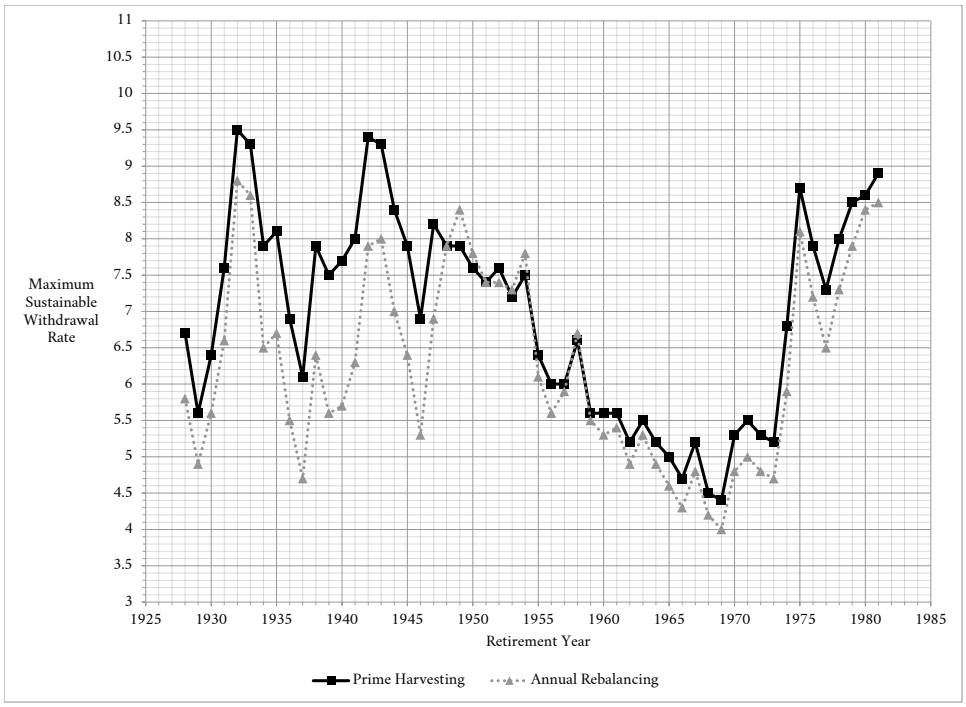

FIGURE 24

Prime Harvesting compared to annual rebalancing.

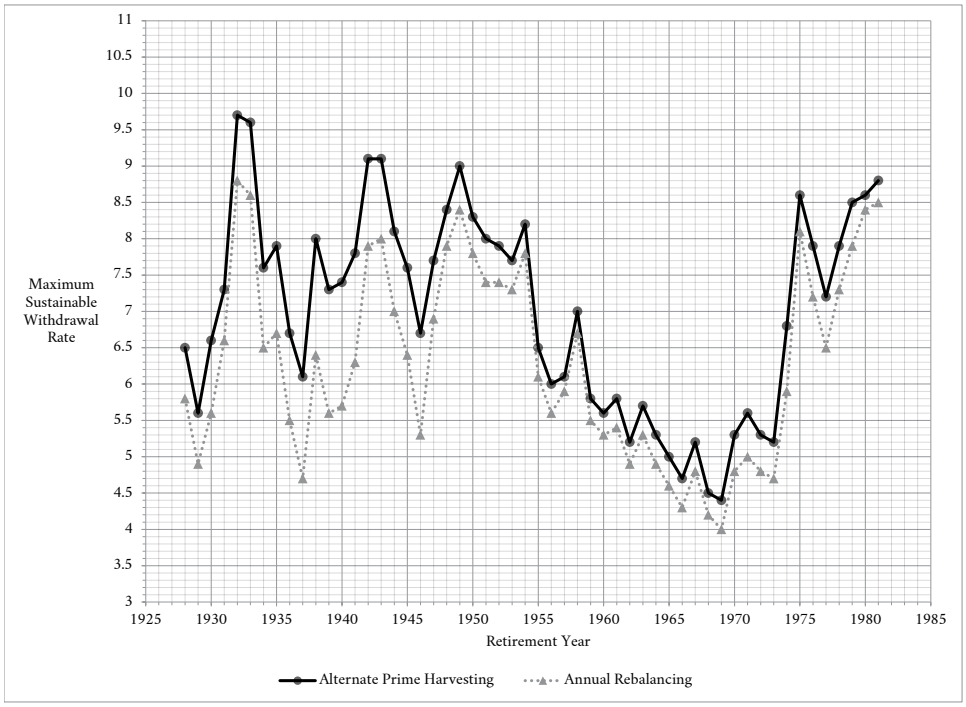

FIGURE 25

Alternate-Prime Harvesting compared to annual rebalancing.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	0.8M	28.1	40.50%	92.70%	75.20%	61.10%
4.0%	20%	1.6M	NA	39.50%	84.60%	68.40%	100.00%
4.0%	30%	2.6M	NA	43.50%	78.70%	63.00%	100.00%
4.0%	40%	3.6M	NA	37.40%	74.90%	57.90%	100.00%
4.0%	50%	4.6M	NA	30.30%	72.40%	53.20%	100.00%
4.0%	60%	5.5M	NA	23.70%	70.40%	48.90%	100.00%
4.0%	70%	6.5M	NA	17.40%	69.10%	44.90%	100.00%
4.0%	80%	7.3M	NA	11.40%	67.80%	41.20%	100.00%
4.0%	90%	8.0M	26	6.60%	67.90%	37.80%	96.30%
4.5%	10%	0.4M	25.4	63.30%	93.70%	72.90%	25.90%
4.5%	20%	0.9M	27.6	26.00%	84.60%	61.50%	74.10%
4.5%	30%	1.7M	28	33.40%	77.10%	56.80%	92.60%
4.5%	40%	2.6M	29	30.10%	72.10%	52.40%	98.10%
4.5%	50%	3.6M	30	25.70%	69.20%	48.50%	98.10%
4.5%	60%	4.5M	27	20.60%	67.70%	44.90%	98.10%
4.5%	70%	5.4M	25.5	15.60%	67.00%	41.40%	96.30%
4.5%	80%	6.2M	22	10.30%	65.60%	38.10%	96.30%
4.5%	90%	6.9M	20	5.60%	64.50%	35.30%	94.40%
5.0%	10%	0.2M	22.5	51.80%	93.20%	72.20%	18.50%
5.0%	20%	0.5M	25.8	37.30%	85.70%	58.10%	35.20%
5.0%	30%	1.0M	26.1	26.40%	76.60%	52.40%	70.40%
5.0%	40%	1.8M	25.3	26.40%	70.30%	48.10%	87.00%
5.0%	50%	2.7M	24.5	22.80%	67.30%	44.40%	92.60%
5.0%	60%	3.6M	22.3	18.60%	65.30%	41.10%	94.40%
5.0%	70%	4.4M	20.7	13.80%	63.60%	37.90%	94.40%
5.0%	80%	5.1M	20	9.30%	62.40%	35.10%	92.60%
5.0%	90%	5.7M	19.8	5.20%	60.50%	32.50%	90.70%

FIGURE 26

Prime Harvesting results for varying withdrawal rates and stock percentages.

Withdraw Rate	Stock	Average Remaining	Average Year of Failure	Lowest-Bond Average	Highest-Bond Average	Bond Average	Success Rate
4.0%	10%	0.7M	27	49.50%	92.70%	80.70%	53.70%
4.0%	20%	1.5M	29	37.30%	83.30%	70.90%	98.10%
4.0%	30%	2.6M	NA	42.10%	75.40%	63.60%	100.00%
4.0%	40%	3.9M	NA	37.30%	66.40%	55.10%	100.00%
4.0%	50%	5.6M	NA	30.30%	55.70%	45.50%	100.00%
4.0%	60%	7.7M	NA	22.50%	43.90%	35.70%	100.00%
4.0%	70%	10.0M	NA	15.00%	32.50%	25.60%	100.00%
4.0%	80%	12.6M	NA	7.80%	20.50%	15.80%	100.00%
4.0%	90%	15.4M	26	2.10%	9.10%	6.50%	96.30%
4.5%	10%	0.4M	24.2	62.10%	93.20%	78.70%	25.90%
4.5%	20%	0.8M	27.7	32.90%	84.30%	65.50%	53.70%
4.5%	30%	1.6M	28	28.70%	74.40%	58.30%	90.70%
4.5%	40%	2.8M	29	31.00%	65.40%	50.80%	98.10%
4.5%	50%	4.3M	30	26.90%	54.80%	42.70%	98.10%
4.5%	60%	6.2M	27	20.40%	43.20%	33.50%	98.10%
4.5%	70%	8.4M	25.5	13.40%	32.00%	24.20%	96.30%
4.5%	80%	10.8M	22	7.00%	20.00%	14.80%	96.30%
4.5%	90%	13.3M	20	1.80%	8.80%	6.00%	94.40%
5.0%	10%	0.2M	21.9	48.30%	93.00%	78.20%	18.50%
5.0%	20%	0.4M	24.9	43.30%	86.20%	63.00%	25.90%
5.0%	30%	0.9M	26.5	24.60%	74.60%	52.90%	61.10%
5.0%	40%	1.9M	25.9	28.10%	65.10%	46.70%	85.20%
5.0%	50%	3.2M	24.3	24.00%	54.50%	39.20%	92.60%
5.0%	60%	4.9M	22.3	18.50%	42.90%	31.20%	94.40%
5.0%	70%	6.9M	20.3	11.80%	31.20%	22.40%	94.40%
5.0%	80%	9.1M	19.8	6.30%	19.30%	13.70%	92.60%
5.0%	90%	11.3M	20.2	1.60%	8.50%	5.50%	88.90%

FIGURE 27

Alternate-Prime Harvesting results for varying withdrawal rates and stock percentages.

