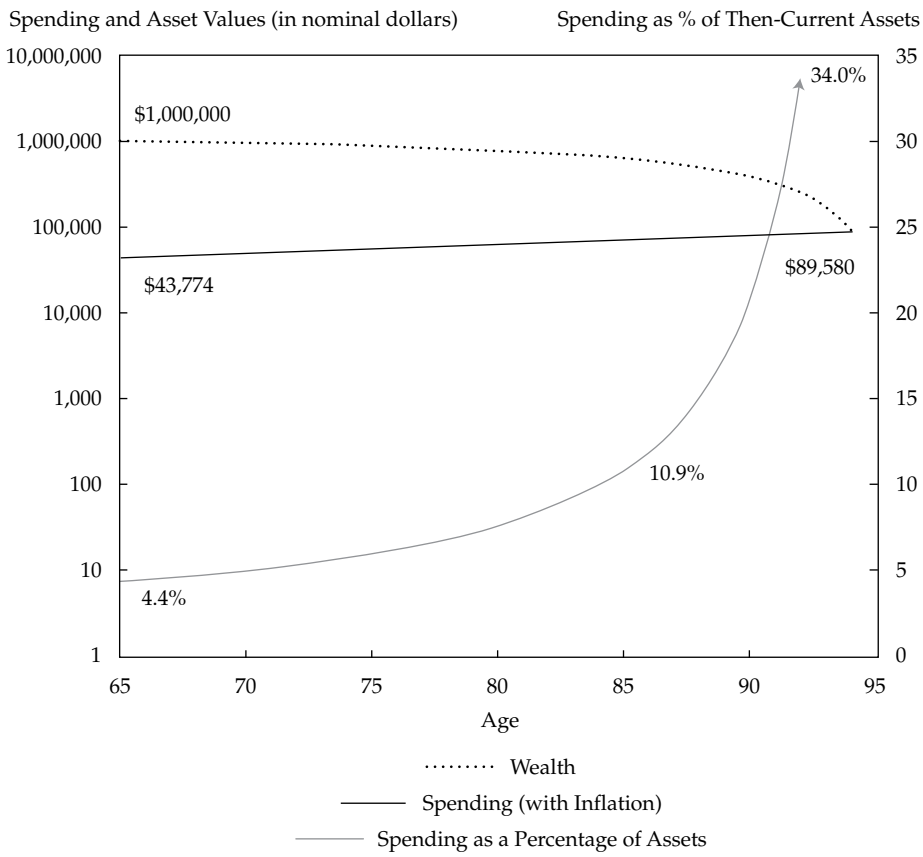
Figure 1. 30 Years of Spending and Asset Values with Riskless Portfolio Earning 2% Real



the end of the term). This utility-maximizing strategy is for the fixed-term investor who wishes to hold the minimum-consumption-variance portfolio (no tolerance for consumption risk). Note that Figure 1 is drawn in nominal dollars rather than the real terms in which the amounts were calculated (in order to show how the assets and liabilities change with inflation) and that the *y*-axis is a log scale in order to show constant growth as a straight line.

Risky Investor: Portfolio Wholly or Partly Unhedged to the Consumption Liability. This analysis should be more fun: If the investment portfolio includes such risky assets as equities, instead of or alongside an approximately riskless ladder of TIPS, we can still use annuity thinking—the ARVA—to calculate the yearly payout; in fact, we must. The risky investor needs this approach because, unlike for the riskless investor, the principal amount changes as it is recalculated each year given the volatile returns on the risky assets. In addition, discount rate changes affect the consumption payment (not being already hedged, as by the TIPS ladder held by the riskless investor). Thus, spending in the first year is the same in either the risky or the riskless case; for the risky investor, ARVA spending in the *second* year will reflect two major changes—the new current real discount rate and a different portfolio value given uncertain investment returns (as well as one less year of time remaining):

$$S_2 = \text{pmt}(r_1, 29, V_1, , 1), \quad (4)$$

where

r_1 = the TIPS interest rate (present value–weighted average interest rate across the TIPS ladder) at the beginning of the second year—that is, at time 1

29 = t, the years remaining in the payout stream at the beginning of the second year (i.e., $t = 30 - 1 = 29$)

V_1 = the asset balance at time 1, after both the prior (first) year's spending and the prior (first) year's investment returns

This process would be repeated each year until the beginning of the 30th year (the end of the 29th year), when remaining $t = 30 - 29 = 1$, at which point the final period's payment is made. In this way, we calculate a spending rate such that if there were no further changes in portfolio value or interest rates, real spending would be protected in the remaining years. Of course, each future year will have such

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changes, given the choice to hold an unhedged portfolio of risky assets.

Repeat each year. That is it. We are done. The investor will receive 30 years of payments of varying size, each appropriate to the then-current value of the portfolio and the interest rate. The portfolio has no chance of being depleted until the end (but it will be depleted at the end, so there will be no waste). The only risk is to the size of each payment, which will vary primarily with investment results (and secondarily with interest rates).

What Is Risk? Risk Tolerance for the ARVA Investor

The ARVA strategy has the advantage of connecting the dots between risk and return in the most meaningful possible way: Investment risk translates directly into consumption risk. More equities and other risky assets and less hedging of consumption mean more volatility—uncertainty—of consumption. Living standards will go up and down unpredictably to the extent of the unhedged risk in the portfolio.

