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NEW EVIDENCE ON THE MONEY'S WORTH OF INDIVIDUAL ANNUITIES

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ABSTRACT

This paper presents new information on the expected present discounted value of payouts on individual life annuities. The annuity we examine is the single premium immediate life annuity, an insurance product that pays out a nominal level sum as long as the covered person lives, in exchange for an initial lump-sum premium. This annuity offers protection against the risk of someone outliving his saving, given uncertainty about longevity. For reasonable estimates of behavioral parameters, we calculate that individual annuities are currently priced so that retirees without bequest motives should find these policies of substantial value in configuring their portfolios to smooth retirement consumption. We also find that the expected present discounted value of payouts, relative to the initial cost of the annuity, has increased over the last decade. These findings bear on the policy debate regarding the role of individual choice and self-reliance in retirement planning.

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> "[I]f you observe, people always live forever when there is any annuity to be paid them...An annuity is a very serious business; it comes over and over every year, and there is no getting rid of it." Jane Austen (1962: 10-11)

As baby boomers near retirement, policy analysts have begun to ask how this cohort will handle the process of drawing down its retirement saving. One mechanism for doing this is the life annuity, an insurance product that pays out a periodic sum for life in exchange for a premium charge. The main appeal of the life annuity is that it offers retirees the opportunity to insure against the risk of outliving their assets by pooling mortality experience across the group of annuity purchasers.

The market for individual life annuities in the United States has historically been small. Previous researchers working in the context of the standard life cycle model, notably Friedman and Warshawsky (1988, 1990), have argued that it is puzzling that so few people avail themselves of the private market for annuities. This market has recently begun to attract substantial attention from those considering proposals to replace part of Social Security with private retirement saving accounts, since one way individuals might choose to spread the payouts from these accounts over their retirement years is by purchasing individual annuity contracts.

The standard explanation for the limited size of the individual annuity market is adverse selection. As the quotation above from Austen suggests, those who voluntarily purchase annuities may tend to live longer than average; insurance premiums therefore must be set high enough to compensate insurers for the longer life expectancies of purchasers. The extent to which adverse selection reduces the attractiveness of life annuities for potential annuitants is an empirical question.

In this paper, we present new data on the value of individual life annuities that were available in the private market in 1995. We develop a more sophisticated algorithm for annuity valuation than that in previous work, by valuing single life annuities for a wider range of ages, by valuing joint-and-survivor annuities, by allowing for a term structure of interest rates rather than by using a single long-term interest rate to value payouts, and by considering the special federal tax treatment of income paid from annuities. We apply this algorithm to annuity policies that are currently available in the marketplace, as well as to policies that were offered in 1985 and 1990. Previous studies of annuity valuation relied on data from more than a decade ago, and many factors have changed in the intervening years, including a sharp decline in nominal interest rates and a general increase in life expectancies at the older ages. Even without our methodological improvements, there is a substantial rationale for re-visiting the question of annuity valuation.

Our empirical findings suggest several conclusions. First, we find that the prices charged for a single premium immediate life annuity vary widely. The difference in annuity payouts between the ten highest payout and the ten lowest payout insurance companies, all per $1,000 premium charged, is close to 20 percent. The benefits of "shopping around," i.e. the dispersion in annuity payouts, also vary by age and by sex of the insured. Next, using a variety of valuation approaches to measure the expected present discounted value of annuity payments per premium dollar, we find that this expected value is well below unity. This implies that a typical retiree with average mortality prospects faces a significant "transaction cost" if he purchases an individual annuity from a commercial insurance carrier. Specifically, the average 65-year-old contemplating the purchase of a life annuity, whose alternative investment is a Treasury bond, receives payouts with a present value of 80 to 85 cents per dollar of premiums. The remaining premium dollars must cover marketing costs, corporate overhead and income taxes, additions to various company contingency reserves, and profits, as well as the cost of adverse selection. Value per premium dollar generally declines as the age of annuity purchaser increases, and, regardless of age, is typically higher for annuities issued to women and joint-and-survivors than for those issued to men.

Our comparisons of current annuity values with those found in the early 1980s suggests that payout value per premium dollar has risen by roughly 13 percentage points during the last decade and a half. This suggests that the effective transaction costs to participating in the individual annuity market have declined during this period. Finally, we find that incorporating the specialized income tax liabilities that are associated with annuity income does not significantly affect the expected present discounted value of annuity payouts. This is because the tax rules governing annuity products approximately offset the tax burdens on other investments that retirees might make.

This paper is divided into seven sections. The first provides an overview of the market for individual annuity products. Section two describes the expected present discounted value (EPDV) approach used to value the stream of payouts from annuity products. Key data inputs used are described in sections three and four, while the fifth section presents results on the EPDV of the payouts on individual annuity contracts and compares expected benefits with the premium cost of these policies. Section six uses an explicit utility function to explore the gain in household expected utility from purchasing an individual annuity instead of following alternative strategies to smooth retirement consumption when facing an uncertain lifetime. Section seven concludes, indicates a number of directions for future research, and indicates the relevance of this research to national retirement policy concerns. As both public and private pension systems move toward greater emphasis on individual choice and self-reliance in retirement planning, the individual annuity market may play a greater role in individual retirement preparation.

1. Overview of the Private Annuity Market

Annuities are contracts between an insurance company and an insured person or persons in which the insured receives a monthly or annual sum as long as he lives, in exchange for a one-time premium payment or flow of premium payments. The date at which level payouts begin can be different from, and in some cases many years after, the premium payment date(s). The objective of the annuity is to offer protection against the risk of someone outliving his saving, given uncertainty about his remaining lifetime.

The annuity contract generally specifies what happens during two distinct phases, namely the *accumulation phase* when the premium is paid and capital accumulates, and the *decumulation phase* when the benefits are paid out.[1] There are many different paths for building up the annuity capital. One approach is to deposit a single premium lump sum

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[1]Poterba (1997) provides a typology of various annuity contracts, describing their provisions during both the accumulation and decumulation periods.

method with the insurer; another is to gradually accumulate capital over a long period. A defined benefit pension plan can in some ways be viewed as an example of a slowly-accumulating annuity. The payout path can also vary a great deal, offering a life annuity with payments over the annuitant's lifetime, and to his survivor if it is a joint-and-survivor benefit, or over the annuitant's lifetime with some number of years certain, so that payments to the annuitant or his heirs are guaranteed to continue for at least a certain number of time periods, even if the annuitant dies before this number of periods has elapsed. Historically, most annuities offered periodic payments fixed in nominal terms, but variable annuities in which accumulations and/or payouts are linked to the returns on an underlying asset such as stocks have become increasingly popular in recent years.

Figure 1 shows the trend in the volume of individual annuity premium payments for the entire life insurance industry over the last decade. It shows that total sales of individual annuity products amounted to slightly less than $100 billion in 1995. While the real value of individual annuity sales nearly doubled between 1985 and 1995, most of this growth is due to *variable annuities*. Variable annuities, while technically insurance contracts, are attractive largely because they provide a tax-advantaged form of asset accumulation. Although assets held in variable annuity contracts can be withdrawn in annuity form, they can also be withdrawn in other ways, for example with a stream of lump-sum payouts. Because most variable annuity contracts have not yet reached their payout phase, it remains to be seen whether many variable annuity purchasers will choose the annuitization payout option. The growth of variable annuities therefore does not necessarily indicate a growing demand for private retirement annuities.

Figure 2 provides additional perspective on the size of the individual annuity market. It records total annual premium payments (in real 1994 dollars) from 1951 through 1993. The surprising finding from this figure is that in the mid-1990s, individual annuity sales were nearly as large as group annuity purchases, mainly from defined benefit pension plans. In 1995, the American Council on Life Insurance (1995) reports that there were roughly 23 million individual annuity policies in force; this number includes policies that were purchased in conjunction with defined benefit pension plans. Reserves to cover promised payments for individual annuity benefits stood at $792 billion, according to the Life Insurance Marketing Research Association International (LIMRA, 1996).

As the foregoing discussion indicates, however, not all annuity contracts generate annuity payouts, and the aggregate flow of annuity premiums includes purchases of immediate annuities as well as other products. To develop this point, it is helpful to recognize that there are two primary types of premium payment in the individual annuity marketplace: flexible premium and single premium. Flexible premium payments are in turn divided into first payments for newly purchased annuities, and renewal payments for existing annuity contracts. The single premium category is divided into single premium deferred annuities (SPDA) and single premium immediate annuities (SPIA).

Flexible premium payments accounted for $46.6 billion in 1995, compared with $52.5 billion of single premium annuity payments (LIMRA,1996). SPIAs, however, accounted for only $6.2 billion of premium payments in 1995, while SPDAs accounted for $46.3 billion. The small volume of SPIA purchases suggests that the recent growth of the aggregate annuity market has not resolved the long-standing puzzle, discussed for example in Friedman and Warshawsky (1990), of why individuals do not choose to annuitize their wealth.

The remainder of this paper focuses on SPIA contracts. Although a life annuity can be used as the decumulation method for all individual annuities regardless of premium payment type, annuity contracts other than SPIAs often offer other payout options, and we are not aware of any information on payouts per premium dollar for the other annuities. In contrast, for the SPIA, we know that the life annuity represents the predominant decumulation method.

Surveys of annuity buyers provide some information on the nature of this market. According to LIMRA International (1996), the average SPIA premium in 1995 was $79,600, and an unpublished LIMRA International 1993 survey of 26 companies selling SPIAs, 55% of individual annuities were sold to men.[2] Most SPIAs (74%) were not part of a tax-

[2]We thank Walter Zultowski of LIMRA for providing us with these unpublished data.

qualified retirement plan such as an IRA.[3] Figure 3 shows the age distribution of SPIA purchasers; the modal purchaser is between the ages of 66 and 70, and more than half of all SPIA buyers are between the ages of 61 and 80.

