Behavioral Obstacles to the Annuity Market

Wei-Yin Hu and Jason S. Scott*

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Pension Research Council
The Wharton School, University of Pennsylvania
3620 Locust Walk, 3000 SH-DH
Philadelphia, PA 19104-6302
Tel: 215.898.7620 Fax: 215.573.3418
Email: prc@wharton.upenn.edu
http://www.pensionresearchcouncil.org

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Abstract

As baby boomers enter retirement, they will look to the investment industry for ways to generate retirement income from a stock of accumulated saving. A longstanding puzzle is why most retirees do not purchase longevity insurance in the form of lifetime annuities. This question is rising in importance due to the rapid decline of defined benefit pensions, which traditionally provided such guaranteed lifetime income. This study applies the lessons of behavioral finance to understand how well-documented anomalies in decision-making under risk may affect the annuity purchase decision. We demonstrate how mental accounting—where an annuity is evaluated as a gamble distinct from the retirement spending and investment plan—can be a powerful reason for the unpopularity of annuities. We also explain the prevalence of "period certain" annuities which guarantee a minimum number of payouts. Finally, we show that delayed payout or "longevity annuities," which are purchased today to begin payouts in the future, may be more desirable than immediate payout annuities due to the overweighting of small probabilities.

Wei-Yin Hu (Corresponding Author)
Financial Engines, Inc.
1804 Embarcadero Rd.
Palo Alto, CA 94313
T: 650-565-7771 ● F:650-565-4905
E-mail: **whu@financialengines.com**

Jason S. Scott
Financial Engines, Inc.
1804 Embarcadero Rd.
Palo Alto, CA 94303
T: 650-565-4925 ● F:650-565-4905
E-mail: **jscott@financialengines.com**

1. Introduction

Over the next decade, the investment industry will be heavily shaped by two major tides: the swell of "baby boomers" approaching retirement and the continuing rapid ebb of defined benefit pensions. Baby boomers will need to rely more heavily on defined contribution pensions (such as 401(k) plans and Individual Retirement Accounts) than did previous generations of retirees. Professionals in private wealth management, financial planning, the mutual fund industry, and the insurance industry are already increasing their efforts to solve the problem of how best to generate retirement income from a stock of accumulated pension wealth. How retirees choose among these alternative solutions will determine who are the winners and losers from these large asset flows.

A significant part of the discussion in the industry focuses on whether retirees are adequately protected against longevity risk, because baby boomers are less likely to have the high degree of guaranteed lifetime income that was formerly provided by defined benefit pensions. A natural replacement for a defined benefit pension is a lifetime income annuity purchased from retirement savings. Decades of economic analysis starting with Yaari [1965] have pointed to annuities as a major component of optimal retirement consumption plans. Yaari showed that a retiree with no desire to leave a bequest should annuitize *all* retirement savings. However, the insurance industry has long faced the dilemma that most retirees do not convert *any* retirement assets into annuities. Studies after Yaari's work have demonstrated that several factors diminish the benefits from full annuitization. However, a significant "annuity puzzle" remains in the fact that there is virtually zero voluntary annuitization beyond the payouts provided by

Social Security and defined benefit pensions. It would be a miraculous coincidence if the optimal partial annuitization strategy equaled the amounts provided by Social Security and defined benefit pensions for the vast majority of retirees. It would be even harder to believe that the shrinking of defined benefit pensions over time should not increase the need for privately purchased annuities.

Some authors have speculated that behavioral factors may prevent most retirees from converting accumulated savings into an annuity income stream. This paper seeks to put that speculation to the test through a systematic analysis of the annuity decision in the light of behavioral finance. The investment industry's success at helping managing retirees' longevity risk will depend heavily on understanding these powerful behavioral influences on retirees' evaluations of annuity products. We seek to answer the questions: Can behavioral finance explain why purchasing annuities with retirement assets is undesirable? What psychological errors documented in the experimental literature are responsible for the largest distortions in the annuity decision?

Previous annuity research has been almost completely focused on immediate payout annuities. However, the insurance industry has continued to create innovative annuity products, one of which is the delayed payout annuity or "longevity annuity," a contract purchased today that begins payments only if the individual reaches an advanced age. Scott, Watson, and Hu [2006] demonstrate that these annuities can be markedly superior to immediate payout annuities for retirees willing to annuitize only a fraction of their savings. While that analysis has a strong normative implication that longevity annuities *should* be highly desirable to an expected utility maximizer, a significant question remains whether this new form of annuity will actually realize significant

demand or whether it will extend the annuity puzzle even further. Our behavioral analysis will show that longevity annuities can be more attractive than immediate annuities to a retiree operating under behavioral biases.