In a conventional (third-party) annuity or in a riskless hedged ARVA, the discount rate and the payment level are locked in for the horizon as of the time of purchase, so consumption is as initially expected. In an ARVA whose assets are not hedged to consumption, both the asset portfolio and the discount rate are subject to market movements. These market movements change the value of the portfolio funding the retirement spending, which means that this year's wealth-appropriate spending amount—this year's recalculated ARVA payment—must and will vary. This variation is possible because, unlike in a commercial annuity, there is no opposing party with rights to protect: The asset owner/annuity payer is also the annuity beneficiary and is motivated (by the fear of eventual penury) to accommodate her spending to the reality of her portfolio's changing value. It is a fair trade—one hopes to be better off than if risklessly hedged, by seeking higher expected returns and taking greater risks; but the risk is that one might end up worse off instead of better off.

In fact, the payment will vary *precisely* proportionally to the change in the asset value (for a given discount rate). Think about the last time you bought a car on time payments. The $40,000 car that you considered had a payment exactly twice that of the $20,000 car. Principal and payment are two sides of the same coin.

It is thus easy to see that spending volatility is the risk—the only risk—you care about when setting your investment policy. And it is controlled by the volatility of the portfolio chosen in the asset allocation process: *The standard deviation of the portfolio's investment strategy is also the standard deviation of consumption (for a constant discount rate).* Hold that risk tolerance thought; you will use it repeatedly when considering spending rules and investment policies.

As a result, in considering the degree of aggressiveness in risky asset holdings—that is, where to be on the surplus efficient frontier as described in Sharpe (1990) or, with a more specific link to multiperiod consumption, in Waring and Whitney (2009)—risk tolerance for the investment portfolio is equivalent to risk tolerance for spending volatility.

Here is the deal: if you cannot take large hits to spending several years in a row, perhaps you should be considering a more closely consumption-hedged investment policy, with fewer nonhedged risky assets. Many people are probably invested more aggressively for their retirement than they might be if they thought this risk tolerance issue through.

Some investors may not like experiencing consumption volatility. Many would like to have their aggressive risky asset portfolio "cake" and eat it smoothly too, as the old saying (almost) goes, holding lots of equities and other risky assets. But—this is a reality check—the "tough love" lesson of this article is worth repeating: consumption volatility directly follows from investment and discount rate volatility and *is what risk is*. Embrace it; remember it. *Manage* it with your investment policy; do not take risk the downside of which would make you unhappy.

Smoothing as a Risk Control Device—Not! It is worthwhile to point out that many who read this article will instinctively want to "solve" the problem of consumption variability by using some sort of average across time of asset values or consumption payouts (sometimes called "smoothing," but in the sense of adjusting consumption gradually rather than suddenly to return realizations, not in the more general sense of spreading consumption over one's lifetime, which we called "consumption smoothing" when reviewing the CAPM literature). However, this approach is the actuarial mistake that has caused so much difficulty for pension plans: risk to the value of a portfolio accumulates over time, rather than going away, so averaging will not always work out. This fact is contrary to the wishful thinking of many in the investment business who like to believe that stocks, for example, are completely mean reverting over long periods, despite all evidence to the contrary (a triumph of hope over experience).

In this averaging sense, smoothing works fine in the many periods when down returns are regularly canceled by up returns. But the sense of security is false. A pretty good model of the markets (not perfect, but pretty good) is that stock movements are a random walk, not mean reverting. In any random process, there can be canceling movements, but there

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can also be long *runs* of up or down returns. If one smoothed consumption during a long run of market underperformance, one would massively overspend, depleting principal and thus forcing a significant curtailment of future levels of consumption.[13]

Even with smoothing, the true underlying, unsmoothed risk is realized whenever there is a long period of disappointing returns. (If this is not immediately apparent, review the discussion and the lower-percentile lines in the exhibit in Waring 2011, pp. 17–20.) This happens quite often; think of 2000 through 2011, when the S&P 500 Index total return averaged less than 1% for 12 years, way below the average returns of 7%–8% that were widely expected! If one believes that the random walk model is a reasonably good model of the markets, the possibilities of ruinous long-term underperformance cannot be ignored.

The bottom line is that consumption averaging, in the sense of gradual adjustment to realized returns, makes sense only when the portion of the total portfolio being annuitized in the ARVA for periodic consumption is small relative to the total portfolio. This means that the investment risk will be borne by the remainder of the portfolio (i.e., lower-priority nonperiodic planned spending, bequests, etc., could be reduced if need be to support desired periodic consumption spending). The very wealthy can bear this risk, but the soul who has to maximally squeeze regular consumption out of an ordinary portfolio should not take this chance.

Prescription: It is important to control consumption risk with investment policy, not with accounting tricks like smoothing.

So, You Want to Spend More? Aspiring to Higher Spending Levels Introduces Additional Risk. The only possibility of establishing a risk-free consumption schedule is to fully hedge it with a ladder of risk-free bonds—inflation-protected bonds if protecting real consumption, nominal if protecting nominal consumption. The balance sheet must be in balance, with assets equal to the value of the hedging portfolio. The present value of spending cannot exceed the value of the available assets (including such economic assets as human capital). The good news is that you are always "fully funded," in an accounting sense, for your personal pension plan; the bad news is that you may not like the size of the benefit promise!

Advisers often suggest to clients that if they "need" $50,000 a year and have only, say, $600,000 available—an amount insufficient to provide for that much spending—they should compute the internal rate of return needed to make the assets provide the desired cash flows and then invest in a strategy with that expected return. The risk side of this suggestion—the possibility that average returns will disappoint—is seldom explored, but it means that you may end up with lower consumption, not higher, and perhaps *much* lower.

Another way to view this approach is as the creation of an additional "aspirational liability" consisting of that part of the present value of proposed spending that cannot be supported risk-free by the assets actually in hand. The investor is then treating herself as if she were underfunded. There is no risk-free means of generating assets to fund this aspirational liability through investment strategy alone. One must seek higher expected returns, taking on greater risk—including downside risk to future consumption.[14]

But, as suggested, assets with high *expected* returns do not always generate high *realized* returns. In fact, those realized returns can be abysmal and can disappoint for very long periods. No present value is created by taking on more risk; the present value of a dollar of cash is the same as the present value of a dollar of equities. By aspiring to spend more than what you have, you create an artificial deep hole to climb out of, which happens only if you get lucky and actually achieve those higher expected returns—50-50 at best.

