Recalibrating Retirement Spending and Saving

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OXFORD
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Great Clarendon Street, Oxford OX2 6DP

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
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Oxford New York

Auckland Cape Town Dar es Salaam Hong Kong Karachi
Kuala Lumpur Madrid Melbourne Mexico City Nairobi
New Delhi Shanghai Taipei Toronto

With offices in

Argentina Austria Brazil Chile Czech Republic France Greece
Guatemala Hungary Italy Japan Poland Portugal Singapore
South Korea Switzerland Thailand Turkey Ukraine Vietnam

Published in the United States
by Oxford University Press Inc., New York

First published 2008

British Library Cataloguing in Publication Data
Data available

Library of Congress Cataloging in Publication Data
Data available

Typeset by SPI Publisher Services, Pondicherry, India
Printed in Great Britain
on acid-free paper by
Biddles Ltd., King's Lynn, Norfolk

ISBN 978–0–19–954910–8

1 3 5 7 9 10 8 6 4 2

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978–0–19–954910–8 00-Ameriks-Prelims OUP239-Ameriks (Typeset by SPI, Delhi) viii of xxii February 29, 2008 18:56

Chapter 10

The Impact of Health Status and Out-of-Pocket Medical Expenditures on Annuity Valuation

Cassio M. Turra and Olivia S. Mitchell

The primary purpose of annuities is to protect people against the risk of outliving their financial resources in old age. Prior analysts have reported that annuities should be of substantial value to risk-averse people who face an uncertain date of death (Yaari 1965), yet relatively few people seem to purchase annuities at the point of retirement (Johnson, Burman, and Kobes 2004). A growing body of research has explored factors that may explain this puzzle, including retirees' desire to leave bequests, the existence of adverse selection in the annuity market, the overannuitization of retirement wealth, and the need for liquidity. Further, researchers have also found that people use private information about their survival chances to make the decision of purchasing an annuity, and those who anticipate living longer are more likely to buy an annuity (Petrova 2004). In any event, there is still little understanding of how private information regarding own health status may be related to the demand for annuities. Some researchers have tried to address this gap in knowledge (Sinclair and Smetters 2004), but empirical investigations of this kind have been hampered by the multidimensional aspect of health, and the absence of long-term nationally representative panel data on health at older ages.

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In this chapter, we contribute to the literature on health status and annuity valuation by describing how differences in retirees' health status might influence the decision to purchase a life annuity. To do this, we use dynamic discrete choice estimation in the context of an economic model of behavior. We propose two approaches to incorporate the effect of health differentials on annuitization valuation. One incorporates the effect of health via differences in survival throughout the life cycle. Yet this approach does not consider precautionary savings that might be motivated by uncertain out-of-pocket medical expenses. Accordingly, our second model posits that retirees in different health states consider the effects of both uncertain out-of-pocket medical expenses and uncertain survival, when making their annuitization choice. We compare the optimal level of annuitization and the insurance value of a life annuity for people in different health states at the point of annuity purchase.

Compared to prior studies, our work is distinguished by its effort to measure the impact of *anticipated* poor health on annuity valuation. This is important in the retirement context since there is substantial risk of becoming disabled after age 65. For instance, the 70-year old must anticipate that he may have severe functional limitations for about one-quarter of his remaining lifetime, and 70 percent of his remaining years will, on average, be spent with at least some functional difficulty (Crimmins, Hayward, and Saito 1994). The greater prevalence of disability among the elderly also brings with it much higher health spending: people with severe functioning limitations have annual Medicare costs $7,000 higher than nondisabled persons (Cutler and Meara 2001). Our study is therefore informative about the potential for development of an impaired annuity market that would provide higher payouts for consumers in poor health.

Understanding how health status affects annuity markets is also important for policy analysts, in particular those who propose personal Social Security retirement accounts (c.f. Cogan and Mitchell 2003). Recent research has suggested that mandating annuitization for all participants in a personal accounts scheme would imply transfers from high-mortality risk groups to low-mortality risk groups (c.f. Brown 2003). Health and mortality are also strongly associated, particularly among the elderly (Hurd, McFadden, and Merrill 2001). Consequently, understanding how health influences the insurance value of annuities may help insurers fashion annuity offerings under Social Security reform plans, so as to make a larger proportion of the participants better off.

The Context

Defined contribution (DC) pension plans now cover over 70 percent of those workers with a pension [United States Department of Labor (U.S. DOL 2004)]. As more employees reach retirement with large DC pension accruals, they are increasingly allowed to receive their savings as a lump sum, rather than annuitizing the saving as under conventional defined benefit (DB) plan. The concern is that, by taking their accumulated DC assets in a lump sum, participants may exhaust their pension assets before dying (Mitchell, Gordon, and Twinney 1997).

One way to protect against such longevity risk is to purchase a life annuity. A long economic literature has shown that risk-averse individuals with no bequest motives should strongly favor converting all their DC pension assets to private annuities. For instance, Mitchell et al. (1999) show that age-65 retirees with access to an actuarially fair annuity market would be predicted to fully annuitize at age 65. Further, that study estimated that people lacking access to an annuity market would be willing to forgo between 30 and 40 percent of their wealth at age 65, in order to purchase actuarially fair annuities. Brown (2003), using the same approach, shows how cross-group mortality differentials can influence life-annuity insurance values. He finds that annuities provide considerable longevity insurance to all groups, regardless of their race, ethnic group, or educational attainment, and even when annuity premiums are actuarially unfair, those facing high mortality (e.g., blacks with low education) would still be predicted to value a life annuity. These studies confirm the pioneering theoretical work of Yaari (1965) who showed that people lacking a bequest motive and facing an uncertain date of death would choose to fully annuitize.[1]

Overall, then, the theoretical literature suggests that that there should be substantial growth in the demand for life annuities, as more workers retire with large investments in DC plans. Yet this has not been the case to date. Thus Johnson, Burman, and Kobes (2004) used 10 years of data from the Health and Retirement Study (HRS)[2] to evaluate how persons aged 55+ disposed of their DC and Individual Retirement Account (IRA) funds. That study reports that only 4 percent of workers with DC plans annuitized their assets when they retired, and only 13 percent of those who took their accumulations from IRAs converted the resources to private annuities. Further, the market for individual life annuity in the USA remains small, amounting to less than 10 percent of the size of the life-insurance market (in 1999, Brown et al. 2001).

