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Behavioral Obstacles in the Annuity Market

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As Baby Boomers enter retirement, they will look to the investment industry for ways to generate income from accumulated savings. Why most retirees do not purchase longevity insurance in the form of lifetime annuities is a long-standing puzzle. Mental accounting and loss aversion can explain the unpopularity of annuities by framing them as risky gambles where potential losses loom larger than potential gains. Moreover, behavioral anomalies can explain the prevalence of "period certain" annuities, which guarantee a minimum number of payouts. Finally, investors may prefer "longevity annuities" purchased today to begin payouts in the future to immediate annuities because investors overweight the small probability of living long enough to receive large future payouts.

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 (DB) pensions. Baby Boomers will need to rely more heavily on defined-contribution (DC) pensions—such as 401(k) plans and IRAs—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 the winners and losers are from these large asset flows.

A significant focus for the industry is whether retirees are adequately protected against longevity risk (the risk of outliving one's assets). Baby Boomers are unlikely to have the high degree of guaranteed lifetime income that was formerly provided by DB pensions. A natural replacement for a DB pension, however, 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. The insurance industry has long faced the dilemma, however, 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, but a significant "annuity puzzle" remains: Virtually zero voluntary annuitization is going on beyond the payouts provided by Social Security and DB pensions. For the vast majority of retirees, however, for their optimal annuitization strategy to equal the amounts provided by Social Security and DB pensions would be a miraculous coincidence. What would be even harder to believe is that the shrinking of DB pensions is not increasing the need for privately purchased annuities.

Some authors have speculated that behavioral factors prevent most retirees from converting accumulated savings into an annuity income stream. We seek 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 manage 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 factors explain why individual investors consider purchasing annuities with retirement assets undesirable? What psychological errors documented in the experimental literature are responsible for the largest distortions in the annuity decision?

Previous annuity research focused almost completely on *immediate-payout* annuities. The insurance industry has continued to create innovative annuity products, however, 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,

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and Hu (2007) demonstrated that these annuities can be markedly superior to immediate-payout annuities for retirees willing to annuitize only a fraction of their savings. Although that analysis has a strong normative implication—namely, that longevity annuities *should* be highly desirable to an expected utility maximizer—a significant remaining question is whether this new form of annuity *will* actually realize significant demand or whether it will complicate the annuity puzzle even further.

To investigate the annuity puzzle, we apply two key ideas from behavioral finance and psychology: mental accounting and cumulative prospect theory. *Mental accounting* can cause a retiree to consider an annuity to be a distinct, risky gamble instead of a way of lessening the risk of having to reduce spending if one lives well beyond life expectancy. We apply *cumulative prospect theory* to show that aversion to losses relative to a status quo (assumed to be the state of nonannuitization) can explain investors' avoidance of annuities even when longevity risk is the only risk. Our analysis also explains the prevalence of period-certain annuities (which guarantee a minimum number of payouts) and shows that longevity annuities may be more attractive than immediate annuities to a retiree operating under the sway of behavioral biases.

Annuities in Expected Utility Models

Yaari (1965) showed that, under the assumption of actuarially fair annuity prices and in the absence of bequest motives, retirees should annuitize all of their wealth upon retirement. In the ensuing decades, several authors argued that partial or delayed annuitization may be preferable because of such factors as the illiquidity of annuities, bequest motives, or the ability to earn higher rates of return through stock investments (see the excellent overviews in Brown and Warshawsky 2004 and Horneff, Maurer, Mitchell, and Stamos 2007 for recent examples.) Other authors 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).

Although all of these factors may diminish the gains from annuitization (or argue for full annuitization at later ages), they do not satisfactorily model the empirical fact that the vast majority of retirees' longevity-insured income streams is provided by Social Security and DB pensions, in amounts that are not optimally chosen by each retiree. For those retirees with little or no retirement savings, these income sources represent effectively full annuitization. For retirees with substantial savings, however, we observe little additional annuitization. Yet, it would be a peculiar coincidence if Social Security and DB pensions were optimal for each person, because the extreme heterogeneity in private savings levels implies different optimal annuitization fractions (determined almost completely by nonvoluntary annuities).