What happens if your luck is bad? We alluded to it earlier, in our discussion of what risk is. As a result of our investor's reaching for his aspiration by taking on greater risk, the assets might earn less than the risk-free return, and if they do, consumption will be *lower* than what he could have had risklessly with a ladder of TIPS worth his actual asset value—$600,000! Lower, not higher—completely defeating the aspirational effort—and perhaps much lower.

Aggressive investment strategies that aim to increase spending beyond an investor's apparent means generate a significant probability that the investor will be worse off, not better off. You can count on what you have (if invested correctly), but aspiring to do better by taking on additional investment risk may or may not end well.

Longevity Risk: More Complicated than a Fixed 30-Year Term

So far, we have developed a strategy for hedging consumption for a fixed term of 30 years, the maximum maturity of a TIPS bond. What about the rest of one's life? That is the true retirement horizon, not our arbitrary 30-year period. In effect, we have been ignoring—intentionally—a non-market-related risk: the uncertainty of our lifespan, over which we need to provide for our consumption with our assets. Being a non-market-related, or nonbeta, risk, it cannot be hedged directly, in the markets, but there are ways to deal with it.[15] We address those ways in this section and the one following.

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People are living longer, and although some are also working longer, others retire as young as 55. The Social Security minimum benefit age of 62 (when a partial benefit becomes available to those who are not disabled) is the most popular age to retire. Of course, retiring later is becoming a popular way to improve one's retirement consumption; there is both more time for asset accumulation and less time remaining of one's maximum possible lifespan in which to consume. Meanwhile, the Social Security annuity tables show nonzero probabilities of being alive out to age 120! From these facts, one could conclude that many retirees face the risk of having to live off their investments for 58–65 years.

A quick reality check shows that the most distant risk is small. According to the Social Security tables, the probability of being alive at age 110 is 0.017% for women and 0.002% for men. The corresponding probability for age 105 is 0.357% for women and 0.074% for men.

Thus, the risk of having to fund life from age 110 to 120 can perhaps be ignored by those willing to live on only Social Security in the event they happen to live beyond that age (in the United States)—although life expectancies have been rising and living to 120 may not be so far-fetched by the time those now saving for retirement are much older. Whatever one's view on the likelihood of living to extreme old age, it seems prudent to provide for oneself to at least age 105 if male or 110 if female, meaning (if one works to age 65) 40–45 potential years of retirement. Some people may want their hedge to last even longer than that; after all, if you happen to be one of the few lucky ones, it would be good to have some investments left over with which to improve your quality of life. Whether 105 or 120, that is still a long time horizon for any prospective retiree.

How can one achieve such long-tailed payouts? Retirees have generally hedged longevity risk—the risk of outliving one's money—through a mixture of Social Security, defined benefit pensions, adjusting one's standard of living on an *ad hoc* basis, and moving in with children. Life annuities have also proved to be a useful tool for some retirees. Before returning to some of the alternatives, let us review how an ARVA strategy can solve this problem in a thoughtful manner.

Do-It-Yourself Insurance: Providing for One's Maximum Possible Lifespan Using the ARVA Methodology. Many would like to maintain investment control over their portfolios and manage the problems themselves; they have reasons for not turning their wealth over to an annuity insurance company. But this approach means providing not just for the shorter term of one's statistical life expectancy, as in a commercial life annuity, but also for the longer term of one's maximum possible lifespan—which, with any luck, will be quite long.

But that potential length is sobering when one considers the effect on consumption expectations. Except at high real interest rates, plugging in, say, 45 years instead of 30 years as the time horizon in Equation 1 yields a distressingly low initial spending rate if we think in level-payment terms: 2.22% of initial capital at a zero real interest rate (way below the 4% rule), 3.32% at a 2% real interest rate, and so on for higher rates. (The corresponding figure is omitted to save space. It resembles Figure 1 closely, with roughly three-quarters as much spending each year.) The initial spending rate will be even lower for horizons of 55 or 60 years.

In our experience, a self-insurance strategy out to the limit of one's possible lifespan is very difficult for most investors to embrace, because it takes a much larger amount of money to provide the same level of spending for a longer term than for a shorter term. It seems that most people are short on retirement savings to begin with and are anxious to convince themselves that their need for more assets to support desired spending is less than it really is. Even otherwise thoughtful investors seem spring-loaded to reject out of hand the need to provide for one's entire life—and yet they do nonetheless worry about the risk of running out of money.

So, the facts must be faced. Longevity risk must be addressed, either through self-insured funds or through an annuity or one of the alternatives discussed later in the article. If longevity risk is ignored, it should be ignored with full appreciation of what the consequences are.

It is also difficult to hedge consumption for that long in one's own portfolio. For practical purposes, it is impossible, at least today, to achieve anything like an accurate or close hedge. In many countries, there are no inflation-protected bonds, and in all countries where they are available, there is an insufficient span of available durations. Markets are simply not sufficiently complete to provide consumption hedging for a very long duration, even in the most highly developed countries. There are sophisticated duration extension techniques that might help—in theory. But in practice, the risks and costs of these techniques make them impractical for providing complete protection at this time, especially for the individual investor.[16]

Before despairing about the lack of longer-term TIPS, remember that *any* amount of hedging, even if incomplete, reduces risk, leading to a far more optimal consumption-protected position than is ever obtained with today's typical unhedged investment policies. In other words, it is extremely valuable to hedge what one can. As for the longer-term,

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imperfectly hedgeable portion, it is good to remember the mantra, "No solutions? Then, no problems!"