2. Annuities under Expected Utility Models

Yaari [1965] showed that retirees should annuitize all of their wealth, assuming actuarially fair annuity prices and the absence of bequest motives. In the ensuing decades, several authors have argued that partial annuitization may be preferred, due to factors such as the illiquidity of annuities, bequest motives, or the ability to earn higher rates of return through stock investments (see the excellent overview in Brown and Warshawsky [2004]). Other authors have noted that annuities may be substituted by intrafamily mortality risk sharing (i.e., a husband and wife can implicitly insure each other by forming their own "mortality pool" of two persons). While all of these factors may diminish the gains from annuitization, they do not satisfactorily model the empirical fact that the vast majority of retirees' longevity-insured income streams is provided by Social Security and defined benefit pensions, in amounts that are not optimally chosen by each retiree. For those retirees with little or no retirement savings, this represents effectively full annuitization. However, for retirees with substantial savings, we observe very little additional annuitization. It would be a very peculiar coincidence if this pattern were optimal, since the extreme heterogeneity in private savings levels would imply very different annuitization fractions (determined almost completely by non-voluntary annuities).

Departing from traditional models with additively separable utility, Davidoff, Brown, and Diamond [2005] use a habit-formation model of utility to "stress-test" the

notion that low annuitization rates might be explained by the possibility that income streams provided by annuities differ markedly from desired consumption paths. Their simulations show that it is "extremely difficult" to find situations where less than two-thirds of retirement wealth should be invested in annuities. Given their lack of success in explaining low annuitization from a rational perspective, they state that "lack of annuity demand may arise from behavioral considerations."

3. A Behavioral Analysis of Annuities

The existing annuity literature is almost entirely *normative*, seeking to explain how a rational individual should behave. The last couple of decades have seen a blossoming of alternative *descriptive* models that better explain how individuals actually make choices, particularly choices involving risky outcomes. Some of these papers such as Kahneman and Tversky [1979] and Tversky and Kahneman [1992] present both formal models as well as experimental evidence to measure the value of model parameters. Other authors have used such models (or some components of these models) to explain economic anomalies that are poorly explained by expected utility models. For example, Benartzi and Thaler [1995] and Barberis, Huang and Santos [2001] apply Tversky and Kahneman's [1992] cumulative prospect theory to explain the equity premium puzzle.

We first define the relevant *mental account* that is likely to be used for the annuity decision. We then apply cumulative prospect theory (CPT) as a baseline model for analyzing the annuity "gamble." In the Appendix, we discuss other behavioral considerations that are less easily quantified but may still be major sources of distortion

in the annuity decision: the availability heuristic, fear of illiquidity, hyperbolic discounting, and the distinction between risk and uncertainty.

Mental Accounting

A cornerstone of behavioral finance is that risky outcomes are not always evaluated in terms of potential outcomes for ending total wealth, but often as outcomes more narrowly defined within their own mental accounts (see Thaler [1999]). For example, a person considering a gamble which puts $10 at risk should, according to expected utility theory, evaluate the overall impact on total wealth; however, behavioral research points to a pattern in which individuals are more likely to evaluate the $10 gamble in isolation. In the case of the annuity decision, a similar question arises whether the retiree recognizes the impact of annuitization on the retirement spending stream he can afford. For example, a retiree without annuities may follow a rule of thumb where initial spending is set equal to say four percent of wealth, and then adjusted over time to keep up with inflation. However, having an annuity stream should allow a retiree to spend more in retirement, because the annuity's longevity insurance reduces the need for precautionary saving against long life. There may be a "broad frame" in which the retiree values the fact that the annuity guarantees income even when he has lived well beyond life expectancy and may have exhausted most of his assets, and at the other extreme a "narrow frame" in which the annuity is evaluated purely as a gamble in itself. Read, Loewenstein, and Rabin [1999] argue that framing of decisions is more likely to be narrow when cognitive limitations on analytical processing power come into play. For the purposes of annuity evaluation, the complexity of intertemporal consumption planning argues strongly that most retirees will adopt a narrow frame. The optimization

of intertemporal consumption is a very complicated task in itself (which is why many retirees adopt rules of thumb such as "don't spend from principal"), and the addition of annuities makes it even more daunting.[1] It is more plausible that a retiree evaluates an annuity from the perspective "will I live long enough to make back my initial investment in this annuity?" Brown and Warshawsky [2004] describe consumers' attitudes in research by an American Council of Life Insurance task force with the statement "some consumer focus group participants equated lifetime annuity payments with *gambling on their lives*" [emphasis added], which means that annuities are perceived as *increasing* overall risk in retirement. Similarly, a Society of Actuaries [2004] survey found that nearly half of workers and retirees in defined contribution plans described "protecting against the loss of value from a pension or annuity investment should they die earlier than expected" as very important. These perspectives can best be understood in terms of the mental accounting framework: an annuity is segregated into its own mental account rather than integrated with all retirement consumption dollars.[2]

Within this mental accounting framework, gains on the annuity "gamble" occur if the total discounted value of payouts exceeds the initial investment (i.e., the retiree lives longer than expected), whereas losses occur if payouts are less than the initial investment (the retiree dies "early"). Behavioral researchers have not reached a consensus on how intertemporal gambles are treated, and in particular on the question of what discount rates are applicable. As a starting point, we make the assumption (to be relaxed later) that

[1] In addition, most financial planning tools also do not solve an intertemporal utility maximization problem.
[2] While mental accounting may prevent retirees from perceiving the value of longevity insurance, it may also lead retirees to ignore some negative features such as the illiquidity of annuities, which may dampen annuity desirability when future spending is uncertain.

