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## Relative risk aversion among the elderly<sup>☆</sup>

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### Abstract

This paper examines portfolio allocation behavior of the elderly, investigating whether their behavior conforms to Arrow's postulate of increasing relative risk aversion. Additionally, the effects on risk aversion of age, race, gender, education, health status, and the number of children are examined. The source of data is the AHEAD data set that is comprised of households with at least one member aged 70 or over. In the preferred specification, evidence supports a finding of modestly decreasing relative risk aversion and statistical significance for the personal characteristics examined. Implications are drawn for the likely security markets effects of an aging population.

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### 1. Introduction

In this study, we examine factors that affect attitudes of the elderly toward risk as manifested in their choices concerning portfolio allocation. Although there have been numerous studies of current saving behavior among the elderly,<sup>1</sup> few have looked at portfolio allocation. Among those that have focused on this topic, none addresses the issue of relative risk aversion. A comprehensive study of portfolio allocation by Poterba and Samrick (1997), which does focus on the elderly, examines, among other things, the effect of age on the fraction of wealth held in the form of risky assets. They do not examine the effect of age on relative risk aversion, i.e., the effect of age on the tendency of individuals to decrease (or increase) the

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<sup>1</sup> See the survey articles by Hurd (1990) and Browning and Lusardi (1996).

fraction of their wealth in risky assets as that wealth increases. Those studies that have examined relative risk aversion across the life cycle have done so with small numbers of elderly observed within their sample. Yet the behavior of this particular age group is worthy of extensive investigation specifically because its absolute and relative size will grow dramatically over the next several decades. According to Census projections, the numbers of Americans aged 65 and over will double between 2000 and 2030, becoming approximately 37% of the population 20 years old and older. Moreover, the probability of anyone having already attained the age of 65 living to any given higher age also will increase, assuring that the elderly population will itself become older, on average.

Accordingly, this age group has possessed and no doubt will continue to possess a share of total personal wealth that is much larger than its share of the population. With the asset holdings of the elderly thus likely to grow substantially as a percent of total holdings, the choices made by the elderly can significantly impact relative returns among the various asset markets. Specifically, the relative risk aversion of this demographic group could potentially affect the price of risk as it expands in size and importance.

Although there exists a substantial literature on portfolio division between risky and riskless assets for the population in general, neither the theoretical arguments nor the empirical findings have been uniform. Whether relative risk aversion increases or decreases with increasing wealth has been controversial. In his classic work, a straight-forward application of the principle of diminishing marginal utility, Arrow (1971) derives his postulates of decreasing absolute risk aversion and increasing relative risk aversion, i.e., that as wealth increases an individual will invest a smaller proportion of his total wealth in risky assets. On the other hand, Stiglitz (1969) has criticized the postulate of increasing relative risk aversion.

On the question of whether relative risk aversion increases or decreases, the empirical literature is mixed. Some attempts to investigate the question involve examining portfolio allocation, which is the subject of this study. Others attempt to answer the question by means such as attitude surveys and laboratory experiments. For example, Hartog, Ferrer-i-Carbonell, and Jonker (2002) have used survey instruments to measure hypothetical willingness to accept risk in a lottery question and from the responses inferred risk aversion measures, which they correlated with demographic characteristics of respondents.<sup>2</sup> Another example is a study by Halek and Eisenhauer (2001) who use data on the purchase of term life insurance to infer relative risk aversion and conclude that relative risk aversion is increasing over a large range, but decreases after about \$4.4 million in wealth. More related to the present research is a study by Barsky, Juster, Kimball, and Shapiro (1997), who use subjective responses to a series of questions in the Health and Retirement Study to construct an index of relative risk aversion. Their index is then correlated with the percent of respondents' assets held in a variety of specific forms. They find that greater risk aversion leads to smaller proportions of total assets being invested in stocks and bonds, and a greater proportion held in the form of saving and checking accounts, treasury bills, IRA, and Keogh accounts.<sup>3</sup>

Among studies that specifically examine portfolio allocation, results regarding relative risk aversion likewise have been inconclusive. Two of the prominent and early studies are those by Friend and Blume (1975) and Cohn, Lewellen, Lease, and Schlarbaum (1975). Cohn et al. find evidence of decreasing relative risk aversion. Friend and Blume also find evidence of decreasing relative risk aversion, but greater support for constant relative risk aversion when owner-occupied housing is included in the definition of wealth and treated as a risky asset. However, Siegel and Hoban (1982), in criticizing the data and method

<sup>2</sup> Hartog et al. inferred measures of absolute risk aversion, which is not the subject matter of this study.

<sup>3</sup> Barsky et al. control for wealth but do not report the coefficients.

of both of the above studies, conclude that with a broader definition of wealth the treatment of housing as riskless leads to a strong conclusion of increasing relative risk aversion.

