RISKY INVESTMENT DECISIONS OF THE ELDERLY

by

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Abstract

This paper analyzes the risky investment decisions of the elderly in the United States. Utilizing the Health and Retirement Study data for 2002-2008, I first examine the effects of different factors on risky asset ownership employing the Heckman's two-step model. I then investigate the existence of a causal relationship between health and wealth using the instrumental variable method. I discover that the incentives generated by the U.S. pension system are of paramount importance for the risky asset investment behavior of the elderly. Those covered by private pension plans, in particular a defined contribution plan, are found to be more prone to risk taking. The effect of retirement on risky asset ownership varies by wealth with the wealthy elderly investing more in risky assets when they retire. The bequest motive, measured by number of kids, is found to decrease the investment in risky assets at the intensive margin for both singles and couples. Yet the elderly couples having kids are found to be more likely to invest in risky assets at the extensive margin. I additionally find that wealth has a sizeable positive effect on the health of the elderly.

1 Introduction

Planning retirement in advance is the key to afford a comfortable living at older ages. Choosing the right mix of risky and non-risky assets according to one's level of risk aversion is an essential part of the planning. Since the degree of risk aversion might change as one gets closer to retirement age, due to the expected loss of a continuous stream of labor income, it is natural to expect to see changes in investment portfolios of the elderly. The data show that only about half of the Americans aged over 50 have stocks, mutual funds, or investment trusts in their portfolios. Among those the average and median of risky asset holdings are around 179,000 and 51,000 USD for non-cohabiting singles and 256,000 and 82,000 USD for couples.

Analyzing the risky asset holdings of the elderly requires modelling the incentives brought about by the Social Security program and private pensions. The normal retirement age in the U.S. is currently 66 years and 10 months. The elderly are allowed to start collecting their Social Security benefits as early as 62. Considering the time left to normal retirement age, amount of benefits is reduced by 5/9 of one percent every month for up to 36 months and by 5/12 of one percent for every month beyond that. The elderly also have the option to delay collecting their Social Security benefits. In this case, benefits are increased by 2/3 of one percent for each month until age 70. These benefit adjustments are indeed actuarially fair for those having average life expectancy and as such do not cause any (dis)incentive to start collecting retirement benefits at a given age. On the other hand the elderly having higher (lower) than average health expectancy are better off to start collecting their Social Security benefits after (before) the normal retirement age.

The individual health insurance premiums are considerably expensive in the United States. As a result the health insurance coverage is employment based for most of the elderly until they become eligible for Medicare, the federal health insurance program, at age 65, contingent on having a minimum of 10 years of work history. In other words the health insurance system provides incentives for the

elderly to stay in the labor force until 65.

There are two types of private pension plans in the United States: defined benefit (DB) and defined contribution (DC). DB plans are in many ways similar to public pension: They usually have an early retirement age (60 or 62) and a normal retirement age (typically, 65). Yet, DB plans have no delayed retirement credit. Since one cannot collect DB benefits while working in the same workplace, these plans incentivize many workers to retire by the normal retirement age (Blundell et al., 2016). On the other hand, DC plans are based on employee contributions that are fully or partly matched by employers, encouraging employees to make active retirement choices. It is then possible to argue that workers having a DC plan have incentives to retire later in order to collect the matched contributions for a longer period. The degree of this incentive in turn depends on the life expectancy, or in other words, for how many years a worker expect to collect benefits. The minimum withdrawal age for DC plans is usually 59.5, and withdrawals are mandatory after 70.5. DC plans also typically offer a menu of default investment options, many of which involve some investment in risky assets. Most members opt to follow one of these options rather than setting up their own portfolio.

Investment portfolios of the elderly also depend on a host of other factors. Vega and Velli (2020) document that people having poor health or relatively lower net worth invest less in risky assets. Educated people, especially those with financial knowledge and literacy, are more likely to have risky asset holdings (Christelis et al., 2010; Neumuller et al., 2017). The risky investment behavior of the elderly may also vary depending on whether they have a bequest motive (Inkmann et al., 2011).

This paper analyzes the relationship between risky asset ownership and retirement decision, paying attention to the incentives brought about by the pension system in the United States, utilizing the Health and Retirement Study. Considering amendments in Social Security rules in 2000 and the Great Recession, I limit the period under consideration to 2002-2008. Firstly, this study is useful to understand

the retirement preparedness through asset allocation, which is a function of age, labor force status, wealth, health, and other factors. Secondly, this study is of interest to policymakers to determine whether the government should sustain the pay-as-you-go Social Security system, providing below market rates of return depending on the number and income of the current and future workers. In this system the burden of unfunded liabilities is passed on from previous to future generations. The increase in life expectancy and decrease in fertility rates over the time, causing the retired to worker ratio to increase dramatically, has put an enormous strain on the Social Security budget. Thirdly, this study helps to understand the contribution of the elderly to the capital stock of the economy, which in turn stimulates long-term economic growth. Fourthly, this study contributes to the understanding of the causes of rising income and wealth inequality among the elderly. Tischbirek (2019) discovers that early stock market participants gain advantages over late ones due to the market structure and information asymmetries. In addition the wealthy tend to invest more, leading to an even wider gap in the distribution of income and wealth. Lastly, constituting nearly one-fifth of the adult population, investment decisions of the elderly influence aggregate marginal propensity to consume, which is used to measure the effects of various macroeconomic policies.

I utilize Heckman's two-step method to empirically estimate the determinants of risky asset holdings. The dummy variable indicating whether the longest job tenure is in the FIRE (finance, insurance, real estate) industry serves as the exclusion restriction. Since couples enjoy leisure complementarity and have a shared budget constraint, I conduct separate analyses for non-cohabiting singles and couples. I further examine the health-wealth gradient using an IV Ordered Probit model. To account for the possible endogeneity of wealth, I use inheritance as an instrumental variable. Considering that a significant proportion of the elderly return to work after being non-participants for a while, which makes the term "retirement" vague, I define non-participants as retired (Yavuzoglu, 2018).

My estimates suggest that the elderly aged 65-75 invest less in risky assets both at the extensive and intensive margins. This finding might be explained via three channels: (i) the incentives brought about by the Social Security system; (ii) cohort-based differences in risky asset ownership; (iii) decrease in overall health capital left unaccounted for by the subjective health measures utilized in this study. The likelihood of risky asset investment is estimated to be higher by about 30 percentage points for the elderly covered by a DC plan. A positive correlation is also observed at the intensive margin: The elderly with DC plan coverage invest around 10 percent more in proportion to their wealth. These findings suggest that a DC based pension system would substantially increase the investment in the capital stock of the economy, contributing to economic growth. DB plan coverage, on the other hand, affect the risky asset investment decision only at the extensive margin with an estimated increase in the likelihood of risky asset investment of around 10 (4) percentage points for singles (couples). Retirement decision is found to alter the risky asset investment behavior depending on wealth: While the wealthy elderly are more likely to invest in risky assets and invest a larger portion of their wealth when they retire, the opposite holds true for the elderly having a limited amount of wealth. I further discover that a 10 percent increase in wealth increases the probability of risky asset investment by around 1 percentage point. Yet, wealth does not seem to affect the amount of stock holdings at the intensive margin. Health is also found to be positively associated with risky asset ownership at the extensive margin. Additionally, healthy couples, unlike singles, invest a larger share of their wealth into risky assets at the intensive margin. The estimates also suggest a positive relationship between education and risky portfolio choice highlighting the role of financial sophistication. It is also found that females, blacks, and other racial minorities are less likely to invest in risky assets with the same being true for couples with a self-employed partner. The bequest motive, measured by number of kids, is estimated to have different implications depending on cohabitation status: While

the elderly couples having two to four children are about 4 percentage points more likely to invest in risky assets, the ratio of risky assets to net wealth is found to be lower by around 0.04 and 0.03 for singles and couples who have kids, and risky assets in their portfolio. I additionally find that a 10 percent increase in wealth increases the probability of having good health by around 1 percentage point, which confirms the existence of the health-wealth gradient for the elderly.

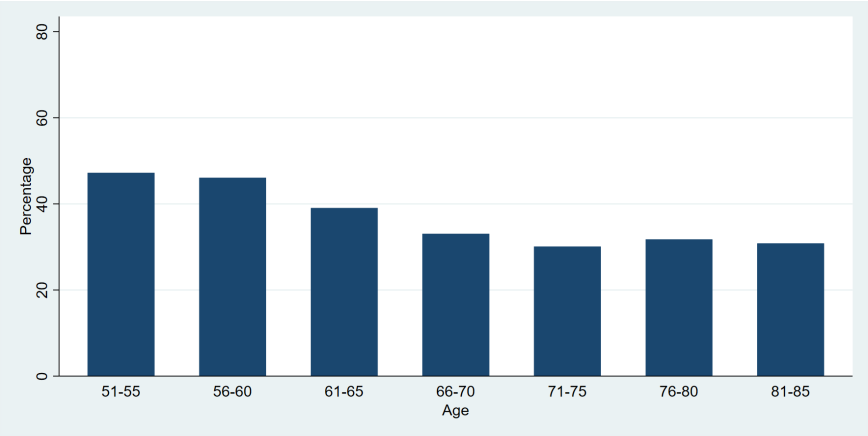
The paper proceeds as follows. Section 2 provides various graphs summarizing the risky asset investment behavior observed in the data. Section 3 presents the recent literature on risky asset ownership. Section 4 introduces the dataset, presents the descriptive statistics, and provides the techniques used to impute the amount of risky assets in pension plans for some of the observations. Sections 5 and 6 present the empirical methodology and estimation results. Section 7 concludes.

2 Background

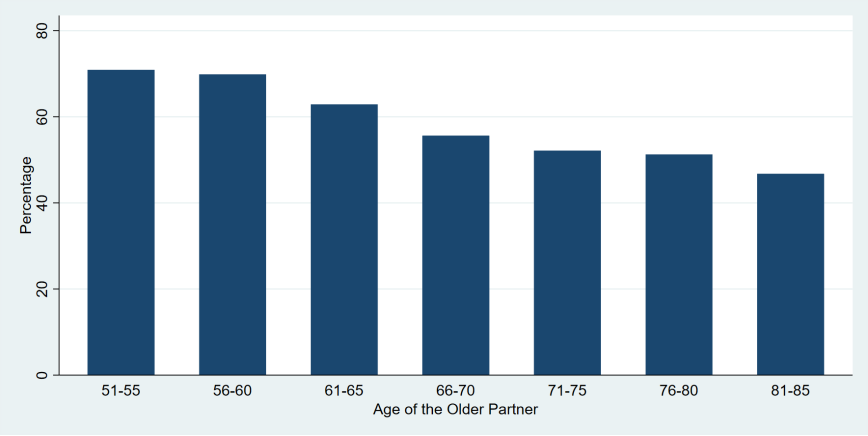
In this section, I provide various graphs depicting the risky asset investment behavior observed in the data by age, health, wealth, and time to retirement. I measure risky asset holdings as the sum of stocks in pension plans (401-k, ESOP, SRA, TSP, 403-b, profit sharing, money purchase, and cash balance plans), IRA and/or Keogh accounts, and the net value of other stock, mutual fund, and investment trust holdings. I respectively refer to them as pension stocks, IRA stocks, and bank stocks. Net wealth is the sum of all components of wealth, including secondary residence, minus debt. Net home is the value of the primary residence less mortgage loans. I utilize the last two terms to analyze the investment decision in risky assets proportional to different measures of wealth. I provide separate graphs for non-cohabiting singles and couples throughout this section. Note that couple observations are at the household level (composed of two partners), and the age of the older partner is utilized in the relevant graphs.

