PIMCO

Financing an Uncertain Retirement Part I: Spending Strategies

AUTHOR

Sean Klein
Executive Vice President
Client Solutions and Analytics

Executive Summary

- Real-world retirees exhibit several behaviors that conflict with the predictions of canonical retirement income models. Often, this is presented as evidence of irrational behavior on the part of retirees.
- This paper, the first in a two-part series, takes a different approach. A key component of retirement is uncertainty: We do not know how long assets must last or even how much we will have to spend.
- Uncertain future spending needs dramatically alter the results of typical retirement income models and generate predictions that more closely reflect real-world behaviors.

INTRODUCTION

The literature on the savings and spending behavior of retirees spans academia, financial advisors and industry professionals. Often, the real-world behavior of retirees is in conflict with what would be predicted by rational agents behaving according to economic models of retirement income.

These models typically begin with savings and investment decisions defined over the retiree's remaining life cycle: Much like the financial industry, these models focus on how to manage an individual's assets. At the same time, there is an equally large literature in economics describing how real-world spending, savings and portfolio allocation outcomes are heavily influenced by realized liabilities in retirement. This paper marries these two approaches in a single analytical framework. The inclusion of uncertain, unhedgeable liabilities helps illuminate several otherwise irrational retiree behaviors.

The principal contribution of this paper is to propose, parameterize and solve a life-cycle decumulation problem with uncertain liabilities. Uncertain future spending alters a household's problem from one with even, predictable needs to one in which there is great (and likely increasing) uncertainty about both how much money will be needed later in life and exactly when it will be necessary. The results help address several empirical puzzles in retiree behavior.

In the first section, a typical asset-focused retirement income model is presented and solved. Several conclusions of this model are at odds with real-world behaviors. Although there are many such puzzles, this paper focuses on wealth drawdown rates that are too slow, consumption that is too volatile and annuitization rates that are too low. The second section reviews the literature that shows a plausible connection between uncertain spending needs in retirement and real-world savings and investment decisions. Finally, the canonical retirement income model is augmented with a realistic parameterization of uncertain liabilities and is solved.

1. A TYPICAL MODEL

In this model, a retirement-age investor chooses how much of their initial wealth W_0 to consume in each period of their retirement, with preferences over consumption in period t given by $U(c_t)$, a rate of preference discounting $\beta < 1$ and a survival rate given by $\pi_t < 1$. Formally, the investor solves

$$\max_{\{c_s\}_{s=0}^{T}} \sum_t \beta^t \pi_t U(c_t).$$

Subject to the budget constraint that their total consumption must be affordable given their initial wealth,

$$\sum_t c_t = W_0.$$

This leads to the well-known Euler equation relating consumption between periods:

$$U'(c_t) = \beta \pi_t U'(c_{t+1}).$$

For example, constant relative risk aversion (CRRA) preferences $\left(U(c_t) = \frac{c_t^{1-\rho}}{1-\rho}\right)$ yields an optimal consumption profile that declines $(\beta\pi_t < 1)$ according to the following relationship:[1]

$$\frac{c_{t+1}}{c_t} = (\beta\pi_t)^{\frac{1}{\rho}}.$$

When this Euler equation is combined with the budget constraint, the optimal amount of wealth allocated to consumption in each period is uniquely identified. The spending problem here is distinct from an asset allocation problem. It is possible to say a great deal without considering asset markets. While this is an obvious simplification, such an approach has the advantage that the conclusions and interpretation of the results do not depend on assumptions about the future of the capital markets.

Typical implementations of this model include uncertain rates of return, uncertain investment or inflation outcomes and choice over asset allocation. Though the details may differ, a model such as this is an appealing characterization of the problem the retiree faces. These sorts of models have formed the foundation of much retirement income research since their introduction over 50 years ago in Yaari (1965). This ubiquity is somewhat surprising. There are a number of implications of this framework that do not map to actual observed behavior.

Puzzle 1: Low decumulation rates

The first issue concerns the rate that assets are spent down. The model above implies that retirees should draw down their assets much faster than is seen in the data. Even if we attempt to slow down the model predictions with conservative assumptions on life expectancy and discounting, it is nearly impossible to reconcile the model with actual behavior without adding to its structure.

Initially, we consider three hypothetical cases (see Exhibit 1). Case 1 uses survival rates for a 65-year-old male, with a rate of time preference of 2.5% and a coefficient of relative risk aversion of 4. Case 2 is identical, but for a 65-year-old female (with longer life expectancy). Finally, Case 3 is an upper bound of what is possible with parameters alone: It represents an individual who will live to age 105 with 100% probability and has no rate of time preference.

