Discount Rates, Mortality Projections, and Money's Worth Calculations for US Individual Annuities

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ABSTRACT

Estimates of the expected present discounted value (EPDV) of future payouts on both immediate and deferred annuities are sensitive to the discount rate used to value future payment streams and to assumptions about future mortality rates. This paper presents EPDV estimates for annuities that were available in the US retail insurance market in January 2021, showing that they are substantially higher when calculated using discount rates drawn from the Treasury rather than corporate bond yield curve, and to a more modest degree, when the rapid but since-attenuated decline in US old-age mortality rates during the 1990s and early 2000s is extrapolated to future decades. Our central estimates of the "money's worth," EPDV divided by the annuity's purchase price, for immediate annuities purchased at age 65, using A-rated corporate bonds and future mortality rates projected by the Society of Actuaries for individual annuitants, are between 93 and 96 cents per premium dollar. For deferred annuities, products purchased at age 65 but beginning payouts at age 85, the money's worth is substantially lower. Recent Department of Labor rulemaking requires defined contribution plan sponsors to provide participants with estimates of the annuity income stream that their plan balance could purchase. These estimates, like EPDVs, are sensitive to both prospective rate of return and mortality rate assumptions.

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Annuity markets attract the attention of economists and financial planners because they offer individuals a way of insuring against longevity risk, one of the most important late-life threats to financial security. In the United States, Social Security provides most retirees with an inflation-indexed annuity. Workers who are covered by defined benefit pension plans, which were more common three decades ago than today, typically receive guaranteed nominal annuity payments, in some cases with partial indexation for inflation.

Relatively few individuals who accumulate assets in defined contribution plans, or who accumulate substantial non-pension financial wealth, choose to annuitize. A large literature has considered whether this is consistent with optimizing behaviour in a stochastic lifecycle model. Explanations for the low rate of annuitization include the presence of a bequest motive for many of those with significant retirement wealth, recently studied by Lockwood (2018), the risk of late-life medical costs that are best addressed with a pool of non-annuitized wealth as in Reichling and Smetters (2015), adverse selection in the annuity market that leads insurers to price products in a way that is unattractive for many potential buyers as studied by Finkelstein and Poterba (2004) and others, mortality pessimism as in O'Dea and Sturrock (2020) and Solomon (2021), and the role of Social Security, Medicare, and Medicaid in providing a guaranteed consumption floor regardless of how long one lives. A number of empirical studies have explored the potential role of adverse selection in annuity pricing, including Canon and Tonks (2004), Mitchell, Poterba, Warshawsky, and Brown (1999), and Verani and Yu (2020). These studies compare expected present discounted value of future payouts on annuity products with their purchase price, typically finding that the "money's worth ratio," the ratio of the value of future payouts to the premium, falls below one. Adverse selection is one explanation for this finding, although Cannon and Tonks (2016) point out that it is difficult to distinguish selection from other pricing-relevant considerations such as regulatory requirements for capital reserves.

The 2019 Setting Every Community Up for Retirement Enhancement (SECURE) Act increases the salience of annuities as a way of drawing down the accumulated assets in defined contribution plans. It requires retirement plan administrators to provide participants with two illustrations each year of the lifetime income stream that their current account balance could purchase. One must show the potential payouts associated with a single life annuity, and the other the payouts from a joint and survivor annuity. In August 2020, the Department of Labor (DOL) issued an Interim Final Rule directing plan administrators to calculate these potential payouts using the interest rate on a 10-year Treasury bond and a gender-neutral mortality table developed by the IRS. Rather than relying on the market prices of retail annuity products, this calculation estimates the annuity payout that a hypothetical at-cost insurer could offer annuitants if it could earn the return on a 10-year Treasury bond for the length of the annuity contract, and if it did not incur any other costs of supplying annuities. Estimates of the money's worth of existing retail annuities and of the potential annuity payouts to a DC plan participant both depend on an assumed rate of return at which future payments are discounted, and an assumed mortality table that describes the probability that an annuitant will be alive at various future dates.

This paper illustrates the sensitivity of money's worth ratios for retail annuities to both discount rate and mortality rate assumptions by focusing on policies that were offered in the U.S. market in January 2021. It also explains how uncertainties that have been recognized in the annuity valuation literature apply to the calculation of potential annuity payouts. One important distinction between retail annuity products and the hypothetical product described by the DOL guidance is that retail annuities are priced differently for men and women, while the annuities offered in retirement plans must be gender-blind. In the retail annuity market, women of a given age receive lower payouts per year per premium dollar than their male counterparts due to their lower average mortality rates at all ages. Annuities offered in qualified retirement plans on a unisex basis provide higher payouts to women, and lower payouts to men, than the payouts that they would receive if gender was considered in pricing.

Most previous empirical work on annuity markets, like the new DOL regulations, focuses on annuities that begin paying policyholders shortly after the date of purchase. These are known as single premium individual annuities (SPIAs) or their closely-related joint-and-survivor counterparts. Recently, deferred annuities have begun to attract interest for their potential role in providing longevity insurance. Deferred annuities are annuity contracts with a substantial period of time between the purchase date and the date on which payouts commence. Horneff, Maurer, and Mitchell (2020) estimate that a 65-year-old man can increase his expected lifetime utility by allocating a small fraction of his wealth to the purchase of an actuarially fair annuity that would begin payouts at age 85. The market for deferred annuities is currently small; we estimate that the money's worth values for these products are lower than for immediate annuities. We also exploit the relationship between SPIAs, deferred annuities, and fixed-period payout contracts offered by insurance companies to compare the relative pricing of immediate and deferred annuities.

This paper is divided into eight sections. The first describes our framework for calculating the expected present discounted value (EPDV) of the payouts associated with an annuity product and its corresponding money's worth. The next three sections describe our data sources for annuity prices, the discount rates that apply to future payouts, and the assumed mortality rates for potential annuity buyers. Section five presents our estimates of the EPDVs of immediate annuities and compares the payouts on retail annuities that are available in the market with the break-even calculations from the DOL algorithm. Section six reports on the share of the expected value of an annuity contract that is life-contingent, relative to the share that is guaranteed, for several annuity products with guarantee periods. The seventh section estimates the EPDVs of deferred annuities, which are generally lower than the estimates for immediate annuities. There is a brief conclusion.

1. Framework for Annuity Valuation

For retail annuity products that are currently offered by US insurance companies, we observe the initial premium as well as the monthly payout that the buyer will receive. We estimate the expected present discounted value (EPDV) of the stream of future payments, and define the money's worth of the policy as the ratio of the EPDV to the policy's premium. Past estimates of money's worth ratios have typically fallen between 0.80 and 0.95, with variation over time and as a function of the valuation assumptions. Koijen and Yogo (2015) report on a short period of time during the global financial crisis of 2009 when some insurers offered annuity policies with money's worth values greater than unity as a means of raising regulatory capital. Even when the EPDV is less than the purchase price, risk-averse potential annuitants may be prepared to purchase these products because they offer insurance against longevity risk.

We simplify our valuation calculations by assuming that annuities make two payouts each year, each equal to six promised monthly payments. We use $V_b(A)$ to denote the EPDV of a life annuity that makes two payments of A dollars each year and that is purchased by an individual of age b. When purchased outside a retirement account, annuity payouts are taxable; we consider that case, but begin with, and focus on, purchases in retirement accounts. If the funds used to purchase the annuity were paid out of the account as a lump sum, they would be taxed at the individual's ordinary income tax rate. When the individual receives annuity payments from the retirement account, they are also taxed at this rate. As long as the annuitant's marginal income tax rate remains constant for his remaining lifetime, and the relevant discount rate is the pre-tax rate of return such as the interest rate on a bond held in a qualified plan account, the money's worth ratio is independent of the tax rate:

(1) $$V_b(A) = \sum_{j=0}^{240-2b} \frac{A * P_{b,j}}{(1+i_j)^j}.$$

We assume that the annuitant will not live beyond the age of 120, which means that b-year-old annuity buyer cannot receive more than 240 – 2*b payments. Our calculations are insensitive to shortening the maximum assumed lifespan to 115, 110 or 105 years.

Equation (1) shows that $V_b(A)$, depends on three inputs: the payouts associated with the annuity contract, the discount rates that are used to compute the present discounted value, and the survival probabilities that determine the likelihood that an annuitant will receive a given future payment. $P_{b,j}$ denotes the probability that an individual who purchases on annuity at age b will still be alive j half-years later, and i_j denotes the nominal pre-tax discount rate for a cash flow received j half-years after the date of the annuity purchase. We assume that the first annuity payout takes place six months after purchase. Our valuation exercises focus on annuities with constant nominal payout streams, but the same framework could be applied to annuities that offer payouts with a fixed nominal escalation schedule or other time-varying payout streams. To apply this framework to inflation-indexed annuities, estimates of future inflation rates, as well as nominal interest rates, would also be needed. The ratio of $V_b(A)$ to the policy premium is the money's worth ratio. When the estimate of the EPDV is below the annuity's purchase price, the difference can be interpreted as the price of longevity insurance as a share of the policy premium. Another way to summarize this divergence is by calculating the internal rate of return, the discount rate at which the annuity's estimated EPDV would equal its purchase price. For an annuity with a purchase price of $100,000 and a semi-annual nominal payment of A, this discount rate is the value ρ that solves the equation

(2) $$100{,}000 = \sum_{j=0}^{240-2b} \frac{A * P_{b,j}}{(1+\rho)^j}.$$

Comparing the implicit rate of return on annuities with other investment opportunities is an alternative to the money's worth ratio for measuring the cost of longevity insurance. Brown, Kling, Mullainathan, and Wrobel (2008) suggest that the demand for annuities can be affected by whether these products are presented to potential buyers as insurance products that offer income for life, or as investment products offering a particular rate of return. The income-for-life framing leads most naturally to the money's worth as a summary measure, while the rate of return formulation leads toward the implied rate of return approach.

