An Actuarial Perspective on Decumulation Risks: How to Utilize Home Equity to Mitigate Spike Expense

Authors: Peter Neuwirth FSA FCA, Barry Sacks PhD JD, Stephen Sacks PhD, Tim Genda PhD
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Abstract

Ensuring a lifetime of stable cash flow is one of the biggest challenges retirees, especially newly retired individuals, face. For most retirees, their source of income outside of Social Security (and for those lucky enough to have pensions) is a portfolio of stocks, bonds and other assets (such as their own home) – these items can be sold or borrowed against to cover living expenses in retirement. Unfortunately, most of these assets don't provide sufficient income streams, so some must be sold off each year, which leaves less income from the remaining assets. As such, it's critical that retirees develop a strategy that can ensure sufficient income that will last for the rest of their lives. This challenge is now typically referred to as the decumulation problem, which Nobel Prize winner William Sharpe called "the hardest, nastiest problem in finance."[1]

Retirees face the following risks, which were largely irrelevant during their working years, but are of paramount importance in the decumulation phase:

1. Longevity Risk: how long these assets must last;
2. Sequence of Returns Risk: the risk of having to sell assets at depressed values; and
3. Spike Expense Risk: the risk that unexpected cash flow needs may arise, which disrupts the orderly decumulation of assets – this risk, until now, has not been studied in detail.

We are all aware that life expectancies have increased over the last century, and despite a minor blip in the trajectory due to the COVID-19 pandemic, many actuaries and demographers believe that life expectancies will continue to increase.
Similarly, there have been several studies that demonstrate that a series of poor investment returns in the early part of retirement can be detrimental, forcing large quantities of assets to be sold off at lower values to meet expenses.

This article focuses on Spike Expense risk and considers the timing of these unexpected expenses, as there is an intrinsic co-dependency between the timing of the spike expenses and their impact on how many assets need to be sold to cover those expenses. Said another way, Spike Expense risk increases dramatically when asset values are depressed. In our research, we have gained a deeper understanding of Spike Expense Risk and the detrimental effects it can have on retirement security.

Specifically, we recognize that many retirees own their homes (and most of whom no longer have mortgages), so we have evaluated strategies and techniques that utilize home equity to mitigate the impact of both sequence of returns risk and spike expense risk, including a new strategy that proves superior under modeled conditions. This article concludes by suggesting future research directions aimed at integrating spike expense modeling into broader decumulation theory.

Theoretical Discussion of Decumulation Risks

Over the last 30 years, significant research has been done on strategies for distributing retirement income from securities portfolios—the "decumulation problem." The work began with William Bengen (1994), who developed and described the *Four Percent Rule*. This rule demonstrated that a withdrawal rate beginning at four percent of the initial portfolio value and continuing annually at the same dollar amount, adjusted for inflation, would ensure sustainable cash flow for a 30-year retirement. Bengen's conclusion was based on historical performance of balanced portfolios across every 30-year period between 1926 and 1993. Its continued use presumes that future capital market performance remains broadly consistent with this historical experience.

Subsequent studies refined Bengen's analysis to reflect evolving capital market assumptions (see, e.g., Finke, Pfau, & Blanchett, 2013; Pfau, 2014). However, most early research assumed retirement income depended solely on the securities portfolio, excluding non-portfolio assets such as home equity. Beginning in 2012, researchers introduced the concepts of "buffer assets" and "buckets" as well as "risk pooling" to mitigate decumulation risks (Sacks & Sacks, 2012; Salter, Pfeiffer, & Evensky, 2012; Pfau, 2016).

Over the past 20 years, researchers have further developed these approaches, integrating behavioral and psychological dimensions into decumulation planning (see for example Pfau & Murguía, 2021; Blanchett, 2014). Yet, with the exception of Steve Vernon FSA and Ken Steiner FSA, until very recently few have adopted explicitly actuarial models.

Steve Vernon and his collaborators at the Stanford Center on Longevity and the Society of Actuaries reframed retirement decumulation as an actuarial lifetime income problem focused on sustainable spending and real retirement decisions—such as when to retire, when to claim Social Security, how to draw income from savings, and how to manage spending levels, as well as whether and how to use home equity—rather than relying solely on static portfolio withdrawal rules—and how to balance annuitization and liquidity (Pfau, Tomlinson, & Vernon, 2017; 2019; Vernon, 2021).

In 2017 Ken Steiner introduced the *Actuarial Financial Planner*, a method for developing and managing retirement income strategies through an individual actuarial valuation of future liabilities versus available assets—yielding a "funded status" measure of retirement readiness. Steiner recommends periodic spending adjustments based on the retiree's surplus or shortfall, and in later work (Steiner, 2023), he extends this framework to discretionary spending decisions, suggesting setting aside a "rainy day fund" akin to "surplus assets" that Qualified DB pension plan sponsors have historically used to increase benefits to Plan participants (e.g. for Cost of Living Adjustments, enhanced early retirement subsidies etc.).

Building on these actuarial and behavioral foundations, more recent research has sought to formalize decumulation strategy selection through quantitative optimization. Avanzi and De Felice (2024) developed a *utility-based dynamic optimization framework* distinguishing retirees' appetites for liquidity risk and investment risk, showing that these differing preferences materially affect optimal drawdown and annuitization decisions, while Forsyth and Li (2025) proposed a *quantitative, risk-metric approach* using expected shortfall and ruin probability as optimization objectives for defined-contribution decumulation.

These two studies go beyond heuristic and behavioral methods and use mathematical models to integrate behavioral, actuarial, and probabilistic dimensions of retirement income risk.

Avanzi and De Felice, in particular, have defined the risks of decumulation in much the same way as they are described in this article. They consider Spike Expense to be a specific example of "liquidity risk" and Sequence of Returns Risk as a form of "portfolio risk" within the broad category of "investment risk."

While these studies represent major progress on the decumulation problem, they largely assume a smooth, predictable spending pattern over time, and neither study explicitly addresses the unpredictable **magnitude** of large one-time expenses nor their impact on existing assets. Such one-time expenses can come in many forms of variable duration and magnitude, including medical emergencies, long term care needs, major home repairs, divorce, or some other family event. Such one-time expenses are defined here as Spike Expenses. Such discontinuities can abruptly destabilize even a theoretically optimized decumulation strategy.