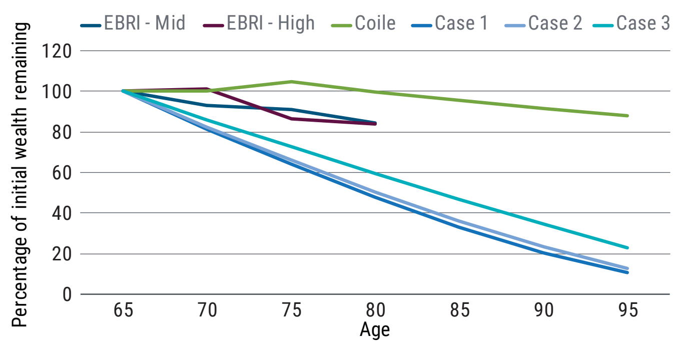
Exhibit 1: Preference parameters

Variable	Symbol	1	2	3
Survival rates	π	Male	Female	105
Discounting	β	2.5%	2.5%	0.0%
Risk aversion	ρ	4	4	4

Hypothetical example for illustrative purposes only. Source: PIMCO

Exhibit 2 depicts the model-implied behavior for the three parameterizations above, alongside actual decumulation rates as documented by the Employee Benefit Research Institute (EBRI) and Coile and Milligan (2009). All of these specifications, even the unrealistically long-lived, very patient version, would decumulate wealth throughout retirement much faster than

Exhibit 2: Model-implied wealth decumulation rates versus actual behavior



Hypothetical example for illustrative purposes only. Source: Author's calculations, EBRI (2018), Coile and Milligan (2009)

1 In addition to their analytical convenience, CRRA preferences are plausible in a retirement context given the focus on replacement rates when retirement income is discussed. A replacement rate target that is independent of wealth or other parameters suggests a relative risk aversion that is constant.

actual retirees would. The model predicts that by age 75 a retiree would have spent down to 65%–75% of their assets, while real-world retirees still hold 90%-plus of their initial balance. (In fact, Coile and Milligan documents a slight increase in asset balances after age 65.)

In short, it is not possible to bridge the gap between model predictions and actual behavior with different parameters.

There are many potential behavioral explanations for this phenomenon. Some show promise, though it is generally difficult to reconcile a far-sighted reluctance to spend in retirement with the well-known myopic unwillingness to save while working. Many in the retirement industry simply force their models to have slower-than-optimal spending rates. This constrains the problem but does not explain it. Instead, with modest, realistic additions to this framework, it is possible to produce much slower decumulation rates, closer to what is seen in real-world data, without appealing to irrational behavior on the part of retirees. First, though, let us describe another puzzle.

Puzzles 2 and 3: Volatile consumption and lack of annuity purchases

Retirees in Yaari-style models smooth out their consumption. Any unexpected shocks to wealth manifest evenly in consumption over the remaining lifetime as near-even shifts from previous levels. In the world described by the model above, spending volatility is suboptimal. Retirees should strongly favor a steady replacement rate, and their primary risk is outliving their assets (often referred to as "longevity risk"). An annuity, which provides a fixed payment for as long as the individual is alive, is a well-paired product for such a framework.[2] In general, the actuarial rate of return on an annuity – for the surviving annuitants, anyway – will eventually dwarf any realistic asset market assumptions.

Needless to say, zero consumption volatility and heavy use of annuities are not what actual retirement behavior looks like. Annual volatility in retirement spending ranges from 5%–10% of total spending, depending on age.[3] In 2019, J.P. Morgan Asset Management research found that 80% of retirees experienced "substantial" changes in spending, with nearly one quarter spending either 20% more or 20% less from year to year.[4] Despite annuities' relatively limited use, their theoretical appeal has been a staple of the literature since their inception: Yaari (1965) showed that life-cycle consumers should annuitize all of their savings under certain conditions (such as those in the baseline model above). Brown, Davidoff and Diamond (2005) went significantly further and proved that annuitization is the dominant strategy under significantly more relaxed circumstances, and highlighted the theoretical appeal of state-contingent annuity products.[5] In these models, the estimates of welfare gains from the deferred annuities are as high as 20% (Horneff, Maurer and Mitchell 2016), and most models find that essentially all retirees would benefit from some allocation to a deferred annuity. The actual annuity market, however, offers almost a perfect contrast to this theoretical appeal. The life annuities market in the U.S. is vanishingly small – so much so that simply collecting enough data for empirical work is difficult (Brown 2009).

The model described above is no different. To see this, consider a modest extension in which the model allows for the purchase of an immediate annuity before the first period that provides a fixed payment for the remainder of the retiree's life. To evaluate the impact of pre-existing annuities, we will also consider a case in which the retiree receives Social Security benefits. Altogether, the objective function changes to

$$\max_{\{c_s\}_{s=0}^{T}} \sum_t \beta^t \pi_t U(c_t + Ann + SS) \text{ s.t.}$$

$$\sum_t c_t + A_0 = W_0$$

$$Ann = \frac{A_0}{P}$$

where SS is the Social Security payment, Ann is the amount of the annuity payment, A_0 is the amount of initial wealth invested in the annuity and P is the annuity's price. For simplicity, we set the Social Security payment equal to the statutory maximum for an individual claiming benefits at their full retirement age ($34,300 per year in 2019). The annuity is priced above the actuarially fair value to reflect actual market prices for immediate nominal annuities.[6] Even when annuities are "expensive," however, an agent in this model heavily favors annuitization.

