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RISK PREFERENCES AND THE INVESTMENT DECISIONS OF OLDER AMERICANS

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The Public Policy Institute, formed in 1985, is part of Public Affairs at AARP. One of the missions of the Institute is to foster research and analysis on public policy issues of interest to older Americans. This paper represents part of that effort.

The views expressed herein are for information, debate, and discussion, and do not necessarily represent formal policies of AARP.

Foreword

Given the trend in private and public pensions to allow more participant choice in retirement saving asset allocation, how much risk individuals take when they invest their assets has important implications for retirement income security. The "three-legged stool" of retirement income policy assumes that, in addition to relying on future Social Security benefits, individuals and households will participate in private pensions and will save on their own to provide an adequate retirement standard of living.

Examination of individual investment portfolios reveals that for many households, accumulated wealth may be insufficient as a component of future retirement income. Although part of the problem is that households simply have lower savings rates than previous generations, also of concern are the high levels of personal debt, the high proportion of household portfolios invested in housing, and the fact that many households are risk averse, i.e., they tend to make substantial investment in low-risk assets with low returns. Since riskier portfolios generally result in higher returns for long-term investors, overly conservative investment behavior may result in reduced retirement wealth.

The role of risk aversion, i.e., attitudes toward risk, in the portfolio allocation and investment decisions of individuals and households—is the focus of this report by researchers Vickie Bajtelsmit and Alexandra Bernasek of Colorado State University. Using the 1994 Health and Retirement Study (HRS) (respondents age 51 to 61 in 1992 and their spouses), these researchers estimate risk preferences and evaluate the factors that impact asset allocation in individual and household portfolios for a sample of older Americans. Of particular interest, based on information from the HRS sample, are differences in the willingness of women and men to make risky investment allocation decisions. They also examine other important factors that impact investment decisions including age, race, wealth, marital status, and education.

Examining the household portfolios of HRS respondents, the authors find that low levels of savings and high levels of personal and real estate debt are serious problems for many households nearing retirement. The net effect is that many households have relatively little wealth to rely on for retirement income.

Whether or not housing assets are included, wealth is a significant determinant of the willingness to take risk in an investment portfolio. The wealthier the household, the greater the allocation to risky assets, even after controlling for age, income, dependents, and other demographic characteristics. The percentage allocation to risky assets is also lower for those with less education and for those with higher defined contribution pension balances.

Excluding housing equity from wealth, single women, single men, and married couples are all likely to make riskier allocation decisions as their wealth increases, while blacks have lower-risk portfolios. Single women are found to be relatively less risk averse than married couples and single men because, as their wealth increases, they

allocate proportionally more to risky assets than single men or married couples. Single men and women tend to have less risky portfolios when they are homeowners and more risky portfolios as the number of children increases.

These findings raise important policy questions about how to improve the retirement income prospects for men, women, and minorities. Encouraging saving and increasing wealth among segments of the population with especially low saving rates is an important retirement income policy concern in itself. However, increasing wealth may lead to greater investment in risky assets, which can lead to higher long-term investment returns. The findings also raise the question whether some Social Security reform proposals that involve individual accounts will produce sufficient returns to risk averse low-income households to offset reductions in benefits.

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Introduction

The "three-legged stool" of retirement income policy assumes that, in addition to relying on projected Social Security benefits, individuals will participate in private pensions and will save on their own to ensure an adequate post-retirement standard of living. Examination of individual portfolios reveals that for many households, accumulated wealth may be insufficient to accomplish this goal. Although part of the problem is that households simply have lower savings rates than in previous generations, we also observe high levels of personal debt, a large proportion of household portfolios invested in housing, and substantial investment in low-risk assets. Since riskier portfolios generally result in higher returns for long-term investors, overly conservative investment behavior may result in reduced retirement wealth. Given the trend in private and public pensions to allow more participant choice in retirement savings asset allocation, individual risk aversion is an important policy issue.

Purpose

This report reviews and synthesizes research findings on individual risk aversion and investment allocation. It then uses the *Health and Retirement Study* (HRS) to estimate risk preferences and to evaluate the factors that impact asset allocation in individual and household portfolios for a sample of older Americans. Of particular interest is the examination of differences in risky allocation decisions between women and men in the sample and investigation of the factors that impact investment decisions for each of these groups, including age, race, income, wealth, marital status, and education.