When an annuity is purchased outside a tax-qualified retirement account, using after-tax funds in a taxable account, the EPDV-to-premium ratio is no longer independent of the individual's tax rate. The discount rate must be measured after-tax, and the annuity payouts must be valued on an after-tax basis. The tax code recognizes that part of the stream of annuity payouts is a return of the annuitant's premium, which is not taxed, and that part reflects a return on capital since the insurance company has the opportunity to invest the premium and returns some of the resulting earnings to the policyholder. As explained in Brown, Mitchell, Poterba, and Warshawsky (1999), the Internal Revenue Service (IRS) determines the fraction of each annuity payment that represents taxable income by computing the expected number of years (T') over which the annuitant can expect to receive benefits. This calculation uses the IRS Individual Annuitant (Unisex) Mortality Table. Conditional on T', the IRS specifies an inclusion ratio (λ), the fraction of each annuity payment that is deemed to result from the insurer's earnings. For example, for an annuity with a $100,000 premium that makes payments twice each year, $\lambda = 1 - \frac{100000}{2*A*T'}$. The annuitant must report 100λ% of each annuity payout as taxable income for the first T' years of annuity ownership. After that, since the annuitant's capital is deemed to have been fully returned, all subsequent annuity payouts are considered taxable income. Long-lived annuitants thus experience an increase in the tax burden on their annuity payouts late in life.

Assuming that the annuitant faces a combined federal and state marginal income tax rate of τ, the tax-adjusted expression for annuity value (V_b') is:

(3) $$V_b'(A) = \sum_{j=0}^{2*T'} \frac{(1-\lambda*\tau)*A*P_{b,j}}{(1+(1-\tau)*i_j)^j} + \sum_{j=2*T'+1}^{240-2b} \frac{(1-\tau)*A*P_{b,j}}{(1+(1-\tau)*i_j)^j}.$$

This expression assumes that the marginal income tax rate on the income from the asset associated with the discount rate is the same as that on annuity income, as it would be if the asset was a taxable bond.

An increase in the marginal income tax rate in equation (3) has two offsetting effects on the EPDV of an annuity contract. First, it decreases the after-tax net income from each annuity payment, with a larger effect on payments after T' years than before. An increase in the tax rate thus reduces the numerator of the EPDV. Second, holding constant the pre-tax discount rate, an increase in the tax rate reduces the after-tax discount rate, which raises the EPDV. Whether the result of a rate increase is a rise or a decline depends on the discount rate. At low discount rates, the denominator effect is small, so a rise in the tax rate lowers the EPDV, but at higher discount rates, since the tax rate applies to the full value of the discount rate but only to part of the payout stream, it is possible for a tax rate increase to raise the EPDV.

2. Information on Annuity Prices and Payouts

We illustrate the sensitivity of EPDV calculations by focusing on retail annuity policies that were available for purchase in January 2021 and that were included in the *Annuity Shopper*, which compiles information on the offerings of 17 large U.S. insurance companies. The policy data were collected on January 8, 2021. We focus on single premium, immediate, non-participating annuities with a fixed nominal payout, as well as otherwise similar policies in which the income stream is deferred from the purchase date by 10 or 20 years. We consider policies with an initial premium of $100,000. The policies are "non-participating:" the benefit payment is fixed and guaranteed, and it does not reflect the insurance company's subsequent unanticipated experience with mortality, investment returns, or expenses. The number of companies in the sample varies across policies.

For an immediate annuity purchased for $100,000 by a 65-year-old man, the average monthly payout was $463 across the 16 companies offering that product. The payouts ranged from a high of $485 to a low of $443 – a range of just over 9 percent of the average. Some of this variation may be due to the different investment ratings of the various insurers. The firm offering the highest payout, Minnesota Life, is rated A+ by A.M. Best, Aa3 by Moody’s and AA- by Standard and Poor’s. The firm with the lowest payout, Principal, receives the same rating, A+, from Moody’s, and higher rates, A+ and A1 A1 respectively, from S&P and Best. A firm’s underwriting practices and firm-specific circumstances such as capital availability can affect pricing decisions. We lack information on the volume of annuity sales by company, so we summarize the prices for a given policy with a simple arithmetic average of the prices for the firms offering that policy.

Table 1 reports the average annual payouts, computed as 12 times the monthly payments, for three immediate annuity products: a single premium immediate annuity (SPIA) that pays the same nominal benefit for as long as the buyer is alive; the same product with a 20-year-certain provision that guarantees payments for 20 years, either to the annuitant or a designated beneficiary; and a graduated annuity with payouts that grow at a 3% nominal rate each year. In our valuation analysis, we focus exclusively on level-payout annuities. For each product type, we report the price for an annuity purchased by a man, a woman, and a married couple seeking to receive benefits for as long as either of the buyers is alive – a "joint and survivor annuity." The first panel shows SPIA pricing. There is variation by age, gender of the buyer, and across three product types. The average annual payment for a male 65-year-old annuitant is $5,556, about 6% greater than the $5,244 for a woman of the same age, and 29% greater than the payout on a joint-and-survivor annuity purchased by a 65-year-old man with a 60-year-old spouse.

The prices in Table 1 display a number of expected patterns. The annual payout rises with the age of the annuitant. The increase is 27% between ages 55 and 65, and 41% between 65 and 75, for a male annuitant, reflecting the greater annual mortality risk between 65 and 75 than between 55 and 65. A graduated annuity offers a smaller initial payout, 36% less for a 65-year-old man, than a level annuity. Opting for a 20-year guarantee period reduces the annual payout for a 65-year-old man by 9.7% but by only 7.4% for a similar-aged woman. A 65-year-old woman is more likely than a 65-year-old man to survive to age 85, so the guarantee provision is less likely to affect the insurer's stream of payouts to a woman than to a man. The payout on a 20-year-certain joint and survivor policy for a 65-year-old man and his 60-year-old wife is only 0.6% less than a policy with no guarantee, since the chance that one of the two will live for at least 20 years is very high. Annuity products that provide guaranteed payouts for a certain number of years place less of the policy-holder's premium at risk of loss in the event of an unexpectedly early death; they involve less longevity insurance than SPIAs without guarantees.

Table 1 also shows that the male/female annuity payout differentials change with age. At age 55, for SPIAs without graduation, men receive annuity payouts that are about 4% higher than those for women. This difference rises to 6% at 65 and to more than 9% at 75. These payment patterns largely reflect differential mortality patterns, especially in the first decade after annuity purchase, for men and women of different ages. The relative difference in life expectancy between men and women rises between ages 55 and 75, thus generating the observed pricing pattern.

3. Discount Rates

Estimating the value of the stream of future payouts associated with an annuity requires a term structure of discount rates. A key consideration in the choice of discount rates is the riskiness of the annuity payouts, which bears on how a consumer would discount them. Riskier payouts should be discounted at a higher rate, reflecting a risk premium.

Annuity payments are not riskless. Although companies participate in various state-level reinsurance pools, it is possible, although rare, for an insurance company to default on its promised payouts. A riskless interest rate, such as the yield on US Treasury bonds, understates the appropriate discount rate. If the stream of annuity payments is about as risky as the assets held in the general accounts of the insurance companies that offer these products, then the yield curve for corporate bonds may be more appropriate.

Most insurance companies invest their policy reserves in assets with greater risk, and greater expected return, than Treasury bonds. S&P Global (2020) reports that at year-end 2019, bonds accounted for 74% of the assets held in life insurance companies' portfolios. Mortgages and other real estate investments represented another 14%, and 5% of the portfolios were held in alternative investments such as venture capital and private equity. Stocks (1%), cash and short-term notes (3%), and alternative investments and contract loans (8%) comprised the remainder of the portfolios. Among the bond holdings, only 8.9% of the portfolios were held in government bonds; the balance was in corporate bonds (46.6%) and other privately-issued credit instruments.