2 Annuities are subject to the claims-paying ability of the issuing insurance company. PIMCO does not offer insurance guaranteed products or products that offer investments containing both securities and insurance features.

3 Fellowes (2017)

4 Roy, Kim-Steiner (2019)

5 They also discuss circumstances in which annuities may be less attractive. In the next section, we will explore one of these.

6 This is usually referred to by the inverse: The "money's worth" of an annuity is the ratio of net present value of expected payouts to the price. Estimates in the literature show money's worth values of approximately 85% (Brown, Mitchell and Poterba 2000). The baseline case here is slightly more expensive (80%), and annuities are still heavily favored.

Exhibit 3: Optimal annuitization rates in the canonical framework

	Life expectancy	Risk aversion	Discounting	Annuity share	With Social Security
1	Male	4	2.50%	89%	100%
2	Female	4	2.50%	86%	100%
3	105	4	0.00%	100%	100%
4	Male	8	2.50%	100%	100%
5	Male	2	2.50%	81%	65%

Hypothetical example for illustrative purposes only. The model outputs included here are not based on any particularized financial situation, or need, and nothing contained herein should be considered investment or retirement advice. PIMCO does not offer insurance guaranteed products or products that offer investments containing both securities and insurance features. The model is limited to analyzing the optimal annuitization rates. Investors should speak to their financial professional regarding the investment mix that may be right for them based on their financial situation and investment objectives. Source: Author's calculations

Life expectancy data is from the Social Security Administration. Annuities are priced at a money's worth of 80%. Life expectancy of 105 represents a retiree who lives to age 105 with 100% probability.

Our baseline parameterization is a 65-year-old male with a relative risk aversion of 4 and a rate of time preference of 2.5%. Despite a money's worth of 80%, this model suggests that nearly 90% of his initial wealth should be invested in annuities. Similarly, a 65-year-old female with the same preference parameters would invest 86% of her assets. For more (less) risk-averse households, this ratio increases (decreases) further, but no set of preference parameters short of very high mortality risk would recover anything near the annuity purchase rates that we see in the data.

There are several potential competing explanations for the lack of a thriving annuity market, including endowments of pre-existing annuities, such as Social Security. The existence of Social Security appears unable to address the issue. When we include Social Security payments (see Exhibit 3), optimal annuitization rates tend to increase, except for individuals with lower risk aversion, who are willing to shift their consumption over time toward the periods when they are likely to be alive, rather than potentially receiving increased payments later in life, conditional on survival.

Perhaps the most cited reference to the annuitization puzzle is from Franco Modigliani's 1985 Nobel acceptance speech: "It is a well-known fact that annuity contracts, other than in the form of group insurance through pension systems, are extremely rare. Why this should be so is a subject of considerable current interest. It is still ill-understood." Since that time, there have been several attempts to explain this difference, appealing to both rational and behavioral motives with some success.[7] The limited real-world appeal of annuities, given their obvious strengths in canonical models, remains an open question.

2. CLOSING THE GAP: AN UNCERTAIN RETIREMENT

More than 60% of Americans report that they don't know how much money they will need to retire.[8] Guided by the conclusions of models similar to those described above, financial advisors and asset managers have focused on how to manage retiree assets, targeting an income replacement requirement. That is, retiree concerns around "running out of money" are often interpreted as uncertainty about their assets: how to invest, how to draw down their wealth or how much income can be financed from existing balances at different ages. The contrast between the model-implied solutions to these sorts of questions and actual observed behavior leads to the puzzles described in the previous section.

Instead of focusing on the assets, here the model is written to focus on uncertainty in the retiree's liabilities. Comments such as "I don't know how much money I will need in my retirement" are interpreted literally: The retiree faces required future expenses, but their size and timing are unknown. Sources of these shocks could include unexpected home repairs or maintenance, potential tax/policy changes or even as a problem-solving heuristic in the presence of uncertain future preferences. While the applications here are broad, this exposition focuses on a single, measurable and large source of uncertainty: healthcare expenses.[9]

Healthcare costs are a significant concern. Only 36% of individuals are confident that they can cover their healthcare costs in retirement.[10] This concern is not unfounded: Even after accounting for Medicare, out-of-pocket healthcare expenses are large and volatile. Once individuals reach age 70, their households will, on average, incur over $122,000 in *out-of-pocket* medical spending over the remainder of their lives, while

7 Brown et al. (2008) and Beshears et al. (2014) are particularly compelling.

8 Bankrate.com (2018)

9 These shocks must not be recreational; barring some requirement for the expense, they would not be consumed. (The marginal utility of the expense in a state where it is not required is zero.) This may not be an accurate description for routine or minor medical expenses, but it is certainly plausible for the large and volatile expenses that drive the bulk of the uncertainty. That is, this framework requires that retirees do not purchase unnecessary, recreational cancer treatments or emergency surgeries.

