Health Risk and Portfolio Choice

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Abstract

This paper investigates the role of self-perceived risky health in explaining continued reductions in financial risk taking after retirement. If future adverse health shocks threaten to increase the marginal utility of consumption, either by absorbing wealth or by changing the utility function, then health risk should prompt individuals to lower their exposure to financial risk. I examine individual-level data from the Study of Assets and Health Dynamics Among the Oldest Old (AHEAD), which reveal that risky health prompts safer investment. Elderly singles respond the most to health risk, consistent with a negative cross partial deriving from health shocks that impede home production. Spouses and planned bequests provide some degree of hedging. Risky health may explain 20% of the age-related decline in financial risk taking after retirement.

KEY WORDS: Background risk, precautionary saving, state-dependent utility, cross partial derivative

Classic portfolio choice theory as stated by Merton (1969, 1971) and Samuelson (1969) recommends that as long as stock returns display no mean-reversion, investors should place a constant share of their wealth in risky assets regardless of their ages or time horizons. This contrasts both with traditional personal investment advice, which proposes that risky portfolio shares should be 100 minus the investor's age (Malkiel, 1999), and with empirical evidence on the actual portfolio behavior of individuals, which generally exhibits declining risk taking through age, even after retirement (Ameriks and Zeldes, 2004; Guiso et al., 2002). Figure 1 depicts this relationship using data from several waves of the Health and Retirement Study (HRS) between 1992 and 2000. These patterns could be produced by any combination of age, cohort, and time effects. As has been widely remarked, identification of these separate effects can only formally derive from restrictions in longitudinal data. There is no universal agreement in the literature, but modeling age and time effects is standard (Heaton and Lucas, 2000a; Ameriks and Zeldes, 2004; Cocco et al., 2005).

There have been numerous efforts to reconcile theory with empirical patterns since Merton and Samuelson published their results. Many of the insights accumulated since then provide compelling explanations for the vast differences in portfolios that we see between young and old investors, but few can explain continued declines in risk taking with age after retirement. Much research has focused on the role of labor income (Jagannathan and Kocherlakota, 1996; Elmendorf and Kimball, 2000; Viceira, 2001; Campbell and Viceira, 2002; Cocco et al., 2005). If labor income is a hedge against financial risk, then young workers should invest their assets more riskily than old retirees. But this rationale best explains relatively abrupt changes in portfolio choice leading up to retirement, not the continuous declines with age after retirement seen in Figure 1.

Examining data from the Study of Assets and Health Dynamics Among the Oldest Old (AHEAD), I show that retired individuals view their health as risky, and they appear to decrease their exposure to financial risk in order to hedge against it. Since health tends to become riskier with age, the presence of undiversifiable health risk may explain why investors decrease their financial risk with age even after retirement. Exactly how risky health prompts investors to hedge in this manner remains somewhat unclear. There are two main candidates: either the specter of out-of-pocket medical expenditures looms large, even for Medicare beneficiaries, or retired investors anticipate that adverse health shocks will raise their marginal utilities, presumably by impeding home production. I show that the evidence seems to fit the latter explanation better, but both channels are potentially important. The presence of spouses and intended bequests, which could represent the promise of informal care arrangements, appear to decrease portfolio responsiveness to risky health, while additional health insurance does not. Point estimates suggest that risky health may explain 20 percent of the age-related decline in financial risk taking after retirement.

1 Background and theoretical motivation

A number of previous efforts have explored the relationship between health and financial decision making. There is a well-established literature on precautionary saving, and a several papers examine how future health expenditures may increase saving (Hubbard et al., 1994; Palumbo, 1999; Dynan et al., 2004). Others have examined portfolio choice relative to health. Guiso et al. (1996) find that Italian households headed by individuals who spent more days sick tended to hold safer financial portfolios, even after controlling for many other variables. Rosen and Wu (2004) show a robust association between fair or poor health status and safe portfolios in the Health and Retirement Study.

1.1 Health and planning

There are several reasons why health might affect financial decisions. First, future health shocks can trigger out-of-pocket medical spending which absorb financial wealth and raise its marginal utility. The precautionary saving motive, or "prudence" (Kimball, 1990), prompts individuals to acquire more wealth to offset this background risk. Similarly, any risk that leads to such precautionary saving should also lower the demand for risky assets, or result in "temperance" (Kimball, 1992; Elmendorf and Kimball, 2000). In this view, health expenditures constitute a type of undiversifiable background risk that prompts safer portfolios (Heaton and Lucas, 2000b). Pratt and Zeckhauser (1987) show that such "proper risk aversion" holds for most commonly used utility functions, while Gollier and Pratt (1996) add that even mean-zero independent risks generate "risk vulnerability," which induces more risk-averse behavior toward any other risk.

The second reason why health could affect financial decisions is if health status directly affects marginal utility, or put another way, if the cross partial derivative of utility is nonzero. If the cross partial is positive, then health and consumption may be called Frisch or Edgeworth-Pareto complements (Samuelson, 1974), and an adverse shock that lowers health will also decrease marginal utility. In such a world, individuals expecting health shocks should save less and invest their savings more riskily, because health shocks are like a hedge against risks to future consumption. The reverse is true if the cross partial is negative: health shocks raise the marginal utility of consumption and compound risks to future consumption.

A third potential channel is through life span or planning horizon. Health and mortality are related, so risky health should imply risky survival. But it is less clear what effect longevity risk has on financial planning. In a model with no labor income or annuities, an uncertain date of death prompts individuals to save in order to hedge against the risk of living too long. But life-span uncertainty also reduces the marginal utility of holding wealth since there is a chance of dying before it can be spent. As discussed by Kalemli-Ozcan and Weil (2002), this may reduce saving if retirement is late enough or can be postponed.

A related question is whether the expected length of the time horizon should matter for portfolio behavior. All things equal, advancing age leaves less time remaining before death, which some may argue is reason enough to invest more safely. But if utility is time-separable and exhibits constant relative risk aversion, and if asset returns are independently and identically distributed, without any mean reversion, then investors facing a planning horizon of any length ought to behave "myopically," maintaining the same optimal risky portfolio share through time (Merton, 1969; Samuelson, 1969). Modern portfolio choice theory admits there may be mean reversion in asset returns, and that labor income may alter decisions prior to retirement, but it typically rejects the notion that a shortening planning planning horizon alone is a reason to reduce risk (Jagannathan and Kocherlakota, 1996; Campbell and Viceira, 2002). Cocco et al. (2005) show that an investor with a defined-benefit pension should optimally shift toward *more* risk with increasing age, as financial wealth diminishes relative to pension wealth through life-cycle dissaving.

Several other elements are related to survival and possibly to portfolio choice. Cocco et al. (2005) find that a bequest motive can in theory make safe assets somewhat more attractive later in life, but the risky share hardly declines with age even in their simulations with the strongest bequest motive.

Hurd (2002) uncovers little evidence that bequest motives are important in describing portfolio choice among elderly Americans in the AHEAD, perhaps reflecting the lack of empirical support for intended bequests (Hurd, 1989). Household composition is another factor related to financial risk taking (Bertaut and Starr-McCluer, 2002; Rosen and Wu, 2004), and trends in health and survival may be correlated with household structure. An emerging theme in this paper is that bequests and household structure should be related to the sign of the cross partial, as I discuss in greater detail later.

It is unclear which of these channels are important in describing the age trajectory of portfolio choice, or if all are. Previous research suggests the two most likely candidates are health expenditures and state-dependent utility. Although out-of-pocket medical expenditures do not appear to be large on average (Smith, 1999), they are autocorrelated and occasionally catastrophic (French and Jones, 2004). Cocco et al. (2005) model portfolio choice with health spending shocks ranging up to 75 percent of retirement income using numerical techniques. They find that financial risk taking actually increases slightly with age after retirement, owing to more rapid depletion of non-pension wealth, but they do not account for the persistence of health expenditure shocks. Rosen and Wu (2004) find that fair or poor health status is associated with safer financial portfolios regardless of health insurance status or out-of-pocket medical expenditures including prescription drugs. Apparently something about poor health other than the risk of current and future health expenditures is affecting portfolio choice.