Departing from traditional models with additively separable utility, Davidoff, Brown, and Diamond (2005) used 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 showed that finding situations in which less than two-thirds of retirement wealth should be invested in annuities is "extremely difficult." Given their lack of success in explaining low annuitization from a rational perspective, they stated that "lack of annuity demand may arise from behavioral considerations" (p. 1589).

A Behavioral Analysis of Annuities

The existing annuity literature is almost entirely *normative*; that is, it seeks to explain how a rational individual should behave. The last couple of decades have seen a blossoming of alternative *descriptive* models, however, that explain how individuals actually make choices, particularly choices involving risky outcomes. Some authors, such as Kahneman and Tversky (1979) and Tversky and Kahneman (1992), presented both formal models and experimental evidence to measure the value of model parameters. Other authors used descriptive 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) applied Tversky and Kahneman's (1992) cumulative prospect theory to explain the equity premium puzzle.

In this section, we apply descriptive behavioral models to the annuity decision. We first define the relevant *mental account* that is likely to be used for the annuity decision. We then apply cumulative prospect theory as a baseline model for analyzing the annuity "gamble." In a later section, we discuss other behavioral considerations that are less easily quantifiable but may 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 man considering a gamble that puts $10 at risk should, according to expected utility theory, evaluate the overall impact of the gamble on his total wealth; behavioral research points to a pattern, however, 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 or she can afford. For example, a retiree without annuities may follow a rule of thumb that sets initial spending equal to, say, 4 percent of wealth and then adjusts that percentage over time to keep up with inflation. Having an annuity stream, however, should allow a retiree to spend more in retirement than this rule allows, because the annuity's longevity insurance reduces the need for precautionary saving against long life. Faced with the annuity decision, retirees may use a "broad frame," in which they value the fact that the annuity guarantees income even when they have lived well beyond life expectancy and may have exhausted most of their assets, or a "narrow frame," in which they evaluate the annuity, like the $10, purely as a gamble unrelated to other assets.

Read, Loewenstein, and Rabin (1999) argued that the 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 (that is, planning for consumption over the course of a life) argues strongly that most retirees will adopt a narrow frame. The optimization of intertemporal consumption is a 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 the optimization even more daunting.[1]

So, retirees may tend to evaluate annuities from the gamble perspective: Will I live long enough to make back my initial investment in this annuity? Brown and Warshawsky (2004) described 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*" (p. 343; emphasis added), which means that they perceived annuities as *increasing* overall risk in retirement. Similarly, a Society of Actuaries (2004) survey found that nearly half of workers and retirees in DC plans described "protecting against the loss of value from a pension or annuity investment should they die earlier than expected" as very important. The combination of these perspectives—considering annuities as gambling on longevity and desiring protection against loss of their assets' values even after death—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—in particular, on the question of what discount rates are applicable. As a starting point, we make the assumption (to be relaxed later) that 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

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

where Y represents the annual annuity payout.[4]

In this analysis, we assume that annuity prices are actuarially fair and based on Social Security mortality tables, with no fees and with 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, using Tversky and Kahneman's (1992) seminal work on cumulative prospect theory (CPT), how behavioral investors evaluate those outcomes.

Cumulative Prospect Theory. CPT has three main components: 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*. It is usually assumed to be the current wealth position. In the case of the annuitization decision, a natural approach is to define the reference point as the status quo of nonannuitization. CPT furthermore posits that gains and losses are valued through a nonlinear value function given by

$$v(x) = x^{\alpha} \text{ if } x \geq 0; \tag{2a}$$

$$v(x) = -\lambda(-x)^{\beta} \text{ if } x < 0. \tag{2b}$$

Tversky and Kahneman (1992; hereafter, TK) estimated a λ of 2.25 and $\alpha = \beta = 0.88$. 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.