Several hypotheses have been offered to explain the low demand for private annuities, though considerable uncertainty about this puzzle remains. Some attribute the problem to adverse selection in annuity markets: for instance, only people with very low mortality might tend to purchase annuities, increasing the premium cost for people with average mortality prospects (e.g., Mitchell and McCarthy 2002). Nevertheless, although adverse selection does generate low rates of return in annuity contracts for persons of average mortality, annuity pricing seems to have little empirical impact on how consumers value life annuities (Brown 2003). Another explanation offered is that the elderly are overannuitized in the form of Social Security, and thus they may not need to purchase additional annuitization to insure against longevity risk. Empirical studies, however, tend to suggest that the elderly would be better off by purchasing additional private annuity contracts (Brown 2001*a*; Brown and Warshawsky 2001). Recently, Petrova (2003) uses the HRS to ask whether perceived mortality influences the desire to purchase a life annuity; this work confirms that private information on longevity has a strong influence on the decision to purchase a life annuity.

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Information on health status is a key component of private information on longevity, and therefore is a determinant of subjective survival probabilities (Hurd, McFadden, and Merril 2001). Earlier studies have investigated how uncertain health and, therefore, uncertain medical expenses affect consumption and saving decisions at older ages (e.g., Hubbard, Skinner, and Zeldes 1995; Davis 1998; Palumbo 1999). One study, in particular, predicts that health shocks can reduce the value of a life annuity for risk-averse individuals (Sinclair and Smetters 2004). In what follows, we offer new empirical evidence of the effect of health status on annuity decision-making. We find that an economic model which ignores anticipated health problems tends to overestimate both the level of desired annuitization and the insurance value of the life annuity. Our results suggest that retirees who face uncertain health would prefer to partially annuitize and maintain some assets in liquid form, so they can buffer the negative effect of unexpected out-of-pocket medical expenses on future consumption.

Valuing Life Annuities

In this section, we first lay out the general multiperiod model of annuity purchase with uncertain survival, and we then extend the approach to incorporate uncertain out-of-pocket medical expenses as well as uncertain survival. Next, we discuss parameterization of the models as well as data sources used to evaluate key outcomes.

Model 1: A Yaari-Type Model

We begin by extending Yaari's classical life-cycle approach with uncertain lifetimes (1965), as further developed by Brown (2003, 2001*b*) and Mitchell et al. (1999). To do so, we posit that, at retirement at, say, age 65, the individual decides how much of his starting wealth should be annuitized. This is a maximization problem: that is, given current and future conditions (e.g., interest rate and mortality distributions), the consumer maximizes the value function by selecting the amount of annuity which provides the largest discounted sum of expected future utility. The model posits that consumers are rational and understand the consequences of their choices for future consumption, even though the exact outcomes are probabilistic. That is, while one's date of death is uncertain, a forward-looking retiree can evaluate his mortality distribution based on his health status at the age of annuity purchase.

The consumer's problem is solved using backward recursion; first the terminal period problem is solved, and then we work backward to find the value function at age 65. In the terminal period, $t = 95$, the future value function is equal to 0 since death is certain by the next period $(t+1)$.[3] As in Brown (2001*b*), and assuming no bequest motive, the retiree would maximize utility while consuming all remaining wealth, W_t; the period t single immediate life annuity, A_t; and preexisting real annuity (e.g., social security benefits) S_t:

$$V_t(c_t) = \max[u(c_t)], \tag{10-1}$$

subject to the following constraints:

$$\begin{aligned} s.t.\quad & W_0 \textit{ given} \\ & W_t \geq 0 \quad \forall t \\ & W_{t+1} = (W_t - C_t + S_t + A_t)(1+r) \end{aligned} \tag{10-2}$$

where r is the interest rate. Knowing the optimal consumption decision in period t allows one to find the optimal consumption decision that maximizes the value function in period $t-1$. The same logic is used subsequently in each previous period to choose the consumption that maximizes the Bellman equation:

$$V_{t-1} = u(c_{t-1}) + \beta\, {}_1p_{t-1}[V_t(c_t)] \tag{10-3}$$

where β is the discount factor, and ${}_1p_{t-1}$ is the probability of surviving from period $t-1$ to t for an individual of health status j at the age at annuity purchase. We approximate optimal consumption paths by making wealth discrete and testing a large number of values between arbitrary minimum and maximum values that are consistent with the initial conditions of the model.

We seek to learn both the optimal level of annuitization at age 65 and the value of a life annuity in the life-cycle model. Following Mitchell et al. (1999), we perform a counterfactual exercise with two scenarios. First, we estimate the value function assuming people have full access to the annuity market; in other words, we choose the optimal level of annuitization that maximizes the value function, ranging from 0 to full annuitization. Next, we estimate the value function in an alternative scenario where people have no access at all to the annuity market, and we ask how much additional starting wealth (W_0) they would have to receive to make them as well off, as in the first scenario with the annuitization option. The insurance value of a life annuity is computed by comparing the two scenarios and computing the Annuity Equivalent Wealth measure (AEW), which indicates how much W_0 in the second scenario needs to be increased to produce the same value function in both scenarios.

Model 2: Out-of-Pocket Medical Expenses

The second model, we assess, takes into account that uncertainty regarding medical expenses may offer a reason for a retiree to maintain additional wealth instead of annuitizing all his assets. Here, the retiree is presumed to consider the effects of both uncertain future medical expenses and uncertain survival when choosing an optimal consumption path. Specifically, at the age of annuity purchase, we posit that he has private information regarding his future health status. He uses this information to evaluate the distribution of future health transitions, although his exact future health outcomes remain probabilistic. Each period (year) from age 65–95 or death, the individual learns whether he will incur out-of-pocket medical expenses. The probability of incurring out-of-pocket medical expenses is posited to be a function of the retiree's health status, age, and sex. The model has the intuitive implication that people cannot precisely predict their future medical expenses, but they know their out-of-pocket medical expenses at each age and can use that information when deciding about optimal future consumption.

The individual's problem in each period now has several possible outcomes. The expected value function is calculated by considering all possible combinations of health status and out-of-pocket medical expenses. The individual is posited to solve for consumption which maximizes utility for each possible path. At each period, the value function is the weighted sum of all solutions found, where the weights are the probabilities for each possible combination of health status and medical expenses:

$$V_{t-1}(c_{t-1}, h_{t-1}, M_{t-1}) = \sum_{y=1}^{k} g_{y,t-1} \max[u(c_{t-1}, h_{t-1}, M_{t-1}) + \beta_1 p_{t-1} V_t(c_t, h_t, M_t)] \qquad (10\text{-}4)$$

subject to the constraints:

$$\begin{aligned} s.t.\ & W_0 \textit{ given} \\ & W_{t-1} \geq 0 \quad \forall t \qquad (10\text{-}5) \\ & W_t = (W_{t-1} - C_{t-1} - M_{t-1} + S_{t-1} + A_{t-1})(1+r), \quad \textit{if} \ \ M_{t-1} > 0 \end{aligned}$$

where h_{t-1} is health status at $t-1$, M_{t-1} is period $t-1$ out-of-pocket medical expenses, and g_{t-1} denotes the probabilities for the k possible combinations of health status and medical expenses. Following earlier studies (e.g., Hubbard, Skinner, and Zeldes 1995; Palumbo 1999), we assume medical expenses are not a consumption good and that individuals cannot borrow against the future. Therefore, a retiree who incurs out-of-pocket medical expenses is constrained to consume only the resources that remain after paying for medical care in each period. We also use the simplifying assumption that medical expenses in each period are not correlated with health status and mortality in the next period.[4]

The solution approach first involves choosing the optimal solution for the terminal period, $t = 95$, and then we continue recursively to find the value function at the age 65. In a fashion identical to that described above, the optimal consumption path is calculated at all values of annuitization and we choose the one that gives the largest discounted sum of expected future utility. We then compute AEW in order to estimate the insurance value of a life annuity in the context of uncertain out-of-pocket medical expenses. Results for both models are compared.