Alternate-Prime always outperformed annual rebalancing. Prime Harvesting always outperformed annual rebalancing during difficult retirement periods, but underperformed in the 1950s when MSWR values were above 6% and performance mattered less for hedging risk.

Based on this US data, Alternate-Prime outpaces Prime Harvesting, but additional data will also show Prime Harvesting is ultimately a little safer than Alternate-Prime. This extra margin of safety comes from sacrificing return during peak stock performance to build up a larger bond reserve. Further analysis will show Prime Harvesting to be the overall top performer.

Prime Harvesting can sometimes have a seemingly undesirable side effect: during long periods of low stock returns, bond levels can go below their preferred limits because they are continuing to fund withdrawals with no stock sells to replenish them. Bond levels do not strongly correlate to systemic-withdrawal risk, but when maintained within preferred limits, they do generally reduce exposure to speculative risk. However, Prime Harvesting has a strong counterbalance to these occasional low bond levels — these periods correspond to attractive stock valuations. Discussed more in a later chapter, attractive stock valuations substantially reduce exposure to known risk. It's important to understand that growing stock percentages using Prime Harvesting is not an anomaly, but a response to the market, trying to minimize overall risk*. It's always important to understand that stocks are never purchased after retirement starts. Instead, bond attrition is the cause of a rising stock percentage.

Briefly mentioned before, it's worth noting that additional tests were run using Prime Harvesting to manage individual asset subclasses (e.g., small stocks, large value stocks) as opposed to stocks as a whole. Performance only improved a little. Although the data wasn't available to also test broader assets like US stocks, developed market stocks, and emerging market stocks, there appears to be significant latitude in the tracking. Further study (with more data) may show the extra complexity of finer tracking is worthwhile for some retirees; however, with the data in hand it's easier and reasonable to avoid the additional complexity.

Other Strategies Investigated But Not Included

Below are the more noteworthy additional strategies tested but not included in the survey.

- Variations of traditional rebalancing.
- More variations of bucket strategies.
- Rebalancing based on trailing real returns.
- Many combinations of strategies, combining the best features of each.

A Rising Glidepath strategy as outlined by Pfau and Kitces[20] was also preliminarily tested after this survey was complete (because of the media attention it received). While age-based strategies lower the stock percentage each successive retirement year, a Rising Glidepath strategy increases the stock percentage, depending on a variety of possible formulas. A Rising Glidepath strategy is generally much better than an age-based strategy. Pfau and Kitces point out, this is partly due to avoiding sequence-of-returns risk early in retirement, an interesting observation. Still, performance is ultimately limited because what is happening in the portfolio (or the market) is not factored in. A Rising Glidepath strategy showed a moderate improvement over traditional rebalancing for some realistic retirement cases when based on equivalent stock-bond averages, but this improvement was not consistent over broader testing. When Rising Glidepath was started with the same initial stock percentage as annual rebalancing but then moved upward each year (e.g., starting

* OmegaNot's low bond average has this same compensating counterbalance, but it's a matter of degree — its bond average is significantly lower than Prime Harvesting's.

at 60% and moving to 89% over 30 years), it did increase performance; however, much of this increase maps back to a higher average stock percentage. Overall, one might say, Rising Glidepath improves performance over annual rebalancing, but the variations tested did not perform at the level of the top harvesting strategies. One important takeaway of the Rising Glidepath paper is, we should not be fretting too much about a high stock percentage late in retirement.

Comparing the Strategies

This section has two goals: 1) comparing the surveyed strategies side by side to show relative performance; 2) exposing each strategy to a substantially broader set of data.

Coming back to the risk of a data-mining bias, it's only by testing with independent (out-of-sample) data can a mature assessment of a strategy's performance be made. So far, all the backtesting has been with the US SBBI data. Now, three other datasets will also be used:

1. Shiller's US data from 1871 to 2010 with a portfolio of S&P stocks (i.e., large stocks). Bonds are based on the US long interest rate (10-year treasury bonds).
2. United Kingdom data from 1923 to 2010 with a portfolio of the UK's total-market stocks. The UK's treasury bills are used for bonds.
3. Japan data from 1950 to 2010 with a portfolio of Japan's total-market stocks. Japan's treasury bills are used for bonds.

Also, bootstrapping will be used to add further diversity (explained in the previous chapter).

The goal is to find consistently strong performance under diverse circumstances. Prime Harvesting is not perfect, but it will be shown to generally meet this goal—certainly better than the alternatives.

Identifying the Top Performers

The primary unit of comparison is first MSWR-100%, documenting performance during the worst retirement period. MSWR-90% is shown next, providing a better view into more typical performance: the top 90% of the retirement periods. Next, bootstrapping results will be shown in a couple of different forms, testing success rates using fixed withdrawal amounts. Finally, a relative ranking of the strategies is shown, providing a succinct snapshot of performance across all the tests.

To start, Figure 28 shows a summary of MSWR-100% backtesting results using US SBBI data, with the default portfolio for 30-year retirements. Again, MSWR-100% corresponds to the worst-case historical scenario within the dataset. All the top performers sustain a 4.4% annual withdrawal rate while the other strategies support progressively lower rates from 4.1% down to 3.4%. Also significant are the bond averages. For example, Prime Harvesting across the 53 retirement periods maintains a bond average of 45.7%, but its average lowest bond percentage was 30.8% and its average for the highest bond percentage was 67.8%. For the top performing strategies, the bond average inversely correlates with the average remaining values at the end of retirement, ranging from Prime Harvesting's 4.7 million average-remaining value to Bonds-First's 12.1 million average-remaining value. One might expect the top strategies to have the most remaining funds at the end of retirement, but this usually isn't the case for a couple of reasons. The top performers support higher withdrawal rates, leaving less value at the end of retirement, but more significantly, the top performers favor lower risk over higher returns. (How to safely boost the assets remaining at the end of retirement is discussed later.)

United States SBBI Data 1928-2010	MSWR-100%	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
Prime	4.4	4.7M	20.8%	67.8%	45.7%
Alternate Prime	4.4	6.5M	20.6%	43.3%	33.9%
Parker	4.4	6.4M	24.5%	41.3%	36.2%
OmegaNot	4.4	8.3M	8.6%	43.1%	21.2%
Bonds-First	4.4	12.1M	0.0%	37.5%	7.1%
Three Buckets	4.1	7.6M	1.7%	67.5%	34.1%
Guyton	4.1	3.2M	27.3%	49.1%	35.3%
Weiss	4	7.5M	23.0%	40.0%	37.6%
Annual Rebalancing	4	6.6M	40.0%	40.0%	40.0%
ETBS	3.9	10.6M	3.3%	46.8%	22.4%
Age-120	3.8	4.7M	45.0%	74.0%	58.4%
Rational	3.7	14.3M	5.1%	23.0%	13.1%
GlidePath	3.7	3.3M	45.6%	100.0%	71.8%
Age-100	3.4	3.0M	65.0%	94.0%	78.4%

FIGURE 28

MSWR-100% comparison of income-harvesting strategies using US SBBI data from 1928 to 2010.

Figure 29 shows a summary of MSWR-100% backtesting results using the US Shiller data for large stocks. Parker's strategy is the top performer this time, with a MSWR-100% of 3.8%. Prime and Alternate-Prime strategies fall into third place, behind Parker and OmegaNot, but also behind Guyton and Annual Rebalancing.

United States Shiller Data 1871-2010	MSWR-100%	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
Parker	3.8	3.2M	24.6%	41.0%	39.9%
OmegaNot	3.7	4.1M	13.9%	44.5%	26.9%
Guyton	3.7	2.1M	28.1%	48.0%	36.7%
Annual Rebalancing	3.7	3.3M	40.0%	40.0%	40.0%
Prime	3.6	3.3M	21.6%	67.4%	47.0%
Alternate Prime	3.6	3.9M	20.4%	44.8%	34.4%
Bonds-First	3.6	5.6M	0.0%	37.9%	9.3%
Weiss	3.6	3.7M	20.3%	40.0%	35.9%
Age-120	3.6	2.5M	45.0%	74.0%	58.4%
Rational	3.5	5.5M	7.5%	23.9%	14.6%
GlidePath	3.4	2.1M	45.6%	100.0%	71.8%
ETBS	3.4	5.1M	2.4%	43.5%	20.4%
Age-100	3.3	1.8M	65.0%	94.0%	78.4%
Three Buckets	3.3	4.9M	1.5%	56.6%	28.4%

FIGURE 29

MSWR-100% comparison of income-harvesting strategies using US Shiller data from 1871 to 2010.

This is the type of data a researcher hates to see. It breaks an anticipated pattern and introduces ambiguities. It raises the question of a data-mining bias. Perhaps Prime Harvesting is a top performer only with the SBBI data. More data will overcome these concerns; however, this case stands as a reminder that any strategy can underperform

in the wrong market circumstances. This time, Prime Harvesting's and Alternate Prime's poor performance comes from one exceedingly poor retirement period starting in 1966, while invested only in US large stocks.

Looking further, every other metric using Shiller's data shows Prime Harvesting as the top performer, including every MSWR test (e.g., MSWR-95%, MSWR-80%, MSWR-50%), along with success rates from fixed rates withdrawals (4%, 4.5%, and 5%).

Two important points surface from backtesting the US Shiller data. First, picking an investment strategy is about probabilities: a strategy can never guarantee future performance. Second, the metric shapes the results—change the metric and you can change the results. Both points reinforce why a single test metric on a single dataset should not be considered a reliable indicator of future performance one way or another. Still, Prime Harvest did underperform in this case and this should be considered in the broader comparison.

Figure 30 shows a summary of the MSWR-100% backtesting results using United Kingdom data. OmegaNot outperforms all other strategies this time, with Prime, Alternate-Prime, and Bonds-First coming close. Parker's Strategy does significantly worse in this case. The age-based strategies do exceptionally poorly with the UK data. Annual rebalancing also performs surprisingly poorly.