individuals correctly compute the net present value of future outcomes.[3] Thus, we define the outcome of an annuity investment in which the retiree invests $\$A$ in an immediate annuity and dies in year s as:

$$x_s \equiv -A + \sum_{t=1}^{s} Y \frac{1}{(1+r)^{t-1}}$$

where Y represents the annual annuity payout.[4] In this analysis, we assume that annuity prices are actuarially fair, based on Social Security mortality tables with no fees and a constant interest rate of 3 percent. These assumptions imply that the expected (probability-weighted) present value of the annuity gamble is zero, so a risk-neutral investor operating within the mental accounting perspective would be indifferent to purchasing the annuity. (A risk-averse investor would be willing to purchase the annuity only if the price were more favorable than actuarially fair.)

Now that the annuity outcomes have been defined according to mental accounting principles, we next describe how behavioral investors evaluate those outcomes, using Tversky and Kahneman's [1992] seminal work on cumulative prospect theory.

Cumulative Prospect Theory (CPT)

CPT has three main components that we introduce in turn: a reference point, a value function, and decision weights. CPT assumes that risky outcomes are evaluated in terms of potential gains or losses relative to a *reference point*. The reference point is usually assumed to be the current wealth position. In the case of the annuitization decision, it is natural to define the reference point as the status quo of non-annuitization.

[3] Ultimately, we hope that the behavioral literature will develop (and empirically calibrate) more complete models of intertemporal choice that can be applied to the annuity decision.

CPT furthermore posits that gains and losses are valued through a nonlinear value function given by

$$v(x) = x^{\alpha} \; if \; x \geq 0$$
$$v(x) = -\lambda(-x)^{\beta} \; if \; x < 0$$

Tversky and Kahneman [1992] estimate λ=2.25, α=β=0.88. This function is concave for gains and convex for losses, thus yielding a property often called "diminishing sensitivity." The convexity in losses can give rise to risk-seeking behavior, which is at odds with expected utility maximization with a concave utility function. The λ coefficient measures the degree of *loss aversion*: a $1 loss is approximately twice as bad as a $1 gain is good, which predicts that fair gambles with equal chances of gains or losses will be disliked.

While expected utility theory assumes that utilities of different states are weighted by their probabilities, CPT argues that *decision weights* may be unequal to probabilities. In particular, low-probability events may be overweighted while larger probabilities may be underweighted. Another feature of this framework is *rank-dependence*: more extreme gains or losses are weighted more heavily than intermediate gains or losses, even if the probabilities are equal. Let *w* be a nonlinear transformation of the outcome probabilities (*p*), and this function may differ for gains and losses:

$$w^{+}(p) = \frac{p^{\gamma}}{(p^{\gamma} + (1-p)^{\gamma})^{1/\gamma}}$$
$$w^{-}(p) = \frac{p^{\delta}}{(p^{\delta} + (1-p)^{\delta})^{1/\delta}}$$

[4] We adopt the convention that *t=1* indicates the first (current) time period, during which the person is certain to be alive and receive payouts from any immediate annuities that have been purchased. Thus, future payouts are discounted starting with *t=2*.

Tversky and Kahneman [1992] estimated γ=0.61 and δ=0.69. These functions obey the conditions $w(0)=0$ and $w(1)=1$. Figure 1 demonstrates the shape of the w^+ function (the w^- function is very similar): probabilities below about 0.4 are overweighted relative to their true probabilities, while larger probabilities are underweighted. The ultimate decision weight π_i attached to an outcome x_i is captured by the *change* in the function w evaluated at the cumulative probability of that outcome x_i. Formally, this is represented for discrete outcomes by

$$\begin{aligned}
\pi_1^- &= w^-(p_1) \\
\pi_i^- &= w^-(p_1+\ldots+p_i) - w^-(p_1+\ldots+p_{i-1}), 2 \le i \le k \\
\pi_i^+ &= w^+(p_i+\ldots+p_T) - w^+(p_{i+1}+\ldots+p_T), k+1 \le i \le T-1 \\
\pi_T^+ &= w^+(p_T)
\end{aligned}$$

where the outcomes have been ranked according to

$$x_1 < x_2 < \ldots < x_k < 0 \le x_{k+1} < \ldots < x_T.$$

One counter-intuitive feature of these decision weights is that they need not add up to one, because separate w functions for gains and losses are allowed.

The value function and decision weights are combined in an intuitive way to arrive at the total value of the annuity under consideration:

$$V(annuity) = \sum_{t=1}^{T} \pi_t v(x_t)$$

We note here that the particular parameter values provided by Tversky and Kahneman [1992] were based on experiments involving gambles that were quite different from the annuities we are analyzing. We therefore caution that our analysis should be interpreted qualitatively, rather than as a precise quantitative prediction of individuals' willlingness to pay for different types of annuities.