The approach in this article differs from Vernon's "sustainable spending" approach and Steiner's deterministic funded-status method, as well as the theoretical mathematical models developed by Avanzi and De Felice and Forsyth and Li, by employing a Monte Carlo simulation to project future cash flows (both inflows and outflows) and remaining asset levels, including home equity. This approach allows each decumulation risk to be explicitly quantified and begins to address a critical gap between theoretical models and real-world retiree behavior.

This article addresses that gap by quantifying Spike Expense Risk as a distinct dimension of decumulation uncertainty and by evaluating the resilience of retirement income strategies—including those incorporating home equity—under stochastic conditions that simulate these irregular spending shocks. In doing so, the study extends decumulation research from managing market and longevity risks to managing the impact of expenditure shocks on portfolio survival and retirement income adequacy.

Mitigating Sequence and Spike Expense Risks through Home Equity Strategies

The use of a buffer asset mitigates the effects of market volatility on a securities portfolio—the Sequence of Returns Risk—allowing the portfolio to recover more effectively (Sacks & Sacks, 2012; Salter, Evensky, & Pfeiffer, 2012; Pfau, 2016; Neuwirth, Sacks, & Sacks, 2017; Walker, Sacks, & Sacks, 2021). This body of research demonstrated that, by incorporating a Home Equity Conversion Mortgage (HECM) credit line into a *Coordinated Strategy*, retirees could withdraw amounts larger than those prescribed by the Four Percent Rule while still maintaining a 90 percent or greater probability of sustaining constant purchasing power throughout a 30-year retirement.

Despite its effectiveness against market-related risks, the Coordinated Strategy[2] still leaves retirees exposed to spike expense risk—the possibility of dramatic, temporary increases in spending due to events such as medical emergencies, home repairs, or long-term care needs. To date, no quantitative research has explicitly addressed how to mitigate this form of expense volatility during retirement.

Prior research has generally maintained the objective of sustaining constant real income throughout retirement and has not accounted for sudden, irregular withdrawals. This article introduces and explicitly models spike expenses as infrequent but potentially large increases in spending, both unanticipated (e.g., health crises) and planned (e.g., home remodels or college expenses for grandchildren).

Earlier work by some of the authors of this article focused on the Coordinated Strategy; for practical reasons described in the next section, that work did not fully evaluate an alternative known as the Reserve Strategy.[3] The Reserve Strategy leverages a unique property of the HECM—its credit line grows over time while unused—to establish a reserve capable of funding spike expenses without prematurely depleting the combined retirement asset base (securities plus home equity).

Under the assumptions presented here, retirees can plan for both steady withdrawals and occasional spending spikes while maintaining at least a 90 percent probability of cash flow survival over 30 years. This outcome is achieved if:

1. The Reserve Strategy is used to determine the source of withdrawals, **and**

2. Initial regular annual withdrawals are reduced by between 4.6% and 7.9% relative to a constant-withdrawal baseline, depending on whether spikes are anticipated to occur later or earlier in retirement.

The analysis demonstrates that the Reserve Strategy provides more effective protection than the Coordinated Strategy against both sequence-of-returns and spike expense risks. Moreover, both outperform the Last Resort Strategy, in which retirees draw solely from investment portfolios until depletion before obtaining and utilizing the HECM. The Reserve Strategy, therefore, offers the most resilient income path but generally results in minimal residual home equity late in life, making it most suitable for retirees with limited bequest motives or those seeking to maximize lifetime cash flow certainty.

Modeling Spike Expense Risk

Most prior decumulation studies assume retirees receive and spend identical, inflation-adjusted income each year (see, e.g., Wagner, 2016). While simplifying analysis, this assumption overlooks the irregular nature of real-world retirement spending. In this study, traditional (inflation-adjusted) spending patterns are modified to incorporate discrete spending spikes occurring at varying intervals over a 30-year retirement horizon. These spikes simulate both unexpected and planned expenses—such as medical care, major home repairs, or family financial support—allowing us to test how different home equity strategies perform under sudden liquidity demands. This modeling approach introduces greater realism into retirement income sustainability analysis and provides a foundation for evaluating explicit spike expense risk within decumulation planning.

Like many of the articles cited earlier, the objective in this article is to determine distribution amounts and distribution strategies that yield a 90% probability of cash flow survival throughout a 30-year retirement. Monte Carlo simulation is used to model the investment performance of the securities in the portfolio and to simulate inflation. A reverse mortgage credit line serves as the buffer asset. But, unlike the articles cited above, a portion of this article focuses on another distribution strategy in addition to the Coordinated Strategy.[2] This additional strategy, referred to as the Reserve Strategy, will involve the establishment of the reverse mortgage credit line at the outset of retirement, but the credit line will be held *in reserve* and allowed to grow, in anticipation of potential spikes in distribution.

The Reserve Strategy takes advantage of a unique feature of the most widely used kind of reverse mortgage, namely the Home Equity Conversion Mortgage (the "HECM"). This feature provides that, once the reverse mortgage credit line is established, the amount available from the credit line *grows.* It grows at a substantial rate, which is the same rate as the interest that accrues (or would accrue) on the amount actually borrowed (or could be borrowed) from the credit line.[3]

As discussed in greater detail below, the Reserve Strategy has the following characteristic, which has led to it being generally ignored, up to now, in considering various decumulation strategies. In this strategy, the retiree establishes a reverse mortgage credit line at the **outset of retirement** but does not draw upon it until **after** the retiree's securities portfolio is exhausted.[4] This exhaustion generally occurs more than 10 years into retirement, and in some cases, never occurs. Exhaustion may never occur if the securities portfolio performs exceptionally well, or if the retiree dies exceptionally early; See Table 1, below.[5]

Thus, the "up-front" fees are incurred, typically in amounts between $20,000 and $30,000, but are not expected to serve any purpose, before 10 to 15 years into retirement, if ever. (These fees are not paid by the retiree out-of-pocket, but they are a lien upon the retiree's home and accrue interest from the outset.) However, because of the potential benefit that can be derived from the Reserve Strategy, the up-front fees can be viewed as a kind of insurance premium, to

insure against, or mitigate, the risk of income exhaustion that might otherwise result from distribution spikes.