10 T. Rowe Price (2017)

households in the highest percentile will see over $600,000 in medical spending.[11] Though these shocks occur strictly outside of asset markets, they affect saving and spending behavior.

There is substantial literature detailing the relationship between healthcare expenses and savings and the portfolio-choice behavior of the elderly. De Nardi, French and Jones (2010) show that medical expenses are a key driver of low decumulation rates. They find that in the absence of medical expenses the rate of drawdown of wealth would more than double between the ages of 74 and 84, an effect that dominates the magnitudes of other common explanations, such as bequest motives. Coile and Milligan (2009) document significant wealth and asset allocation consequences of health expenses in retirement, including the sale of stocks and drawdown of IRAs, as well as a reduction in primary housing assets after health shocks. Rosen and Wu (2004) show that in addition to lower overall levels of assets, sick households hold a higher fraction of their portfolios in low-risk assets than do healthy households; particularly relevant for investment advisors, this effect appears to be twice as large as the retirees' overall attitudes toward risk. Similarly, Poterba, Venti and Wise (2017) estimate that from 1992–2008 households with "excellent" self-reported health experience accumulated nearly 50% more assets than those with "poor" health did – equivalent to an extra 250 basis points (bps) of asset returns when annualized. In their 2011 paper, Poterba, Venti and Wise note similarly large effects and, like Coile and Milligan, show that people deploy their home equity and nonannuitized wealth as a precautionary reserve for very long-life or substantial medical outlays. The consequences of healthcare shocks on wealth and portfolio choice in retirement are large, especially when compared with the impact of typical risk and asset allocation modifications advocated in the industry.

Healthcare costs are obviously important, though they are only one example of uncertain or unanticipated future expenses. Given the array of potential risks and uncertainties, it is not economical (or even feasible) to purchase complete insurance for every eventuality. However, readily available data on the magnitude of these expenses allows us to explore this question. Unsurprisingly, both the mean and the variance of healthcare expenses increase with age, and the distribution of health expenses has a very large right tail. For simplicity, we assume annual required expenses are independently distributed, and follow distributions based on the data on out-of-pocket medical expenses by age reported in Jones et al. (2018).[12] Exhibit 4 shows the resulting distribution of required healthcare expenses.

Exhibit 4: Parameterized out-of-pocket healthcare expenses ($000)

Age	65	75	85	95	Lifetime
μ	0.41	0.98	1.37	1.65	
σ	1.34	1.39	1.46	1.51	
Mean	3.1	5.9	9.3	13.2	126
Median	1.5	2.7	3.9	5.2	116
75th percentile	3.6	6.7	10.3	14.2	150
90th percentile	7.8	14.9	23.9	34.0	193
95th percentile	12.1	23.5	38.5	55.8	222

Hypothetical example for illustrative purposes only. Source: Author's calculations
Values are in thousands. Lifetime values reflect the Social Security Administration's published survival rates for a 65-year-old male. The simulation is drawn from a lognormal distribution parameterized by mean μ and variance σ^2.

Once it is weighted to reflect survival rates, this process recovers a lifetime distribution of out-of-pocket costs similar to what is observed in the data (Jones et al. 2018 and EBRI 2014), with the top percentiles exceeding $200,000 in present value. With a median net worth at retirement of approximately $250,000 in 2016, according to the Survey of Consumer Finances, it is no wonder that so many retirees fear they may not be able to afford their healthcare expenses in retirement.

3. A MODEL OF UNCERTAIN CONSUMPTION REQUIREMENTS

We now extend the model in Section 1 so that preferences are defined over expected utility, itself a function of consumption in excess of some unknown minimum level h_t:

$$\max_{\{c_s\}_{s=0}^{T}} \sum_t \beta_t \pi_t E[U(c_t - h_t)] \text{ subject to}$$

$$c_t \leq W_t + SS + Ann_t - h_t.$$

If the required consumption exceeds available funds that period, then all assets are depleted and consumption is fixed at a guaranteed minimum level c_t for all remaining periods:

11 Jones et al. (2018)

12 These shocks are parameterized in absolute dollars, though there is evidence that healthcare expenses increase with income levels. More complex health cost models are common, such as Markov transitions, autocorrelated shocks or endogenous mortality later in life, but for a healthy new retiree, as in this model, planning with an unconditional risk distribution is substantively similar to a conditionally autocorrelated process. Finally, this analysis does not account for the fact that healthcare prices typically rise faster than inflation/discretionary consumption; this would exacerbate the ultimate effects.