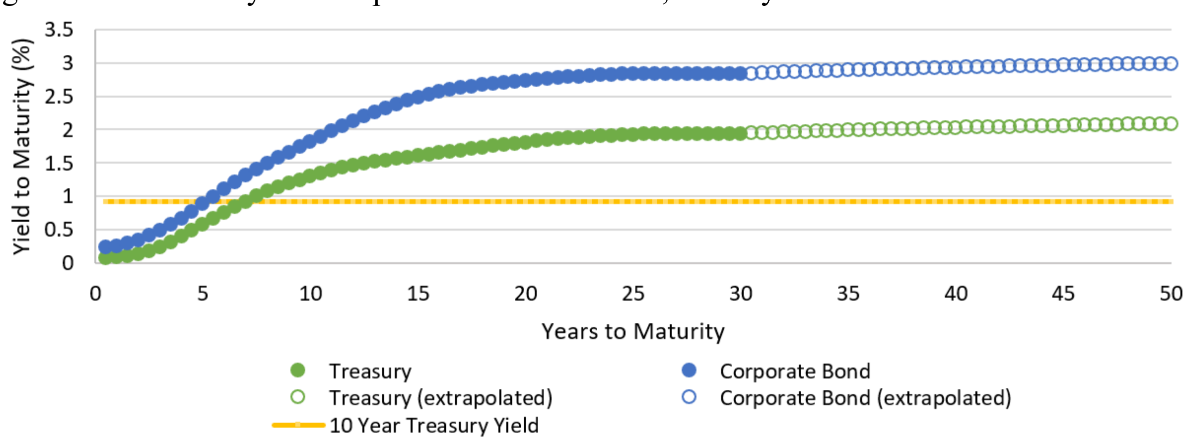
To illustrate how assumptions about the risk premium used in discounting affects EPDV estimates, we present calculations using two interest rate term structures: one for U.S. Treasury bonds and the other for high-grade (A-rated) corporate bonds. For each case, we collect data on yields-to-maturity (YTMs) at various maturities (6 months, 1 year, then 2, 3, 5, 7, 10, 20, and 30 years) in January 2021 on the day when the *Annuity Shopper* collected annuity prices. For corporate bonds, we use the Bloomberg average yield on corporate bonds rated A+, A, or A-. S&P Global (2020) reports that, of the corporate bonds held in life insurance company portfolios in 2020, 59% were rated between A and AAA, 35% were BBB, and 6% were rated below BBB. We use the A-rated yield curve to reflect something close to the median bond in the insurers' portfolios. By presenting results using both corporate A and Treasury yield curves, we illustrate the range of values that can result from different discount rate assumptions. On January 8, 2021, when the annuity payouts that we analyze were collected, the 10-year corporate A yield was

1.82%, and the 30-year A yield was 2.83%. For Treasuries, yields were 1.30% and 1.94%, respectively.

We interpolate between the maturities at which we observe yields using a cubic spline. This generates a yield curve, in half-year intervals, for maturities of up to 30 years. Because some annuity payouts may be more than 30 years after the policy purchase date, we need to extrapolate the observed yield curves to longer maturities. We do this assuming that the six-month forward rates at all maturities beyond 30 years will equal the average of the forward rates at maturities between 15 and 30 years that are implied by our fitted term structure calculations. As the maturity lengthens, our forecast therefore converges toward the average implied short-term rate during that 15-year window. In practice, the discount rates at maturities beyond 30 years, which apply to annuity cash flows that would be received after 2051, do not have a substantial effect on EPDV calculations.

Figure 1 plots the January 2021 yield curves for Treasury bonds and the Bloomberg A-rated corporate bond index. It includes a horizontal line at 1.13%, the value of the 10-year

Figure 1: US Treasury and Corporate A Yield Curves, January 2021



Notes: "Corporate bond" refers to A-rated corporate bonds. The yellow horizontal line at 0.92% is the yield on a 10-year Treasury bond on December 1, 2020, the rate that the DOL requires in the calculation of potential annuity income during the month of January, 2021, which corresponds to our *Annuity Shopper* pricing information.

Treasury yield on January 8, 2021. This is the discount rate specified by the algorithm that DOL requires defined contribution plan sponsors to use in calculating potential annuity payouts for their participants. The Treasury yield curve is below the corporate A yield curve at all maturities, with a typical risk premium of more than 50 basis points at maturities of more than 15 years, but substantially less at shorter maturities.

Discounting future annuity payouts using the Treasury yield curve is likely to overstate the EPDV of an annuity, because annuity payments are likely to be riskier than the yield on Treasury bonds. The corporate A-rated yield is closer to the yield on the assets that back the annuity contracts. The DOL recommendation that pension plan administrators use the 10-year Treasury rate when calculating potential annuity payouts may understate the payments that could be available to future retirees, since it understates both the risk and the expected return associated with the assets in insurance company portfolios. If insurance companies assume that they can earn a return in excess of the Treasury return, then they could offer an annuity payout greater than what the DOL calculation will suggest.

Annuity payouts as a fraction of the policy premium decline when interest rates drop, all else equal. The substantial decline in nominal interest rates over the last 15 years has been associated with lower payouts. The average annual payout on an SPIA for a 65-year-old man was $5,556 in January 2021, compared to $6,456 in June 2015, $7,344 in June 2010, and $7,740 in June 2005. The Bank of America (BofA) A-rated corporate bond yield index averaged 1.62% in January 2021. It averaged 2.93% in June 2015, 4.34% in June 2010, and 4.70% in June 2005.

Movements in annuity payouts since January 2020, and through the COVID-19 pandemic, are also consistent with the interest-rate-to-payout link, although as Charupat, Kamstra, and Milvsky (2015) report, these adjustments may occur with a lag. In January 2020, when the A-rated corporate bond yield index averaged 2.54%, the average annual payout on a SPIA purchased by a 65-year-old man was $6,000. In June, 2020, the BofA index was 1.90%, and the SPIA payout averaged $5,748. The BofA yield fell further, to 1.62%, in January 2021, and the SPIA payout also declined, to $5,556. Between January and June 2021, the BofA yield rose from 1.62% to 1.85%. The average SPIA payout also rose, reaching $5,796.

4. Mortality Rates

Estimating the EPDV for an annuity product requires a cohort mortality table that includes projections of future mortality rates for an individual of a given age at the time of annuity purchase. The projections which underlie the survival probabilities $P_{b,j}$ in equation (1) are an important source of uncertainty. Let $q_{a,t}$ denote the probability that an individual of age a

at the beginning of half-year t will die during that half-year. We define $t = 0$ to be January 2021, so the first half year is the first six months of 2021. $P_{b,j}$ is the probability that a $b/2$ year old annuity buyer (b is age in half-years) who buys at $t = 0$ survives for at least j half-years:

(4) $$P_{b,j} = (1 - q_{b,0})(1 - q_{b+1,1}) \ldots (1 - q_{b+j-1,j-1}).$$

We set $P_{b,240-2*b} = 0$, for all *b*.

Different subgroups of the population exhibit different mortality rates. There is substantial evidence that mortality among annuitants is lower than mortality in the general population. This is likely due to two factors. First, Waldron (2007), Chetty et al. (2016), and others show that age-specific mortality rates are a declining function of economic status. Annuity buyers in both the retail and group annuity markets are drawn from an economically-more-successful than average part of the population, so they would therefore be expected to display lower-than-average mortality. Second, conditional on net worth, those who purchase individual annuities in the retail market may know that they are healthier than average, or at least know that they are not facing any current life-threatening health conditions. This would also lead to observed mortality below the population average.

Past research has reported the money's worth of annuities from two perspectives: that of an individual in the general population, and that of a typical annuity buyer. The former involves valuing the stream of future annuity payouts using the survival rates associated with the population mortality table, while the latter involves using an annuitant mortality table. We follow this tradition in presenting EPDV calculations using both a cohort mortality table corresponding to annuitants, and a cohort mortality table corresponding to the population at large. We compare the mortality rates in these tables with those in the unisex mortality table compiled by the IRS, recommended by the DOL for use by pension plan administrators.

When constructing EPDV measures that would apply to the U.S. population at large, we use the cohort mortality table compiled by the Social Security Administration (SSA) Office of the Actuary in 2019. For example, to value annuities offered to 65-year-olds in 2021, we use the mortality rates for the 1956 birth cohort. We choose other birth cohorts for annuities purchased by individuals at other ages. The SSA mortality tables embed projections of the future rate of mortality improvement.

When constructing EPDV measures from the perspective of annuitants, we use annuitant mortality tables constructed by the Society of Actuaries (SOA). These mortality tables are based on the historical experience of annuitants. SOA's most recent comprehensive annuitant mortality table is the Individual Annuitant Mortality (IAM) 2012 table, which is described in American Academy of Actuaries / Society of Actuaries (2011). It provides cohort mortality tables for annuity buyers in 2012, along with a recommended set of mortality improvement factors that can be used to project mortality rates for later years. The factors imply substantially more rapid decline in post-2012 mortality rates than has been observed in recent years, or than the SSA projects for future years. We construct an SOA cohort annuitant mortality table for 2021 by applying the SOA's recommended mortality improvement factors to the 2012 table.

