ANNUITIZATION: KEEPING YOUR OPTIONS OPEN

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ABSTRACT

Annuities provide insurance against outliving one's wealth. Previous studies have indicated that, for many households, the value of the longevity insurance should outweigh the actuarial unfairness of prices in the voluntary annuity market. Nonetheless, voluntary annuitization rates are extremely low.

Previous research on the value of annuitization has compared the alternative of an optimal decumulation of unannuitized wealth with the alternative of annuitizing all unannuitized wealth at age 65. We relax these assumptions, allowing households to annuitize any part of their unannuitized wealth at any age and to return to the annuity market as many times as they wish.

Using numerical optimization techniques, and retaining the assumption made in previous research that half of the household wealth is pre-annuitized, we conclude that it is optimal for couples to delay annuitization until they are aged 74 to 89, and in some cases never to annuitize. It is usually optimal for single men and women to annuitize at substantially younger ages, around 65 and 70 respectively. Households that annuitize will generally wish to annuitize only part of their unannuitized wealth.

Using data from the Asset and Health Dynamics Among the Oldest Old and Health and Retirement Study panels, we show that much of the failure of the average currently retired household to annuitize can be attributed to the exceptionally high proportion of the wealth of these cohorts that is pre-annuitized. We expect younger cohorts to have smaller proportions of pre-annuitized wealth and we project increasing demand for annuitization as successive cohorts age.

JEL Codes: D91, E21, G11, J14, J26

Annuities provide insurance against outliving one's wealth. Previous research by Mitchell et al (1999) has suggested that although annuities are actuarially unfair, load factors alone cannot explain the almost total absence of voluntary annuitization among single individuals. Brown and Poterba (2000) find that longevity risk pooling reduces the value of annuitization to married couples, but not to levels that would, for plausible parameter values, explain the almost total lack of voluntary annuitization.

The above authors compare the alternative of an optimal decumulation of unannuitized wealth with that of annuitizing all unannuitized wealth at age 65. In practice, households can annuitize at any age, can annuitize any proportion of their unannuitized wealth, and can return to the annuity market as many times as they wish. If there are advantages to delay or if the marginal value of further annuitization decreases with increases in the proportion of wealth that is pre-annuitized, then the value of annuitizing at least some wealth at the optimal age will be even greater. The almost total absence of voluntary annuitization is thus even more puzzling than it first appears.

We therefore extend the above authors' work by allowing households to annuitize any proportions of their unannuitized wealth at any ages. We examine whether there are age-related variations in the degree of actuarial unfairness as these might affect the optimal age at which to annuitize. We provide evidence that the degree of actuarial unfairness does not, in fact, vary significantly with age. We also find that small age-related variations in the degree of actuarial unfairness would not significantly affect the optimal age.

Assuming the same proportions of pre-annuitized wealth and degrees of risk aversion as those used in previous research, we find that it is usually optimal for married couples to delay annuitization for substantial periods. However, it is usually optimal for single individuals to annuitize soon after age 65. Even when a household does annuitize, it will usually choose to annuitize only part of its unannuitized wealth. An increase in the degree of actuarial unfairness has the effect of inducing a delay in annuitization and a reduction in the amount annuitized. Highly risk-averse households will find it optimal to annuitize larger proportions of their wealth and at younger ages. To illustrate, assuming a

typical annuity expected present value of 85.6 percent, a married couple with none of its wealth pre-annuitized will wish to annuitize at age 77 when its coefficient of risk aversion is two and at 70 when its coefficient of risk aversion is five. The expected present value of an annuity is calculated by dividing the stream of payments, discounted by survival probabilities and a rate of interest, by the purchase price.

When half the household's wealth is pre-annuitized, the couple will never annuitize when their coefficient of risk-aversion is two, but will annuitize at 73 when the coefficient equals five. Of course, when offered an actuarially fair annuity, all household types immediately annuitize all of their unannuitized wealth provided the survivor benefit is appropriate and they are not unduly impatient. In contrast to married couples, single men and women will usually wish to annuitize either at age 65, the starting point of our calculations, or very soon thereafter.

When we assume that households have mortality equal to that of the average annuitant, it becomes optimal for households to annuitize at younger ages, at smaller degrees of risk aversion and to annuitize larger proportions of their unannuitized wealth.

Although the above analysis provides an explanation of why married couples do not annuitize on retirement, it does not explain why few households appear to annuitize at any age. Previous authors either disregarded pre-annuitized wealth, or assumed that one half of the household's wealth was pre-annuitized through employer pensions and Social Security. Using data from waves 2-5 of the Health and Retirement Study, a panel of individuals aged 51-61 in 1992 and their spouses of any age, we calculated the balance sheets of households as they turned 65. We found that the proportion of pre-annuitized wealth was generally much larger. Annuitized defined benefit pension and Social Security wealth comprised more than half of total financial wealth for 94 percent of households. We sorted households by total wealth and calculated the mean proportion of pre-annuitized wealth for the median 20 percent of married couples. Pre-annuitized wealth equaled 94 percent of the total for those that had no pension, 86 percent for those with a defined benefit (DB) plan, and 75 percent for those with only a defined contribution (DC) plan. Our simulations indicate that, given plausible assumptions regarding actuarial unfairness and levels of risk-aversion, these married couples are too highly annuitized to annuitize voluntarily at any age, regardless of pension type. We find

that single women are even more highly annuitized, but that, lacking longevity risk pooling, it can sometimes be optimal for them to annuitize depending on their degree of risk aversion. If it is optimal for a single woman to annuitize, the most appropriate age is either at age 65 or soon thereafter. There were too few single men to produce meaningful results, but their optimal plans would resemble those of single women with similar proportions of pre-annuitized wealth.

Thus, as far as the median household is concerned, if there is an "annuity puzzle", it would appear to be restricted to single individuals. Wealthier households typically have smaller proportions of pre-annuitized wealth. For plausible utility functions and assuming that their greater wealth is not a reflection of a stronger bequest motive, they will value annuitization more highly. There is also a strong and well documented relationship between wealth and longevity.[1] If wealthier households believe that they have lower than average mortality, this will further increase the value they place on annuitization. It is not unreasonable to assume that the median household believes it has population average mortality. However, calculating optimal plans for wealthier households involves constructing wealth related subjective mortality tables, and is a subject that we defer to future research.

Although currently retired households are highly annuitized, subsequent birth cohorts will have much smaller proportions of pre-annuitized wealth as DC pensions, which almost never mandate annuitization, displace DB plans. The increase in the Social Security normal retirement age will reduce the real value of Social Security wealth. Poterba, Venti, and Wise (2000) project that, as a result, the mean 401(k) plan balance of the cohort retiring in 2025 will exceed their mean Social Security wealth, even allowing for the impact of increased longevity on the latter. The reforms proposed by the President's Commission (2001), if enacted without a provision for mandatory annuitization, will further reduce the compulsorily annuitized proportion of a household's wealth. Munnell (2003) highlights the impact of projected increases in Medicare part B premiums and in the proportion of retirees who will pay income tax on Social Security.

[1] We refer the reader to Attanasio and Hoynes (2000), Hurd, McFadden and Merrill (1999), and Menchik (1993). With the exception of Menchik, whose data is old, these papers suffer from the disadvantage for our purposes of conditioning mortality on current, rather than initial wealth. Current wealth is unlikely to be exogenous, and calculations based on the data in these papers would be affected by survivor bias.

She calculates that average Social Security income replacement rates could drop from the current 41.2 percent to 26.9 percent by 2030.

We simulate the impact of changes in pension structure by replacing DB pension wealth by DC wealth of equivalent present value. Annuitization becomes more attractive to both married couples and single women, but couples will only annuitize when the annuity expected present value and coefficient of risk aversion are both at the top of our assumed range. Even then, they will delay until age 78.

The remainder of the paper is organized as follows. The first section discusses trends in pension provision and in the amount and composition of household wealth. The second summarizes the findings of previous research. The third describes the results of our simulations. Section four offers explanations for the lack of demand for annuities among the currently old and forecasts demand among the HRS and subsequent birth cohorts as they age. Section five concludes.

Section I. Trends in Pension Provision and Household Wealth

Pension Provision

The past twenty years has seen a major shift in employer pension provision away from annuitized defined benefit pension plans towards 401(k) and other defined contribution plans. Friedberg and Webb (2003) report that among employees with a pension plan in 1983, 87 percent had a DB plan and 40 percent a DC plan. By 1998, 44 percent had a DB plan and 79 percent a DC plan. However, DB pensions still predominate among workers nearing retirement. Among pensioned employees in the HRS in 1992 and then aged 51-61, 80 percent had a DB plan and 40 percent a DC plan.[2]

Defined benefit pension plans typically pay benefits in annuitized form, although Brown and Warshawsky (2001) report an increase from 14 to 22 percent over the period 1991-1997 in the proportion of DB plans offering a 100 percent lump sum option. By comparison, Brown, Mitchell, Poterba, and Warshawsky (2001) find that annuity payments are available to only 17 percent of private sector defined contribution pension

[2] As of wave 5, the latest wave for which data is available, this cohort is aged 59-69 and entering retirement.

participants. Furthermore, the Investment Company Institute (2000) reports that annuitization is almost never compulsory in such plans.[3] It follows that the displacement of DB by DC plans will lead to a considerable fall in coming years in the proportion of employer pension wealth that is compulsorily annuitized.