Our attention in this paper is exclusively on non-participating annuities, that is, on contracts where the insurance company guarantees principal and a fixed return. Participating annuities, in contrast, guarantee principal and minimum investment return payments and supplement those payments with dividends that depend on the insurance company's evolving investment, mortality, and expense experience. Because of a lessened need to maintain large contingency reserves to cover reinvestment and other risks, an insurer issuing participating contracts should be able to offer higher returns than one issuing non-participating contracts. With the prominent exception of TIAA, the non-profit insurer issuing annuity contracts exclusively to workers in higher education and non-profit research institutions, participating annuities are rare.

We also ignore variable annuities in the analysis below. In contrast to both non-participating and participating annuities, variable annuities do not provide any guarantee of principal or return. Valuing the expected payout from a variable annuity therefore requires forecasting the future returns on various types of securities in a way that valuing a fixed annuity does not.

2. The Money's Worth Framework

The centerpiece of our analysis is a straightforward calculation of the expected present discounted value (EPDV) of payouts for immediate annuities. We compare this value with the premium cost of the annuity. The expected present discounted value depends on three inputs: the *amount* of the annuity payout, the *interest rate* that is used to discount future

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[3]According to the 1993 survey, although the majority of SPIA annuitants had chosen a life annuity payout option, most selected some form of period certain or installment refund option as well: only 8% chose zero refurn and only 7% elected a joint-and-survivor life option. The age distribution of annuitants, shown in Figure 3, clearly tends toward older ages. The relatively small group of young annuitants below age 50 may include substantial numbers of individuals receiving annuities in structured payment of legal settlements.

payouts, and the *mortality* rates used to compute the probability that the representative annuity purchaser will still be alive at a given future date.

The most straightforward component of the EPDV calculation is the amount of the annuity payout (A). As we shall see below, data are available on the monthly payout to an individual purchasing an immediate single-life annuity for some initial purchase price, say $100,000 in a given year. This amount varies across annuity policies, but for the policies we will consider, it remains fixed in nominal terms for the life of the annuity contract.

To discount nominal cash flows received j periods into the future, we make two alternative assumptions about the term structure of future short-term nominal interest rates. First, we use the term structure of yields on Treasury bonds to estimate the time series of expected, future, nominal short-term interest rates.[4] We use i_k to denote the nominal short rate k periods into the future. The present discounted value today of one dollar paid j periods in the future is therefore $1/[(1+i_1)* \ldots *(1+i_j)]$. In addition to this riskless term structure, we also consider a term structure of risky interest rates. We compute the difference between the average yield on BAA corporate bonds, and the yield on a Treasury bond with ten years to maturity; let ν denote this yield differential. Then, we assume that this risk premium is constant at all maturuties, and we construct a term structure of risky interest rates using nominal future short-term rates of $i_k + \nu$. We label the two term structures "Treasuries" and "Corporates" in what follows.[5]

Estimating anticipated future mortality rates represents the most complex step in our EPDV calculation. We let $q_{a,t}$ denote the probability that an a-month-old individual who is alive at the beginning of month t will die during that month. To illustrate this notation,

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[4]We use the nominal yields on Treasury bonds of with fixed maturities of 1, 2, 3, 5, 7, 10, 20, and 30 years to estimate the term structure of expected short term interest rates. We calculate the expected nominal short rate in each future period as the nominal short rate that would satisfy the expectations theory of the term structure for the two adjacent long-term bonds.

[5]Friedman and Warshawsky (1990) assumed a flat term structure, and used the yield to maturity on 10-year Treasury bonds, 30-year Treasury bonds, and BAA corporate bonds to calculated the expected present discounted value of annuity payouts. For comparability with their findings, we report similar results in an appendix.

consider an individual whose 65th birthday is this month, and normalize this month to be calendar month one. The probability that this individual will die this month is $q_{780,1}$, where 780 = 12*65. The probability that this individual will be alive at the end of the current month is $(1-q_{780,1})$, and the probability that this individual will still be alive in two months is $(1-q_{780,1})*(1-q_{781,2})$. We summarize future mortality experience by defining P_j as the probability that someone who is 65 years old at the time when he purchases an annuity survives for at least j months:

$$P_j = (1-q_{780,1})*(1-q_{781,2})*...*(1-q_{780+j-1,j}).$$

We set $P_{600} = 0$, which imposes the restriction that no one lives beyond age 115 years.[6] To compute the EPDV of an annuity that a 65-year-old might purchase in 1995, we need to forecast this individual's *future* mortality rates. Section four below considers the construction of such mortality rate forecasts.

We use V_b to denote the EPDV of a life annuity with monthly payout A purchased by an individual of age b. The expression we evaluate, which differs from that in Warshawsky (1988) and Friedman and Warshawsky (1988, 1990) primarily in our allowance for a term structure of interest rates, is:

$$V_b = \sum_{j=1}^{600} \frac{A*P_j}{\Pi_{k=1}^{j}(1+i_k)}$$

For comparison with earlier analyses, in an appendix we report key results under the assumption that the term structure is flat, and under three assumptions about nominal interest rates. We consider cases in which the short-term interest rate for each period equals the ten-year Treasury bond yield, the thirty-year Treasury bond yield, and the BAA corporate bond yield.

Taxes are not included in this valuation expression, even though after-tax annuity

[6]The calculations reported below are relatively insensitive to assumptions about the upper limit on lifespan. Assuming a value of 100 years instead of 115 years results in estimates of the expected present discounted value within .02% of those reported below.

payments determine the consumption opportunities of individual annuity purchasers. The federal tax treatment of annuities is governed by a specialized set of rules which are described by the U.S. General Accounting Office (1990) and Trieschmann and Gustavson (1995), among others. For any annuity contract, the Internal Revenue Service specifies the expected number of years over which the annuitant can expect to receive benefits. We label this expected payout period T'; it is determined by the IRS using the 1983 Individual Annuitant (Unisex) Mortality Table and the individual annuitant's age at the time when payouts begin. Using T', the tax law prescribes how to calculate an inclusion ratio (λ), which determines the share of annuity payments in each period that must be included in the recipient's taxable income. The inclusion ratio is designed to measure the fraction of each annuity payout that reflects the capital income on the accumulating value of the annuity premium. For an annuity policy with a $100,000 premium, during the first T' years of payouts, this ratio is defined by:

$$\lambda = 1 - \frac{100000}{A*T'}.$$

After T' years, all payouts from the annuity policy are included in taxable income. 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:

$$V_{b'} = \sum_{j=1}^{12*T'} \frac{(1-\lambda*\tau)*A*P_j}{\Pi_{k=1}^{j}(1+(1-\tau)*i_k)} + \sum_{j=12*T'+1}^{600} \frac{(1-\tau)*A*P_j}{\Pi_{k=1}^{j}(1+(1-\tau)*i_k)}$$

In the after-tax calculation, the appropriate interest rate is the after-tax interest rate facing the annuitant. We report both the before-tax and after-tax calculations, V_b and V_b', in our analysis below. We also consider annuity policies that are offered to individuals at age 55, 65, and 75; the money's worth framework described above generalizes easily to these ages.

While we focus on the expected present discounted value of annuity payouts, it is also possible to compare annuities with other investment alternatives by computing the internal rate of return at which the present discounted value of annuity payouts will equal the cost of purchasing the policy. For the standardized $100,000 SPIAs that we consider, this amounts to finding the value ρ^* for the no-tax case, and ρ^*_{AT} for the after-tax case, that satisfies:

$$100000 = \sum_{j=1}^{600} \frac{A*P_j}{(1+\rho^*)^j}$$

and

$$100000 = \sum_{j=1}^{12*T'} \frac{(1 - \lambda*\tau)*A*P_j}{(1+(1-\tau)*\rho^*_{at})^j} + \sum_{j=12*T'+1}^{600} \frac{(1 - \tau)*A*P_j}{(1+(1-\tau)*\rho^*_{at})^j} .$$

For some purposes, these internal rates of return may be easier to interpret than the present discounted value of annuity payouts.

3. Data on Annuity Prices and Payouts

We assume that an individual is contemplating purchasing a *non-participating, single-premium, immediate, individual life annuity* from a commercial life insurance company. "Non-participating" means that the benefit payment is fixed and guaranteed, and does not reflect the insurance company's subsequent unanticipated experience with mortality, investment returns, or expenses. "Single-premium immediate" means that the investor pays a one-time premium and then begins receiving annuity payments within the next month, quarter, or year, depending on the payment frequency chosen. "Individual" means that the annuity is purchased directly from an insurance company, generally via an agent or broker, for the named investor, and is not obtained through a group annuity owned by an employer-sponsored pension plan.[7]

To say that an annuity is a "life" annuity means that payments are promised to continue for the investor's lifetime.[8] "Commercial life insurance companies" include U.S. mutual and stock companies of all sizes, domiciles, and financial strength classifications, but

[7]Below we also consider a "joint-and-survivor" life annuity purchased by a couple, where the level benefit payments continue as long as one member of the couple is alive.

[8]We do not consider annuity contracts that guaranty payments for a "fixed-period certain," although it would be straightforward to extend our money's worth framework to analyze these contracts.

exclude most of the life insurance organizations, generally non-profit, that have memberships in specialized industrial, religious, or professional groupings.