Whereas expected utility theory assumes that the utilities of various states are weighted by their probabilities, CPT argues that *decision weights* may be unequal to probabilities. In particular, low-probability events may be overweighted and events with larger probabilities, 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. We assign w to represent the nonlinear transformation of the outcome probabilities, p, and this function may differ for gains and losses as follows:

$$w^{+}(p) = \frac{p^{\gamma}}{\left[p^{\gamma} + (1-p)^{\gamma}\right]^{1/\gamma}}; \tag{3a}$$

$$w^{-}(p) = \frac{p^{\delta}}{\left[p^{\delta} + (1-p)^{\delta}\right]^{1/\delta}}. \tag{3b}$$

TK estimated γ to be 0.61 and δ to be 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 similar): Probabilities below about 0.4 are overweighted relative to their true probabilities, whereas larger probabilities are underweighted. The ultimate decision weight, π_i, attached to outcome x_i is captured by the *change* in function w evaluated at the cumulative probability of that outcome x_i. Formally, this ultimate decision weight is represented for discrete outcomes by

$$\pi_1^{-} = w^{-}(p_1), \tag{4a}$$

$$\pi_i^{-} = w^{-}(p_1 + \ldots + p_i) - w^{-}(p_1 + \ldots + p_{i-1}),\ 2 \leq i \leq k, \tag{4b}$$

$$\pi_i^{+} = w^{+}(p_i + \ldots + p_T) - w^{+}(p_{i+1} + \ldots + p_T),\ k+1 \leq i \leq T-1, \tag{4c}$$

$$\pi_T^{+} = w^{+}(p_T), \tag{4d}$$

where the outcomes have been ranked according to

$$x_1 < x_2 < \ldots < x_k < 0 \leq x_{k+1} < \ldots < x_T. \tag{5}$$

A counterintuitive feature of these decision weights is that they need not add up to 1.0 because separate w functions for gains and losses are allowed.

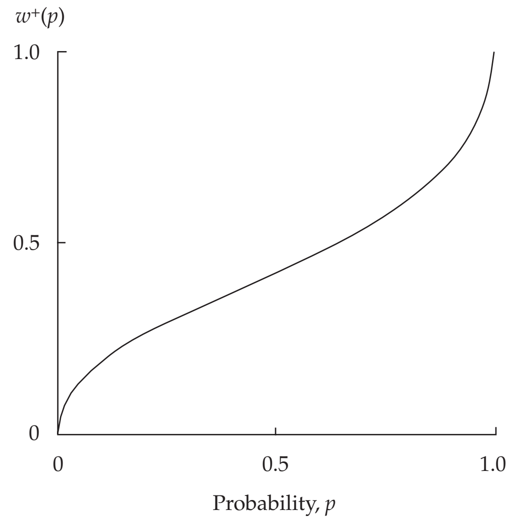
The value function and decision weights are combined in an intuitive way to arrive at the total value of the annuity under consideration:

$$V(\text{annuity}) = \sum_{t=1}^{T} \pi_t v(x_t). \tag{6}$$

We note here that the particular parameter values provided by TK were based on experiments involving gambles quite different from the annuities we are analyzing. We thus caution that our analysis should be interpreted qualitatively rather than as a precise quantitative prediction of individuals' willingness to pay for various types of annuities. In Appendix A, we explore the sensitivity of the results to changes in key parameter values.

Note also that this analysis does not incorporate possible bequest motives, which would reduce the desirability of annuities. Bequest motives might play a role in explaining the relative popularity, among individuals willing to annuitize, of period-certain annuities because these annuities preserve

Figure 1. CPT Probability-Weighting Function



some bequest possibilities. We show in the next section that CPT is powerful enough to explain low annuity demand overall (combined with the relative preference for period-certain annuities) even in the absence of bequest motives.