Figure 1 shows that the percentage of elderly having risky assets in their portfolio decrease over time. It is also apparent that a higher proportion of couples invest in risky assets. Figure 2 shows the average ratios of risky asset holdings to net wealth, and net wealth minus net home for those having risky assets. First, the qualitative findings do not differ depending on which wealth measure is utilized. I, therefore, consider only net wealth in the rest of the graphs presented in this section. Second, for those investing in risky assets, the average ratio of risky asset holdings proportional to wealth remain more or less the same until age 75 followed by an increase. This behavior might be due to the differential mortality rates.

Figure 1: Percentage of Elderly Having Risky Assets, by Age



(a) Singles

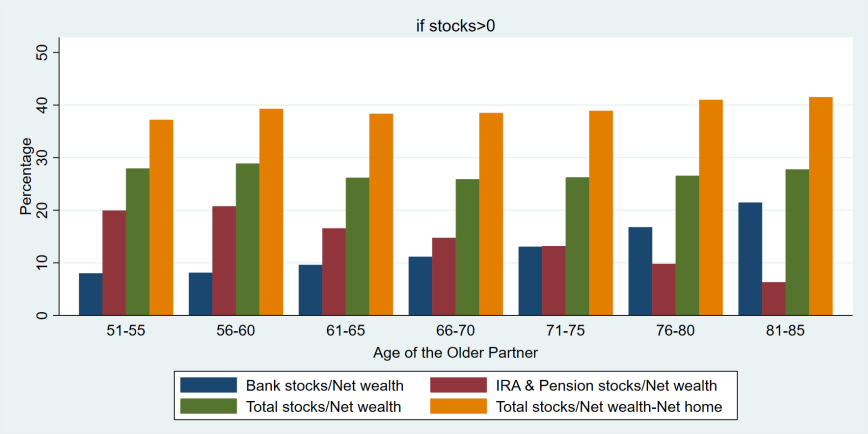


(b) Couples

Source: Health and Retirement Study

Figure 2: Average Ratio of Risky Asset Holdings (if> 0) to Net Wealth, by Age

(a) Singles

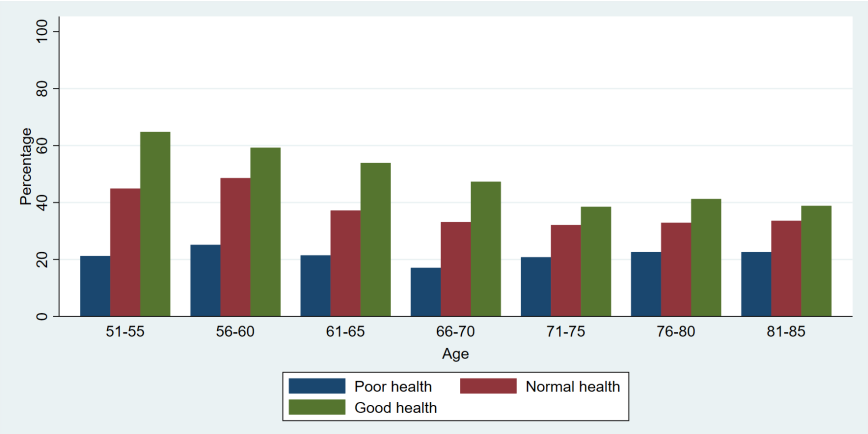


(b) Couples

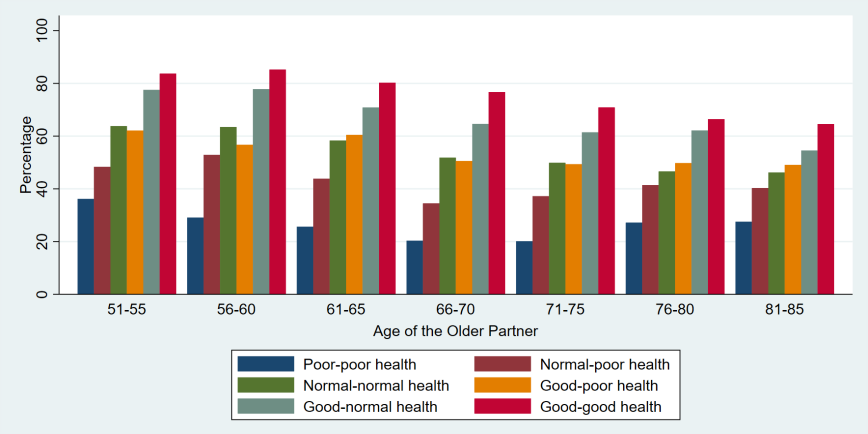
Source: Health and Retirement Study

HRS has 5 self-reported health categories. I define the worst two categories as poor health, the best two as good health, and the middle one as normal health. Accordingly there are 6 health categories for couples based on the health status of each partner: good-good, good-normal, good-poor, normal-normal, normal-poor, poor-poor. Figure 3 reveals that the main effect of health on risky asset ownership is observed at the extensive margin: The elderly having better health are more likely to have risky assets. The risky asset holding probability decreases for those having good or normal health until age 75 except that it continues to decrease beyond this age for couples having good-good health. For singles having poor health and also

Figure 3: Percentage of Elderly Having Risky Assets, by Health and Age



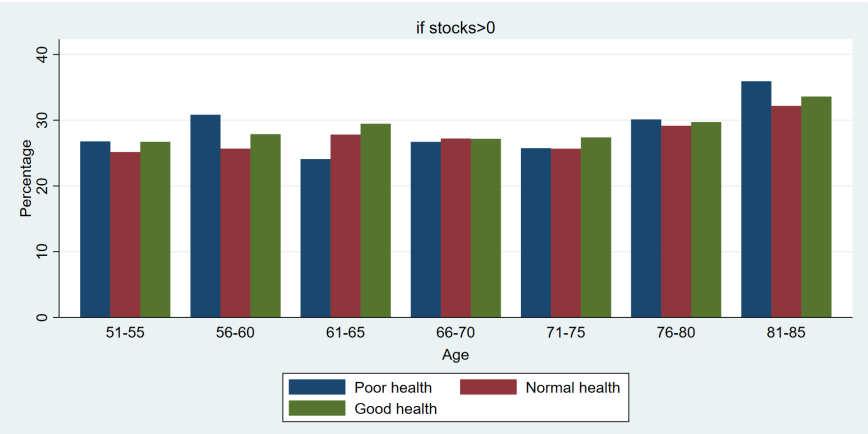
(a) Singles



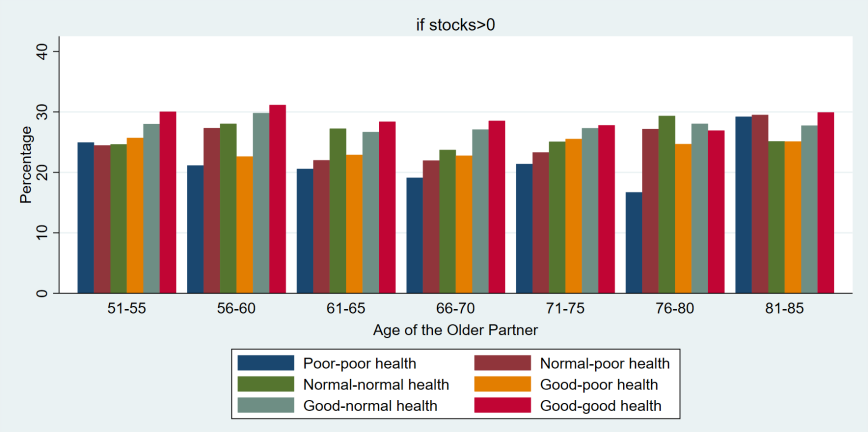
(b) Couples

Source: Health and Retirement Study

Figure 4: Average Ratio of Risky Asset Holdings (if> 0) to Net Wealth, by Health and Age



(a) Singles



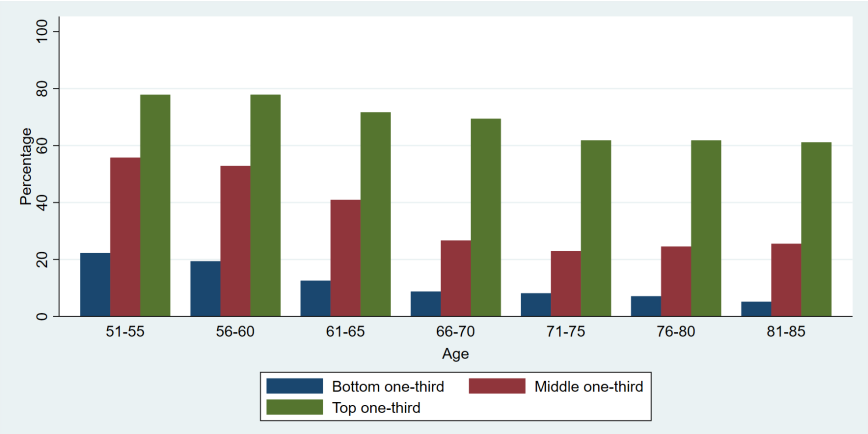
(b) Couples

Source: Health and Retirement Study

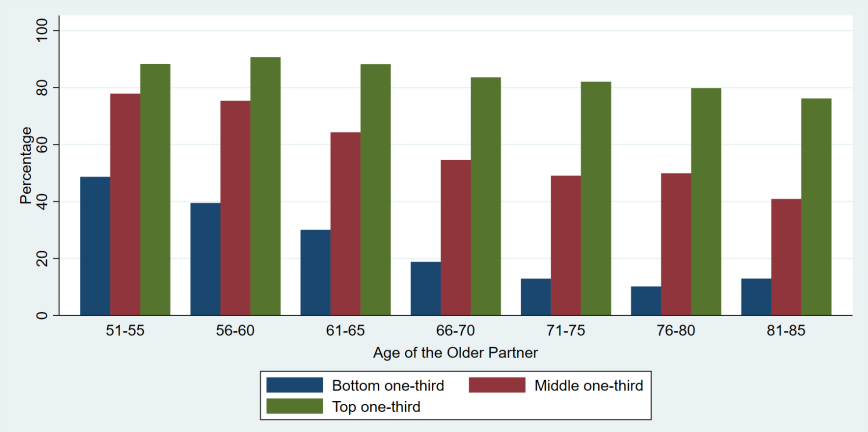
couples having poor-poor/normal-poor health the relationship is found to be U-shaped, with its minimum observed at around age 70. Figure 4 shows that for singles, once age is controlled, health does not seem to alter the relative size of risky asset holdings to net wealth. Yet, this does not generalize to couples. Couples with good-good or good-normal health invest a larger share of their net wealth into risky assets. The increase observed at the intensive margin after age 75 when data are aggregated only by age seems to be mainly driven by the behavior of respondents having poor health status.