Premiums for life annuities are reported periodically in numerous publications issued by A. M. Best. We gathered data on annuity policies offered by a wide range of life insurance firms in 1985, 1990, and 1995. We collected data for immediate single life annuities, as well as joint-and-survivor annuities. For 1985 and 1990, we drew reported annuity premiums from Best's Flitcraft Compend, which is the source used by Warshawsky (1988) in his analysis of annuity prices over the period 1919 through 1984. For premiums charged in 1995, we used data from the July 1995 issue of Best's Review, where Best's is now reporting the results of its annual survey of insurance companies issuing single premium immediate annuities.[9] The Best's data correspond to single premium annuities with a $100,000 premium; we do not have any information on how the ratio of annuity payouts to the premium varies as the size of the premium changes. The data file excludes annuities offered by TIAA, on the grounds that these policies are not available to the general public, that they are participating annuity policies, and that TIAA does not offer single-premium immediate annuities.

The number of companies in the Best's annuity data base varies over the years. Large life insurers with a national presence and immediately recognizable names are always included, along with many small companies with apparently regional customer footings or firms that emphasize special insurance product lines. In 1985, for example, there were 47 companies in the A.M. Best's database; in 1990, 133 companies appeared, and in 1995, 100. For analysis carried out with data from the 1995 year, we gathered annuity premiums charged to men, women, and couples purchasing these products at ages 55, 65, and 75, respectively. For the comparative analysis over time, we collected data only on premiums for annuities issued to 65-year-old men using the 1985 and 1990 publications. In all cases, the premiums published are gross of state premium taxes, as well as federal and state income

[9]The Best's survey is conducted at the beginning of May, and we use the term structure of Treasury yields for the first week of May in calculating the discount factors that we use below.

taxes that must be paid on the annuity flows.[10]

To provide illustrative information on annuity policies, Table 1 indicates the monthly income payment per $1,000 of premium for annuities issued in 1995 to single men and women, and to couples, of different ages. The first panel in the table records the average monthly annuity payment offered by all companies in the data base. For example, a 65-year old man purchasing a typical $100,000 single premium annuity at age 65 would expect to receive a monthly payment of $794, or $9,528 per year, for life. Because women live longer than men on average, a 65-year old woman paying the same $100,000 premium would receive about 10% less, for a monthly $717 (annual $8,604). A 65-year-old couple buying a joint-and-survivor annuity would receive $648 monthly, or about 18% less than a single male.

Monthly annuity payments also increase with the age of the individual or couple to whom the annuity is issued. For example, a 75-year old man paying $100,000 for an annuity would receive a payout of $1,052 per month, almost one-third more than his counterpart 10 years his junior. For women, aging also raises the value of the annuity payout, but by less: the 75-year old woman receives only 28% more than the woman a decade younger. Table 1 also shows that the male/female annuity payout differential changes with age. At age 55 men receive annuity payouts that are six percent higher than those for women, but by age 75, the monthly amount to men is 14% higher than that for women. The joint and survivor benefit payments also change with age. At age 55, the couple receives a monthly benefit 13% below that paid to a single man, but by age 75, the couple's annuity amount is 25% lower. These payment patterns reflect differential mortality patterns for the various types of annuity purchasers.

The next two panels in Table 1 suggest the rather wide range of benefits paid by companies in Best's database. The range of payouts between the 10 highest-payout annuity contracts and the 10 lowest-payout policies, all conditional on a $100,000 premium payment,

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[10]Castillo (1996) reports that most states do not tax annuity premiums, even if they do impose a premium tax on life insurance purchases.

is 18% for 65-year-old men ((8.72-7.25)/.5*(8.72+7.25)). A 65-year-old man might receive from $725 to $872 monthly depending on the identity of the company from which he purchased the annuity. The all-firm average for such a purchaser was $794. The range of payouts for 65-year old men is slightly lower than the range for 75-year-old men (about 20%), and slightly higher than that for 65-year old women (about 16%). These data suggest that the benefits of "shopping around" for an annuity policy vary by age and by sex.[11]

A possible explanation for the variation in annuity payouts is that this reflects differences in the financial stability of the insurance companies selling the annuities. That is, it is conceivable that insurers rated as more stable would pay lower annuity amounts, while companies rated as riskier might be forced by the market to pay higher monthly benefits to attract investors. One way to judge whether this is true is to examine the fourth panel in Table 1, which sets out average annuity payments made by the twenty highest-ranked companies according to Belth's (1995) index of financial strength.[12] The results are similar to those in the top row of Table 1, and they suggest that annuity investors do not pay a substantially higher price when purchasing an annuity from a firm with an above-average financial rating. The final panel of Table 1, which shows payments made by the 10 insurance companies with the largest market share in the individual annuity market as reported by A.M. Best (1995), suggests a similar conclusion with respect to firm size. The average price for the large firms is similar to that for all firms.

4. Data on Current and Projected Mortality Rates

Valuing an annuity stream requires formalizing future expectations about the relevant mortality probabilities facing an individual annuitant or couple. Since future mortality

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[11]We found substantial correlation in the relative payouts that different firms offered to annuitants of different ages. For example, eight of the 10 firms that offered the highest payouts to 65-year-old male annuitants were also among the 10 firms offering the highest payouts to 55-year-old male annuitants.

[12]Belth's (1995) criterion focuses on firms receiving very high ratings from at least two of the four major private rating firms: Standard and Poor's, Moody's, Duff and Phelps, and Weiss.

probabilities are not known, it is necessary to use available data on past mortality rates to forecast future rates.

There are two relevant types of mortality probabilities. The first set reflects the expected mortality experience of the *general population*, based on mortality tables created by the Office of the Actuary at the U. S. Social Security Administration. These tables are used in the annual Social Security Trustees Reports to project the future financial position of the nation's major social insurance systems. The second set reflects expected mortality probabilities of the subset of the population that purchases *individual annuities*. Annuitant mortality data are based on tables made available by the Society of Actuaries, and are consistent with data actually used or proposed for use in the calculation of life insurance company reserves for individual annuity products.

Mortality probabilities for the general population and for individual annuity purchasers are significantly different. When compared within the same year and cohort, the mortality probabilities for both men and women in the general population at every age are higher than the mortality probabilities for annuity purchasers. This difference may be due to two nonexclusive factors: individuals with higher than average net worth may live longer than those without substantial assets, and the individuals who purchase individual annuities may live longer, on average, than those who do not. The latter type of adverse selection could occur even after allowing for the possibility that wealthier individuals face lower mortality risks.

With respect to the link between wealth and annuitant mortality, it is likely that the individuals and couples who demand an annuity stream beyond that given by Social Security and many private pension plans have higher-than-average net worth. Recent research has suggested that individuals with higher than average net worth actually live somewhat longer than the population at large (see Attanasio and Hoynes, 1995; Pappas, *et al.*, 1993). With respect to other types of adverse selection, it is possible that individuals with higher than average mortality risk, such as those with serious illnesses, conclude that annuities are too expensive for them, given their likely life expectancy. Hence, the average mortality probability of the group that decides to purchase annuities is truncated. Insurance companies, of course, price annuities with this truncation in mind; such pricing is the cornerstone of the analysis of equilibrium in competitive insurance markets developed by Rothschild and Stiglitz (1976) and Wilson (1980).

In addition to deciding whether to use general population or annuity purchasers' life tables, one must also decide whether to use *period* or *cohort* life tables to project mortality rates for annuitants. A period table represents the mortality experience of a group of people during a relatively short period of time, usually a year.[13] By contrast, a cohort or generation table represents lifetime mortality experience of a cohort of persons born during a particular year.[14] For cohorts that are no longer alive, cohort tables can be compiled from past period tables. For currently-living cohorts, however, constructing a cohort table requires blending information from past as well as projected future period tables.

When calculating annuity values it seems natural to use cohort tables, because they reflect the probabilities that a rational forward-looking individual would likely apply in making his decision concerning the purchase of an annuity. Note that the projected age-specific mortality rate for individuals in a given cohort may change over time as a result of new information on trends in individual mortality patterns and life expectancy. For example, the 1960 cohort mortality table for individuals born in 1930 would show a different projection for the mortality rate of this group when it reached age 70, in the year 2000, than would the 1990 cohort mortality table for the same cohort. The 1990 table would presumably show a lower projected mortality rate as a result of the substantial unpredicted mortality rate declines in the three decades between 1960 and 1990.

In the EPDV calculations below, we use two different types of mortality data. One approach is to use projected cohort mortality tables for the general population as compiled by the Social Security Administration Office of the Actuary in 1995. These mortality tables are based on unpublished statistics used for the 1996 Social Security Trustees' Report projections

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[13]This approach is taken in the Society of Actuaries tables and some Social Security tables, as explained by Bell et al. (1992, p. 1).

[14]This second approach is also sometimes used by the Social Security Administration.

for each relevant birth cohort.[15] For valuing annuites offered to 65-year-olds in 1995, we use the 1930 birth cohort probabilities. For 55-year-olds in 1995, we use data for the 1940 birth cohort, and for 75-year-olds, we use probabilities from the 1920 birth cohort. In each case we rely on SSA's 1995 projections of the future mortality experience for these cohorts, because such projections should be based on the same information about aggregate mortality trends that insurance companies might use in pricing their annuities.