Model Parameterization

To implement the model, we adopt the popular isoelastic CRRA utility function of the form:

$$U(c) = \frac{C^{1-\gamma} - 1}{1 - \gamma}, \tag{10-6}$$

where γ is the coefficient of risk aversion (Hubbard, Skinner, and Zeldes 1995; Brown 2001*b*;). Since the third derivative of this function is positive, it implicitly allows for precautionary saving that arise from having uncertain out-of-pocket medical expenses in our second model (Deaton 1992). Consistent with earlier studies (e.g., Hubbard, Skinner, and Zeldes 1995), we assume a value for γ of three in our main analysis, and we also present sensitivity analyses using alternative values for γ of one and five.[5] Further, we assume a value of 3 percent for the rate of time preference, β, and a real 3 percent rate of interest per year, consistent with earlier studies (Mitchell et al. 1999; Brown 2001*b*; Petrova 2003).

We must also specify the probabilities of dying at each age, conditional on the health status at the age of annuity purchase (assumed to be 65). For example, suppose we are solving the models for an individual in good health at age 65. We need to know his age-specific probabilities of dying at ages 65–95, given he was in good health 1–30 years previously. The ideal data-set to estimate these would offer as many years of observation as the life spans modeled. Unfortunately, no nationally representative panel data on long-term health and mortality have been collected. Consequently, we instead use a multistate model (Schoen and Land 1979; Palloni 2001) to mimic the dependence of mortality on initial health states. This allows us to follow a hypothetical cohort from age 65 onward, and to calculate the probabilities of dying at each age, assuming persons at age 65 were in a specific state of health j. Each age-specific probability of dying is then posited to reflect health status as of the entry age of 65.

The use of a multistate model requires the estimation of forces of decrement between states of health. We use the HRS from 1993 to 2000 to estimate these decrements, since that survey reports mortality and health changes every two years stayed in the same state of health for up to five years. Using cohort data is an improvement, compared to cross-sectional forms of the multistate model, since we can reasonably approximate some of the effects of duration on the forces of transition (Schoen 1988). The duration-specific probabilities are specified as a multinomial logit model of the following form:

$$\ln\left(\frac{p_j}{p_J}\right) = \alpha_j + \beta_j^{\text{Age}} x_1 + \beta_j^h x_2 + \beta_j^h x_3 \qquad j = 1, \ldots, J-1, \qquad (10\text{-}7)$$

where p_j is probability that an event j (health transition or death) occurs; p_J is the probability that a baseline event occurs; and x_i are indicators of the individual's health status in earlier waves.

As noted by many analysts, health is a multidimensional concept that can be measured in many different ways. Our previous study evaluated predictors of old-age mortality among several self-reported health indicators measured at the point of retirement (Turra 2004), and we concluded that functional status, smoking, and self-assessed health are good predictors of death patterns over the age of 70+. Accordingly, for the present analysis, we derive results using three states of health based on functional status data: no functioning problems, IADL limitations,[6] and activities of daily living (ADL) limitations.[7]

Au: Please provide the expanded forms of 'IADL'.

Table 10-1 summarizes estimates calculated from the mortality model described above in the HRS data, where we show life expectancy at age 65 for both men and women, conditional on health status at age 65. Not surprisingly, age-65 health differences have important implications for differences in life expectancy. For example, women with no functional limitations as of retirement age can expect to live 6.71 more years at age 65 than can women with ADL limitations. Among men, the difference of 5.7 years is smaller but still substantial.

Table 10-1 Life Expectancy at Age 65, HRS (1993–2000)

	Women	*Men*
No functioning problems	21.04	16.78
IADL limitations	18.89	14.20
ADL limitations	14.33	11.06

Source: Author's calculations as described in the text.

Assuming no loading and no taxes, the expected present value of the payment stream from a single immediate life annuity is given by Brown (2001*b*) as:

$$A_t = \frac{W_0 \times \alpha}{\sum_{j=1}^{35} \frac{\prod_{j=1}^{t} (1 - q_j)}{\prod_{k=1}^{j} (1 + r_k)(1 + \pi_k)}}, \tag{10-8}$$

where q_j is the age-specific probability of dying, r_k is the real interest rate, and π_k is the inflation rate. The proportion of starting wealth (W_0) held in single immediate life annuity, α, indicates the optimal level of annuitization and is determined by the model.

To investigate the effects of adverse selection in the annuity market, we calculate optimal annuitization patterns under two approaches to annuity pricing. A first set of estimates assumes that retirees have access to actuarially fairly priced annuities[8]: in this case, we use the mortality distributions discussed above to calculate single immediate life-annuity payments for someone in each health status. A second set of estimates assumes that all purchasers pay uniform prices; in this case, we use the same mortality distribution for everyone to calculate the annuity payments irrespective of health status. The second scenario uses the annuitant life table from the Society of Actuaries (SOA 1999).

Table 10-2 presents money's worth values, or estimated expected discounted values of annuity payments per premium dollar. These values assume that all purchases pay uniform pricing, and they indicate how annuity payouts vary across people in different health states. The findings show that the value-per-premium dollar is always below one, regardless of sex and discount rate. These results confirm findings by Turra (2004), who showed that annuitant mortality is slightly lower than mortality of healthy individuals in the population. This explains why the results in Table 10-2 are always less than 1. The money's worth values are especially low for men, overall, and for retirees with ADL limitations—between 0.65 and 0.70. These estimates therefore imply that there would be significant adverse selection in the private annuity market, so that the decision to purchase a life annuity implies payouts well below the actuarially fair value, especially for retirees in poor health.