Table 2 shows the projected population and annuitant mortality rates for men and women who were 65 years old in 2021. The mortality rate for a 65-year-old male annuitant, 0.0079 (almost eight tenths of one percent), is roughly half the mortality rate for the population at large (0.0151). The absolute difference in the two sets of mortality rates grows at older ages, but the proportional difference contracts. At age 85, for example, a male annuity-buyer who is 65 years old in 2021 male is projected to face a mortality rate of 0.0602, while for a randomly-selected 65-year-old in the population in 2021, the analogous value is 0.094. The general pattern of differences between the population and the annuitant tables is similar, but smaller, for women.

The disparity between the mortality rates in the 2021 SSA and SOA cohort tables arises from two sources: different historical levels of mortality between the population at large and annuity buyers, and different assumed rate of mortality improvement between the SSA and SOA. The first factor is more important than the second; annuitant mortality rates in the years that generate data to calibrate the SOA table were lower than those in the US population. The SOA mortality rates in Table 2 are the result of projecting the 2012 table, which is based on observed mortality rates through 2004, forward for nine years using the SOA mortality improvement factors. The SSA cohort mortality table is based on death rates observed through to 2017, along with projections for subsequent years. To illustrate the role of mortality improvement factors, consider the mortality rate for an age a individual in a given group, such as the group of annuitants in 2012. If we denote this mortality rate as $q_{a,2012}$ and the mortality improvement factor for age $a + t$ in year s as $g_{a+t,s}$, then the projected mortality for an $a + t$ year-old in year $2012 + t$ is

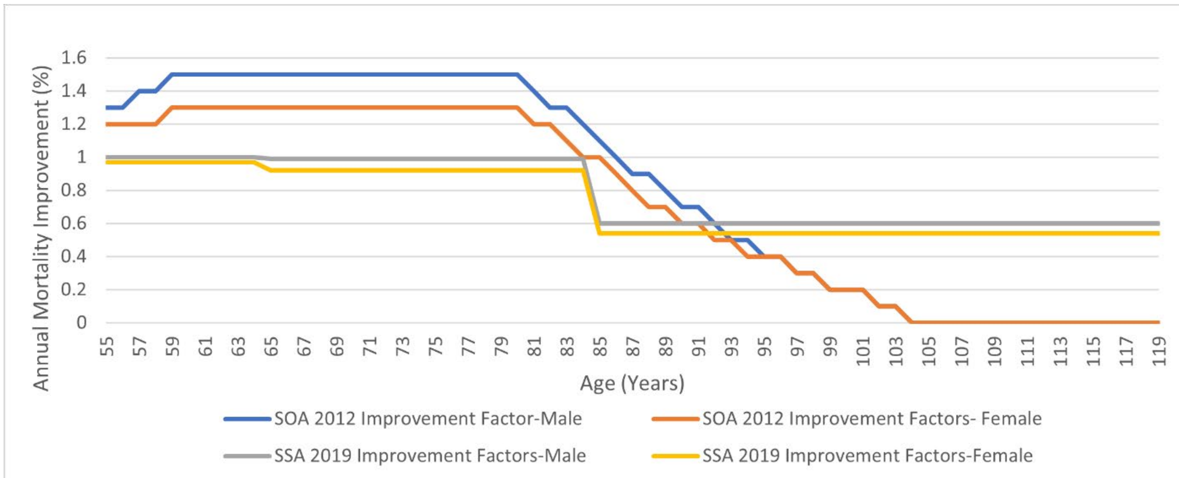
(5) $$q_{a+t,2012+t} = q_{a+t,2012} * \prod_{s=1}^{t} \left(1 - g_{a+t,2012+s}\right).$$

The rate of mortality improvement has varied over time and across ages within the elderly population, which admits the possibility that different analysts might make different projections regarding future improvement rates. This is the case with the SOA and SSA. The SOA assumes a time invariant rate improvement factor, i.e. $g_{a+t,s} = g_{a+t}$, whereas the SSA uses one rate of mortality improvement until 2044, and another thereafter. These varying patterns reflect the changes over time in age-specific life expectancy at retirement age.

We illustrate these changes by focusing on the white population, because consistent mortality data are available for the longest time for this group. For white men, life expectancy at age 65 was 13 years in both 1960 and 1970. It rose to 14.3 years in 1980, 15.2 in 1990, and 16.2 in 2000. The large gains during the 1970s had many sources. Improved control of hypertension and an associated reduction in cardio-vascular mortality is identified by Cutler, Glaeser, and Rosen (2009) as a leading factor. Between 2000 and 2010, life expectancy rose 1.6 years, even faster than in the 1970s, reaching 17.8 years in 2010. But in subsequent years, it rose more slowly. In 2017, the last year for which the Center for Disease Control (CDC) reports complete statistics, it was 18.1 years. The life expectancy increase of only 0.3 years over a span of seven years suggests that the increase for the 2010-20 decade will be the slowest since the 1960s, even before allowing for the effects of the COVID-19 pandemic at the end of this period. The pattern for white women also shows rapid life expectancy gains in the 1970s, from 16.9 years to 18.6 years, but more modest gains in the 2000-2010 period, from 19.2 to 20.3 years. The gain from 2010-2017 was also just 0.3 years. For women as for men, 2010-2019 was marked by slower mortality reduction than previous decades.

Projections of the future rate of mortality improvement will differ as a function of the weights placed on the historical experience in different periods. Table 3 reports, and Figure 2 depicts, the mortality improvement factors associated with both the SOA and the SSA cohort mortality tables. Figure 2 shows that the SOA assumes mortality improvement that is roughly half a percent per year faster than SSA. Table 3 also presents information on past rates of mortality improvement, showing that for men between the ages of 65 and 84, the 1999-2009 decade was a period of particularly rapid improvement. This was also a favorable time for women's mortality, but the rate of improvement was even higher in 1968-1982.

Figure 2: Society of Actuaries and Social Security Administration Mortality Improvement Factors, 2012-2021, by Age



Source: SSA (2019), Table 2.2 "Intermediate Alternative', and SOA (2011) Exhibit III, "Projection Scale G2"

Mortality rates between the ages of 65 and 84 are a key determinant of the EPDV values for annuities purchased at age 65. In 2012, SOA projected annual mortality improvement of 1.44% for this age range, which implies that after 20 years, the mortality rate at a given age is 0.748 times the mortality rate in the base year. SSA, by contrast, assigns a 0.86% per year improvement factor, which translates to an age-specific mortality rate in 20 years of 0.841 times the base year value. Beyond age 85, SSA assumes mortality improvement of 0.54% per year, which is more rapid that the SOA assumption of 0.30% per year. The post-85 rate of mortality improvement has relatively modest effects on the EPDV estimates.

The SOA projections appear to place substantial weight on the rapid mortality decline experience of the 2000-2009 period, while the SSA projections place greater weight on the slower long-term rate of mortality improvement, especially post-2009. The rate of mortality improvement since 2009 has not matched the rate in the previous two decades. While there are no detailed data on realized annuitant mortality in years after 2012, in years such as 2017, the SOA projected rates of mortality improvement for 65-year-old men and women are faster than the observed rates in the population. Neither the SOA nor the SSA projections incorporate any information on the impact of the COVID-19 pandemic on prospective mortality rates. Early estimates, such as Andrasfay and Goldman (2021) and Arias, Tejada-Vera, and Ahmad (2021), raise the possibility of substantial impacts.

To recognize that annuitants have lower mortality rates than individuals drawn from the population at large, as the SOA mortality table does, while also recognizing that the rate of mortality improvement post-2009 has been substantially lower than that projected in the SOA (2012) analysis, we create a modified SOA mortality table that begins with the 2012 IAM table but then applies the SSA rates of projected age-specific mortality improvement for the years after 2012. This modified SOA table captures the level differences in annuitant and population mortality while also projecting rates of mortality improvement that are close to those observed in the last decade.

The SOA and SSA mortality tables present separate information for men and women, reflecting the higher mortality rate at all post-retirement ages for men. In contrast, the IRS mortality table that DOL directs retirement plan sponsors to use for making illustrative lifetime income calculations is a unisex table that is used to value the liabilities of defined benefit (DB) pension plans. It is based on the SOA (2014) mortality table for DB plan participants, which separates men and women and also distinguishes those who are receiving benefits from those who are still working and accumulating benefits. The IRS applies the mortality improvement factors for the 2014 tables in SOA (2018) to construct gender-specific mortality tables for DB plan participants in 2021. It creates a weighted average of the participant and beneficiary tables for men, and a separate weighted average table for women, based on the relative sizes of these groups, and then combines the two gender-specific tables in an equally weighted average. The supporting documentation associated with this table, reported at IRS (2020), indicates that it should be used without any allowance for future mortality improvement. The absence of mortality improvement factors means that the IRS mortality table may lead to over-estimation of feasible annuity payouts. Mortality improvements raise life expectancy, and longer life expectancy translates into lower feasible annuity payouts.