4. Results

Before we review the behavioral valuation of annuities as described in the previous section, we define a benchmark measure that describes valuation under the standard expected utility model and can also be extended to the CPT case. We calculate the annuity price that would make an individual indifferent to buying an annuity. This *reservation price* may differ from the actual annuity price. If the reservation price is lower than the actual price, then the annuity is unattractive: the individual requires a discount in order to be willing to buy the annuity. Conversely, if the reservation price is higher than the actual price, then the annuity is attractive. In order to demonstrate the desirability of annuitization under expected utility, we analyze a hypothetical situation where a retiree without a bequest motive has chosen an optimal consumption stream that is provided by a series of zero-coupon bonds each costing $\{B_1, B_2, ..., B_T\}$.[5] If the term structure of interest rates were flat, each B_t would equal $1/(1+r)^{t-1}$. Suppose he considers switching a dollar of consumption in every period from bonds to an annuity, with the annuity price given by A. Assuming actuarially fair annuity prices, the move from bonds to annuities will be able to provide the same level of consumption at a lower cost, because annuity prices have built-in mortality "discounts" reflecting the probability of being alive to receive the future payments. We can calculate the reservation price R (defined as a fraction of the actual annuity price) that would make the retiree indifferent between bonds and annuities by setting

$$B_1 + ... + B_T = A \times R$$

The left-hand side of this equation is the saved wealth from reducing the bond-funded spending, and the right-hand side represents the equivalent cost of a hypothetical

[5] For ease of exposition, we ignore the availability of equity investments and equity-linked variable annuities.

annuity (with a cost premium) that provides the same amount of spending power. We then have $R = \sum_{t=1}^{T} B_t / A$.[6] We can calculate similar measures for reservation prices under the CPT framework (although there is no simple formula owing to the way that gains or losses are accounted for). Because we analyze annuities with different costs, the reservation price that we report is always normalized by the actuarially fair annuity cost: values above one imply that an actuarially fairly priced annuity is desirable, whereas values below one imply that the annuity is undesirable.[7]

Table 1 reports the reservation prices for a hypothetical 65-year old male considering investing in an annuity. In order to understand which behavioral influences account for the largest distortions in the annuity decision, we calculate reservation prices under the expected utility model and also under CPT with various specific features added piecemeal. The rows represent these different models, while the columns represent different annuity types, from immediate annuities to longevity annuities with payouts beginning between 10 and 30 years in the future (but all purchased at age 65).

We note first that the reservation prices under expected utility are substantially greater than one and increase the further out the payments are received, reflecting the fact that annuity prices are more heavily discounted relative to bonds at later ages (with lower chances of survival). In all of the behavioral models, the reservation price is much lower

[6] We have assumed that there is no bequest motive, so the individual cares only about spending when he is alive and not about money left to heirs. The presence of a bequest motive would reduce the reservation price, because trading in a bond portfolio for an equivalent annuity would reduce money left to heirs. In the very extreme case of an individual who cares equally about his own spending when alive as about his heirs' spending from the inheritance when he is dead, an immediate annuity would provide lower utility than a bond portfolio, because the bond portfolio is already able to provide a stable stream of income whether alive or dead.

[7] The inferences from analyzing reservation prices are qualitatively similar to findings based on calculations of certainty equivalents, another commonly used method of measuring the value of gambles.

than under expected utility. The gain-loss mental accounting perspective is thus likely the single most important behavioral explanation for the unattractiveness of annuities. When analyzing the behavioral models' reservation prices, we see from row A that a linear value function (passing through zero with slope 1) results in a neutral 1.0 reservation price. This merely captures the fact a risk-neutral individual would have a linear value or utility function, and would accept an actuarially fairly priced annuity because it is a fair gamble.

Two other patterns emerge from the behavioral models: loss aversion always makes annuities less attractive, and the distortion of probabilities into decision weights can result in longevity annuities becoming attractive gambles. (The full CPT model implies that the reservation price surpasses one at age 93.) A contributing factor is that the annual payouts associated with such long-delayed annuities are quite large relative to the initial investment. For example, a longevity annuity beginning payouts at age 95 would have an annual payout of approximately $10 per $1 investment at age 65. In this sense, these annuities are somewhat like lottery tickets. We observe here that CPT has been used to explain why individuals play lotteries with negative expected values, and our later analysis of the decisions weights will show how this applies to making longevity annuities attractive. However, we again urge caution against interpreting these results too literally. The reservation prices shown here are intended to provide qualitative explanations of the relative attractiveness of different types of annuities. We do not believe that the Tversky and Kahneman CPT parameter values should be used to make

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We use reservation price here because it provides a simple measure under the expected utility model that does not require assumptions about the specific form of the utility function.

precise predictions about, for example, whether a longevity annuity which starts payouts at age 90 will remain unattractive.