Another important economic parameter is the amount of starting wealth invested in a preexisting real annuity; for instance, this could include DB pension benefits and Social Security payments. The larger is the starting wealth in a preexisting real annuity, the smaller will be the amount remaining that the retiree can use to purchase the life annuity. For many

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TABLE 10-2 Annuity Values per Premium Dollar for a Fixed Immediate Real Annuity Purchased at Age 65 (before tax)

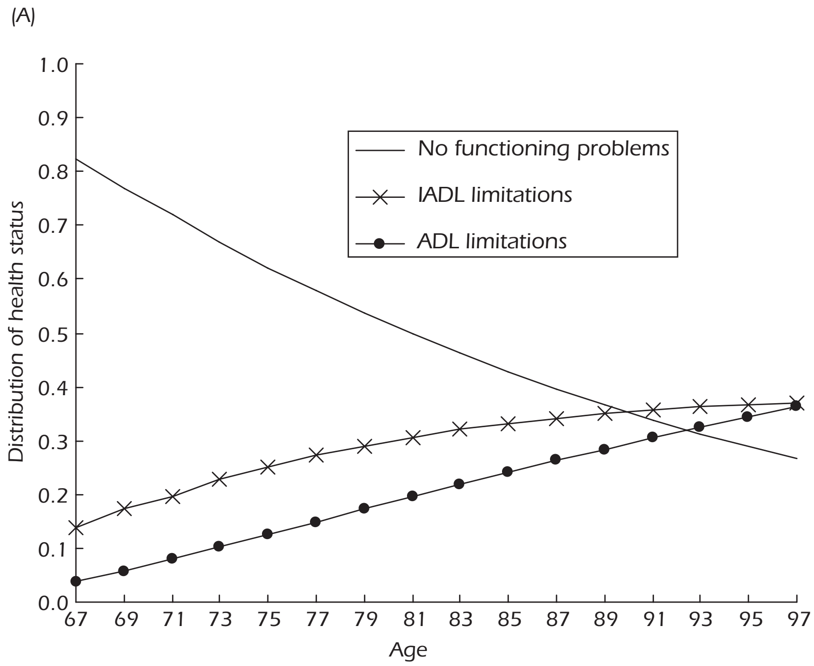
Sex & Discount Rate (%)	*Health at the Age of Annuity Purchase*		
	No Functioning Problems	*IADL Limitations*	*ADL Limitations*
Men			
3	0.89	0.76	0.60
5	0.91	0.79	0.63
7	0.92	0.81	0.66
Women			
3	0.97	0.88	0.69
5	0.98	0.90	0.71
7	0.98	0.91	0.74

Source: Authors' calculations.

Notes: Each entry shows the expected present discounted value of the annuity payouts per dollar of annuity premium. All calculations assume premium costs calculated based on the Annuitant Mortality Life Table (SOA 1999); no loads as per Mitchell et al. (1999).

simulations, we assume that half of initial wealth is held in a preexisting real annuity, a stylized description of the Social Security system (Mitchell and Moore 1998; Moore and Mitchell 2000). For sensitivity analyses, we also assume that the preexisting real annuity is either 25 or 75 percent of total retirement wealth.

Our empirical approach handles out-of-pocket medical expenses as a percent of the retiree's preexisting real annuity (pension or Social Security income), for two reasons. First, using relative rather than dollar values for out-of-pocket medical expenses avoids having to estimate dollar values for other model parameters, that is, all values are given in relative terms (e.g., relative to $W_0 = 100$). Second, by making medical expenses a function of retirement income, this implicitly assumes that the amount that the elderly spend on health care depends on income levels, which is a reasonable way to represent the distribution of health-care costs by socioeconomic group. Estimating out-of-pocket medical expenses requires calculating: (*a*) the distribution of health status at each age, (*b*) the value of medical expenses (as a proportion of Social Security income), and (*c*) the probabilities of incurring medical expenses by age and health. To derive the distribution of health status by age, we use the multistate life table model discussed above to calculate the probability of being in each health state by age, conditional on the health state at the age of annuity purchase (assumed to be 65). Figure 10-1 summarizes the results for men, and the graphs show the distribution of health status by age among male survivors, given their



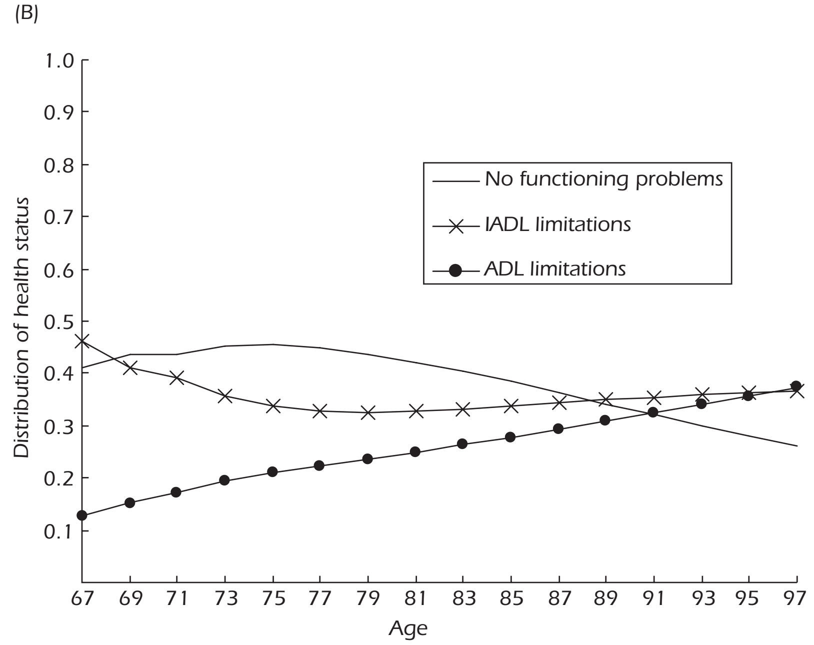


Figure 10-1. Distribution of health status by age, conditional on health status at the age of 65, men: no functioning problems at the age of 65. (A) No functioning problems at the age of 65. (B) IADL limitations at the age of 65. (C) ADL limitations at the age of 65. *Source*: Authors' calculations using the Health and Retirement Study.