To analyze the effects of wealth, by age, on risky asset ownership, I utilize the tertiles of the net wealth distribution. The respondents having net wealth of $60,000 or less fall into the bottom tertile, $60,000 to $220,000 to the middle tertile, and over $220,000 to the top tertile. Since couples are composed of two partners the relevant tertiles for them are double of the provided statistics. Figure 5 shows that wealth and probability to invest in risky assets are positively associated. The percentage of those investing in risky assets, regardless of their level of net wealth, decrease until age 75, then remain relatively stable. Figure 6 depicts that respondents at the top one-third of the net wealth distribution invest a higher share of their wealth in risky assets compared to those in the middle one-third of the net wealth distribution. The behavior of the respondents at the bottom tercile of income distribution differs

Figure 5: Percentage of Elderly Having Risky Assets, by Net Wealth and Age



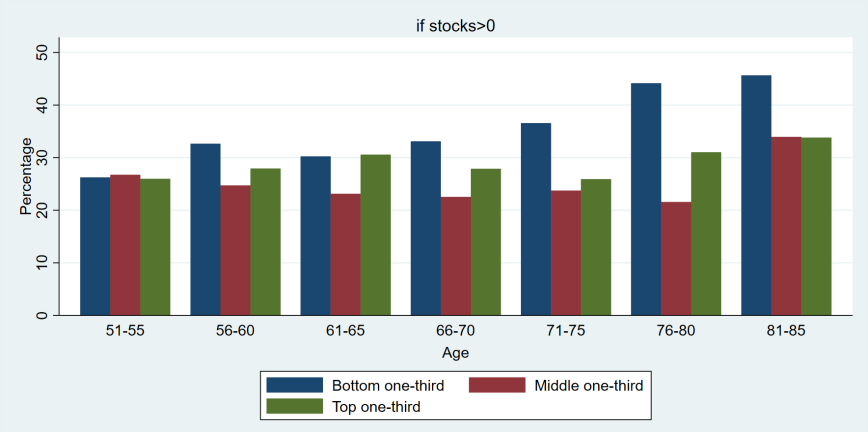
(a) Singles



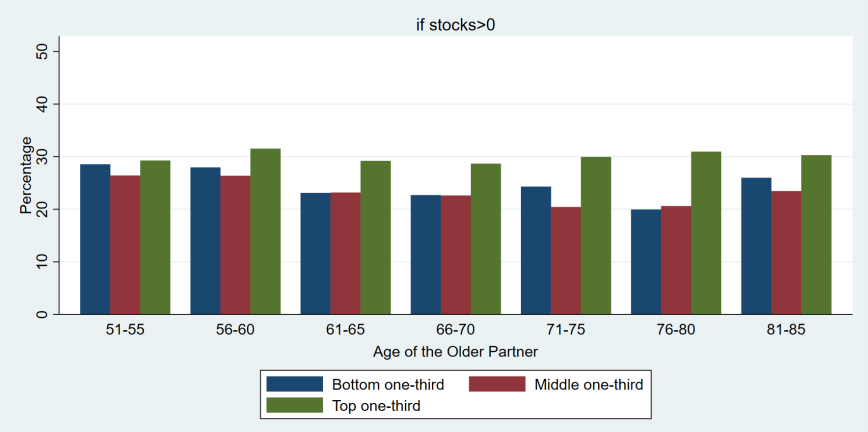
(b) Couples

Source: Health and Retirement Study

Figure 6: Average Ratio of Risky Asset Holdings (if> 0) to Net Wealth, by Net Wealth and Age



(a) Singles



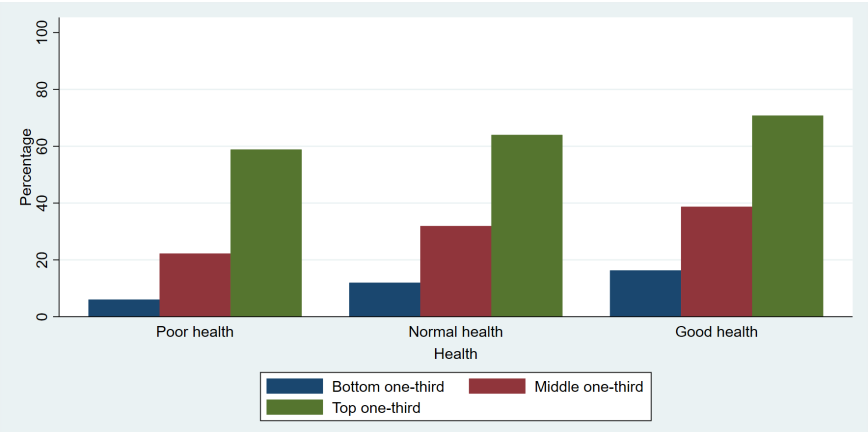
(b) Couples

Source: Health and Retirement Study

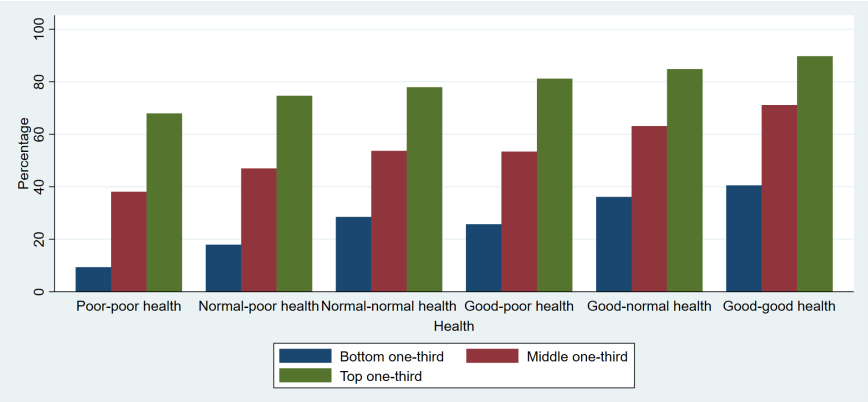
significantly by cohabitation status: while the limited number of singles having risky assets in their portfolio invest proportionately the most, the risky asset investment behavior of couples, proportional to their wealth, resembles to those in the middle one-third of income distribution.

I next analyze the effects of health and wealth, jointly, on risky asset ownership. Figure 7 demonstrates that both better health and wealth are associated with a higher probability of investment in risky assets at the extensive margin. Notably the role of wealth is observed to be significantly larger than the role of health. Figure 8 shows that once wealth is controlled the risky asset investment behavior

Figure 7: Percentage of Elderly Having Risky Assets, by Health and Net Wealth



(a) Singles

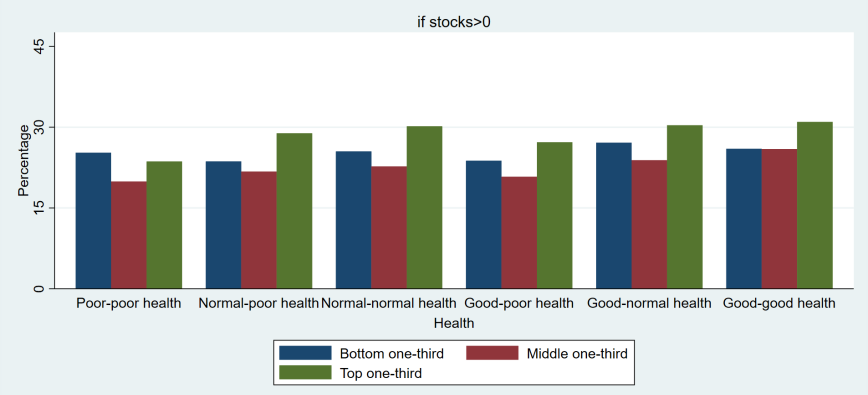


(b) Couples

Source: Health and Retirement Study

Figure 8: Average Ratio of Risky Asset Holdings (if> 0) to Net Wealth, by Health and Net Wealth

(a) Singles



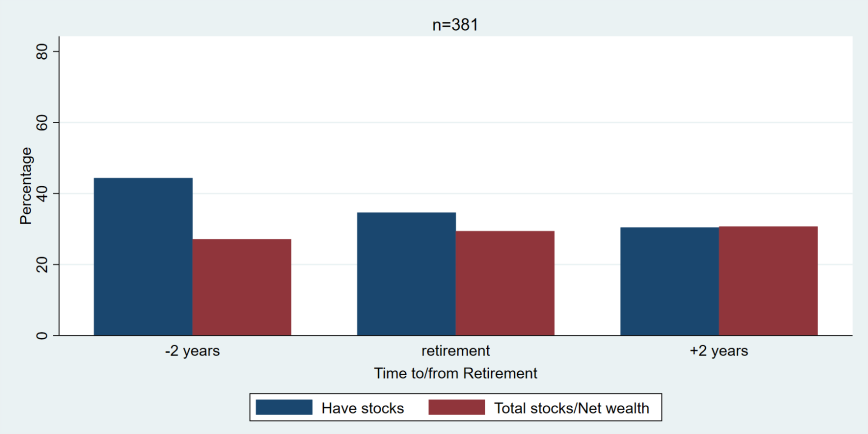
(b) Couples

Source: Health and Retirement Study

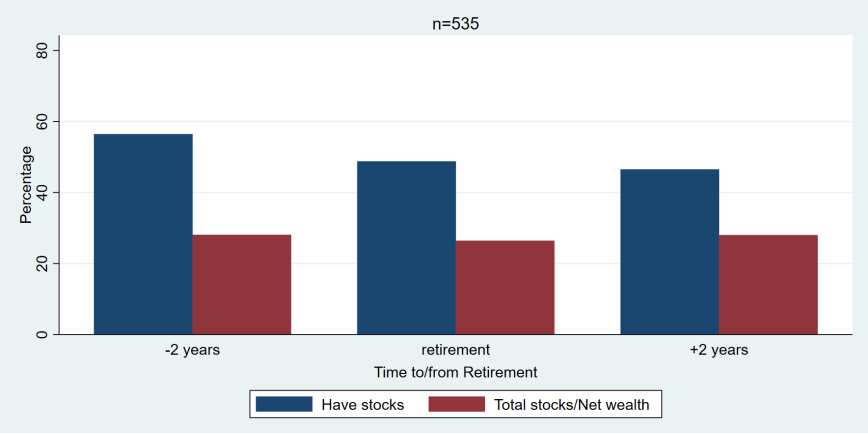
at the intensive margin does not change with health for singles in all health categories and for couples having normal-poor, normal-normal, and good-poor health. While couples with above average health invest in stocks proportionally slightly more, the opposite is true for couples having poor-poor health.

The last figure depicts average changes in risky asset ownership by the time of retirement, defined as being out of the labor force as mentioned earlier. The percentage of elderly having risky assets in their portfolio decrease upon retirement, then do not change much over the next two years. Yet the average share of risky assets is not altered by the retirement status for those who continue to invest.

Figure 9: Percentage of Elderly Having Risky Assets and Average Ratio of Risky Asset Holdings (if> 0) to Net Wealth, by Time to/from Retirement



(a) Singles



(b) Couples

Source: Health and Retirement Study

3 Literature review

Choosing the right investment strategy is crucial to prepare for retirement. The chosen investment strategy should ensure a stable income, and the resources accumulated for retirement should not be exhausted too soon. Crawford and O'Dea (2020), utilizing heterogeneous discount factors for households and tying them to replacement rates out of average lifetime income, find that most of the British aged 50 or over have high replacement rates. In other words, they are well-prepared for retirement. Scholz et al. (2006), using a single asset life-cycle model with a homogeneous discount rate, find a similar result: only less than 20% of Americans have accumulated less wealth than their optimal target, calculated using how much they should have saved given their life cycle problem. Additionally the wealth deficits for the majority of those who undersaved are observed to be small.