The last column of Table 2 shows the unisex mortality rates from the DOL-recommended mortality table. For women, the mortality rates in this column fall between the SOA (annuitant) and SSA (population) mortality rates. At age 65, for example, the SOA annuitant table shows a mortality rate of 0.0062, compared with 0.0079 in the IRS table – nearly 25% higher. The population mortality rate for women at age 65 is 0.0093, higher than the IRS value. For men, the mortality rate at age 65 in the IRS table (0.0079) is the same as that in the SOA table; both are well below the population mortality rate (0.0151). This is because the IRS table averages the mortality rates for men and women, and the mortality rates for women at all ages in Table 2 are lower than those for men. By age 70, however, the absence of any annual mortality improvement in the IRS table leads the IRS mortality rate (0.0129) to exceed the mortality rate for men in the SOA table (0.0110). The pattern is the same, and the disparity grows, at older ages. The mortality rates for men in the population table are always higher than the mortality rates in the IRS table.

5. Estimates of EPDV and Implicit Discount Rates for Immediate Annuities

We now use the annuity prices, discount rates, and mortality tables described in the last three sections to estimate the EPDVs and implicit discount rates for a subset of the annuity products described in Table 1. Since the annuity policies that we consider have purchase prices of $100,000, the money's worth ratio in each case is EPDV/$100,000. We also relate the potential annuity payout calculation outlined in the DOL regulatory guidance to these measures.

5.1 Money's Worth for SPIAs

The first panel of Table 4 presents EPDV estimates for the no-tax case, corresponding to annuity purchase in a retirement account. We focus on the findings for 65-year-olds; the pattern of results is similar for buyers of other ages. The calculations show the difference in the EPDV calculated using a population and an annuitant mortality table. The EPDV is substantially lower when the calculation is based on the population mortality table, compared to either the SOA or the modified SOA annuitant mortality table. The EPDV is also much higher when the Treasury yield curve is used to set the discount rate, than when the discount rates correspond to the A-rated corporate yield curve.

The results for a 65-year-old male annuity buyer illustrate these patterns. The lowest EPDV in the row, $82,033, corresponds to the population mortality table and the corporate A-rated yield curve. This value suggests that the expected cost of longevity protection, for an individual facing population-wide mortality rates, is nearly 20% of the policy premium. When the population mortality table is replaced with the SOA annuitant mortality table, the estimated EPDV rises to $96.234, for money's worth value of more than 96 cents per dollar. This is the combination of discount rates and mortality rates that we consider as our benchmark case. When the SOA annuitant mortality table is updated using the SSA mortality improvement factors rather than the SOA factors, a change that implies slower prospective mortality rate decline, the estimated EPDV falls to $94,761, and the expected cost of longevity protection is just over 5% of the premium.

When the Treasury yield curve is used to discount future annuity payouts, the EPDV estimates with the SOA mortality table, and most of the estimates using the modified SOA mortality table, are greater than $100,000. For instance, for 65-year-old men, when the SOA mortality table is combined with the Treasury yield curve, the estimated EPDV is $105,127. If an insurance company expected to earn the Treasury yield on its investments and expected the mortality experience of its annuitants to follow the SOA mortality table, it would expect to lose money on the policies offered to men and women at all but one (women age 75) of the ages shown in Table 4. It seems more likely, especially given the composition of insurance company investment portfolios, that the firms expect to earn a rate of return that exceeds the riskless Treasury rate, than that they are pricing these policies below the cost of delivering the future annuity payouts. The EPDV estimates using the corporate A-rated yield curve are consistent with this view; they never exceed $96,234 in these cases.

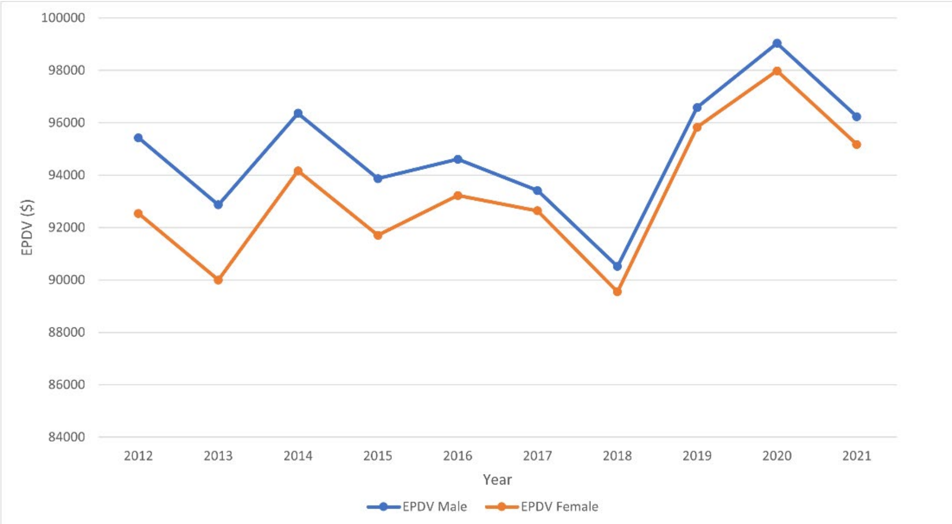
The results in Table 4 illustrate the quantitative importance of replacing the SOA mortality improvement assumption with the SSA assumption to generate the "modified SOA" table. The estimated EPDV for a 65-year-old man is between 1 and 3% lower, depending on the discount rate chosen, with the modified SOA table instead of the SOA table. The effect of using the modified table is similar for other age and gender categories as well. For a 65-year-old woman, for example, with the corporate bond yield curve, the EPDV value with the SOA mortality table and the SOA improvement factors is $95,176, while with the SOA table updated with SSA improvement it is $94,354, almost one percent less.

Our primary analysis focuses on the valuation of annuities in a pre-tax setting, but some retail annuities are purchased in taxable accounts. The lower panel of Table 4 presents results for the after-tax case, assuming that the annuitant's marginal tax rate is 25 percent. The pattern of EPDV values is broadly similar to that for the no-tax case, but there is some evidence that the tax system reduces the value of annuities for older buyers more than younger ones. The EPDVs in the taxable case exceed $100,000 for buyers aged 55 and 65 when we use the SOA mortality table or the SOA table modified with SSA mortality improvement factors. When we use the A-rated corporate bond yield curve and the SOA mortality table, the EPDV for a 65-year-old man is $96,448, compared with $96,324 in the no-tax case. For a 65-year-old woman, the analogous values are $96,384 (taxable) and $95,176 (non-taxable). The disparities are larger, however, when we compare the taxable and no-tax cases at older ages. For men at age 75, using the SOA mortality curve, the taxable and before-tax values are $94,220 and $95,526, and for women the values are $92,558 and $94,244. The discount rate and the choice of mortality rate affect the difference between the taxable and non-taxable EPDVs, because they alter the duration of the expected payout stream from the annuity. When using the population mortality table, which results in an earlier set of payouts than the SOA table, the taxable results are always lower than the non-taxable ones. The same mortality rates with the A-rated corporate yield curve, however, yields results in which the taxable results are higher than the non-taxable ones for men and women aged 55 and 65. It is therefore difficult to generalize about the comparison between the EPDV in a taxable and a non-taxable setting. The shift to the taxable setting has a relatively modest effect on discount rates when those rates are relatively low, as they are with the Treasury yield curve, the tax rate does not have much effect on the discount rate, but it does reduce the payout stream. At higher discount rates, such as those associated with the corporate bond yield curve, a 25% tax on the discount rate is sufficient to increase the present value of the payout stream.

5.2 Time Series Evidence on EPDVs

The *Annuity Shopper* collects annuity prices twice each year. This makes it possible to study the time historical evolution of the EPDV for various annuity policies. Figure 3 shows these values, for 65-year-old men and women since 2012. The values are higher in the later years of this period than the earlier ones, which may reflect slow adjustment of annuity payouts to the lower interest rates that prevailed late in the sample and especially in 2020.

Figure 3: Time Series Variation in EPDVs, 2012-21, Men and Women at Age 65



Entries correspond to the EPDVs for 65-year-old men and women, calculated using the SOA mortality curve and the corporate A-rated bond yield curve, using mid-year data for all years except 2021, when the annuity values and other information are from January not June.

5.3 Potential Annuity Payouts and the DOL Algorithm

The implied discount rate calculation is related to the DOL guidance for plan administrators, which specifies computing the potential annuity payout DC plan participants can expect using the 10-year Treasury interest rate prevailing on the first day of the month before the calculation, as well as the IRS unisex mortality table. In our formulation, the potential payout is the value A_{DOL} that solves the equation

(6) $$100{,}000 = \sum_{j=0}^{240-2b} \frac{A_{DOL} * P_{b,j}^{IRS}}{(1+i^{Treasury,10\,Year})^{j}}.$$

The survival probabilities are drawn from the IRS mortality table and are the same for men and women. These mortality rates are substantially higher than the SOA mortality rates for women at all ages, and they are equal to, or slightly higher, than the corresponding mortality rates for men in their 60s, and significantly higher at older ages. The higher mortality rate should translate, all else equal, into a potential annuity payout that is *higher* than what is offered in the private market.