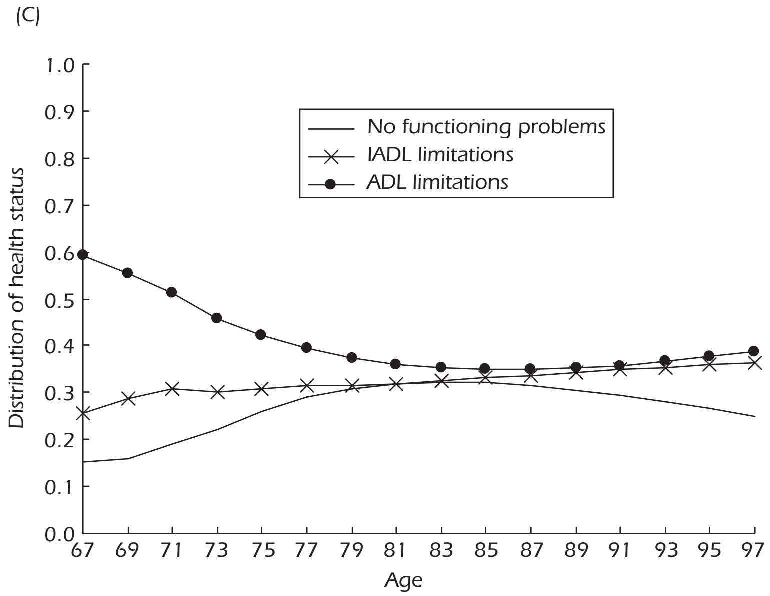


Figure 10-1. (*Continued*)

functional status at age 65. As expected, the distributions of health states are very different at early ages, but they become more similar at very old ages, as health deteriorates for all people regardless of their initial state of heath.[9]

Next, we calculate the value of out-of-pocket medical expenses as a proportion of Social Security income. Here we rely on estimates provided by RAND[10] based on data from the HRS for the years 1998 and 2000. In the data-set, out-of-pocket medical expenses include expenditures not covered by health insurance in services such as hospital stays, nursing home stays, doctor visits, prescription drugs, dental care, home health care, outpatient surgery, and other services. In addition, we include total costs of premium for health insurance coverage.[11] For each respondent aged 65+, we calculate the ratio of out-of-pocket medical expenses to Social Security income. For purposes of analytical tractability, we then create a discrete distribution of the ratios by dividing them into 11 categories of expenses, anchored at 0 and ranging to ≥300 percent of Social Security income. Table 10-3 summarizes the distribution of observations in each of these categories, in the year 2000. As is clear, most of the individuals who incurred out-of-pocket expenses spent less than 25 percent of their annual Social Security income. Nevertheless, about 5.5 percent of the elderly above age 65 did devote more

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TABLE 10-3 Distribution of Out-of-Pocket Medical Expenses (as a proportion of social security income)

Categories (% of social security income)	*Median Value ($)*	*Frequency (%)*
0	0	20.12
0–25	11.79	48.87
25–50	43.53	16.20
50–75	68.58	6.52
75–100	96.04	2.76
100–125	122.25	1.48
125–150	139.19	0.92
150–175	168.02	0.64
175–200	194.13	0.44
200–300	268.32	0.81
300+	489.34	1.25

Source: Authors' calculations as described in the text using HRS 2000.

than 100 percent of their Social Security income to out-of-pocket medical expenses.

To calculate the probability of incurring out-pocket-medical expenses in each category, we use a multinomial Logit model which controls for health status two years earlier, age, and sex. Table 10-4 presents the results from fitting the model for five categories of medical expenses.[12] The estimated coefficients give the partial effects of the explanatory variables on the log-odds of being in each category of medical expenses relative to the lowest category (of 0–25 percent of Social Security income). A positive coefficient indicates that the explanatory variable increases the probability of being in each category relative to the comparison category. It is apparent from Table 10-4 that the probability of incurring medical expenditures is significantly higher for women and persons in poor health status. The partial effects further indicate that age is significantly associated with the probability of incurring the highest category of medical costs (300+ percent of Social Security income).

These probabilities of incurring out-of-pocket medical expenses are combined with the distributions of health status by age as described before, to compute the probability of each possible consumption path by age and health. Finally, to represent the value of out-of-pocket medical expenses and health, we use the median ratio in each category of out-of-pocket medical expenses (see Table 10-3).

TABLE 10-4 Maximum Likelihood Estimation Results of the Probability of Incurring Out-of-Pocket Medical Expenses Between 1998 and 2000, Age 65+

Condition in 1998	*Log (L2/L1)*	*Log (L4/L1)*	*Log (L6/L1)*	*Log (L8/L1)*	*Log (L10/L1)*
Constant	−2.024**	−4.414**	−4.556**	−8.656**	−10.938**
	(0.335)	(0.730)	(1.279)	(1.905)	(1.079)
Age	0.005	0.002	−0.016	0.046	0.073*
	(0.004)	(0.010)	(0.017)	(0.025)	(0.013)
Female	0.272**	0.644**	0.835**	−0.030	0.455**
	(0.061)	(0.145)	(0.256)	(0.372)	(0.229)
Health status					
No functioning problems (omitted)					
IADL limitations	0.251**	0.391*	0.441	−0.015	0.932**
	(0.065)	(0.154)	(0.256)	(0.461)	(0.288)
ADL limitations	0.239**	0.935**	0.845**	1.010*	1.736**
	(0.089)	(0.174)	(0.301)	(0.446)	(0.291)
Log-likelihood = −13,110					
Sample size = 9,038					

Source: Authors' calculations from HRS (1998, 2000).

Notes: Categories of Medical Expenses computed as % of Social Security Income: L1 = 0–25%, L2 = 25–50%, L4 = 75–100%, L6 = 125–150%, L8 = 175–200%, L10 = 300+%. Standard errors in parentheses; *$p < 0.05$; **$p < 0.01$.

Empirical Findings

As is standard in economic models of annuity valuation, we present both the optimal annuitization level generated by the model and also the AEW for a variety of cases. The AEW refers to the amount of additional wealth that the retiree would require, if he did not have access to an annuity market, to achieve the lifetime utility level that he could achieve with access to an annuity market.

First we compute the AEW for people who face no uncertain medical expenses. For each state of health, we provide the optimal choices under uniform pricing and actuarially fair risk pricing. We assume a preexisting real annuity worth 50 percent of initial wealth, and three alternative degrees of risk aversion. Focusing for discussion purposes on a risk-aversion level of three, it appears that there are utility gains from purchasing a nominal annuity; see Table 10-5. This is consistent with previous empirical analyses (e.g., Mitchell et al. 1999; Brown 2003). Full annuitization

TABLE 10-5 Annuity Equivalent Value and Optimal Annuitization, Model 1, Fixed Nominal Annuity (inflation = 3.2%)

	CRRA = 1		*CRRA = 3*		*CRRA = 5*	
	Annuity Equivalent Wealth	*Optimal Additional Annuitization (% wealth)*	*Annuity Equivalent Wealth*	*Optimal Additional Annuitization (% wealth)*	*Annuity Equivalent Wealth*	*Optimal Additional Annuitization (% wealth)*
Women						
No functioning problems						
Actuarially fair premium	1.172	50	1.244	50	1.245	50
Uniform pricing	1.152	50	1.222	50	1.224	50
IADL limitations						
Actuarially fair premium	1.241	50	1.340	50	1.359	50
Uniform pricing	1.122	50	1.220	50	1.229	50
ADL limitations						
Actuarially fair premium	1.435	50	1.629	50	1.675	50
Uniform pricing	1.043	39	1.170	50	1.230	50
Men						
No functioning problems						
Actuarially fair premium	1.261	50	1.395	50	1.437	50
Uniform pricing	1.156	50	1.277	50	1.366	50
IADL limitations						
Actuarially fair premium	1.379	50	1.570	50	1.639	50
Uniform pricing	1.096	46	1.248	50	1.311	50
ADL limitations						
Actuarially fair premium	1.550	50	1.852	50	1.980	50
Uniform pricing	1.022	26	1.167	50	1.263	50