Analysis

The analysis begins with considering a representative retiree who has a securities portfolio as the primary source of retirement income, with an initial value, at the outset of retirement, of $400,000. This retiree also has a home with a value, at the outset of retirement, of $800,000, owned free and clear of any mortgage.

This retiree was chosen based on U.S. data that indicates that **the ratio of home value/retirement plan assets** is approximately 2:1 and reflects the fact that individuals at or near retirement age tend to have both higher-value homes and higher investment portfolios.[6]

The analytic method runs three spreadsheets simultaneously, with the performance of both the securities portfolio and inflation Monte Carlo-simulated and identical on each of the three spreadsheets. In determining the source of the distributions, the first spreadsheet uses the Coordinated Strategy, the second spreadsheet uses the Reserve Strategy, and the third spreadsheet uses the Last Resort Strategy. The distributions on the spreadsheets begin with an initial amount, which is the same on all three spreadsheets, and continue, adjusted only for inflation, identically on all three spreadsheets. The result for each of the spreadsheets is a graph of the probability of inflation-adjusted (constant purchasing power) cash flow survival at various points in time, from 15 years to 30 years into retirement.

Baseline Case -- for Reference

As a baseline and for convenient reference, the spreadsheet program is first run without distribution spikes. The results showing the probability of sustainable constant purchasing power cash flow for time periods between 15 years and 30 years are shown in Figure 1, below.

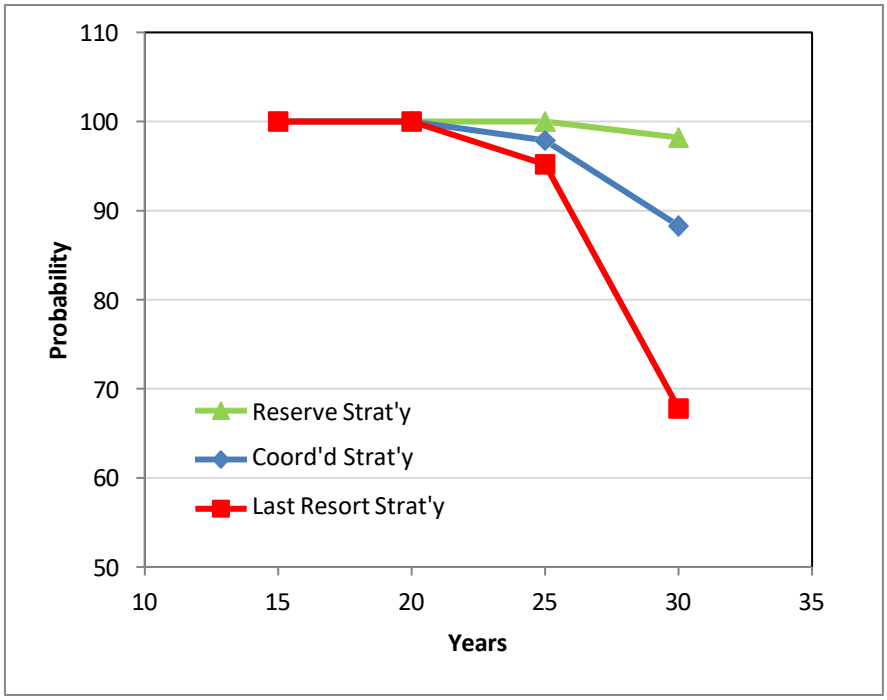

Figure 1: Probability of Inflation-adjusted cash flow sustainability, for each of the three strategies considered in this article (but without distribution spikes): The Coordinated Strategy, the Reserve Strategy, and the Last Resort Strategy. (The initial year's distribution is 8.4% of the portfolio's initial value, i.e., 8.4% x $400,000 = $33,600. All subsequent years' distributions are the same dollar amount, adjusted only for inflation.)

Clearly, the Reserve Strategy provides a greater probability of cash flow sustainability than the Coordinated Strategy for Retiree No. 1. In fact, the 30-year probability resulting from the Reserve Strategy is close to 100 percent. By contrast, the Last Resort Strategy provides a significantly lower probability of cash flow sustainability than either of the other two strategies.

Thus, a retiree expecting a constant (inflation-adjusted) distribution amount over the years of retirement is more likely to choose the Coordinated Strategy rather than the Reserve Strategy for three reasons:

1. The retiree wouldn't be inclined to incur the upfront cost of the reverse mortgage credit line without expecting to use it for 10 or 15 years, if ever;[7]

2. The Reserve Strategy, by exhausting the securities portfolio earlier than the Coordinated Strategy does, leaves the reverse mortgage credit line as the only later-in-retirement source of cash flow. That source is less manageable by a retiree's financial planner and less subject to investment management than the

securities portfolio in coordination with the credit line. (See, e.g., Sacks, Neuwirth and Sacks, 2022.)

3. A 90 percent probability of inflation-adjusted cash flow sustainability resulting from the Coordinated Strategy may be adequate in light of the two disadvantages of the use of the Reserve Strategy stated just above.

Noting from Figure 1 that the probability of 30-year cash flow sustainability is nearly 100% when the Reserve Strategy is used, there is another way to examine the issue of sustainable (constant purchasing power) cash flow. That way is to determine how much *more* can be distributed annually using the Reserve Strategy and still maintain a probability of a 30-year sustainable cash flow at 90%. It turns out that, if the regular annual distribution were equal to 9.1% x $400,000 = $36,400, the Reserve Strategy would result in a 30-year cash flow sustainability probability of 90%. (And at this distribution rate, the Coordinated Strategy results in a 75% probability of 30-year cash flow survival, and the Last Resort Strategy results in a 33% probability of 30-year cash flow survival.) See Figure 2, below:

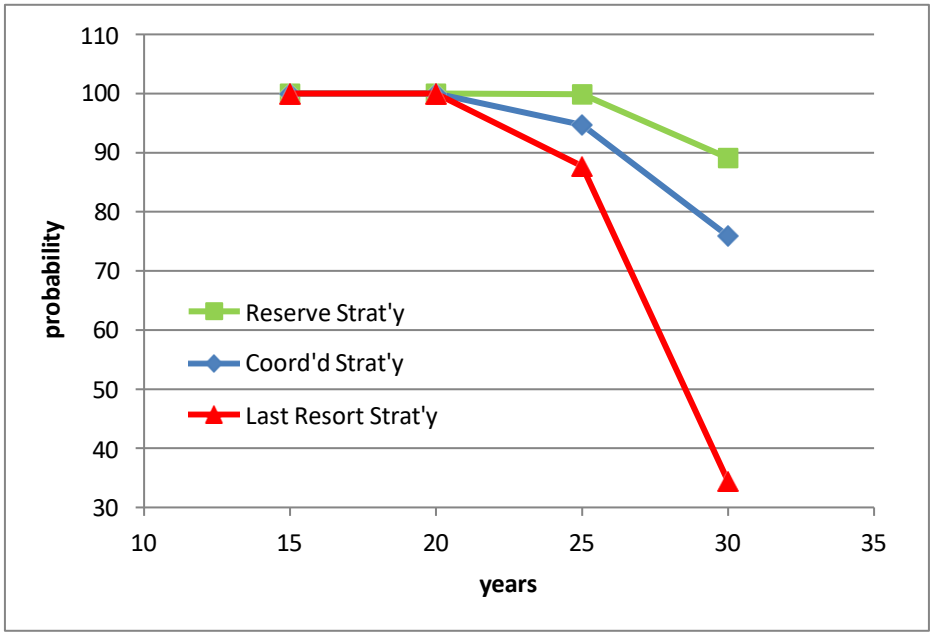

Figure 2: Probability of Inflation-adjusted Cash Flow sustainability, for each of the three strategies considered (but without distribution spikes): The Coordinated Strategy, the Last Resort Strategy, and the Reserve Strategy. To result in a 90% probability of cash flow survival using the Reserve Strategy, the initial year's distribution is 9.1% of the portfolio's initial value, i.e., 9.1% x $400,000 = $36,400. This is an increase of $2,800 over the amount used in Figure 1. All subsequent years' distributions are the same dollar amount, adjusted only for inflation. (With this greater initial year's distribution amount of $36,400, the legacy (net worth) amounts, obviously, are smaller than with the lesser

initial year's distribution amount of $33,600). And, with the increased distribution amount over that used in Figure 1, the Last Resort Strategy results in an even lower probability of cash flow survival.

	Median No. of Yrs Portfolio Not Exhausted	10th percentile No. of Yrs Portfolio Not Exhausted
Coordinated Strategy	**30**	**30**
Reserve Strategy	**14**	**22**
Last Resort Strategy	**14**	**22**

Table 1. This table summarizes the median and 10th percentile number of years before the securities portfolio is exhausted for each decumulation strategy, **with no spikes** and using the initial year distribution of 8.4% ($33,600). The 10th percentile indicates that the portfolio has a 10% probability of not being exhausted by the 30th year (in the case of the Coordinated Strategy) nor by the 22nd year (in the cases of the Reserve Strategy and the Last Resort Strategy). There is even a 4% probability that the portfolio will not be exhausted by the 30th year, in the cases of the Reserve Strategy and the Last Resort Strategy.

Having set out, for reference and comparison, a brief discussion of the situation *without* spending spikes, consideration now turns to the situation *with* spending spikes.

EFFECTS OF DISTRIBUTION SPIKES

At the outset of these considerations, it should be noted that generally, but not always, the timing and magnitude of any retiree's need for spending spikes cannot be predicted with any certainty. Examples of those that cannot be predicted include emergency repairs of the home, a serious medical emergency of a family member, etc. On the other hand, such expenditures as a remodeling of the home or the repayment of some of a grandchild's college loan, can be anticipated and timed. Thus, as is intuitively expected, and as is shown quantitatively in the following sections, the impact of earlier years' spikes is significantly greater than that of later years' spikes. Accordingly, to the extent that the anticipated spike expenses can be deferred, financial planners can demonstrate to their clients the economic advantage in doing so. And even without any specifically anticipated spike expenses, financial planners can provide a significant service to their clients by making the clients aware of the level of reduced regular annual spending that is needed to protect their 30-year cash flow survival against the various times and magnitudes of the spikes.

Consider a situation during retirement in which the retiree incurs two distribution spikes of magnitude $75,000 each. (This amount is more than double the regular annual distributions described above.) Within a 30-year retirement period, there are 30 x 29 = 870 different combinations of years in which two spikes could occur. As simple examples, this article will only examine a few cases; these will be pairs of contiguous years in which the spikes occur: Years 25 and 26, years 15 and 16, and years 5 and 6. Consideration will be given to the effect of the timing of the spikes on the probability of cash flow sustainability. In each case, the magnitude of the spikes is adjusted for inflation, so later years' spikes are nominally greater than earlier years' spikes.

The inquiry will examine the reduction in the probability of 30-year inflation-adjusted cash flow survival resulting from the spikes and the reduction in regular annual spending needed to restore the probability of such cash flow survival to 90% when the Reserve Strategy is used. As is intuitively expected, the quantitative results will show that the impact of earlier years' spikes is significantly greater than that of later years' spikes.

The Spikes in Years 25 and 26:

As can be seen in Figure 3, the existence of two distribution spikes of $75,000 each (inflation-adjusted), in years 25 and 26 after the onset of retirement, significantly lowers the probability of 30-year cash flow survival when using the same initial withdrawal amount that yielded a 90% success rate at 30 years for the Reserve Strategy ($36,400). By lowering the initial withdrawal amount to $33,200, the Reserve Strategy can achieve a 90% success rate at 30 years when the spikes in spending are assumed.