1.2 The nature of the cross partial

A negative cross partial could explain the results of Rosen and Wu (2004) if poor health today were predictive of poor health, and thus higher marginal utility, in the future. Health insurance typically reimburses the costs of medical goods and services rather than simply paying cash in the unhealthy state, so risk associated with a negative cross partial could impinge regardless of insurance status. Unfortunately, evidence on the sign of the cross partial is mixed. Viscusi and Evans (1990) find that chemical workers expect their marginal utilities to decline in bad health, or that the cross partial is positive. Evans and Viscusi (1991) report that temporary health conditions like burns and poisonings seem not to affect the marginal utilities of surveyed adults. Lillard and Weiss (1997) show that adverse health shocks apparently raise the marginal utility of consumption among elderly households, or that the cross partial is negative, which induces transfers from the healthy to the sick partner and providing an extra precautionary motive for saving.

It is unclear what may be driving the different results across these empirical studies; they use completely different data and focus on individuals of vastly different ages who face completely different types of health conditions. The cross partial could change sign during the life course, if the reaction to specific health conditions varied by health status or prior exposure. The cross partial could also be different for different health conditions, which can also be age-specific.

The cross partial should be positive for conditions that simply impede the enjoyment of consumption, for example when a common cold inhibits going to the theater or taking a vacation. Debilitating illness may do likewise but would surely also impede non-market production of essential goods and services, which should raise the demand for funds to replace them. In addition to lowering the marginal utility of a vacation, a broken hip may require taking a taxi instead of walking, for example, or hiring a maid instead of cleaning. Depending on the value of lost home production relative to the value of foregone recreational spending, the net cross partial for debilitating shocks may be positive or negative. If it were negative, the presence of family members should partially hedge this risk to essential non-market production, since their labor could make up the difference. Families may also affect how an individual's recreational enjoyment of goods and services changes with his or her health, but it is less clear how.

The findings of Cocco et al. (2005) and Rosen and Wu (2004) with regard to health expenditures and insurance suggest it is worthwhile to examine how a negative cross partial could theoretically affect portfolio choice. To motivate my subsequent empirical analysis, I present and discuss an analytical solution to a log-linearized model of portfolio choice that I have developed elsewhere (Edwards, 2007). I leave to future efforts a more detailed examination of a full life-cycle model of portfolio choice with calibrated risks of future health shocks, health expenditures, uncertain life spans, bequests, and household composition.

2 Portfolio choice and the cross partial

Following Picone et al. (1998), suppose retired investors have nonseparable Cobb-Douglas tastes over health, H_t, and consumption, C_t:

$$U_t(C_t, H_t) = \frac{({C_t}^{\psi} {H_t}^{1-\psi})^{1-\gamma}}{1-\gamma}, \tag{1}$$

where $\psi \in (0,1)$ and $\gamma > 0$. There are two states of nature, healthiness and unhealthiness. Healthy investors are endowed with health and cannot purchase any more but perceive a periodic risk, $\pi_h \in (0,1)$, of becoming permanently unhealthy. Unhealthy investors must purchase their health each period. Both investors may allocate their wealth into risky or risk-free assets, which pay returns of $r \sim N(\mu_r, \sigma_r^2)$ and r_f, and there is no labor income.

As shown by Edwards (2007), this problem can be solved using the log-linearization techniques of Viceira (2001) and Campbell and Viceira (2002). Healthy investors who perceive a level of periodic health risk π_h will invest a share α_t of their wealth in the risky asset that is given by

$$\alpha_t = \frac{E_t[r_{t+1}] - r_f + \frac{1}{2}\sigma_r^2}{R(\psi, \gamma, \pi_h) \cdot \sigma_r^2}, \tag{2}$$

where $E_t[r_{t+1}] - r_f$ is the equity risk premium, σ_r^2 is the variance in risky asset returns, and

$$R(\psi, \gamma, \pi_h) = 1 - (1-\gamma)(\psi + (1-\psi)\pi_h) \tag{3}$$

is an expression for what we can call the investor's effective risk aversion, a function of the preference parameters and perceived health risk. When the investor does not care about health, $\psi = 1$ and $R = \gamma$, and equation (2) reduces to the classic Merton-Samuelson result.

The implications of this model for portfolio choice when health is risky depend on the sign of the cross partial derivative of utility, $\partial^2 U/\partial H \partial C$, which is determined by the magnitude of γ. When $\gamma \in (0,1)$, the cross partial is positive; when $\gamma = 1$, the cross partial is zero; and when $\gamma > 1$, the cross partial is negative. As long as health affects utility, equations (2) and (3) reveal that when the cross partial is negative, investors will reduce their risky portfolio shares in response to increasing health risk; when it is zero, they will not change their portfolio shares; and when it is positive, they will increase their risk taking in response to health risk:

$$\frac{\partial \alpha^h}{\partial \pi_h} = -\frac{E_t[r_{1,t+1}] - r_f + \frac{1}{2}\sigma_r^2}{\sigma_r^2} \cdot \frac{1}{R^2} \cdot \frac{\partial R}{\partial \pi_h}, \tag{4}$$

where

$$\frac{\partial R}{\partial \pi_h} = (\gamma - 1)(1 - \psi). \tag{5}$$

When the cross partial is negative, $\gamma > 1$ and future health shocks will raise marginal utility. In the model, health risk π_h raises effective risk aversion, $R(\cdot)$, and inspires less risk taking. If instead the cross partial is positive, investors will increase their risky portfolio share as health risk increases. Health shocks are actually a form of implicit insurance in that setting, since the demand for funds is diminished when sick, and effective risk aversion is lower. If the cross partial is zero, then health shocks do not affect the marginal utility of consumption, and investors will not alter their portfolio strategies in response to risky health status.

The importance of the cross partial to the analytical result is simultaneously limiting and interesting. As I discussed in the previous section, the empirical literature is split on the sign of the cross partial, with the nature of the health shock a potentially important variable. But the notion that health may affect portfolio choice directly through the utility function is a new insight. To be sure, any shock that changes marginal utility will also affect intertemporal choice. Health is special because it represents truly undiversifiable risk, and it varies systematically over the life cycle. Many shocks threaten to absorb wealth and thus raise marginal utility. But if contingent claims markets are complete, individuals should be able to write contracts that diversify away many such risks. Health, unlike cash, certainly cannot be insured in-kind. Contracts that directly deliver cash contingent on the health state are typically limited to life insurance, which conditions on a very special health state.

But expenditures on health can be insured, and we know that many Americans face significant gaps in health insurance coverage. A noteworthy and unfortunate absence in the solution to this log-linearized model is any role for the risk of future health expenditures. They do induce precautionary saving in the model, but as long as they are uncorrelated with financial market risk, they have no effect on portfolio choice. Given the breadth of theoretical and empirical literature revealing portfolio responses to background risk, this seems like a result that is specific to the log-linearization technique and not a general one.

Unraveling the effects of risks to health status versus risks of out-of-pocket health expenditures is a worthwhile future endeavor. Here, I instead explore the empirical relationship between self-perceived risks to health and risky portfolios in order to assess the scope for a model of risky health to provide insights into actual behavior. I calibrate the solution of the log-linearized model of portfolio choice to aggregate data and use those findings as motivation and guide to interpreting microeconometric results.

3 Aggregate patterns and model calibration

3.1 The data

Figure 1 shows seven cross-sectional age profiles of risky portfolio shares between 1992 and 2000, averaged within 2-year age groups. The risky portfolio share, α, is defined as risky financial wealth, such as stocks and stock mutual funds, divided by total financial wealth, which also includes safer instruments like bills, bonds, and bank accounts. I observe risky shares during five waves of the Health and Retirement Study (HRS) and two waves of its sister dataset, the Study of Assets and Health Dynamics Among the Oldest Old (AHEAD), and I connect observations for each wave. A clear downward trend in financial risk taking by age is apparent. Investors of working age, or younger than 65, generally have α's between 0.25 and 0.35, or about 0.30 on average. Older investors are clustered between 0.10 and about 0.25, or perhaps 0.175 on average. Ameriks and Zeldes (2004) report similar levels based on Surveys of Consumer Finances and TIAA-CREF data.