Source: Author's calculations as described in the text.

is the optimal solution even when retirees lack access to an actuarially fair contract. Yet there is a much larger dispersion in the AEW values across population subgroups, as compared to earlier studies. Our figures vary between 1.17 and 1.85, and they depend heavily on the interaction between health status and annuity pricing. In the case of women with ADL limitations, for example, the AEW falls from 1.85 when annuities are actuarially fair to only 1.17 under uniform pricing. In other words, adverse selection in annuities appears to impose high opportunity costs for people in poor health, and it also reduces considerably the insurance value of a nominal annuity. The effects of adverse selection are also strong at the lower-risk-aversion level of one. In this case, the results in Table 10-5 show that women with ADL limitations and men with IADL or ADL limitations will choose partial annuitization. For example, men with ADL limitations will invest only half of available wealth in private annuities. Not surprisingly, the insurance value of annuities also falls considerably: AEW is 1.02 and 1.04, respectively, for men and women with ADL limitations.

Table 10-6 assumes that annuities provide consumers with a constant real payout stream; these results continue to ignore uncertain medical expenses. Compared to previous findings in the nominal annuity case, the actuarial pricing results indicate a slight increase in the utility gains from purchasing a real annuity. This pattern holds for people in good health, as well as for people in poor health with access to actuarially fair annuity premiums. Under uniform pricing, however, the opposite results obtain. Both men and women with ADL limitations would be worse off if they purchased a real rather than a fixed nominal annuity. This result is due to the fact that these individuals have a low probability of surviving to the oldest ages. Since a fixed nominal annuity offers higher real payouts early on, as compared to a real annuity, the utility gains for the less healthy are higher in the first case. These findings suggest that insurers can mitigate the effects of adverse selection for people in poor health, and increase the demand for private annuities, by providing annuities that offer higher payments in earlier years of the contracts.

We now shift attention to the results of our extended model to show how desired annuitization and AEW values change when people face both uncertain survival and uncertain out-of-pocket medical expenses. Table 10-7 reports the figures for each state of health and three values of preexisting real annuity: 25, 50, and 75 percent of wealth. We focus on the case of a fixed nominal annuity under uniform pricing, and a risk-aversion level of three. Here we see that both optimal annuitization and utility gains from purchasing a nominal annuity are lower when people face out-of-pocket medical expenses. In the case of a preexisting real annuity

Table 10-6 Annuity Equivalent Value and Optimal Annuitization: Model 1, Real Annuity

	CRRA = 1		*CRRA = 3*		*CRRA = 5*	
	Annuity Equivalent Wealth	*Optimal Additional Annuitization (% wealth)*	*Annuity Equivalent Wealth*	*Optimal Additional Annuitization (% wealth)*	*Annuity Equivalent Wealth*	*Optimal Additional Annuitization (% wealth)*
Women						
No functioning problems						
Actuarially fair premium	1.187	50	1.290	50	1.322	50
Uniform pricing	1.154	50	1.255	50	1.285	50
IADL limitations						
Actuarially fair premium	1.255	50	1.387	50	1.439	50
Uniform pricing	1.110	44	1.230	50	1.270	50
ADL limitations						
Actuarially fair premium	1.451	50	1.681	50	1.776	50
Uniform pricing	1.030	25	1.151	42	1.220	44
Men						
No functioning problems						
Actuarially fair premium	1.273	50	1.441	50	1.510	50
Uniform pricing	1.139	46	1.280	50	1.359	50
IADL limitations						
Actuarially fair premium	1.393	50	1.616	50	1.727	50
Uniform pricing	1.075	35	1.228	45	1.309	50
ADL limitations						
Actuarially fair premium	1.563	50	1.903	50	2.073	50
Uniform pricing	1.011	16	1.140	38	1.233	43

Source: Author's calculations as described in the text.

TABLE 10-7 Annuity Equivalent Value and Optimal Annuitization Under Uniform Pricing and Uncertain Survival: With and Without Out-of-Pocket (OOP) Medical Costs and Fixed Nominal Annuity

	Preexisting Real Annuity Worth 25% of Wealth		*Preexisting Real Annuity Worth 50% of Wealth*		*Preexisting Real Annuity Worth 75% of Wealth*	
	Annuity Equivalent Wealth	*Optimal Additional Annuitization (% wealth)*	*Annuity Equivalent Wealth*	*Optimal Additional Annuitization (% wealth)*	*Annuity Equivalent Wealth*	*Optimal Additional Annuitization (% wealth)*
Women						
No functioning problems						
Model 1: Uncertain survival	1.229	75	1.222	50	1.195	25
Model 2: Uncertain survival w/OOP costs	1.221	75	1.160	46	1.066	16
IADL Limitations						
Model 1: Uncertain survival	1.229	75	1.220	50	1.220	25
Model 2: Uncertain survival w/OOP costs	1.207	75	1.129	36	1.017	13
ADL Limitations						
Model 1: Uncertain survival	1.221	75	1.170	50	1.068	25
Model 2: Uncertain survival w/OOP costs	1.183	67	1.051	27	0.985	−3
Men						
No Functioning Problems						
Model 1: Uncertain survival	1.332	75	1.277	50	1.193	25
Model 2: Uncertain survival w/OOP costs	1.301	75	1.196	36	1.061	15
IADL Limitations						
Model 1: Uncertain survival	1.309	75	1.248	50	1.139	25
Model 2: Uncertain survival w/OOP costs	1.282	69	1.135	31	1.019	12
ADL Limitations						
Model 1: Uncertain survival	1.276	75	1.167	50	1.046	18
Model 2: Uncertain survival w/OOP costs	1.230	64	1.042	19	0.987	−3

Source: Authors' calculations as described in the text.

Notes: Model 1: Only Uncertain Survival; Model 2: Both Uncertain Survival and Out-of-Pocket Medical Costs. Both models assume inflation = 3.2% and CRRA = 3.

worth 50 percent of wealth, we find that people would forgo less of their wealth to purchase a nominal annuity. When uncertain medical expenses are accounted for, the AEW values fall from 1.17 to 1.04 for men with ADL limitations, and from 1.27 to 1.19 for men with no functioning problems. Similar results are observed for women. These results suggest that AEW is overstated 5–11 percent ignoring out-of-pocket medical expenses. Not surprisingly, the largest differences are for people with functional limitations, since they have the highest probability of remaining in poor health and therefore have the highest risk of incurring out-of-pocket medical expenses over the life cycle.