Mechanically, a maximum-life ARVA with constant real spending is the same as the risky investor's 30-year ARVA discussed earlier but with a longer time frame. Because the term is longer, annual consumption is less and the hedging opportunities will always be incomplete.

It takes a lot of money to provide an ARVA for one's maximum lifespan, and the likelihood is that much of it will go to one's heirs. One might have a higher spending rate with a commercial life annuity priced instead on one's (less lengthy) life expectancy (discussed later), but our ARVA for one's entire life may be viewed by many as the more secure alternative.

Reconfiguring the *Shape* of the Payout: More Earlier, Less Later? Perhaps there is another way to avoid a commercial annuity and also to spend more, at least during the more active portion of one's retirement. The ARVA need not provide for a constant real spending level but might have some other, perhaps front-loaded, *shape*.

Because more than half of women die before age 85 (80 for men), their heirs will often be substantial secondary beneficiaries of a self-insurance strategy pursued to the limit of their lifespans, given that most of us will probably not live that long. This possibility may motivate a desire to spend a bit more earlier and a bit less later, at least for those not having strong bequest intentions. Regardless of the strength of such intentions, most retirees wish to consume more in their own, likely shorter, lifetimes than they could by spreading their spending evenly over their maximum possible lifespans. However, one might want to set aside money for a specific bequest or the unforeseen emergency (a contingency fund of some sort) rather than committing all of one's wealth to periodic consumption.

One way to do these things is to modify the shape of the payout, the relative amounts spent over time. There is nothing special about equal payments (equal in either nominal or real terms) other than their resemblance to car payments or mortgage payments and their ease of calculation on a spreadsheet or financial calculator.

As with any stream of cash flows, the shape of the cash flow payouts to a retiree can be engineered to be anything the retiree wants, so long as the various cash flow payouts have the same present value, on a risk-free real interest rate basis, as the available assets (the ARVA value, economically a liability, is necessarily equal to the original investment plus the present value of any additional funds expected to be received from human capital or whatever).

Let us assume that an investor puts a premium on income received in the early part of retirement—when she is likely to travel and have other expensive consumption goals—and that she has Social Security as well as full insurance coverage for health care costs, including late-in-life care. She would benefit from a front-loaded spending rule (her income would be lower when she is older) but at a level that still provides a guarantee of never running out of money during her lifetime. Such shapes can be constructed. Here, we illustrate a couple of simple shape modifications, using ARVAs, to show that there is an opportunity to modify consumption in order to maximize personal timing preferences. There is no right answer, but there are some choices to be made.

We experimented with a number of front-loaded rules as an alternative to a real level-payment rule. For many investors, the simplest and perhaps most intuitive rule is to take one's remaining life *expectancy* (instead of the maximum possible lifespan) as the time horizon, apply Equation 1 for a riskless portfolio (if hedging instruments are available) or Equation 1 and Equation 4 for a risky one, and update the life expectancy each year (each year of life extends one's life expectancy a bit).

This approach is very appealing because one's remaining life expectancy does get longer—albeit slowly—as one lives longer, and we might think this strategy would work out well. But upon closer examination, we see that it provides a payout shape so front loaded that for a female, spending is robust only until age 83, is cut in half by age 91 (in nominal terms), and then plummets further. Some retirees might find this degree of front loading acceptable. But we are extremely averse to longevity risk and know many 83-year-olds who are trekking in exotic lands, so we do not recommend this approach.[17]

What about a blend of life expectancy and maximum lifespan as one possible compromise, supporting higher spending earlier and lower but perhaps sufficient spending later? **Figure 2** shows spending, the wealth level, and spending as a percentage of wealth for a rule that takes the average of the remaining life expectancy (from Social Security tables) and the maximum possible lifespan as the time horizon and then updates the calculation each year as one's life expectancy slowly extends. In Figure 2, we use 120 as the maximum possible lifespan. We show the results using consumption-hedged risk-free investments to make the figure easier to read: With risky assets, the volatility would generate a wide dispersion of consumption values over time, depending on the path of the risky returns during the retirement period—just as one would expect. (Figure 2, like Figure 1, is drawn in nominal terms.)

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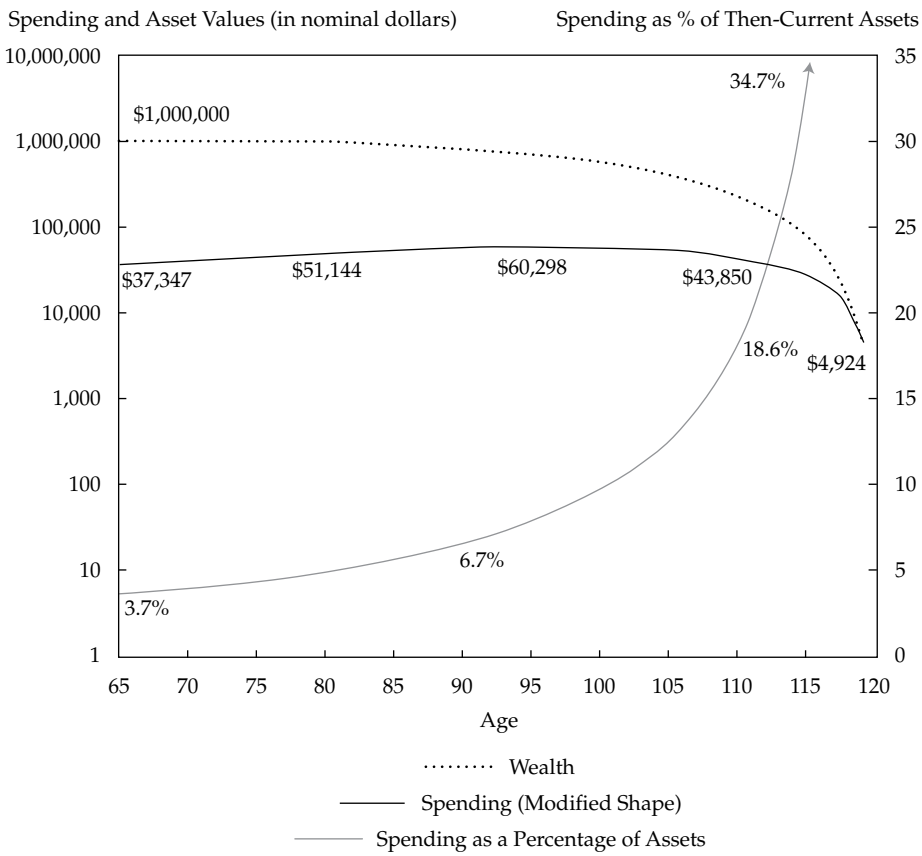
Figure 2. 55 Years of Spending and Asset Values with Riskless Portfolio: Annuity Time Horizon Updated Each Year to Equal the Average of Remaining Life Expectancy and Max Lifespan