Time Discounting

CPT was intended to explain choices over single-period gambles, whereas annuities have payouts occurring over multiple periods. In our application of CPT to the annuity decision, we have assumed that future payouts were correctly discounted to a present value. This would be a difficult computational task for most retirees to perform correctly, so we provide an additional set of calculations assuming no time discounting of the payouts (but maintaining the assumed interest rate of 3 percent which is used to price bonds and annuities). For example, a 65-year old male retiree considering investing $100,000 in an immediate annuity would expect an annual payout of $7,560 under our interest rate and mortality assumptions. If he were to evaluate the payouts by simply multiplying $7,560 by a life expectancy of 17 years, his "expected payout" would appear to be an attractive $129,000. This is similar to the notion that many individuals suffer from "money illusion" by confounding real and nominal dollars (Shafir, Diamond, and Tversky [1997]).[8]

Because all annuity contracts involve a current investment in exchange for potential future payouts, a lower rate of time discount will raise the reservation price values. Table 2 shows that this effect is strong enough to make all annuities attractive to an individual who shows all of the behavioral anomalies of CPT. While we have not

[8] We do not explicitly analyze issues related to the fact that most annuities have nominal payouts. However, our analysis can be interpreted as an evaluation of annuities priced with a 3% nominal interest rate, and discounted with either a 3% discount rate (no money illusion) or a 0% discount rate (money illusion). Qualitatively, it should be clear that individuals suffering from money illusion should like annuities more than otherwise.

found compelling empirical evidence showing that this extreme form of mis-discounting is widespread, investment professionals are well familiar with the fact that people typically underestimate the power of compound interest. This effect is more pronounced for longevity annuities, since *all* of the payouts may need to be discounted by multiple years. (In contrast, immediate annuities have several payments that need to be discounted only by a few years.) Thus, one might expect mis-discounting to make longevity annuities more attractive than immediate annuities.[9]

The Distribution of Annuity Outcomes

Purchasing an immediate annuity entails a small probability of losing all of the initial investment (if death occurs immediately after signing the contract), while longevity annuities may have very large probabilities of not receiving any payouts. On the positive side, an actuarially fairly priced immediate annuity holds approximately a 50% chance of earning back the initial investment.[10] In contrast, under our pricing assumptions a longevity annuity beginning payouts at age 85 has only about a 30% chance of breaking even, but the potential subsequent gains are larger than for immediate annuities. Table 3 shows the cumulative distribution of outcomes for an immediate annuity and for an age 85 longevity annuity. The second-to-last column shows the cumulative decision weights associated with the outcomes at each age. For example, at age 65, there is a 2 percent probability of dying in the next year, but the decision weight on that outcome is an

[9] The large magnitude of longevity annuities' payments is one feature that Milevsky [2005] argues should make these annuities more appealing than immediate annuities. Put simply, payments that incorporate many years of accrued interest look quite large relative to the initial investment. Of course, the annual payments for longevity annuities are also boosted by the fact that the payments are contingent on survival until those later ages.

[10] It is not an exact 50% probability, because the shape of the survival curve at all ages affects the annuity price and the chance of breaking even.

overstated 6 percent; this is the classic behavioral property of overweighting of small probabilities. For an immediate annuity, this means that the worst event's importance is overstated under CPT. In contrast, observe that surviving through age 80 still results in a loss of 100 percent for a longevity annuity, but its true probability of 45 percent is slightly *underweighted* in a decision weight of only 42 percent. Thus, one essential behavioral difference between immediate annuities and longevity annuities is the weighting attached to their worst outcomes.

Another difference becomes apparent by examining the magnitude of possible gains in Table 3. For a person who buys an immediate annuity at age 65 and dies at age 100, the immediate annuity results in approximately a 70 percent return on investment (i.e., the present discounted value of payouts is equal to 1.7 times the initial outlay). However, a similarly long-lived individual who had purchased a longevity annuity that starts payouts at age 85 would earn back a return of nearly 500 percent. The difference reflects the fact that the annual income from a longevity annuity is many times the income from an immediate annuity purchased with the same initial outlay. The last column in the table reports the cumulative decision weight attached to outcomes better than each column's outcome: at age 100, the true one percent probability of outliving that age is overweighted to a six percent decision weight. (A similar pattern can be seen at ages 90 and 95.) Thus, we see the second essential behavioral difference between immediate and longevity annuities: longevity annuities have much larger potential gains if the retiree lives a very long time, and this prospect is likely to be overweighted.

Explaining Annuity Contract Forms: Period Certain Annuities

The preceding analysis has explained the relative unpopularity of immediate annuities: a behavioral investor will overweight the low probability of early death, which results in a near-complete loss of the initial investment, and loss aversion makes this outcome even more unpalatable. Among annuities that are purchased, one of the most popular contract features is the guarantee of a minimum number of payouts, even if the annuity purchaser dies early. These "life with period certain" annuities represent 73 percent of all individual immediate life annuities sold in the U.S. (LIMRA 1998).

From an economic point of view, a life with period certain annuity is identical to a combination of two different investments: a series of zero-coupon bonds for the guaranteed period, plus a longevity annuity commencing after the guarantee period. The interesting question then becomes why do individuals wish to purchase a combination of bonds and an annuity from an insurance provider (often with substantial fees), rather than creating these bundles themselves? Is there a financial alchemy that results from the combination of these two products that does not occur when they are separated? Extending the application of CPT to these annuities sheds light on this question.