Previous findings regarding the effect of age on relative risk aversion are of primary concern for the present study. The evidence is not entirely conclusive on the issue of life cycle effects on relative risk aversion. An early study by Morin and Suarez (1983) finds evidence of relative risk aversion increasing with age. In a related study, Bellante and Saba (1986) find that their strongest evidence supports the opposite conclusion. Both studies use categorical variables for age so that, for example, the latter study finds that those age 65 and above are less risk averse than those in lower age categories. However, their use of categorical variables does not permit a conclusion as to the direction of relative risk aversion as age increases beyond 65. Another study that uses a dummy variable for observations over 65 years of age is by Jianakoplos and Bernasek (1998). In that study, *ceteris paribus*, those over 65 were significantly less risk averse than those in all age groups younger than 65. However, a study by Riley and Chow (1992) examines the effect of age on relative risk aversion by including a continuous variable in age as well as a dummy variable for age greater than 65. Although the age dummy indicates that those over 65 are significantly more risk averse than younger individuals in terms of portfolio allocation, the linear coefficient on age is overwhelmingly influenced by younger investors and, thus, may not accurately represent the effect of increasing age of older individuals. The continuous age variable used by Riley and Chow indicates a tendency for risk aversion to decrease with age.<sup>4</sup> Their study does not treat homes or bonds as risky assets.

To examine in detail the portfolio allocation of the elderly, the present study employs the AHEAD database of households with at least one member aged 70 years or more. With the life expectancy of those having already attained the age of 70 continuing to increase, the AHEAD study is an ideal source of data with which to examine the behavior of this demographic group of increasing relative size.

## 2. Method

Empirical studies on relative risk aversion have employed a variety of formulations; the present work is patterned, with adaptation, after the previously mentioned research of Morin and Suarez (1983) and Bellante and Saba (1986). Both of those studies built their empirical models on the earlier theoretical formulation provided by Friend and Blume (1975), who model the choice between risky and riskless assets as:

$$\alpha = E(r_m - r_f)(\sigma_m^2)^{-1}[(1 - t)(1 - h)C]^{-1} - h(1 - h)^{-1}\beta_{h,m} \quad (1)$$

where:  $\alpha$  = the proportion of risky assets in the individual's asset portfolio,  $r_m$  = the rate of return on risky marketable assets,  $r_f$  = the rate of return on risk-free assets,  $E(r_m - r_f)$  = the expected difference between the rate of return on risky marketable assets and the rate of return on risk-free assets,  $\sigma_m^2$  = the variance of the market portfolio of risky assets,  $t$  = the effective tax rate of the individual,  $h$  = the ratio of the

<sup>4</sup> Cohn et al. (1975) also find that the proportion invested in risky assets tends to increase with age. Again, this result is generated by regression with a continuous age variable. The estimation of this coefficient also is overwhelmingly influenced by observations of younger individuals.

individual's human wealth to total net wealth,  $C$  = Pratt's (1964) measure of relative risk aversion, and  $\beta_{h,m}$  = the ratio of the covariance between  $r_m$  and  $r_h$  (the rate of return on human capital) to  $\sigma_m^2$ .

Liberman (1980) and Fama and Schwert (1977) have empirically shown that  $\beta_{h,m}$  is zero. Relying on this finding makes it possible to simplify Eq. (1). Since the ratio  $E(r_m - r_f)(\sigma_m^2)^{-1}$  is the equilibrium market price of risk, Eq. (1) further simplifies to:

$$(1 - t)(1 - h)\alpha = \text{MPR}/C \quad (2)$$

where MPR is the market price of risk.

In Pratt's measure of risk aversion,  $C$  is a function of net wealth,  $W$ . Hence, empirical estimates of the effect of changes in wealth on risk aversion are obtained as:

$$(1 - t)(1 - h)\alpha = f(W, V) \quad (3)$$

where  $V$  is a vector of variables that, in addition to wealth, influence portfolio allocation. For estimation purposes, the equation becomes:

$$(1 - t)(1 - h)\alpha = \beta_0 + \beta_1 \ln(W) + \beta_2 [\ln(W)]^2 + \beta_3 \text{AGE} \ln(W) + \beta_4 \text{SFEMALE} + \beta_5 \text{SMALE} \\ + \beta_6 \text{HEALTH} + \beta_7 \text{NON-WHITE} + \beta_8 \text{HS} + \beta_9 \text{COLLEGE} + \beta_{10} \text{KIDS} + \varepsilon \quad (4)$$

where:  $\beta_0$  = the intercept,  $\ln(W)$  and  $[\ln(W)]^2$  = the log of net wealth and the square of the log of net wealth, AGE = the household head's actual age minus 65, SFEMALE = a dummy variable equal to one for a one-person female household, SMALE = a dummy variable equal to one for a one-person male household,<sup>5</sup> HEALTH = a dummy variable equal to one if either the head or spouse identifies him/herself as in fair or poor health, NON-WHITE = a dummy variable equal to one if the race of the household head is non-White, HS = a dummy variable equal to one if the most highly educated member of the household is a high school graduate, but not a college graduate, COLLEGE = a dummy variable equal to one if the most highly educated member of the household is a graduate of a four-year college, KIDS = the number of children ever born to the head and/or spouse, and  $\varepsilon$  = an error term, assumed to be normally distributed.