$$\text{If } h_t > W_t + SS + Ann_t,\ \ \{c_{t+s} - h_{t+s}\}_{s=0}^{T}$$

$$= \{c_{t+s}\}_{s=0}^{T},\ \ \{W_{t+s}\}_{s=0}^{T} = 0.$$

This seems realistic. Individuals receive Medicaid coverage with very small out-of-pocket costs only after paying a deductible of essentially all their remaining assets.[13] Of course, with any type of guarantee, it is possible for a rapid divesting of all assets to be the dominant strategy, as this maximizes the value of the guarantee for the remaining years. This is not a widely observed strategy among retirees (and does not reflect typical guidance from financial professionals), suggesting that real-world welfare guarantees represent a rather low level of consumption. Consistent with this, we select a guarantee equal to the fifth percentile of income for individuals in the U.S. aged 65 and over.[14] Reasonable changes in the level of the guarantee will impact the magnitude of the results in this paper but will not affect their existence.[15]

With uncertain expenses, wealth decumulation rates become state dependent. Optimal consumption in each year (c_t) is given by a function of age, current wealth levels (W_t) and current minimum spending requirements (h_t): $c^*(t, W_t, h_t)$. Given the process for spending requirements (h_t) in Exhibit 4, it is possible to numerically solve for the optimal consumption function through recursion.

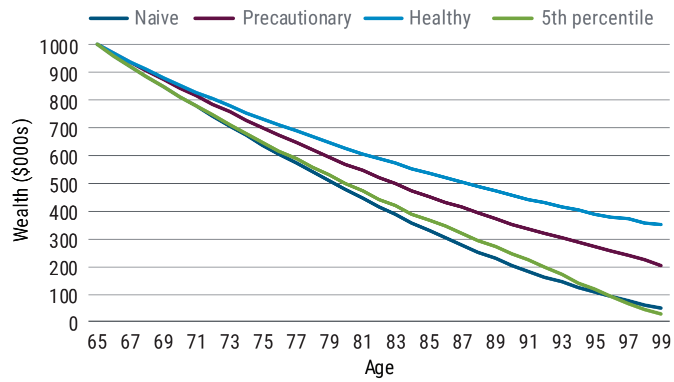
This addition to the model leads to substantively different behavioral predictions, particularly for the three puzzles discussed in the first section: wealth decumulation rates, consumption volatility and annuitization rates.

Slower wealth decumulation

Unsurprisingly, an uncertain future liability stream increases precautionary savings motives (Deaton 1991; Carroll 1992; Hubbard, Skinner and Zeldes 1995). This desire to self-insure against risky future spending increases the motivation to preserve assets and slows the rate of wealth decumulation.

With this new model, individual, nonmarket risks suddenly appear very relevant to retirement planning. In Exhibit 5, we depict the average wealth decumulation under the model with an uncertain liability process for a retiree with initial wealth of $1 million ("Precautionary"), a process for a retiree who was very lucky and saw no required expenses ("Healthy"), a process for a retiree who was very unlucky and in the fifth percentile of the distribution and, finally, the naive decumulation rates from the canonical Yaari-style model discussed in Section 1 ("Naive").

Exhibit 5: Wealth decumulation with uncertain liabilities



Hypothetical example for illustrative purposes only. Source: Author's calculations

Consistent with the empirical evidence, health outcomes significantly affect retirees' remaining wealth. A healthy 85-year-old has approximately 45% more assets than an individual in the lowest fifth percentile of the cumulative distribution, which is still slightly higher than the remaining wealth predicted by the canonical model.

Volatile consumption: Joint targeting of income and wealth

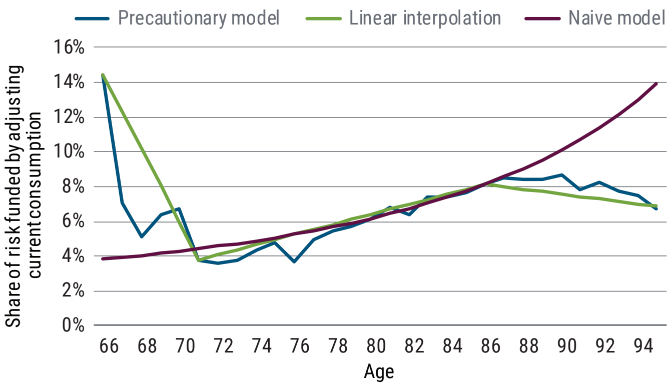
In this model, required spending can be funded in one of two ways: Either current spending can fall, or wealth can fall to meet the required healthcare shocks. The results suggest that retirees will raise and lower current discretionary spending to partially offset required outflows. Discretionary spending in retirement will be volatile, as this volatility helps preserve wealth for future needs. Early in retirement, uncertain required expenses are funded through larger reductions in discretionary spending than they are later in retirement. Only very late in retirement does the opposite relationship hold as retirees finally spend down their excess wealth. Exhibit 6 shows the fraction of uncertain expenses that are funded by changes in current discretionary consumption (the remainder is funded from wealth), by age. Early in retirement, as much as 15% of required expenses are paid for by immediate decreases in discretionary consumption. This share declines rapidly with age until age 70, when 4% of shocks are funded by changes in consumption and 96% from asset balances.