A simple calculation of the increase in the proportion of pension plans that offer a lump sum option considerably understates the trend toward voluntary annuitization. As the 401(k) system matures, the average duration of participation and therefore the average plan balance will increase. Using employee reported data, we calculate mean 401(k) wealth to be $78,360 in 1992 dollars among HRS households aged 65 who reported ever having participated and who had not closed their account. The distribution of plan balances is highly skewed, and the corresponding median plan balance is only $26,353. As only 19 percent of HRS households reported having accounts, the mean balance over all households is only $14,744. In contrast, Poterba, Venti and Wise (2002) project mean balances averaged over all households of $103,000 and $136,500 respectively for the cohorts retiring in 2025 and 2035.[4]

Household Wealth

Using data from waves 2-5, we show in Tables 1a –1e, the financial position at the first interview after age 65, of those HRS households that had turned 65 by 2000. At that interview 46 percent of married men and 39 percent of single women in the panel had attained age 65, and of these, 48 percent of married men and 44 percent of single women had retired.[5]

[3] Individuals may withdraw funds from their pension plan and buy a non-qualifying annuity. This is less tax-efficient than purchasing a qualified annuity within the DC plan or rolling the funds over into an IRA and then purchasing a qualifying annuity within the IRA. Qualified annuity payments and non-annuitized withdrawals from pension plans are both taxed as income, but tax regulations require that the recipient of the non-qualified annuity also pay tax on the part of the annuity that is deemed not to represent a return of capital; the so-called "inclusion ratio". Differences between the taxation of the insurance company's qualifying and non-qualifying life funds may also affect the annuity rates offered. Men may find it advantageous to take an IRA annuity rather than one offered by the pension plan because pension plans, including 401(k)s, are legally required to offer unisex annuity rates.

[4] Their Table II in 1992 dollars and assuming a 50:50 bond/stock portfolio.

[5] An individual is considered to be retired if he reported that he/she was "completely retired" and that he was not doing any work for pay.

Gustman and Steinmeier (1999) have documented substantial discrepancies between employer and employee reported pension data. It is possible that the accuracy of the employee reported data has improved as people enter retirement and become better aware of their entitlements. On the other hand, the accuracy of the employer provided data, which was collected once only, in 1992, may well have declined as it was applied to each succeeding wave. We have therefore chosen to calculate pension wealth from self-reported pension and Social Security data. We assume all households have population average mortality. Excluding Supplementary Security Income (SSI) produces very low levels of annuitized wealth in the bottom wealth decile. We include SSI in Social Security wealth, assuming that SSI benefits will continue in payment for the remainder of the individuals' lives.

We rank households by total wealth and calculate the mean of each wealth component for each decile. There are significant differences in the amount and composition of total wealth between married couples, single men and single women. We therefore report separate results at Tables 1a and 1b for married couples and single women, there being insufficient single men in the sample to permit an analysis by wealth decile.[6] Table 1c reports overall means. Tables 1d and 1e report means for the median 20 percent by household and pension type.

Married couples are much wealthier than single individuals, with the difference being greatest in unannuitized financial wealth and least in Social Security wealth. In the top decile, the non-pension financial retirement wealth of single women is only a third of that of couples. Among both couples and single women, housing and Social Security wealth is much more equally distributed than employer pension wealth, with non-pension wealth being highly concentrated among the wealthiest households.

Among couples, mean Social Security wealth varies from $210,237 in the bottom decile to $403,614 in the top one. Mean DB and DC employer pension wealth ranges from $8,020 in the bottom decile to $494,085 in the top. The overwhelming majority of employer pension wealth is held in DB plans. DC plan balances average 10 percent of pension wealth in the bottom nine deciles rising to 26 percent in the top decile. As a

[6] There were 188 single men of which 67 had a DB pension, 5 a DC and 116 had no pension.

result, mean annuitized wealth exceeds 85 percent of financial wealth among couples in all the first six deciles and is still 53 percent in the top decile.

Single women are even more highly annuitized than married couples, with mean annuitized wealth exceeding 91 percent of total financial wealth in the first six deciles and equaling 62 percent in the top decile. Only 6 percent of single women have less than half their financial wealth in annuitized form, and only 21 percent have less than three quarters. A majority of single women has almost no annuitizable financial wealth and only 30 percent have more than $50,000.

We compare our results with Gustman, Mitchell, Samwick, and Steinmeier (1997) analysis of wave 1 of the HRS when the panel was aged 51-61. We obtain somewhat higher proportions of pre-annuitized wealth, primarily Social Security. This is to be expected, as Gustman et al pro-rated pension and Social Security accruals to individuals' ages in 1992, whereas we calculate pension and Social Security wealth at age 65. To check the validity of our figures, we compared the average Social Security benefit reported by the HRS sample with the average benefits reported by the Social Security Administration.

Mitchell and Moore (1997) further analyze Gustman et al and show that it is only above the 95th percentile of total wealth that average non-pension financial wealth exceeds combined pension and Social Security wealth. They do not distinguish between annuitized and unannuitized pension wealth, but as our analyses show, except in the top wealth decile, the average DC plan balance in this cohort is quite modest. Even though, for the reasons explained above, they arrive at lower figures for Social Security wealth, both their and our analyses clearly show that most households entering retirement hold more than half of their financial wealth in annuitized form.

Tables 2a-2e report the same analysis for the Asset and Health Dynamics among the Oldest Old (AHEAD) households in the year 2000. This is a panel born in 1923 or earlier and their spouses of any age. Their distribution of wealth by category and wealth decile is similar to that of the HRS households. Average pension and Social Security wealth is much smaller, mainly reflecting the shorter remaining life expectancy of this cohort.

II. Findings of Previous Research

Yaari (1965) was the first to derive conditions under which full annuitization was optimal. His restrictive assumptions included complete markets, the absence of a bequest motive, and the availability of actuarially fair annuities. Davidoff, Brown and Diamond (2003) relax the assumption of complete markets and find that full annuitization is often no longer optimal.

Most of the literature has analyzed the effect of annuitization on expected utility. An alternative approach, taken by Milevsky (1998, 2000), has been to calculate the impact of deferring annuitization on expected returns, and the probability that deferral will leave the individual no worse off. Assuming that only nominal annuities are available, he investigated a strategy of postponing annuitization and investing in equities.[7] He assumed that individuals who postponed annuitization would consume from their unannuitized wealth at a rate equal to the annuity income they could have initially obtained. In practice one would expect individuals to re-evaluate their consumption plans in the light of realized investment returns. He found that individuals who postpone annuitization stand a high probability of being eventually able to buy a larger annuity.

Probability based measures provide little guidance as to what risk of failure is acceptable for any given level of risk-aversion and for this reason we favor utility based analyses. In the first of a series of papers, Mitchell et al (1999) used numerical optimization to calculate a utility based measure of the wealth equivalent of an annuity. They defined the wealth equivalent as the expected present value of the annuity at which an individual would be indifferent between annuitizing all his unannuitized assets and continuing to hold those assets in unannuitized form.

[7] Investment linked annuities have in fact been available since 1952 when TIAA-CREF launched its CREF equity based immediate and deferred annuities. Initially, CREF immediate annuities could only be purchased with the proceeds of CREF deferred annuities, and in the first year only six immediate annuity contracts were sold, Greenough (1990). The market remains small. The National Association for Variable Annuities (2002) report overall 2001 immediate annuity sales of $10.2 billion, of which only $0.6 billion were variable. Brown and Poterba (2000) point out that approximately half of immediate annuity sales are for period certain rather than for life contingent annuities. If applied pro-rata, this suggests sales of immediate life contingent variable annuities of $300 million a year.

Assuming a real interest rate of 3 percent, an inflation rate of 3.2 percent, a rate of time preference of 1 percent, no bequest motive, no pre-existing annuities, population mortality, and a coefficient of risk aversion equal to one, they calculated the before tax wealth equivalent of a nominal annuity to be 0.659 for a single male. At a coefficient of two, the wealth equivalent fell to 0.619. If half the individual's wealth was held in the form of a pre-existing real annuity, the wealth equivalents increased to 0.730 and 0.695 under the same assumptions. As discussed above, only a very small proportion of single households have half or less of their financial wealth in annuitized form. These results are therefore representative only of the wealthiest households who may also have a stronger than average bequest motive.[8]

In the same paper, they calculated annuity EPVs at ages 55, 65, and 75. At age 65, these varied from 75.6 to 92.7 percent, depending on whether one discounts the payments at the Treasury or corporate bond yield curve and whether population or annuitant mortality tables are used. A comparison between these EPVs and the reciprocals of the wealth equivalents referred to in the preceding paragraphs would, at first glance, suggest a substantial role for annuities in financing retirement consumption.

We assume in our calculations that the degree of actuarial unfairness of annuities does not vary with age or marital status. Although Finkelstein and Poterba (2000) find evidence that the degree of adverse selection varies with annuity type, a comparison of (Mitchell et al 1999) EPVs suggests that although the differences between ages 55 and 65 are more substantial, the degree of actuarial unfairness does not change significantly between 65 and 75. There is no clear pattern to the changes between ages 65 and 75 and the largest single change is only 2.3 percent. At very young ages, the insurance company's assumptions regarding rates of return will have a proportionately greater effect on the price of the annuity. At these ages, the insurance company's obligations extend well beyond the life of even the longest maturity bond, and differences between the rate of return used by the insurance company to price the annuity and that assumed by Mitchell et al may significantly affect the EPV.