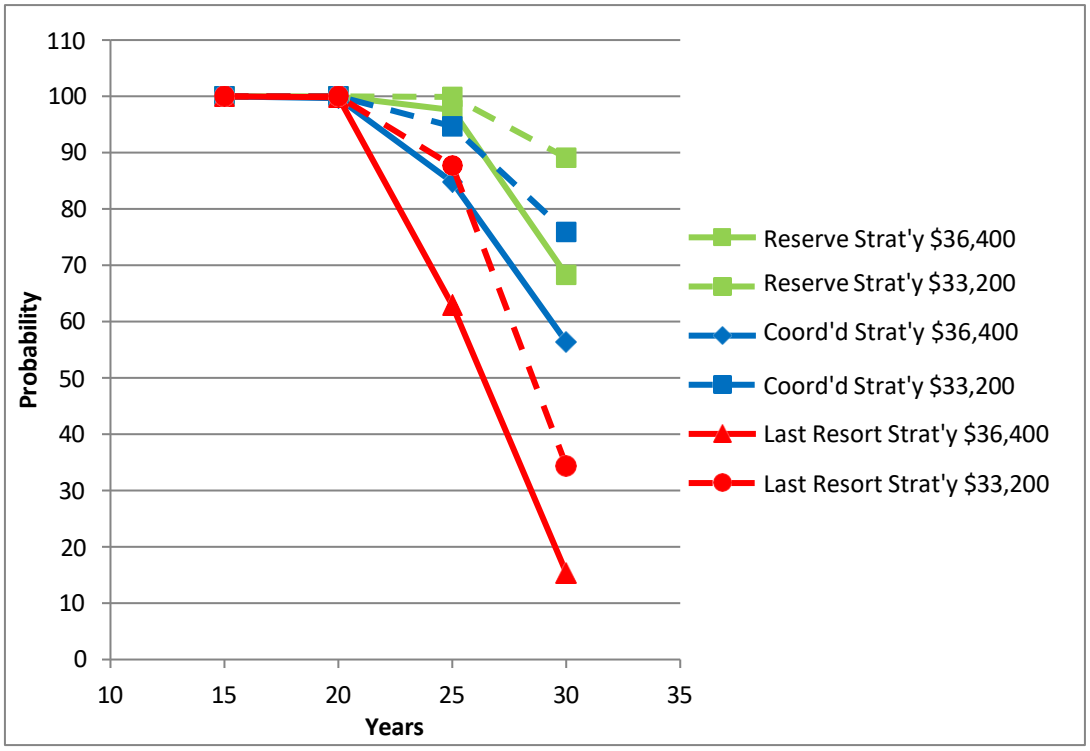

Figure 3: Probability of Cash Flow survival in the case where there are two spending spikes of $75,000 each, one in year 25 of retirement and the other in year 26. The graph compares the probabilities when the initial year's spending is $36,400 (the amount that results in a 90% probability of 30-year cash flow survival, using the Reserve Strategy, with no spending spikes) and the case where the initial year's spending is $33,200 (the amount that results in a 90% probability, also using the Reserve Strategy, but with the two $75,000 spending spikes).

The Spikes in Years 15 and 16

There is a much larger difference in the probability of cash flow survival between the case with two spikes and the case with no spikes, when the spikes occur in years 15 and 16 than when the spikes occur in the years 25 and 26. This difference can be seen in Figure 4 (below). In addition, the reduction in the annual distribution for the probability is brought up to 90% for the Reserve Strategy, is also greater in this case than in the case where the spikes occurred in years 25 and 26. In this case the reduction is $5,200 per year as compared with $3,200 per year. Because the distributions are inflation-adjusted, this difference also is inflation-adjusted over the years of retirement.

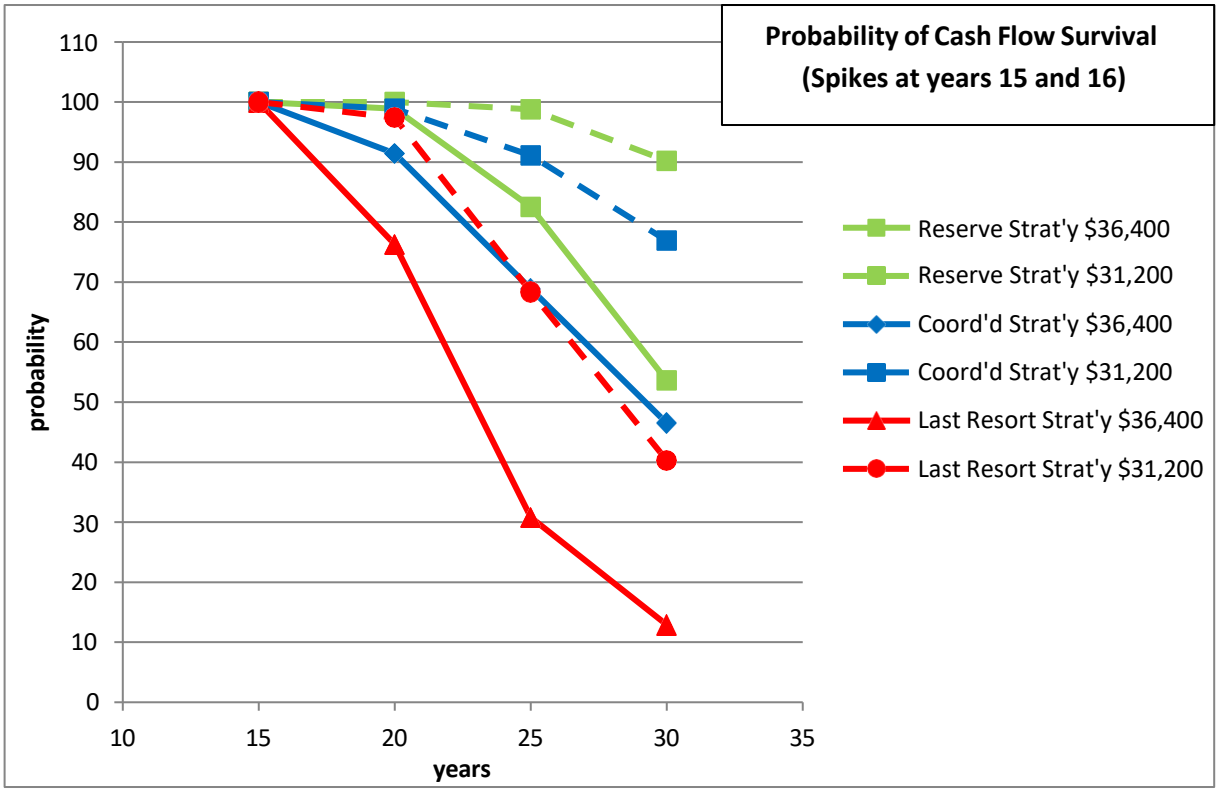

Figure 4: Probability of cash flow survival in the case where there are two spending spikes of $75,000 each, one in year 15 of retirement and the other in year 16. The graph compares the probabilities when the initial year's distribution is $36,400 (the amount that results in a 90% probability of 30-year cash flow survival, using the Reserve Strategy, with no distribution spikes) and the case where the initial year's distribution is $31,200 (the amount that results in a 90% probability, also using the Reserve Strategy, with the two $75,000 distribution spikes).