It is more difficult to measure risks to health. Researchers have imputed future health expenditure risks from cross-sectional data (Palumbo, 1999; Lillard and Weiss, 1997), panel data on tax returns (Hubbard et al., 1994), or more recently from rich panel data in the HRS/AHEAD surveys (French and Jones, 2004). In this paper, I take a simpler approach that explores individuals' actual perceptions of risk. A question contained in the 1993 and 1995 waves of the AHEAD allows me to examine the self-reported probabilities of future health events expected by retirees rather than imputations of likely future events. During these waves, individuals over age 70 were asked to state the probability that "medical expenses will use up all [their household] savings in the next five years." Respondents indicated a risk of this future event, a probability I will label π_h and refer to as health risk, that averaged between 25 and 30 percent. Although the data exhibit much pooling at focal responses like 0, 50, and 100, we know that the HRS expected survivorship questions also exhibit pooling but still are good indicators of health and mortality (Hurd and McGarry, 1995, 2002). So it is likely that the answers to this AHEAD question reflect legitimate assessments of risks of health expenditures.

These perceptions of catastrophic or near-catastrophic risks to out-of-pocket health expenditures are arguably also measuring self-perceived catastrophic risks to health status. To be sure, these two sets of outcomes, one concerning health expenditure and the other health status, may not perfectly overlap. The AHEAD question will mismeasure risk to health status by missing any cheap but debilitating shocks while picking up expensive but relatively benign conditions. Since the latter, or a false positive, is likely to be a rare occurrence at older ages, the AHEAD variable may understate the true catastrophic risks to health status.

Another limitation is that we do not know how households younger than those in the AHEAD would have answered this question. The younger HRS cohorts were only asked about the probability of health limiting their work activity. Thus we can only measure self-perceived risks to health at older ages, and we can only guess at how they evolve over the life cycle.

3.2 Model calibration

Given that we observe an average self-perceived health risk of about $\pi_h = 0.25$ among AHEAD respondents, we might conjecture that the average increase over the life cycle in π_h could be as much as 0.25. Suppose all of the observed age-related decline in the risky portfolio share, α, from 0.3 to 0.175, were due to that increase in π_h. Then a very simple estimate of the regression coefficient on health risk in a multivariate linear regression of portfolio shares is $\partial\alpha/\partial\pi_h \approx \Delta\alpha/\Delta\pi_h = (0.3 - 0.175)/0.25 = -0.5$.

Now consider our stylized analytical model of portfolio choice under health risk with Cobb-Douglas preferences over consumption and health. We can recover an estimate of $\partial\alpha/\partial\pi_h$ from this model by calibrating equation (2) using moments of aggregate financial data, observed risky portfolio shares, and observations and assumptions about π_h. There are three unknowns: the health risk faced by younger investors, and the two preference parameters:

γ, which governs the overall utility curvature and also determines the sign of the cross partial, and ψ, the utility weight on consumption. Researchers typically make assumptions about the preference parameters (Hubbard et al., 1994; Picone et al., 1998; Heaton and Lucas, 2000b). But since the sign of the cross partial depends on γ, it seems more appropriate in this case to recover the preference parameters from assumptions about the health risk faced by younger investors. We can write down two versions of equation (2), one for young investors and one for old investors, and then solve for the two unknown preference parameters assuming some level of health risk faced by young investors.

Table 1 displays means and standard deviations of the financial parameters as reported by Campbell et al. (1997) and revealed from HRS and AHEAD data on portfolio shares in Figure 1. In the middle of Table 2, I list several combinations of the preference parameters, γ and ψ, that are consistent with the financial parameters and with assumptions about health risk among younger investors, π_h^y, and the amount of the age-related decline in portfolio shares to be explained by the model. At the bottom of the table, I report the levels of $\partial\alpha/\partial\pi_h$ that are consistent with these preference parameters.

If we assume that all of the age-related decline in risky portfolio shares is due to health risk, π_h, and if we assume that younger investors face $\pi_h = 0$, then the model requires that $\gamma = 23.5$ and $\psi = 0.226$. This is shown in the first column of Table 2. The levels of effective risk aversion implied by $\gamma = 23.5$ and $\psi = 0.226$ for various levels of health risk are between 6.1 and 10.4, which are consistent with the range explored by Heaton and Lucas (2000b). The marginal effects of health risk on the risky portfolio share vary between -0.86 for young investors facing virtually no risk and -0.29 for retired investors facing $\pi_h = 0.25$. The consumption weight, ψ is small compared with that assumed by Picone et al. (1998), who choose $\psi = 0.6$, and it implies rather unrealistically that investors in the unhealthy state would spend 77 percent of their income on health. Health gets such a large utility weight because nothing else in the stylized model can explain the rather large age-related decline in α from 0.3 to 0.175 other than health. Health gets an even larger utility weight in the second column, where I set the unknown level of health risk among young investors to $\pi_h^y = 0.05$ instead of zero. Since we are still forcing the model to explain a decline of 12.5 percentage points in the risky portfolio share with changing health risk, a smaller change in π_h requires a larger utility weight on health to explain $\Delta\alpha$.

In the third column, I ask the model to explain only half the drop in α, or the 6.2 percentage points from 0.3 to 0.238, and the calibrated consumption weight rises to a more reasonable $\psi = 0.443$. The marginal effect of health risk varies between -0.2 and -0.32 depending on its level.

With a negative cross partial derivative, so that the need for funds is greater in the unhealthy state, the analytical model can reproduce observed moments in the financial data and trends in portfolio behavior by age after retirement. The calibration exercise reveals estimates of the marginal effect of health risk on portfolio choice, $\partial\alpha/\partial\pi_h$ that average about -0.3 for individuals facing levels of health risk around $\pi_h = 0.25$, such as AHEAD respondents. But although it is possible to explain all the age-related decline in risky portfolio shares using the model, the associated calibrated results are less than fully convincing because the model places an unrealistically heavy weight on health in utility. This suggests there are other factors affecting portfolio choice that the model is missing, and that I should account for a range of covariates in the empirical analysis of microdata.

4 Micro-level tests of the health risk model

4.1 The data

To further explore portfolio choice and health risk, I examine microdata from the AHEAD dataset. The AHEAD follows roughly 8,200 individuals in 6,000 households selected to represent the birth cohorts born in 1923 and earlier (Juster and Suzman, 1995). First interviewed in 1993, the panel was reinterviewed in 1995 and then merged with its sister study, the HRS, in 1998. Only in the 1993 and 1995 waves of the AHEAD were any individuals asked the question about the likelihood of catastrophic health expenditures that I discussed earlier. Each respondent in the household could answer that question, while wealth variables are defined only at the level of the household. In the analysis that follows, I assign the household's wealth and portfolio shares to both individuals when present, and I condition on household composition.

I obtained most of the variables from version E of the RAND HRS dataset, which is a cleaned, more user-friendly version of the original source data. I merged the RAND data with the original AHEAD datafiles in order to obtain the measure of self-perceived risks to health and several other variables.

4.2 Empirical strategy

I posit the following linear regression model of the risky portfolio share observed for individual i at time t:

$$\alpha(i,t) = \beta_0 + D(t) + \beta(i) + \beta_h \pi_h(i,t) + \sum_k \beta_k x_k(i,t) + \epsilon(i,t), \qquad (6)$$

where β_0 is a constant that measures aggregate financial parameters like the equity risk premium, $D(t)$ is a time dummy that picks up changes in aggregate financial parameters, $\beta(i)$ is an individual (household) random effect which I include as a robustness check, $\pi_h(i,t)$ is self-perceived health risk, and the $x_k(i,t)$'s are other covariates that matter for portfolio choice, which I discuss below. Including a time dummy represents an identifying assumption that there are age and time effects in portfolio choice and no cohort effects. As I acknowledged earlier, there is no a priori reason to make this assumption. Rather, it reflects the precedent set by Heaton and Lucas (2000a), Cocco et al. (2005), and Ameriks and Zeldes (2004), the latter of whom argue that patterns in panel data do not support cohort effects.

As is typical, empirical measures of risky portfolio shares exhibit significant pooling at $\alpha = 0$ and 1, and many even lie outside the unit interval. The basic Merton-Samuelson framework suggests that portfolio shares should lie between zero and one given the financial parameters listed in Table 1, unless the individual has extremely small or negative effective risk aversion. Practically speaking, a variety of other influences may prompt investors to hold either all or none of their financial wealth in risky assets, such as nonparticipation in equity markets, large holdings of risk-free nonfinancial assets, executive compensation in the form of company stock, and so on. Measurement error could also push the risky portfolio share too high or too low; financial wealth in the HRS/AHEAD surveys is imputed using hot-deck techniques for a large number of households (Juster and Suzman, 1995). Following Guiso et al. (1996), Rosen and Wu (2004), and others, I use the tobit model to estimate (6), with limits at both truncation points: $\alpha = 0$ and 1.