13 Brown and Finkelstein (2011)

14 Social Security Administration "Income of the Aged Chartbook," 2014.

15 For example, with the baseline parameterization, consumption guarantees at or below the federal poverty line lead to a net slowdown of wealth decumulation rates.

Exhibit 6: Funding uncertainty: Wealth versus discretionary consumption



Hypothetical example for illustrative purposes only. Source: Author's calculations
Discretionary consumption responses are estimated via linear regression on simulated shocks evaluated through the optimal consumption function. The age profile presented is smoothed using a piecewise linear transformation with knots at ages 70 and 85.

As a percentage, discretionary consumption is five times as responsive as wealth to required expenses at the beginning of retirement, when a 1% decline in wealth corresponds to a 5% decline in consumption. This falls over time until the elasticity of consumption and wealth converge after 10 to 15 years. A declining profile is the reverse of the effect of wealth shocks in a Yaari-style model,[16] in which the retiree would more significantly draw down their wealth early in retirement to stabilize lifelong income. Between the ages 70 and 85, the funding pattern nearly matches the canonical model, and late in retirement we see accumulated precautionary wealth increasingly used to help dampen the volatility in late-retirement discretionary consumption.

The patterns in discretionary consumption volatility suggest different roles for assets in early, middle and late retirement. Initially, preserving assets is paramount and spending is relatively responsive to ensure wealth can be maintained to fund a full retirement. As time passes, the assets are increasingly relied upon to finance late-retirement needs. Exhibit 6 suggests that assets are spent down differently depending on whether the retiree is in early, middle or late retirement.

Lower annuity purchases

Uncertain future expenses lead the retiree to tolerate more income volatility early in retirement in exchange for the preservation of future wealth. It is no surprise, then, that retirees in this model would place a lower value on a stable income stream. Higher, fixed payments are not useful if they deplete assets enough at the outset so that the retiree is unable to absorb potentially large future expense shocks. The behavioral literature explicitly supports this precautionary aversion to annuities: Beshears et al. (2014) document the top self-reported reasons for not purchasing an annuity as "[I] want to ensure I have enough income later in life," "[I] want flexibility in the timing of my spending," and "[I] may have a big (unanticipated) spending need." They also report that presenting annuities and highlighting the loss of "flexibility and control" of assets is associated with the greatest reduction in annuity purchases.

As shown in Exhibit 7, optimal annuity purchases are cut by 50%–100% relative to a Yaari-style model.[17] Based on these results, precautionary saving appears to play a part in the limited real-world appeal of annuities. Annuity purchases fall more with lower levels of initial wealth, as relatively larger unknown expenses provide a stronger desire to preserve assets when they are low.

16 The effect under the naive model can be analytically determined in closed form as the derivative of the optimal consumption rule with respect to wealth in each period.

17 Here the focus is on purchases at retirement. An increasing survivorship premium would increase the appeal of late-retirement, deferred and actuarially fair rolling one-year annuities as an investment rather than as insurance, as described in Pang and Warshawsky (2010) and Brown, Davidoff and Diamond (2005).

Exhibit 7: Optimal annuity purchase with uncertain liabilities

	Life expectancy	Risk aversion	Discounting	Wealth ($000)	Optimal annuity share: Yaari model	Optimal annuity share: Uncertain liabilities
1	Male	4	2.50%	$1,000	100%	54%
2	Female	4	2.50%	$1,000	100%	44%
3	105	4	0.00%	$1,000	100%	36%
4	Male	2	2.50%	$1,000	65%	61%
5	Male	8	2.50%	$1,000	100%	16%
6	Male	4	2.50%	$210	100%	0%
7	Female	4	2.50%	$210	73%	0%

Hypothetical example for illustrative purposes only. The model outputs included here are not based on any particularized financial situation, or need, and nothing contained herein should be considered investment or retirement advice. PIMCO does not offer insurance guaranteed products or products that offer investments containing both securities and insurance features. The model is limited to analyzing the optimal annuitization rates. Investors should speak to their financial professional regarding the investment mix that may be right for them based on their financial situation and investment objectives. Source: Author's calculations.

Life expectancy data is from the Social Security Administration. Annuities are priced at a money's worth of 80%. Life expectancy of 105 represents a retiree who lives to age 105 with 100% probability. Annuity shares are in addition to a guaranteed Social Security payment equal to the statutory maximum for a full retirement age claimant.