[8] Calculation of the pre-annuitized proportion of total wealth would be significantly affected by the inclusion of housing wealth in the denominator and by one's choice of assumptions about how the use of the house entered into the utility function and whether the house was available to finance consumption. We defer consideration of these issues to future research.

As a check, we calculated the annuity that an individual could purchase at each age from 51 to 105 if insurance companies sold actuarially fair annuities, priced using a three percent real return and the basic annuity 2000 period mortality table.[9] We then calculated the EPVs of the annuities at the same interest rate, using population mortality tables for the appropriate birth cohorts. At age 65, the EPVs for men and women were 86 and 92 percent respectively. By age 80, the male expected present value had decreased to 82 percent, but the female had increased to 96 percent. If insurance companies price annuities in this way, then the actuarial unfairness of female annuities would decrease significantly with age, and that of male annuities would increase marginally. This divergence in age-related trends in actuarial unfairness is surprising, but our finding offers no support for the belief that people with population life expectancy would face significantly greater actuarial unfairness were they to delay annuitization.

An individual who postpones annuitization does however face the risk that insurance companies might reduce annuity rates if long-term interest rates declined. This risk can be largely, if not wholly, hedged by investing in a portfolio of bonds of appropriate duration. What cannot be hedged is the risk that annuity rates might fall as a result of unexpected increases in longevity among the annuitant population.

Brown and Poterba (2000) extended the analysis to married couples considering the purchase of a joint life and survivor annuity. They assumed that couples have a utility function of the following form:

$$U_m(C_t^m, C_t^f) = \frac{(C_t^m + l\, C_t^f)^{1-g}}{1-g}, U_f(C_t^f, C_t^m) = \frac{(C_t^f + l\, C_t^m)^{1-g}}{1-g} \qquad (1)$$

where ? measures the jointness of consumption, C_t^m, C_t^f denote the consumption of the husband and wife at time *t*, and ? is the coefficient of risk aversion. When ? equals one, all consumption is joint. When ? equals zero, none of the household's consumption is joint. They calculated "annuity equivalent wealth", the premium over expected present value at which a household would surrender the right to purchase an actuarially

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[9] Basic means that it is formed from industry experience without an additional margin for conservatism. A period table predicts the current mortality of people of varying ages, in contrast to a cohort table that predicts the future mortality of people born in a particular year. We use the basic table because we understand that the insurance industry does not use cohort tables to price annuities.

fair annuity. When there are no pre-existing annuities, annuity equivalent wealth is simply the reciprocal of the wealth equivalent. With pre-existing annuities, this simple relationship breaks down.

The effect of marriage on the value of annuitization depends on whether the married couple is allowed to choose an annuity with a survivor benefit appropriate to its degree of risk aversion and the value of ? in its utility function.[10] When ? = 0, the rate of interest equals the rate of time preferences, and a real annuity is available, the optimal survivor benefit is 0.5 regardless of the degree of risk aversion.[11] When ? = 1, the optimal survivor benefit increases from 0.5 with log utility to almost 1 at very high levels of risk aversion. When ? = 0.5 and ? equals five it is 0.652.

Married couples value annuitization less highly than do single individuals, regardless of the degree of risk-aversion, particularity when much of the household's consumption is joint. This is a result of the ability of couples to pool longevity risk. Assuming population mortality, no pre-existing annuities, a coefficient of risk aversion of two, a rate of time preference and a real rate of interest both of 3 percent, and a rate of inflation of 3.2 percent, Brown and Poterba calculate that annuity equivalent wealth for a 65 year old single man to be 1.576. When ? equals zero, they calculate the annuity equivalent wealth of a joint life and 50 percent survivor annuity to be 1.244 under the same assumptions. Marriage decreases the value of annuitization by 58 percent. When the coefficient of risk aversion equals ten, their comparable figures are 1.703, 1.407 and 42 percent. At higher values of ? annuitization is even less valuable to married couples, particularly if the annuity has an inappropriate survivor benefit. When ? equals one and the degree of risk aversion equals ten, the optimal survivor benefit is 97 percent. We replicate their calculations and find that the annuity equivalent wealth of a joint life and 50 percent survivor annuity is only 1.108. Annuitization has very little value because a 50 percent survivor annuity gives too little income to the surviving spouse. Even with a

[10] If the survivor benefit is inappropriate, or if, in a model with constant inflation, the household is not permitted to purchase an increasing annuity, the value of annuitization also depends on whether fully annuitized households are permitted to save out of their annuity income and to purchase additional annuities with their savings. Brown and Poterba tell us that their households are permitted to save but not to purchase additional annuities.

[11] Brown and Poterba obtain somewhat higher values for annuity equivalent wealth when the survivor ratio is 2/3. This is a result of assuming that the payments from the annuity decline in real terms.

100 percent survivor benefit, we calculate that annuity equivalent wealth is still only 1.278, significantly less than their value of 1.407 when ? equals zero.

The reciprocals of these results can be compared with the annuity EPVs calculated by Mitchell et al (1999). Using the corporate bond yield curve and population mortality tables, Mitchell et al calculated the expected present value of a joint and survivor annuity at age 65 to be 79.2 percent. Assuming zero complementarity in consumption and no bequest motive, we calculate that is it only optimal for a couple with half its wealth pre-annuitized to annuitize its remaining wealth when its coefficient of risk-aversion exceeds five. When three quarters of the couple's wealth is pre-annuitized, a coefficient of risk aversion greater than 10 is required. The comparable numbers for people with annuitant mortality are 3 and 6.

It is unclear whether it is more appropriate to use annuitant or population mortality. There is a strong relationship between wealth and mortality, and many people with potential annuitizable wealth may not only have lower than average mortality, but also be aware of that fact. We defer further consideration of this issues to future research.

In practice, households can invest their unannuitized wealth in a variety of asset classes, and insurance companies offer not only nominal annuities but also annuities with payments linked to the returns on Treasury Inflation Protected Securities (TIPS) and stock market securities. Brown, Mitchell, and Poterba (2001) used numerical optimization to calculate the wealth equivalents of investment and inflation linked annuities. They found that for plausible degrees of risk aversion, households would generally value an investment linked annuity more highly than a real annuity because the additional returns more than compensated for the volatility of prospective payments.

They also considered the impact of inflation on the value of nominal annuities. The inflation protection offered by a real annuity had only modest value. The wealth equivalent of nominal annuities decreased only slightly when they assumed i.i.d inflation calibrated to 1926-97 data. When they assumed that inflation followed an AR(1) process the wealth equivalent further decreased, but the difference was only substantial at high coefficients of risk aversion or when the individual had no pre-annuitized wealth.

The above literature compares annuitizing at some arbitrary age with the alternative of never annuitizing. If the household can do better by delaying, the above calculations will understate the value of annuitizing at the optimal age.

Milevsky and Young (2003) used analytical techniques to calculate the optimal age at which to annuitize. They examined the decision faced by individuals, rather than couples and used a Gompertz approximation to mortality tables. In some specifications they permitted partial annuitization of unannuitized wealth. They assume that actuarial unfairness reduced the returns on nominal and investment linked annuities by 50 and 100 basis points respectively. When only nominal annuities are available but partial annuitization is not permitted, it is optimal for men and women to annuitize at ages 75 and 80 respectively when the coefficient of risk aversion equals two. The availability of investment linked annuities greatly reduces the optimal age. When investment linked annuities are also available, it becomes optimal for men and women to annuitize at 64 and at 71 respectively.

There are relatively few empirical investigations of the determinants of voluntary annuitization. This is, no doubt, partly due to the rarity of its occurrence. Brown (2001) examined the annuitization plans of individuals who participated in defined contribution (DC) plans and whose plans offered an annuitization option, using household level data to calculate annuity equivalent wealth. In contrast with the very low levels of voluntary annuitization observed in the HRS and AHEAD datasets, he found that almost half of these individuals intended to annuitize their DC pension wealth. He also found that those with higher AEWs were more likely to report that they intended to annuitize.

When Brown wrote his paper, the HRS had only released data from the first two waves of the panel, plus preliminary data from the third. Only a few of the individuals in the study had retired. Our analysis of this data indicates that very few individuals had in fact annuitized by wave 5 when they were aged 59-69. Our simulations indicate that although it can sometimes be optimal for single women with population average mortality and proportion of pre-annuitized wealth to annuitize in her late sixties, it will almost invariably be optimal for married couples to delay annuitization until much more advanced ages. It is thus too soon to determine whether the HRS cohort will eventually act in accordance with their stated intentions.

III. Numerical simulations of the Annuitization Decision

We use numerical optimization techniques to calculate the optimal age at which to annuitize. We focus on the intertemporal evolution of the allocation of the household's portfolio between annuitized and unannuitized wealth. In contrast to previous research, we permit households to annuitize at any age, to annuitize any proportion of their wealth, and to return to the annuity market as many times as they wish. We study both married couples and single individuals, and examine how the level of actuarial unfairness, the existence of pre-annuitized wealth, and the household's degree of risk-aversion affect the age at which it annuitizes and the amounts annuitized.