4.3 Portfolio choice covariates

An assortment of other variables belong in the empirical model even though they do not formally appear in the stylized theoretical model. The inclusion of many of these can be justified by their association with preferences for risk, which are parameters of the theoretical model that are not directly measurable.

Wealth directly affects tastes for risk if utility does not display constant relative risk aversion. The AHEAD measures several types of wealth, including financial wealth, housing, and vehicular assets, so I can easily control for them. Some types of wealth are interesting for life-cycle behavior even when utility is CRRA. Annuities and defined-benefit pensions like Social Security pay out some fixed amount each period, sometimes indexed to inflation, conditional only survival. As mentioned earlier, life-cycle dissaving of non-pension wealth through age will increase the relative size of this essentially risk-free pension wealth in the overall portfolio, incentivizing greater risk-taking. I construct Social Security wealth and defined-benefit pension wealth for the AHEAD cohort utilizing the techniques of Poterba et al. (2003). I use cohort life tables for men and women produced by the Social Security Administration (Bell and Miller, 2005) to weight future income flows. These are also discounted by a real rate of 3 percent in the case of Social Security benefits, which are indexed against inflation, and 6 percent for defined-benefit pensions, which typically are not. If both members of a couple remain alive, the household receives both respondent's individual Social Security benefit. When only one member of the couple is alive, the household receives the maximum of the two benefits.

Following Rosen and Wu (2004) and others, I also include as covariates current health status, education, sex, race and ethnicity, household composition, the number of surviving children, and age. Rosen and Wu find that portfolio shares are robustly associated with a binary measure of fair or poor self-reported health status among younger members of HRS households, so I include the same variable here. Education may affect portfolio choice by enhancing financial knowledge about the benefits of diversification or the equity premium. Sex, race, and ethnicity typically matter because these subgroups may differ in their perceptions of and tolerances for risk. Household composition and the number of surviving children may affect portfolio choice through the bequest motive, and they may also represent a means to spread risk informally. In particular, households of sufficient size may be able to hedge idiosyncratic risks to home production. This is a particularly interesting channel to explore since a negative cross partial could stem from debilitating health shocks that threaten home production.

Age may be a proxy for risk preferences, and traditional investment advice specifies portfolio shares as a linear function of age (Malkiel, 1999). With the AHEAD data, I can also construct a variable that measures a person's expected remaining years of life by transforming self-reported survivorship probabilities in the appropriate way. Since each respondent provides only one probability, I assume a linear survivorship schedule with everyone dying by age 110. If the time horizon matters for portfolio choice, expected remaining years of life should have a more robust effect than age, which is at best a rough proxy for a particular individual's time horizon.

The richness of the AHEAD datasets also allows me to control for stated bequest motives and several types of health insurance. This parallels Rosen and Wu, who examine portfolio choice among the original HRS cohort. They were asked similar questions about the probability of leaving any bequest, the presence of additional health insurance, long-term care insurance, and life insurance. All of these may affect financial decision making.

Summary statistics for the variables in the pooled AHEAD dataset are presented in Table 3. The average risky portfolio share across both years is 0.219, with a high standard deviation. I have manually truncated portfolio shares at 0 and 1 to be consistent with the tobit regressions later. The average health risk in the two-year pooled dataset is 0.307, while it is 0.253 in 1993 for individuals who answered it both years. I include lagged health risk because it is a useful instrument. Future health risk is thus relatively high, and almost thirty percent of the pooled sample report fair or poor health. Household finances vary considerably across the sample. Net worth, which is the sum of the values of housing and other real estate, vehicles, businesses, financial assets minus the sum of all debts, averages $263,000 and also displays much variability. Social Security wealth amounts to only about $95,000 per household, but it is much more evenly distributed. Defined-benefit pension and annuity wealth is smaller still, at $79,000 per household, with an extremely high standard deviation.

Almost 60 percent of the sample is female, but over half of all individuals are in couple households. Children are common, and family size varies considerably. The average self-reported probability of leaving any bequest at all is nearly 60 percent. Survivorship probabilities average 45 percent, almost 20 percentage points higher and more variable than suggested by official period life tables. Expected years of life, which I compute from self-reported survivorship, therefore average a relatively high 13.6 years with a standard deviation of 5.8 years. A large share of individuals, over 75 percent, report health insurance coverage in addition to Medicare. Barely 15 percent have private long-term care insurance. Over 60 percent have life insurance. The bottom of the table lists variables I use as instruments for health risk. There is considerable variation in past and even present smoking behavior, as well as in the life spans of parents, and all of these variables should determine expectations about future health events.

4.4 Results

4.4.1 Baseline tobits by household composition

Calibration of the model to aggregated data suggests that the coefficient on health risk should be negative, $\beta_h < 0$, in the range of -0.2 to -0.4 for the AHEAD cohort. The first row of Table 4 presents estimates of β_h from two-limit tobit regressions of portfolio shares using various subsets of the pooled AHEAD data characterized first by household status and then by year. Subsequent rows list estimated coefficients for the other covariates. The average risky portfolio share, α, in each subsample appears at the bottom of each column, followed by regression diagnostics.

Over all households in the pooled sample, the marginal association between health risk and the risky portfolio share is $\beta_h = -0.138$, as shown in the first column. This is a smaller coefficient than predicted by the calibration exercise and one that attributes about 3 percentage points, or about one quarter, of the 12.5 percent decline in the risky portfolio share to age-related increases in health risk. Other coefficient estimates in the first column generally match our priors and the results in previous literature. Fair or poor health reduces the risky share by about 7 percentage points, which is roughly in line with the results of Rosen and Wu (2004), who examined the younger HRS cohort. It is worth remarking that even after conditioning on current health status, health risk is still significantly associated with safer portfolio shares. All three types of wealth — net worth, Social Security wealth, and defined-benefit (DB) pension wealth — matter for portfolio choice. Of the three, Social Security wealth has the largest impact on portfolio choice, but it also varies the least within the sample. I also tested alternative definitions of net worth such as financial or non-housing net worth and found results varied little. Education is robustly associated with riskier portfolios, while being female, African-American, or Hispanic is associated with safer portfolios. The effect of age is negative and fairly robust, averaging about -0.01 across the first three columns. This is consistent with the standard investment advice provided by Malkiel (1999), who suggests declines of one percentage point per year of age. Although its coefficient is at least positively signed, expected remaining years of life have no significant impact, perhaps because the variable is noisy.

Table 4 reveals strong effects of household composition on portfolio choice. The coefficient on the couple dummy in the first column is positive and significant, showing that the presence of a spouse or partner is associated with riskier portfolios. But the number of surviving children does not provide the same kind of hedge; that coefficient is negative and significant, even after controlling for wealth. To explore the effects of household composition further, I split the sample into couples and singles and reestimate in the next two columns. This reveals a significantly stronger effect of health risk among singles, with $\beta_h = -0.220$, than it is among couples, for whom $\beta_h = -0.072$, with both coefficients significant at 5 percent level and displaying nonoverlapping confidence intervals. Not only do couples take on more financial risk than singles, which is a standard finding, they also view risks to health as less threatening. This is consistent with a negative cross partial deriving from the need to replace home production when sick. Under those circumstances, the presence of a spouse or partner is a direct hedge against health risk, while a single must replace home production with market production when sick.

The fourth and fifth columns explore conditioning on one or the other sample year rather than household composition, in order to examine the temporal variation in the pooled dataset. The wealth questions and imputations have evolved with the survey, and we would like to know whether the more recent data are better. Few notable differences emerge, which suggests there is no significant change in quality between the two waves. The average risky portfolio share among this large age cohort jumped from 0.18 to 0.22 between 1993 and 1995, probably spurred by the roughly 25 percent cumulative rise in stock indexes during this period.

4.4.2 Tobits with random effects

The first three columns in the left-hand panel of Table 5 adds household random effects to the tobit regressions as a robustness check. Fixed effects are less practical in a short panel with relatively little time variation, and they are more difficult to estimate in a truncated regression model (Honore, 1992). Rosen and Wu (2004) and van Soest and Kapteyn (2006) both use random effects in explaining portfolio behavior in several waves of the HRS. Including household random effects using both years of data does not significantly alter the results. Estimated coefficients on health risk become smaller in magnitude by about one standard error, but they remain significant. As before, household composition matters for the size of the health risk coefficient, with singles still experiencing almost three times as large an effect as couples.