A second approach we also follow is to use period tables for the annuitant population, in conjunction with the SSA cohort tables, to construct our own estimates of the 1995 cohort mortality table for individual annuitants. Cohort tables are unavailable for the annuity purchasing population, so we must make adjustments to the period tables for annuitants in order to mimic the desirable forward-looking properties of a cohort table. In our 1995 calculations, for example, we use information from the unpublished "basic" Annuity 2000 period table to estimate the cohort mortality patterns for individual annuitants.[16] The Annuity 2000 life table is designed to reflect projected annuitant mortality experience in the year 2000; it was recently issued by a committee of the Society of Actuaries.[17] To

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[15]We thank Felicitie Bell of the Social Security Administration for providing these data.
[16]"Basic" in this context means a mortality table formed from industry experience without an additional margin for conservatism. The difference between a "basic" table and a table without this modifier is an implicit load for annuity pricing. The 1983 IAM Table A and the 1983 Individual Annuity Basic A tables, for example, differ by a 10% load factor. Throughout our calculations, we use annuitant basic tables for various years.
[17]The Annuity 2000 table has an interesting history. The 1983 annuity table was based on actual annuitants' mortality experience in a large group of companies over the period 1971-76, updated to reflect and project 1983 conditions. The Society of Actuaries' Individual Annuity Experience Committee (1991-92) studied the annuity experience of a small group of companies over the period 1976-86, and concluded that the 1983 table was adequate for the 1980s. More recent population mortality statistics from the Social Security Administration and the National Center for Health Statistics, along with evolving conditions in the group annuity market, however, convinced Johansen (1996), an actuary actively involved in the earlier studies, to call for a new individual annuity table. His call, although not his specific recommendations, was answered affirmatively and a Society of Actuaries committee was convened to consider the subject. Because there are no recent studies of industry-wide annuitant mortality experience, however, the committee decided simply to use the basic 1983 annuity table projected forward to the year 2000 using mortality improvement factors consistent with the recent experience of the general population as well as that of one

construct a cohort-like table for 1995 annuitants, we first interpolate between the basic Annuity 2000 table and the 1983 Table A reported in the Committee to Recommend a New Mortality Basis for Individual Annuity Valuation (1981). Then, the ratios of relevant mortality probabilities from the 1995 Social Security cohort table to the 1995 Social Security period table are applied to the 1995 annuity period table. This correction, which assumes that the prospective rate of mortality improvement for annuitants will be the same as that for the general population, yields a 1995 cohort-like annuitant mortality table.

Table 2 shows the resulting 1995 population and annuitant mortality rates by gender and age, and it illustrates the lower mortality rates for the annuitant population. The differential is most notable, greater than one-third, at ages immediately following the traditional age of retirement.

To compare the expected discounted value of annuity payouts in different years, our analysis also requires cohort-like general population mortality probabilities for 1985 and 1990.[18] To carry out our analysis for 1990, we made the 1990 Social Security period table in Bell et al. (1992) into a cohort-like table by applying projected annual survival improvements of 0.75 and 1.00% for men and women, respectively. These improvement rates were previously used by Warshawsky (1988) and Friedman and Warshawsky (1988, 1990), and represent half the actual rates observed during the prior 15-year period. For 1985, we created a period table by interpolating between the 1980 Social Security period table appearing in Faber (1982) and the 1990 period table. The resulting 1985 period table was then made cohort-like by applying the same survival improvement rates.

A similar methodology was used to produce cohort-like annuitant mortality probabilities for earlier years. The 1983 Individual Annuity Mortality Basic Table A was brought forward to 1985 and 1990 by general population survival improvement rates observed over the relevant periods to produce period tables. These period tables were then made cohort-like by applying the projected survival improvement rates mentioned above.

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company with substantial annuity business.

[18]It was not possible to obtain the actual cohort tables used by the Social Security Administration in preparing the 1986 and 1991 Trustees' Reports.

5. Basic Money's Worth Results

We begin our summary of results with the detailed findings for 1995, and then move on to present calculations for earlier years. Tables 3 through 5 present annuity values for the 1995 database. Computations in Tables 3 and 4 use the all-company average payout rates from Table 1 to estimate the stream of payments associated with individual annuity contracts by sex and age. The difference between Tables 3 and 4 is that the former uses the 1995 *population* cohort mortality table, while the latter uses the 1995 *annuitant* cohort-like mortality table. In Table 5 we use both mortality tables to present annuity values from the 10 highest and 10 lowest-payout firms, as well as the largest and most highly rated insurance companies selling annuities.

All annuity values are computed using both the term structure of short-term nominal interest rates implicit in the Treasury bond yield curve, and the related yield curve for BAA corporate bonds. The first two columns of Tables 3 through 5 report results with no consideration given to the federal or state personal taxation of either annuity payments or interest payments on bonds, although they do allow for state premium taxes on annuity purchases.[19] The last two columns in each table present after-tax annuity value calculations, assuming that the annuitant faces a 28% combined federal and state tax rate.[20]

Table 3 shows the present value of annuity payments per dollar premium in 1995 calculated using general population mortality tables. For example, for a 65-year-old man the value per premium dollar for a life annuity on a before-tax basis is 0.816 assuming that we use the Treasury yield curve in valuation, and .742 if we use the corporate bond term structure. For a woman of the same age the average values are higher, at 0.829 and 0.745,

[19]Only 12 states impose taxes on annuity premiums; their average rate is 1.5%. To get the national average state premium tax rate of 0.52%, we weighted the individual state tax rates by the percentages of the U.S.-over-65-year-old population residing in each state. We thank Marci Castillo for providing us with data on state premium taxes.

[20]Because many annuity income recipients may also be Social Security recipients, the marginal tax rate on annuity or interest income could exceed the combined federal and state tax rate if this income leads to inclusion of Social Security benefits in taxable income. We explored the sensitivity of our results to higher marginal tax rates, but did not find any substantial changes relative to the findings reported here.

respectively. In general, the fact that all value per premium entries in Table 3 are well below 1.00 implies that a typical retiree with average mortality prospects would perceive a noticeable "transaction cost" when purchasing an annuity from a commercial insurance carrier. This is equivalent to purchasing an actuarially fair annuity as determined from the general population mortality table, but having to give up some fraction of one's wealth before investing the remainder in this annuity product.

Table 3 also shows that the higher the discount rate used in the valuation exercise, the lower the value per premium. The expected discounted value of annuity payouts are systematically lower when we use BAA corporate interest rates to discount payouts, than when we use the Treasury term structure. Another conclusion from Table 3 is that value per premium declines with age, regardless of discount rate. Values also vary by gender: controlling for age, value per premium is lowest for men, and is similar for women and couples. Finally, except for annuities issued to men age 65 and 75, the value per premium on an after-tax basis is somewhat higher than on a before-tax basis. It is possible that the general advantage to the after-tax calculations derives from the fact the IRS has mandated the use of an old period mortality table, the 1983 IAM table, in the calculation of the exclusion ratio.[21]

Our analysis assumes that couples evaluate joint-and-survivor annuities assuming that their individual mortality probabilities are independent. However, recent research by Frees et al. (1996) suggests that the mortality of husbands and wives exhibits positive dependence. Canadian insurance data suggest that annuity values should be reduced by about five percent when dependent mortality models, relative to the values computed using standard models that assume independence.

Table 4 presents annuity value to premium ratios using annuitant mortality probabilities rather than the general mortality rates analyzed above. Because annuitants have longer life expectancies than non-annuitants, the entries in Table 4 are uniformly higher than

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[21]Moshe Milevsky has informed us that in Canada, Revenue Canada requires the use of the 1971 IAM Table.

those in the previous table. For example, a 65-year-old man using the annuitants' mortality table would assess the value per premium as 0.916 on a pretax basis using the Treasury yield curve, and 0.927 after tax. This compares to a ratio of 0.816 (0.814) using general population survival rates. For a 65-year-old woman, the average values are again higher, at 0.893 pretax and 0.927 post tax, versus 0.829 and 0.854 respectively using general population tables.

We can also present the information in Tables 3 and 4 by computing internal rates of return on annuity policies. For a 65-year old man, the internal rate of return that equates the expected present discounted value of an annuity policy in the before-tax case with its premium cost is 4.62 percent when we use the population mortality table, and 6.31 percent when we use the annuitant table. For women, the analogous internal rates of return are 5.13 percent and 6.09 percent. To place these returns in perspective, the yield on a Treasury bond with ten years to maturity was 7.09 percent at the beginning of May, 1995, and the yield on a 30-year Treasury was 7.35 percent. BAA corporate bonds yielded an average of 8.57 percent at this time.

In comparing Tables 3 and 4, we find that the value per premium figures vary substantially more as the discount rate changes from the Treasury yield curve to the corporate yield curve in the case that uses annuitant mortality probabilities than general population mortality rates. This is because the effective duration of payouts is greater when the annuity policy is evaluated using the annuitant table. With a longer duration, the present value calculations become more sensitive to differences in the discount rate. We also find that, irrespective of discount rate, value per premium increases with age on a before tax basis when annuitant mortality is used. By contrast, in the before tax and after tax calculations for the general population, value per premium declines with age. This difference may be due to the fact that the ratio of the life expectancies of annuitants, and members of the general population, is greater for older than for younger individuals.

Regardless of tax basis or discount rate, and controlling for age, value per premium here is roughly comparable for men, women and couples. By contrast, in the general population calculations, value per premium was lowest for men. This result may be due to the fact that the ratio of life expectancies in the annuitant and general populations is greater for men than for women.

The results in Table 4 using the corporate term structure imply that annuity purchasers in the age ranges examined here would expect to receive payouts of between 82 and 86 cents per dollar invested. This set of calculations presumably represents the pure mortality and investment-related costs to the insurance companies of issuing life annuities, assuming that their typical portfolio investment is a BAA corporate bond. If this is true, it implies that commercial insurance companies in 1995 allowed about 14-18 percent of annuity premiums to cover marketing costs, corporate overhead and income taxes, additions to various company contingency reserves, and profits.[22] These figures are somewhat smaller than the figure of 25 percent computed for the 1970's and early 1980s by Friedman and Warshawsky (1988) and significantly smaller than the figure of 31 percent for the early 1980s alone.

Finally, we can calculate the cost of adverse selection in 1995 by comparing, for like age, gender and discount rate, the value per premium ratios in Table 3 and 4. For example, for an annuity sold to a man aged 65 and using the Treasury yield curve, the cost of adverse selection is 10 percent (.916 - .816). For the 1970's and early 1980s, the cost of adverse selection was 9 percent, roughly similar to the current cost. Adverse selection appears to explain roughly half of the disparity between the expected discounted present value of annuity payouts, and the cost of an individual annuity, from the standpoint of an average individual.