The DOL direction to use a Treasury interest rate, selected from a particular maturity and from the month prior to the annuity valuation, pushes in the opposite direction, leading to annuity payout estimates that could be *lower* than the payouts offered in the private market because, as noted above, Treasury yields appear to be lower than those used by insurers to price annuity policies. In the specific case we consider, the valuation of annuities in early January 2021, interest rates were rising between December 1 (the first day of the month before the valuation) and January 8 (the day on which annuity prices were collected). The 10-year Treasury yield was 0.92 in December 1, and 1.12 on January 8. The stipulated interest rate in the DOL formulate was therefore low for two reasons: use of the riskless Treasury yield and the short-term movement in yields.

For a 65-year-old retirement plan participant, the DOL annuity payout value for January 2021 is $5,296 per year. By comparison, the average value of the SPIA offerings in Table 1 was $5,556 for men, and $5,244 for women. The DOL calculation is thus about 5% below the average annuity premium available in the individual annuity market for men, and 1% above for women. Applying the same algorithm for a retirement plan participant at age 75, the potential annuity payout is $8,154 per year. The average market payouts from Table 1 are $7,812 for men and $7,152 for women, so the DOL calculation is substantially higher in both cases. This pattern, the DOL over-stating private market payouts at older ages, but under-stating them at younger ages, illustrates the tension between the mortality rate and discount rate effects associated with the DOL calculation. Because the mortality rate assumption plays a more important role in the payout calculation for older annuitants, the higher-than-SOA mortality assumption boosts the calculated annuity payout more at older ages than younger ones. The assumed discount rate specified by DOL, which may fall below the discount rates assumed by private insurers, matters more for younger annuity buyers, and may understate potential annuity payouts.

6. Guarantee Provisions and Exposure to Life-Contingent Income Streams

Although the foregoing analysis emphasized single-premium immediate annuities without any guarantee period, in practice, annuities with guarantees are more popular than those without. Brown, Poterba, and Richardson (2021) report that at TIAA, a large provider of retirement income for workers in the non-profit sector, more than three quarters of annuitants select an annuity with a guarantee period.

The EPDV framework can be used to illustrate the extent to which guarantee provisions in annuity contracts alter the balance between a life-contingent payment stream and a certain payout stream such as that associated with a bond. An annuity with a 50-year guarantee period, purchased by a 65-year-old man, is effectively a bond, and not a life-contingent contract. But what if the annuity provides a 20-year guarantee period? Using the SOA mortality table and the corporate A-rated yield curve for discounting, we value the payouts of an SPIA-with-20-year-guarantee purchased by a 65-year-old man. Table 1 reports that the annual payout on this contract is $5,016 per year, compared with $5,556 for an SPIA with no guarantee. The present discounted value of the payouts in the first 20 years – the guaranteed period – is $81,729. The EPDV of the contract, including the life-contingent payouts beyond the 20-year window, is $95,572. This compares with $96,234 for a SPIA with no guarantee purchased by a 65-year-old man, as in Table 4. Thus 86% of the value of this guaranteed annuity is associated with its bond-like component. For a 65-year-old woman purchasing an SPIA with a 20-year-guarantee period, 83% of the value comes from the bond-like component because the woman is more likely than her male counterpart to outlive the guarantee period.

A key attraction of the guarantee period is that it reduces the likelihood that the annuitant and his or her heirs will receive very limited payouts from the annuity contract. Using the SOA mortality table and the corporate A-rated yield curve, we calculate that a 65-year-old man purchasing a $100,000 SPIA with no guarantee period has a 4% chance of dying before he receives payouts with a present discounted value of $25,000, and 11% chance of dying before receiving $50,000. The annuitant must live to age 70 to pass the first milestone, and 75 to pass the second.

With a 20-year guarantee period, the annuitant is protected from the risk of receiving payouts worth only a small fraction of the annuity premium. This protection comes at the cost of a lower annual annuity payout, namely, 9.7% less in the case of a 65-year-old male annuitant. By electing to purchase an annuity with a guarantee period, the buyer not only alters the level of the payout but also changes the nature of the product being purchased, replacing a completely life-contingent contract with one that is largely a fixed-income bond.

Annuity contracts with some guarantee features are more popular than those without any assured level of payouts. One of the most popular products currently is the lump sum refund annuity, a policy that promises to pay the annuitant's beneficiaries the difference between the purchase price and the cumulated sum of benefit payments if the annuitant dies before receiving $100,000 in total nominal benefits. Refund annuities, just like other guaranteed annuities discussed above, can be valued using the EPDV framework. For a 65-year-old man, the annual payout on a lump-sum refund annuity is $4932, compared with $5556 for a SPIA. The analogous values for women are $4764, compared with $5244. The EPDV for these policies are similar to those for SPIAs. Valued using the SOA mortality table and corporate A-rated yields, the EPDV of the lump-sum refund policy for a 65-year-old man is $95,941. For women, the value is $95,414. For men, the expected present value of the benefits that will be paid while the annuity buyer is alive is $85,426, or 89% of the total EPDV. For women, the paid-while-alive benefits have an expected present value of $86,464, or 91% of the total. Valuing the lump-sum refund policies using the Treasury yield curve raises the EPDV for both men (to $104,395) and women ($104,430). These patterns are similar to the findings for SPIAs and guaranteed annuities.

7. Deferred Annuities

Our analysis so far has focused on immediate annuities, but there is growing interest in deferred annuities – products that do not pay annuitants anything for a period that may span several decades, and then provide income only in late life. Table 5 presents information on the average payouts associated with deferred annuities, purchased either at age 55 or age 65, and starting payouts at either age 75 or age 85. The average policy with a premium of $100,000 promises a 65-year-old man a $29,421 annual payout if the payout stream begins at 85, but just over one third as much -- $10,580 – if the payouts start at age 75. The much larger payout on the longer-deferred annuity reflects the time value of money – the insurance company can invest the proceeds in the first case for two decades without making payouts, while for only one decade in the second case – and the smaller likelihood that the a 65-year-old man will still be alive at 85 than that he will be alive at 75. The SOA annuitant mortality table indicates that a 65-year-old man has an 90% chance of living to 75 and a 69% chance of living to 85. The corresponding survival probabilities in the population mortality table are 81% and 50%, respectively.

The payouts from deferred annuities that start at a given age are larger when they are purchased at a younger age. For men, the payout at 85 is $37,709 when the deferred annuity is bought at 55, compared with $29,421 when the policy is purchased at 65. For any purchase age/payout age combination, the deferred annuity payout for women is lower than that for men, reflecting the greater likelihood of the annuitant surviving to advanced ages.

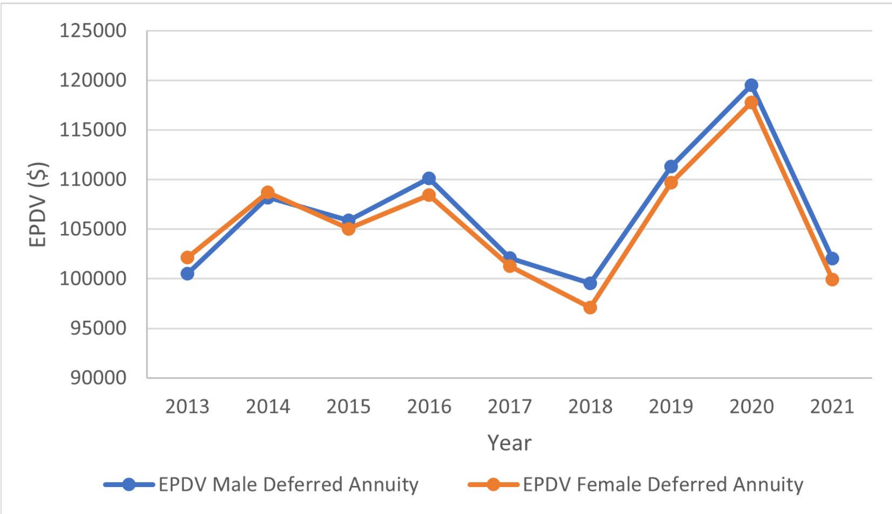
7.1 EPDV Estimates for Deferred Annuities

We estimate the EPDV of deferred annuities using the same approach that we applied for immediate annuities. We only consider the case of deferred annuities purchased in retirement accounts. To frame the results, we estimate the portion of the EPDV of an immediate annuity that is associated to payouts at age 85 and later if purchased by a 65-year-old man that is associated with payouts at age 85 and later. The EPDV of the annuity, valued using the corporate A-rated term structure and the SOA mortality table, is $96,234. The EPDV of the post-85 stream is $15,333, or 16% of the policy's value. This is similar to, but not the same as, the 14% value reported above for a 20-year guaranteed annuity purchased by a 65-year-old man. The analogous calculation for a 65-year-old woman indicates that the post-85 payouts account for 18% of the immediate annuity's EPDV, very similar to the 17% above for a 20-year guaranteed annuity. Using the Treasury yield curve in place of the corporate yields, all EPDV values increase substantially, and the share of the value associated with post-85 payouts also rises. It is 18% for men and 21% for women. These summary measures underscore the earlier point that most of the value in an immediate annuity contract purchased at age 65 is attributable to payouts made before the annuitant reaches age 85, even if the Treasury yield curve is used for discounting.