The effect of uncertain out-of-pocket medical expenses is more evident when we compare optimal levels of annuitization. Previous studies have indicated that people in poor health rarely annuitize (Brown 2001*b*; Johnson, Burman, and Kobes 2004). Indeed, our findings rationalize this empirical evidence, since because of precautionary motives, full annuitization is unlikely to be an optimal solution. In contrast to earlier studies and our simpler model, we now predict that all retirees, regardless of health status, will only partially annuitize at age 65. As expected, those in poorest health would be expected to convert the smallest amount of their wealth into an annuity. Table 10-6 shows that among men with ADL limitations, the optimal annuitization of additional wealth (conditional on Social Security being half of total wealth) is 19 percent, while among women in the same health status, the figure is 27 percent.

Finally, it is of interest to explore sensitivity analysis for other parameters. Increasing the levels of Social Security and DB pensions to 75 percent of wealth further reduces the optimal levels of annuitization and AEW values. Two factors explain this additional reduction. First, when more initial wealth is held as a preexisting real annuity, the insurance value of additional annuitization is reduced. Second, as discussed earlier, out-of-pocket medical expenses are measured as a proportion of Social Security benefits. Therefore, increasing the value of preexisting real annuity automatically increases the nominal value of out-of-pocket medical expenses, and therefore it produces more precautionary savings in our model. Although this is only one way to formulate the problem, it is illustrative in showing that private annuities can become worthless for people in poor health who are overannuitized and face the risk of incurring large out-of-pocket medical expenses.

Discussion and Conclusions

In this analysis, we have examined how retirees' health status may influence their decisions to purchase payout life annuities. Our main contribution is to show that the insurance value of a life annuity may be smaller than that reported in prior studies. The findings suggest that differences in health and anticipated health-care expenses can help explain why many people do not fully annuitize at retirement. While prior research suggested that an average person would forgo about 40 percent of his wealth to purchase a life annuity (Mitchell et al. 1999), our work indicates that this may not hold for the majority of the population. For someone with health problems, a life annuity priced using annuitant mortality rates implies expected payouts well below the actuarially fair value for that retiree. We provide evidence that adverse selection in annuities reduces the annuity equivalent wealth from values greater than 1.5, to values close to 1.17 for people in poor health, and 1.28 for people in good health. Prior studies have also ignored precautionary savings motivated by uncertain out-of-pocket medical expenses. Our stylized life cycle model with uncertain out-of-pocket medical expenses shows that annuities become less attractive to people facing such medical expenses. Thus, regardless of health status and medical shocks, full annuitization would still be optimal, if annuity markets were truly complete and were both life and health contingent (Davidoff, Brown, and Diamond 2005). Nevertheless, when both adverse selection and uncertain medical expenses are accounted for and annuity markets are incomplete, we show that annuity equivalent wealth values are fairly low for people in poor health, and about 25 percent higher for people in good health.

Some implications of our analysis are worth noting. First, earlier investigations have used annuity equivalent wealth measures as explanatory variables in models predicting retirees' probability of annuitizing (Brown 2001*b*; Petrova 2003). Although such models control for health status (Brown 2001*b*), our study indicates that they should also account directly for health differentials in the AEW measures. Second, our results also imply that offering higher payouts for consumers in case of a medical shock could make annuities more attractive for many, and perhaps even most, of the retiring population. Future research should evaluate how insurers might fashion annuity contracts that better fit the needs of the older, perhaps unhealthy, population. Finally, our model predicts that most retirees would be made worse off by requiring full annuitization, if uniform pricing were involved. These results are important in the context of Social Security reforms proposing personal retirement accounts with mandatory annuitization. Indeed, mandatory annuitization should integrate risk classification providing actuarially fair annuities to people in different health states.

Future research can extend our work by taking into account additional heterogeneity between people in different health states. In addition, it

978–0–19–954910–8 10-Ameriks-c10 OUP239-Ameriks (Typeset by SPI, Delhi) 247 of 250 February 29, 2008 17:3

would be of interest to incorporate correlation between medical expenses and future mortality as well as bequest motives.

Acknowledgments

This research received support from the Social Security Administration via the Michigan Retirement Research Center at the University of Michigan and the Pension Research Council at the Wharton School of the University of Pennsylvania. Additional support was provided to the first author by Grant AG10168 from the National Institute on Aging, Samuel H. Preston, Principal Investigator. The authors are grateful to Jeffrey Brown for sharing his optimization code and for useful suggestions. Helpful comments were also provided by Irma Elo, Silvia Matos, Alex Muermann, Samuel Preston, Sara Rix, and members of the Wharton IRM Seminar series.

Notes

[1] Davidoff, Brown, and Diamond (2005) recently extended Yaari's model and derived conditions for optimal full annuitization in a more general setting. They show that when markets are complete, full annuitization is optimal even if some assumptions of Yaari's model are relaxed, such as additively separable utility. The value of annuities lessens if annuity markets are incomplete, but some annuitization is still optimal as long as there is a positive premium for annuitizing wealth and conventional markets are complete.

[2] The HRS is a nationally representative study of the non-institutionalized population over age 50 and their spouses/partners (regardless of age). The HRS data-set contains detailed data on health, financial status, retirement, and family support. Cohorts were interviewed in different waves from 1992 to 2002 (hrsonline.isr.umich.edu).

[3] This is the maximum age for which we can estimate reliable parameters based on actual data. Using an older age for the terminal age does not affect our conclusions since the probability of surviving beyond age 95 is low.

[4] Health status and mortality in period t depend on health status in period $t-1$, and the probability of incurring medical costs is a function of health status in period $t-1$. For this reason, part of the correlation between medical expenses and health status or survival in period t is indirectly accounted for in our model. Future work will explore alternative formulations.

[5] Previous studies have suggested that risk aversion may vary across population subgroups; thus Halek and Eisenhauer (2001) find that risk aversion in the HRS increases with education and is higher among natives and non-Hispanics; also self-reported depressed individuals have 13 percent lower risk aversion than the average individual. In future research we will evaluate the sensitivity of results to the hypothesis that people in poor health have lower risk aversion than those in good health.