As before, we calculate the potential outcome of the annuity at different potential ages of death, for an annuity purchaser who is a 65-year old male. For example, when considering a life annuity with 10 years of guaranteed payouts, all outcomes where death occurs within the first 10 years are identical. We then apply the same CPT value function and decision weights as were used for the results in Table 1. Table 4 shows the CPT reservation prices for various guarantee periods. The first row reproduces the earlier results for an immediate annuity with no guaranteed payouts.

Adding guaranteed payouts to the annuity contract makes the annuity more attractive. An alternative method of viewing these results is that a fixed $100 investment in the annuity with more guaranteed payouts means a lower-risk investment overall. For example, a life annuity with a 10-year guarantee period costing $100 (and yielding an annual payment of $7) is fundamentally comprised of a package of bonds worth $63 plus a longevity annuity costing $37. The greater attractiveness of period certain annuities is due to the fact that the mental account now combines a riskless bond portfolio with a smaller risky annuity. The bond component has a 100% reservation price (per dollar of bond investment), thus increasing the overall reservation price per dollar of the blended bond-plus-annuity investment. This effect makes sense of why most annuity purchasers choose a guaranteed period. Interpreted in a more intuitive sense, the guarantee period minimizes the anxiety associated with possible early death after the annuity investment is made.[11] While longevity annuities are too new to have reliable data on their popularity, we conjecture that guarantee periods or similar features such as death benefits will be a common feature of these annuities when they are purchased. This leads to the irony that one way to make longevity insurance more acceptable is to dilute the insurance with a bond investment.

5. Conclusion

Many researchers have used variations of expected utility models to attempt to explain the "annuity puzzle" of why the vast majority of retirees do not voluntarily

[11] In a more surreal sense, the guarantee period reduces the fear of "regretting" the annuity decision from the grave, should the purchaser die early. It is possible that individuals have a "legacy motive" in which they consider whether their children will think poorly of a decision to annuitize should they die early. This differs from a standard bequest motive in which the individual derives utility from the dollar value of a bequest.

annuitize any retirement savings. Despite these efforts, a significant puzzle remains. This paper applies the lessons of behavioral decision research to the annuity decision in order to determine whether well-documented anomalies that individuals make in choosing between risky outcomes *might* explain low annuity demand. We identified several factors that make annuities look undesirable, explained the popularity of guaranteed period life annuities, and made some predictions about the potential attractiveness of newly introduced longevity annuities.

The most important potential reason for annuities being unpopular is mental accounting. If annuity outcomes are segregated from their impact on total retirement spending, then purchasing an annuity appears to be a gamble which *increases* overall risk, rather than a form of insurance which can reduce risk. In order to combat this problem, annuity marketers and financial advisors need to better frame the annuity as longevity insurance. Having longevity insurance in the form of an annuity should reduce the need for precautionary saving and thus allow annuity holders to consume more in retirement. Ironically, the recent growth of variable annuities, which provide a combination of investment return and longevity insurance, may have undermined the ability to frame annuities as longevity insurance rather than as investment products.

Among those retirees who do annuitize some retirement savings, the popularity of annuities with guaranteed minimum payouts can be explained by the mental accounting framework. Life with period certain annuities combine a riskless bond portfolio with a risky annuity contract, thus making the overall bundle less risky than a pure annuity contract. Thus, our application of behavioral finance to annuities allows us to explain not

only the overall low demand for annuities, but also the types of annuity offerings seen in the marketplace.

Within the context of cumulative prospect theory, loss aversion and the overweighting of small probabilities are each significant factors that make annuities look more undesirable than under expected utility. Interestingly, the overweighting of small probabilities may make some longevity annuities look more attractive than immediate annuities. Money illusion in the form of mistakes in time discounting may also contribute to the attractiveness of longevity annuities. While exploiting behavioral anomalies would be an ignoble way to induce annuity demand, these distortions may induce some retirees to more thoroughly consider these longevity annuities, which have been shown to be more desirable than immediate annuities in a normative, expected utility context (Scott, Watson, and Hu [2006]). Less easily quantifiable biases such as the availability heuristic or ambiguity aversion may alter annuity demand differently than our quantitative analysis suggests, however. Ultimately, we hope that the behavioral biases working against annuities can be overcome through proper framing and analysis, so that more retirees might agree with the normative economic conclusion that annuitization of some part of retirement savings should be desirable in many cases.

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Appendix - Other Behavioral Factors

Cumulative prospect theory allows us to rigorously combine all of the many possible outcomes and their probabilities into a single "value" (or utility) measure. However, we have so far ignored some other behavioral anomalies that are less straightforward to incorporate into the analysis. In this section, we discuss in turn the availability heuristic, fear of illiquidity, hyperbolic discounting, and the behavioral distinction between risk and uncertainty.