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 maximum acceptable price (sometimes called "reservation price") may differ from the actual annuity price. If the maximum acceptable price is lower than the actual price, then the annuity is unattractive: The individual requires a discount to be willing to buy the annuity. Conversely, if the maximum acceptable price is higher than the actual price, then the annuity is attractive.

To demonstrate the desirability of annuitization under expected utility, we analyze a hypothetical situation in which a retiree without a bequest motive has chosen an optimal consumption stream that is provided by a series of zero-coupon bonds each costing $\{B_1, B_2, \ldots, B_T\}$ per dollar of consumption.[5] [If the term structure of interest rates were flat, each B_t would equal $1/(1 + r)^{t-1}$.] Suppose this retiree 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 provide the same level of consumption as bonds 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 maximum acceptable price, P_M (defined as a fraction of the actual annuity price), that would make the retiree indifferent between bonds and annuities by setting

$$B_1 + \ldots + B_T = P_M A. \tag{7}$$

The left-hand side of Equation 7 is the saved wealth from reducing the bond-funded spending, and the right-hand side represents the equivalent cost of a hypothetical annuity (with a cost premium) that provides the same amount of spending power. We then have[6]

$$P_M = \sum_{t=1}^{T} \frac{B_t}{A}. \tag{8}$$

Thus, the maximum acceptable price under expected utility can be thought of as a measure of the extra cost of a bond portfolio that provides the same retirement spending as a lifetime annuity. The extra cost arises because bonds have payouts even if the retiree dies whereas annuities pay out only should the retiree survive to a given age. If this extra bond-related cost is large, then the maximum acceptable price is higher and an expected utility–maximizing individual finds annuities more desirable than bonds.

We can calculate similar measures for maximum acceptable prices under the CPT framework (although because of the way that gains or losses are accounted for, no simple formula exists). Because we analyze annuities with different costs, the maximum acceptable price that we report has always been normalized by the actuarially fair annuity cost: Values above 1.0 imply that an actuarially fairly priced annuity is desirable; values below 1.0 imply that the annuity is undesirable.[7]

Table 1 reports the maximum acceptable prices for a hypothetical 65-year-old male considering investing in an annuity. To explore which behavioral influences account for the largest distortions in the annuity decision, we calculated maximum acceptable prices by the expected utility model and also by CPT with various specific features added piecemeal. The columns represent various annuity types, from immediate annuities (paying out at 65) to longevity annuities with payouts beginning between 10 and 30 years in the future (but all purchased at age 65).

Note first that the maximum acceptable prices under expected utility are substantially greater than 1.0 and increase the farther 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 maximum acceptable price is much lower than under expected utility. The gain/loss mental accounting perspective can thus be the most powerful behavioral explanation for individuals who do not perceive the risk-hedging benefits of annuities. When analyzing the behavioral models' maximum acceptable prices, the linear value function (passing through 0 with slope 1) results in a neutral 1.0 maximum acceptable price. This result merely captures the fact that a risk-neutral individual has a linear value or utility function and will accept an actuarially fairly priced annuity because it is a fair gamble.

Loss aversion always reduces the attractiveness of annuities. Simply put, an actuarially fair immediate annuity will be rejected because the loss from possible early death looms twice as large as a gain possible from living long enough to earn back the annuity premium.

Table 1. Maximum Acceptable Annuity Price per $1 for a 65-Year-Old Male

	Age of First Annuity Payout			
Model	65	75	85	95
Expected utility	2.10	3.62	9.95	78.44
Mental accounting				
Linear value function (no loss aversion)	1.00	1.00	1.00	1.00
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
CPT including probability distortion				
No loss aversion	0.98	1.06	1.39	2.78
With loss aversion	0.77	0.68	0.74	1.20

The distortion of probabilities into decision weights has two effects. First, it reduces the desirability of an immediate annuity because the small possibility of large losses from early death is overstated. Second, it can result in longevity annuities becoming attractive gambles. (The full CPT model implies that the longevity annuity's maximum acceptable price surpasses 1.0 at age 93.) For example, although there is only a 5 percent likelihood of living until age 95, that prospect is overweighted with a decision weight of 14 percent. 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 may be perceived in a way similar to the perception of lottery tickets: Indeed, CPT has been invoked frequently to explain why individuals play lotteries with negative expected values.[8]

We again urge caution in interpreting these results too literally. The maximum acceptable prices shown here are intended to provide qualitative explanations of the relative attractiveness of various types of annuities. We do not believe that the TK parameter values for CPT should be used to make precise predictions about, for example, whether a longevity annuity that starts payouts at age 90 would remain unattractive.