Of particular note is the effect of life expectancy and risk tolerance. Absent spending requirements, a longer life expectancy for an individual should increase the appeal of a lifetime annuity. Here we see the opposite: The long-lived 105-year-old – who would normally be an ideal annuity customer – actually has a stronger desire to avoid annuities in a world with uncertain required spending. Although annuities provide an exceptionally high rate of return in this case, the retiree also runs a higher risk of larger expenses later in retirement that exceed the obtainable income stream from annuitization.[18] Using the healthcare expense distribution in Exhibit 4, a 105-year life expectancy suggests an average lifetime out-of-pocket expense of nearly half a million dollars and a 95th percentile cost of over $750,000! The increased appeal of longevity protection is weighed against the increased desire to accumulate precautionary wealth. These results suggest that the second effect appears to dominate the first. Risk tolerance has a similar counterintuitive effect: Increases in risk aversion decrease the appeal of annuities, reversing the conclusion of typical retirement income models. With uncertain liabilities, longevity risk is no longer the retiree's primary concern.

CONCLUSION

Real-world retirees exhibit several behaviors that conflict with the predictions of canonical retirement income models. They appear overly averse to spending their accumulated wealth, their consumption is far too volatile, and they buy far too few annuities. With few exceptions, the response of the retirement industry to this behavior has been to try and persuade retirees to behave more like the model prescribes. This included designing drawdown strategies, facilitating annuity purchases and designing products to help mitigate volatile spending.

The focus on the retiree's assets ignores large risks that real-world retirees must manage. They face expenses that are not easy to forecast or anticipate. Even when these risks cannot be hedged by financial instruments, they have significant impacts on behavior. This is not theoretical: There is a large literature that shows health status and health expenses dramatically impact asset balances, portfolio allocations and total spending. Indeed, the desire to save for future healthcare expenses is a well-documented self-reported concern, particularly among the elderly.

This paper explicitly incorporates unknown required future expenses into the retirement planning problem by parameterizing a healthcare expense process based on real-world out-of-pocket expenses. Incorporating this feature appears to help close the gap between model-predicted and real-world behavior. This view can partially rationalize a series of otherwise puzzling behaviors, including slow drawdown of retirement wealth, excess consumption volatility and a lack of annuitization.

18 We do not consider state-contingent annuities – contracts that pay more in certain states potentially unrelated to financial markets. These products are essentially nonexistent. Brown, Davidoff and Diamond (2005) explicitly mention incomplete markets (those without state-contingent annuities) combined with precautionary savings motives – exactly as we have in this model – as one in which annuitization may not be optimal.

REFERENCES

Banerjee, Sudipto. "Annuity and Lump-Sum Decisions in Defined Benefit Pension Plans: The Role of Plan Rules." Employee Benefit Research Institute Issue Brief no. 381, January 2013.

Banerjee, Sudipto. "Asset Decumulation or Asset Preservation? What Guides Retirement Spending?" Employee Benefit Research Institute Issue Brief no. 447, April 2018.

Beshears, John, James J. Choi, David Laibson, Brigitte C. Madrian and Stephen P. Zeldes. "What Makes Annuitization More Appealing?" *Journal of Public Economics*, August 2014.

Brown, Jeffrey R. "Understanding the Role of Annuities in Retirement Planning." In *Overcoming the Saving Slump: How to Increase the Effectiveness of Financial Education and Saving Programs* (ed. Annamaria Lusardi). Chicago: University of Chicago Press, 2009.

Brown, Jeffrey R., Thomas Davidoff and Peter A. Diamond. "Annuities and Individual Welfare." *American Economic Review*, December 2005.

Brown, Jeffrey R. and Amy Finkelstein. "Insuring Long-Term Care in the United States." *Journal of Economic Perspectives*, November 2011.

Brown, Jeffrey R., Jeffrey R. Kling, Sendhil Mullainathan and Marian V. Wrobel. "Why Don't People Insure Late Life Consumption? A Framing Explanation of the Under-Annuitization Puzzle." *American Economic Review*, May 2008.

Brown, Jeffrey R., Olivia S. Mitchell and James M. Poterba. "The Role of Real Annuities and Indexed Bonds in an Individual Accounts Retirement Program." *Risk Aspects of Investment-Based Social Security Reform* (ed. John Y. Campbell and Martin Feldstein). Chicago: University of Chicago Press, 2000.

Carroll, Christopher D. "The Buffer Stock Theory of Saving: Some Macroeconomic Evidence." *Brookings Papers on Economic Activity*, 1992.

Coile, Courtney and Kevin Milligan. "How Household Portfolios Evolve After Retirement: The Effect of Aging and Health Shocks." *Review of Income and Wealth*, June 2009.

De Nardi, Mariacristina, Eric French and John B. Jones. "Why Do the Elderly Save? The Role of Medical Expenses." *Journal of Political Economy*, February 2010.

Deaton, Angus. "Saving and Liquidity Constraints." *Econometrica*, September 1991.