Rust and Phelan (1997) find that SS rules have important implications on retirement behavior, especially for those who are financially constrained and do not have access to health insurance. Blundell et al. (2016) discuss that DB plans, which are prevalent among the elderly workers, encourage them to retire at specific ages.

Alan (2006) shows that there is an entry cost, defined as the time it takes to learn about the stock market, that limits stock market participation. Entry costs discourage small investors, making it not beneficial for them to own risky assets. This partly explains the relationship between wealth distribution and risky assets observed in the data. Gomes and Michaelides (2003) find that people are more willing to pay the entry cost and participate in the stock market in the early years of their working life rather than when they are close to retirement age. Tischbirek (2019) demonstrates that people who participate in the stock market from an early age accumulate wealth faster, which contributes to wealth inequality with age.

There are many studies attempting to explain portfolio choice of the elderly based on different factors. Brunetti and Toricelli (2006) find a direct relationship between a person's investment portfolio and his age: young people invest in riskier

assets while the elderly prefer to receive guaranteed income from non-risky assets such as government bonds or real estate. Ameriks and Zeldes (2004), considering the age group 55-70, find evidence for a gradual reduction in the probability of investing in risky assets but the average share of risky assets to wealth conditional on ownership with age. These findings are in line with what I discover in Section 2. Christelis et al. (2010) link the risky asset investment behavior of the elderly not only to their age, but also to the level of financial literacy and cognitive abilities. Neumuller and Rothschild (2017) show that financial sophistication greatly affects wealth inequality over the life cycle. Unsophisticated people, having lower returns on risky assets, invest less both at the extensive (stock market participation) and intensive (share of risky assets) margins. As a result, they accumulate less wealth by the time they retire. Pistaferri et al. (2020) find that there is a significant heterogeneity in returns to wealth that depend on not only the portfolio choice between risky and safe assets but also on household characteristics including type and length of educational attainment as measures of financial sophistication. This is an area that cannot be explored with the HRS data since it is not possible to recover the returns on households' portfolio choices.

Inkmann et al. (2011) find that a bequest motive generates balanced portfolios even at retirement, since it breaks the decumulation of financial wealth. This effect is stronger for the married considering a possible bequest motive for the surviving spouses. Arano et al. (2010) find that women in marriage are more risk averse than their spouses, which influences the decision to invest in risky assets.

There is a growing literature on the role of health in asset allocation. Michelangeli (2013) discovers that health problems and accidents may significantly affect the level of risk aversion of the elderly. Vega and Velli (2020) find that negative health shocks significantly decrease the share of risky assets in investment portfolios of the elderly. In addition, Yogo (2016) demonstrates that the correlation between risky asset ownership and health is stronger for younger retirees than for older ones.

4 Data

The data come from the Health and Retirement Study (HRS), a biennial panel survey targeted on Americans aged over 50. The survey contains information on a host of topics such as asset allocation, employment status, health, wealth, pension plans, etc. I focus on the time period from 2002 to 2008, in between the 2000 Social Security Amendments and the Great Recession. I conduct separate analyses for singles and couples. The raw sample has a total of 73,781 observations, but 24 of them do not provide their relationship status: 25,677 of the remaining observations are non-cohabiting singles and the rest are cohabiting couples (married/partnered), referred to as singles and couples from now on for brevity. For singles, I first drop 716 respondents who are younger than 51 or older than 94. I, next, limit my sample to respondents having positive net wealth with their reported stock value not exceeding their net wealth, dropping another 3,853 observations. Then, I drop 610 disabled singles and 727 observations with missing item response for any of the variables of interest in this study. For couples, I first drop 1,116 non-cohabiting partners along with 268 couples with the older partner aged less than 51 or more than 94. Restricting my sample to couples having positive net wealth with their reported stock value not exceeding their net wealth, I drop another 2,894 observations. I also drop 1,584 couples with a disabled partner and 144 same-sex couples. Finally, I drop 1,912 observations with missing item response for any of the variables of interest in this study. These restrictions leave me with 19,776 single and 40,162 couple observations. Since some information including risky asset ownership are provided at the household level, I am compelled to represent each couple via a single observation in my regressions, ending up with 20,081 couple observations.

The main variable of interest is the risky asset holdings of the elderly. RAND HRS provides the net value of the shares of stocks in publicly held corporations, mutual funds, and investment trusts outside of those in pension plans, which are

referred to as bank stocks in the paper. In addition the elderly may hold risky assets in their defined contribution pension (401-k, ESOP, SRA, TSP, 403-b, etc.) and IRA/Keogh plans. While HRS data have information on the sizes of pension and IRA/Keogh plans along with the percentage of stock investment in these plans, this information is provided in the form of complete or incomplete brackets for a significant number of respondents, and reported as missing values for some others. I impute these values following a strategy similar to Gustman, Steinmeier, Tabatabai (2012).

Imputations

I utilize Hot-Deck or Mixed method to impute the bracketed and missing values for the amount of stock holdings in DC and IRA plans depending on the relevant sample size. For relatively small samples, I rely on the Hot-Deck method since producing fitted values for imputation purposes, i.e. the Mixed Method, ceases to be effective. To that end, I first assign a random number to each observation, including those where the relevant information is provided as a tight-bracketed, an untight-bracketed, or an unbracketed interval. Next, I reorder the relevant observations based on the assigned random numbers. The last step is to impute unknown values with the closest observation within the bracket of interest until all values are imputed. I prefer to use the preceding observation over the following in case of an equal distance.

For relatively large samples, I employ the Mixed method utilizing fitted values from a regression used for matching along with the hot-decking method to distinguish between the observations having the same fitted value. Let Y denote the amount in a pension/IRA account, or the share invested in stocks in this account. The independent variables include gender, age, race, education, marital status, and employment characteristics. I use quadratic specifications for age, weekly wage, job tenure, and firm size. I also utilize dummy variables indicating missing values for

marital status, weekly wage, job tenure, self-employment, union membership, and public sector. I further have interaction terms between gender and various socio-economic factors. If any regressor turns out to have a limited amount of variation in the relevant subsample used for imputation, I drop it from the model. The reference categories are whites, high school graduates, and not working respondents. In subsamples where all respondents are workers, full-time workers are used as the reference category.

$$Y = \beta_0 + \beta_1 female + \beta_2 age + \beta_3 agesq + \beta_4 black + \beta_5 otherrace + \beta_6 missingrace + \beta_7 HSdropout + \beta_8 somecollege + \beta_9 unigrad + \beta_{10} missingeduc + \beta_{11} married + \beta_{12} missingmarried + \beta_{13} fulltime + \beta_{14} parttime + \beta_{15} notworking + \beta_{16} weeklywage + \beta_{17} weeklywagesq + \beta_{18} missingwageworkers + \beta_{19} tenurecurrent + \beta_{20} tenurecurrentsq + \beta_{21} missingtenurecurrentworkers + \beta_{22} tenurelongest + \beta_{23} tenurelongestsq + \beta_{24} missingtenurelongest + \beta_{25} selfemployed + \beta_{26} missingselfemployed + \beta_{27} union + \beta_{28} missingunion + \beta_{29} govemp + \beta_{30} missinggovemp + \beta_{31} firmsize + \beta_{32} firmsizesq + \beta_{33} missingfirmsizeworkers + \beta_{34} femaleblack + \beta_{35} femaleotherrace + \beta_{36} femaleHSdropout + \beta_{37} femaleunigrad + \beta_{38} femalemarried + \beta_{39} femalefulltime + \beta_{40} femaleparttime + \beta_{41} femaleselfemployed + \beta_{42} femaleunion + \varepsilon \quad (1)$$

After running the regression provided in Equation (1) on the observations with known Y values, I generate fitted values for all the observations, including those with information on Y provided as a tight-bracketed, an untight-bracketed, or an unbracketed interval. I additionally assign a uniformly distributed random number to each observation. Within the type of the bracket provided, I reorder the observations based on their fitted values, then random numbers to distinguish the order of the observations having the same fitted value. The unknown Y value is then imputed using the closest observation, the preceding over the proceeding in case of an equal distance, with a known Y value.

HRS records information for multiple pension and IRA plans each year along with the share invested in stocks in these plans. Imputations are carried out for each account in each year.

Descriptive statistics

The normal retirement age in the United States was 65 in 2002 and increased by 2 months each year until it reached 66 in 2008. Accordingly, to model the incentives of the Social Security system, I define 62-64 as the early retirement age, 65-70 as the normal retirement age, and 71-75 as the late retirement age. Note that the normal retirement age group also controls for the effects of being eligible for Medicare at age 65. I further control for private pension plans to measure their effects on risky asset investment behavior. Given that some of the elderly tend to return to work after retirement, which makes the term "retirement" vague, I refer to non-participants as retired. Those who work part-time and mention retirement as the reason are assigned to partly retired category. I utilize these two terms to examine how risky asset investment behavior changes with the loss of a continuous stream of labor income, and retirement expectations in the short-term accompanied by a decrease in labor income. I control for part-time work allowing me to distinguishing between those who work part-time without plans for retirement in the short-run and are partly retired, and marriage status for couples to analyze whether legality of the relationship matters. I control for number of children to analyze the relationship between risky asset ownership and bequest motives. I also control for various socio-demographic and employment characteristics, as well as the sectoral variation for those who work. The industry codes are based on the 1980 Census due to cross-wave differences in data collection.

Table 1 provides summary statistics for the variables of interest by cohabitation status across the entire sample and for those investing in risky assets. In addition to the discussion in Section 2, one can see that the elderly invest the most in bank

Table 1: Sample means (Std. dev.s) of key variables by cohabitation status

Variable	Singles		Couples	
	All respondents	Risky asset holders	All respondents	Risky asset holders
Age				
51-61	0.165	0.233	0.279	0.327
62-64	0.073	0.085	0.107	0.111
65-70	0.194	0.188	0.233	0.220
71-75	0.149	0.130	0.151	0.136
76-94	0.419	0.364	0.190	0.161
Risky assets				
Total stocks	62,474	179,136	150,274	255,993
	(326,386)	(533,461)	(615,341)	(786,112)
Pension stocks	1,942	5,569	12,610	21,482
	(20,874)	(35,062)	(67,324)	(86,781)
IRA stocks	12,133	34,788	48,680	82,927
	(60,130)	(97,877)	(350,381)	(454,201)
Bank stocks	48,399	138,778	88,983	151,583
	(307,248)	(508,096)	(471,455)	(607,583)
Pension plan type				
DB plan	0.102	0.217	0.173	0.250
DC plan	0.065	0.161	0.117	0.188
Labor force status				
Full-time	0.151	0.245	0.251	0.311
Part-time	0.103	0.125	0.145	0.159
Partly retired	0.068	0.088	0.090	0.097
Retired	0.745	0.630	0.604	0.529
Marital status				
Married	-	-	0.964	0.969
Net wealth				
Wealth	299,282	596,815	621,066	872,969
	(115,215)	(1,813,869)	(1,330,833)	(1,616,857)
Health status				
Good health	0.343	0.460	0.442	0.533
Normal health	0.322	0.324	0.323	0.310
Poor health	0.336	0.216	0.235	0.157
Gender				
Female	0.755	0.731	0.500	0.500
Race				
White	0.789	0.896	0.866	0.920
Black	0.174	0.079	0.092	0.050
Other race	0.038	0.025	0.043	0.030