Time Discounting. CPT was intended to explain choices for 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 discounting would be a difficult computational task for most retirees to perform correctly, so we provide an additional set of calculations that assume no time discounting of the payouts (but maintain the assumed interest rate of 3 percent 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 payout by simply multiplying $7,560 by a life expectancy of 17 years, his "expected payout" would appear to be an attractive $129,000. The possibility of this incorrect discounting is similar to the notion that many individuals suffer from "money illusion" by confounding real and nominal dollars (Shafir, Diamond, and Tversky 1997).[9]

Because all annuity contracts involve a current investment in exchange for potential future payouts, a lower rate of time discount will raise the maximum acceptable price values. **Table 2** shows that this effect is strong enough to make all annuities attractive to an individual with all of the behavioral anomalies of CPT. Although we have not found compelling empirical evidence that this extreme form of mis-discounting is widespread, investment professionals are quite familiar with the fact that people typically underestimate the power of compound interest. This effect is more pronounced for longevity annuities because *all* of the payouts may need to be discounted by multiple years.[10] (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.[11]

Table 2. No Time Discounting

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

Explaining Annuity Contract Forms: Period-Certain Annuities. The preceding analysis explained the relative unpopularity of plain immediate annuities: A behavioral investor's loss aversion will cause her to place great emphasis on the nearly complete loss of the initial investment should she die early. Among annuities that are purchased, one of the most popular contract features, therefore, 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 United States (LIMRA International 1998).

From an economic point of view, a life-with-period-certain annuity is identical to a combination of two investments: a series of zero-coupon bonds for the guarantee period plus a longevity annuity commencing after the guarantee period. The interesting question then becomes why individuals are willing to buy the combination product but not the individual components. Extending the application of CPT to these annuities sheds light on this question.[12]

As previously, we calculate the potential outcome of the annuity at various 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 probability distortion as were used for the results in Table 1. **Table 3** shows the CPT maximum acceptable prices for various guarantee periods. The first row reproduces the earlier results for an immediate annuity with no guaranteed payouts.

Table 3. Life-with-Period-Certain Annuities

Number of Guaranteed Years	Annual Payout	Maximum Acceptable 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

Adding guaranteed payouts to the annuity contract makes the annuity more attractive. An alternative way to view these results is that a fixed $100 investment in the annuity with more guaranteed payouts means a lower-risk investment, within this mental account. For example, a life annuity with a 10-year guarantee period costing $100 (and yielding an annual payment of $7) is fundamentally composed of a package of bonds worth $63 plus a longevity annuity costing $37. The relatively greater attractiveness of the period-certain annuities is because the mental account now combines a riskless bond portfolio with a smaller risky annuity. The bond component has a 100 percent maximum acceptable price (per dollar of bond investment), thus increasing the overall maximum acceptable price per dollar of the blended bond-plus-annuity investment. This effect makes sense of why most annuity purchasers choose a guarantee period. Intuitively, the guarantee period minimizes the anxiety associated with possible early death after the annuity investment is made.[13]

Although longevity annuities are too new for reliable data on their popularity to be available, we conjecture that guarantee periods or similar features, such as death benefits, will become a popular feature of annuities. The irony is that one way to make longevity insurance acceptable is to dilute the insurance with a bond investment. This combination appears to be a less risky investment within a mental accounting framework, but the dilution of longevity insurance may actually *increase* the risk to intertemporal consumption.