Literature and Methodology

The first part of the report reviews the economics of risk aversion and surveys the relevant literature on investment allocation. Although several studies have considered investment allocation, they tend to be based on limited data samples or on samples that are missing key demographic, socioeconomic, and household variables. Most studies have concluded that individuals are more averse to risk than theory would suggest is optimal. When left to their own devices, individuals tend to invest much more conservatively than professional asset managers would recommend. The implication of this observation is that, on average, individual portfolios will have lower return on investment and consequently will produce lower retirement accumulations than would otherwise be the case. In considering differences by characteristics such as gender, age, and income, previous studies have fairly consistently found that women are more conservative investors than men, older people have lower-risk portfolios than younger people and that higher income people are less risk averse.

In the second part of the report, relative risk aversion is estimated using the 1994 wave of the Health and Retirement Study, a nationally representative panel study of 6,979 households nearing retirement (respondents age 51 to 61 in 1992 and their spouses). This survey includes detailed information on financial, health, experiences, and attitudes. Since the focus of the study is on investment allocation, the sample is limited to those households with at least $1,000 in net wealth.

Principal Findings

Examination of the household portfolios of HRS respondents reveals that low levels of savings and high levels of personal and real estate debt are serious problems for many households in this age category. The net effect is that about half of the surveyed households have relatively little wealth to rely on for retirement income. Specifically, fifty percent of all the households in the sample have less than $200,000 in net wealth (including checking, savings, investments, real estate equity, pension balances, less personal debt). The lowest 25 percent have less than $77,000 in net wealth. This distribution of wealth persists across all the age groups in the sample, with those at or near retirement age having only slightly more wealth on average than those in their 50s. The study measures net present wealth only and excludes the value of future inheritances, defined benefit plan benefits, and Social Security benefits.

The empirical study presented in this report examines the determinants of portfolio allocation to risky assets, with and without including housing wealth, since housing is purchased for both consumption and investment. Net wealth is defined to include dollar balances in checking and savings accounts, equity value of automobiles, certificates of deposit, U.S. savings bonds and treasury securities, cash value of life insurance, stocks, bonds, mutual funds, owned businesses, defined contribution (DC) pension balances, investment real estate, and other assets (collectibles, jewelry, IOUs), and is net of personal debt.

Whether or not we include housing, net wealth is found to be a significant determinant of the willingness of households to take risk in investing their portfolio. The results of this research are strongly consistent with decreasing relative risk aversion, i.e., the wealthier the household, the greater is their portfolio allocation to risky assets, even after controlling for age, income, dependents, and other demographic characteristics. The percentage allocation to risky assets is also found to be lower for those with a lower education (high school or less) and for those with higher DC pension balances. When housing is not included in the definition of wealth, blacks have lower-risk portfolios and single women have higher-risk portfolios. When housing is included in the definition of wealth, blacks tend to have a larger allocation to risky assets, an indication that they allocate more of wealth to housing than non-blacks.

Marital status and gender differences are investigated in this study by comparing portfolio allocations of single women to single men and married couple households, not including housing equity in the definition of wealth. Although all three groups are found to exhibit decreasing relative risk aversion, single women in this age group are found to

be relatively less risk averse than married couples and single men in that, as their wealth increases, they allocate proportionally more to risky assets. Singles (both men and women) tend to have less risky portfolios when they are homeowners and more risky portfolios as the number of children under age 18 increases. Unlike the results for the entire sample, having lower education and being black is not a significant factor in single women's risky allocation.

Introduction

With the retirement of the baby boom fast approaching and Social Security's long-term financial viability in serious jeopardy, individual savings and investment behavior have never been more important. Although Social Security, even with its projected long-term solvency problems, will continue to provide a safety net, adequate replacement of pre-retirement income will, at least in part, depend on private pension plan coverage and investment choices. With savings rates at an all-time low and less than half of all workers participating in an employer sponsored pension, it is doubtful that retirees will be able to sustain their pre-retirement standard of living without retiring later or changing their savings and investment behavior radically.

Essential to consideration of this problem is a better understanding of why and how individuals make investment decisions. Unfortunately, our current state of knowledge on these issues is inadequate to the task of accurately predicting the ultimate well-being of retirees in the next century. Even where we can make statements about the outcome "on average," the heterogeneity of the population makes it likely that a focus on average outcomes will disguise serious problems at the individual level. Has the general health of the economy and the bull stock market of the last decade guaranteed a better standard of living for future retirees? Is the trend toward self-directed defined contribution pension plans, where participants can choose their own investments, a benefit or a detriment to long-term savings? Are individual and household investment portfolios designed appropriately to achieve retirement goals? Will savings be sufficient to support the American "retirement dream"?