Table 1 - continued

Variable	Singles		Couples	
	All respondents	Risky asset holders	All respondents	Risky asset holders
Education level				
High school dropout	0.258	0.084	0.185	0.082
High school graduate	0.374	0.352	0.359	0.335
Some college	0.210	0.276	0.221	0.255
University graduate	0.158	0.287	0.235	0.328
Job characteristics				
Job tenure	3.001	4.889	4.911	6.131
	(7.946)	(9.898)	(9.794)	(10.592)
Self-employed	0.055	0.073	0.103	0.117
Union member	0.037	0.059	0.049	0.062
Number of children				
No children	0.127	0.159	0.034	0.033
One child	0.133	0.137	0.079	0.081
Two children	0.247	0.293	0.272	0.311
Three children	0.191	0.199	0.231	0.248
Four children	0.128	0.109	0.152	0.147
Five children and more	0.174	0.103	0.231	0.181
Sample size	19,776	6,897	40,162	23,576

stocks. DB plans are observed to be more prevalent than DC plans among the elderly Americans, and both plans are associated with a higher likelihood to invest in risky assets. This suggests that the elderly covered by a private pension plan are willing to take more risks in their investment decisions. Among singles (couples), 75 (60) percent are retired, and 7 (9) percent are partly retired. Females constitute a larger fraction of singles, probably due to the differential mortality rates by gender. Regarding race, a higher proportion of whites invest in risky assets. The summary statistics also present a positive relationship between education and probability to invest in risky assets. Risky asset owners have longer job tenure on average, suggesting that those with stable jobs are less risk averse. While those having 2 (5+) kids are observed to be slightly more (less) likely to invest in risky assets, no significant correlations observed between risky asset ownership and the other levels of number of children.

5 Methodology

I utilize a two-step Heckman selection method to determine how various factors affect the risky asset holdings of the elderly. This method was first developed by Heckman (1979) to correct non-random sampling bias. Since the results may differ for cohabiting couples due to leisure complementarity and a shared budget constraint, I conduct separate analyses for singles and couples. In the first step, I estimate the probability of having risky assets using a probit model (the selection equation), then in the second step, I estimate the amount of risky assets proportional to wealth within a linear regression framework (the outcome equation), including the relevant selection correction term.

The identification in Heckman's method is achieved via a regressor that affects the selection but not the outcome equation, the so-called exclusion restriction. In my study, it is a dummy variable that indicates whether the longest tenure is in the FIRE (finance, insurance, real estate) industry. In the model for singles, I denote it as $longestfinance$, and in the model for couples as $atlonelongestfinance$, where the latter indicates whether at least one partner's longest tenure is in the FIRE industry. The literature points out the presence of an entry cost limiting stock market participation and argues that people with financial knowledge are more likely to participate in the stock market (Alan, 2006; Neumuller et al., 2017). Since the respondents who worked in the financial sector for a long period should be better informed about the stock market, they should have higher likelihood to invest in risky assets. Yet, Cupak et al. (2020) show that conditional on factors controlling the socio-demographic characteristics the level of financial literacy is found not to alter the share of wealth in risky assets for participants. HRS data support these findings: While the proportion of elderly having risky assets in their portfolio is about 20 percentage points higher for those with the longest tenure in the FIRE industry, the elderly having risky assets in their portfolio invest around 30 percent of their wealth in risky assets regardless of whether their longest tenure

is in the FIRE industry, as depicted in Table 2.

Table 2: Risky investment decisions by sector of longest tenure

Sector of Longest Tenure	Singles		Couples	
	Have stocks (%)	Stock to wealth ratio	Have stocks (%)	Stock to wealth ratio
FIRE	52.30	0.294	72.81	0.292
Other	33.98	0.295	57.12	0.269

The two-step model for singles is provided in Equations (4) and (5). Let z* be a latent variable measuring the propensity to invest in risky assets, and *havestocks* be a dummy variable indicating risky asset ownership. *stocks/wealth* denotes the ratio of risky assets to net wealth for respondents who invest in risky assets. The non-randomness of the subsample consisting of only those who invest in risky assets is addressed via a selection correction term, denoted by λ, in the regression equation. The reference categories are the following: for age - 51-61; for labor force status - full-time workers; for health - normal health; for race - whites; for education - high school graduates; for number of children - not having any; for job sectors - professional services sector.

The vector $\underline{\text{INT}}$ contains the pairwise interactions considered in the model. The interaction terms between age and health are included to indirectly control for the incentives brought about by the Social Security system depending on longevity. The interaction terms between age and wealth are included to test whether risky investment behavior at various ages differ by the amount of wealth. The interaction terms between health and wealth are included to analyze the interplay between two important sources of risk appetite of the elderly. Given that DB and DC plans provide different retirement incentives at specific ages the model also contains the interactions between age and pension plan type. I control for the interaction terms between retirement status and wealth to check how the effect of retirement on risky asset holding decision differs by wealth. Lastly, the interaction terms between gender and race, gender and age, gender and education, and race and education are

included to analyze the socio-economic differences in risky asset holding behavior. I include only those interaction terms that are estimated to be highly significant in my final specification. I assume that the error terms of the selection and outcome equations have a bivariate normal distribution.

$$z^* = \beta_0 + \beta_1 age6264 + \beta_2 age6570 + \beta_3 age7175 + \beta_4 age7694 + \beta_5 DBplan + \beta_6 DCplan +$$
$$\beta_7 parttime + \beta_8 partlyretired + \beta_9 retired + \beta_{10} ln(wealth) + \beta_{11} poorhealth +$$
$$\beta_{12} goodhealth + \beta_{13} female + \beta_{14} black + \beta_{15} otherrace + \beta_{16} HSdropout +$$
$$\beta_{17} somecollege + \beta_{18} unigrad + \beta_{19} jobtenure + \beta_{20} selfemployed + \beta_{21} union +$$
$$\beta_{22} nchild1 + \beta_{23} nchild2 + \beta_{24} nchild3 + \beta_{25} nchild4 + \beta_{26} nchild5more +$$
$$\beta_{27} agriculture + \beta_{28} miningconstruction + \beta_{29} manufacturing + \beta_{30} transportation +$$
$$\beta_{31} wholesaleretail + \beta_{32} financeinsestate + \beta_{33} businessrepair +$$
$$\beta_{34} personalservices + \beta_{35} entertainmentrecreation + \beta_{36} govemp + \beta_{37} othersector +$$
$$\beta_{38} longestfinance + \beta \underline{INT} + \varepsilon$$

where

$$havestocks = \begin{cases} 1 = \text{have stocks} & \text{if } z^* > 0 \\ 0 = \text{do not have} & \text{if } z^* \leq 0 \end{cases} \tag{2}$$

$$stocks/wealth = \alpha_0 + \alpha_1 age6264 + \alpha_2 age6570 + \alpha_3 age7175 + \alpha_4 age7694 +$$
$$\alpha_5 DBplan + \alpha_6 DCplan + \alpha_7 parttime + \alpha_8 partlyretired + \alpha_9 retired +$$
$$\alpha_{10} ln(wealth) + \alpha_{11} poorhealth + \alpha_{12} goodhealth + \alpha_{13} female + \alpha_{14} black +$$
$$\alpha_{15} otherrace + \alpha_{16} HSdropout + \alpha_{17} somecollege + \alpha_{18} unigrad + \alpha_{19} jobtenure +$$
$$\alpha_{20} selfemployed + \alpha_{21} union + \alpha_{22} nchild1 + \alpha_{23} nchild2 + \alpha_{24} nchild3 + \alpha_{25} nchild4 +$$
$$\alpha_{26} nchild5more + \alpha_{27} agriculture + \alpha_{28} miningconstruction + \alpha_{29} manufacturing +$$
$$\alpha_{30} transportation + \alpha_{31} wholesaleretail + \alpha_{32} financeinsestate + \alpha_{33} businessrepair +$$
$$\alpha_{34} personalservices + \alpha_{35} entertainmentrecreation + \alpha_{36} govemp + \alpha_{37} othersector +$$

$$\alpha \underline{INT} + \lambda + u \tag{3}$$

To analyze the risky investment decision of couples, since I observe some information only at the household level, I am compelled to introduce some new variables in place of those provided for singles. I control for the retirement status of couples via two dummy variables indicating whether one, and both of the partners are retired. Health dummies represent the self-reported health status of each partner, namely good-good, good-normal, good-poor, normal-normal, normal-poor, and poor-poor health. Education is measured via its level for the partner who had more education. I also define whether at least one of the partners has a DB plan, a DC plan, is black, of another non-white race, self-employed, and unionized. The reference categories are the following: for age - the older partner is 51-61; for retirement status - both partners are workers; for health - normal-normal health; for race - white couples; for education - the partner having more education is a high school graduate; for number of children - not having any; for job sectors - whether male works in the professional services sector. I utilize the same set of interaction terms as before. I again assume that the error terms of the selection and outcome equations have a bivariate normal distribution.

$$z^* = \beta_0 + \beta_1 maxage6264 + \beta_2 maxage6570 + \beta_3 maxage7175 + \beta_4 maxage7694 +$$
$$\beta_5 agediff + \beta_6 married + \beta_7 atloneDBplan + \beta_8 atloneDCplan + \beta_9 oneretired +$$
$$\beta_{10} bothretired + \beta_{11} ln(wealth) + \beta_{12} poorpoorhealth + \beta_{13} normalpoorhealth +$$
$$\beta_{14} goodpoorhealth + \beta_{15} goodnormalhealth + \beta_{16} goodgoodhealth + \beta_{17} atloneblack +$$
$$\beta_{18} atloneotherrace + \beta_{19} highestHSdropout + \beta_{20} highestsomecollege +$$
$$\beta_{21} highestunigrad + \beta_{22} jobtenure + \beta_{23} sjobtenure + \beta_{24} atloneselfemployed +$$
$$\beta_{25} atloneunion + \beta_{26} agriculture + \beta_{27} sagriculture + \beta_{28} miningconstruction +$$
$$\beta_{29} sminingconstruction + \beta_{30} manufacturing + \beta_{31} smanufacturing +$$
$$\beta_{32} transportation + \beta_{33} stransportation + \beta_{34} wholesaleretail + \beta_{35} swholesaleretail +$$
$$\beta_{36} financeinsestate + \beta_{37} sfinanceinsestate + \beta_{38} businessrepair +$$

$$\beta_{39} sbusinessrepair + \beta_{40} sprofessionalservices + \beta_{41} govemp + \beta_{42} sgovemp +$$

$$\beta_{43} othersector + \beta_{44} sothersector + \beta_{45} atlonelongestfinance + \beta \underline{INT} + \varepsilon$$

where

$$havestocks = \begin{cases} 1 = \text{have stocks} & \text{if } z^* > 0 \\ 0 = \text{do not have} & \text{if } z^* \leq 0 \end{cases} \tag{4}$$

$$stocks/wealth = \alpha_0 + \alpha_1 maxage6264 + \alpha_2 maxage6570 + \alpha_3 maxage7175 +$$