United Kingdom 1923-2010	MSWR-100%	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
OmegaNot	3.8	8.1M	5.9%	45.4%	19.5%
Prime	3.7	6.6M	11.2%	66.7%	37.5%
Alternate Prime	3.7	7.7M	10.4%	51.7%	31.1%
Bonds-First	3.7	10.6M	0.0%	38.1%	7.9%
Weiss	3.4	10.3M	12.5%	40.0%	34.6%
Parker	3.2	8.0M	26.9%	49.8%	42.4%
Guyton	3.2	4.5M	26.7%	53.1%	36.1%
Rational	3.1	13.9M	6.6%	22.0%	13.8%
ETBS	3.1	12.3M	1.6%	40.0%	18.6%
Three Buckets	3.1	10.1M	1.4%	55.9%	27.6%
Annual Rebalancing	3	10.5M	40.0%	40.0%	40.0%
Age-120	2.6	8.8M	45.0%	74.0%	58.4%
GlidePath	2.4	6.9M	45.6%	100.0%	71.8%
Age-100	2.2	6.2M	65.0%	94.0%	78.4%

FIGURE 30

MSWR-100% comparison of income-harvesting strategies using UK data from 1923 to 2010.

Figure 31 shows a summary of the MSWR-100% backtesting results using the Japan data. Surprisingly, the Three-Bucket strategy comes in well ahead of the other strategies—an anomaly* due to Japan's specific market conditions. Prime and Alternate-Prime are the next top performers, significantly ahead of the others.

* Some but not all of this high performance for the Three-Bucket Strategy with Japanese data is due to simulating bucket 2 returns (i.e., T-bill rate plus 3%). Using the Japanese T-bill rate instead for the second bucket resulted in 3.8% MSWR-100%—still in first place with Prime Harvesting but no longer outstanding.

Japan 1950-2010	MSWR-100%	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
Three Buckets	4.3	5.6M	2.2%	65.5%	36.4%
Prime	3.8	6.2M	24.8%	76.4%	53.5%
Alternate Prime	3.8	10.6M	24.9%	45.5%	36.8%
OmegaNot	3.5	16.1M	9.2%	40.3%	23.4%
Bonds-First	3.5	21.5M	0.0%	35.7%	7.4%
Weiss	3.4	11.3M	27.5%	40.0%	37.7%
Guyton	3.3	3.3M	22.3%	50.5%	37.3%
ETBS	3.3	21.1M	1.6%	34.8%	15.4%
Annual Rebalancing	3.3	11.2M	40.0%	40.0%	40.0%
Parker	3.2	9.6M	29.6%	56.2%	46.4%
Age-120	3.1	7.4M	45.0%	74.0%	58.4%
GlidePath	3.1	4.6M	45.6%	100.0%	71.8%
Rational	3	27.3M	2.8%	15.7%	8.6%
Age-100	3	3.5M	65.0%	94.0%	78.4%

FIGURE 31

MSWR-100% comparison of income-harvesting strategies using Japan data from 1950 to 2010.

Up until this point, all the comparisons have been using MSWR-100%, which captures behavior for each dataset's worst retirement period. While Prime and Alternate-Prime's performance has been strong, neither has been outstanding for MSWR-100%.

Figure 32 shows MSWR-90% for the same four datasets, capturing more common retirement cases (i.e., top 90%). Prime is a top performer in every case, and Alternate-Prime second in every case but one—both strategies start to stand out as the tests are broadened.

	US SBBI	US Shiller	UK	Japan
Prime	5.2	4.5	4.2	5.6
Alternate Prime	5.2	4.5	4.2	5.5
Parker	5.1	4.3	3.9	4.8
OmegaNot	5.2	4.4	4.2	5.2
Bonds-First	5	4.4	4.2	5.2
Weiss	4.9	4.4	4.1	5
Guyton	4.9	4.4	3.8	4.8
Rational	4.6	4.3	3.8	4.9
ETBS	4.5	3.9	3.5	4.4
Annual Rebalancing	4.7	4.3	3.8	4.6
Three Buckets	4.5	3.9	3.5	4.6
Age-120	4.5	4.1	3.4	4.2
GlidePath	4.2	3.9	3	3.8
Age-100	3.9	3.8	2.6	3.6

FIGURE 32

Combined MSWR-90% for US, UK, and Japan datasets.

Given its prominence as a research method, bootstrapping results are shown next. As previously outlined, bootstrapping randomly resamples the data (i.e., the SBBI data) in different sequences to produce many new sets of market data. Given that the same data can be resampled multiple times in a single simulation, the overall return and volatility characteristics vary substantially when a large number of simulations are performed. This extreme diversity adds a new dimension to the testing, although reordering the data also filters out return disposition (e.g., momentum, valuation effects) and in effect reduces the performance difference between strategies.

Figure 33 shows the average success rate for backtesting 5000 simulated markets using bootstrapping. The resampled data is narrowed down to only include annualized total-market returns between 3% and 10% over the complete dataset to keep the tests somewhat realistic. The success rate is shown this time, as opposed to MSWR-100%, only because it's faster and easier to calculate during bootstrapping simulations. Keep in mind that, because of the nature of the test, including a quarter million individual retirement periods with semi-random data, small percentage differences are more significant. Prime Harvesting is the top performer.

	Success Rate	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
Prime	86.01%	3.7M	25%	72%	48%
Alternate Prime	85.46%	5.9M	23%	45%	34%
Parker	84.86%	5.8M	23%	47%	16%
Weiss	84.42%	5.7M	23%	40%	37%
OmegaNot	84.15%	8.1M	10%	43%	24%
Annual Rebalancing	83.64%	5.4M	40%	40%	40%
Guyton	83.55%	2.1M	24%	50%	36%
Age-120	82.20%	3.3M	45%	74%	58%
Three Buckets	81.00%	6.2M	2%	70%	43%
Rational	80.47%	10.8M	6%	27%	17%
Bonds-First	80.46%	11.9M	0%	36%	8%
GlidePath	78.40%	2.1M	46%	100%	71%
ETBS	78.36%	8.1M	4%	52%	32%
Age-100	76.30%	1.4M	65%	94%	78%

FIGURE 33

Bootstrapping simulation (i.e., resampling with replacement) for 5000 random markets using a 4.5% inflation-adjusted withdrawal rate.

Simple-block bootstrapping helps to partially preserve return disposition by randomly rearranging the return data only in 5-year blocks (e.g., 1928 to 1932).

Figure 34 and Figure 35 show the results using simple-block bootstrapping to simulate 1000 different markets, then averaging the backtesting results using a 4.5% and 5% fixed withdrawal rate respectively.

	Success Rate	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
OmegaNot	97.92%	9.3M	9%	42%	21%
Prime	97.85%	4.7M	23%	69%	46%
Alternate Prime	97.82%	6.7M	22%	43%	34%
Bonds-First	96.92%	13.8M	0%	38%	7%
Weiss	95.71%	6.2M	26%	40%	38%
Parker	95.60%	6.7M	23%	43%	37%
Guyton	94.86%	2.7M	26%	49%	35%
Annual Rebalancing	93.65%	5.7M	40%	40%	40%
Three Buckets	93.42%	6.0M	2%	72%	41%
Rational	90.50%	12.0M	7%	28%	17%
ETBS	90.08%	8.1M	5%	50%	30%
Age-120	89.99%	3.3M	45%	74%	58%
GlidePath	82.80%	2.0M	46%	100%	71%
Age-100	71.46%	1.1M	65%	94%	78%

FIGURE 34

Simple-block bootstrapping simulation for 1000 markets using a 4.5% inflation-adjusted withdrawal rate.

	Success Rate	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
Prime	91.83%	3.7M	21%	64%	43%
Alternate Prime	91.82%	5.3M	21%	42%	32%
OmegaNot	91.32%	7.5M	9%	41%	21%
Bonds-First	89.87%	11.8M	0%	37%	6%
Weiss	88.55%	4.7M	27%	40%	38%
Parker	87.60%	5.6M	20%	39%	34%
Guyton	86.36%	2.2M	24%	46%	33%
Annual Rebalancing	84.97%	4.3M	40%	40%	40%
Rational	82.60%	9.3M	7%	31%	19%
ETBS	77.33%	4.9M	9%	58%	39%
Age-120	76.69%	2.3M	45%	74%	58%
Three Buckets	70.81%	2.9M	2%	82%	52%
GlidePath	65.10%	1.3M	46%	100%	70%
Age-100	43.50%	0.6M	65%	94%	77%

FIGURE 35

Simple-block bootstrapping simulation for 1000 markets using a 5% inflation-adjusted withdrawal rate.

Figure 36 shows simple-block bootstrapping again using a 4.5% withdrawal rate, but for a 40-year retirement (as opposed to the default 30-years).

	Success Rate	Average Remaining	Lowest-Bond Average	Highest-Bond Average	Bond Average
Alternate Prime	88.42%	11.4M	22%	43%	33%
Prime	88.27%	6.1M	23%	70%	45%
OmegaNot	87.77%	19.6M	7%	42%	17%
Bonds-First	86.65%	35.0M	0%	37%	5%
Weiss	83.03%	9.7M	30%	40%	38%
Parker	82.42%	12.5M	21%	46%	34%
Rational	78.15%	27.0M	5%	28%	17%
Annual Rebalancing	77.09%	9.0M	40%	40%	40%
Guyton	76.49%	2.9M	23%	49%	33%
Age-120	71.75%	6.1M	35%	74%	53%
ETBS	67.45%	12.3M	7%	53%	36%
GlidePath	63.41%	3.4M	35%	100%	61%
Three Buckets	53.03%	6.1M	1%	79%	49%
Age-100	29.95%	0.5M	55%	94%	71%

FIGURE 36

Simple-block bootstrapping simulation for 1000 markets using a 5% inflation-adjusted withdrawal rate for 40-year retirement.