The resulting spending curve gives a great deal of real income protection well into one's 11th decade, while increasing spending by a full 26% at age 65 and by 19% at age 80, relative to a level-real-payment spend-down to age 120 (it pays more until age 93, which is past life expectancy for most, and then pays less thereafter—16% less at age 100 and 51% less at age 110). Many might see such an approach as a sensible way to spend a bit more money earlier in one's retirement, when one can enjoy the spending, while still protecting modest but helpful amounts against the potential of an extended lifespan.[18] Like a commercial annuity, it offers greater spending for a given amount of money, at least for a time, but retains investment flexibility and avoids the high costs and potential default risks of dealing with commercial providers.

Demonstrating the flexibility of the ARVA approach, the investor can accommodate any desired shape for her anticipated consumption.

We have focused on regular periodic consumption, but consumption planning can include nonrecurring items—for example, providing for college expenses, contingency reserves, and specific bequests. The only limitation is that the sum of the present values of these future payments, discounted at the real risk-free rate—along with the desired consumption-spending annuity in whatever shape—must be equal to the assets available (economic assets and liabilities must be equal!). Choose an approximate horizon for, say, the college fund and price a zero-coupon inflation-protected bond against it. Repeat for any other special allowances. Subtract from the available assets (including appropriately discounted and decremented expected future additions to one's assets), and the remainder is what is available to create the basic consumption annuity.[19]

Other Ways to Manage Longevity Risk

An ARVA strategy is not the only way to fund spending during one's retirement, to protect consumption for one's entire life—even though we think it is a very good strategy, and in many cases the best. Here are some other options:

1. Annuitize through life insurance company commercial annuities.

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2. Create a blend of deferred life annuities and conventional investing using an ARVA strategy.
3. Use insurance riders for lifetime income, such as a guaranteed withdrawal life benefit or a ruin-contingent life annuity.

We also propose some market-focused reforms in the commercial annuity industry, in order to create better and safer annuities for retirees in the future and a larger and more profitable annuity marketplace for the issuers.

Let us briefly examine each of these approaches.

Annuitize Using Commercial Life Annuities or Deferred Life Annuities from Life Insurance Companies. Why not take advantage of the "insurance principle" (small contributions by many will pay the large losses of an unlucky few, through pooling of longevity risk) and just dump the whole longevity risk problem on a commercial insurance company by buying a life annuity from the company?[20] Using such an annuity, one can spend for one's entire life as if one were going to live only to the age of one's life expectancy at the time of buying the annuity; on its face, this is a very good deal. In earlier work (Waring and Siegel 2007), we calculated that this approach might decrease one's assets required for a given spending level by 35%, equivalent to raising one's spending level for a given level of assets by 53%. If it is such a good deal, we need to look at it more seriously.[21] Are there any concerns?

Yes. Among the concerns are the following: (1) fully implemented, a life annuity strategy consumes all the investor's liquidity, so if you need extra money for emergencies or just want to have it available, you are out of luck;[22] (2) you cannot direct your own investment choices, and the annuity payout as typically structured is roughly equivalent to a risk-free rate investment strategy with no opportunity to take some risk in search of higher returns (so-called variable life annuities are not a good answer to this objection); (3) it is hard to figure out whether you are getting a fairly priced deal, so you are probably not; and (4) the annuity contract is subject to counterparty risk—the possibility that the insurance company will not pay, perhaps decades in the future.

Any of these concerns can be a deal killer for those seeking to secure their retirement. The literature on the "annuity puzzle" asks why, if annuities are such a good deal, take-up is so poor (see Milevsky 2013). We would respond that the four concerns just cited are reason enough. It is not much of a puzzle.

A compromise solution that works for some investors is to put only part of their savings into commercial annuities, leaving the rest for discretionary investment and spending. (One such method is highlighted in the next section.) It also seems prudent in such a strategy to diversify among issuers, hoping they do not all go bankrupt at the same time. But the experience of 2008 suggests that default risk among financial institutions tends to cluster, making diversification less effective than it otherwise would be. Although many states have insurance guarantee funds, such funds typically have low payout caps and if defaults are clustered or large, the funds could be quickly exhausted.