Many other variables retain similar effects as when estimated without random effects. An exception is the indicator of fair or poor self-rated health, where couples' portfolios lose sensitivity and the coefficient in the combined regression falls in size. This result is somewhat perplexing given the results of Rosen and Wu (2004), who specify random effects in all their regressions and never fail to recover a significant impact of current health status on the portfolios of younger HRS respondents. One potential explanation is that current health could affect portfolios among respondents of working age by destroying labor income in addition to changing utility and triggering medical spending. If this is true, retirees without labor income should be less affected.

4.4.3 Instrumental variables tobits

There are two reasons to employ instrumental variables here. The health risk variable exhibits much response pooling, which is a common trait of subjective probability data (Hurd and McGarry, 1995) and a form of measurement error. A second reason is that an instrumental variables approach can help isolate the causal effect of health risk on portfolio choice rather than just the association. Regular regression estimates may be unreliable due to reverse causality or, as is more plausible in this setting, the influences of a third omitted variable that affects both.

I experimented with an array of instrument sets that included various measures of health and predictors of future health events. Overidentification tests suggested that a parsimonious set of 5 instruments reflecting the information set was optimal. I use lagged health risk, i.e. measured in the 1993 AHEAD wave, combined with the ages at which the respondent's mother and father died, whether the individual ever smoked, and whether he or she still smoked at the time of interview. Results using this instrument set for health risk are presented in columns 4 through 6 on the right-hand side of Table 5. Coefficients on health risk are considerably larger here than in the regular tobit specifications, by roughly a factor of 4. For all individuals, $\beta_h = -0.449$, while for singles it is again larger at -0.664 versus -0.283 for couples. While certainly large, all these IV-tobit coefficients are well within the range suggested as reasonable by the calibration exercise. Response pooling in the health risk variable may have created considerable attenuation bias.

It is also possible that instrumental variables are untangling the effects of an omitted variable that is positively associated with both health risk and portfolio shares. By this reasoning, the direct marginal effect of health risk on portfolio choice is large at first but then diminished by the behavior of the omitted variable. One potential story is that perceptions of increased health risk also prompt the purchase of health insurance, which then reduces exposure and raises risky portfolio shares. Another distinct possibility is that risky health incentivizes the planning of bequests, if they can be reliably exchanged for the guarantee of informal care (Bernheim et al., 1985). Bequests are interesting because if they do represent contracted care arrangements, they could directly hedge debilitating risks to health and thus encourage financial risk taking. Additionally, planned bequests may be allocated according to the risk preferences of their intended recipients, who are probably younger and more risk tolerant, and who face a longer planning horizon.

4.4.4 Tobits with health insurance and bequests

As a final exercise, I reestimate the portfolio share tobit models after adding a set of indicator variables for various types of insurance against health-related expenditures, and then also adding the self-reported probability of leaving any bequests. Health insurance, long-term care insurance, and life insurance all hedge against the direct financial risks associated with health shocks. Planned bequests may hedge informally through intergenerational care arrangements (Bernheim et al., 1985).

The first three columns in Table 6 show that additional health-related insurance is indeed associated with greater financial risk taking. Couples with additional health insurance beyond Medicare, for which everyone in the sample is age-eligible, have risky shares almost 10 percentage points higher than those who do not. Singles with such policies have 6.6 percentage points more risk in their portfolios. Long-term care insurance, i.e., other than Medicaid, is significantly associated with greater financial risk taking for singles, but not for couples perhaps because it is partially redundant. Life insurance has no clear effect on risky portfolio shares, although the point estimate is at least positive for couples, the class of households for whom it should matter.

Including these insurance indicators does almost nothing to the health risk coefficients, as shown in the first row. That additional health insurance seems not to impact the size or the significance of the health risk variable is a telling result. If people feared risky health because of the specter of out-of-pocket medical expenditures sneaking through gaps in Medicare, then additional health insurance should decrease the association between health risk and portfolio shares. But if health risk decreases risk taking because the cross partial is negative, or because shocks to health at older ages impede home production and raise the marginal utility of wealth, then additional medical expenditure insurance should have no effect, and this is what we find. A health insurance contract that simply paid out money in the poor health state could in principle lessen this exposure to the cross partial, but typical health insurance plans only cover a specific range of medical expenditures.

When I also include the self-reported probability of leaving any bequests as a covariate, I find results that are similar along one dimension and more revealing along another. The three rightmost columns in Table 6 show that portfolio shares for singles and couples alike are positively associated with bequest motives and with additional insurance alike. Bequests have a stronger direct effect for singles, with an estimated coefficient of 0.388 versus 0.185 for couples. At the average effect of 0.275, an increase of 10 percentage points in the perceived chance of leaving any bequest is associated with an increase of almost 3 percentage points in the risky portfolio share. These results are consistent with intended bequests as wealth held in trust for younger generations with longer planning horizons and higher risk tolerance.

More striking is the impact of including bequests on the health risk coefficients: a drop in the magnitude of each by about one third. For couples, the inclusion of the bequest probability renders health risk insignificant, but it remains significant among singles and the whole pooled sample. If intended bequests are one side of a bargained informal care arrangement, these findings are consistent with a negative cross partial. Parents who fear debilitating health shocks because they require spending to replace home production may be able to hedge by securing future care from their children through promised inheritances. This story is consistent with the larger IV-tobit coefficients on health risk we found earlier; perceived health risk lowers the risky portfolio share but also incentivizes promised bequests, which raise the risky share.

5 Discussion

Evaluating the links between health risk and portfolio selection is a natural extension of two literatures: portfolio choice in the presence of background risk, and precautionary saving in response to health expenditure risk. Consistent with evidence in the precautionary saving literature, this paper finds that retired individuals perceive significant risks associated with future health shocks, and these perceptions are correlated with hedging behavior. I find that individuals over age 70 in the AHEAD hold safer financial portfolios when they view their future health as more risky. The riskiness of health tends to rise with age, so this result can partially explain the decline in financial risk taking after retirement that we see in the data.

The precise motivation for decreasing exposure to financial risk when health is risky remains unclear, and there may be more than one. We know that there are significant gaps in coverage under Medicare and that out-of-pocket medical expenditures, though small on average, can also be catastrophic. When viewed as a type of background risk that raises the marginal utility of wealth by absorbing it, medical expenditure risk seems a likely candidate explanation.

But health shocks do more than absorb wealth. That additional health insurance beyond Medicare does not reduce the association between health risk and portfolio shares in AHEAD data suggests a second and overlapping element is important: health-induced changes in the utility function. Theory suggests the sign of the cross partial derivative of utility over consumption and health should matter for portfolio choice. But depending on their characteristics, health shocks could either raise, lower, or leave unchanged the enjoyment of consumption, and the empirical literature finds different signs at different ages and associated with different types of health shocks. When health shocks are disabling and thus hinder the ability of individuals to engage in essential activities and home production, the cross partial is negative, and sick individuals demand more funds to pay for lost home production. If health insurance simply paid money to the sick, then buying sufficient coverage could hedge this risk. But health insurance typically pays for specific goods and services and is not a direct cash transfer.

Patterns in the data are consistent with a negative cross partial for individuals. Household composition turns out to be important for the marginal association between risky portfolio shares and health risk. I find that the presence of a spouse hedges against risky future health, which suggests that individuals fear the loss of home production but expect a spouse to partially replace it. Owing to their closer proximity, spouses should be more direct hedges in this regard than children, and I find that they are. It is odd that the number of surviving children turns out to be negatively associated with financial risk taking in these data. Preferences over childbearing and risk are apparently negatively correlated, enough so that any hedging characteristics of simply having children are overwhelmed. But I find evidence that bequest motives hedge against health risk just like the presence of a spouse. Strategic bequests planned in exchange for the promise of informal care would naturally offset the risk of a negative cross partial stemming from the potential loss of home production. If this story is true, the use of bequests as hedges against health risk can explain instrumental variables estimates that reveal larger direct effects of health risk on portfolio choice that are then moderated by intended bequests. Finally, I find that the presence of additional health insurance increases risk taking but does not reduce the marginal impact of risky health on portfolio shares. This is more consistent with individuals' fear of an unhedged change in utility than of medical expenditures.