Prime Harvesting, Alternate-Prime, and OmegaNot are consistently the top performers across these tests. However, so much data with varying results can be hard to assimilate. A clearer pattern can be seen by stepping back to focus on the relative rank of the strategies across the results.

Figure 37 shows the relative rank of all the strategies across all the tests plus MSWR-80% and MSWR-50%. The top three rankings are highlighted for each case to form a clearer visual picture. A rank of "1" indicates a strategy is a top performer for the case (or tied for it); a rank of "2" indicates a second place ranking, and so on.

	US SBBI MSWR				**US Shiller** MSWR				**UK** MSWR				**Japan** MSWR				**Bootstrapping** Success Rate			
	100%	90%	80%	50%	100%	90%	80%	50%	100%	90%	80%	50%	100%	90%	80%	50%	Test 1	Test 2	Test 3	Test 4
Prime	1	1	2	3	3	1	1	1	2	1	1	2	2	1	1	2	1	2	1	2
Alternate Prime	1	1	1	3	3	1	1	1	2	1	1	1	2	2	2	2	2	3	2	1
Parker	1	2	3	4	1	3	2	2	4	3	2	3	6	6	5	4	3	6	6	6
OmegaNot	1	1	3	2	2	2	1	1	1	1	1	2	3	3	3	3	5	1	3	3
Bonds-First	1	3	4	1	3	2	2	1	2	1	2	2	3	3	2	1	11	4	4	4
Three Buckets	2	7	8	10	6	5	5	8	5	5	6	6	1	7	9	8	9	9	12	13
Guyton	2	4	5	6	2	2	2	5	4	4	3	5	5	6	6	5	7	7	7	9
Weiss	3	4	4	5	3	2	2	4	3	2	2	4	4	4	4	5	4	5	5	5
Annual Rebalancing	3	5	6	7	2	3	3	5	6	4	3	5	5	7	7	5	6	8	8	8
ETBS	4	7	7	9	5	5	5	6	5	5	4	6	5	6	8	7	13	11	10	11
Age-120	5	7	8	8	3	4	4	7	7	6	5	7	7	8	10	6	8	12	11	10
Rational	6	6	6	6	4	3	2	3	5	4	3	4	5	5	4	4	10	10	9	7
GlidePath	6	8	9	11	5	5	6	8	8	7	7	8	7	9	11	9	12	13	13	12
Age-100	7	9	10	12	6	6	7	9	9	8	8	9	8	10	12	10	14	14	14	14

FIGURE 37

Summary of relative ranking of income-harvesting strategies.

Prime Harvesting and Alternate-Prime Harvesting are the most consistent strategies, usually ranking in the first or second position and always in the top three ranks. No other strategies are consistently in the top three ranks. OmegaNot and Weiss' strategy are always in the top 5 ranks. Parker's strategy is always in the top 6 ranks. All the other strategies including annual rebalancing come in considerably behind.

Considering Different Asset Allocations

The emphasis so far has been on comparing strategies across multiple datasets. It's also important to ensure the top-performers work well across different asset allocations.

This section examines a variety of allocations, with a narrower focus on the top performers: Prime Harvesting and Alternate-Prime. Annual rebalancing is included as the baseline as well as Parker's strategy as another alternative for comparison.

The next few figures compare performance using 5000 randomly generated portfolios. The portfolios are formed from the US SBBI dataset, since it breaks down asset returns. The stock percentage is randomly varied from 25% to 75%, with the balance going into bonds. The stock allocation is divided into 10% portions and randomly allocated to each of the asset classes (e.g., small, large value) allowing duplicates (i.e., the same asset class can be randomly reselected more than once for an additional 10% allocation). This same approach is used for bonds: the allocation is divided into 10% portions and randomly allocated to the available bond categories with duplicates possible. (Appendix A shows all stock and bond categories.) This random selection creates a diverse set of 5000 portfolios.

Figure 38 compares Prime Harvesting's and annual rebalancing's backtesting results for the 5000 portfolios — each portfolio (along the x-axis) is backtested once with Prime Harvesting and once with annual rebalancing with both MSWR-100% results recorded (on the y-axis). So some sense can be made of the data, the results are sorted by Prime Harvesting's MSWR-100% values, descending from 5.7% down to 3.1%. For example, for the portfolio numbers around 1000 (on the horizontal axis), Prime Harvesting's MSWR-100% values are all at 4.5%, and annual rebalancing's MSWR-100% values for the same set of portfolios ranging from 4.2% down to 3.7%, with most results coming in around 4%. (Each small point, representing one of the 5000 portfolios' MSWR-100% values, is displayed with an element of transparency, so darker points represent a higher number of clustered results around a specific value.)

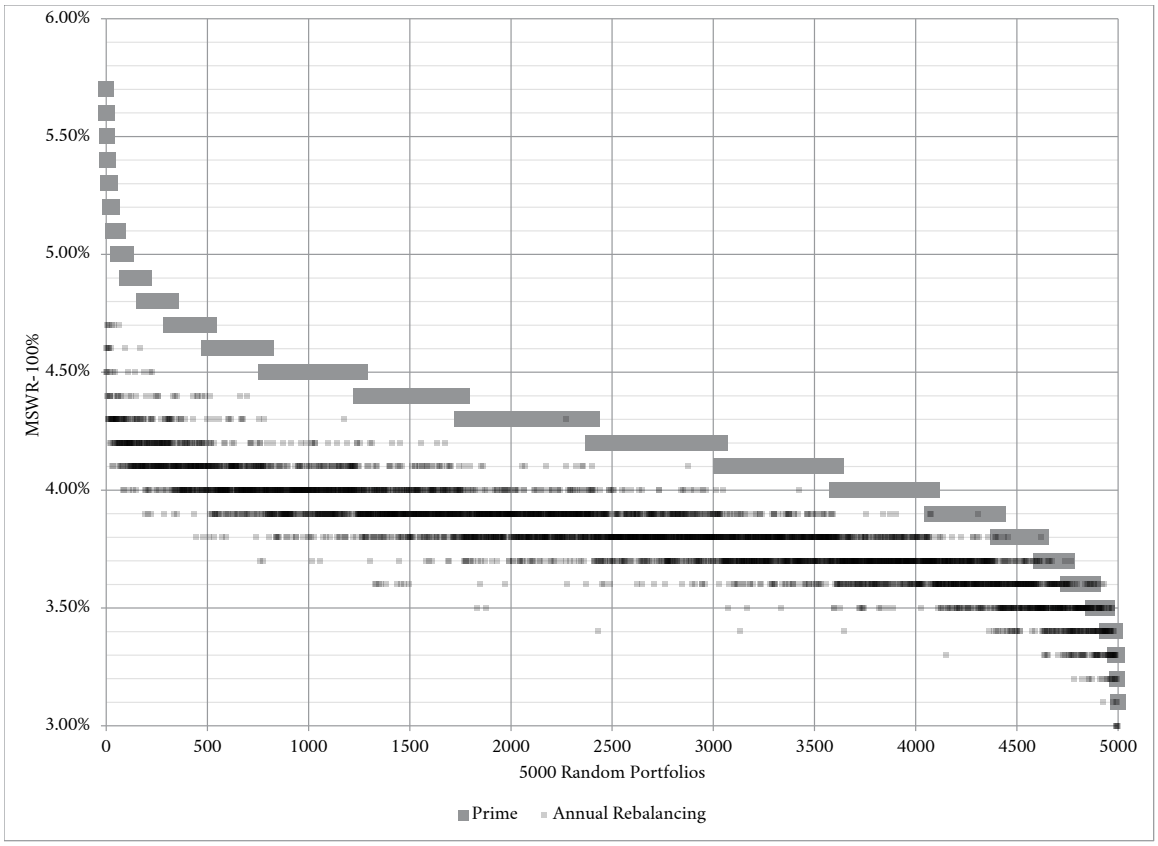

FIGURE 38

Prime Harvesting versus annual rebalancing backtesting performance for 5000 random portfolios.

What does Figure 38 show? Prime Harvesting performs significantly better (i.e., a higher MSWR-100%) than annual rebalancing for virtually all the 5000 retirement portfolios. Only in rare cases for the poorest portfolios did annual rebalancing beat Prime Harvesting (this can only be seen in the raw data). Specifically, annual rebalancing beat Prime Harvesting only 12 times out of the 5000 portfolios, each with very poor retirement portfolios (at the far right-end of the figure) that should not be used.

Figure 39 compares Prime Harvesting's and Parker's backtesting results for the same 5000 portfolios. Prime Harvesting's results are again the stronger of the two. Prime Harvesting comes out ahead of Parker's strategy approximately 50% of the time, ties around 30% of the time, and comes out behind 20% of the time. As seen with annual rebalancing, Prime Harvesting's relative performance drops for the poorer portfolios. Also notable, when Prime Harvesting comes out behind, it's usually close.