Blend of Conventional Investments and Deferred Annuities. Sexauer, Peskin, and Cassidy (SPC 2012) and Sexauer and Siegel (2013) have proposed a retirement decumulation benchmark consisting of a portfolio of laddered TIPS plus deferred income annuities (DIAs) designed to start paying many years after retirement and held in a ratio designed to provide a smooth consumption path. DIAs are surprisingly inexpensive, for reasons made clear later. A nominal (noninflating) annuity that pays $100,000 in annual income starting at age 85 can be purchased by a 65-year-old male today for $203,046.[23]

Some very risk-averse retirees, corresponding roughly to our riskless investor, will hold the benchmark in an index fund–like configuration. But SPC do not recommend this mix to everyone. Instead, they make the point that the TIPS-plus-DIA blend is a passive, essentially risk-minimizing reference point or benchmark that investors (resembling our risky investor) can use for making active portfolio decisions if they want to try to earn a higher return or obtain a different payout pattern.[24]

The reasons for the large conditional rate of return (i.e., conditional on surviving to get it) are (1) the long wait before receiving any benefit (while the insurance company is earning interest on your money), (2) the likelihood (probably less than 50%) that a buyer will live long enough to collect at all, (3) the fact that most of those who do live long enough to collect will die within a few years, and (4) default risk—the possibility that the insurer is promising a higher payout than it can provide safely, with all risks hedged, so the promised payout includes a credit risk premium.

In SPC's design, the conventional investment portfolio portion can be "riskless" or risky. In their base case, the conventional assets are riskless (fully hedged to the consumption liability and thus consisting of laddered TIPS) and are equivalent to a riskless ARVA in our nomenclature. If the conventional asset portfolio is risky, equivalent to a risky ARVA, it has the same implications for variable spending as those we described earlier. (Sexauer and Siegel [2013] refer to the resulting variation in spending as requiring a "personal fiscal adjustment," or PFA.)

The appeal of the plan is that it is much less expensive than self-insurance to a very old age and enables the individual to focus on the earlier part of retirement, when he believes he is likely to be alive and healthy enough to engage in discretionary

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consumption—instead of giving up when faced with the prospect of saving for a 45-year retirement. By making the final years of life (should they occur) the insurance company's problem, the plan makes retirement investing feel more manageable.

This benefit, of course, comes at a price. The DIA, as acknowledged by SPC, is subject to the same default risk problems as those discussed earlier with respect to "immediate" (nondeferred) life annuities, perhaps more so. Commercial annuity providers are not known to precisely hedge their long-term obligations, and their promises to us might easily extend out for 40 or 50 years. That is a long time and a lot of market events through which they must remain solvent. One can try to mitigate the risks of the DIA portion of SPC's DIA-plus-TIPS plan through insurer diversification, reliance *in extremis* on state insurance funds (but only up to their guarantee caps), and leaving some surplus funds in the conventional portfolio as a reserve against insurance company default in the DIA payout years.

Insurance Riders Providing Longevity Protection. In its seemingly boundless desire to offer something—anything—to appeal to longevity risk hedgers without providing safe (properly hedged), simple, transparent, and fairly priced life annuities, the insurance industry has designed a number of strategies that guarantee a lifetime income (subject to the insurer's continued solvency). The best-known such product is the guaranteed withdrawal life benefit (GWLB), a rider attached to a variable annuity that allows the annuitant to continue to withdraw a pre-specified income amount even if the annuitant's portfolio has become worthless owing to withdrawals and/or poor market performance. (Variable annuities are essentially high-fee mutual fund portfolios convertible into life annuities at some future point on the basis of then-available pricing but otherwise having little in common with the immediate or deferred life annuities discussed earlier.)

Ruin-contingent life annuities (RCLAs) represent a similar promise by an insurance company but are structured somewhat differently.[25] They do not need to be attached as a rider to a variable annuity program but can be marketed independently and overlaid on a conventional investment portfolio. The insurer needs to police withdrawals and investment risk.

GWLBs, RCLAs, and similar products need to be evaluated carefully for their default risk, explicit and hidden fees, and conditions under which the guarantee does not apply. Again, the industry could do a better job of making all these longevity risk–pooling opportunities safe, transparent, and cross comparable.

Riskless Longevity Insurance: A Challenge to the Industry. Why is guaranteeing a lifetime income such a thorny problem? In principle, longevity risk pooling is simple and obvious. Can insurance companies not hedge their risks so that investors do not have to worry about default and the many other headaches we have been discussing?

We believe the answer could be yes. We would like to challenge the life insurance and annuity community to create a highly competitive, index fund–like annuity structure, with the intent of capturing a large share of the huge overhanging demand for life annuities. Suppose a life annuity–only insurance company were set up with the following characteristics (learning from the options exchanges and the index fund providers):

- Separate corporate structure, insulated from financial exposure to affiliated companies. All reserves held in default-free Treasury bonds and TIPS and properly hedged to the liability as closely as possible, at all times. That is, minimize inflation risk, real interest rate risk, credit risk, and all other risky asset risk.
- Using the life expectancy tables thought to be the statistical "best estimates" of true mortality risk and identifying the tables used.
- Participating policies holding that any longevity surprises in the population are charged against (or added to!) benefits so that the insurer does not need to add *any* risk charges.
- Very broad participation so there is little adverse selection.

In addition, we would all benefit from transparent and standardized annuity contracts, but these are strictly necessary only for fair pricing, not for annuity security. The benefit of standardization, however, would be to give confidence to the marketplace, fueling a huge expansion—just as it did for the options exchanges. The industry would make up many times in volume what it sacrifices in unit fees. Because the company issues only life annuities, risk from other insurance lines does not affect the asset reserves.

The resulting annuity business, which we call Riskless Longevity Insurance (RLI), looks a little like a bond index fund on its investment side and in its revenue model, with an annuity payout benchmark, and is fully funded by the participants and offered by private enterprise.[26] Would-be retirees could then hedge longevity risk fully, over as long a time horizon as Treasury securities exist and with much-diminished risk for longer horizons. (On this large scale, the skillful use of leverage and derivatives, coupled with duration matching in place of cash flow matching, makes it possible to hedge longer periods.) Although participants would still face a small amount of risk to spending from longevity

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adjustments, default risk—a much bigger risk and a much bigger obstacle to adoption—would be all but eliminated.