Table 5 presents value per premium dollar calculations for annuities offered to 65-year-old men for a range of different insurers, using both general population and annuitant mortality probabilities.[23] The entries in the table suggest two conclusions. First, there are

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[22]For insurance companies licensed to write business in New York state, marketing costs include commissions to agents and brokers and related direct expenses are not allowed to exceed 7% of the annuity premium.

[23]One question that arises with the Best's data is whether some firms that are listed in the data base are not currently issuing policies, so that the "offered" price quotes are dated or otherwise correspond to firms that are not actually selling policies. We attempt to address

large differences in values per premium across insurance companies. For example, on a pre-tax basis and using the Treasury yield curve and the general population mortality table, the average value per premium for the ten best paying annuities is 0.895, compared to 0.745 for the ten worst paying annuities -- a difference of 15 percent. Second, those companies issuing the ten best paying annuities seem to have relatively small margins for expenses. More specifically, the value per premium using annuitant mortality tables and the corporate yield curve 0.905, so that only about nine cents per premium dollar are left for expenses, additions to contingency funds, and profits. These companies may have very low cost structures, perhaps by selling annuities through direct marketing, and/or they may believe that they will experience better investment results or mortality results than we have assumed.[24] In any event, these high value per premium figures confirm the conclusion that there has been a marked shrinkage in the gap between premium paid and annuity value received, particularly as compared to the earlier Friedman and Warshawsky (1988) findings.

Having examined the expected value of annuity products that were offered to the public in 1995, we now consider how the expected value of these products has changed over time. Table 6 shows the value per premium calculations for annuities offered to 65-year-old men, using the Best's all-company average payout for 1985, 1990, and 1995. It is clear that irrespective of the discount rate, mortality table, or tax basis, value per premium dollar grew roughly eight percentage points between 1985 and 1995. The present estimates for 1985 are close to Warshawsky's (1988) calculations for 1984, confirming that our methodology is similar enough to generate comparable results for nearby years. We also note that our 1995 results are reminiscent of the high values per premium dollar that Warshawsky (1988) reports

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this issue by presenting separate tabulations for the ten firms with the largest annuity business, on the grounds that these firms are likely to be actively involved in the market.

[24]We explored the persistence of firms in the "ten best" and "ten worst" categories between 1990 and 1995. There were 59 companies in the Best's data base in both 1990 and 1995. The rank correlation between the payouts on annuities for 65-year-old men was +0.17 between the two years. Of the twelve companies in the highest payout quintile in 1990, only three were in the highest payout quintile in 1995, and of the eleven companies in the lowest payout quintile, only two remained there in 1995. Thus there appears to be substantial fluctuation in the payouts that insurers offer on their annuity policies.

for several earlier periods, including the 1940's, early 1950's, and mid 1960's.

A question that arises from the fluctuations in annuity value per premium dollar is what determines the market price of annuity contracts. This price should be related to the level of real interest rates, but it may also be related to the level and variability of nominal interest rates. When interest rates are low and stable, insurance companies may be able to price non-participating annuities more competitively with other fixed-income investments. In contrast, when interest rates are high and variable, insurance companies may be reluctant to assume that current yields will be maintained for the duration of annuities issued in that year, and therefore they act more conservatively and require larger contingency funds from their annuity pricing.

A particularly important question concerning the interpretation of the results in Table 6 is whether the increase in the expected present discounted value of annuity payouts per premium dollar is the result of a trend toward higher payouts, or an artifact of cyclical fluctuations in annuity pricing. This is an issue that we cannot resolve with the information presented here, but it is a problem that we hope to explore in future work.

In addition to changes over time in the relationship between the expected present discounted value of annuity payouts and the annuity premium, there have also been changes in the range of annuity prices in the market. Focusing on policies available to 65-year-old men, we find that in 1985, the monthly income for the ten highest payout policies averages 1.152 times that for the entire sample of policies in the Best's data base, while the average payout for the ten lowest payout companies is 0.885 times the sample average. In 1990, the analogous statistics were 1.097 and 0.892, and in 1995, 1.098 and 0.913. Thus the spread between the high- and low-payout annuity policies declined between 1985 and 1990, and again, although by less, between 1990 and 1995. About two-thirds of the narrowing was due to a decline in the relative payouts of the annuity contracts that offered the highest payouts per premium dollar.

6. "Self-Insured Annuities": Alternative Ways to Smooth Retirement Consumption

The foregoing discussion has focused on the expected present discounted value of annuity payouts. This analysis neglects the central fact that annuities are designed to provide insurance to individuals. Focusing solely on the expected value of payouts does not recognize this important feature. To address this question, it is necessary to develop a calculation with an explicit individual utility function and to compare the expected *utility* of purchasing an annuity with that from alternative, non-annuity options for spreading consumption over time.[25]

In this section we compare purchasing an actuarially fair annuity contract, versus pursuing a simple "self-insurance" annuitization strategy. Any strategy in the second category faces a dilemma. If an individual chooses a high level of consumption early in retirement and then turns out to live a long time, he will be forced to sharply reduce consumption in later years. Alternatively, if consumption is set to a low level in the early retirement years so that there will be sufficient resources if the individual is long-lived, then there is a chance that the individual will die with substantial resources that have not been consumed.

One simple strategy for spreading resources over the retirement period is to set nominal consumption at age a equal to:

$$C_a = \frac{W_a}{L_a}$$

where W_a denotes the nominal value of wealth at the beginning of period a, and L_a denotes the individual's life expectancy (in years) at age a. Because life expectancy declines as the individual ages, the fraction of wealth that will be consumed in each period will increase with age, but the level of wealth remaining will decline substantially with age. The individual's consumption plan is completely determined by information on wealth at retirement age, the consumption rule above, and the following equation for the evolution of wealth from one period to the next:

$$W_{a+1} = [1+i(1-\tau)]*(W_a - C_a).$$

[25]For recent treatments of the question of whether individuals should purchase annuity contracts see Brugiavini (1993) and Milevsky (1996).

We assume that the nominal interest rate (i) equals the sum of the real interest rate (r) and the inflation rate, and that it is the same in all periods.[26] We consider a range of possible real interest rates and inflation rates in our calculations below, and we also present calculations that set the tax rate to zero. The consumption rule described here is not the optimal rule for consuming a fixed stock of wealth in the presence of mortality uncertainty, but it is a simple rule that individuals might actually implement. The optimal rule in general depends on parameters of the individual utility function and the time path of mortality probabilities.

For the individual who purchases an annuity, nominal consumption in each period is determined by his wealth at the beginning of retirement, which we treat as age 65, the periodic annuity payout per dollar of premium payment (θ), and the tax rules that govern annuity income. This can be summarized as:

$$C_a = [1 - \lambda * \tau * I_{a<65+T'} - \tau * I_{a\geq 65+T'}] * \theta * W_{65}.$$

The variable $I_{a<65+T'}$ is an indicator variable set equal to one for ages less than the date at which all annuity income is included in taxable income, and zero otherwise. The other indicator variable is defined in complementary fashion.

We limit our analysis to annuity contracts that pay fixed nominal benefit streams, and we consider situations with constant inflation rates. We consider inflation rates of both 3 and 6% per year; these translate into real annuities that decline in real value at these rates.[27] We compute the actuarially fair annuity payout per premium dollar (θ) for a 65-year old male, in 1995, using the Social Security Administration's cohort life table for men born in

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[26]Because we deflate nominal consumption flows by the price level when they enter the utility function specified below, the real after-tax interest rate facing the individual is $[(1-\tau)i-\pi]$.
[27]We have done some calculations comparing the utility levels afforded by these nominal annuities and alternative real annuity contracts. Even though the nominal annuities offer consumption streams that decline in real value, the deviation from the constant real consumption path that would be optimal from the annuitant's standpoint does not lead to a large reduction in utility. This is because the tilting of the real consumption profile takes place locally around the optimal path. The graded payment method for annuity payouts, first proposed by Biggs (1969) and implemented by TIAA in 1982, allows for an increasing payout profile roughly in line with the rate of inflation.

1930. We find θ from the following equation:

$$1 = \sum_{j=1}^{600} \frac{\theta * P_j}{(1 + i(1-\tau))^j}.$$

Note that the value of θ resulting from this calculation is higher than the annuity payout per premium dollar for policies that are actually available in the marketplace.

To compare the expected discounted utility stream associated with the actual annuity and the "self-insurance" annuity option, we assume that individuals have additively-separable utility functions of the following form:

$$U = \sum_{j=1}^{600} P_j * \frac{\left(\left(\frac{C_j}{(1 + \pi)^j}\right)^{1-\beta} - 1\right)}{(1 - \beta)*(1 + \rho)^j}.$$

The parameter β determines the individual's risk aversion and also the degree of intertemporal substitution in consumption. The nominal consumption flow is deflated by the price index, $(1+\pi)^j$.

Our comparison proceeds in two steps. First, we compute the stream of consumption and the associated present discounted value of utility for an individual who reaches age 65 and pursues the self-insurance annuitization strategy with an arbitrary wealth level (we set $W_{65} = 1$). We denote this utility level by U^*; it is the result of evaluating U in the expression above for the consumption path that results from following the "consume wealth over life expectancy" rule. Second, we ask what amount of wealth at age 65 ($WEQUIV_{65}$) an individual would need to be able to reach utility level U^* if he were purchasing an actuarially fair annuity. This wealth level can be solved for implicitly from the following expression:

$$U^* = \sum_{j=1}^{600} P_j * \frac{\left[\left(\frac{\theta * WEQUIV_{65}}{(1 + \pi)^j}\right)^{1-\beta} - 1\right]}{(1 - \beta)*(1 + \rho)^j}$$

Purchasing an actuarially fair real annuity is the optimal consumption plan for an individual with a zero discount rate, a stochastic lifetime, and no other future uncertainty. Since the actuarially fair nominal annuity that we consider offers a relatively similar consumption stream, we expect that $WEQUIV_{65}$ will be less than one.