Other Behavioral Factors

Cumulative prospect theory allows all of the many possible outcomes and their probabilities to be rigorously combined into a single "value" (or utility) measure. Some other behavioral anomalies, however, are less straightforward to incorporate into the analysis. In this section, we discuss these anomalies: 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 may be particularly relevant for annuity decisions is 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 than other, less available events/facts. In the case of annuities, the availability heuristic may play a role by overemphasizing the possibility of dying shortly after the annuity is purchased because an individual can imagine his imminent demise in many ways. The likelihood of greatly outliving one's life expectancy may not have as much salience, except in those cases where family members or other acquaintances have survived to advanced ages. This exaggeration of the likelihood of early death would make annuities appear less desirable than in the results of the previous section. (This overemphasis could also be a contributing factor to the popularity of life-with-period-certain 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 bright. She majored in philosophy. As a student, she was deeply concerned with issues of discrimination and social justice and also participated in antinuclear 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, and so on, as separate events. In contrast, the prospect of living a very long time is more difficult to disassemble into several compound events that would be separately overweighted. Thus, the conjunction fallacy combined with the availability heuristic can lead to a greater emphasis being placed on the potential loss because of early death than on the potential gains from outliving one's life expectancy.

Fear of Illiquidity. A significant feature of annuities is their illiquidity: Once an investment in an annuity is made, withdrawing funds in case of unanticipated higher spending needs (beyond regularly scheduled payments) is usually impossible. In a Society of Actuaries (2004) survey, among workers who were asked what factors were important in choosing a retirement plan payout option, 61 percent responded that "being able to maintain control of your investments" is very important. Although the potential need for liquidity 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, as in the behavioral mistakes that individuals make when assessing the probability of dying at an early age, individuals may also overstate the likelihood of catastrophic events that require sudden spending that could not be met after annuitization. Such errors may be a result of the availability heuristic (health shocks are relatively easy to imagine) and are made worse by the conjunction fallacy (multiple types of health shocks may be imagined; hence, their joint likelihood is overstated).

In a similar vein, retirees may overstate the likelihood of bankruptcy for the insurance company that sells the annuity. Such a bankruptcy, to the extent that the annuity payments are not guaranteed (see Babbel and Merrill 2006), would, of course, jeopardize the funds in the annuity.

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 even more unattractive, because an annuity shifts money from the present into the future. Second, Laibson (1997) showed 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."[14] Christmas savings clubs and tax-advantaged DC 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 anomalies, 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.[15] This heuristic, a 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; in contrast, the so-called naive hyperbolic discounters are unaware of their self-control issues. The "don't spend from principal" rule may be powerful and simple enough that it causes even the sophisticated hyperbolic discounter to choose this method of commitment over annuities.

Risk vs. 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 than on a ball drawn from an urn with 100 balls of unknown composition of black and red balls. In the behavioral literature, this preference has been called "ambiguity aversion": Individuals are more averse to "uncertain" gambles (unknown probabilities) than to "risky" gambles (known probabilities). In the TK calibration of the CPT model parameters and in the previous section, we assumed that survival probabilities were known. This assumption places a high degree of confidence in the knowledge of most retirees. Ellsberg's result can be extended, however, to suggest qualitatively that retirees who are uncertain about survival probabilities will be more averse to annuities than is implied by our earlier results. One can further conjecture that, in a comparison of immediate and longevity annuities, the degree of uncertainty may be more relevant for longevity annuities because outcomes for longevity annuities depend more on events farther in the future (i.e., many retirees may have a relatively accurate sense of the probability of living until age 75 but no accurate 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 CPT analysis.

An important countervailing factor is the fact that purchasing a longevity annuity may 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 focus the investment portfolio on providing spending from age 65 until age 85. This reduction in uncertainty would be ignored by an individual engaging strictly in mental accounting, but it is one major advantage of longevity annuities that we think likely to be communicated in annuity marketing materials.