Following the previous literature, we consider households with both population and annuitant mortality. We use the Social Security Administration life tables for the 1930 male and 1933 female birth cohorts to forecast population mortality, and follow the methodology used by Mitchell et al. (1999) to construct cohort annuitant life tables.

In all our models, we follow Brown and Poterba (2000) and assume that the household's utility function takes the form set out in equation (1). The cost of an annuity is as follows:

$$1/a_t \left[\left(\sum_t^{T=105} \frac{A * P_t^m P_t^f}{\Pi^t (1+r_t+i_t)} \right) + \left(\sum_t^{T=105} \frac{A * y_f * (1-P_t^m) P_t^f}{\Pi^t (1+r_t+i_t)} \right) + \left(\sum_t^{T=105} \frac{A * y_m * P_t^m (1-P_t^f)}{\Pi^t (1+r_t+i_t)} \right) \right] \qquad (2)$$

where A is the annual amount payable when both husband and wife are alive, P_m^t, P_f^t are the respective probabilities of a man and woman alive at time t surviving to time t, r_t and i_t are the real interest rate and inflation rate at time t, a_t is the reciprocal of the expected present value of the annuity, and $?_m$, $?_f$ are the husband's and wife's survivor benefits expressed as a decimal of the initial amount payable.

For ease of computation, we assume that couples are only able to purchase annuities with 2/3 percent survivor benefits. LIMRA (1997) reports that insurance companies are willing to offer annuities with almost any survivor benefit. Surviving

spouses are, of course, only able to buy single life annuities. Pre-annuitized wealth is assumed to be held in a real joint life and 2/3 survivor real annuity. This corresponds with the Social Security annuity provided to a household in which the wife's pension is paid by reason of her husband's contributions. As previously discussed, we also assume that the expected present value of an annuity does not vary with age.

We assume that the inflation rate is zero percent, the rate of time preference is $1/1.03$, the real rate of interest is 3 percent, and that the wife is three years younger than the husband, the average for the cohort entering retirement. The insurance market offers not only level but also increasing annuities, and our assumption of zero inflation is therefore equivalent to assuming the purchase of a nominal annuity increasing at a fixed rate of inflation.

We report in Table 3a the ages at which our numerical simulations indicate that households with population life expectancy and varying degrees of risk aversion should start annuitizing their financial wealth. It also shows the proportion of initial financial wealth remaining immediately prior to annuitization. We report results for married couples, single men and single women; for risk aversion coefficients of one, two and five; pre-annuitized proportions of total wealth of zero, 50 and 75 percent; and for annuity EPVs of 85.6 and 79.2 percent. These correspond to the average of Mitchell et al's ages 65 and 75 annuity present values, calculated by reference to the Treasury and corporate bond interest rates respectively. We also report in Table 3b corresponding results for households with annuitant mortality. In the simulations with annuitant mortality we assume annuity EPVs of 92.4 and 84.9 percent. These correspond to the averages of the age 65 and age 75 EPVs for individuals with annuitant mortality when one discounts the annuity income at the Treasury strip and corporate bond interest rates, respectively. As a reality check, we also ran simulations assuming no actuarial unfairness, and found that all household types annuitized immediately, even when the annuity provided an inappropriate survivor benefit.

Households of all types are more likely to annuitize and to annuitize at younger ages if they have a large coefficient of risk aversion, a small proportion of pre-annuitized wealth, and are able to annuitize on relatively favorable terms. However, for any given set of parameter values, there are substantial differences between singles and married

couples in whether, when and how much, they should annuitize. Even when a household annuitizes, it usually annuitizes only a proportion of its wealth. It sometimes returns to the annuity market after a few years to make one or more additional, smaller purchases.

Considering first the households with population life expectancy, in none of the cases examined is it optimal for a married couple to annuitize before age 70. In many cases it is optimal to annuitize in the late 70's and in others it is optimal never to annuitize. Quite small changes in the assumptions can change the optimal age by several years. For example, when no wealth is pre-annuitized, an increase in the degree of risk aversion from one to two decreases the optimal age by six years.

When the coefficient of risk aversion is small or the couple has a large proportion of pre-annuitized wealth, they spend down their unannuitized wealth quite rapidly. This decreases both the proportion of unannuitized wealth and the attractiveness of annuitization. By the time they reach the ages at which the annuitization of even small proportions of wealth would be worthwhile, all their unannuitized wealth has been consumed.

In contrast, single men and women, unable to pool risk within the household, invariably annuitize at age 65, or soon thereafter, even at low levels of risk aversion, high proportions of pre-annuitized wealth and substantial degrees of actuarial unfairness. It will usually be optimal for surviving spouses to annuitize immediately on the death of their partner.

Figure I shows the optimal paths for consumption, unannuitized and total wealth for a married couple with population mortality and with half its wealth pre-annuitized. We assume that the household's wealth comprises $280,000 cash plus a Social Security pension of $18,000 a year, reducing to $12,000 on the death of either spouse. The expected present discounted value of the pension equals $280,000, so half of the household's wealth is pre-annuitized. The household's coefficient of risk aversion is two, the real rate of return and the rate of time preference both equal three percent, the annuity's expected present value is 79.2 percent, and ? = 0.5. The first panel shows the couple's consumption path from age 65 to age 105 for the case in which both spouses survive to that age. The second panel shows the evolution of the household's wealth excluding Social Security. They never annuitize, and both consumption and wealth

decline until age 90 when they exhaust all their financial wealth. Thereafter, they rely upon Social Security to finance consumption.

Figure II shows the same data for the case in which the coefficient of risk-aversion equals five. Consumption declines more slowly prior to annuitization, reflecting the smaller intertemporal elasticity of substitution, and the household first annuitizes at age 82. At that age, 44 percent of the couple's wealth remains unconsumed. They only annuitize 17 percent of their wealth as there are decreasing marginal returns to annuitization. They finally exhaust their unannuitized wealth at age 100.

We attempted to replicate the calculation by Milevsky and Young (2002) that single men and women with a coefficient of relative risk aversion of 2 and no pre-annuitized wealth should annuitize at ages 64 and 71, respectively. Their expense load correspond to an expected present value of 91.2 percent, at which level we calculate that both men and women should annuitize at 65, the age at which we start our simulation.[12]

We suspect that our model predicts earlier annuitization than Milevsky and Young's because their model, while assuming uncertain investment returns, does not permit the individual to save out of his annuity income. Under constant relative risk-aversion, the marginal utility of consumption is convex, and uncertainty over future consumption leads households to undertake precautionary saving. We conjecture that their model underestimates the value of annuitization by preventing annuitized households from undertaking desired precautionary saving.

As one might expect, households with annuitant mortality find annuitization more attractive than those with population mortality. They annuitize at lower degrees of risk aversion and higher proportions of pre-annuitized wealth. When they do annuitize, they annuitize a larger proportion of their initial wealth, and make their purchases at younger ages.

Our models incorporate a transaction cost of $250. Our analyses of annuity rates suggest that insurance companies face only small fixed costs of producing annuities.[13] The transaction cost is intended to cover the psychic and time costs of making the

[12] We follow their assumption of a 6 percent rate of time preference. We use an expected investment return of 10.12 percent, equal to a weighted average of their risky and risk-free returns.
[13] Consistent with the predictions of models of adverse selection, some U.K. insurers actually charge higher premiums for larger annuities.

annuitization decision. In the absence of this transaction cost, households would optimally choose to annuitize small amounts of their wealth over several years. Changing the amount of the transaction cost has little effect on the age at which annuitization starts or the proportion of wealth that the household annuitizes, but does discourage already highly annuitized households from making small additional purchases. For example, when the coefficient of risk aversion equals two, the household has population mortality, the annuity expected present value is 85.6 percent, and there is no pre-annuitized wealth, doubling the charge leaves the optimal annuitization age unchanged but increases the amount that the household annuitizes by three percent of initial wealth. Halving the charge to $125 results in the household annuitizing two years earlier, returning for a second purchase after an interval of four years. The household's annuitized wealth after the second purchase is almost identical to that of the household with the $250 transaction charge.

IV. Empirical investigation of the annuitization decision

We use our numerical optimization program to calculate the optimal annuitization strategies of the average households in the HRS and AHEAD cohorts. We use coefficients of risk aversion of 1, 2 and 5 and EPVs of 85.6 and 79.2 percent, and consider married couples and single women separately.

As we are studying the average household, we assume that they believe they have population average mortality, consistent with rational expectations. Wealthier households will generally have smaller proportions of pre-annuitized wealth and lower mortality, and will therefore value annuitization more highly. As explained previously, we defer consideration of this issue to further research.

We classify households according to whether they are unpensioned, have a DB plan, and in the case of the HRS cohort, whether they only have a DC plan. We calculate the mean annuitized percentage of financial wealth for the median 20 percent of the households in each category. To simulate the effect of the displacement of DB by DC pension wealth, we also calculate the annuitized percentage for DB households in the HRS assuming that DB wealth has been replaced by an equivalent amount of DC wealth.

Table 4 reports our results. It is never optimal for the married couples in the HRS to annuitize, at either of the assumed expected present values, regardless of pension type or degree of risk aversion. If DB wealth is replaced by an equivalent amount of DC wealth, it can be optimal to annuitize, but only at age 78, and only if the degrees of risk aversion and actuarial unfairness are at the top and bottom, respectively, of our assumed ranges.