The Spikes in Years 5 and 6

There is an even larger difference in the probability of cash flow survival between the case with two spikes and the case with no spikes when the two spikes occur in years 5 and 6 than when the spikes occur in the years 15 and 16. The results for the spikes occurring in years 5 and 6 can be seen in Figure 5 (below). In addition, the reduction in the annual distribution, in order to bring the probability up to 90% for the Reserve Strategy, is also greater in this case than in the case where the spikes occurred in years 15 and 16. In this case the reduction is $6,800 per year, as compared with $5,200 per year. Because the distributions are inflation-adjusted, this difference also is inflation-adjusted over the years of retirement.

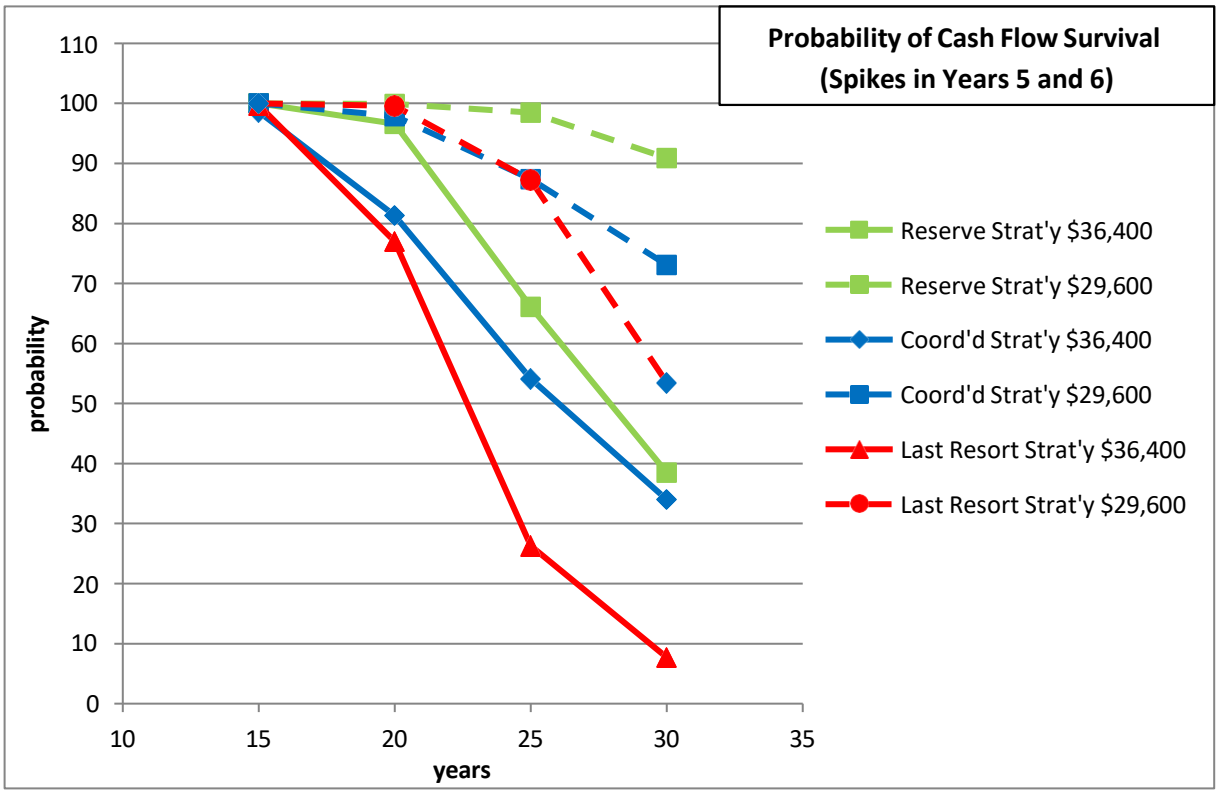

Figure 5: Probability of cash flow survival in the case where there are two distribution spikes of $75,000 each, one in year 5 of retirement and the other in year 6. The graph compares the probabilities when the initial year's distribution is $36,400 (the amount that results in a 90% probability of 30-year cash flow survival, using the Reserve Strategy, with no spending spikes) and the case where the initial year's distribution is $29,600 (the amount that results in a 90% probability, also using the Reserve Strategy, with the two $75,000 distribution spikes).

Summary of Results, Including Some Additional Results

The results of the various calculations discussed above, as well as the results of calculations involving spending spikes in the 10th and 11th years of retirement and the 20th and 21st years of retirement, are summarized in Table 2, below. In Tables 3 and 4, similar results are summarized, *except* that the magnitudes of the spikes are $50,000 and $125,000, respectively.

"Locations" of Spikes (Years)	No Spikes	5, 6	10, 11	15, 16	20, 21	25, 26
Initial Year's Distribution (Dollars)	$36,400	$29,600	$30,600	$31,200	$32,400	$33,200
Initial Year's Distribution (Percentage)	9.10%	7.40%	7.65%	7.80%	8.10%	8.30%

Table 2. This table summarizes the results described in the foregoing sections of this article. The spending spikes are at the "locations" indicated and are all of magnitude **$75,000**. The dollar amounts and percentages are the initial distribution amounts that result in a 90% probability of 30-year inflation-adjusted cash flow survival when the Reserve Strategy is used.