$$\alpha_4 maxage7694 + \alpha_5 agediff + \alpha_6 married + \alpha_7 atloneDBplan + \alpha_8 atloneDCplan +$$

$$\alpha_9 oneretired + \alpha_{10} bothretired + \alpha_{11} ln(wealth) + \alpha_{12} poorpoorhealth +$$

$$\alpha_{13} normalpoorhealth + \alpha_{14} goodpoorhealth + \alpha_{15} goodnormalhealth +$$

$$\alpha_{16} goodgoodhealth + \alpha_{17} atloneblack + \alpha_{18} atloneotherrace + \alpha_{19} highestHSdropout +$$

$$\alpha_{20} highestsomecollege + \alpha_{21} highestunigrad + \alpha_{22} jobtenure + \alpha_{23} sjobtenure +$$

$$\alpha_{24} atloneselfemployed + \alpha_{25} atloneunion + \alpha_{26} agriculture + \alpha_{27} sagriculture +$$

$$\alpha_{28} miningconstruction + \alpha_{29} sminingconstruction + \alpha_{30} manufacturing +$$

$$\alpha_{31} smanufacturing + \alpha_{32} transportation + \alpha_{33} stransportation + \alpha_{34} wholesaleretail +$$

$$\alpha_{35} swholesaleretail + \alpha_{36} financeinsestate + \alpha_{37} sfinanceinsestate +$$

$$\alpha_{38} businessrepair + \alpha_{39} sbusinessrepair + \alpha_{40} sprofessionalservices + \alpha_{41} govemp +$$

$$\alpha_{42} sgovemp + \alpha_{43} othersector + \alpha_{44} sothersector + \alpha \underline{INT} + \lambda + u \tag{5}$$

In addition, I estimate the IV Ordered Probit model presented in Equations (8) and (9) to see how wealth determines health status. The estimation method was generalized by Roodman (2011), with the first stage as OLS and the second stage as Ordered Probit. The algorithm is very similar to 2SLS, but in the second step, it allows a categorical variable to be used as a dependent variable. HRS records information on the amount of money or property ($10,000 or more) that the respondent (or his/her partner) inherited since the last interview. I utilize

the amount of inheritance as an instrumental variable to account for the possible endogeneity of wealth. While the amount of inheritance is certainly correlated with changes in wealth, it is reasonable to assume that it is not related to changes in health status, making it a valid instrument (Meer et al., 2003; Michaud et al., 2008).

$$\widehat{ln(wealth)} = \widehat{\delta_0} + \widehat{\delta_1} age6264 + \widehat{\delta_2} age6570 + \widehat{\delta_3} age7175 + \widehat{\delta_4} age7694 + \widehat{\delta_5} female +$$
$$\widehat{\delta_6} black + \widehat{\delta_7} otherrace + \widehat{\delta_8} HSdropout + \widehat{\delta_9} somecollege + \widehat{\delta_{10}} unigrad +$$
$$\widehat{\delta_{11}} inheritanceamount + \widehat{\delta_{12}} femaleblack + \widehat{\delta_{13}} femaleotherrace +$$
$$\widehat{\delta_{14}} femaleHSdropout + \widehat{\delta_{15}} femalesomecollege + \widehat{\delta_{16}} femaleunigrad +$$
$$\widehat{\delta_{17}} blackHSdropout + \widehat{\delta_{18}} blacksomecollege + \widehat{\delta_{19}} blackunigrad + \upsilon \tag{6}$$

$$\theta^* = \gamma_1 \widehat{ln(wealth)} + \gamma_2 age6264 + \gamma_3 age6570 + \gamma_4 age7175 + \gamma_5 age7694 +$$
$$\gamma_6 female + \gamma_7 black + \gamma_8 otherrace + \gamma_9 HSdropout + \gamma_{10} somecollege + \gamma_{11} unigrad +$$
$$\gamma_{12} femaleblack + \gamma_{13} femaleotherrace + \gamma_{14} femaleHSdropout +$$
$$\gamma_{15} femalesomecollege + \gamma_{16} femaleunigrad + \gamma_{17} blackHSdropout +$$
$$\gamma_{18} blacksomecollege + \gamma_{19} blackunigrad + \xi$$

where

$$healthst = \begin{cases} 1 = \text{poor health} & \text{if } \theta^* \leq \alpha_1 \\ 2 = \text{normal health} & \text{if } \alpha_1 < \theta^* \leq \alpha_2 \\ 3 = \text{good health} & \text{if } \theta^* > \alpha_2 \end{cases} \tag{7}$$

$\widehat{ln(wealth)}$ contains the predicted values of the log wealth from the first stage. θ^* is a latent variable measuring the unobserved health capital of the elderly. *healthst* is a dummy variable indicating self-reported health status. I control for age, gender, race, and education. I further have the pairwise interactions between gender and race, and gender and education since their effects on health may differ depending on the respondent's socio-economic background.

6 Results

Table 3 provides the estimates of the Probit model for singles along with the average marginal effects (AME). The estimates suggest that while the elderly singles in normal retirement age (65-70) are on average 4 percentage points less likely to invest in risky assets than the elderly under normal retirement age, the elderly singles aged 71+ are on average around 6 percentage points less likely to invest in risky assets. The decision to invest in risky assets is additionally found to be positively associated with both types of private pension plans. The probability of investing in risky assets increases by almost 30 percentage points for the elderly singles covered by a DC plan while for those covered by a DB plan the increase is about 10 percentage points. This finding shows that the elderly singles covered by private pension plans are less risk averse. The observed decrease at the extensive margin of risky asset behavior by the time of retirement in Section 2 seems to hold only for the elderly singles at the middle or bottom tercile of income distribution while those at the top tercile of income distribution are found to be more likely to invest in risky assets when they retire. Yet the decrease in labor income due to part-time work with or without retirement expectations is not found to affect the risky asset investment behavior of the elderly singles at the extensive margin.

I next focus on the effects of wealth and health on risky asset investment behavior of the elderly singles at the extensive margin. I discover that a 10 percent increase in wealth increases the probability of having risky assets by around 1 percentage point. On the other hand the elderly singles in poor health are estimated to be about 2 percentage points less likely to invest in risky assets than those in normal health. While having good health is positively associated with the decision to invest in risky assets in general, this association disappears for the age group 65-70. This finding might be explained through the incentives brought about by the Social Security rules: Since the elderly with above average health tend to postpone collecting their SS benefits, they might be more risk averse. The effect of poor versus normal health

Table 3: Probit model for singles

Variables	Coefficients	Std. errors	AME	Std. errors
age6264	0.076	0.087	−0.018	0.013
age6570	−0.218***	0.058	−0.037***	0.012
age7175	−0.228***	0.055	−0.055***	0.013
age7694	−0.229***	0.052	−0.055***	0.013
DBplan	0.427***	0.081	0.103***	0.019
DCplan	1.223***	0.083	0.295***	0.019
parttime	0.020	0.075	0.005	0.018
partlyretired	0.089	0.080	0.022	0.019
retired	−1.289***	0.294	−0.009	0.020
ln(wealth)	0.359***	0.019	0.104***	0.002
poorhealth	−0.095***	0.033	−0.023***	0.008
goodhealth	0.181***	0.059	0.012	0.007
female	−0.189*	0.098	−0.012	0.009
black	−0.615***	0.053	−0.133***	0.011
otherrace	−0.486***	0.109	−0.072***	0.019
HSdropout	−0.174	0.111	−0.095***	0.011
somecollege	0.262***	0.041	0.063***	0.009
unigrad	0.414***	0.047	0.099***	0.011
jobtenure	−0.004*	0.003	−0.001*	0.001
selfemployed	0.003	0.073	0.001	0.018
union	−0.114	0.084	−0.027	0.020
nchild1	−0.028	0.063	−0.007	0.015
nchild2	−0.019	0.054	−0.005	0.013
nchild3	−0.061	0.057	−0.015	0.014
nchild4	−0.127**	0.063	−0.031**	0.015
nchild5more	−0.267***	0.062	−0.065***	0.015
agriculture	0.057	0.183	0.014	0.044
miningconstruction	−0.439***	0.137	−0.106***	0.033
manufacturing	0.089	0.101	0.021	0.024
transportation	−0.212	0.146	−0.051	0.035
wholesaleretail	0.064	0.089	0.015	0.021
financeinsestate	−0.216	0.138	−0.052	0.033
businessrepair	−0.059	0.123	−0.014	0.029
personalservices	0.058	0.128	0.014	0.031
entertainmentrecreation	0.085	0.169	0.020	0.041
govemp	−0.162	0.125	−0.039	0.030
othersector	−0.204**	0.082	−0.049**	0.019
longestfinance	0.189***	0.073	0.046***	0.018
age6570goodhealth	−0.163**	0.063		
retiredln(wealth)	0.105***	0.024		
age6264female	0.206**	0.098		
femaleotherrace	0.648***	0.186		
femaleHSdropout	0.197**	0.089		
blackHSdropout	−0.306***	0.113		
intercept	−4.348***	0.242		
Sample size	19,776			
Pseudo R^2	0.342			

*10% significance level, **5% significance level, ***1% significance level.
Clustered standard errors are provided.

on the decision to invest in risky assets are equivalent to a 20 percent increase in wealth. In other words, for the elderly singles, wealth is significantly more important than health in their decision to invest in risky assets.

Females are in general less likely to invest in risky assets except that those who are of other race are as likely to invest in risky assets as white men. Blacks and other racial minorities are found to be, on average, around 13 and 7 percentage points less likely to invest in risky assets than whites, respectively. The estimates also suggest a positive relationship between education and the decision to invest in risky assets, as expected. On the other hand, job stability, self-employment, and being unionized are estimated not to effect the decision of the elderly singles to invest in risky assets. The estimates for the number of children show that bequest motives do not play a role in the risky asset investment behavior of singles at the extensive margin. The only observed significant associations are for respondents having more than 3 kids and are negative. The sectoral variation, except for the mining and construction and other sectors, seems to be unimportant in the decision of the elderly singles to invest in risky assets.

The exclusion restriction, $longestfinance$, is estimated to be both economically and statistically significant, confirming that working in the FIRE industry for a long time has a positive effect on risky asset ownership.