According to the above formulation, relative risk aversion,  $d\alpha/dW$ , is itself a function of age and whether it is positive or negative depends on the value of  $[(\beta_1 + \beta_3 \text{AGE})\ln(W)] + \beta_2 [\ln(W)]^2$  at any particular values of AGE and  $W$ . Hence, no prediction is offered as to the signs of  $\beta_1$  and  $\beta_2$ . Variables reflecting age have been employed in previous studies to gauge life-cycle effects and, as previously noted, their findings are contradictory.<sup>6</sup> It is our maintained hypothesis that any factor, including age that would shorten the time horizon of an elderly individual would tend to decrease that individual's tendency to invest in risky assets. Thus, we expect the sign of the coefficient on AGE,  $\beta_3$ , to be negative, which would indicate that relative risk aversion increases with age.

<sup>5</sup> The omitted basis group is households consisting of a husband and wife.

<sup>6</sup> However, the difference between Bellante and Saba (1986) and Morin and Suarez (1983) might be explained by the fact that Bellante and Saba control separately for age and human capital, whereas Morin and Suarez control only for age and consider age to be a proxy for human capital.

In some previous studies, women have been found to be more risk averse than men. One study (Jianakoplos & Bernasek, 1998) focused specifically on gender differences in portfolio allocation. They found that single women were more risk averse than married couples, who in turn were more risk averse than single men. The variables SFEMALE and SMALE are employed to determine whether this result holds up for the elderly. In accordance with the Jianakoplos–Bernasek finding, we hypothesize that  $\beta_4$ , the coefficient of SFEMALE, will be negative and  $\beta_5$ , that of SMALE, will be positive.

The inclusion of the HS and COLLEGE variables stems from the belief that more educated individuals are likely to be better informed of the opportunities and vicissitudes relating to personal investment, and that this will tend to lower their aversion to risk. The coefficients on HS and COLLEGE,  $\beta_8$  and  $\beta_9$ , respectively, are then expected to be positive with  $\beta_9 > \beta_8$ .

The variable HEALTH is expected to affect behavior toward risk in much the same way as AGE, i.e., through its effect on the individual's subjective estimate of life expectancy. Since the variable indicates the presence of poor or fair health (in contrast to a self-assessment of good, very good, or excellent), the coefficient on HEALTH ( $\beta_6$ ) is expected to be negative.

The variable NON-WHITE is included to determine if there are significant racial differences, ceteris paribus, in attitudes toward financial risk. It is not immediately obvious what these differences should be expected to be; however, racial differences have been hypothesized and observed in saving behavior and wealth accumulation. Therefore, it seems reasonable to allow for the possibility of differences in relative risk aversion, particularly since participation in (and thus familiarity with) equity markets historically has been much more limited for non-Whites than for Whites. This lack of familiarity might make risky assets appear even more so, relative to riskless assets. Non-Whites might also tend to have less trust in securities and investments industries dominated by white males. Of note is a study by Straight (2002) which compares asset holdings of Whites and Blacks in 1998, using the Fed's *Survey of Consumer Finances*. He reports that among high-income, college-educated subjects, Whites had 63% of their assets in stocks, whereas Blacks had invested only 50%. However, given the significant differences in average income and wealth accumulation, even within this college-educated group, it is not clear that anything about racial differences in risk tolerance can be inferred from this observation.

In addition, for any given age, non-Whites have a lower life expectancy and this fact may shorten the time horizon of non-Whites beyond what is captured by the HEALTH or AGE variables. Consistent with our maintained hypothesis, the coefficient on NON-WHITE,  $\beta_7$ , is thus expected to be negative.

If members of an elderly household desire to leave an inheritance to their children, this bequest motive may serve to lengthen the investment time horizon (to include a consideration of the life span of offspring) and hence affect portfolio allocation. The variable KIDS is included to capture this effect.<sup>7</sup> Moreover, the existence of children may provide a safety net that mitigates the downside of undertaking risky investments and thus perhaps increasing, ceteris paribus, the willingness of elderly households to invest a greater proportion of their wealth in risky assets. Although the effect of HEALTH is expected to reinforce the effect of AGE, according to this reasoning, the effect of KIDS will have the opposite effect of HEALTH on risk avoidance and thus its coefficient  $\beta_{10}$  is expected to be positive.