These findings yield several implications. First, they can partially explain the decline in financial risk taking through age that we observe even after retirement. Data from the AHEAD suggest that the marginal association $\partial\alpha/\partial\pi_h \approx -0.1$ over different specifications. The direct effect, estimated with instrumental variables, may be more like -0.45, but other hedging behaviors like intended bequests appear to reduce the net impact. Among elderly singles, the group that is most likely to have a negative cross partial, the marginal effect ranges between about -0.15 and -0.65. At $\partial\alpha/\partial\pi_h = -0.1$, a rise in π_h of about 25 percentage points on average over the life cycle would be associated with a decrease in the risky share α of 2.5 percentage points. Since risky portfolio shares fall about 12.5 percentage points after retirement, health risk may explain 20 percent of the observed decrease through age.

At the individual level, these results suggest that the elderly fear risky health. Improvements in old-age health security are clearly desirable. Especially for elderly singles, a group Social Security was largely intended to support, it seems fair to say that the cross partial derivative of utility is effectively negative. They would prefer more than the actuarially fair amount of health insurance, or some additional insurance that provided for their non-medical needs when sick. The introduction of the Medicare prescription drug benefit is surely a beneficial innovation for the elderly, as is the movement toward covering home care. Whether innovations like these may have altered portfolio behavior in the time since the AHEAD was conducted is an open question worthy of further research.

At the aggregate level, undiversifiable health risk may be responsible for what would otherwise appear to be suboptimal risk taking. Injecting more risk into Social Security through privatization in order to exploit the equity risk premium may be at best counterproductive if older investors are intentionally holding safer portfolios. If they wanted to but were unable to counterbalance increased risk in Social Security, such a policy could be welfare reducing. But pension reform could be more desirable if it were coupled with Medicare expansion.

The burgeoning richness of the HRS/AHEAD datasets suggests several directions for further inquiry into choice under uncertainty. As demonstrated by French and Jones (2004), the panel provides much improved insights into the distribution of out-of-pocket medical expenditures. Data on consumption and time use are available for a subset of households starting every two years in 2001. Future efforts could reestimate the sign of the cross partial with data on specific health conditions, types of spending, and shifts in asset holdings. Untangling the overlapping influences of health expenditures, health status, and survivorship expectations on choice is a bold undertaking worthy of future efforts. As population aging continues apace, understanding the dynamics of aging, health, and economic well-being increasingly becomes a priority for research and policy.

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Table 1: Moments of financial data

Mean stock returns, $E_t[r_{1,t+1}]$	0.0601
Risk-free return, r_f	0.0183
Variance in stock returns, σ_r^2	0.0315
Risky portfolio shares among:	
Working-age households, α^y	0.300
Retired households, α^o	0.175

Notes: Rows 1–3 are taken from Table 8.1 in Campbell et al. (1997). Stock returns are measured as annual log real returns on the S&P 500 index since 1926 and a comparable series prior to 1926. Risk-free returns are annual log real returns on 6-month commercial paper bought in January and rolled over in July. $\sigma_r^2 = Var_t[r_{1,t+1} - r_f]$. Rows 4–5 are average risky portfolio shares across households by age based on data in the HRS and AHEAD datasets shown in Figure 1.

Table 2: Calibration of the portfolio choice model with Cobb-Douglas preferences over health and consumption under various assumptions

	1	2	3
Assumptions:			
Risky portfolio share when young, α^y	0.300	0.300	0.300
Risky portfolio share when old, α^o	0.175	0.175	0.238
Health risk when young, π_h^y	0.000	0.050	0.000
Health risk when old, π_h^o	0.250	0.250	0.250
Calibrated preference parameters:			
Utility curvature, γ	23.5	26.8	12.5
Consumption weight, ψ	0.226	0.155	0.443
Effective risk aversion, $R(\psi, \gamma, \pi_h)$, when			
$\pi_h = 0$	6.1	5.0	6.1
$\pi_h = 0.125$	8.3	7.7	6.9
$\pi_h = 0.25$	10.4	10.4	7.7
$\partial\alpha/\partial\pi_h$ when			
$\pi_h = 0$	-0.86	-1.60	-0.32
$\pi_h = 0.125$	-0.47	-0.67	-0.25
$\pi_h = 0.25$	-0.29	-0.37	-0.20

Notes: This table reports calibrated parameters of a model of portfolio choice under Cobb-Douglas preferences shown in equation (1). The calibration proceeds by assuming XXX

Table 3: Means and standard deviations in the pooled AHEAD dataset

Variable	N	Mean	Standard deviation
Risky portfolio share	8,172	0.195	0.294
Health risk, π_h	8,172	0.307	0.320
Lagged health risk, π_h	3,453	0.253	0.305
Fair/poor health	8,172	0.291	0.454
Net worth/10^6	8,172	0.263	0.742
Net worth squared/10^{12}	8,172	0.619	19.662
Social Security wealth/10^6	8,172	0.095	0.054
SSW squared/10^{12}	8,172	0.012	0.014
DB pension wealth/10^6	8,172	0.079	1.715
DB wealth squared/10^{12}	8,172	2.946	187.075
Education in years	8,172	11.859	3.099
Female	8,172	0.584	0.493
Couple	8,172	0.551	0.497
Number of children	8,172	2.620	1.962
Probability of leaving bequest	7,958	0.582	0.396
African-American	8,172	0.082	0.275
Hispanic	8,172	0.026	0.160
Age in years	8,172	77.282	4.943
Birth year	8,172	1916.736	4.832
Probability of living 10-15 years	8,172	0.451	0.333
Official prob. of living 10-15 years	8,172	0.263	0.128
Expected remaining years	8,172	13.623	5.786
Has other health insurance	8,134	0.781	0.414
Has long-term care insurance	7,907	0.147	0.354
Has life insurance	8,105	0.613	0.487
Ever smoked	8,159	0.554	0.497
Smokes now	8,172	0.087	0.282
Father's age at death	7,761	71.449	15.031
Mother's age at death	7,929	74.739	16.879
Year	8,172	1993.971	1.000

(Notes following)

Notes: Data are pooled observations of individuals in the 1993 and 1995 waves of the Study of Assets and Health Dynamics Among the Oldest Old (AHEAD). Wealth is a household variable. Risky portfolio shares are constructed as the ratio of risky financial assets to total financial assets. Total financial assets are IRA/Keogh accounts plus stocks and stock mutual funds plus checking, saving, and money market accounts plus CD's, government savings bonds and Treasury bills plus corporate and other government bonds and bond funds plus other financial assets minus debts. Risky financial assets are defined as the sum of the risky portion of IRA/Keogh accounts plus stocks and stock mutual funds. The risky portion of IRA/Keogh accounts is set at half of total IRA/Keogh balances except Total net worth is total (net) financial assets plus the value of real estate, businesses, and vehicles. Social Security wealth and defined-benefit (DB) pension wealth are the expected present value of the household's future Social Security income or pension/annuity income, constructed as in Poterba et al. (2003) and described in the text. Expected remaining years of life is derived from the self-reported survivorship probability as described in the text. The official probability of living another 10–15 years is taken from NCHS period life tables.

Table 4: Tobit regressions of portfolio shares using pooled AHEAD data with varying household composition and year