The purpose of this report is to take a first step toward answering the questions posed above by investigating the impact that risk attitudes have on investment allocation. Better understanding of individual risk-taking and portfolio allocation may make it possible to design policy interventions and educational programs that have greater likelihood of achieving the desired goal: ensuring adequate retirement income for everyone.

The first part of this report reviews the theoretical and empirical literature on individual risk attitudes and investment allocation. While the methodologies and datasets differ, most studies have concluded that individuals are more averse to risk than theory would suggest is optimal. When left to their own devices, individuals tend to invest much more conservatively than professional asset managers would recommend. The implication of this observation is that, on average, individual portfolios will have lower return on investment and consequently will produce lower retirement accumulations than would otherwise be the case.

After reviewing the prior research, the second part of this report explores these issues empirically using financial and demographic data collected in the Health and Retirement Study, a survey which includes a nationally representative panel sample of 6,979 households on the verge of retirement (age 51-61 in 1992). Careful consideration

of portfolio allocations and wealth accumulations in this sample provide additional support for the notion that this group may not be adequately prepared for their imminent retirement. Special consideration is given to the differences between household portfolio allocations by characteristics such as age, income, gender, education, and race. Based on the background literature and the empirical results of this study, conclusions and implications for policy are provided in the last section.

What Do We Know About Risky Decisionmaking?

When individuals make decisions in situations where there is some uncertainty about outcomes, those decisions generally involve some element of risk. There are a number of theories that seek to explain how people deal with risk and how they make decisions under conditions of uncertainty. While, some of the theories are based on formal mathematical models with deterministic solutions, critiques of these theories have led to the formulation of alternative models that focus more on institutional analyses of decisionmaking in the presence of risk. All of these theories are necessarily simplified stories that abstract from many of the details of risky decisionmaking and attempt to focus on the essence of the process. A brief summary of the main theories of individual decisionmaking under uncertainty is presented in this section and discussion of the more technical aspects of the theories can be found in the Appendix.

Expected Utility Theory: A Framework for Analyzing Investment Behavior

In economics, the most widely accepted framework for analyzing individual decisionmaking under uncertainty is *expected utility theory*. When faced with some uncertain event that has various possible outcomes (some of which may be good, others bad), each with a certain probability of occurring, individuals routinely make decisions taking into account the consequences of these outcomes and their likelihood of occurring. The important insight into this process offered by the pioneers of expected utility theory, Von Neumann and Morgenstern (1953), was that individuals care only about the satisfaction or *utility* they gain from the outcomes of some uncertain event, not about the dollar value of the outcomes. For example, if a person has a 50:50 chance of winning $100 or losing $100, then what is important to the person is not the gain of $100 in one case and the loss of $100 in the other; it is increase in the utility, or satisfaction, from having an additional $100 in the first case versus the loss of utility from having $100 less in the second case.

The foundation of expected utility theory is the assumption that an individual's preferences can be represented by an *expected utility function*. The utility function is assumed to have the property that the utility of an uncertain event is equal to the sum of the utilities of the possible outcomes of the event, weighted by their probabilities of occurring. Individuals are then assumed to make decisions based on which option provides the highest expected utility. A person's attitudes toward risk are captured in the specific form of the expected utility function which will determine their indifference between various choices they are presented with.

An example of a utility function and how it is applied:

To illustrate the use of a utility function, suppose that a particular individual's utility can be described as the square root of her wealth ($U=\sqrt{W}$). (Note that this particular function is only one of many that might be used to represent the utility function and is chosen for mathematical simplicity.) If her initial wealth is $1,000,000, then she has utility of wealth equal to 1000 (the square root of $1,000,000). Suppose that this person is exposed to a 50:50 risk of losing $200,000 which implies that expected wealth is equal to .5($1,000,000)+ .5($800,000) = $900,000. In the event of loss, utility will fall to $\sqrt{800,000}$ or 894.43. Expected utility will be .5(1000) + .5(894.43)= 947.22. Thus, this person will be indifferent between facing this risk and having $897,226 for certain since the utility of that amount is also 947.22. An application of this result is the observation that this person would be willing to pay up to ($900,000-$897,226) = $2,774 to purchase insurance against this risk. At any price lower than that amount, the insured wealth will provide greater utility than in the risky case.

Definition of risk aversion. A person is described as risk averse if, when faced with a gamble, the utility they derive from the gamble's expected value (or expected pay-off) is higher than the utility they can expect from taking the gamble. This means that a risk averse person would rather have a given amount of wealth for certain, than face the risk involved in an uncertain event, even if the expected value of that event (what you would get on average if you faced this event a large number of times) was the same as the amount of wealth the person could have for certain. The implications of this are that a risk averse person (a) will actually be willing to pay some positive amount to avoid an uncertain event, and (b) will have to be paid some positive amount to be willing to face an uncertain event.