Conclusion

Many researchers have used variations of expected utility models in an attempt to explain the annuity puzzle of why the vast majority of retirees do not voluntarily annuitize any retirement savings. Despite these efforts, the puzzle remains. We applied the lessons of behavioral decision research to the annuity decision to determine whether well-documented anomalies in individuals' choices between risky outcomes might explain low annuity demand. We identified several factors that make annuities look undesirable, explained the popularity of life-with-period-certain annuities, and made some predictions about the potential attractiveness of newly introduced longevity annuities.

Mental accounting can explain in large part why annuities have not realized the demand that expected utility models have recommended. If annuity outcomes are segregated from their impact on total retirement spending, then purchasing an annuity appears to be a gamble that *increases* overall risk, rather than a form of insurance that can reduce risk. To combat this problem, annuity marketers and financial advisers 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 alone can make annuities look more undesirable than in expected utility theory. Interestingly, a different factor—the overweighting of small probabilities—may overcome loss aversion to make some longevity annuities, with their delayed payouts, 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. Although exploiting behavioral anomalies would be an ignoble way to induce annuity demand, these distortions may encourage some retirees to more thoroughly consider these longevity annuities.

Less easily quantifiable biases, such as the availability heuristic and ambiguity aversion, may alter annuity demand differently, however, from how our quantitative analysis suggests.

Ultimately, we hope that the behavioral biases working against annuities can be overcome through proper framing and analysis. Achieving that goal should convince more retirees of the normative economic conclusion that they should annuitize some part of their retirement savings.

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This article qualifies for 1 PD credit.

Appendix A. Sensitivity Analysis

In the text, we assumed the validity of the parameter values estimated by TK for the annuity decision, although annuity decisions typically involve much larger investments than the gambles used in psychological experiments. What is not obvious, however, is whether the behavioral biases we discussed should be weaker or stronger when the size affected by the decision increases. We focus attention on the loss aversion parameter, λ, and the curvature of the probability-weighting function, δ and γ.[16]

Benartzi and Thaler (1995) showed that a loss aversion of 2, combined with the observed size of the equity risk premium, implies that investors evaluate their portfolio gains or losses annually. This finding provides intuitively appealing support for the notion that a loss aversion of about 2 is relevant for material economic decisions, such as investing. In the housing market, which probably represents transactions affecting a greater fraction of typical household wealth than investing does, Genesove and Mayer (2001) found that listing prices are affected by earlier purchase prices, reflecting loss aversion in nominal terms.

Evidence is available about whether probability distortions apply to large gambles. Kahneman and Tversky's (1979) experimental results, from Israeli subjects, were based on gambles with payoffs as high as twice the median monthly family income in Israel. Dodonova and Khoroshilov (2006) found that much smaller gambles are generally subject to the same distortions, with some evidence that smaller gambles have weaker distortions. Thus, this evidence does not suggest a weakening of the probability distortion when (larger) annuity investments are being evaluated.

Table A1 shows how the annuity's maximum acceptable price is affected by weaker or stronger loss aversion and by weaker or stronger probability distortion. The results from Table 1 are repeated for comparison, and the last four rows show the results when a CPT parameter is altered. In each of the last four rows, the other CPT parameters are kept fixed at the TK values; only the parameters named in each row are being changed. The loss aversion estimates show that any degree of loss aversion is enough to make immediate annuities undesirable. A weaker degree of loss aversion will make the longevity annuities even more desirable, as the likely 100 percent loss of the initial investment becomes less important. With a loss aversion of 3, longevity annuities become undesirable but they are still more desirable than immediate annuities.

When the extent of probability distortion is altered, immediate annuities retain their undesirability. When the probability distortion is weakened, the long-delayed longevity annuities become less desirable because less decision weight is placed on the extremely high payoffs associated with the low-probability cases in which the retiree greatly outlives life expectancy.