<sup>7</sup> The effect of a bequest motive on asset accumulation has been extensively examined (e.g., Bernheim, Shleifer, & Summers, 1985), but not its effect on asset allocation. In the only portfolio allocation study of which we are aware that takes children into account, the results are mixed: For their broad sample, Jianakoplos and Bernasek (1998) find that the number of children is negatively associated with investment in risky assets for single women, but positively associated for single men and married couples.

### 3. Data

The sample used here is taken from the nationwide AHEAD (*Asset and Health Dynamics Among the Oldest Old*) study conducted by the University of Michigan Institute for Social Research (for an overview of the AHEAD Survey, see Hurd, Rogers, Soldo, & Wallace, 1994). The target population for the initial data collection was people born in 1923 or before (i.e., aged 70 and older) living in households in the United States in 1993–1994. African Americans were oversampled. If an individual was married or living with a partner, the partner was also included in the AHEAD database, regardless of age. Since the purpose of this study is to examine the behavior of the elderly, to minimize potentially distorting effects, couples with a spouse under 66 years of age were excluded. After also eliminating those households for which one or more relevant variables were missing, 4596 observations remained. Because some households are missing data for variables needed to estimate taxes, in the regressions reported below that employ a tax adjustment  $(1 - t)$  the sample size was further reduced to 4260.

In calculating  $\alpha$ , the denominator is total wealth including human capital whereas the numerator includes whatever are defined as risky assets. As pointed out in the Introduction, the question of whether relative risk aversion increases or decreases is quite sensitive to whether housing investment is counted as a risky asset. We would argue, however, that whatever case can be made for treating housing as a risky investment among younger households, a strong case can be made that the elderly view and treat housing as a riskless asset. First, the elderly who occupy their own homes are far more likely than younger cohorts to own these homes outright or carry relatively little mortgage debt. Hence, the risk to equity associated with real estate value fluctuations is not as great as for more leveraged younger cohorts. Second, the elderly are likely to see their relatively unleveraged housing investments as less subject to inflation risk than those assets such as bank accounts that are traditionally categorized as riskless assets. Third, and perhaps most important, the elderly are far more likely to see as the most significant return on their housing investment the housing services that flow from ownership rather than potential capital gains, and the value of these services is more stable relative to market values of housing.

To estimate  $t$ , the effective tax rate, we used the 1993 IRS tax schedule, as actual income taxes paid are not reported in the AHEAD data. However, we do know which households paid none. To generate estimates for those who did report paying taxes, we assumed that the standard deduction was used, and that married couples filed jointly.<sup>8</sup> If a respondent or spouse was blind, the number of deductions was adjusted accordingly. The total estimated income tax bill was divided by total income to arrive at an estimate of  $t$ . The ratio of human capital to total wealth,  $h$ , was calculated for households where the respondent or the spouse was currently employed. Human wealth is calculated as the discounted present value of estimated future earnings. Although previous studies have assumed that those younger than 65 years of age would work until 65, estimation of the work life of those over 65 is problematic. We assumed that those currently working who were between 66 and 69 years of age would continue to work four more years, that those 70 to 74 would work two more years, and that those over 74 would work one more year. This is the manner in which projected work life was handled by both Morin and Suarez (1983) and Bellante and Saba (1986). Future earnings were discounted at a rate of 5%. However, fewer than 9% of the households in the AHEAD sample have any labor income. For this group,  $1 - h$  averages .82; for the rest, it is equal to 1. Of the 462 households with one or more members in the labor force, both husband and

<sup>8</sup> Since mortgage interest usually figures largely in itemized tax returns, and since most of the elderly living in their own homes own them outright, this assumption of the use of the standard deduction does not seem unreasonable.

Table 1  
Variable means

Variable	Mean ( $n=4596$ )	Mean ( $n=4260$ )
$(1-t)$	0.982	0.982
$(1-h)$	0.982	0.981
Housing as a Riskless Asset		
$\alpha$	0.196	0.195
$(1-t)(1-h)\alpha$	0.176	0.176
Housing as a Risky Asset		
$\alpha$	0.668	0.667
$(1-t)(1-h)\alpha$	0.638	0.638
$H$	0.472	0.472
$(1-t)(1-h)H$	0.462	0.462
$W$	\$161,865	\$160,328
$\ln(W)$	10.886	10.846
$[\ln(W)]^2$	122.191	121.421
SFEMALE	0.491	0.495
SMALE	0.134	0.137
AGE-65	13.07	13.07
HEALTH	0.414	0.419
NON-WHITE	0.136	0.136
HS	0.477	0.474
COLLEGE	0.148	0.146
KIDS	2.608	2.646

wife worked in 80 of them. In this elderly sample then, the effects of human capital are likely to be inconsequential and not sensitive to the assumptions underlying its estimation.