Table 6 presents estimates of the EPDV for the various deferred annuity products shown in Table 5. The table suggests three conclusions. First, the money's worth of a deferred annuity is more sensitive to discount rate assumptions than the money's worth of an immediate annuity. This can be seen from the greater disparity in the EPDV values in Table 7 in the columns corresponding to the Treasury and the corporate A-rated yield curves, compared to the analogous columns in Table 4. For a 65-year-old man, a deferred annuity beginning at age 85 has an EPDV of $81,194 when valued using the corporate A yield curve, and of $102,047 when valued using Treasury yields. The disparities are similar for women at age 65, $79,211 and $99,955 respectively, and they are larger if the deferred annuity is purchased at age 55 rather than age 65.

A second conclusion is that the EPDVs for deferred annuities are lower than the corresponding values for immediate annuities, particularly when valued using the yield curve for corporate bonds. The largest EPDV entry when the SOA mortality table and A-rated corporate bond yield curve are used in valuation is $88,510, for a 10-year deferred annuity for a 65-year-old man. Several values are below $80,000. In contrast, the lowest value for a SPIA was greater than $94,000. The time series evidence on the EPDV of deferred annuities shows a pattern of stability that is similar to the pattern for SPIAs in Figure 4.

Figure 4: Time Series Variation in EPDV of Deferred Annuities



Entries correspond to EPDV for deferred annuities beginning payouts at age 85, sold to 65-year-old buyers, using *Annuity Shopper* pricing data from July of each year except 2021 (January) and corporate A-rated yield curves and SOA mortality rates for discounting.

The lower EPDV for the deferred annuities may reflect insurers' reluctance to offer long-duration policies with substantial risk of medical progress or other unexpected developments before payouts begin. These risks may be difficult for the insurance company to hedge. It is also consistent with more pronounced selection in the market for deferred annuities, with only the healthiest individuals at age 65 choosing to purchase deferred annuities. The risk of such selection for the insurer depends on whether potential buyers have meaningful information about their likelihood of living for several decades. Deferred annuities may also expose insurers to greater risk of asset-liability mis-match risk, because they have much longer duration than immediate annuities. For a 65-year-old man (woman), we estimate the duration of the payouts associated with an immediate annuity, using the corporate A yield curve and the SOA mortality table, to be 11.4 (11.9) years. By comparison, the duration of a deferred annuity for a 65-year old buyer is 25.4 years (man) and 25.8 years (woman). Verani and Yu (2020) note that about 90% of all corporate bonds are issued with maturities of ten years or less. This may make it difficult for portfolio managers at insurance companies to identify bonds with attractive risk and return attributes and long enough duration to match the liability stream of a deferred annuity.

Third, when deferred annuities are valued using the population mortality table and the corporate yield curve, the EPDVs are no greater than $71,000 and as low as $43,743 for the case of a 10-year deferred annuity offered to a 65-year-old man. The comparatively low money's worth values for these products raises the same question that has been asked when immediate annuities appear to have money's worth values below unity: are they unattractive for typical retires? Horneff, Maurer, and Mitchell (2020) assume that deferred annuities are priced to be actuarially fair (money's worth of unity) using the annuitant mortality table and a riskless interest rate of 1%. When they calculate the consumer's expected utility, however, they use the population mortality table.

The finding that the EPDV of a deferred annuity is well below its purchase price does not preclude the conclusion that buying such annuity can raise consumer welfare. Mitchell, Poterba, Warshawsky, and Brown (1999) found that, even when the money's worth of immediate annuities was on the order of 0.80, buying such annuities could improve lifetime expected utility when retirees lack other sources of annuity-like income. Those findings were sensitive, however, to the presence or absence of an income stream like Social Security. The money's worth estimates in Table 7 suggest the value of further exploration of pricing and valuation of deferred annuity contracts.

7.2 Term Certain Annuities, SPIAs, and Deferred Annuities: Pricing Parity?

In addition to the life-contingent payout products, SPIAs and deferred annuities, insurance companies also offer products known as "period certain annuities" which provide the buyer with a level payment for a fixed number of periods. This instrument is a variant on a bond, with the principal repaid over the life of the contract rather than at maturity. The price of a term annuity is not affected by the age or gender of the buyer. In January 2021, for the 17 companies with term annuity prices reported in *The Annuity Shopper,* the average monthly (annual) payment for a 20-year period certain product was $484 ($5808). The internal rate of return that equates this payout stream to $100,000 is 1.56%, about midway between the 10-year Treasury and 10-year A-rated corporate interest rates when the annuities were priced. It is helpful to compare this value with the various discount rates that we have applied in annuity valuation. This value is greater than the 10-year Treasury yield specified by the DOL calculation, but below the corporate yield curves. The low implied yields are somewhat surprising given the similarity of the payouts on a term certain "annuity" and other fixed income products in the market place.

A potential buyer of a SPIA with a 20-year guarantee could achieve her desired payout stream in either of two ways. One is to buy the SPIA-with-guarantee, delivering a certain payout for 20 years and life-contingent payouts beyond. The other is to purchase both a 20-year period certain annuity, delivering guaranteed payouts for the next 20 years, and a deferred annuity that will begin payouts in 20 years, thereby providing life-contingent payouts starting at age 85. In the absence of administrative costs for issuing insurance contracts, and potential selection effects in the set of buyers for the SPIA and deferred annuity contracts, the total cost of these two ways to achieve this payout stream should be equal. In practice, there are non-trivial differences.

To illustrate the price comparison, we focus on the insurance products offered by a single company, American General, the first company in alphabetical order offering all three products. This company's SPIA with 20-year guarantee for a 65-year-old male offers a payout of $421/month for a $100,000 premium. We calculate the cost of a "build your own" SPIA with a 20-year guarantee by noting that a 20-year first term annuity from this firm pays $466/month for a $100,000 purchase price. To provide $421/month for the next 20 years, a buyer would therefore need to spend (421/466)*$100,000 = $90,343. American General's 20-year deferred annuity for a 65-year-old man promises $28,926 *per year* beginning at age 85 for a $100,000 purchase price. To secure $421 per month, or $421*12 = $5052 per year, a buyer would need to spend (5052/28926)*$100,000 = $17,465 for a deferred annuity product. Thus, the income stream that could be purchased for $100,000 with a SPIA-with-20-year guarantee would cost $107,808 if purchased by assembling the deferred annuity and the term certain product.

Table 7 presents the results of the analogous calculations for the set of ten firms that offered all three policies in January 2021 for men and women at age 65. In 35 of the 40 cases presented for company/gender/age combinations in the table, the cost of buying the deferred annuity and the term certain annuity exceeds that of the SPIA-with-guarantee. The five cases that turn out the other way are concentrated at two companies, Lincoln National (three cases) and Symetra (two). The average cost difference is $3797 for men, and $4187 for women.

What might explain this disparity? One explanation is that there are costs of issuing policies, and that buying two policies rather than one is an inefficient way to generate the desired income stream. Another is that insurers are charging more to insure the life contingencies associated with the deferred annuity product than the SPIA-with-guarantee. That is consistent with the firms expecting greater selection in the pool of deferred annuity buyers – only 65-year-olds in excellent health would purchase such policies – and pricing them accordingly. Is this reasonable? In work that is currently underway, Poterba and Solomon (2021), we find a "term structure" of selection in annuity products, with much lower mortality in the first few years after an annuity is purchased, relative to population mortality, than in later years. This suggests that annuity buyers may not have much information about mortality prospects well into the future. Nevertheless, the pool of deferred annuity buyers might still be selected on liquidity or financial sophistication which might in turn correlate with longevity, even if their private information about the latter is weaker 20 years prospectively than currently.

8. Conclusion

This paper presents new evidence on the relationship between the purchase price and the expected present discounted values of payouts on immediate annuities. We illustrate this by calculating EPDV for products that were available in the U.S. in January 2021. Our preferred specification, combining s discount rates drawn from the term structure of A-rated corporate bond yields with the individual annuitant mortality table developed by the Society of Actuaries, yields an immediate annuity money's worth ratio for 65-year-old buyers is between 0.94 and 0.97. The money's worth ratios are substantially lower, between 0.78 and 0.87, when the mortality table for the population rather than for annuitants is used in the valuation calculation. This reflects the substantially longer life expectancy of annuitants relative to the general population.

When future payouts are discounted using the Treasury yield curve, the money's worth values are greater than unity – suggesting that that the present value of expected future payouts is greater than the premium cost. This suggests that insurance companies assume a portfolio return greater than the Treasury yield in valuing their future payout liabilities.

The EPDV framework can also be applied to deferred annuities, policies purchased by individuals in their 50s or 60s that promise benefits beginning at age 75 or 85. The money's worth ratios for these annuities are lower than those for immediate annuities, ranging between 0.77 and 0.89. The disparities between these values and the comparable measures for immediate annuities may be partly accounted for by adverse selection, a tendency for only the healthiest individuals to purchase deferred annuities. An open question is the degree of private information that prospective annuitants have with regard to their long-term survival prospects. This is likely to be more limited than private information about near-term mortality risks. Deferred annuities can be combined with fixed-term payment products, “term annuities,” to replicate the payout stream associated with single-premium individual annuities. Buying two policies to replicate a SPIA generally costs more than the SPIA, which may be a result of the differential selection in the SPIA and deferred annuity markets.