The business case for this product that is a radical annuity reform is historically proven: As happened with the large index fund providers, fees head down fast, but the winners of the most market share do very well, with low costs and high margins, making this an attractive proposition for the life insurance company willing to pioneer the product line.[27] Similarly, when options went from being negotiated instruments to being standardized instruments, volume—and the profits of the Chicago Board Options Exchange—went through the roof. Insurers, arise!

Most investors would want to blend life annuities and conventional investing, because they want both liquidity (essentially, the option to spend sooner) and expected returns higher than those of Treasury bonds. But they would not have to. They could build their entire retirement portfolio out of these idealized annuities, for a riskless (but rigid) consumption plan.

Conclusion

A spending rule for retirement is, at its heart, an annuitization problem. It does not require an actual annuity, but it does require annuity thinking. Investors should think of retirement spending as payouts from either an actual or, more likely, a virtual annuity: our ARVA spending rule. If the investments are "riskless" (i.e., hedged to the investor's consumption liability through laddered TIPS or similar holdings), then spending will be constant in real terms although at a relatively low level, reflecting the low risk in this strategy.

The more interesting situation is when the investments include risky assets and are imperfectly hedged to consumption. If the investments involve risk, the recalculated annuity periodically adjusts spending to keep it appropriate to fluctuating portfolio values and interest rate levels; in this way, spending will always be sized appropriately to one's assets and the possibility of ruin can be avoided.

Even if the investor chooses only riskless assets, the hedge will be imperfect because markets today are incomplete and do not offer the full range of tools needed for putting in place the consumption hedge that we consider desirable. Among these missing tools are TIPS of all maturities and shapes, including STRIPS; riskless and fairly priced annuities, both immediate and deferred; and fully effective income guarantees in the style of a GWLB or RCLA.

Risk tolerance must be set carefully when deciding the aggressiveness of the asset allocation or investment strategy. Risk in the investment portfolio translates directly into risk in the investor's lifetime consumption stream: a 10% portfolio loss requires a 10% reduction in spending. It should be no surprise to anyone that the decision to seek higher expected returns in an effort to increase consumption means taking on greater expected risk—risk that realized returns, and thus consumption, might end up lower rather than higher.

You can do all this on your own—provide for planned spending, including a thoughtfully "shaped" consumption plan—and in doing so retain control over your portfolio and enable the use of risky assets in the search for higher returns. The shapes can include expected future cash needs in any form, including bequests, college expenses, and so on. Likewise, with some thought, this approach is quickly generalizable to include such economic assets as future savings from wages, incoming bequests, or other expected sources. Social Security is a readily integrated set of future cash inflows.

Some investors will want to take advantage of the insurance principle to pool some or all of their longevity risk with that of other investors in the form of commercial annuities, making it possible to consume more during one's lifetime for a given amount saved—conditional, of course, on there being no default during the extended payout period. No currently available strategy for doing so is without problems. But we can envision an insurance product that fully accomplishes that goal, and we encourage the insurance industry to take up our challenge.

This article qualifies for 0.5 CE credit.

Notes

1. Here, we mean "as well off" in terms of *level consumption*—that is, in terms of being able to continue to consume at the real (inflation-adjusted) level at which one has been consuming.
2. Slightly earlier, Bierwirth (1994) covered similar territory.
3. The Trinity study, like many such studies, covered only a 30-year holding period, which, as we show later in the article, is too short to represent the planning horizons of most individuals at retirement.
4. We are being a bit generous to Merton (1975, 1977) in characterizing his solution as including a real life annuity and to Rubinstein (1976), who actually described a nominal, rather than a real, life annuity. But they were both forgivably—and brilliantly—close, given the times. Merton showed a five-fund investment policy solution, one of the funds being, of course, risky assets. But the other four are recognizable, in hindsight and taken together, as constituting something very similar to a real risk-free hedge; we will give full credit because TIPS were not then available—likely explaining why he needed a four-part solution when a ladder of TIPS would have served. Rubinstein, unlike Merton, had the insight to explicitly use the term "annuity" as the risk-free asset, and we are confident that had TIPS been available, he would have framed it in real terms—again, worth full credit under the circumstances. Both were ahead of their time. Their work was influential in the two-fund CAPM

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theory for investors with multiperiod spending plans (Waring and Whitney 2009), on which this article is based.

5. Our literature summary is necessarily quite incomplete because the important problem of managing one's finances in retirement has attracted the attention of literally hundreds of scholars. Patrick Collins has prepared a several-hundred-page review of the literature on "longevity risk and portfolio sustainability" and is shortening it for publication by the CFA Institute Research Foundation.
6. See, for example, Sedlacek (2011) and Garland (2013).
7. A few corporate bonds have longer maturities, but those markets are not deep; moreover, they add credit risk to the consumption-funding plan, a risk that must be explicitly accepted—because defaults can happen.
8. Moreover, TIPS are not available with maturities longer than 30 years, so hedging one's consumption liability beyond 30 years requires sophisticated techniques involving swaps or other derivatives—or else just budgeting some extra money to hedge those liabilities (plus any residual risk from the mismatch of actual TIPS with liabilities during the initial 30 years) as they become hedgeable. Although we cannot get all the way to a perfect consumption liability hedge in today's market, we can get much, much closer than in current practice! For investors outside the United States, replace "TIPS" with inflation-indexed bonds that pay off in the investor's consumption currency, if available; examples include "linkers" in the United Kingdom and the OATei in France.
9. A complete analysis would include amounts that the investor has not yet saved but will save by the time she retires.
10. One can remind oneself of the time value of money functions at https://en.wikipedia.org/wiki/Time_value_of_money. To obtain the formula for payments, we set up the formula given for the time value of a growing annuity (due) and solve for the payment, which gives (where inflation is the relevant growth rate)

$$\text{PMT} = \frac{\text{PV}}{\left[\frac{(1+\text{Nominal})}{(\text{Nominal}-\text{Inflation})}\right]\left[1-\left(\frac{1+\text{Inflation}}{1+\text{Nominal}}\right)^{\text{Term}}\right]}.$$

However, it is easier simply to use the real interest rate in the standard Excel payment formula in place of the nominal rate! We obtain the correct result if our real rate is the geometric difference between the nominal rate and the inflation rate.