Table A1. Maximum Acceptable Annuity Price per $1 for a 65-Year-Old Male

	Age of First Annuity Payment			
Model	65	75	85	95
Expected utility (no bequest motive)	2.10	3.62	9.95	78.44
Mental accounting				
Linear value function (no loss aversion)	1.00	1.00	1.00	1.00
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
CPT including probability distortion				
No loss aversion	0.98	1.06	1.39	2.78
With loss aversion	0.77	0.68	0.74	1.20
CPT baseline	0.77	0.68	0.74	1.20
CPT sensitivity analysis				
Less loss aversion (λ = 1.5)	0.88	0.86	1.03	1.85
Greater loss aversion (λ = 3)	0.70	0.56	0.57	0.88
Less probability distortion ($\delta = \gamma$ = 0.8)	0.81	0.69	0.61	0.60
Greater probability distortion ($\delta = \gamma$ = 0.5)	0.72	0.72	0.98	2.14

Note: "Less" and "greater" are in relation to the TK parameters: λ = 2.25, γ = 0.61, and δ = 0.69.

Notes

1. In addition, most financial planning tools do not solve an intertemporal utility maximization problem.
2. Although mental accounting may prevent retirees from perceiving the value of longevity insurance, it may also lead retirees to ignore some negative features of annuities, such as illiquidity, which may dampen annuity desirability when future spending is uncertain.
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. Some empirical evidence suggests that discount rates may be quite high; Warner and Pleeter (2001) found evidence of discount rates exceeding 17 percent in the case of choices about forms of military pension payment (lump sum versus annuity). Such high discount rates would dramatically disfavor annuitization because the mental accounting framework poses the question as a choice between wealth today and wealth spread out over future years.
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 $t = 2$.
5. For ease of exposition, we ignore the availability of equity investments and equity-linked variable annuities.
6. We have assumed that there is no bequest motive, so the individual cares only about spending when she is alive, not about money left to heirs. The presence of a bequest motive would reduce the maximum acceptable 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 her own spending when alive as about her heirs' spending from the inheritance when she is dead, an immediate annuity would provide lower utility than a bond portfolio because the bond portfolio already provides a stable stream of income whether the investor is alive or dead.
7. The inferences from analyzing maximum acceptable prices are qualitatively similar to findings based on calculations of certainty equivalents, another commonly used method of measuring the value of gambles. We use maximum acceptable price here because it provides a simple measure in the expected utility model that does not require assumptions about the specific form of the utility function.
8. Another interesting feature of longevity annuities is the weighting of the worst outcome—death before any payouts. A 65-year-old male choosing a longevity annuity starting payouts at age 85 faces a 64 percent probability of dying before age 85; that prospect is actually *underweighted* with a decision weight of 52 percent.
9. 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 percent nominal interest rate and discounted with either a 3 percent discount rate (no money illusion) or a 0 percent discount rate (money illusion). Qualitatively, it should be clear that individuals suffering from money illusion should like annuities more than those who have no money illusion.
10. In the calculations for Table 2, we assumed that an individual still assigns positive weight to annuity payouts that may come after his life expectancy, in contrast to the simple example of the previous paragraph, in which only payments up until life expectancy were used.
11. 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.
12. Apart from the CPT-based answer we propose here, it could be that individuals do not perceive the equivalence between a period-certain annuity and an annuity-plus-bond package. Or the transaction costs associated with bond ladders may be too large for some retirees. We owe an anonymous referee for this comment.
13. In a more surreal sense, the guarantee period reduces the fear of "regretting" the annuity decision from the grave should the purchaser die early. An individual may have a "legacy motive," in which she or he considers whether the children will think poorly of a decision to annuitize should the individual die early. This motive differs from the standard bequest motive, in which the individual derives utility from the dollar value of a bequest.
14. "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.
15. Laibson (1997) noted that some consumers may use "internal self-control mechanisms, like 'will-power' and 'personal rules'" (p. 469).
16. As Table 1 shows, the CPT value function results in only modest changes in annuity valuations from the linear case because the value function is close to linear. Thus, we do not further examine the sensitivity of this dimension.

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