A recent regulatory directive from the Department of Labor that instructs sponsors of defined contribution pension plans to calculate the potential lifetime income stream that plan participants can purchase with their accumulated balances. The regulations outline a procedure for calculating the potential annuity payout assuming that future benefits are discounted at the 10-year Treasury yield, and participant mortality can be described by a unisex mortality table for defined benefit pension plan participants. This algorithm generates potential annuity streams that differ the policies that individuals can purchase in the private market. The assumed rate of return is likely to be lower than that assumed by insurance companies, and the mortality rate is higher. The net effect of these two factors on the estimated annuity payout depends on the age of the potential annuitant, and tends to understate potential payouts at younger ages, but to overstate them at older ages.

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Table 1: Cross-Company Average Annual Annuity Payouts, Per $100,000 Premium, January 2021

	Age 55	Age 65	Age 75
Single Premium Immediate Annuity (SPIA)			
Men	$4,380 (16)	$5,556 (16)	$7,812 (16)
Women	$4,212 (16)	$5,244 (16)	$7,152 (16)
Joint and Survivor (Male of Column Age, Female Spouse 5 Years Younger)	n/a	$4,296 (16)	$5,508 (16)
SPIA, 3% COLA			
Men	$2,736 (10)	$3,912 (14)	$6,144 (14)
Women	$2,556 (10)	$3,600 (14)	$5,520 (14)
Joint and Survivor	n/a	$2,748 (11)	$3,984 (12)
SPIA, 20 Year Guarantee			
Men	$4,224 (17)	$5,016 (17)	$5,664 (17)
Women	$4,092 (17)	$4,860 (17)	$5,580 (17)
Joint and Survivor	n/a	$4,272 (17)	$5,172 (17)

Source: *Annuity Shopper*, January 2021. Each entry reports the average value of 12 times the monthly payout amount for the set of annuities included in the sample. Numbers in parentheses denote the sample size for each product class. Note that the average annual payout on a 20-year term annuity (no life contingency) from the 17 firms in the sample was $5,808, and for a 30-year term annuity (offered by 9 firms in the sample) was $4,356.

Table 2: Population and Annuitant Mortality Rates for 65-Year-Old Men and Women in 2021

	SSA 2019 Cohort Table, Birth Year 1956	SOA Annuity 2012 Table updated to 2021 with SOA mortality improvements	SOA Annuity 2012 Table updated to 2021 with SSA mortality improvements	IRS Unisex Pension Liability Valuation Table, 2021
Men				
65	0.0151	0.0079	0.0082	0.0079
70	0.0218	0.0110	0.0115	0.0129
75	0.0338	0.0182	0.0191	0.0217
80	0.0551	0.0322	0.0338	0.0385
85	0.0940	0.0602	0.0630	0.0694
90	0.1605	0.1147	0.1158	0.1259
95	0.2569	0.1986	0.1950	0.2043
Women				
65	0.0092	0.0061	0.0063	0.0079
70	0.0146	0.0090	0.0093	0.0129
75	0.0237	0.0141	0.0146	0.0217
80	0.0419	0.0245	0.0254	0.0385
85	0.0723	0.0497	0.0519	0.0694
90	0.1281	0.0930	0.0935	0.1259
95	0.2128	0.1570	0.1550	0.2043

Source: Authors' calculations as described in equation (6) with SOA mortality improvements drawn from SOA (2011) Exhibit III, "Projection Scale G2," and SSA mortality improvements from SSA (2019), Table 2.2 "Intermediate Alternative.' The entries in each column reflect the mortality rates at future ages for individuals who are 65 years old in 2021. The entries for 75-year-olds, for example, correspond to mortality rates expected to prevail in 2031.

Table 3: Selected Comparisons between SOA and SSA Older-Age Mortality Improvement Projection Factors and Historical Population Experience

	Age Group	Historical Data				SOA Projection	SSA Projection	
		1968-1982	1982-1999	1999-2009	2009-2016	2002 onwards	Pre-2044	Post-2044
Male	50-64	2.28	1.92	1.15	-0.29	1.33	1	1.05
	65-84	1.46	1.23	2.42	0.86	1.46	0.99	0.79
	85+	1.56	-0.32	1.49	0.37	0.28	0.6	0.53
Female	50-64	1.72	1.09	1.46	-0.46	1.19	0.97	1.05
	65-84	2.03	0.43	1.71	0.72	1.27	0.92	0.73
	85+	2.06	-0.43	1.16	0.16	0.25	0.54	0.50

Source: Historical data on mortality improvement rates are drawn from SSA (2019). SOA (2011) reports the assumed rates for the annuitant mortality table, and SSA (2019) the values for the SSA mortality table.

Table 4: Estimates of the EPDV of Immediate Annuity Payouts, Per $100,000 Premium

	SSA (2019) Population Mortality Table Updated with SSA Improvement Factors		SOA (2011) Annuitant Mortality Table updated with SOA Improvement Factors		SOA (2011) Annuitant Mortality Table updated with SSA Improvement Factors	
	Treasury Yields	Corporate A Yields	Treasury Yields	Corporate A Yields	Treasury Yields	Corporate A Yields
Panel A: Estimates Assuming Tax Rate = 0						
Men Age 55	$92,181	$82,971	$106,811	$94,631	$104,988	$93,205
Men Age 65	88,345	82,033	105,127	96,234	103,397	94,761
Men Age 75	81,861	78,449	100,788	95,526	99,409	94,238
Women Age 55	96,881	86,431	106,774	94,419	105,714	93,318
Women Age 65	92,562	85,251	104,529	95,176	103,581	94,354
Women Age 75	84,903	80,812	99,992	94,244	99,338	93,608
Panel B: Estimates Assuming Tax Rate = 0.25						
Men Age 55	90,906	83,826	105,170	95,870	103,415	94,408
Men Age 65	87,100	82,407	102,972	96,448	101,352	95,008
Men Age 75	80,454	78,071	97,826	94,220	96,545	92,999
Women Age 55	96,217	88,160	105,808	96,133	104,789	95,282
Women Age 65	92,033	86,590	103,268	96,384	102,378	95,581
Women Age 75	82,817	79,995	96,469	92,558	95,857	91,957

Source: Authors' calculations using equation (1) and mortality rates and yield curves as described in the text, along with payouts on immediate annuity contracts in January 2021 as reported in Table 1.

Table 5: Cross-Company Average Annual Deferred Annuity Payouts, Per $100,000 Premium, January 2021

	Purchased at Age 55		Purchased at Age 65	
	Male	Female	Male	Female
Deferred Annuity Payouts Beginning at Age 75	$13,785	$12,411	$10,580	$9,511
Deferred Annuity Payouts Beginning at Age 85	$37,709	$31,427	$29,421	$24,287

Source: *Annuity Shopper*, January 2021. There are ten firms in the sample for all product classes.

Table 6: Estimates of the EPDV of Deferred Annuity Payouts, Per $100,000 Premium

	Population Mortality Table		SOA (2012) Annuitant Mortality Table		Modified SOA (2012) Annuitant Mortality Table	
	Treasury Yields	Corporate A Yields	Treasury Yields	Corporate A Yields	Treasury Yields	Corporate A Yields
Panel A: Deferred Annuity Beginning at Age 75						
Men Age 55	$74,938	$58,563	$107,970	$83,540	$103,165	$79,877
Men Age 65	76,018	65,682	103,640	88,510	100,640	85,991
Women Age 55	83,596	64,960	106,472	82,047	103,805	80,000
Women Age 65	82,247	70,576	101,969	86,650	100,409	85,315
Panel B: Deferred Annuity Beginning at Age 85						
Men Age 55	59,598	43,743	109,384	79,775	101,833	74,193
Men Age 65	58,257	46,636	102,047	81,194	97,330	77,349
Women Age 55	70,741	51,682	107,001	77,737	103,094	74,809
Women Age 65	67,372	53,688	99,955	79,211	97,794	77,390

Source: Authors' calculations using equation (1) and mortality rates and yield curves as described in the text, along with payouts on deferred annuity contracts in January 2021 as reported in Table 6.

Table 7: Additional Cost of Purchasing SPIA-with-20-Year Certain Income Stream by Combining Term-Certain and Deferred Annuities, January 2021 FIX

Company Offering Insurance Products	Purchased at Age 55		Purchased at Age 65	
	Male	Female	Male	Female
American General	$4748	$4138	$7809	$7784
Guardian Life	6547	6176	7075	6893
Integrity	4661	5133	3415	4937
Lincoln National	-135	1995	-598	-597
Massachusetts Mutual	923	699	1160	1069
Mutual of Omaha	1257	370	2211	1786
New York Life	3820	3892	6326	6496
Pacific Life	6599	6486	3022	4235
Principal	5653	7384	7504	8278
Symetra	-602	-114	41	991
Sample Average	3547	3605	3798	4187

Source: *Annuity Shopper*, January 2021. There are ten firms in the sample for all product classes.