Fellowes, Matt. "Living Too Frugally? Economic Sentiment and Spending Among Older Americans." United Income, May 2017.

Fronstin, Dallas Salisbury, Jack VanDerhei and Craig Copeland. "Amount of Savings Needed for Health Expenses for People Eligible for Medicare: Good News Not So Rare Anymore." EBRI Notes. October 2014.

Horneff, Vanya, Raimond Maurer and Olivia S. Mitchell. "Putting the Pension Back in 401(k) Plans: Optimal Versus Default Longevity Income Annuities." NBER Working Paper no. 22717, October 2016.

Hubbard, R. Glenn, Jonathan Skinner and Stephen P. Zeldes. "Precautionary Saving and Social Insurance." *Journal of Political Economy*, April 1995.

Jones, John Bailey, Mariacristina De Nardi, Eric French, Rory McGee and Justin Kirschner. "The Lifetime Medical Spending of Retirees." NBER Working Paper no. 24599, May 2018.

Klein, Sean. "Investing in Retirement." *PIMCO Quantitative Research and Analytics*, April 2015.

Kline, Daniel B. "Most Americans Don't Know How Much Money They Will Need for Retirement." *USA Today*, June 16, 2018.

Miller, Keith, David Madland and Christian E. Weller. "The Reality of the Retirement Crisis." Center for American Progress, January 26, 2015.

Pang, Gaobo and Mark Warshawsky. "Optimizing the Equity-Bond Annuity Portfolio in Retirement: The Impact of Uncertain Health Expenses." *Insurance: Mathematics and Economics*, February 2010.

Poterba, James M., Steven F. Venti and David A. Wise. "The Asset Cost of Poor Health." *Journal of the Economics of Ageing*, June 2017.

Poterba, James, Steven Venti and David Wise. “The Composition and Drawdown of Wealth in Retirement.” *Journal of Economic Perspectives*, fall 2011.

Rosen, Harvey S. and Stephen Wu. “Portfolio Choice and Health Status.” *Journal of Financial Economics*, June 2004.

Roy, Katherine and Yoojin Kim-Steiner. “Three Retirement Spending Surprises.” J.P. Morgan Asset Management Retirement Insights, January 2019.

Social Security Administration. “Income of the Aged Chartbook, 2014.” https://www.ssa.gov/policy/docs/chartbooks/income_aged/2014/iac14.pdf

Social Security Administration. “Actuarial Life Table,” 2010. https://www.ssa.gov/oact/STATS/table4c6_2010.html

T. Rowe Price. “Retirement Savings and Spending Study,” 2017.

Yaari, Menahem E. “Uncertain Lifetime, Life Insurance, and the Theory of the Consumer.” *Review of Economic Studies*, April 1965.

PIMCO

The models, scenarios and decisions included here are not based on any particular financial situation, or need, and are not intended to be, and should not be construed as a forecast, research, investment advice or a recommendation for any specific PIMCO or other strategy, product or service. Individuals should consult with their own financial advisors to determine the most appropriate allocations for their financial situation, including their investment objectives, time frame, risk tolerance, savings and other investments.

The analysis contained in this paper is based on hypothetical modeling. Hypothetical performance results have many inherent limitations, some of which are described below. No representation is being made that any account will or is likely to achieve profits or losses similar to those shown. In fact, there are frequently sharp differences between hypothetical performance results and the actual results subsequently achieved by any particular trading program or strategy.

One of the limitations of hypothetical performance results is that they are generally prepared with the benefit of hindsight. In addition, hypothetical trading or modeling does not involve financial risk, and no hypothetical example can completely account for the impact of financial risk in actual trading. For example, the ability to withstand losses or to adhere to a particular trading program in spite of trading losses, are material points which can also adversely affect actual trading results. There are numerous other factors related to the markets in general or to the implementation of any specific trading program which cannot be fully accounted for in the preparation of hypothetical performance results, all of which can adversely affect actual results. No guarantee is being made that the stated results will be achieved.

Return assumptions are for illustrative purposes only and are not a prediction or a projection of return. Return assumption is an estimate of what investments may earn on average over the long term. Actual returns may be higher or lower than those shown and may vary substantially over shorter time periods. These figures are not indicative of the past or future performance of any PIMCO product.

Annuity guarantees are backed by the claims-paying ability of the issuing insurance company. PIMCO is not a licensed insurance provider and, as such, does not offer insurance-guaranteed products or products that offer investments containing both securities and insurance features.

Figures are provided for illustrative purposes and are not indicative of the past or future performance of any PIMCO product.

PIMCO does not provide legal or tax advice. Please consult your tax and/or legal counsel for specific tax or legal questions and concerns.

There is no guarantee that these investment strategies will work under all market conditions or are appropriate for all investors and each investor should evaluate their ability to invest long-term, especially during periods of downturn in the market. Investors should consult their investment professional prior to making an investment decision.

PC465_68330

CMR2020-0527-1198461