Table 4 provides the estimates of the outcome regression for singles including the selection correction term, estimated to be highly significant, along with the non-trivial AMEs. It is then possible to conclude that the Heckman model, eliminating the self-selection bias associated with considering only the respondents investing in risky assets, provides more reliable results compared to the conventional OLS regression. The finding in the first step estimation that the elderly singles beyond normal retirement age are less likely to invest in risky assets is complemented by the second step estimates that the elderly singles aged 65-75 having risky assets in their portfolio invest less in proportion to their wealth. These findings likely underscore

Table 4: Outcome regression for singles

Variables	Coefficients	Std. errors	AME^{NT}	Std. errors
age6264	−0.005	0.013		
age6570	−0.024**	0.011		
age7175	−0.042***	0.013		
age7694	0.017	0.012		
DBplan	0.015	0.020		
DCplan	0.103***	0.021		
parttime	0.007	0.018		
partlyretired	0.030	0.019		
retired	−0.318***	0.085	0.026	0.019
ln(wealth)	0.003	0.006	0.026***	0.008
poorhealth	−0.00001	0.009		
goodhealth	0.015**	0.007		
female	−0.032***	0.007	−0.036***	0.007
black	−0.099***	0.015		
otherrace	−0.151***	0.026	−0.123***	0.021
HSdropout	−0.029**	0.015		
somecollege	0.050***	0.009		
unigrad	0.071***	0.010		
jobtenure	0.001	0.001		
selfemployed	−0.015	0.016		
union	0.025	0.016		
nchild1	−0.042***	0.012		
nchild2	−0.022**	0.009		
nchild3	−0.040***	0.011		
nchild4	−0.048***	0.013		
nchild5more	−0.049***	0.014		
agriculture	−0.119***	0.039		
miningconstruction	−0.087**	0.034		
manufacturing	0.004	0.019		
transportation	0.017	0.029		
wholesaleretail	−0.032*	0.018		
financeinsestate	0.029	0.022		
businessrepair	−0.052**	0.025		
personalservices	−0.0003	0.027		
entertainmentrecreation	−0.064*	0.034		
govemp	−0.074***	0.024		
othersector	−0.035*	0.020		
retiredln(wealth)	0.031***	0.007		
femaleotherrace	0.115***	0.044		
λ	0.128***	0.029		
intercept	0.134	0.095		
Selected sample size	6,897			
ρ	0.477			

*10% significance level, **5% significance level, ***1% significance level.

Asymptotic standard errors are provided.

NT: Only non-trivial AMEs are provided.

the importance of incentives brought about by the Social Security system. The observed effects might partly be caused by the portion of deteriorating health capital with age that not captured via the controlled subjective health status. They might also partly reflect the cohort effect: Older cohorts may have been less exposed to risky assets since the financial markets were less developed when they were young. Similarly, the finding in the first step estimation that the elderly singles covered by a DC plan are more likely to invest in risky assets is complemented with a positive correlation at the intensive margin, a 10.3 percent more investment in risky assets in proportion to their wealth. It is then apparent that a DC based pension system would increase investment in the capital stock of the economy which in turn accelerate economic growth. On the other hand, DB plan coverage does not seem to alter the risky asset investment behavior at the intensive margin. Retirement decision is observed to increase the share of investment in risky assets with respect to wealth except for those having a very small amount of wealth, less than 29,000 USD. Interpreting this finding along with the first step estimates, retirement seems to have diverging effects based on wealth. While the unwealthy elderly singles are less likely to invest in risky assets and invest a smaller portion of their wealth, the elderly singles at the top tercile of income distribution are more likely to invest in risky assets and invest more of their wealth. Other labor force statuses do not seem to affect the share of stocks invested in risky assets, as it is the case at the extensive margin.

I further discover that wealth does not substantially alter the amount of stock holdings at the intensive margin: a 10 percent increase in wealth increases the amount of stocks by only about 0.3 percent of wealth. Similarly the effect of health for the elderly singles is not substantial at the intensive margin. The ratio of risky assets to net wealth is estimated to be only around 0.02 higher for those having good health compared to those having normal health.

It turns out that females invest less in risky assets by 3.6 percent of their wealth

on average. Blacks and other racial minorities are estimated to invest less in risky assets by 9.9 and 12.3 percent of their wealth compared to whites, respectively. The positive association between education and risky assets is also observed at the intensive margin: While the stock-wealth ratio is 0.03 lower for high school dropouts compared to high school graduates, it is higher by around 0.05 and 0.07 for those who completed some college and university degree, respectively. These findings highlight the important role of financial sophistication in risky asset investment behavior of the elderly singles. Job tenure, self-employment, and union membership are found to be statistically insignificant. The bequest motives indeed seem to matter at the intensive margin: The elderly singles having kids are estimated to be more risk averse: their investment in risky assets fall short by around 4 percent of their wealth. As for the sectoral variation the estimates show that those who work in the agriculture, mining and construction, wholesale and retail, business and repair, entertainment and recreation, public, and other sectors invest less proportionately to their wealth.

Table 5 provides the estimates of the Probit model for couples along with the AMEs. Majority of the couples with the older partner who are in the normal or late retirement age are observed to be less likely to invest in risky assets, with its likelihood decreasing with size of wealth. The relationship at the normal retirement age turns out to be positive for the elderly couples having wealth more than 320,000 USD, and at the late retirement age for those having wealth more than 477,000 USD. Additionally the age gap between the partners affect the risky asset investment decision at the extensive margin slightly negatively: Couples having 3 years of age difference are 1 percentage point less likely invest in risky assets compared to same age couples. The legality of the relationship, on the other hand, appears to be neither statistically nor economically significant at the extensive margin. The probability of investing in risky assets is estimated to be higher by around 4 and 34 percentage points for a couple where at least one of the partners is covered by a

Table 5: Probit model for couples

Variables	Coefficients	Std. errors	AME	Std. errors
maxage6264	0.014	0.048	0.003	0.012
maxage6570	−1.293***	0.355	−0.005	0.011
maxage7175	−1.582***	0.474	−0.016	0.012
maxage7694	−0.048	0.052	−0.012	0.013
agediff	−0.011***	0.003	−0.003***	0.001
married	0.002	0.076	0.0004	0.018
atloneDB	0.169***	0.056	0.041***	0.014
atloneDC	1.372***	0.058	0.335***	0.013
oneretired	0.062	0.078	0.015	0.019
bothretired	−2.013***	0.369	0.018	0.018
ln(wealth)	0.386***	0.019	0.126***	0.003
poorpoorhealth	−0.161***	0.056	−0.039***	0.014
normalpoorhealth	−0.052	0.043	−0.013	0.011
goodpoorhealth	0.048	0.046	0.012	0.011
goodnormalhealth	0.125***	0.039	0.031***	0.009
goodgoodhealth	0.239***	0.044	0.058***	0.011
atloneblack	−0.511***	0.063	−0.108***	0.013
atloneotherrace	−0.355***	0.063	−0.087***	0.015
highestHSdropout	−0.464***	0.060	−0.113***	0.015
highestsomecollege	0.459***	0.102	0.049***	0.009
highestunigrad	0.437***	0.040	0.107***	0.009
jobtenure	−0.003*	0.002	−0.001*	0.0004
sjobtenure	−0.004	0.003	−0.001	0.001
atloneselfemployed	−0.101**	0.048	−0.025**	0.012
atloneunion	0.074	0.055	0.018	0.013
nchild1	0.058	0.097	0.014	0.024
nchild2	0.188**	0.086	0.046**	0.021
nchild3	0.185**	0.087	0.045**	0.021
nchild4	0.159*	0.089	0.039*	0.022
nchild5more	0.078	0.087	0.019	0.021
agriculture	−0.325***	0.116	−0.079***	0.028
sagriculture	0.168	0.225	0.041	0.055
miningconstruction	0.131	0.095	0.032	0.023
sminingconstruction	0.472**	0.204	0.115**	0.049
manufacturing	0.233***	0.084	0.057***	0.021
smanufacturing	0.246**	0.119	0.060**	0.029
transportation	0.081	0.097	0.019	0.024
stransportation	0.073	0.149	0.018	0.036
wholesaleretail	0.114	0.084	0.028	0.021
swholesaleretail	0.291***	0.103	0.071***	0.025
financeinsestate	0.199*	0.111	0.049*	0.027
sfinanceinsestate	0.078	0.115	0.019	0.028
businessrepair	0.184*	0.099	0.045*	0.024
sbusinessrepair	0.329**	0.135	0.080**	0.033

Table 5 - continued

Variables	Coefficients	Std. errors	AME	Std. errors
personalservices	0.173	0.172	0.042	0.042
spersonalservices	0.079	0.117	0.019	0.029
entertainmentrecreation	0.469***	0.168	0.115***	0.041
sentertainmentrecreation	0.138	0.220	0.034	0.054
sprofessionalservices	0.196**	0.091	0.048**	0.022
govemp	−0.094	0.111	−0.023	0.027
sgovemp	0.114	0.148	0.028	0.036
othersector	−0.051	0.078	−0.013	0.019
sothersector	0.218**	0.090	0.053**	0.022
atlonelongestfinance	0.123**	0.055	0.030**	0.013
maxage6570ln(wealth)	0.102***	0.029		
maxage7175ln(wealth)	0.121***	0.038		
bothretiredln(wealth)	0.167***	0.029		
intercept	−5.197***	0.293		
Sample size	20,081			
Pseudo R^2	0.365			

*10% significance level, **5% significance level, ***1% significance level.
Clustered standard errors are provided.

DB and a DC plan, respectively. Like the case for singles, we observe that private pension plans encourage couples to take more risks. We also observe that the likelihood of couples who are both retired to invest in risky assets depends on their wealth: While those with a limited amount of net wealth (less than 172,000 USD) are less likely to invest in risky assets, those who are more wealthy invest more.

I further find that a 10 percent increase in wealth is associated with a slightly over 1 percentage point increase in the probability of having risky assets for couples. Unlike the case for singles, health status is estimated to be also important in the decision to invest in risky assets: While the elderly couples with both partners having good health are around 6 percentage points more likely to invest in risky assets than those with both having normal health, couples with both partners having poor health are about 4 percentage points less likely to invest in risky assets.

Couples where at least one partner is black and of other minor race are found to be around 11 and 9 percentage points less likely to invest in risky assets than white

couples, respectively. The estimates also suggest a positive relationship between education and risky asset ownership like the case for singles. While probability of investing in risky assets increases by about 11 (5) percentage points for the elderly couples with the more educated partner having university (some college) education compared to elderly couples where the more educated partner is a high school graduate, it decreases by around 11 percentage points for the elderly couples with both partners not having a high school diploma. Job tenure does not seem to matter economically suggesting that the elderly couples having stable jobs are as risk averse as those who do not. While the likelihood of risky asset investment does not change for couples where at least one partner is a union member, couples with at least one self-employed partner are estimated to be more risk averse. Unlike singles, it can be seen that bequest motives have a positive effect on the risky investment decisions of elderly couples at the extensive margin: The elderly couples having two to four children are about 4 to 5 percentage points more likely to invest in risky assets, meaning that such households are willing to take more risks in their decision to invest in risky assets. Sectoral variation seems to have a bigger impact on the risky portfolio choice of couples than singles. Compared to couples with the male partner working in the professional services sector, it is estimated that couples with the male partner working in the manufacturing, finance, insurance, and real estate, business and repair, entertainment and recreation, and with the female partner working in the mining and construction, manufacturing, wholesale and retail, business and repair, professional services, and other sectors are more likely to invest in risky assets. Yet the effect is negative for couples with the male partner working in the agriculture.

The exclusion restriction, $atlonelongestfinance$, is estimated to be both economically and statistically significant. This confirms, for couples, the existence of positive relationship between working in the FIRE industry for a long time and the decision to invest in risky assets.