The position of single women is somewhat different. It is usually optimal for single women with DC pensions to annuitize. Single women with DB pensions have larger proportions of pre-annuitized wealth, and those with no pension, still larger proportions. Those with DB pensions may wish to annuitize some of their non-pension wealth if they are risk averse. Those with no pension have almost all of their wealth in the form of Social Security and have too small a proportion of annuitizable financial wealth to make further annuitization worthwhile. Those who annuitize will, however, generally wish to do so soon after retirement. When DB pension wealth is replaced by an equivalent amount of DC wealth, it is optimal for single women to annuitize around age 65 under most plausible assumptions. There are insufficient single men to produce meaningful statistics. Their optimal annuitization strategies would however closely resemble those of single women with similar proportions of pre-annuitized wealth.

We then consider the annuitization decision faced by the AHEAD households. Married couples will only wish to annuitize when they are risk averse, when they have no DB pension, and when they discount the annuity payments at the Treasury bill rate of interest. Those who decide to annuitize will wish to do so immediately. Single women will generally wish to annuitize immediately.

The inconsistency between the HRS and the AHEAD results reflects the fact that our simulations predict that the HRS cohort will have much less financial wealth by the time they reach the ages of the AHEAD cohort than is currently held by the latter cohort. We do not, of course, know what amounts of financial wealth the AHEAD cohort held when they were the current ages of the HRS cohort, but it seems unlikely that their wealth would have exceeded that of the HRS cohort. Their apparent failure of the AHEAD cohort to decumulate to the extent predicted by our simulations may possibly reflect unexpected stock market gains, precautionary saving, or survivor bias.

Our results show that if there is an "annuity puzzle" among households at median wealth levels, it is primarily among single individuals. These single individuals generally have very modest amounts of annuitizable wealth and it is possible that liquidity considerations play a part in explaining their failure to annuitize.

V. Conclusions

Previous research into annuitization has typically assumed that 50 percent of the wealth of households entering retirement is compulsorily annuitized. Our analysis of the HRS shows that this is a very considerable underestimate and that the average percentage of financial wealth that is compulsorily annuitized only falls to 50 percent in the top decile of total wealth. As a result, previous authors have considerably overestimated the value of annuitization to the average household.

The focus of this paper is on the behavior of the median household. Our simulations indicate that, for all pension types, one need look no further than the high proportion of pre-annuitized wealth for the failure of the median currently retired married couple to voluntarily annuitize.

The behavior of single women is more puzzling, as our research suggests that they ought to value annuitization more highly despite their greater proportions of pre-annuitized wealth. It is possible that liquidity concerns influence their decision. There were insufficient single men in our sample to permit a detailed analysis by pension type, but much of what we say about single women probably also applies to single men.

The displacement of DB by DC pension wealth will lead to a fall in the pre-annuitized proportion of household wealth that may result in increasing levels of voluntary annuitization among more risk-averse households. Whether it will, in fact, do so, depends on the presence of other impediments to voluntary annuitization such as those considered by Brown and Warshawsky (2001).

Annuitization may well be more attractive to wealthier couples, who have lower average mortality and smaller proportions of pre-annuitized wealth. On the other hand, these households may also have a stronger bequest motive. We defer modeling the behavior of such households to future research.

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Table 1a

Composition of HRS Households' Balance Sheets at Age 65 - Couples

Total Wealth Deciles		1	2	3	4	5	6	7	8	9	10
Lower Bound of Total Wealth		22,673	337,330	444,969	531,704	617,763	704,421	809,106	942,380	1,132,442	1,516,948
						Means by Deciles					
Net Non-Retirement Financial Wealth		6,670	14,709	20,485	42,933	78,267	88,274	162,910	218,523	361,731	853,477
Business Assets		2,368	3,352	2,239	9,971	12,267	12,558	20,607	27,139	53,718	206,742
Financial Assets		2,311	7,131	8,408	21,144	32,302	49,382	75,085	118,271	189,610	418,249
IRAs		1,991	4,226	9,838	11,818	33,698	26,332	67,218	73,113	118,403	228,486
Property		27,269	48,519	60,971	81,144	102,189	121,155	131,946	178,389	231,869	498,915
Primary Residence Net of Mortgage		26,304	43,887	52,753	72,607	82,046	97,797	101,531	128,033	157,799	224,929
Net Other Property		965	4,632	8,218	8,537	20,143	23,358	30,415	50,356	74,070	273,986
Retirement Wealth		218,257	327,258	403,626	451,087	477,526	546,231	586,141	640,504	693,709	897,699
Social Security		210,237	299,360	350,719	364,839	377,124	376,236	389,881	380,760	393,270	403,614
DB Pensions		6,635	21,879	47,242	78,075	90,553	155,287	172,895	235,002	267,588	364,396
DC Pensions		1,385	6,019	5,665	8,174	9,849	14,708	23,365	24,742	32,851	129,689
Total Wealth		252,196	390,486	485,082	575,164	657,982	755,660	880,997	1,037,416	1,287,309	2,250,092
Annuitized Wealth as % of Financial and Retirement Wealth	All	96	93	94	91	86	85	78	75	66	53
	With DB	97	93	96	93	90	88	81	78	71	60
	Without DB	95	93	90	86	78	70	63	60	47	39
As % of Total Wealth		86	82	82	77	71	70	64	59	51	36
% of Homeowners		66	86	94	96	97	99	97	99	98	99
% with Living Children		96	98	96	97	99	97	99	98	97	96
N of obs	Total	154	153	154	153	153	154	153	154	153	138
	With DB	23	59	91	109	108	130	125	124	122	92
	Without DB	131	94	63	44	45	24	28	30	31	46

Notes: Data from Health and Retirement Study, waves 2 to 5. Sample: married couples who turned 65 in any of the waves 2 to 5. Sample size - 1534 observations, from which 15 observations falling in the 100th wealth percentile were dropped resulting in a sample of 1519. We excluded the 100th percentile from the 10th decile and the wealth upper cut-off point is $4,294,318. The present values of Social Security and employer Defined Benefit pensions were calculated using a real rate of interest of 3% and an inflation rate of 2.5%. Annuitized wealth equals the sum of Social Security and DB pensions. All reported figures are in 1992 dollars.

Table 1b

Composition of HRS Households' Balance Sheets at Age 65 - Single Women

Total Wealth Deciles		1	2	3	4	5	6	7	8	9	10
Lower Bound of Total Wealth		1,885	86,309	141,368	178,711	211,732	251,756	311,053	388,269	485,789	695,482
						Means by Deciles					
Net Non-Retirement Financial Wealth		-140	-25	2,885	5,221	12,278	16,239	32,749	66,541	118,834	285,065
Business Assets		0	0	0	0	5	717	3,704	1,691	13,025	9,431
Financial Assets		-140	-206	2,451	3,736	8,193	9,080	17,235	46,179	61,522	186,904
IRAs		0	181	434	1,485	4,080	6,442	11,810	18,671	44,287	88,730
Property		2,098	10,566	11,272	18,016	32,869	50,040	59,989	89,472	114,356	219,756
Primary Residence Net of Mortgage		2,082	10,264	11,051	17,577	30,970	48,179	49,412	80,289	95,086	150,328
Net Other Property		16	302	221	439	1,899	1,861	10,577	9,183	19,270	69,428
Retirement Wealth		58,314	99,841	144,233	170,331	187,197	216,357	253,398	270,873	334,893	441,741
Social Security		58,125	99,424	142,584	164,227	172,541	181,382	195,713	194,364	189,328	219,707
DB Pensions		178	413	959	4,923	13,129	31,686	51,373	69,887	142,378	208,189
DC Pensions		11	4	690	1,181	1,527	3,289	6,312	6,622	3,187	13,845
Total Wealth		60,272	110,382	158,390	193,568	232,344	282,636	346,136	426,886	568,083	946,562
Annuitized Wealth as % of Financial and Retirement Wealth	All	99	99	97	95	92	91	87	78	75	62
	With DB	99	99	99	99	95	92	93	87	82	75
	Without DB	99	99	97	94	91	89	78	62	53	37
As % of Total Wealth		96	90	90	87	80	75	71	62	59	47
% of Homeowners		15	40	34	61	69	76	77	88	95	98
% with Living Children		93	91	88	98	99	90	93	79	91	92
N of obs	Total	58	58	58	57	58	58	57	58	58	52
	With DB	1	1	3	9	14	27	33	39	45	33
	Without DB	57	57	55	48	44	31	24	19	13	19

Notes: Data from Health and Retirement Study, waves 2 to 5. Sample - Single women who turned 65 in any of the waves 2 to 5. Sample size - 577 observations, from which 5 observations falling in the 100th wealth percentile were dropped resulting in a sample of 572. We excluded the 100th percentile from the 10th decile and the wealth upper cut-off point is $1,532,258. The present values of Social Security and employer Defined Benefit pensions were calculated using a real rate of interest of 3% and an inflation rate of 2.5%. Annuitized wealth equals the sum of Social Security and DB pensions.