Table 1 contains the mean values of all of the variables used in the study. Means are shown both for the larger sample and the smaller one in which the tax adjustment was employed. Note that the numbers reported in the means cells for the dichotomous variables (SFEMALE, SMALE, NON-WHITE, HS, COLLEGE, and HEALTH) are the proportions of the sample that fall in that category. Recall also that the AGE variable is not actual age, but age minus 65; hence the average actual age of individuals in both samples is 78.07. Several points are worth noting. For all variables, there are only small differences between mean values in the two samples. Although it is not entirely clear whether housing is properly considered a risky asset, many of the previously mentioned studies have considered it as such. The variable  $H$  is the percent of total net assets composed of the value of housing. As Table 1 illustrates, since housing makes up over 47% of total assets on average, its inclusion in risky assets dramatically raises the average value of  $\alpha$ . Note also that households headed by single females make up almost half of all elderly households in either sample.

#### 4. Results

Several alternative versions of Eq. (4) were estimated using ordinary least squares. These results are provided in Table 2. A negative coefficient on any variable indicates higher aversion to risk. The age and wealth effects on portfolio allocation will be discussed below.

Table 2  
Relative risk aversion regressions (*t* ratios in parentheses)

$$(1-t)(1-h)\alpha = \beta_0 + \beta_1 \ln(W) + \beta_2 [\ln(W)]^2 + \beta_3 \text{AGE} \ln(W) + \beta_4 \text{SFEMALE} + \beta_5 \text{SMALE} + \beta_6 \text{HEALTH} + \beta_7 \text{NON-WHITE} \\ + \beta_8 \text{HS} + \beta_9 \text{COLLEGE} + \beta_{10} \text{KIDS} + \varepsilon$$

Treatment of housing	Riskless asset				Risky asset	Percent of total assets
Equation	4.1	4.2	4.3	4.4	4.5	4.6
Dependent variable	$(1-t)(1-h)\alpha$	$\alpha$	$(1-t)\alpha$	$(1-h)\alpha$	$(1-t)(1-h)\alpha$	$(1-t)(1-h)H$
Coefficient						
$\beta_0$	0.5761 (9.92)	0.6541 (10.41)	0.5569 (8.93)	0.6689 (11.38)	-1.2307 (-16.22)	-1.8068 (-20.69)
$\beta_1$	-0.1526 (-12.69)	-0.1627 (-12.55)	-0.1368 (-10.60)	-0.1768 (-14.59)	0.2483 (15.81)	0.4009 (22.17)
$\beta_2$	0.0103 (16.47)	0.0109 (16.25)	0.0094 (13.96)	0.0117 (18.72)	-0.0066 (-8.06)	-0.0169 (-17.96)
$\beta_3$	-0.0001 (-1.69)*	-0.0002 (-3.94)	-0.0002 (-3.85)	-0.0001 (-1.84)*	-0.0004 (-5.39)	-0.0003 (-3.55)****
$\beta_4$	-0.0106 (-1.26) <sup>a</sup>	-0.0158 (-1.77)*	-0.0172 (-1.90)*	-0.0098 (-1.18) <sup>a</sup>	0.0078 (0.71) <sup>a</sup>	0.0184 (1.45) <sup>a</sup>
$\beta_5$	0.0030 (0.26) <sup>a</sup>	-0.0006 (-0.05) <sup>a</sup>	-0.0046 (-0.37) <sup>a</sup>	0.0049 (0.42) <sup>a</sup>	-0.0497 (-3.26)***	-0.0527 (-3.00)***
$\beta_6$	-0.0228 (-3.02)***	-0.0332 (-4.14)	-0.0310 (-3.83)	-0.0252 (-3.36)****	0.0438 (4.44)	0.0667 (5.87)
$\beta_7$	-0.0322 (-2.97)***	-0.0311 (-2.71)***	-0.0275 (-2.37)**	-0.0350 (-3.26)***	0.1629 (11.50)	0.1951 (11.96)
$\beta_8$	0.0486 (5.72)	0.0500 (5.57)	0.0493 (5.42)	0.0490 (5.84)	-0.0540 (-4.87)	-0.1025 (-8.04)
$\beta_9$	0.0859 (6.97)	0.1073 (8.28)	0.0964 (7.29)	0.0970 (8.01)	-0.0912 (-5.67)	-0.1771 (-9.56)
$\beta_{10}$	0.0005 (0.30) <sup>a</sup>	0.0001 (0.07) <sup>a</sup>	-0.0002 (-0.10) <sup>a</sup>	0.0006 (0.40) <sup>a</sup>	0.0115 (5.56)	0.0110 (4.63)
Adj. $R^2$	.24	.23	.20	.26	.36	.24
<i>n</i>	4260	4596	4260	4596	4260	4260

All coefficients are statistically significant at the .0001 level unless otherwise indicated.