	By household composition			By year, all HH's	
	All	Singles	Couples	1993	1995
Variable	HH's	Only	Only	Only	Only
Health risk, π_h	−0.138*	−0.220*	−0.072*	−0.126*	−0.133*
	(0.023)	(0.042)	(0.027)	(0.036)	(0.029)
Fair/poor health	−0.073*	−0.079*	−0.062*	−0.074*	−0.065*
	(0.016)	(0.031)	(0.019)	(0.025)	(0.021)
Net worth/10^6	0.221*	0.348*	0.273*	0.527*	0.166*
	(0.014)	(0.034)	(0.019)	(0.036)	(0.015)
Net worth squared/10^{12}	−0.006*	−0.008*	−0.014*	−0.033*	−0.004*
	(0.000)	(0.001)	(0.001)	(0.004)	(0.001)
Social Security wealth/10^6	1.441*	2.195*	1.057*	1.561*	1.711*
	(0.372)	(0.997)	(0.416)	(0.629)	(0.461)
SSW squared/10^{12}	−2.071	−2.409	−1.409	−3.596	−2.657
	(1.300)	(5.309)	(1.374)	(2.328)	(1.536)
DB pension wealth/10^6	0.088	0.105	0.118*	0.439*	0.088
	(0.049)	(0.197)	(0.056)	(0.153)	(0.054)
DB wealth squared/10^{12}	−0.001	−0.061	−0.001*	−0.350*	−0.001
	(0.000)	(0.049)	(0.001)	(0.105)	(0.000)
Education in years	0.046*	0.054*	0.038*	0.038*	0.045*
	(0.003)	(0.005)	(0.003)	(0.004)	(0.003)
Female	−0.048*	−0.059	−0.042*	−0.041	−0.051*
	(0.014)	(0.031)	(0.016)	(0.022)	(0.019)
Couple	0.082*			0.101*	0.042
	(0.017)			(0.026)	(0.022)
Number of children	−0.013*	−0.025*	−0.008	−0.013*	−0.012*
	(0.004)	(0.007)	(0.004)	(0.006)	(0.005)
African-American	−0.331*	−0.372*	−0.297*	−0.338*	−0.311*
	(0.032)	(0.055)	(0.042)	(0.050)	(0.042)
Hispanic	−0.196*	−0.227*	−0.188*	−0.204*	−0.188*
	(0.052)	(0.099)	(0.060)	(0.084)	(0.064)
Age	−0.010*	−0.008*	−0.010*	−0.011*	−0.007*
	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
Expected remaining years	0.001	0.001	−0.000	0.000	0.001
	(0.001)	(0.003)	(0.002)	(0.002)	(0.002)
Year	0.062*	0.095*	0.041*		
	(0.007)	(0.013)	(0.008)		
$E[\alpha]$	0.20	0.15	0.23	0.18	0.22

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	By household composition			By year, all HH's	
	All HH's	Singles Only	Couples Only	1993 Only	1995 Only
observations	8,172	3,668	4,504	4,206	3,966
χ^2-statistic	1,847	693	949	967	922
Prob $> \chi^2$	0.00	0.00	0.00	0.00	0.00

Notes: Standard errors are in parentheses. Asterisks denote significance at the 5% level. Data are pooled observations of individuals in the 1993 and 1995 AHEAD surveys, except for columns 4 and 5, which include only one wave each as a robustness check. The dependent variable is α, the risky portfolio share, constructed as described in the text and in the notes to Table 3. All regressions are tobits with limits $\alpha = 0$ and $\alpha = 1$, and all include a constant term (not shown). Health risk, π_h, is the self-assessed probability that medical expenses will use up all household savings in the next five years, expressed as a fraction, 0 to 1. Health status may be reported as excellent, very good, good, fair or poor. Net worth is total assets, including real estate, business, vehicular, and financial assets, minus debts. Social Security wealth and defined benefit (DB) pension wealth are constructed as described in the text and in the notes to Table 3. Education is measured in years. Couple, African-American, and Hispanic are indicator variables. Kids is the number of surviving children. Remaining years are the expected number of remaining years before death as inferred from the individual's subjective survivorship response.

Table 5: Tobit regressions of portfolio shares using pooled AHEAD data with varying household composition, with household random effects or instrumental variables

	Random effects			Instrumental variables		
Variable	All HH's	Singles Only	Couples Only	All HH's	Singles Only	Couples Only
Health risk, π_h	−0.112*	−0.179*	−0.064*	−0.449*	−0.664*	−0.283*
	(0.021)	(0.038)	(0.023)	(0.123)	(0.224)	(0.144)
Fair/poor health	−0.033*	−0.066*	−0.015	−0.044	−0.060	−0.026
	(0.015)	(0.029)	(0.016)	(0.024)	(0.046)	(0.028)
Net worth/10^6	0.197*	0.342*	0.186*	0.136*	0.258*	0.156*
	(0.014)	(0.032)	(0.019)	(0.017)	(0.042)	(0.025)
Net worth squared/10^{12}	−0.005*	−0.008*	−0.008*	−0.003*	−0.006*	−0.007*
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Social Security wealth/10^6	1.298*	1.833*	0.847	1.657*	1.986	1.418*
	(0.372)	(0.932)	(0.434)	(0.494)	(1.374)	(0.545)
SSW squared/10^{12}	−1.880	−1.311	−0.706	−2.507	−3.059	−2.089
	(1.200)	(4.930)	(1.316)	(1.627)	(7.156)	(1.689)
DB pension wealth/10^6	0.096*	0.136	0.072	0.056	−0.287	0.099
	(0.045)	(0.179)	(0.051)	(0.056)	(0.253)	(0.065)
DB wealth squared/10^{12}	−0.001*	−0.046	−0.001	−0.001	0.043	−0.001
	(0.000)	(0.043)	(0.000)	(0.001)	(0.057)	(0.001)
Education in years	0.041*	0.052*	0.028*	0.041*	0.046*	0.037*
	(0.003)	(0.005)	(0.003)	(0.004)	(0.007)	(0.004)
Female	−0.029*	−0.061	−0.022	−0.032	−0.021	−0.036
	(0.012)	(0.031)	(0.012)	(0.022)	(0.045)	(0.023)
Couple	0.087*			0.050*		
	(0.020)			(0.024)		
Number of children	−0.016*	−0.023*	−0.009	−0.009	−0.019	−0.006
	(0.005)	(0.007)	(0.006)	(0.005)	(0.010)	(0.006)
African-American	−0.375*	−0.340*	−0.357*	−0.254*	−0.249*	−0.255*
	(0.042)	(0.053)	(0.047)	(0.048)	(0.077)	(0.064)
Hispanic	−0.206*	−0.208*	−0.255*	−0.168*	−0.176	−0.180
	(0.058)	(0.099)	(0.067)	(0.076)	(0.132)	(0.094)
Age	−0.009*	−0.007*	−0.009*	−0.009*	−0.013*	−0.008*
	(0.002)	(0.003)	(0.002)	(0.002)	(0.005)	(0.003)
Expected remaining years	0.001	0.001	0.001	−0.000	−0.002	0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.004)	(0.002)
Year	0.061*	0.081*	0.046*			
	(0.005)	(0.010)	(0.006)			

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(continued from previous)	Random effects			Instrumental variables		
	All HH's	Singles Only	Couples Only	All HH's	Singles Only	Couples Only
$E[\alpha]$	0.20	0.15	0.23	0.23	0.18	0.27
observations	8,172	3,668	4,504	3,267	1,467	1,800
χ^2-statistic	1,006	559	465	602	228	318
Prob > χ^2	0.00	0.00	0.00	0.00	0.00	0.00
Instrumented varible				Health risk, π_h		
Number of instruments				5	5	5
First-stage F-stat				23.6	11.4	14.9
First-stage R^2				0.127	0.130	0.137
χ^2-stat, overid				5.70	2.97	2.94
Prob > χ^2, overid				0.223	0.562	0.414

Notes: Standard errors are in parentheses. Asterisks denote significance at the 5% level. Data are pooled observations of individuals in the 1993 and 1995 AHEAD surveys, except for columns 4 and 5, which include only one wave each as a robustness check. The dependent variable is α, the risky portfolio share, constructed as described in the text and in the notes to Table 3. All regressions are tobits with limits $\alpha = 0$ and $\alpha = 1$, and all include a constant term (not shown). Health risk, π_h, is the self-assessed probability that medical expenses will use up all household savings in the next five years, expressed as a fraction, 0 to 1. Health status may be reported as excellent, very good, good, fair or poor. Net worth is total assets, including real estate, business, vehicular, and financial assets, minus debts. Social Security wealth and defined benefit (DB) pension wealth are constructed as described in the text and in the notes to Table 3. Education is measured in years. Couple, African-American, and Hispanic are indicator variables. Kids is the number of surviving children. Remaining years are the expected number of remaining years before death as inferred from the individual's subjective survivorship response.
The fourth through sixth columns on the right side of the table report estimates from IV-tobit regressions where health risk is instrumented. The instrument set includes the lagged value of self-reported health risk, reports of mother's age at death and father's age at death, and two indicator variables for having ever smoked and whether smoking now. The use of lagged health risk restricts these IV-tobits to modeling portfolio choice in the 1995 wave only.