Table 7 presents the results of these calculations for two different assumptions about individual risk aversion ($\beta = 1$ and $\beta = 2$), and for several different assumptions about the level of real interest rates and individual time preference rates. These calculations, which are similar to those presented by Kotlikoff and Spivak (1981) for the case of private annuities and Hubbard (1987) for the case of publicly-provided annuities, suggest that individuals should be prepared to give up substantial fractions of their wealth in order to purchase actuarially fair annuities. In the before-tax calculations with an inflation rate of 3%, for example, we find that individuals would accept a reduction of between 30% and 46% in their wealth at age 65 if they were able to purchase actuarially fair annuities rather than pursue the "self insured" annuitization strategy. The amount of wealth that individuals would forego is increasing in their risk aversion, and decreasing in the rate of return that they can earn on their own investments.

These calculations suggest that in simplified stochastic lifecycle models without bequest motives, utility-maximizing individuals should purchase annuities even if these contracts cost more than actuarially fair contracts. One way to interpret the findings in Table 7 is that even if the EPDV calculations presented above yielded only 0.70 per dollar of premium payment, people with preferences such as those modeled here would still prefer to purchase the annuity, versus undertaking the "self-insurance" alternative that we consider.

These calculations should be viewed as exploratory for several reasons. First, they ignore the possibility of bequest motives, even though a substantial literature suggests that individuals behave in ways that are consistent with the presence of at least some such motives.[28] Second, the self-insurance annuity strategy that we have considered is not

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[28]Laitner and Juster (1996) and Wilhelm (1996) represent recent contributions to the literature on bequest motives and provide references to earlier studies. Abel and Warshawsky (1988) discuss alternative specifications of the bequest motive that could be used to modify the

necessarily the optimal policy for an individual who is trying to optimally smooth retirement consumption without access to an annuity market. Alternative consumption plans might generate higher values of $WEQUIV_{65}$, and they could be explored in future work.

7. Conclusions and Future Work

This paper presents evidence on the expected present discounted value of payments for annuity policies payments and compares these to the cost of purchasing an individual annuity contract. The central finding is that the average annuity policy delivered payouts valued at between 80 and 85 cents per dollar of annuity premium in 1995. Further, there was substantial heterogeneity across annuity providers in the payouts per dollar of premium payment. We find evidence that the expected present discounted value of annuity payouts relative to premium payments has increased by approximately eight percentage points during the last decade. Thus, from the standpoint of potential purchasers, individual annuity contracts appear to be more attractive products today than ten years ago.

In addition to providing information on options that individuals can use to smooth consumption in retirement, our research is also relevant to a set of issues that arise in designing national retirement policy. Although the individual annuity market is currently quite small, it has attracted substantial interest from researchers and policy makers concerned with the evolving system of retirement income provision. In light of current discussions of Social Security reform, and the shift from defined benefit to defined contribution private pension plans, we suspect that there may be increased interest in individual annuity products in the future. Current trends place greater emphasis on individual choice and self-reliance in planning for retirement. These developments may increase the demand for individual annuity products as retirees confront the problems of optimal decumulation of assets accumulated in various retirement plans.

Valuation calculations such as those presented here are also important for evaluating the extent of adverse selection in the market for individual annuities. This, in turn, is a key

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calculations presented above.

consideration in the policy debate regarding whether the government should intervene directly and mandate a national annuity pool if part of the current Social Security system were replaced by a mandatory private saving system (TIRS 1995).[29] These results provide an important input for this analysis, although they should be viewed with caution because a policy change of this magnitude could alter the set of individuals purchasing annuities and therefore alter the pricing of these products.

Our findings raise a number of questions for future research. The most important outstanding issue is probably the explanation of the differential between the expected present discounted value of annuity payouts and the premiums for these policies. This difference may be partly due to taxes on the insurance companies that offer annuity products. Our analysis has recognized the effect of annuitant-level taxes on the relative value of annuities and other financial products, but it has not tried to explain how taxes at the corporate level affect the pricing of annuities. Another portion of the differential between premium and discounted benefit flow is attributable to the insurance company load, or charge levied to cover administration costs and normal profitability. There may be company-to-company differences in underwriting, making the cross-firm premium variation reflective of specific risk pools that our overall correction does not fully capture. Nonetheless, the fact that the differential has diminished over time suggests that potential imperfections in the annuity business of two decades ago may be attenuated in today's insurance market.

Future research could usefully extend this analysis to consider the pricing and value of group annuity products. Because of the risk pooling inherent in the purchase of group annuities, for example through a pension fund, there is likely to be less adverse selection in the group market than in the individual annuity market. Hence we would expect to see smaller differences between the expected present discounted values and premium costs for the population, and for group annuitants, than we found in the individual annuity market. One

[29]The potential for market failure in the individual annuity market has historically been advanced as one of the reasons for government provision of retirement income. Diamond (1977) discusses this issue; Abel (1986) provides a formal analysis of the interactions between public retirement programs and private annuity markets.

of the central difficulties in analyzing the group annuity market is the absence of data on the current prices for group annuity policies.

It would also be helpful to expand our analysis to include risky assets, and other components of household portfolios more generally. We have effectively assumed that the payouts from an annuity contract are certain, conditional on individual life length, and that the individual holds only riskless assets such as Treasury securities or investment-quality corporate bonds as alternatives to an annuity contract. If the individual's portfolio also includes risky securities such as corporate equities, then the comparison between purchasing an annuity and holding other financial assets may differ from the one we present. The comparison between the payout stream associated with a variable annuity and the "self-insurance annuity" considered here would also differ from the comparison we report. Yet another complexity arises from the recent introduction of bonds with yields linked to changes in the Consumer Price Index. These "indexed bonds" may lead to the introduction of annuity contracts with fixed real payouts rather than fixed nominal payouts; these would also involve different comparisons than the ones we report. Finally, there have been important changes through time in the extent to which individual retirement resources are annuitized. Auerbach, Kotlikoff, and Weil (1992) observe that there has been a post-war trend toward increasing annuitization of the elderly, as Social Security, defined benefit pension payouts, and the insurance value of Medicare have grown as a fraction of retiree resources. Bernheim (1991) finds some evidence that households with higher fractions of their wealth in an "externally annuitized" form demand more life insurance, and that those without such annuitization are more likely to hold individual annuities. Analyzing the value of further annuitization, in the presence of substantial annuitization through government transfer programs, is another natural extension to pursue.

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Table 1: Immediate Annuity Payouts By Age and Sex, 1995

	Age 55	Age 65	Age 75
All Companies, Average:			
Men	6.64	7.94	10.52
Women	6.24	7.17	9.22
Joint and Survivor	5.78	6.48	7.94
Ten Highest Payouts, Average:			
Men	7.38	8.72	11.61
Women	6.88	7.76	9.99
Joint and Survivor	6.39	7.07	8.60
Ten Lowest Payouts, Average:			
Men	5.98	7.25	9.45
Women	5.59	6.56	8.63
Joint and Survivor	5.14	5.84	7.23
Twenty Highest Rated Firms, Average:			
Men	6.50	7.78	10.35
Women	6.09	7.07	9.09
Joint and Survivor	5.72	6.40	7.82
Ten Largest Annuity Firms, Average:			
Men	6.72	7.98	10.43
Women	6.31	7.21	9.14
Joint and Survivor	5.84	6.43	7.79

Source: Annuity payout data provided in Best's Review, July 1995. Each entry indicates the monthly income, in dollars, per $1000 of initial annuity purchase, based on the purchase of a $100,000 single premium immediate life annuity policy. The $100,000 purchase price is inclusive of policy fees, but excludes state annuity premium taxes.

Table 2: General Population and Annuitant Mortality Rates (Per 1000 Persons), 1995

1995 Individual Gender and Age	Life Table for 1930 Birth Cohort General Population	1995 Individual Annuitant Life Table
Men:		
65	22.2	11.5
70	31.5	18.8
75	46.7	30.9
80	73.7	50.4
85	113.8	79.8
90	169.0	120.6
95	238.4	172.6
100	305.3	236.0
105	380.4	341.9
Women:		
65	13.4	7.3
70	19.8	11.5
75	29.1	19.4
80	44.3	33.4
85	69.6	57.6
90	116.7	101.3
95	189.5	158.4
100	259.2	211.3
105	337.1	299.0

Source: The first column is based on unpublished tabulations provided by the Social Security Administration, Office of the Actuary. The second column is drawn from mortality tables produced as part of the Society of Actuaries Annuity 2000 project, adjusted to reflect mortality rates in 1995 rather than 2000.

Table 3: Annuity Values per Premium Dollar, 1995, Using Population Life Table

	Before Tax Calculation		*After-Tax Calculation*	
	Treasury Yield Curve	Corporate Yield Curve	Treasury Yield Curve	Corporate Yield Curve
Men:				
Age 55	.838	.745	.852	.773
Age 65	.816	.742	.814	.756
Age 75	.797	.744	.783	.743
Women:				
Age 55	.845	.743	.880	.791
Age 65	.829	.745	.854	.785
Age 75	.833	.768	.846	.796
Joint and Survivor:				
Age 55	.850	.741	.889	.792
Age 65	.841	.750	.868	.792
Age 75	.831	.762	.846	.791

Notes: Each entry shows the expected present discounted value of the annuity payouts per dollar of annuity premium. All calculations use the all company sample average annuity payout rates to estimate the stream of payments associated with individual annuity contracts.