Table 1c

Composition of HRS Households' Balance Sheets at Age 65

		Married couples	Single men	Single women			
				All	Never married	Separated/ divorced	Widowed
				Overall Means			
Net Non-Retirement Financial Wealth		177,928	76,408	51,663	68,633	39,564	56,497
Business Assets		33,338	25,139	2,792	353	853	4,448
Financial Assets		88,844	35,559	31,967	36,234	25,087	35,635
IRAs		55,746	15,710	16,904	32,046	13,624	16,414
Property		144,639	67,466	59,253	39,668	45,050	71,679
Primary Residence Net of Mortgage		97,463	37,134	48,522	32,964	41,268	55,818
Net Other Property		47,176	30,332	10,731	6,704	3,782	15,861
Retirement Wealth		520,326	219,591	215,388	205,437	209,575	220,805
Social Security		354,054	147,407	161,068	151,294	149,816	169,931
DB Pensions		141,692	66,484	50,761	52,076	55,572	47,461
DC Pensions		24,580	5,700	3,559	2,067	4,187	3,413
Total Wealth		842,893	363,465	326,305	313,738	294,189	348,981
Annuitized Wealth as % of Financial and Retirement Wealth	All	82	88	88	86	89	87
	With DB	83	85	87	85	90	85
	Without DB	80	90	88	87	88	88
As % of Total Wealth		68	77	76	79	79	73
% of Homeowners		93	55	65	52	61	70
% with Living Children		97	81	92	57	94	96
N of obs	Total	1,519	188	572	54	202	316
	With DB	983	67	205	21	67	117
	Without DB	536	121	367	33	135	199

Note: Data sources and assumptions as in the previous tables.

Table 1d

Composition of HRS Households' Balance Sheets at Age 65 – Median 20%

		Married couples	Single men	Single women			
				All	Never married	Separated/ divorced	Widowed
Lower Bound of Total Wealth		617,763	191,593	211,732	230,386	214,802	211,732
Upper Bound of Total Wealth		808,716	277,286	310,709	305,524	310,708	310,324
				Means of the median 20%			
Net Non-Retirement Financial Wealth		83,287	5,196	14,258	11,578	15,231	14,192
Business Assets		12,414	998	361	0	10	540
Financial Assets		40,870	1,552	8,637	6,582	9,157	8,674
IRAs		30,003	2,646	5,260	4,996	6,064	4,978
Property		111,703	23,016	41,455	41,395	47,867	38,963
Primary Residence Net of Mortgage		89,947	19,901	39,575	41,395	45,261	37,147
Net Other Property		21,756	3,115	1,880	0	2,606	1,816
Retirement Wealth		511,991	201,584	201,777	208,586	190,924	205,209
Social Security		376,679	175,795	176,963	177,554	164,794	181,633
DB Pensions		123,026	18,095	22,407	29,741	24,609	20,692
DC Pensions		12,286	7,694	2,408	1,291	1,521	2,884
Total Wealth		706,981	229,796	257,490	261,559	254,022	258,364
Annuitized Wealth as % of Financial and Retirement Wealth	All	86	93	91	93	91	91
	With DB	89	94	93	98	93	92
	Without DB	75	93	91	87	90	91
As % of Total Wealth		71	84	77	80	75	78
% of Homeowners		98	42	72	67	77	71
% with Living Children		98	84	95	78	100	95
N of obs	Total	307	38	116	9	30	77
	With DB	238	12	41	5	9	27
	Without DB	69	26	75	4	21	50

Note: Data sources and assumptions as in the previous tables.

Table 1e
Composition of HRS Households' Balance Sheets at Age 65, by Pension Types - Median 20%

	Married Couples				Single Women			
	All	With DB	DC only	No pension	All	With DB	DC only	No pension
	Means of the Median 20%							
Net Non-Retirement Financial Wealth	83,287	63,662	134,535	155,336	14,258	10,547	7,353	17,354
Business Assets	12,414	4,727	31,772	40,759	361	-	-	625
Financial Assets	40,870	34,416	48,313	66,906	8,637	5,729	4,976	10,853
IRA's	30,003	24,482	54,449	47,671	5,260	4,819	2,377	5,776
Property	11,703	95,475	103,835	183,928	41,455	25,933	21,602	53,324
Primary Residence Net of Mortgage	89,947	81,761	78,314	128,333	39,575	25,135	21,602	50,557
Net Other Property	21,756	13,714	25,521	55,595	1,880	798	-	2,766
Retirement Wealth	511,991	553,160	454,350	348,510	201,777	233,066	217,621	180,738
Social Security	376,679	384,513	354,161	348,510	176,963	167,278	194,957	180,738
DB Pensions	123,026	158,693	-	-	22,407	63,397	-	-
DC Pensions	12,286	9,955	100,188	-	2,408	2,391	22,664	-
Total Wealth	706,981	712,257	692,720	687,774	257,490	269,546	246,576	251,416
Annuitized Wealth as % of Financial and Retirement wealth	86	89	64	77	91	93	86	91
As % of Total Wealth	71	76	52	51	77	85	79	73
% Homeowners	98	98	93	98	72	63	63	79
% with Living Children	98	98	100	98	95	98	100	93
N of Obs.	307	238	14	55	116	41	8	67

Note: Data sources and assumptions as in the previous tables

Table 2a

Composition of AHEAD Households' Balance Sheets at Wave 5 - Couples

Total Wealth Deciles		1	2	3	4	5	6	7	8	9	10
Lower Bound of Total Wealth		-47,767	150,300	220,401	275,573	351,453	420,893	503,404	641,722	875,186	1,280,983
						Means by Deciles					
Net Non-Retirement Financial Wealth		3,320	13,181	32,354	50,511	85,985	115,446	179,221	283,530	484,134	1,120,261
Business Assets		392	297	50	1,040	1,188	7,553	7,014	23,436	60,703	152,825
Financial Assets		2,389	11,518	30,113	43,241	67,684	89,548	140,168	229,555	326,618	811,429
IRAs		539	1,366	2,191	6,230	17,113	18,345	32,039	30,539	96,813	156,007
Property		25,469	53,906	63,713	96,292	102,154	126,875	151,836	212,067	270,012	549,242
Primary Residence Net of Mortgage		24,625	52,713	56,050	85,886	91,445	110,375	125,158	137,925	179,474	277,044
Net Other Property		844	1,193	7,663	10,406	10,709	16,500	26,678	74,142	90,538	272,198
Retirement Wealth		71,566	117,069	150,560	166,955	191,896	214,802	234,690	255,889	308,055	422,228
Social Security		64,241	101,345	113,722	121,000	125,994	131,001	129,458	139,335	140,364	148,555
DB Pensions		7,325	15,724	36,838	45,695	65,902	83,801	105,232	116,554	167,691	273,673
DC Pensions		-	-	-	-	-	-	-	-	-	-
Total Wealth		100,355	184,156	246,627	313,498	380,035	457,123	565,747	751,486	1,062,201	2,091,731
Annuitized Wealth as % of Financial and Retirement Wealth	Total	93	88	81	77	70	68	58	51	45	34
	With DB	94	90	83	80	75	72	61	58	50	39
	Without DB	92	87	78	71	49	50	43	36	27	21
As % of Total Wealth		70	64	61	53	50	47	41	34	29	21
% of Homeowners		72	88	88	94	92	96	96	92	99	100
Age		83	81	81	81	80	80	80	80	80	80
N of obs	Total	102	101	101	101	101	102	101	101	101	91
	With DB	37	51	66	70	80	82	86	71	77	67
	Without DB	65	50	35	31	21	20	15	30	24	24

Notes: Data from HRS – wave5. Sample: AHEAD married couples in wave 5. Sample size-1012 observations, from which 10 obs falling in the 100th wealth percentile were dropped resulting in a sample of 1002. We excluded the 100th percentile from the 10th decile and the wealth upper cut-off point is $5,528,553. The present values of SS and employer DB pensions were calculated using a real rate of interest of 3% and an inflation rate of 2.5%. Annuitized wealth equals the sum of SS and DB pensions. The AHEAD data set does not contain information about DC pensions, but only a very small proportion of these oldest households will have a DC pension, some of which may have been rolled over into IRAs.