Table 6: Tobit regressions of portfolio shares using pooled AHEAD data with varying household composition and expanded insurance and bequest variables

	Adding insurance only			Insurance and bequests		
Variable	All HH's	Singles Only	Couples Only	All HH's	Singles Only	Couples Only
Health risk, π_h	−0.133*	−0.214*	−0.069*	−0.079*	−0.142*	−0.037
	(0.023)	(0.043)	(0.028)	(0.024)	(0.043)	(0.029)
Fair/poor health	−0.073*	−0.077*	−0.063*	−0.060*	−0.053	−0.058*
	(0.016)	(0.031)	(0.019)	(0.016)	(0.031)	(0.019)
Net worth/10^6	0.216*	0.343*	0.266*	0.182*	0.267*	0.238*
	(0.014)	(0.035)	(0.019)	(0.014)	(0.035)	(0.019)
Net worth squared/10^{12}	−0.005*	−0.008*	−0.013*	−0.005*	−0.006*	−0.012*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Social Security wealth/10^6	1.311*	2.127*	0.883*	1.062*	1.290	0.837*
	(0.377)	(1.025)	(0.420)	(0.377)	(1.017)	(0.421)
SSW squared/10^{12}	−1.750	−2.122	−0.914	−1.363	−0.368	−0.948
	(1.316)	(5.440)	(1.385)	(1.307)	(5.416)	(1.385)
DB pension wealth/10^6	0.055	−0.006	0.082	0.008	−0.174	0.044
	(0.050)	(0.201)	(0.057)	(0.049)	(0.197)	(0.057)
DB wealth squared/10^{12}	−0.001	−0.036	−0.001	−0.000	0.010	−0.000
	(0.000)	(0.049)	(0.001)	(0.000)	(0.048)	(0.001)
Education in years	0.044*	0.052*	0.038*	0.039*	0.046*	0.033*
	(0.003)	(0.005)	(0.003)	(0.003)	(0.005)	(0.003)
Female	−0.046*	−0.059	−0.036*	−0.026	−0.002	−0.032
	(0.015)	(0.031)	(0.017)	(0.015)	(0.031)	(0.017)
Couple	0.082*			0.081*		
	(0.017)			(0.017)		
Number of children	−0.013*	−0.024*	−0.009*	−0.011*	−0.020*	−0.007
	(0.004)	(0.007)	(0.004)	(0.004)	(0.007)	(0.004)
African-American	−0.322*	−0.367*	−0.286*	−0.287*	−0.336*	−0.251*
	(0.033)	(0.056)	(0.043)	(0.034)	(0.056)	(0.044)
Hispanic	−0.151*	−0.204*	−0.128*	−0.152*	−0.191	−0.136*
	(0.053)	(0.100)	(0.062)	(0.053)	(0.100)	(0.062)
Age	−0.009*	−0.008*	−0.009*	−0.010*	−0.011*	−0.010*
	(0.002)	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)
Expected remaining years	0.001	0.002	0.000	−0.000	0.000	−0.001
	(0.001)	(0.003)	(0.002)	(0.001)	(0.003)	(0.002)
Prob. of leaving bequest				0.275*	0.388*	0.185*
				(0.020)	(0.037)	(0.024)

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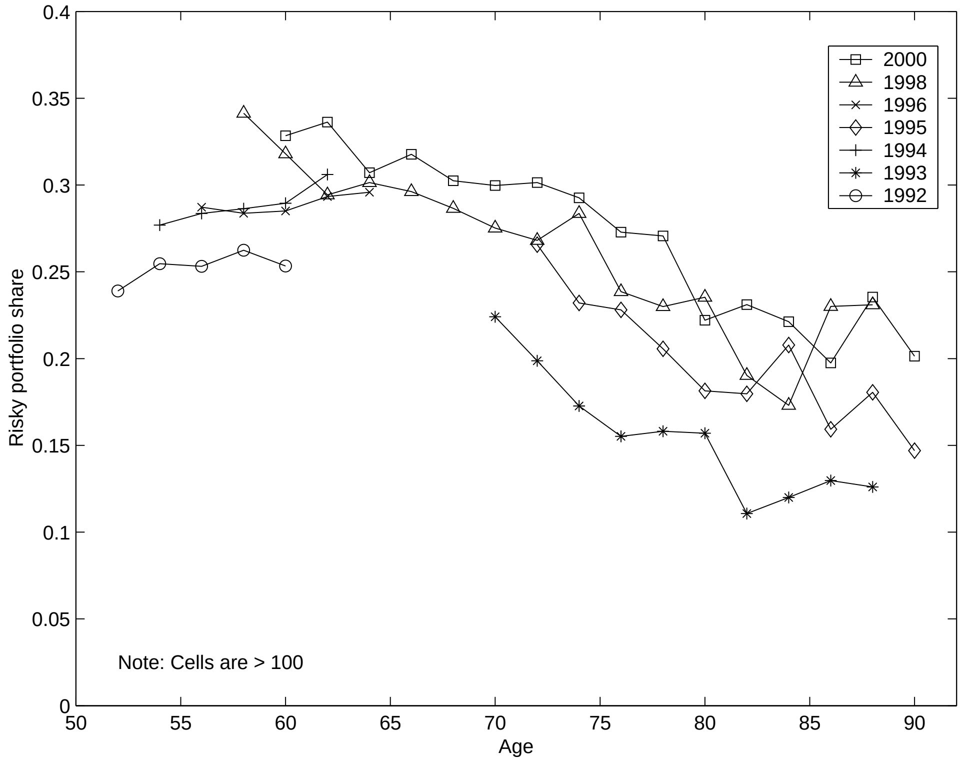
	Adding insurance only			Insurance and bequests		
	All HH's	Singles Only	Couples Only	All HH's	Singles Only	Couples Only
Other health insurance	0.091*	0.066*	0.097*	0.078*	0.045	0.089*
	(0.018)	(0.033)	(0.022)	(0.018)	(0.033)	(0.022)
Long-term care insurance	0.047*	0.081*	0.030	0.041*	0.074*	0.025
	(0.019)	(0.036)	(0.021)	(0.019)	(0.036)	(0.021)
Life insurance	0.005	−0.017	0.022	−0.002	−0.017	0.013
	(0.015)	(0.027)	(0.017)	(0.015)	(0.027)	(0.017)
Year	0.066*	0.102*	0.042*	0.068*	0.105*	0.045*
	(0.007)	(0.014)	(0.008)	(0.007)	(0.014)	(0.008)
$E[\alpha]$	0.20	0.15	0.24	0.20	0.15	0.24
observations	7,846	3,505	4,341	7,643	3,409	4,234
χ^2-statistic	1,810	673	938	1,937	770	956
Prob > χ^2	0.00	0.00	0.00	0.00	0.00	0.00

Notes: Standard errors are in parentheses. Asterisks denote significance at the 5% level. Data are pooled observations of individuals in the 1993 and 1995 AHEAD surveys, except for columns 4 and 5, which include only one wave each as a robustness check. The dependent variable is α, the risky portfolio share, constructed as described in the text and in the notes to Table 3. All regressions are tobits with limits $\alpha = 0$ and $\alpha = 1$, and all include a constant term (not shown). Health risk, π_h, is the self-assessed probability that medical expenses will use up all household savings in the next five years, expressed as a fraction, 0 to 1. Health status may be reported as excellent, very good, good, fair or poor. Net worth is total assets, including real estate, business, vehicular, and financial assets, minus debts. Social Security wealth and defined benefit (DB) pension wealth are constructed as described in the text and in the notes to Table 3. Education is measured in years. Couple, African-American, and Hispanic are indicator variables. Kids is the number of surviving children. Remaining years are the expected number of remaining years before death as inferred from the individual's subjective survivorship response.
The fourth through sixth columns on the right side of the table include the self-reported probability of leaving any bequest. All columns include indicator variables for having other health insurance beyond Medicare, for which all respondents are age-eligible, for having long-term care insurance, and for having life insurance.

Figure 1: Age profiles of α in 5 HRS and 2 AHEAD waves



Notes: Data are from the 1992, 1994, 1996, 1998, and 2000 HRS waves, and the 1993 and 1995 AHEAD waves. Each age range is labeled with its endpoint. Risky portfolio shares are constructed as the ratio of risky financial assets to total financial assets. Total financial assets include IRA/Keogh accounts; stocks and stock mutual funds; checking, saving, and money market accounts; CD's, government savings bonds, and Treasury bills; and corporate and other government bonds and bond funds. Risky financial assets are defined as the sum of the risky portion of IRA/Keogh accounts plus stocks and stock mutual funds. The risky portion of IRA/Keogh accounts is set at half of total IRA/Keogh balances except in the 1998 and 2000 HRS, when available data indicated a 60-40 split.