The Availability Heuristic

Separately from prospect theory, Tversky and Kahneman [1974] delineated several ways in which individuals' probability assessments are influenced by the use of simple heuristics. One that is particularly relevant for annuity decisions may be the "availability heuristic": events or facts that are more easily imagined (i.e., more available to the mind) carry greater salience and hence are assigned greater likelihood. In the case of annuities, the availability heuristic may play a role in overemphasizing the possibility of dying shortly after the annuity is purchased, because there are many ways an individual can imagine his imminent demise. The likelihood of greatly outliving one's life expectancy may, on the other hand, not have as much salience, except in those cases where family members or other acquaintances have survived to very advanced ages. This exaggeration of the likelihood of early death would make annuities appear worse than in the analysis of section 4. (This overemphasis could also be another contributing factor to the popularity of guaranteed period annuities.)

A related anomaly is the conjunction fallacy (Tversky and Kahneman 1983), which leads individuals to mistakenly believe that a combination of events is more likely

than either event alone. In a classic experiment, individuals were presented with the following description of a hypothetical woman: "Linda is 31 years old, single, outspoken, and very bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice, and also participated in anti-nuclear demonstrations." Most individuals believed that it was more likely that Linda was both a bank teller *and* active in the feminist movement than that she was a bank teller. For an annuity purchaser, this anomaly in probability assessment can lead to an overstatement of the likelihood of early death, if the individual imagines death from car accidents, airplane crashes, heart disease, etc. as separate events. In contrast, the prospect of living a very long time is more difficult to disassemble into several compound events which would be separately overweighted. Thus, the conjunction fallacy combined with the availability heuristic can lead to a greater emphasis on the potential losses due to early death, without a similar overemphasis on the potential gains from outliving one's life expectancy.

Fear of Illiquidity

A significant feature of annuities is their illiquidity: once an investment is made, it is usually impossible to withdraw funds (beyond regularly scheduled payments) in case of unanticipated higher spending needs. In a Society of Actuaries [2004] survey, among workers who were asked what factors were important in choosing a retirement plan payout option, sixty-one percent responded that "being able maintain control of your investments" was very important. While potential liquidity needs is certainly a valid reason not to annuitize all retirement savings, it should not be a significant concern when evaluating whether to annuitize modest fractions of retirement wealth. However, similar to the behavioral mistakes that individuals make when assessing probabilities of dying at

early ages, it is quite possible that individuals also overstate the likelihood of catastrophic events that may require sudden spending that could not be met after annuitization. Such errors may be due to the availability heuristic (health shocks are relatively easy to imagine) and made worse by the conjunction fallacy (there are multiple types of health shocks that may be imagined and hence their joint likelihood overstated).

Hyperbolic Discounting

A distinct branch of the literature has focused on anomalies related to time discounting. One prominent model—hyperbolic discounting—posits that, viewed from period t, the discount rate between t and $t+1$ is higher than that between $t+k$ and $t+k+1$ (assuming $k>0$). This description of decision-making has two interesting (and opposing) implications for annuity decisions. First, any annuity evaluated narrowly as a gamble in its own mental account will look more unattractive, because an annuity shifts money from the present into the future. Second, Laibson [1997] shows that hyperbolic discounters who are aware that their rate of impatience will evolve over time will benefit from self-commitment devices that prevent them from "overspending."[12] Christmas savings clubs and tax-advantaged defined contribution plans with early withdrawal penalties have been identified as potential commitment devices. Annuities are another mechanism for committing to a retirement spending plan.

One might then ask why annuities are not as much demanded as some other savings-commitment devices. We can point to two plausible explanations. First, using an annuity as a commitment device requires the retiree to overcome the other behavioral

[12] "Overspending" is defined as spending more at time $t+k$ (relative to time $t+k+1$) than would have been desired when a consumption plan was made at time t.

anomalies analyzed in this paper, whereas choosing to save in a 401(k) plan is usually not thought of as risky. Second, annuities compete against a popular heuristic—"don't spend from principal"—that may serve as an adequate (though economically inefficient) commitment.[13] This heuristic, another form of mental accounting, does not have the same legal force as an annuity contract, but casual observation suggests that it is powerful enough for retirees to follow. Moreover, the argument that hyperbolic discounters will demand commitment devices requires that they be "sophisticated" enough to know that their preferences will change; this contrasts to the so-called "naïve" hyperbolic discounters who are unaware of their self-control issues. It is conceivable that the "don't spend from principal" rule is powerful and simple enough for the "sophisticated" hyperbolic discounter to choose this method of commitment over annuities.

Risk v. Uncertainty

Ellsberg [1961] demonstrated that many individuals prefer to bet on a single ball drawn from an urn with 50 black and 50 red balls, rather than on a ball drawn from an urn with 100 balls of unknown composition of black and red balls. In the behavioral literature, this has been called "ambiguity aversion": individuals are more averse to "uncertain" gambles (unknown probabilities) than to "risky" gambles (known probabilities). In Tversky and Kahneman's calibration of the CPT model parameters and in our analysis in section 4, we assumed that survival probabilities were known. This assumption places a high degree of confidence in the knowledge of most retirees. It is straightforward to extend Ellsberg's result to suggest qualitatively that retirees who are

[13] Laibson [1997] notes that some consumers may use "internal self-control mechanisms, like 'will-power' and 'personal rules.'"

uncertain about survival probabilities will be more averse to annuities than implied by our earlier results. One can further conjecture that, in comparing immediate and longevity annuities, the degree of uncertainty may be more relevant for longevity annuities, since outcomes for longevity annuities depend more on events further into the future (i.e., many retirees may have a relatively accurate sense of the probability of living until age 75, but a worse idea of the likelihood of living until age 100). Thus, the relative attractiveness of longevity annuities vis-à-vis immediate annuities may be worse than implied by the analysis in section 4.