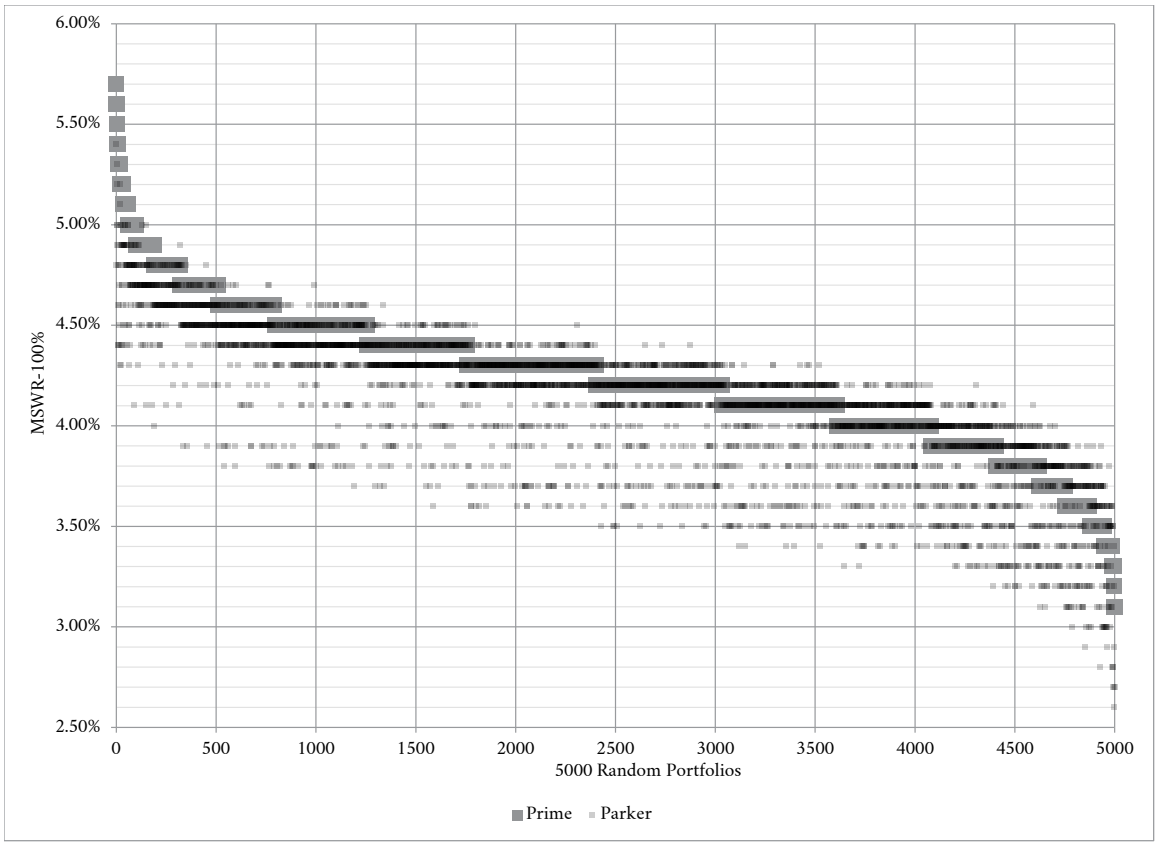

FIGURE 39

Prime Harvesting versus the Parker Strategy for 5000 random portfolios.

Figure 40 compares Prime Harvesting's and Alternate-Prime-Harvesting's backtesting results for the same 5000 portfolios. Again, Prime Harvesting is the top performer, but this time the results are much closer. For 86% of the cases, the strategies have the same results; 10% of the time Prime Harvesting wins (usually by 0.1%); 4% of the time Alternate-Prime Harvesting wins. The closeness illustrates why Alternate-Prime Harvesting is a viable alternative for gaining extra income for a small amount of additional risk; however, under extreme market conditions Prime Harvesting could perform significantly better.

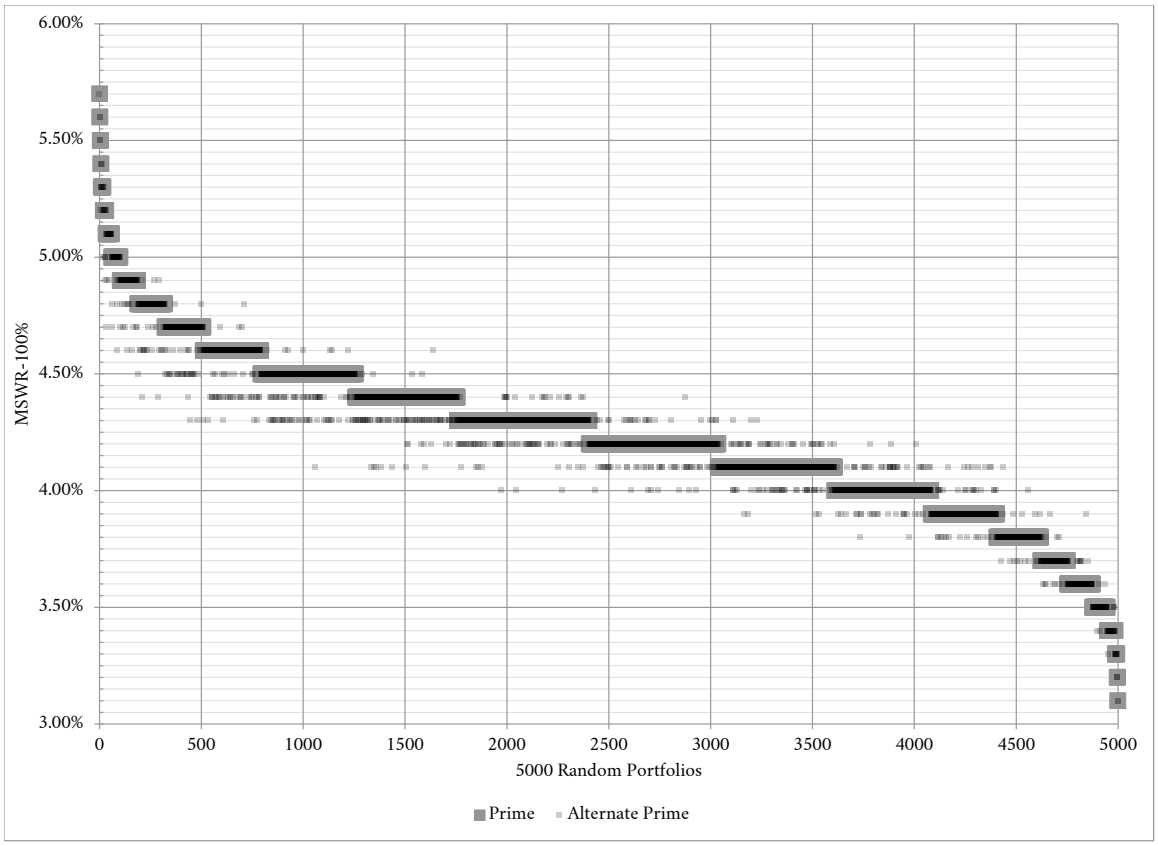

FIGURE 40

Prime Harvesting versus Alternate-Prime for 5000 random portfolios.

Not shown are the same comparisons using OmegaNot and Bonds-First. OmegaNot performs very well across different allocations, coming in very close to Prime Harvesting. Bonds-First also does very well in comparison, but weaker than OmegaNot. Again, the main reason OmegaNot and Bonds-First are not viable contenders is their lower average bond percentages compared to Prime Harvesting.

For one last look at asset allocation, Figure 41 again compares Prime Harvesting to annual rebalancing using the 5000 portfolio, but this time MSWR-90% is shown (as opposed to MSWR-100%). This graph shows that, for the more common cases (as opposed to the worst-case) the disparity in performance grows even larger, with Prime Harvesting doing substantially better.

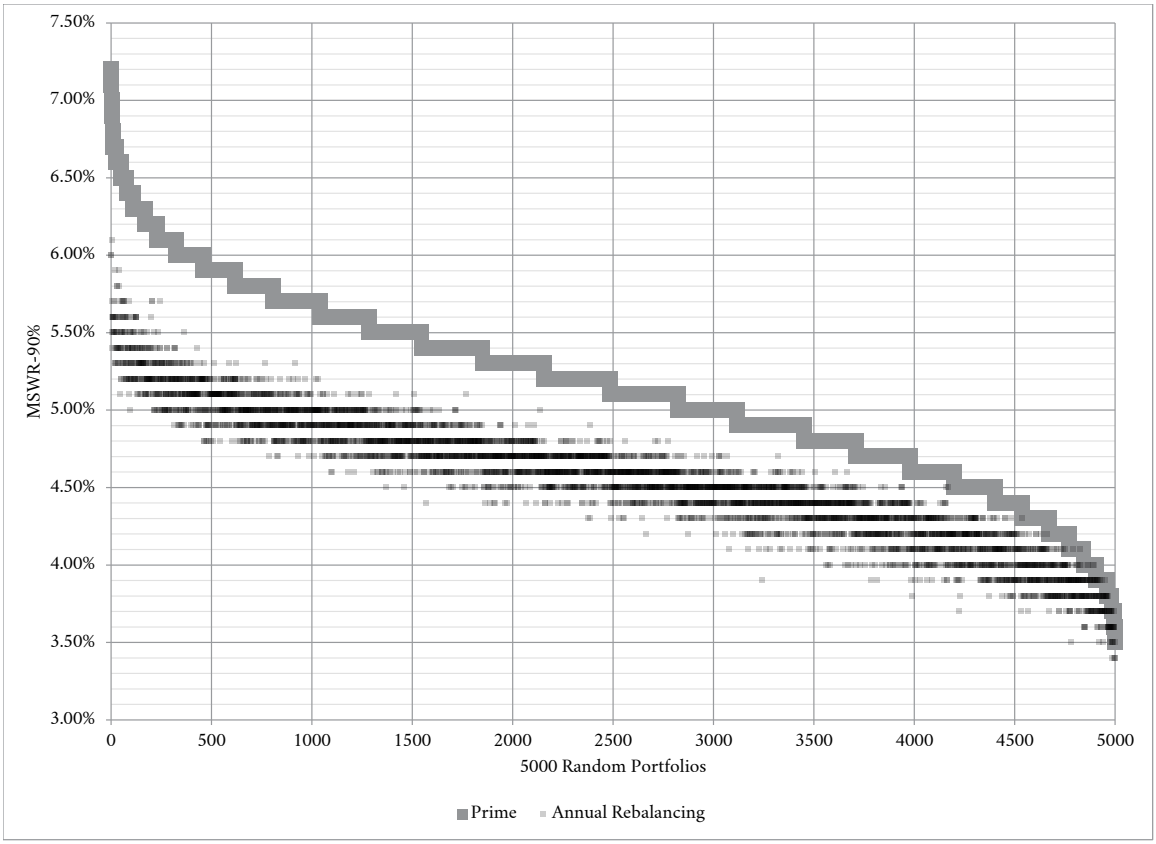

FIGURE 41

MSWR-90% for Prime Harvesting versus annual rebalancing for 5000 random portfolios.