Table 4: Annuity Values per Premium Dollar, 1995, Using Annuitant Life Table

	Before Tax Calculation		*After-Tax Calculation*	
	Treasury Yield Curve	Corporate Yield Curve	Treasury Yield Curve	Corporate Yield Curve
Men:				
Age 55	.904	.796	.934	.840
Age 65	.916	.825	.927	.853
Age 75	.922	.852	.913	.860
Women:				
Age 55	.891	.778	.937	.838
Age 65	.893	.797	.927	.847
Age 75	.902	.827	.919	.861
Joint and Survivor:				
Age 55	.879	.761	.930	.824
Age 65	.890	.788	.929	.841
Age 75	.900	.818	.922	.857

Notes: Each entry shows the expected present discounted value of the annuity payouts per dollar of annuity premium. All calculations use the all company sample average annuity payout rates to estimate the stream of payments associated with individual annuity contracts.

Table 5: Values per Premium Dollar (1995) of Annuity Policies Offered for Men Age 65

	Before Tax Calculation Treasury Yield Curve	*Before Tax Calculation* Corporate Yield Curve	*After-Tax Calculation* Treasury Yield Curve	*After-Tax Calculation* Corporate Yield Curve
Using Population Life Tables:				
All Sample Average	.816	.742	.814	.756
Ten Best Payouts	.895	.815	.881	.818
Ten Worst Payouts	.745	.678	.755	.701
Ten Largest Annuity Firms	.820	.746	.818	.759
Twenty Best-Rated Firms	.799	.727	.801	.745
Using Annuitant Life Tables:				
All Sample Average	.916	.825	.927	.853
Ten Best Payouts	1.006	.905	1.003	.923
Ten Worst Payouts	.837	.753	.859	.791
Ten Largest Annuity Firms	.921	.829	.931	.857
Twenty Best-Rated Firms	.898	.809	.912	.839

Notes: Each entry shows the expected present discounted value of the annuity payouts per dollar of annuity premium.

Table 6: Values per Premium Dollar of Annuity Policies Offered for Men Age 65 -- 1985-95

	Before Tax Calculation		*After-Tax Calculation*	
	Treasury Yield Curve	Corporate Yield Curve	Treasury Yield Curve	Corporate Yield Curve
Using Population Life Tables:				
1985	.749	.677	.764	.704
1990	.814	.746	.812	.757
1995	.816	.742	.814	.756
Using Annuitant Life Tables:				
1985	.827	.740	.865	.790
1990	.912	.828	.926	.856
1995	.916	.825	.927	.853

Notes: All entries show the present discounted value of annuity payouts per dollar of annuity premium, assuming a $100,000 single-premium immediate annuity purchase. The population life tables underlying the calculations are based on unpublished Social Security Administration, Office of the Actuary data. The annuitant life tables are based on our projections of the 1973 Individual Annuitant Mortality table, with projections based on Warshawsky's (1988) method assuming constant year-to-year mortality improvements. The 1985 after-tax calculations apply the exclusion ratio to all annuity payouts, rather than only those received at the beginning of the payout period, because of differences between the 1985 tax law and the 1995 tax law, which is described in the text.

Table 7: "Wealth Equivalence" Between Annuitized and Non-Annuitized Assets

Parameter Values	Before Tax Calculation $\beta = 1$	Before Tax Calculation $\beta = 2$	After-Tax Calculation $\beta = 1$	After-Tax Calculation $\beta = 2$
$\pi = .03$:				
r = .03, ρ = .01	.672	.538	.771	.540
r = .03, ρ = .03	.679	.591	.788	.622
r = .05, ρ = .01	.706	.633	.792	.630
r = .05, ρ = .03	.700	.659	.798	.692
$\pi = .06$:				
r = .03, ρ = .01	.727	.627	.804	.563
r = .03, ρ = .03	.714	.665	.805	.643
r = .05, ρ = .01	.778	.751	.835	.678
r = .05, ρ = .03	.750	.755	.824	.736

Note: Each entry indicates the value of annuitized assets, as a fraction of non-annuitized assets, that would be required to achieve a given level of expected lifetime utility. All calculations assume that individuals have access to an actuarially fair annuity market in which they can purchase single-premium immediate annuities with fixed nominal payout streams. Individuals exhibit time-separable utility functions of the form:

$$U = \sum_{j=65}^{115} P_j * \frac{\left(\frac{C_j}{(1+\pi)^j}\right)^{1-\beta} - 1}{(1-\beta)*(1+\rho)^j}$$

In the absence of annuitization, consumption each period is set equal to beginning-of-period wealth divided by remaining life expectancy. The inflation rate is fixed at π*100 percent per year. The parameter r denotes the real interest rate which determines both the actuarially fair annuity payout and the trajectory of consumption under the 'self-insurance' annuity assumption. The SSA cohort life table for men born in 1930 is used for all calculations.

Table A-1: Annuity Values per Premium Dollar, 1995, Using Flat Term Structure

	Before Tax Calculation			*After-Tax Calculation*		
	10-Year Treasury	30-Year Treasury	BAA Corporate	10-Year Treasury	30-Year Treasury	BAA Corporate
			POPULATION LIFE TABLE			
Men:						
Age 55	.862	.844	.765	.868	.853	.786
Age 65	.835	.821	.758	.828	.816	.766
Age 75	.809	.798	.753	.790	.782	.748
Women:						
Age 55	.870	.850	.764	.897	.879	.804
Age 65	.852	.835	.764	.870	.856	.797
Age 75	.850	.837	.782	.857	.847	.804
Joint and Survivor:						
Age 55	.877	.854	.762	.906	.887	.806
Age 65	.866	.848	.771	.885	.870	.805
Age 75	.850	.836	.777	.858	.848	.800
			ANNUITANT LIFE TABLE			
Men:						
Age 55	.932	.910	.818	.952	.933	.853
Age 65	.941	.923	.845	.944	.930	.866
Age 75	.940	.926	.866	.924	.913	.868
Women:						
Age 55	.919	.896	.800	.956	.936	.851
Age 65	.919	.899	.818	.945	.929	.861
Age 75	.921	.907	.843	.931	.920	.870
Joint and Survivor:						
Age 55	.908	.883	.784	.949	.927	.837
Age 65	.918	.897	.810	.948	.931	.856
Age 75	.922	.906	.837	.938	.925	.869

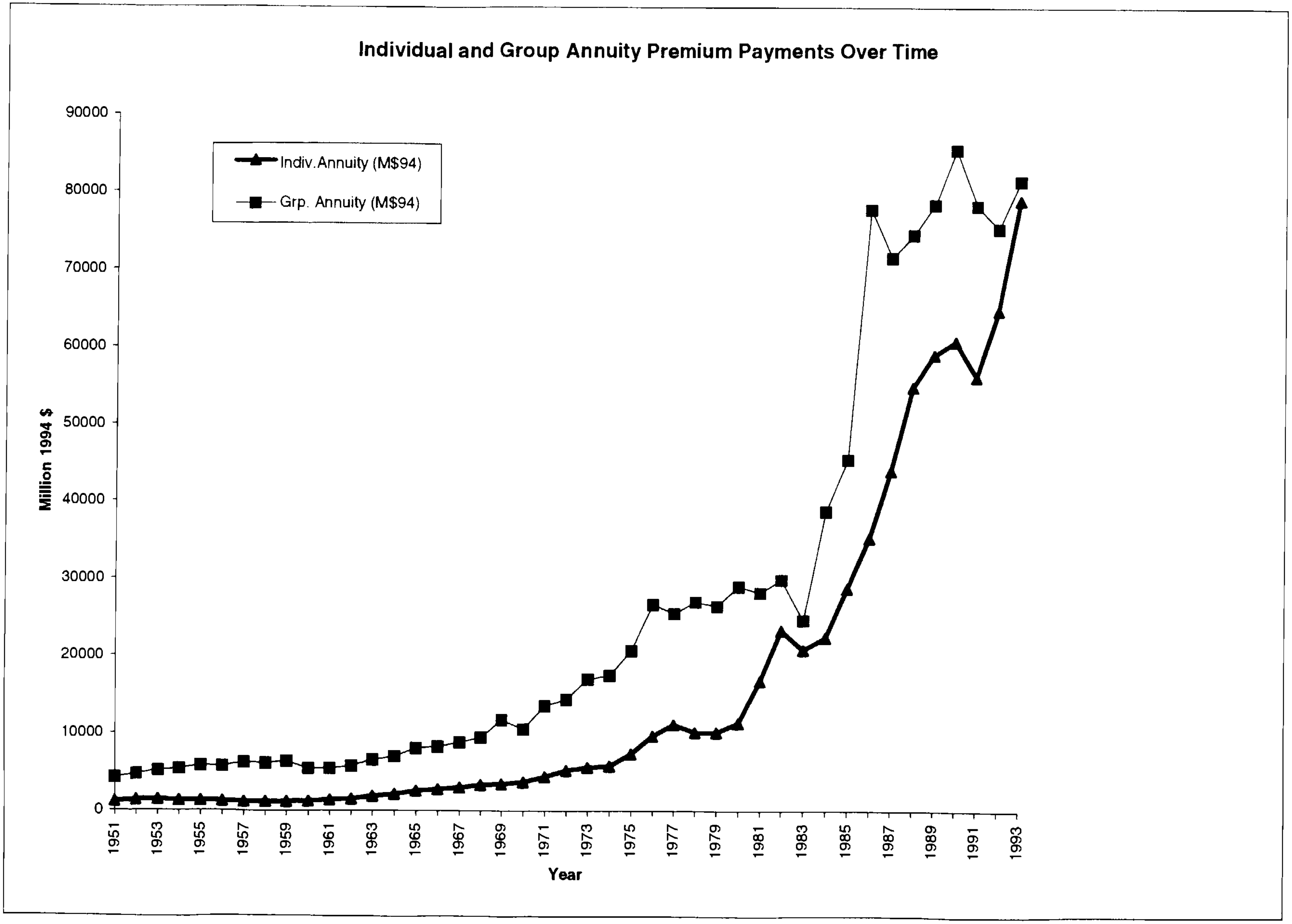
Notes: Each entry shows the expected present discounted value of the annuity payouts per dollar of annuity premium. All calculations use the all company sample average annuity payout rates to estimate the stream of payments associated with individual annuity contracts.