Table 6 provides the estimates of the outcome regression for couples including the selection correction term, which is highly significant, along with the non-trivial AMEs. My estimation methodology, as a result, addresses non-random self-selection of couples into investing in risky assets due to unobservables. The estimates suggest that, in addition to the negative association discovered at the extensive margin, couples with the older partner aged 65-75, unless they are extremely wealthy, invest less in risky assets in proportion to their wealth. These findings are similar to those for the case of singles such that it likely reflects the role of Social Security rules in the decision to invest in risky assets. The other possible reasons such as the deteriorating health capital with age that not captured by the self-reported health status and the cohort effect likely do not hold here since the risky investment portfolios of the elderly couples with the older partner above 75 are similar to those where the older partner is below 65. Neither the age gap between partners nor the legality of the relationship seem to be important also at the intensive margin. The estimates show that couples with at least one partner covered by a DC plan invest on average 11 percent more of their wealth into risky assets. Hence it can be concluded that a DC based pension system opens up a potential source of economic growth causing an increase in risky asset investment. DB plan coverage, on the other hand, does not alter the risky asset investment behavior at the intensive margin also for couples. The effect of retirement on risky asset investment behavior is similar to singles such that while relatively unwealthy couples, having a wealth of less than 292,000 USD, invest a smaller share of their wealth into risky assets, if they decide to hold risky assets in their portfolio, wealthy couples having risky assets in their portfolios invest a higher share of their wealth into risky assets.

I next focus on the effects of wealth and health on joint risky asset investment behavior at the intensive margin. I find that a 10 percent increase in wealth increases the amount of stocks invested by couples by only around 0.3 percent of their wealth. Unlike the case for singles, health also seem to matter substantially at the intensive

Table 6: Outcome regression for couples

Variables	Coefficients	Std. errors	AME^{NT}	Std. errors
maxage6264	−0.006	0.008		
maxage6570	−0.128**	0.059	−0.006	0.007
maxage7175	−0.242***	0.076	−0.017*	0.009
maxage7694	0.009	0.008		
agediff	−0.001**	0.001		
married	−0.003	0.012		
atloneDB	−0.011	0.009		
atloneDC	0.108***	0.011		
oneretired	0.001	0.011		
bothretired	−0.453***	0.066	−0.007	0.011
ln(wealth)	0.011***	0.004	0.033***	0.004
poorpoorhealth	−0.031**	0.012		
normalpoorhealth	−0.011	0.009		
goodpoorhealth	−0.021**	0.009		
goodnormalhealth	0.008	0.008		
goodgoodhealth	0.020***	0.008		
atloneblack	−0.059***	0.009		
atloneotherrace	−0.038***	0.010		
highestHSdropout	−0.082***	0.015		
highestsomecollege	0.029***	0.006		
highestunigrad	0.078***	0.006		
jobtenure	0.0002	0.0002		
sjobtenure	0.001***	0.0003		
atloneselfemployed	−0.054***	0.007		
atloneunion	0.014*	0.008		
nchild1	−0.039***	0.014		
nchild2	−0.021*	0.012		
nchild3	−0.032**	0.012		
nchild4	−0.030**	0.013		
nchild5more	−0.042***	0.013		
agriculture	−0.084***	0.018		
sagriculture	−0.057*	0.031		
miningconstruction	−0.025*	0.013		
sminingconstruction	−0.043	0.029		
manufacturing	0.029***	0.011		
smanufacturing	−0.037**	0.016		
transportation	0.012	0.013		
stransportation	−0.038*	0.021		
wholesaleretail	−0.004	0.011		
swholesaleretail	−0.033**	0.014		
financeinsestate	0.028**	0.013		
sfinanceinsestate	−0.004	0.015		
businessrepair	0.016	0.013		
sbusinessrepair	−0.012	0.018		

Table 6 - continued

Variables	Coefficients	Std. errors	AME^{NT}	Std. errors
personalservices	−0.035	0.030		
spersonalservices	−0.037*	0.019		
entertainmentrecreation	0.013	0.023		
sentertainmentrecreation	0.048	0.029		
sprofessionalservices	−0.029**	0.013		
govemp	0.005	0.015		
sgovemp	−0.034*	0.020		
othersector	−0.035***	0.013		
sothersector	−0.003	0.014		
maxage6570ln(wealth)	0.009**	0.005		
maxage7175ln(wealth)	0.018***	0.006		
bothretiredln(wealth)	0.036***	0.005		
λ	0.076***	0.017		
intercept	0.065	0.059		
Selected sample size	11,788			
ρ	0.330			

*10% significance level, **5% significance level, ***1% significance level.
Asymptotic standard errors are provided.
NT: Only non-trivial AMEs are provided.

margin: While the stock-to-wealth ratio is estimated to be around 0.02 higher for couples with both partners having good health than those with both having normal health, it is 0.03 lower for couples with both partners having poor health.

Couples where at least one partner is black and of other minor race are estimated to invest less in risky assets by 5.9 and 3.8 percent of their wealth, respectively. I further discover that education is positively associated with the ratio of risky assets to net wealth: While this ratio is 0.08 lower for the elderly couples where none of the partners has a high-school diploma compared to couples with the more educated partner being a high school graduate, it is higher by around 0.03 and 0.08 for couples with the more educated partner having some college and university degree, respectively. The positive correlations between education and risky asset investment behavior observed for couples both at the extensive and intensive margins underline the role of financial sophistication. Job tenure does not seem to have an economically significant effect also at the intensive margin. While the stock-to-wealth ratio

is found to be only slightly higher for couples with a unionized partner, couples with a self-employed partner are estimated to invest less in risky assets by 5.4 percent of their wealth. Unlike its effect at the extensive margin, bequest motives have a negative effect at the intensive margin such that couples having at least one child are estimated to invest 3 percent less of their wealth in risky assets. While couples with the male partner in the manufacturing, finance, insurance, and real estate sectors invest in risky assets more in proportion to their wealth, couples with the male partner in the agriculture, mining and construction, and with the female partner in the manufacturing, wholesale and retail, personal services, and professional services sectors invest less proportionately.

Table 7 provides the estimates of the IV Ordered Probit model along with the AMEs by health categories (1-poor health, 2-normal health, 3-good health). The estimates suggest that a 10 percent increase in wealth also increases (decreases) the probability of having good (poor) health by more or less around 1 percentage point. The effect on normal health is found to be negative but not substantial. These findings confirm the existence of the health-wealth gradient for the elderly.

It is also estimated that the elderly beyond retirement age are less likely to have good health and more likely to have poor health than those under retirement age. The effects of different age ranges on the probability of having poor health vary from 5 to 12 percentage points and get stronger with age. I further discover that females have better health than males on average, more so for non-white women. Blacks and other racial minorities are found to be around 1 and 2 percentage points more (less) likely to have good (poor) health status than whites, respectively. Education is estimated to be positively associated with health status: While high school dropouts are about 7 percentage points less likely to have good health than high school graduates the probability of having good health increases by around 4 percentage points for university graduates. The effect of education on health is estimated to be more pronounced for females and blacks.

Table 7: IV Ordered Probit model

Variables	Coefficients	Std. errors	AME	Std. errors
ln(wealth)	0.304***	0.093	−0.086*** (1)	0.024
			−0.017*** (2)	0.005
			0.103*** (3)	0.029
age6264	−0.160***	0.021	0.045*** (1)	0.005
			0.009*** (2)	0.001
			−0.054*** (3)	0.006
age6570	−0.208***	0.015	0.059*** (1)	0.004
			0.012*** (2)	0.001
			−0.071*** (3)	0.005
age7175	−0.314***	0.015	0.089*** (1)	0.005
			0.018*** (2)	0.001
			−0.107*** (3)	0.006
age7694	−0.432***	0.034	0.123*** (1)	0.012
			0.025*** (2)	0.003
			−0.147*** (3)	0.015
female	0.157***	0.023	−0.009** (1)	0.004
			−0.002 (2)	0.001
			0.011** (3)	0.004
black	−0.036	0.156	−0.011** (1)	0.005
			−0.002** (2)	0.001
			0.013** (3)	0.006
otherrace	−0.107	0.087	−0.016*** (1)	0.006
			−0.003*** (2)	0.001
			0.019*** (3)	0.007
HSdropout	0.028	0.086	0.053*** (1)	0.014
			0.012*** (2)	0.004
			−0.065*** (3)	0.017
somecollege	0.061	0.088	0.013 (1)	0.014
			0.003 (2)	0.003
			−0.016 (3)	0.017
unigrad	−0.020	0.149	−0.029** (1)	0.012
			−0.006** (2)	0.003
			0.036** (3)	0.014
femaleblack	0.092**	0.038	-	-
femaleotherrace	0.131***	0.049	-	-
femaleunigrad	0.057**	0.026	-	-
blackHSdropout	−0.218***	0.063	-	-
blackunigrad	0.092**	0.047	-	-
Sample size	59,938			
Pseudo R^2	0.065			

*10% significance level, **5% significance level, ***1% significance level.

Robust standard errors are provided.

7 Conclusion

This paper analyzes changes in risky asset ownership of the elderly using the Health and Retirement Study data for 2002-2008. To examine the investment portfolio decisions of the elderly and the health-wealth gradient, I utilize Heckman's two-step and the IV Ordered Probit models. I conduct separate analyses for non-cohabiting singles and couples considering the leisure complementarity and a shared budget constraint.

The estimates suggest that the elderly singles and couples with the older partner aged 65-75 invest less in risky assets both at the extensive and intensive margins. This finding underlines the importance of the Social Security rules in the risky asset investment behavior of the elderly. The other partial reasons behind this finding might be the age-related decline in health capital beyond self-reported health measures utilized and cohort differences. The elderly covered by a DC plan are found to be significantly more likely to invest in risky assets and also allocate a larger proportion of their wealth into stock holdings. On the other hand, DB plan coverage seem to affect the risky asset investment behavior only at the extensive margin though its magnitude is small in comparison to DC plans. The effect of retirement on risky asset ownership varies by wealth such that the wealthy elderly have a higher probability of risky asset ownership and invest more proportionately when they retire. The opposite is true for the elderly having a limited amount of wealth. The effects of bequest motives differ based on cohabitation status. The elderly singles having risky assets in their portfolio, if they have children, invest a smaller share of their wealth in risky assets. For the elderly couples having children, we see a positive association at the extensive margin accompanied by a negative effect at the intensive margin, making the overall effect ambiguous. Overall, these findings underline the important roles of the Social Security system, private pension plans, retirement decision and bequest motives in risky investment decisions that have not yet been explored in the literature.

The rest of the findings are in line with previous research. While wealth is estimated to be a significantly more important determinant than health at the extensive margin, the latter seems to be important for couples both at the extensive and intensive margins. Education is found to be positively associated with risky asset ownership, which likely underlines the role of financial sophistication. Females and racial minorities are estimated to be more risky averse in their risky asset investment behavior while the same holds true for couples with at least one self-employed partner.

The IV estimates suggest that there is a significant correlation between wealth and health status, further confirming the existence of the health-wealth gradient for the elderly. It is additionally found that females and racial minorities have better health than males and whites, respectively. Health status is also found to be positively associated with education.

There are currently more than 110 million people in the United States aged 50 and over, half of whom have already reached the retirement age. The total value of their risky asset holdings is estimated at 12.9 trillion dollars. Given the rapid increase in the number of elderly and growing inequalities in wealth and income, it is then in the interest of government, firms, and households to be familiar with the determinants of risky portfolio choice. The results suggest that policymakers should lean more towards DC pension plans as part of a public debate to overhaul the current pension system. This would allow not only to increase investment in the capital stock of the economy, but also to reduce the burden of unfunded liabilities of Social Security. Macroeconomic policies addressing income and wealth inequality should additionally be aimed towards increasing participation in the stock market. From the perspective of households, improving the financial literacy is the key to make better decisions on asset allocation.

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