A Closer Look at Bond Levels

The previous sections establish Prime Harvesting as the top income-harvesting strategy; however, it's important for the retiree to clearly understand and accept there's a possibly of a wide range of stock and bond percentages during a "normal" 30-year retirement.

Figure 42 compares the 30-year average bond percentage for Prime, Alternate-Prime, Parker, and annual rebalancing strategies using a 5% withdrawal rate with the SBBI dataset. For example, the average bond percentage using Prime Harvesting for the 30-year retirement period starting in 1935 is 48%; for the retirement period starting in 1955 is 44%; for the retirement period starting in 1968 is a mere 8%.

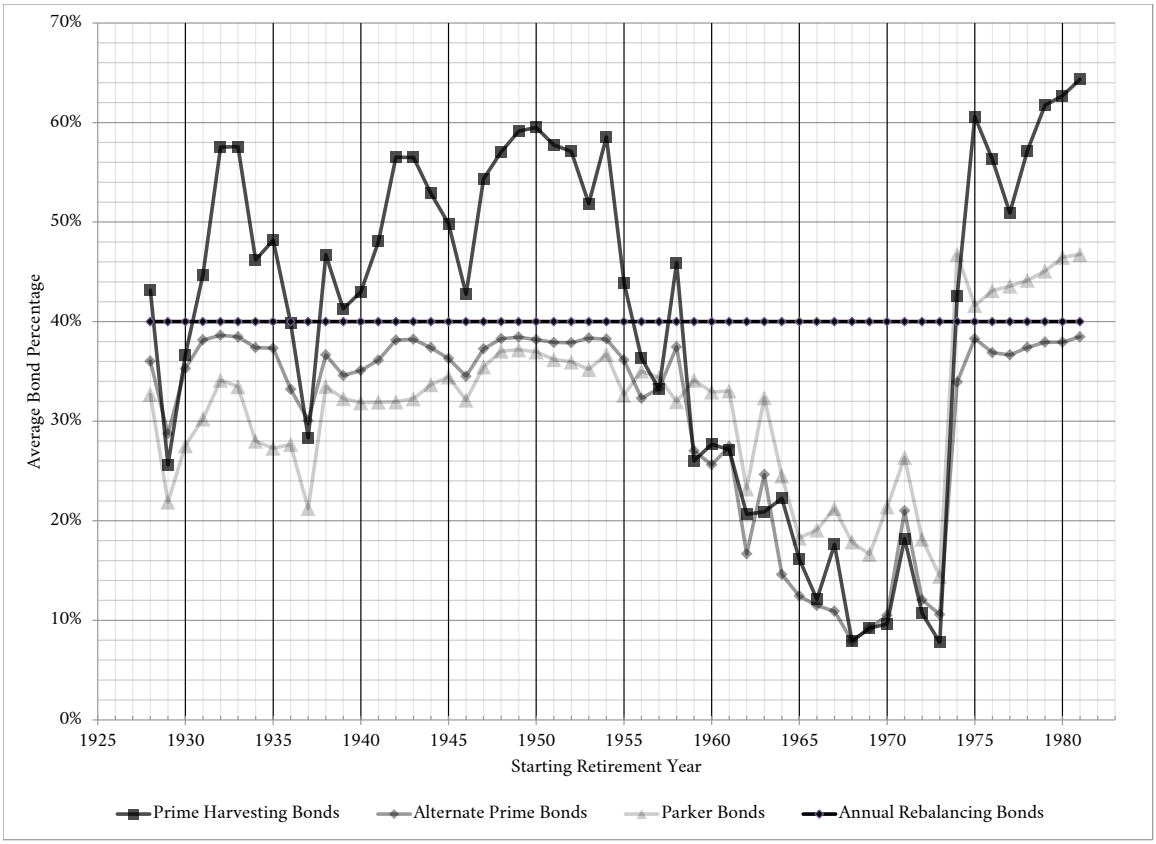

FIGURE 42

Average bond percentage at 5% withdrawal rate.

The low bond averages extend through the difficult retirement periods from the late 1960s to the early 1970s; during these difficult times the strategies were essentially waiting for stock prices to recover before selling to rebalance to a lower stock level. It's interesting and reassuring that during this period (when the stock percentages where very high) the corresponding stock valuations were very attractive. Generally when Prime Harvesting is heavy with stocks, prices are depressed. This makes the risk of further loss lower and the probability of strong stock returns higher. *Remember, Prime Harvesting never buys additional stock after retirement starts—high stock percentages can occur only when bonds are being sold to insulate stocks.*

This variation in the stock-bond ratio will make some retirees uncomfortable. Nevertheless, this exact behavior lowers risk. This isn't just true for Prime Harvesting; it applies to OmegaNot, Parker's Strategy, Weiss' strategy, and others. Backtesting clearly shows that eliminating this occasional tilt toward a high stock percentage *increases* known risk. If a retiree chooses to hedge speculative risk, generally the best approach is supplementing systemic withdrawal with guaranteed income, not by tweaking Prime Harvesting.

With these large variations in the stock-bond ratio, it's interesting to examining how much of an income-harvesting strategy's performance might be due simply to the average stock or bond level.

To consider this, each of the strategies is configured to produce the same bond average, approximately 40%. For most strategies, a 40% average in bonds is obtained by setting the starting stock-bond ratio, but for some an alternate approach is required: instead of 100-Age or 120-Age, 137-Age must be used to achieve a 40% bond

average; Glidepath's starting retirement age must be 45; Rational must use 9 years for the targeted time in bonds; Three-Buckets must use 5.7 years as the bucket size in years.

Figure 43 shows the SBBI results with a 5% withdrawal rate when all strategies are configured to have near a 40% bond average. For some strategies, there is little change in performance, for others there is a large change. Notably, Prime Harvesting, Alternate-Prime, and Parker continue as the top performers. In contrast, Bonds-First with its simplistic strategy has a large drop in performance. OmegaNot's performance drops some. The implication is, some strategies perform well primarily due to the stock-bond ratio they maintain, while for others it's more due to their overall strategy. The top-performing strategies all fit in the latter category, with behavior due to more than raw stock percentages. Ultimately, the top-performing strategies are smarter, delivering more income per unit of volatility.

Equalized Bonds United States SBBI Data 1928-2010	Success Rate	Initial Stock Allocation	Average Remaining	Average Year of Failure	Lowest Bond Average	Highest Bond Average	Bond Average
Prime	94.4%	64%	3.9M	21.7	17%	65%	40%
Alternate-Prime	92.6%	49%	3.1M	24.3	25%	56%	40%
Parker	92.6%	47%	3.3M	24.5	21%	46%	40%
Weiss	90.7%	56%	3.8M	23.6	27%	43%	40%
OmegaNot	87.0%	41%	2.3M	25.3	22%	66%	40%
Age-137	79.6%	NA	4.3M	23.7	28%	57%	41%
Guyton PMR	79.6%	53%	1.7M	25.5	31%	56%	41%
ETBS	79.6%	NA	4.0M	21.8	10%	63%	40%
Glidepath (Age: 45 to 74)	79.6%	13%	4.1M	23.4	26%	59%	41%
Annual Rebalancing	77.8%	60%	3.7M	25.5	40%	40%	40%
Rational (9-Year)	74.1%	NA	3.4M	22.9	21%	54%	41%
Three-Buckets (5.7 years)	70.4%	NA	4.4M	24.1	1%	66%	40%
Bonds-First	61.1%	13%	1.3M	23.2	2%	86%	39%

FIGURE 43

Results after normalizing bond averages for a 5% withdrawal rate.

A closer consideration of Prime Harvesting and Alternate-Prime make their bond-handling characteristics clear. Starting with Alternate-Prime, the more straightforward case, Figure 44 shows bond averages over 30-year retirements. These averages come from backtesting 100 randomly generated high-performing portfolios* over a range of starting stock percentages. For example, the figure shows that, with a starting bond percentage of 50%, the average bond percentage across all the backtested retirement periods for the 100 portfolios ranged from an average low of 34% to an average high of 56%, with an overall average of 46% in bonds.

* Five thousand random portfolios were generated with the top one hundred selected based on their performance.