An important countervailing factor is the fact that purchasing a longevity annuity can significantly reduce the uncertainty of the retiree's planning horizon. For example, a retiree who purchases an annuity to cover all anticipated expenses after age 85 can better focus the investment portfolio on providing spending from age 65 until 85. This reduction in uncertainty would be ignored by an individual engaging strictly in mental accounting, but this is one major advantage of longevity annuities that we would think likely to be communicated in annuity marketing materials.

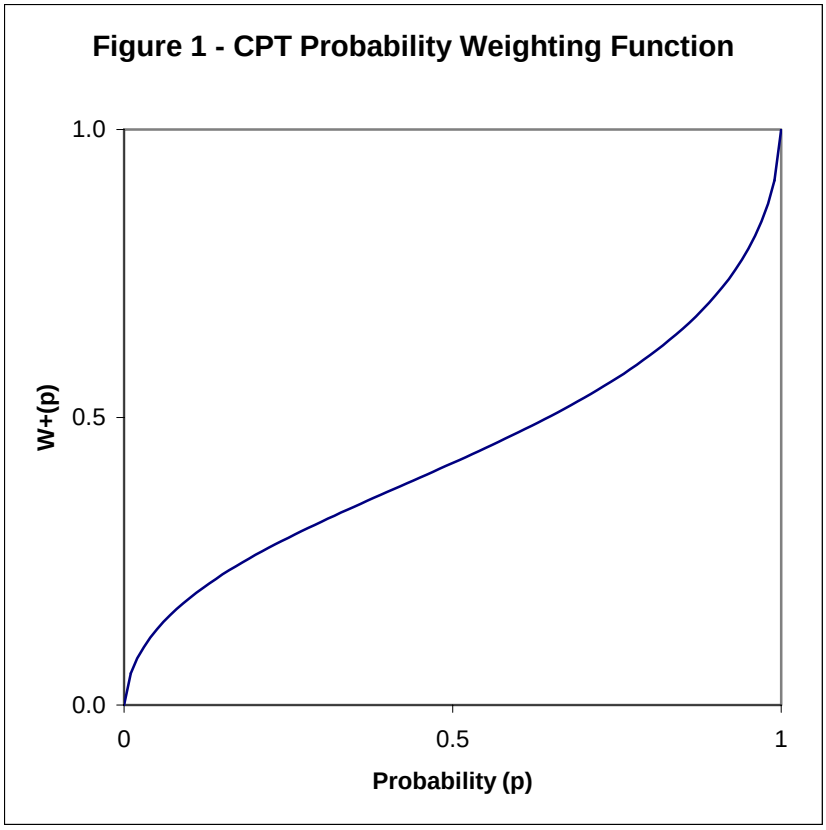
Figure 1 - CPT Probability Weighting Function
1.0
0.5
0.0
W+(p)
0
0.5
1
Probability (p)

Table 1
Annuity Reservation Price per $1 for a 65-Year Old Male

	Age of First Annuity Payout:			
	65	**75**	**85**	**95**
Expected Utility	2.10	3.62	9.95	78.44
Mental Accounting with Reference Point:				
A. Linear Value Function (No Loss Aversion)	1.00	1.00	1.00	1.00
B. CPT Value Function				
No Loss Aversion	1.00	1.00	0.92	0.70
With Loss Aversion	0.85	0.70	0.48	0.29
C. CPT including Decision Weights				
No Loss Aversion	0.98	1.06	1.39	2.78
With Loss Aversion	0.77	0.68	0.74	1.20

Table 2
No Time Discounting

Age of First Annuity Payout	Reservation Price per $1
65	1.03
75	1.16
85	1.57
95	3.24

Table 3
Summary of Outcomes and Decision Weights for a 65-year old Male

		Annuity Outcomes		*Decision Weights*	
Age	**Probability of Dying by Each Age**	**Immediate Annuity**	**Age 85 Longevity Annuity**	**Cumulative Weight**	**Weight on Better Outcomes**
65	0.02	-92%	-100%	0.06	0.81
70	0.13	-58%	-100%	0.20	0.67
75	0.27	-28%	-100%	0.31	0.56
80	0.45	-2%	-100%	0.42	0.45
85	0.64	20%	-56%	0.52	0.35
90	0.83	39%	147%	0.63	0.24
95	0.95	56%	322%	0.73	0.14
100	0.99	70%	472%	0.81	0.06

Note: Sum of decision weights equals 0.87, not 1.

Table 4
Life with Period Certain Annuities

Number of Guaranteed Years	Annual Payout	Reservation Price per $1
0	7.6	0.77
5	7.5	0.81
10	7.1	0.88
15	6.6	0.94
20	6.0	0.98