<sup>a</sup> Not significant.

\* Statistically significant at the .10 level.

\*\* Statistically significant at the .05 level.

\*\*\* Statistically significant at the .01 level.

\*\*\*\* Statistically significant at the .001 level.

Since we have argued for exclusion of housing from the list of risky assets, our initial focus is on Eq. (4.1). All coefficients in 4.1 are statistically significant except for those for SFEMALE, SMALE, and KIDS. The independent variables collectively explain 24% of the variation in the adjusted ratio of risky to total assets,  $(1-t)(1-h)\alpha$ .

On the basis of previous research over the general population of investors, we had expected females to allocate less of their wealth and single males to devote more of their wealth to risky assets than would couples. Although the coefficients of SFEMALE and SMALE are of the predicted signs, in this



specification they are insignificant. There are many possible explanations for this result. One might be that an elderly single female is likely to be a widow who inherited a portfolio from a deceased husband and whose allocation preferences may have been “learned” from the deceased husband, or retained out of inertia.

In section 2 we argued that the presence of poor health would, perhaps among other effects, shorten the time horizon and thus affect behavior toward risk. The small negative but highly significant value of  $\beta_6$  suggests that poor health on the part of one or both elderly household members does in fact decrease the fraction of a portfolio that will be allocated to risky assets by about 2.28%.<sup>9</sup>

The negative value of  $\beta_7$  indicates that non-Whites invest 3.22% less in risky assets than do Whites. This finding too is in conformity with our prior tentative expectation.

The values of  $\beta_8$  and  $\beta_9$  together indicate that, ceteris paribus, high school graduates, as expected, exhibit a greater tendency to accept risk than those without a high school diploma, but a lesser tendency than those possessing a college degree. Thus, education and tolerance of risk seem to be positively associated, at least in this specification. Moreover, differences in education levels account for greater differences in portfolio allocation than any other categorical variables.

We speculated in section 2 that the existence of children would lengthen the planning horizon to the extent that the prospect of intergenerational transfers causes elderly households to take heirs’ lifetimes into account in their own portfolio allocations. Consequently, we expected the coefficient involving KIDS,  $\beta_{10}$ , to be positive. However, although  $\beta_{10}$  is positive, it is not significantly different from zero.

As for the age and wealth relationships with relative risk aversion, the negative coefficient on  $\text{AGE}\ln(W)$ ,  $\beta_3$ , indicates that relative risk aversion tends to increase with age at any given level of wealth. The negative sign on  $\beta_1$  combined with the positive sign on  $\beta_2$  demonstrate that the effect of wealth on risk aversion is nonlinear in the log of wealth. The question of whether and to what extent relative risk aversion increases or decreases, or possibly reverses sign, as mentioned previously, depends on the range of values for  $[(\beta_1 + \beta_3\text{AGE})\ln(W)] + \beta_2[\ln(W)]^2$  over the relevant range of values for AGE and  $W$ . The age–wealth relationship is best illustrated by simulating some values of  $(1 - t)(1 - h)\alpha$ . Table 3 provides such values for two age and three wealth categories. With housing treated as a riskless asset, at both 70 and 90 years of age,<sup>10</sup> relative risk aversion clearly decreases as wealth increases from US\$100,000 to 1,000,000. For both age categories, the fraction of the portfolio made up of risky assets approximately doubles.<sup>11</sup> However, the increase in risk aversion between 70 and 90 years of age is quite small, despite the statistical significance of  $\beta_3$ . Again, the confounding effects of age on health may bias somewhat toward zero the simulated effect of age on relative risk aversion.

The estimates of  $h$  and  $t$  were not precise. As previously mentioned, the AHEAD survey does not contain data on taxes paid, so  $t$  had to be estimated on the basis of the assumption that each elderly household used the standard deduction. Similarly, in calculating  $h$ , the percentage of wealth composed of human capital, quite arbitrary assumptions about remaining work life had to be employed. However, since as Table 1 indicates, the average estimated values of both  $t$  and  $h$  were quite small, the adjusted value of  $\alpha$ ,

<sup>9</sup> One problem with the specification of our equations is that health and age are not independent; health tends to deteriorate with age. Thus, our health variable may be capturing part of the effect of age, to the extent that age and health are causally related.

<sup>10</sup> Less than 3.5% of households had a member more than 90 years of age.

<sup>11</sup> At the mean age of the sample, simulated relative risk aversion decreases for all wealth levels in excess of US\$1764, indicating that over the range of wealth that includes almost our entire sample of elderly, relative risk aversion decreases in the log of wealth.