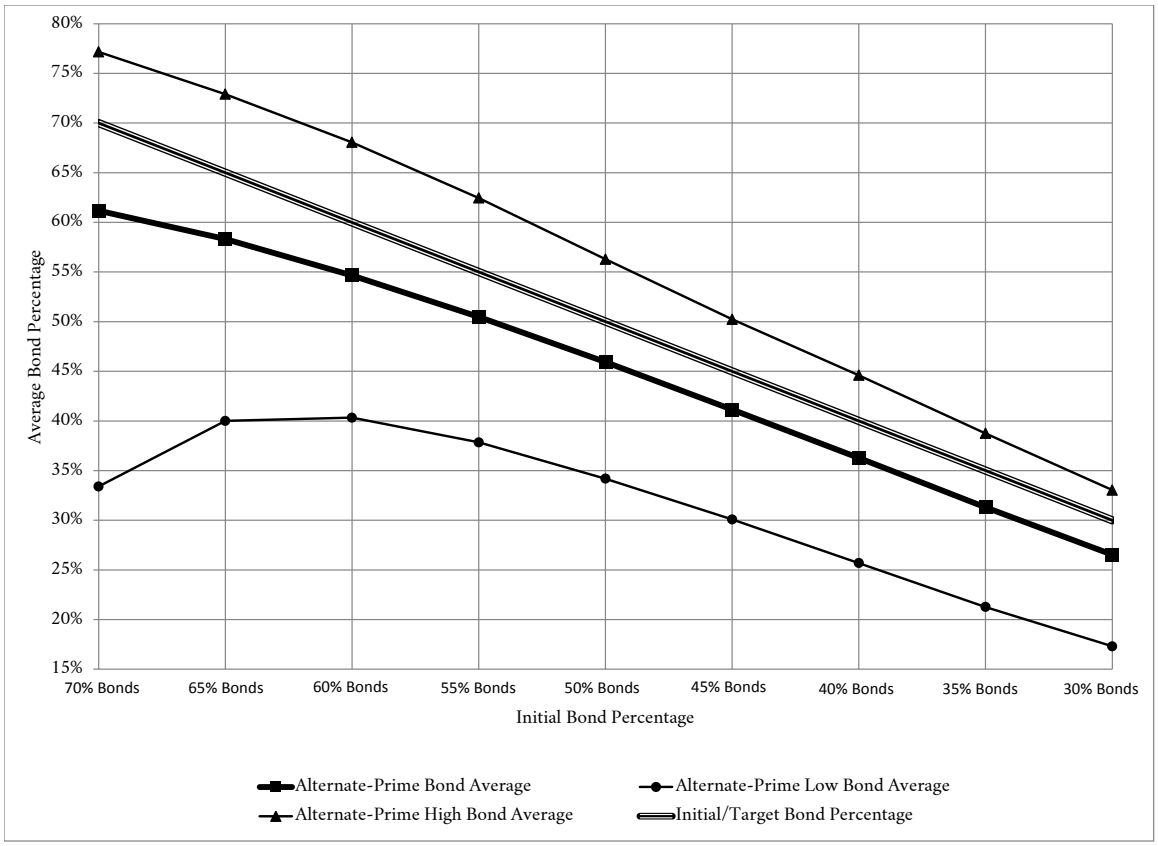

FIGURE 44

Alternate-Prime Harvesting bond averages for 100 top-performing portfolios.

For Prime Harvesting, Figure 45 shows the same results. With an initial bond percentage of 50%, the average bond percentage for 30-year retirements across the 100 portfolios ranged from an average low of 34% to an average high of 73%, with an overall average of 56% in bonds. Unlike Alternate-Prime, Prime Harvesting has no upper bound for bonds, allowing the bond percentage to continue upward as long as it's supported by sufficient stock growth.

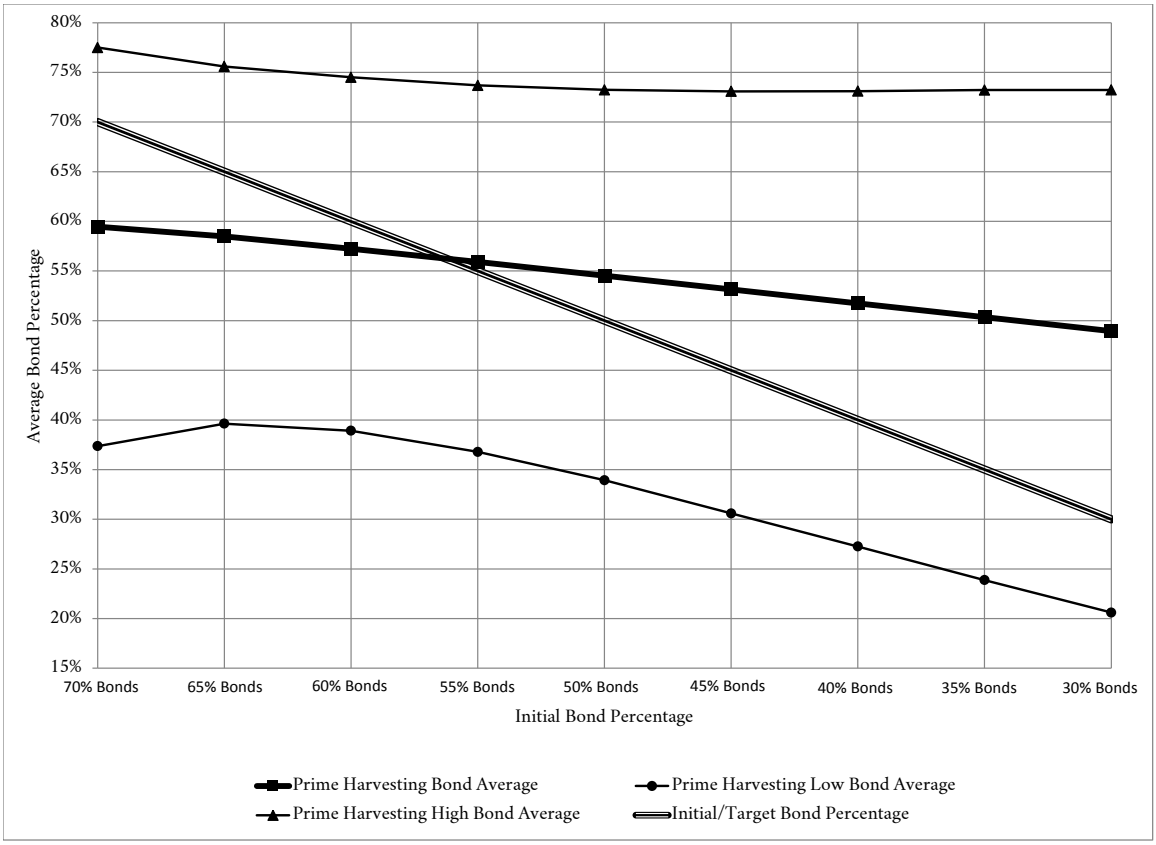

FIGURE 45

Prime Harvesting bond averages for 100 top-performing portfolios.

Although it's tidier and more comforting to have a fixed stock-bond ratio, it comes at a cost. The data indicates, allowing income-harvesting strategies to float the ratio produces a substantial income premium. If the stock returns are up, the bond percentage will typically rise as stock gains are locked in; if the stock returns are down, the bond percentage will typically reduce to insulate stocks. However, the average is still dependent on the initial rate. A higher initial withdrawal rate results in a higher stock average; likewise a lower initial rate results in a lower stock average.

Despite the data, retirees can still choose to maintain a bond floor, selling stocks as needed to maintain a minimum bonds percentage. Figure 46 shows this case: a 30% bond floor is enforced using Prime Harvesting with a 60% initial stock percentage. There is a moderate but consistent loss in income based on the SBBI data. While this is a viable option for retirees who are uncomfortable with a low bond percentage, it's important to understand that across four datasets (SBBI, Shiller, UK, Japan) this consistently *lowered* performance during difficult retirement periods. On the other hand, when combined with a variable-withdrawal strategy, the loss in income is divided across many years without a major impact—this is briefly revisited in Chapter 10. Bounding the lower bond level isn't recommended based on the data, but an otherwise strong retirement plan can handle it.

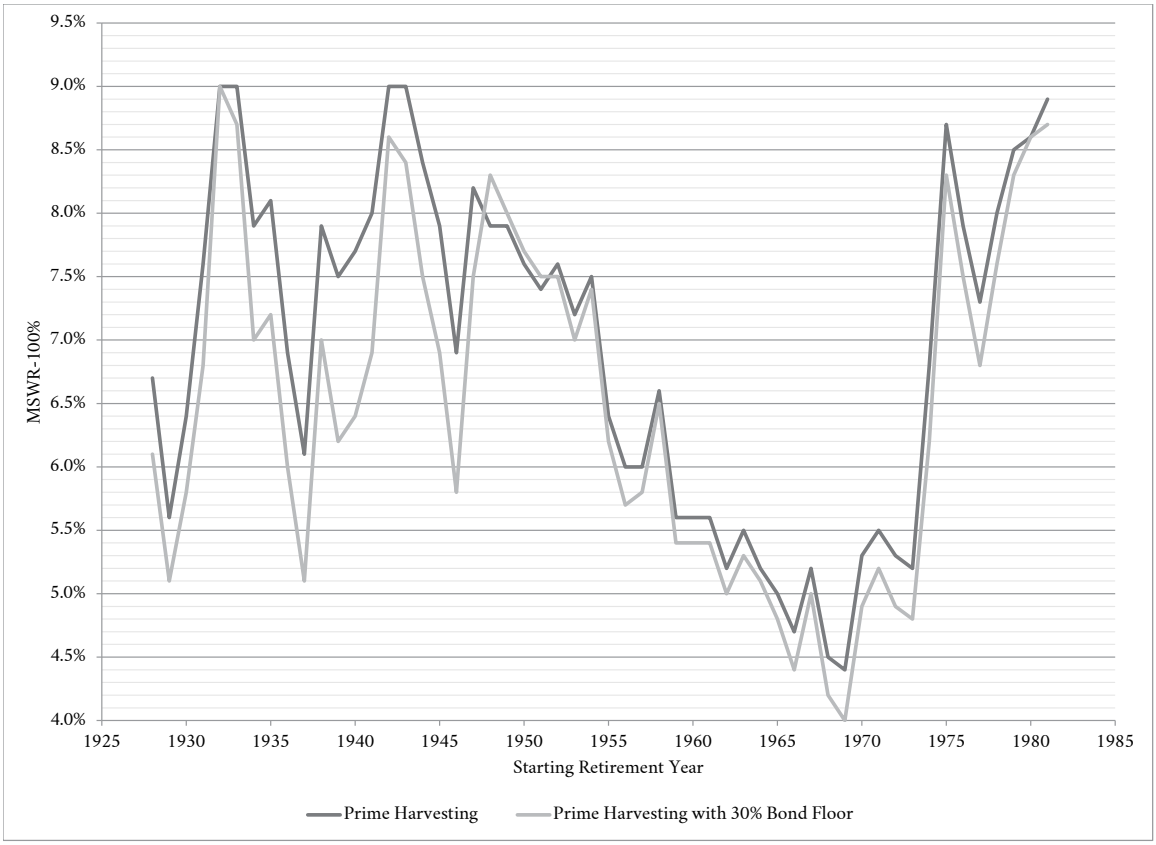

FIGURE 46

Prime Harvest comparison without and with 30% bond floor.