[6] IADLs refer to Instrumental Activities of Daily Living which include difficulties in performing at least one of the following activities: managing the money, making phone calls, preparing a hot meal, and shopping for groceries.
[7] ADLs refer to Activities of Daily Living which include difficulties in performing at least one of the following activities: bathing/showering, dressing, eating and using the toilet, and getting in and out of bed.
[8] An actuarially fair premium is one in which the premium equals the present discounted value of expected annuity payments.
[9] In general, results for women are similar, although the proportion of female survivors with functional limitations is higher than that of men (results available upon request).
[10] We use the 2004 RAND SSA-HRS datafile (www.rand.org/labor/aging/dataprod/#randhrs).
[11] Total premiums includes premiums for employer-provided health insurance, private health insurance, long-term care insurance, Medicare through a Health Maintenance Organization, and Medigap.
[12] We present only results for five categories for clarity; results for the omitted categories are consistent with those presented in Table 10-4.

References

Brown, Jeffrey R. (2001*a*). 'Are the Elderly Really Over-annuitized? New Evidence on Life Insurance and Bequests,' in D. A. Wise (ed.), *Themes in the Economics of Aging*. Chicago, IL: University of Chicago Press, pp. 91–126.

—— (2001*b*). 'Private Pensions, Mortality Risk, and the Decision to Annuitize,' *Journal of Public Economics*, 82(1): 29–62.

—— (2003). 'Redistribution and Insurance: Mandatory Annuitization with Mortality Heterogeneity,' *Journal of Risk and Insurance*, 70(1):17–41.

—— and Mark J. Warshawsky (2001). 'Longevity-Insured Retirement Distributions from Pension Plans: Market and Regulatory Issues,' National Bureau of Economic Research Working Paper no. 8064.

—— , Olivia S. Mitchell, James M. Poterba, and Mark J. Warshawsky. (2001). *The Role of Annuity Markets in Financing Retirement*. Cambridge, MA: MIT Press.

Cogan, John F. and Olivia S. Mitchell (2003). 'The Role of Economic Policy in Social Security Reform: Perspectives from the President Commission,' *Journal of Economic Perspectives*, 17(2): 149–72.

Crimmins, Eileen M., Mark D. Hayward, and Yasuhiko Saito (1994). 'Changing Mortality and Morbidity Rates and the Health-Status and Life Expectancy of the Older Population,' *Demography*, 31(1): 159–75.

Cutler, David M. and Ellen Meara (2001). 'The Concentration of Medical Spending: An Update,' in D. A. Wise (ed.), *Themes in the Economics of Aging*. Chicago, IL: University of Chicago Press, pp. 217–40.

Davidoff, Thomas, Jeffrey R. Brown, and Peter Diamond (2005). 'Annuities and Individual Welfare,' *American Economic Review*, 95(5): 1573–90.

Davis, Morris A. (1998). 'The Health and Financial Decisions of the Elderly,' Ph.D. Dissertation in the Department of Economics, University of Pennsylvania.

Deaton, Angus (1992). *Understanding Consumption*. New York: Clarendon Press.

Halek, Martin and Joseph G. Eisenhauer (2001). 'Demography of Risk Aversion,' *Journal of Risk and Insurance*, 68(1): 1–24.

Hubbard, R. Glenn, Jonathan Skinner, and Stephen P. Zeldes (1995). 'Precautionary Saving and Social Insurance,' *Journal of Political Economy*, 103(2): 360–99.

Hurd, Michael D., Daniel McFadden, and Angela Merrill (2001). 'Predictors of Mortality among the Elderly,' in D. A. Wise (ed.), *Themes in the Economics of Aging*. Chicago, IL: University of Chicago Press, pp. 171–98.

Johnson, Richard W., Leonard E. Burman, and Deborah I. Kobes (2004). 'Annuitized Wealth at Older Ages: Evidence from the Health and Retirement Study,' Final Report to the Employee Benefits Security Administration, U.S. Department of Labor. Washington, DC: The Urban Institute.

Mitchell, Olivia S. and David McCarthy (2002). 'Estimating International Adverse Selection in Annuities,' *North American Actuarial Journal*, 6(4): 38–42.

—— and James F. Moore (1998). 'Can Americans Afford to Retire? New Evidence on Retirement Saving Adequacy,' *Journal of Risk and Insurance*, 65(3): 371–400.

—— , Michael S. Gordon, and Mark M. Twinney (1997). 'Introduction: Assessing the Challenges to the Pension System,' in M. S. Gordon, O. S. Mitchell and M. M. Twinney (eds.), *Positioning Pensions for the Twenty-First Century*. Philadelphia, PA: University of Pennsylvania Press, pp. 1–11.

—— , James M. Poterba, Mark J. Warshawsky, and Jeffrey R. Brown (1999). 'New Evidence on the Money's Worth of Individual Annuities,' *American Economic Review*, 89(5): 1299–318.

Moore, James F. and Olivia S. Mitchell (2000). 'Projected Retirement Wealth and Savings Adequacy,' in O. S. Mitchell, P. B. Hammond, and A. M. Rappaport (eds.), *Forecasting Retirement Needs and Retirement Wealth*. Philadelphia, PA: University of Pennsylvania Press, pp. 68–94.

Palloni, Alberto (2001). 'Increment-Decrement Life Tables,' in S. H. Preston, P. Heuveline, and M. Guillot (eds.), *Demography: Measuring and Modeling Population Processes*. Malden, MA: Blackwell Publishers, pp. 256–72.

Palumbo, Michael G. (1999). 'Uncertain Medical Expenses and Precautionary Saving near the End of the Life Cycle,' *Review of Economic Studies*, 66(2): 395–421.

Petrova, Petia (2003). 'The Annuity Puzzle Gets Bigger,' Center for Retirement Research Working Paper BC01-D02A0403F, Boston College.

Schoen, Robert (1988). *Modeling Multigroup Populations*. Plenum Series on Demographic Methods and Population Analysis. New York: Plenum Press.

—— and Kenneth C. Land (1979). 'General Algorithm for Estimating a Markov-Generated Increment-Decrement Life Table with Applications to Marital-Status Patterns,' *Journal of the American Statistical Association*, 74(368): 761–76.

Sinclair, Sven H. and Kent A. Smetters (2004). 'Health Shocks and the Demand for Annuities,' Technical Paper 2004–9, July. Washington, DC: Congressional Budget Office.

Society of Actuaries (1999). 'Exposure Draft: The Rp-2000 Mortality Tables,' Working Paper. Schaumburg, IL: Society of Actuaries.

Turra, Cassio M. (2004). 'Living and Dying at Older Ages: Essays on the Hispanic Mortality Paradox and the Annuity Puzzle in the U.S,' Doctoral Dissertation in the Graduate Group in Demography, University of Pennsylvania.

United States Department of Labor (U.S. DOL) Pension and Welfare Benefits Administration. (2004). *Abstract of 1998 Form 5500 Annual Reports.* Private Pension Plan Bulletin No. 12, Summer 2004. Washington, DC: USGPO.

Yaari, Menahem E. (1965). 'Uncertain Lifetime, Life-Insurance, and the Theory of the Consumer,' *Review of Economic Studies,* 32: 137–50.