Table 3

Predicted values of adjusted  $\alpha$  (assumptions: Single Female, White, College Graduate, Good, Very Good or Excellent Health, One Child)

Age	Net wealth (US\$)		
	100,000	500,000	1,000,000
<i>Housing as a riskless asset</i>			
70	0.255	0.416	0.503
90	0.231	0.390	0.475
<i>Housing as a risky asset</i>			
70	0.658	0.793	0.840
90	0.566	0.688	0.730
<i>Housing as a percent of total assets</i>			
70	0.404	0.376	0.338
90	0.335	0.298	0.255

that is  $(1 - t)(1 - h)\alpha$ , is not much different than its unadjusted value, on average. To illustrate the unimportance of the tax and human capital adjustments to  $\alpha$  among this age group, three alternative specifications of the dependent variable also are shown in Table 2—Eqs. 4.2, 4.3, and 4.4. Note that none of the coefficients vary dramatically across specifications. The adjusted  $R^2$  also is only modestly affected by the particular specification of the dependent variable. Given that  $1 - h$  and  $1 - t$  are both, on average, about .98 (with standard deviations of .10 and .04, respectively) among these elderly households, the unimportance of these adjustments are not surprising. In contrast, previous studies over a much broader age range, the samples of which exhibited much greater variation in  $h$  and in  $t$ , have found that these adjustments do materially alter the quantitative results and sometimes the qualitative conclusions.<sup>12</sup> To the extent that one is concerned with the risk behavior of the elderly, the unimportance of tax and human capital adjustments is reassuring, as it suggests that researchers can have confidence in results obtained from data sources that do not contain information on human capital and/or effective tax rates.

We have argued that, at least among the elderly, housing should not be considered a risky asset. However, since a majority of previous studies have treated housing as risky, we have for comparative purposes reestimated Eq. (4.1) with housing treated as a risky asset. The result is reported as Eq. (4.5) in Table 2. As in Eq. (4.1), the coefficients on wealth and its square demonstrate nonlinearity in the log of wealth, although the signs of  $\beta_1$  and  $\beta_2$  are reversed. In both versions, the coefficient  $\beta_3$  is consistent with relative risk aversion increasing with age, although much more so when housing is considered a risky asset.

Except for  $\beta_{10}$ , the remaining coefficients in Eq. (4.5) are contrary to our expectations as well as to our results in Eq. (4.1). Specifically, the results of Eq. (4.5) suggest that, holding wealth constant, risk aversion decreases with fair or poor health, is lesser for non-Whites than for Whites, and increases with higher levels of education. They also suggest that single males are more risk averse than both single females and couples. All of these are contrary to our predictions and most are inconsistent with our maintained hypothesis that any factor that decreases the expected time horizon will increase risk aversion.

<sup>12</sup> The studies referred to are the previously mentioned works of Friend and Blume (1975), Morin and Suarez (1983), and Bellante and Saba (1986).

The one that is consistent is  $\beta_{10}$ , the coefficient involving the number of children. Although this coefficient was not significant in Eq. (4.1), it is positive and highly significant in Eq. (4.5). Note also that the  $R^2$  of Eq. (4.5) is substantially higher than that of Eq. (4.1).

Although we conclude that Eq. (4.1) is the more reliable version because of its consistency with our prior logic, the reader may be unconvinced by our argument since its  $R^2$  is considerably lower than that of Eq. (4.5). It should be noted, however, that the difference in the definition and hence measurement of  $\alpha$  renders the  $R^2$  of the two equations noncomparable. Furthermore, we would argue that even the result with regard to KIDS in Eq. (4.5) may be misleading, as it is due to the effect of the number of children on housing wealth. To illustrate this, we have estimated another equation (Eq. (4.6)), in which the dependent variable is the value of the home as a percent of net wealth,  $H$ , with the same tax and human capital adjustments as were employed in Eqs. (4.1) and (4.5). Note that the dependent variable of Eq. (4.1) is equal to Eq. (4.5)'s  $(1-t)(1-h)\alpha$  minus  $(1-t)(1-h)H$  from Eq. (4.6). Thus, each  $\beta_i$  in Eq. (4.6) is equal, except for rounding error, to its value in Eq. (4.5) minus its value in Eq. (4.1). In Eq. (4.6), with  $\beta_1$  positive and  $\beta_2$  negative, the percent of wealth composed of home value increases only up to about US\$138,458 of wealth and decreases thereafter for those at age 70. For those at the mean age and at age 90, the turning points are US\$126,114 and 115,832, respectively. This result is not at all surprising, nor, for that matter, are the findings with respect to any of the other variables. But this result does illustrate that it is the behavior of elderly households with respect to housing that in large measure drives the results of Eq. (4.5). Eq. (4.6) also shows why the coefficient involving KIDS,  $\beta_{10}$ , is insignificant in Eq. (4.1). The coefficient  $\beta_{10}$  is virtually identical in Eqs. (4.5) and (4.6). This implies that, when housing is defined as risky, the only effect of additional children on the holding of risky assets comes from the effect of children on the value of the home. Of course it is easy to hypothesize reasons for the connection between number of children and housing investment. For one, the perceived currently optimal home size may take into account the actual or hoped-for “visits from the kids.” For another, a greater current housing investment associated with a greater number of children may reflect a past necessity of housing those children combined with heavy transactions costs impeding the movement from past housing investment to what might be currently optimal in the absence of such costs.<sup>13</sup>