Valuation-Based Strategies

For completeness, it is worth briefly diverging to discuss valuation-based strategies. Valuation-based strategies are at the extreme end of the conventionality spectrum; however, they are commonly discussed in the literature and sometimes perform extremely well. These strategies dynamically adjust the stock-bond ratio based on market valuations. The exact parameters vary depending on the specific strategy, but the same basic formula usually applies: if stock valuations are attractive, increase the portfolio's stock allocation, but if stock valuations are unattractive, decrease the portfolio's stock allocation.

Given a philosophy of following the data wherever it leads, I spent an inordinate amount of time researching valuation-based strategies for this book, with the assumption that they would be included in this survey. Backtesting was done using multiple valuation metrics, including CAPE-10, Peak-PE, and the Q Ratio. These "enhanced" strategies were also combined with the conventional income-harvesting strategies to explore synergies. Overall, the results were promising, beating out all other strategies, although ultimately too problematic, and with a tendency to be misleading.

The fundamental problem for valuation-based strategies is that they can't meet the guidelines for evidence-based research. Sometimes this is due to a lack of data, sometimes it's due to a strategy's metrics require tuning across datasets (which leads to a data-mining bias), and sometimes to a set of specific red flags in the data. Generally the strategies have substantial evidence within the confines of the US historical data, but not enough for a global portfolio; however, it's not even clear if the evidence is sufficient for a US-only portfolio.

Their omission is in no way from the standpoint of purism…there is simply not enough data available to form a strategy that can be used without undue risk when compared to the alternatives. Good odds are not the same as safe odds.

For readers seeking more details, here's a brief rundown on some of the CAPE-10 issues encountered. Each valuation metric has its own specific problems, but this list is representative of problems across all the valuation-based income-harvesting strategies.

1. CAPE-10 strategies must be carefully tuned, which increases the risk of a data-mining bias. This might be okay if sufficient out-of-sample data were available for verification, but CAPE-10 long-term data is limited.
2. When CAPE-10 was tested with the UK data (the only other available dataset with long-term PE data) it did no better than Prime Harvesting for MSWR-100% and significantly poorer for MSWR-80%. The UK Price-Earnings data was for the FTSE-32 index, while the return data was for the full FTSE index, but a similar limitation did not degrade performance using US data (i.e., Shiller's PE values are used for the SBBI dataset).
3. Short-term studies in the literature indicate PE characteristics can shift between countries, adding to the overall challenge of ever having an out-of-sample test.
4. The most successful US strategies could not generally be applied in a small way for top performance. For example, a pure CAPE-10 strategy outperformed Prime Harvesting in the US, only using a 100% stock allocation for attractive valuations and less than a 20% stock allocation for unattractive valuations. Smaller tilts generally underperformed Prime Harvesting.
5. The 2000-era PE data is extreme, which skews the overall results when calibrating a strategy, plus it introduces questions about the stability of the metric. For example, performing a regression analysis on CAPE-10 to predict the supported withdrawal rate, a *negative* withdrawal rate was predicted for retirements starting around 2000.
6. The strategy can significantly raise taxes for retirement accounts that are not tax-advantaged.

Valuations are used elsewhere in this book, but in a limited fashion to roughly gauge long-term market performance. This limited use of valuations is fundamentally distinct from using an income-harvesting strategy to dynamically adjusting the year-to-year stock-bond ratio.

Recommendations with Concluding Thoughts

In light of the data, Prime Harvesting is the recommended income-harvesting strategy, with Alternate-Prime remaining an attractive alternative. Both strategies operate with any reasonable set of retirement parameters. Both strategies are also, for the most part, independent from the other retirement mechanics, although as the strategies of choice here they will be put to use throughout the rest of this book.

A few concluding thoughts will help fill in loose ends.

- There is nothing exceptional about waiting until stocks reach precisely 120% of their original inflation-adjusted value before rebalancing; however this specific trigger performs very well across a diverse range of market conditions. Rebalancing at 110% or 100% of the original stock value also works, although with a little poorer historical performance. The key, which is more difficult to find than one might expect, is to sell when stocks are up and to take advantage of market momentum.
- Some retirees might conclude, annual rebalancing is good enough because they plan on taking a lower than necessary withdrawal rate. After all, annual rebalancing had a 100% success rate for 4% annual withdrawals using the default portfolio with the SBBI data. There's a problem with this thinking though — the potential effects of speculative risk are unknown, in theory stressing any withdrawal rate. It's always safer to have an efficient income-harvesting strategy.
- Deploying Prime Harvesting should be independent of a retiree's risk tolerance. However, for those uncomfortable with a varying stock percentage (which is distinct from risk), an upper bound can be enforced as long as the withdrawal rate is lowered to compensate. It is worth noting though, a guaranteed-income solution as outlined in the final chapter of this book always provides a stronger hedge against speculative risk than suboptimally bounding the stock percentage.
- Alternate-Prime will usually outperform Prime Harvesting when valuations are attractive at the start of retirement. It's also fair to note, the same is probably true for OmegaNot and Bonds-First, although their exposure to speculative risk is higher. Valuation levels are defined and applied in Chapter 9; however, valuations certainly need not be considered to put Prime Harvesting to use.
- Very stable stock prices (i.e., low standard deviation) reduce the advantages of most harvesting strategies over traditional rebalancing, as does a very low stock percentage. At the far end, income-harvesting is not applicable to a portfolio of only bonds.
- Prime Harvesting and Alternate-Prime can both work well with bond ladders, because the assets allocated to bonds will never be later needed to buy stocks. Although this is not one of this book's recommendations, the tradeoffs are explored in Appendix B.
- Resiliency is an important characteristic not emphasized in the tables and graphs, but it can be attributed to all top-performing strategies including Prime Harvesting. Resiliency means a small change in parameters does not greatly affect the results. It also means results are generally strong across a variety of conditions. Finally, it means that results taper off slowly as conditions worsen, with no drastic drops in performance from small parameter changes.
- A smart harvesting strategy like Prime Harvesting provides a significant advantage when setting the initial stock percentage at the start of retirement. This is covered in Chapter 7.

A Prime Harvesting Example

An example below clarifies how to apply Prime Harvesting, although the spreadsheet from the book's website will perform the calculations. To recap, here are the Prime Harvesting steps:

1. If stock assets are greater than 120% of their initial value after annually adjusting for inflation, sell 20% of stocks to buy additional bonds.
2. Sell enough bond assets to fund the next withdrawal; if bonds are depleted, sell enough from stocks to cover the withdrawal.
3. Withdraw the annual living expenses from the portfolio's cash.
4. Buy and sell as needed to rebalance individual stock assets to their target stock values (without modifying the portfolio's stock percentage).
5. Buy and sell as needed to rebalance individual bond assets to their target bond values (without modifying the portfolio's bond percentage).

For the example, assume a retiree has a starting portfolio value of $500,000 and an initial withdrawal rate of 5%. Also, assume the portfolio is evenly split between 50% stocks and 50% bonds.

At the start of retirement, the following steps are taken.

a. Calculate the first year withdrawal: $500,000 * 5% = $25,000.
b. Withdraw (transfer to a bank or money market account) the $25,000, leaving a portfolio value of $475,000. Half of the portfolio ($237,500) is invested in stocks, and half in bonds.
c. Record the initial value of the stocks ($237,500).

After the first year, assume stocks have risen 10% to $261,250, bonds have risen 5% to $249,375, and inflation is 3%.

a. Adjust the withdrawal amount by inflation: $25,000 + ($25,000 * 3%) = $25,750.
b. Adjust the recorded initial value of stock by inflation: $237,500 + ($237,500 * 3%) = $244,625.
c. Check if stock value is greater than 120% of the initial stock value adjusted for inflation.

   120% of the initial stock value adjusted for inflation is 120% * $244,625 = $293,550. Therefore, the current stock value ($261,250) is not greater than the adjusted initial stock value ($293,550). This means, no stocks are sold to buy bonds this year.

d. Sell enough bonds to fund the next withdrawal of $25,750. The bond amount drops from $249,375 to $223,625 and the stock amount remains at $261,250.
e. $25,750 is transferred out of the portfolio for living expenses.
f. Individual stock assets are rebalanced to their target values within the current $261,250 stock allocation.
g. Individual bond assets are rebalanced to their target values within the current $223,625 bond allocation.

After the second year, assume stocks have risen 22% from $261,250 to $318,725, bonds have risen 4% from $223,625 to $232,570, and inflation is 4%.

a. Adjust the previous withdrawal amount by inflation: $25,750 + ($25,750 * 4%) = $26,780.

b. Adjust the recorded initial value of stock by inflation: $244,625 + ($244,625* 4%) = $254,410.

c. Check if stock value is great then 120% of the initial stock value adjusted for inflation.

   120% of the initial stock value adjusted for inflation is 120% * $254,410 = $305,292; therefore, the current stock value ($318,725) is greater than the adjusted initial stock value ($305,292), so 20% of stocks (i.e., 20% * $318,725) are sold to buy bonds this year.

   The stock value decreases to $254,980 and the bond value increases to $296,315.

d. Sell enough bonds to fund the next withdrawal of $26,780. The bond amount drops from $296,315 to $269,535 and the stock amount remains at $254,980.

e. $26,780 is transferred out of the portfolio for living expenses.

f. Individual stock assets are rebalanced to their target values within the current $254,980 stock allocation.

g. Individual bond assets are rebalanced to their target values within the current $269,535 bond allocation.

This same pattern continues after each year of retirement. The only difference from a real retirement scenario is that the annual withdrawal amount will be calculated by a separate variable-withdrawal strategy.

The Point

Prime Harvesting is the overall safest income-harvesting strategy identified, clearly performing substantially better than traditional rebalancing. Alternate-Prime Harvesting is a close second with a little more risk for higher income. These strategies perform well across different markets, portfolios, retirement lengths, and withdrawal rates.

This is the end of the preview version.

More about the book can be found on its website:
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