Table A-2: Values per Premium Dollar of Annuity Policies Offered for Men Age 65
1985-1995 Results, Using Flat Term Structure

	Before Tax Calculation			*After-Tax Calculation*		
	10-Year Treasury	30-Year Treasury	BAA Corporate	10-Year Treasury	30-Year Treasury	BAA Corporate
Using Population Life Tables:						
1985	.767	.763	.689	.768	.765	.703
1990	.814	.812	.745	.809	.806	.752
1995	.834	.820	.757	.828	.816	.766
Using Annuitant Life Tables:						
1985	.849	.844	.753	.867	.863	.786
1990	.911	.908	.827	.920	.918	.849
1995	.940	.921	.843	.944	.929	.865

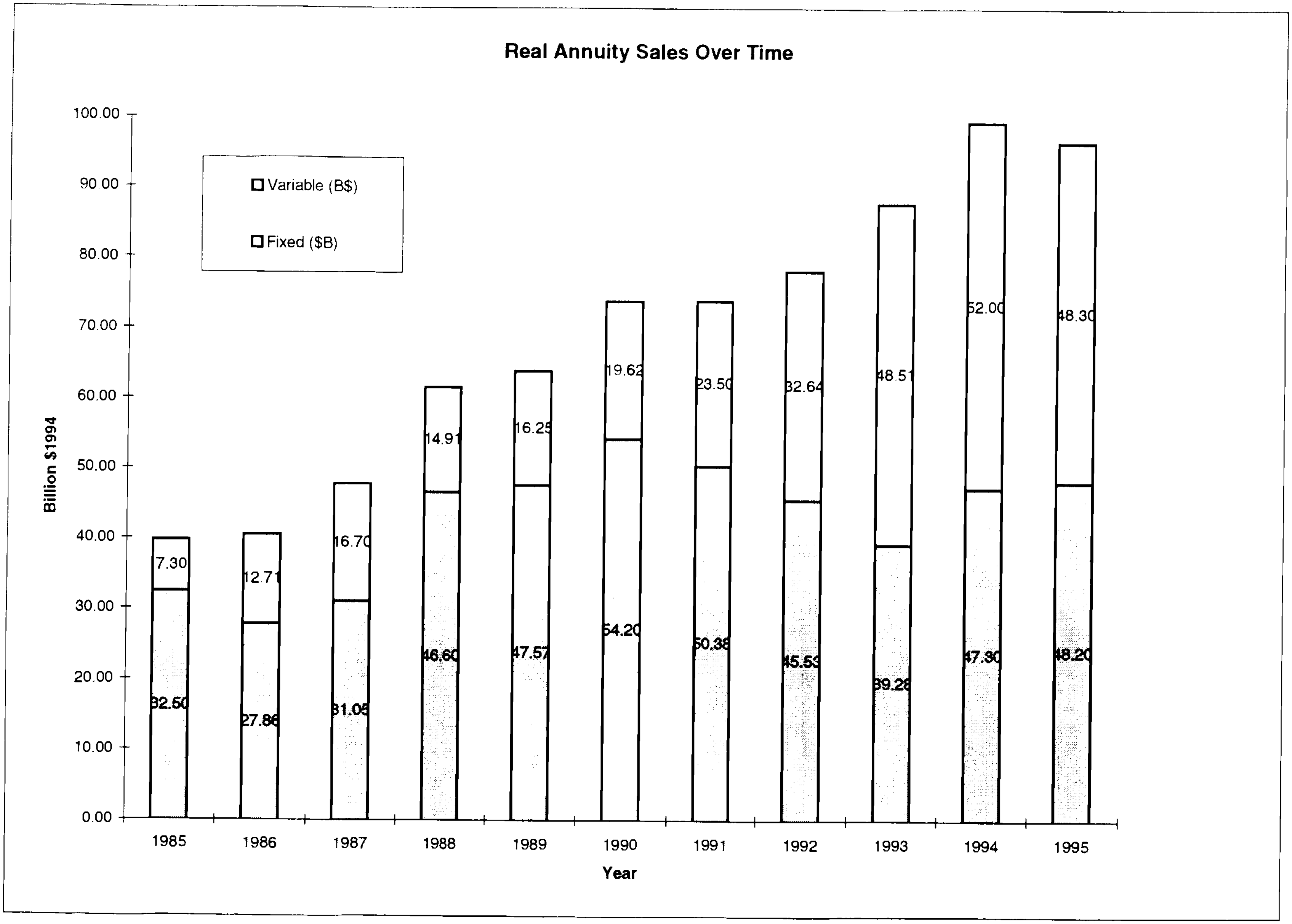
Notes: All entries show the present discounted value of annuity payouts per dollar of annuity premium, assuming a $100,000 single-premium immediate annuity purchase. The population life tables underlying the calculations are based on unpublished Social Security Administration, Office of the Actuary data. The annuitant life tables are based on our projections of the 1973 Individual Annuitant Mortality table, with projections based on Warshawsky's (1988) method assuming constant year-to-year mortality improvements.

Figure 1



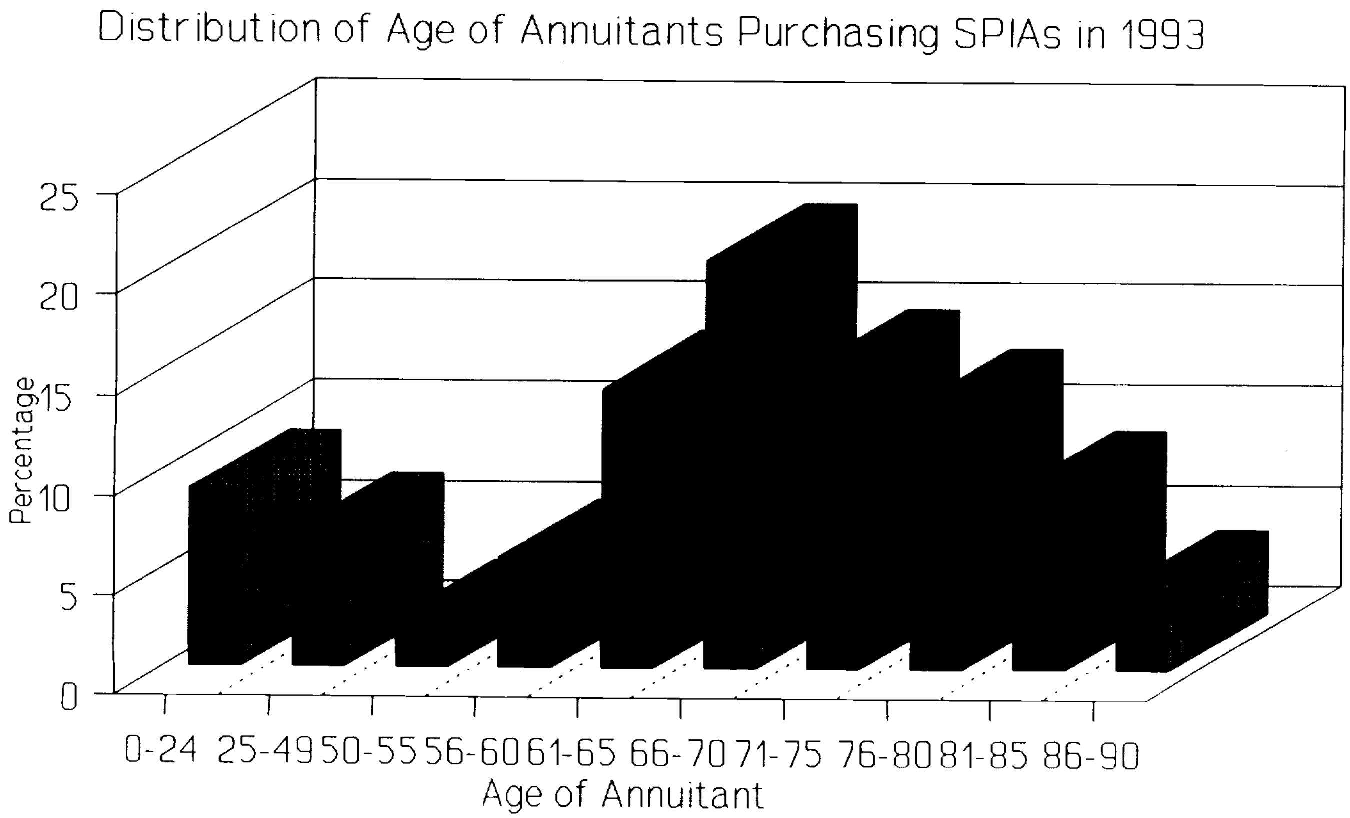
Source: Poterba (1995), Table 2

Figure 2



Source: LIMRA (1996), Figure 1.

Figure 3



Distribution of Age of Annuitants Purchasing SPIAs in 1993
25
20
15
10
5
0
Percentage
0-24
25-49
50-55
56-60
61-65
66-70
71-75
76-80
81-85
86-90
Age of Annuitant