Table 2b

Composition of AHEAD Households' Balance Sheets at Wave 5 - Single women

Total Wealth Deciles		1	2	3	4	5	6	7	8	9	10
Lower Bound of Total Wealth		-1,826	47,986	68,699	95,506	126,789	156,744	196,858	255,131	349,858	557,321
					Means by Deciles						
Net Non-Retirement Financial Wealth		78	1,557	5,523	7,812	13,549	26,145	37,604	74,457	152,267	465,906
Business Assets		0	0	63	0	253	1,202	2,627	1,835	9,494	35,070
Financial Assets		78	1,551	5,340	7,543	13,071	23,776	32,814	65,781	132,803	404,017
IRAs		0	6	120	269	225	1,167	2,163	6,841	9,970	26,819
Property		2,167	6,889	19,697	37,137	51,678	67,114	92,552	112,628	164,105	254,045
Primary Residence Net of Mortgage		2,164	6,668	18,890	36,086	50,653	65,560	85,922	101,479	130,485	179,189
Net Other Property		3	221	807	1,051	1,025	1,554	6,630	11,149	33,620	74,856
Retirement Wealth		32,008	49,081	56,303	64,615	76,428	82,220	94,090	107,776	125,333	174,478
Social Security		31,353	47,190	51,059	54,859	57,965	60,218	68,194	70,858	72,057	71,983
DB Pensions		655	1,891	5,244	9,756	18,463	22,002	25,896	36,918	53,276	102,495
DC Pensions		-	-	-	-	-	-	-	-	-	-
Total Wealth		34,253	57,527	81,523	109,564	141,655	175,479	224,246	294,861	441,705	894,429
Annuitized Wealth as % of Financial and Retirement Wealth	All	94	96	90	90	86	80	77	64	54	36
	With DB	97	98	90	91	90	83	80	72	59	40
	Without DB	93	96	90	89	82	76	74	53	45	25
As % of Total Wealth		89	85	69	59	54	47	42	37	28	21
% of Homeowners		18	33	58	72	83	84	91	89	90	88
Age		87	83	83	83	82	82	82	81	81	82
N of obs	All	158	158	158	158	158	158	158	158	158	142
	With DB	15	23	41	55	78	79	80	93	105	101
	Without DB	143	135	117	103	80	79	78	65	53	41

Notes: Data from HRS – wave 5. Sample: AHEAD single women. Sample size - 1579 observations, from which 15 obs falling in the 100th wealth percentile were dropped resulting in a sample of 1564. We excluded the 100th percentile from the 10th decile and the wealth upper cut-off point is $1,868,744. The present values of SS and employer DB pensions were calculated using a real rate of interest of 3% and an inflation rate of 2.5%. Annuitized wealth equals the sum of SS and DB pensions. The AHEAD data set does not contain information about DC pensions, but only a very small proportion of these oldest households will have a DC pension, some of which may have been rolled over into IRAs.

Table 2c

Composition of AHEAD Households' Balance Sheets at Wave 5

		Married Couples	Single men	Single women			
				All	Never married	Separated/ divorced	Widowed
				Overall Means			
Net Non-Retirement Financial Wealth		227,623	134,820	74,526	83,590	57,122	75,991
Business Assets		24,136	8,667	4,747	2,112	5,467	4,806
Financial Assets		168,619	115,228	65,247	75,037	47,858	66,671
IRAs		34,868	10,925	4,532	6,441	3,797	4,514
Property		161,146	95,933	79,029	58,796	58,223	82,423
Primary Residence Net of Mortgage		112,350	68,281	66,569	55,704	51,123	68,869
Net Other Property		48,796	27,653	12,460	3,092	7,100	13,554
Retirement Wealth		211,120	104,727	85,331	100,120	77,980	85,369
Social Security		121,184	58,371	58,437	57,323	55,247	58,856
DB Pensions		89,936	46,356	26,894	42,887	22,733	26,513
DC Pensions		-	-	-	-	-	-
Total Wealth		599,889	335,480	238,886	242,506	193,325	243,783
Annuitized Wealth as % of Financial and Retirement Wealth	All	67	70	77	75	82	77
	With DB	68	68	74	69	79	73
	Without DB	64	72	80	80	84	79
As % of Total wealth		47	51	53	57	60	53
% homeowners		92	68	70	55	62	72
Age		81	82	83	83	81	83
N of obs	Total	1,002	474	1,564	71	150	1,343
	With DB	687	293	670	31	59	580
	Without DB	315	181	894	40	91	763

Note: Data sources and assumptions as in the previous tables.

Table 2d

Composition of AHEAD Households' Balance Sheets at Wave 5 - Median 20%

		Married Couples	Single men	Single women			
				All	Never married	Separated/ divorced	Widowed
Lower Bound of Total Wealth		351,453	153,436	126,789	132,038	128,992	126,789
Upper Bound of Total Wealth		502,179	255,563	196,783	183,368	196,783	196,559
				Means of the median 20%			
Net Non-Retirement Financial Wealth		100,788	36,911	19,847	19,521	23,253	19,447
Business Assets		4,386	1,316	728	0	1,212	691
Financial Assets		78,670	33,122	18,423	17,521	21,041	18,135
IRAs		17,732	2,473	696	2,000	1,000	621
Property		114,576	62,646	59,396	75,500	53,379	59,737
Primary Residence Net of Mortgage		100,957	60,010	58,106	72,500	52,394	58,373
Net Other Property		13,619	2,636	1,290	0	985	1,364
Retirement Wealth		203,406	103,487	79,324	73,187	85,369	78,778
Social Security		128,510	66,191	59,092	52,904	60,417	59,113
DB Pensions		74,896	37,296	20,232	20,283	24,952	19,665
DC Pensions		-	-	-	-	-	-
Total Wealth		418,770	203,044	158,567	165,208	162,001	157,962
Annuitized Wealth as % of Financial and Retirement Wealth	All	69	75	83	82	84	83
	With DB	74	78	86	80	85	86
	Without DB	50	66	79	84	82	79
As % of Total Wealth		49	52	50	46	54	50
% of homeowners		94	80	84	63	79	85
Age		80	81	82	83	80	83
N of obs	Total	203	95	316	8	33	275
	With DB	162	72	157	4	17	136
	Without DB	41	23	159	4	16	139

Note: Data sources and assumptions as in the previous tables.

Table 2e

Composition of AHEAD Households' Balance Sheets at Wave 5, by Pension Types - Median 20%

	Married Couples			Single women		
	All	With DB	Without DB	All	With DB	Without DB
	Means of the median 20%					
Net Non-Retirement Financial Wealth	100,788	85,190	162,419	19,847	17,872	21,798
Business Assets	4,386	1,790	14,644	728	255	1,195
Financial Assets	78,670	69,221	116,007	18,423	17,151	19,680
IRA's	17,732	14,179	31,768	696	466	923
Property	114,576	111,081	128,385	59,396	44,270	74,331
Primary Residence Net of Mortgage	100,957	102,336	95,507	58,106	43,334	72,693
Net Other Property	13,619	8,744	32,878	1,290	936	1,638
Retirement Wealth	203,406	223,508	123,975	79,324	98,118	60,767
Social Security	128,510	129,658	123,975	59,092	57,395	60,767
DB Pensions	74,896	93,851	-	20,232	40,723	-
DC Pensions	-	-	-	-	-	-
Total Wealth	418,770	419,779	414,779	158,567	160,259	156,897
Annuitized Wealth as % of Financial and Retirement Wealth	69	74	50	83	86	79
As % of Total Wealth	49	54	30	50	61	39
% of homeowners	94	96	85	84	75	92
Age	80	80	81	82	82	83
N of obs	203	162	41	316	157	159

Note: Data sources and assumptions as in the previous tables.

Table 3a

Optimal ages at which to start and complete the process of annuitizing one's wealth using population mortality tables

		Expected present value			
		85.60%		79.20%	
		Optimal age to start annuitization	% of initial wealth remaining prior to annuitization	Optimal age to start annuitization	% of initial wealth remaining prior to annuitization
			No pre-annuitized wealth		
Risk aversion = 1	Couple	83	30	89	13
	Single male	65	100	65	100
	Single female	65	100	70	83
Risk aversion = 2	Couple	77	59	83	38
	Single male	65	100	65	100
	Single female	65	100	71	83
Risk aversion = 5	Couple	70	85	74	74
	Single male	65	100	65	100
	Single female	65	100	70	88
			50% wealth pre-annuitized		
Risk aversion = 1	Couple	Never	0	Never	0
	Single male	65	100	65	100
	Single female	65	100	70	77
Risk aversion = 2	Couple	Never	0	Never	0
	Single male	65	100	65	100
	Single female	66	96	69	87
Risk aversion = 5	Couple	73	73	82	44
	Single male	65	100	65	100
	Single female	65	100	70	87
			75% wealth pre-annuitized		
Risk aversion = 1	Couple	Never	0	Never	0
	Single male	65	100	65	100
	Single female	66	94	Never	0
Risk aversion = 2	Couple	Never	0	Never	0
	Single male	65	100	65	100
	Single female	65	100	70	78
Risk aversion = 5	Couple	Never	0	Never	0
	Single male	65	100	65	100
	Single female	65	100	71	82

? = 0.5, ? = 0.9709, p = 0.025, *r* = 0.03, wife three years younger than husband, mortality = SSA table for 1930 male and 1933 female birth cohorts, 2/3 annuity survivor benefit.

Table 3b

Optimal ages at which to start and complete the process of annuitizing one's wealth using annuitant mortality tables

		Expected present value			
		92.40%		84.90%	
		Optimal age to start annuitization	% of initial wealth remaining prior to annuitization	Optimal age to start annuitization	% of initial wealth remaining prior to annuitization
			No pre-annuitized wealth		
Risk aversion = 1	Couple	76	61	87	24
	Single male	65	100	65	100
	Single female	65	100	65	100
Risk aversion = 2	Couple	72	79	80	54
	Single male	65	100	65	100
	Single female	65	100	65	100
Risk aversion = 5	Couple	65	100	73	79
	Single male	65	100	65	100
	Single female	65	100	65	100
			50% wealth pre-annuitized		
Risk aversion = 1	Couple	Never	-	Never	-
	Single male	65	100	65	100
	Single female	65	100	65	100
Risk aversion = 2	Couple	77	58	Never	-
	Single male	65	100	65	100
	Single female	65	100	74	70
Risk aversion = 5	Couple	69	89	80	61
	Single male	65	100	65	100
	Single female	65	100	65	100
			75% wealth pre-annuitized		
Risk aversion = 1	Couple	Never	-	Never	-
	Single male	65	100	65	100
	Single female	65	100	Never	-
Risk aversion = 2	Couple	Never	-	Never	-
	Single male	65	100	65	100
	Single female	65	100	65	100
Risk aversion = 5	Couple	80	18	Never	-
	Single male	65	100	65	100
	Single female	65	100	65	100

? = 0.5, ? = 0.9709, p = 0.025, *r* = 0.03, wife three years younger than husband, mortality = annuitant, 2/3 survivor benefit.