11. Note that Equation 1 is very much like the formula for calculating a mortgage payment, applied in reverse (most mortgages are nominal, not real, which is not material to this point). Reverse mortgages have such a bad reputation that we are reluctant even to use the term and then expect to be taken seriously. But a (self-constructed) reverse mortgage is exactly the right way to think about spending down capital (even if many of today's reverse mortgages are not based on fair market terms). A mortgage involves obtaining an endowment of capital now and paying for it in installments over time; a reverse mortgage, or an asset drawdown, involves giving up an endowment of capital now and getting it back in installments over time. The dangers come from adjustments made by the third party, offering to "help" with the standard reverse mortgage.
12. That we adjust spending only once a year is purely arbitrary; the period could be any reasonable length. The longer the period between adjustments, the larger the adjustment is likely to be—and the greater the danger of overspending, relative to current market values, between adjustments.
13. This is not news; it has been pointed out before (Kotlikoff 2008). Note that in some of the advanced academic literature on consumption investment policy, a variant known as Epstein–Zin utility suggests that there may be an "intertemporal elasticity of substitution"—in plain English, that one might do a small amount of smoothing (for a technical discussion, see Campbell and Viceira 2002, p. 42). If an investor does smooth consumption, however, the amount must literally be small, because too much spent today clearly means that a corresponding amount must be forgone tomorrow—with interest. And you never know when a few bad periods will turn into an extended period of disappointing returns. Epstein–Zin utility thus has very little utility.
14. Another approach to resolving the problem of having less money than you intend to spend is to delay retirement. Part of your expected future earnings, or human capital, will be converted into financial capital and added to your asset balance in the future. Your personal balance sheet is then in balance (as it always must be), but it can be seen to be in balance only by including human capital. In effect, you have an option to make your human capital larger or smaller by retiring later or earlier.
15. There have been some halting efforts at creating a mortality risk market (see, e.g., Wessel 2010).
16. One can, however, do the next-best thing—budget for a remainder amount to be available at age 95 (the end of one's hedging capability at age 65), making it possible to do additional consumption hedging at 95. Of course, this imperfect consumption hedging introduces interest rate risk. Another approach might be to set up an ARVA using the growing annuity formula to create payments with regular government bonds that grow at today's *expected* rate of inflation; this approach would leave the investor unprotected against only the *unexpected* portion of inflation.
17. The US Internal Revenue Service's required minimum distribution rule (MDR) for IRAs and 401(k) accounts pays out a fraction of the account each year equal to 1 divided by the investor's remaining life expectancy. This rule is similar to an ARVA based on remaining life expectancy, but it will pay out a bit less than our trial-balloon life expectancy ARVA in the early years and, of course, a bit more later. Still, it pays out too fast, just as our version did—which is why we rejected it.
18. Another means of shifting spending to earlier from later would be to set up a nominal, rather than real, ARVA. This strategy, which protects spending only in nominal terms, may be the only one available for many investors, particularly outside the few countries that offer inflation-protected bonds. Although this strategy does shift spending to earlier from later, it is not a well-controlled strategy in that the investor leaves to chance the possibility that later spending might be substantially diminished by inflation rates unexpectedly larger than had been hoped for.
19. There are some subtleties to the discount rates for uncertain expectations of future earnings and expected incoming bequests and so on, and for the spending that corresponds to them, but we gloss over that here. A different article is needed to address those matters.
20. Formally, the insurance principle is just the law of large numbers: The average outcome for many independent trials of an experiment will approach the expected value of the experiment. Our version of the insurance principle, borrowed from Deane Waldman (www.americanthinker.com/2014/02/healthcare_and_the_insurance_principle.html), is more revealing.
21. Although most life annuities are nominal, real life annuities (those with a payout adjusted for inflation) are also available, albeit much less widely.
22. Many current life annuity products do offer features that preserve some liquidity or potential return of capital. Of course, these features come at a price; if the insurance company cannot keep all the money, it cannot give full value for that money when determining the annuity payment. Income will suffer, and chances are that the calculations will not be in favor of the recipient.
23. The source is Allianz Global Investors (www.DCDBBenchmark.com), which provides a variety of data on the TIPS-plus-DIA benchmark. Annuity quotes represent a survey of insurers, and Allianz is not one of the insurers surveyed. The quote shown here was updated in April 2014.

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24. The easiest-to-buy and almost certainly cheapest and least risky deferred annuity is the one obtainable by waiting until age 70 to take Social Security benefits (see Bernstein 2012, p. 25). However, most investors who are interested in our method will want a larger deferred annuity than can be obtained in that way.
25. RCLAs were proposed by Huang, Milevsky, and Salisbury (2014). To our knowledge, only one RCLA has been issued: ARIA from Transamerica.
26. It even looks a little like a privatized version of US Social Security (see Goetzmann 2008).
27. There will need to be some work done with insurance regulators, unfamiliar with modern concepts of surplus optimization and hedging, in order to keep traditional regulatory accounting from getting in the way of the success of this economically proper solution.

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