"Locations" of Spikes (Years)	No Spikes	5, 6	10, 11	15, 16	20, 21	25, 26
Initial Year's Distribution (Dollars)	$36,400	$32,200	$32,400	$33,000	$33,600	$34,400
Initial Year's Distribution (Percentage)	9.10%	8.05%	8.10%	8.25%	8.40%	8.60%

Table 3. This table summarizes results obtained exactly as those in Table 2, with spikes at the same locations as described above, *except* that the spikes are all of magnitude **$50,000.**

"Locations" of Spikes (Years)	No Spikes	5, 6	10, 11	15, 16	20, 21	25, 26
Initial Year's Distribution (Dollars)	$36,400	$24,800	$25,600	$27,600	$29,600	$31,000
Initial Year's Distribution (Percentage)	9.10%	6.20%	6.40%	6.90%	7.40%	7.75%

Table 4. This table summarizes results obtained exactly as those in Table 2, with spikes at the same locations as described above, *except* that the spikes are all of magnitude **$125,000.**

A Brief Note on Legacy and Net Worth Implications under the Reserve Strategy

In this brief note, the terms "legacy" and "net worth" are used for the same quantity, which is the sum of the retiree's portfolio value plus his/her home equity. The reason for the two terms is that the legacy amount (the total) is most relevant for the heirs, while the two separate components are most relevant to

the retiree while still living.

Prior research (e.g., Sacks, Neuwirth, and Sacks, 2022) has shown that, a few years into retirement and beyond, the Coordinated Strategy generally yields a slightly smaller residual net worth (if the retiree is still living) or legacy (if the retiree dies) than the Last Resort Strategy. However, the *composition* of the assets held (or left behind) by the retiree under the two strategies is significantly different: Under the Last Resort Strategy, virtually all the net worth or legacy is in the form of home equity, while under the Coordinated Strategy, the net worth or legacy primarily consists of the retiree's remaining investment portfolio.

In that paper, it is suggested that these results are significant for *both* the retirees *and* their financial advisors. Most relevant is the fact that a portfolio of securities is much more flexible and manageable, financially, than a home. Therefore, if the financial climate changes, and/or if the retiree's personal circumstances change, the financial advisor can recommend and implement adjustments and changes in the retiree's securities portfolio to accommodate such changes. On the other hand, if the retiree has no securities left, there is not much that the financial advisor can do. So, if, for any given net worth, the retiree has more value in the securities portfolio, there is more that an advisor or planner can do to assist the retiree to adjust to changing economic and financial conditions.

When Spike Expenses are considered, particularly under the Reserve Strategy, this phenomenon becomes even more pronounced. In many scenarios, particularly under the Reserve Strategy when spikes occur early in retirement, both the portfolio and the HECM (but not home equity) are exhausted before death, leaving the retiree little choice but to sell the house and live on the proceeds for the rest of his/her life.[8] This phenomenon can also occur under rare circumstances under the other two strategies when spike expense is considered, but is not nearly as significant as under the Reserve Strategy with its potential to provide higher income for a longer period than either the Coordinated or Last Resort Strategies, and generally only when significant spike expenses occur early in retirement.

Given the complexities of precise modeling of legacy amounts when both the portfolio and HECM debt capacity are exhausted, a detailed comparative analysis of the legacy implications of the three strategies in the presence of spike expense is not included in this article but is expected in the future.

Planning Considerations

1. As part of their understanding of their clients' needs and preferences, planners will come to know their clients' respective balances between preferences for spending and for minimizing the risk of cash flow exhaustion. If the clients' primary concern is to minimize the risk of cash flow exhaustion, the Reserve Strategy is the recommended strategy.

On the other hand, if the client has a strong legacy/bequest desire, sufficient to opt for a lesser spending ("lifestyle") pattern, the Coordinated Strategy (or even the Last Resort Strategy) is the recommended strategy.

2. As noted above, to the extent that some spending spikes can be anticipated, it is clear from the results derived above that these spikes should be deferred as long as possible. And for the spikes that cannot be specifically anticipated or deferred, provision can be made in the form of reductions in regular annual spending, as shown in Tables 2, 3, and 4, above.

3. Some consideration should be given by planners and their clients to the dollar amounts in Tables 2, 3, and 4. For example, it is worth noting from Table 2 that, to plan for the possibility of the $75,000 spikes occurring at the earliest times posited, i.e., at 5 and 6 years into retirement, the reduction in annual distribution from the "no spikes" planning amount is ($36,400 - $29,600) $6,800 in order to maintain a 90% cash flow probability when using the Reserve Strategy.

To put this amount into a hypothetical (but not unrealistic) context, a typical retiree receives at least $30,000 per year in Social Security benefits. If both members of a retired couple are receiving Social Security benefits, the combined amount could be estimated at $50,000 per year or more. If no spending spikes were anticipated, the couple's annual gross income (including, in addition

to Social Security, the distributions from the portfolio or the credit line) would be approximately $86,400. Thus, a reduction of $6,800 from an $86,400 annual gross income. For a strongly risk-averse couple, this represents a 7.9% reduction.

For a couple planning for the possibility of the $75,000 spikes occurring later into retirement, e.g., at the years 20 and 21, the reduction in regular annual spending from the no-spikes planning amount is ($36,400 - $32,400) $4,000 from a gross annual income of $86,000. For this couple, this amount represents a 4.6% reduction.

Concluding Thoughts

1. Consistent with the intuitive expectations stated earlier in this article, the computations show that spending spikes that occur early in retirement have a greater impact than equal spikes later in retirement (equal in real terms, i.e. in amounts adjusted for inflation).
2. The impact of spending spikes is felt not only in a reduction in the probability of cash flow survival for a given initial distribution amount, but also in the substantial reduction in the legacy amount.
3. As a way of improving the cash flow survival probability, a retiree can use the Reserve Strategy rather than the Coordinated Strategy or the Last Resort Strategy, but the costs are: 1) A substantial reduction in the legacy amount, especially in the later years of retirement; and 2) A loss of investment management flexibility, also especially in the later years of retirement.
4. As mentioned earlier in this article, and as shown in greater detail in earlier work, the Last Resort Strategy provides the least benefit in terms of cash flow survival probability but has certain other advantages. Those other advantages include: 1) The possibility (although not a high probability) of the retiree's never needing to incur the cost of establishing a reverse mortgage credit line; and 2) Because the reverse mortgage credit line is established, if ever, later in retirement than in the other two strategies, the amount of home equity made available is less than in the other two strategies, and hence the amount of legacy remaining is greater than in the other two strategies

5. Despite the recent progress researchers have made, the decumulation problem remains almost as "hard and nasty" as it was in 2017 when William Sharpe made his comment, and Spike expense remains one of its most intractable aspects.