Table 4

Optimal Age at Which to Annuitize – population mortality tables

		HRS				AHEAD	
		No Pension	DB or DB and DC	DC only	DB replaced by DC	No Pension	DB
Married couples							
% pre-annuitized[1]		94	86	75	58	50	84
EPDV 85.6%	CRRA = 1	Never	Never	Never	Never	Never	Never
	2	Never	Never	Never	Never	82	Never
	5	Never	Never	Never	78	81	81
EPDV 79.2%	CRRA = 1	Never	Never	Never	Never	Never	Never
	2	Never	Never	Never	Never	Never	Never
	5	Never	Never	Never	Never	Never	Never
Single women[2]							
% pre-annuitized		96	87	75	62	80	84
EPDV 85.6%	CRRA = 1	Never	Never	65	65	81	81
	2	Never	65	65	65	81	81
	5	Never	65	65	65	81	81
EPDV 79.2%	CRRA = 1	Never	Never	Never	68	Never	Never
	2	Never	Never	68	67	81	81
	5	Never	68	67	69	81	81

[1] Mean pre-annuitized percentage of financial wealth for median 20 percent of sample. [2] There are insufficient observations for single men.

Figure I.

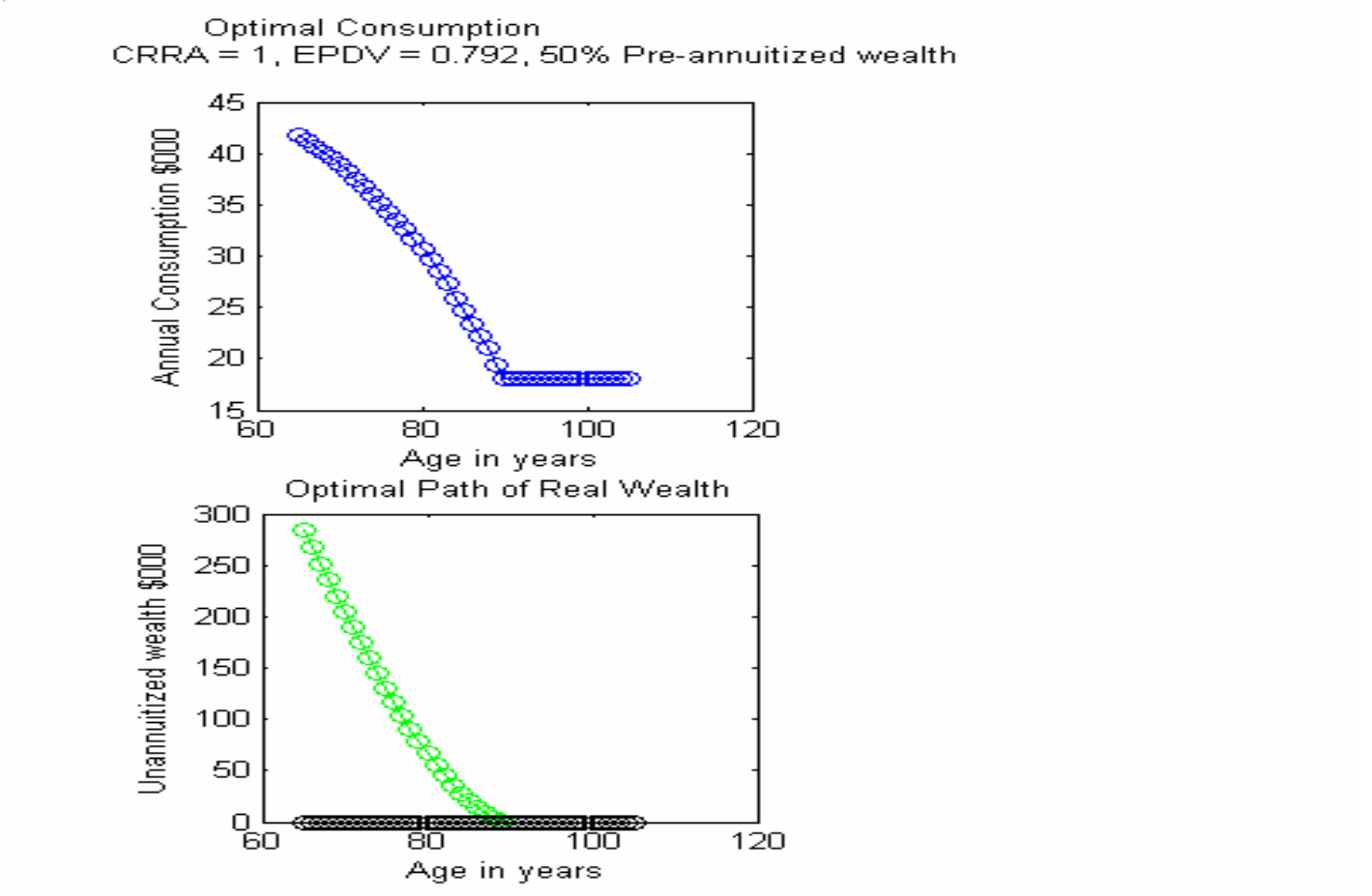
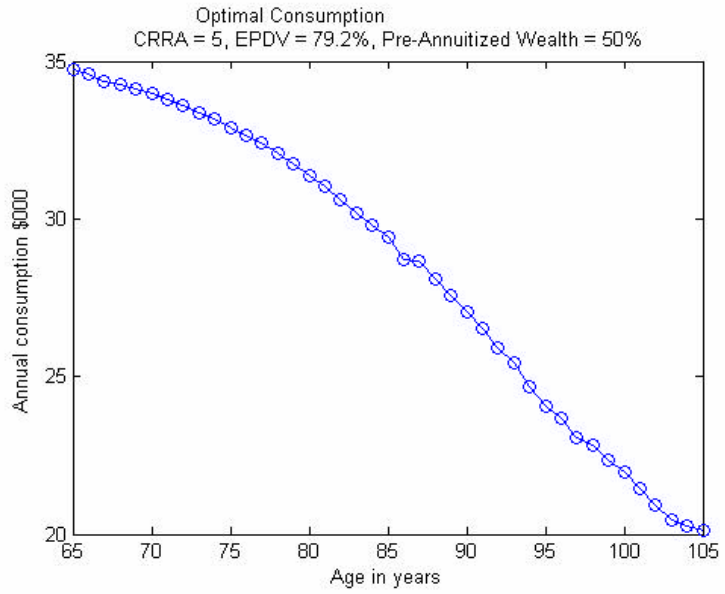
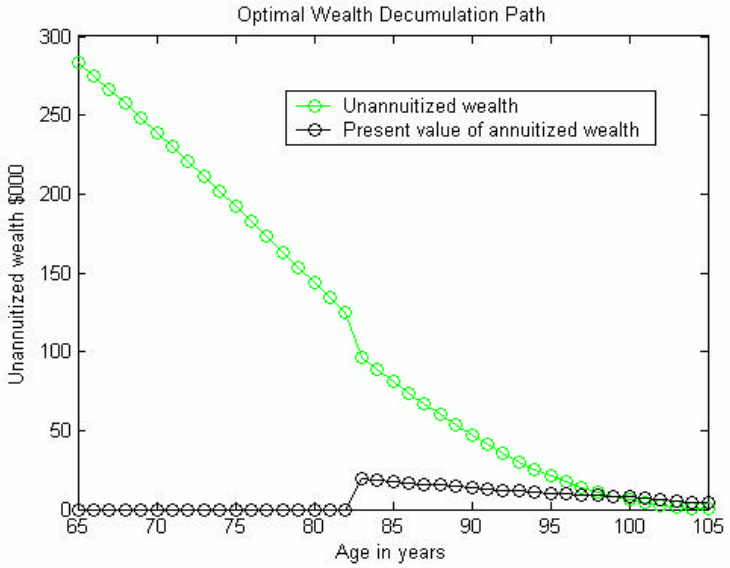

Optimal Consumption
CRRA = 1, EPDV = 0.792, 50% Pre-annuitized wealth
Annual Consumption $000
45
40
35
30
25
20
15
60
80
100
120
Age in years
Optimal Path of Real Wealth
Unannuitized wealth $000
300
250
200
150
100
50
0
60
80
100
120
Age in years

Figure II


Optimal Consumption
CRRA = 5, EPDV = 79.2%, Pre-Annuitized Wealth = 50%
Annual consumption $000
Age in years
35
30
25
20
65
70
75
80
85
90
95
100
105


Optimal Wealth Decumulation Path
Unannuitized wealth
Present value of annuitized wealth
Unannuitized wealth $000
Age in years
300
250
200
150
100
50
0
65
70
75
80
85
90
95
100
105

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