The question of how seriously estimates of relative risk aversion are affected by the treatment of housing can be examined more precisely with the help of simulations provided in Table 3. Clearly, relative risk aversion decreases across the wealth groups examined regardless of whether housing is treated as a risky or riskless asset. However, relative risk aversion decreases (i.e., investment in “risky” assets increases) much more rapidly when the home is treated as a riskless asset. Conversely, although in both treatments of housing relative risk aversion increases with age, it increases considerably more rapidly when housing is treated as a risky asset since housing as a percent of wealth tends to decrease with age.

In interpreting these results, a caveat is in order. Either explicitly or implicitly, previous studies have tended to treat the innate risk aversion characteristic of utility functions as derivable from actual portfolio allocation. Neither their empirical results nor ours measure the pure psychological tendencies of wealth holders but rather their revealed preferences, i.e., their (possibly) constrained behavior toward risk. For one example, Blacks may face institutional constraints in housing investment (Charles & Hurst, 2002). For another, fixed costs of entry into asset markets rather than psychological attitudes toward risk may explain some of the empirical wealth–risk relationship (Vissing-Jørgensen, 2002).

<sup>13</sup> Besides the usual relocation costs, these would include psychic costs such as those of breaking existing neighborhood-related social networks and establishing new ones, something that might be particularly costly among the elderly.

## 5. Conclusion

This study has examined relative risk aversion in portfolio allocation decisions among the elderly population. We find clear support for the postulate of decreasing relative risk aversion among the elderly. However, there is equally clear evidence that relative risk aversion increases modestly as the elderly grow older. In contrast to previous studies, these two qualitative findings are not sensitive to changes in the treatment of housing. The previously mentioned study by Siegel and Hoban (1982), for example, when treating housing as riskless finds strong evidence for increasing relative risk aversion. Our evidence suggests that this finding does not generalize to the elderly population.

The personal characteristics of race, education, health status, and the number of children significantly affected portfolio allocation. However, the directions of these effects were in fact sensitive to the treatment of housing. We have argued that, particularly among the elderly, housing should be treated as a riskless asset and probably is largely regarded as such by the elderly themselves. We found that the signs of the coefficients related to these variables conformed to a priori expectations when housing was considered a riskless asset, but otherwise did not conform. Readers can decide for themselves whether conformity to expectations is sufficient reason for preferring one specification to another.

Research into all aspects of the elderly population has of late become a growth industry. The aging of the population has led to often-stated concern about the effects of this demographic transition both on national savings in general and on the projected insolvency of the Social Security system. Of lesser urgency but still of considerable interest is the effect of this demographic transition on returns in securities markets. It has been argued that as baby boomers reach retirement age, dissolution of their portfolios will result in a dramatic lowering of the return on risky assets. First, and contrary to the life-cycle hypothesis, there is a lack of evidence that the elderly substantially decrease their total wealth in old age (Hurd, 1990). Second, on the question of a shift away from risky assets affecting security returns, there is no agreement. Able (2001) presents the argument for a substantial depressing effect of the baby-boom cohort on asset returns, whereas Poterba (2001) finds little empirical support for this hypothesized demographic relationship to market returns.<sup>14</sup> Our own results tentatively suggest that concern for a securities market “meltdown” may be grossly exaggerated, since as retirees age, they do not seem greatly inclined to sell off their risky assets. If one is interested in speculations about possible effects of an aging population on securities markets, then our specification that treats housing as riskless is the one to examine. As Table 3 indicates, going from 70 to 90 years of age may statistically significantly reduce the fraction of nonhousing wealth held as risky assets, but the magnitude of the reduction is trivial. A shift between ages 70 and 90 of less than 3% cannot conceivably have a material effect on securities prices. Moreover, when the baby boomers and later generations retire, they will be substantially more educated than those sampled in the present study. Given our finding of a greater tendency of the more educated to invest in risky securities in old age, there is one more reason to suspect that concerns for a dramatic shift in the market returns to risky assets may be unwarranted. Nonetheless, the increasing size and importance of this demographic group suggest that their financial behavior will be a worthy subject for continuing research.

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<sup>14</sup> Brooks (2002) reviews these arguments and puts this argument in the context of “who should pay” for Social Security reform in a potential shift toward a securities component to Social Security.

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