6. With respect to Spike Expense Risk, a great deal more research is warranted. In particular, the distribution, frequency and magnitude of spikes that might occur throughout retirement needs to be more comprehensively considered in conjunction with data on actual retiree spending experience.

Appendix

The Monte Carlo simulation is based on six asset classes in the securities portion of the portfolio. Each of these asset classes is individually simulated, and inflation, also, is simulated. All are assumed to have normal distributions. Home equity is based on the initial value specified and is assumed to grow at a 2% annual rate. It is assumed to be accessed by a reverse mortgage credit line, the interest on which is equal to the one-year Treasury bill (simulated) plus a 2.5 percent margin. The securities portion of the portfolios is assumed to be rebalanced annually. (As a result of the rebalancing, bonds are sometimes sold at a loss, hence the standard deviation can spread the normal distribution into negative territory.)

The asset classes and their means and standard deviations used are the following:			
Asset Class	**Percent of Portfolio**	**Mean**	**Standard Deviation**
U.S. Large-Cap Stock (S&P 500)	40%	7.00%	20.00%
U.S. Small-Cap Stock (Ibbotson)	10%	7.70%	22.00%
MSCI EAFE (International Stock)	10%	8.85%	22.50%
Long Term Government Bonds	10%	3.30%	12.00%
Intermediate-Term Bonds	15%	3.50%	6.50%
One-year Treasury Bills	15%	3.30%	2.00%
Inflation	N/A	2.00%	1.50%

Endnotes

1. Sharpe, William F. 2017. "Tackling the 'Nastiest, Hardest Problem in Finance.'" *Bloomberg Opinion*, June 5, 2017.

2. The Coordinated Strategy works as follows: A reverse mortgage credit line is established at the outset of retirement. At the beginning of the first year of retirement, the first year's distribution of retirement income is taken from the portfolio. At the end of each year, the investment performance of the portfolio during that year is determined. If the performance was positive, the ensuing year's retirement income is distributed from the

portfolio. If the performance was negative, the ensuing year's income is distributed from the reverse mortgage credit line. (If the dollar amount of the portfolio's positive performance was less than the scheduled income distribution, only the amount of the positive performance is distributed from the portfolio, and the remaining portion of the scheduled income distribution is taken from the credit line. Also, of course, if the investment performance was negative but the credit line already has been exhausted, the entire distribution will come from the portfolio.)

3. The Reserve Strategy works as follows: A reverse mortgage credit line is established by the retiree at the outset of retirement. However, beginning with the first year of retirement, all distributions are taken from the
retiree's securities portfolio until the portfolio is exhausted. During that time, the amount available from the reverse mortgage credit line is increasing. The rate of increase is equal to the interest rate applicable to any amount that could be borrowed (even if none is borrowed). That interest rate, called the "effective rate," is equal to an index (typically the one-year Treasury rate) plus the lender's margin. Once the securities portfolio is exhausted, all subsequent distributions are drawn from the reverse mortgage credit line. As distributions are drawn from the credit line, they are a debt that accrues interest at the effective rate, and the amount not yet drawn (and hence to be subsequently available) continues to grow, also at the effective rate.

4. The growth of the amount available from the credit line from the time of establishment is greater than the increase in the credit line amount that would occur by merely waiting until a later age to establish the credit line. That is because the increase resulting from merely waiting is based on actuarial factors rather than interest rates; the relevant interest rates produce significantly greater growth than the actuarial factors. See Pfau 2025.

5. Table 1 shows the median number of years that the securities portfolio remains non-zero, i.e., not yet exhausted, for the situation where there are no distribution spikes and the initial distribution amount is $33,600, i.e., 8.4% of the portfolio's initial value. For the Reserve Strategy (and the Last Resort Strategy), the median is 14 years, and the 10th percentile is 22 years (meaning that there is a 10% probability that the portfolio's investments will perform well enough to last 22 or more years before exhaustion. In fact, the spreadsheet program indicates a 4% probability that it will last 30 years.)

6. Recent data from EBRI and the Federal Reserve's Survey of Consumer Finances indicates that the median home value of homeowners is around $400,000 while the median retirement assets of those approaching retirement age is a little less than $200,000. For our analysis we assumed that most retirees will have nearly or completely paid off their mortgage, and used a 2-1 ratio while using a higher dollar value to reflect the likely higher level of total wealth among retirees who own their home, have material retirement assets and would likely be in a position to utilize a more sophisticated approach to decumulating their assets. Note also that in May 2018 the authors of this article published a note in the Pension Section News that considered 4 different retirees: with home equity/portfolio values of 800/400, 400/800, 300/150 and 150/300 to show that the coordinated strategy was effective across a range of home equity/portfolio ratios and levels of aggregate wealth.

7. When there are spikes in the distribution, of magnitude $75,000, under the Reserve Strategy (and the Last Resort Strategy), the median duration of the portfolio ranges from 10 years, when the spikes occur early in retirement, to 14 years, when the spikes occur late in retirement, and the 10th percentile duration ranges from 17 years, when the spikes occur early in retirement, to 22 years when the spikes occur late in retirement. However,

when there are spikes, the program indicates a probability of the portfolio's lasting 30 years is below 2%.

8. In the context of the potential sale of the home, tax considerations are important: If the retiree has no cash and little home equity, and the home has substantially appreciated since it was purchased, the capital gain tax on the sale could be close to, or even greater than, the net amount realized after repayment of the reverse mortgage debt. (In such a situation, the only resolution of the tax problem that can be expected is an offer in compromise.) Accordingly, financial planners and their clients should make plans that project well into the future, frequently monitor the portfolios and the debt accruals, and make mid-course corrections whenever warranted.

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