An example of risk aversion:
Suppose you could choose between having $1,000,000 in final retirement wealth for certain and having a 50:50 chance of either $800,000 or $1,200,000. A risk averse person would rather take the $1,000,000 for certain than face the risk of the uncertain event, even though the expected value of the uncertain event is also equal to $1,000,000 (Expected value = 0.5 ($800,000) + 0.5 ($1,200,000) = $1,000,000). To see that the square root function used in the previous example describes a risk averse person, note that the utility of $1,000,000 for certain is 1000 as in the previous example. The expected utility of the risky scenario is $.5(\sqrt{800,000}) + .5(\sqrt{1,200,000}) = 994.93$. This person would be indifferent between facing this risk and having $989,886 for certain (i.e., $\sqrt{989,886} = 994.93$). Another way of looking at this is to say that a risk averse person will require a premium to be willing to take risk. As an alternative, note that in the case of a 50:50 chance of either $800,000 or $1,300,000, the utility of the gamble outweighs the utility of $1,000,000 for certain. The larger the required *risk premium*, the more risk averse a person is said to be.

Measures of risk aversion. Expected utility theory was extended by Pratt (1964) and Arrow (1971) who developed two measures of risk aversion to compare people in

terms of their attitudes toward risk. The measure of *absolute risk aversion* determines the dollar amount of wealth a person will hold in risky assets. The more risk averse a person is, the smaller their dollar holdings of risky assets. One person is said to be more risk averse than another if, given the same wealth, they hold a smaller dollar balance of risky assets. The measure of *relative risk aversion* determines the proportion of wealth a person will hold in risky assets. The more risk averse a person is, the smaller will be the proportion of their wealth they hold in risky assets. Once again, one person is said to be more risk averse than another if for the same level of wealth, they hold a smaller proportion of their wealth in risky assets.

How risk aversion is affected by changes in wealth. An important question arising from the expected utility framework is how attitudes toward risk are likely to be affected by changes in wealth. For example, we would like to know if a person becomes less risk averse as they accumulate more wealth. We would also like to know if people with lower levels of wealth will tend to be more risk averse, all other things equal, than people with higher levels of wealth.

Expected utility theory predicts that absolute risk aversion decreases with wealth. Higher levels of wealth are associated with larger dollar balances invested in risky assets. This property is known as *decreasing absolute risk aversion* and is usually abbreviated as DARA. There is no equivalent theoretical prediction when it comes to relative risk aversion, i.e., higher levels of wealth may be associated with either higher or lower proportions of wealth invested in risky assets. Although Stiglitz (1969) under certain conditions derived a prediction that relative risk aversion will increase with wealth, it has not been possible to generalize the prediction, and the consensus among economists is that the effect of changes in wealth on relative risk aversion is an empirical question. In fact, the most common finding from empirical studies is that relative risk aversion is either decreasing or constant as wealth increases. These properties are referred to as *decreasing relative risk aversion* (DRRA) and *constant relative risk aversion* (CRRA). At least for small changes in wealth (e.g., less than $1,000), CRRA seems more consistent with intuition.

Studies of Relative Risk Aversion

Why does the form of relative risk aversion matter? This section reviews the results of many studies that have considered the form of relative risk aversion. The reason that this has been such a popular topic for consideration in recent years is closely tied to policy issues related to retirement. In most aspects of life, it would not overly concern us if one person, or a group of individuals, were more risk averse than another. However, attitudes toward investment risk are known to have a large impact on wealth. Simulations based on past performance of stocks versus bonds indicate that a balanced stock portfolio will, on average, yield ten times as much retirement wealth as a long-term bond portfolio over a forty year investment period (Bajtelsmit, 1996). Significantly lower wealth in retirement increases reliance on Social Security and public health insurance programs. If it can be shown that certain groups of individuals (e.g., by wealth, gender, or race) are more risk averse than others, this may put these groups at higher risk of poverty in old age.

How is wealth measured? The results of previous studies are heavily dependent on how wealth is defined. In particular, principal residences, human capital, and automobiles may or may not be included in wealth definitions. The justification for treating these asset classes differently than others is generally based on two concerns: 1) the illiquidity of the asset, or 2) the non-investment intent of the purchase of the asset.

The theoretical models assume that all assets are perfectly liquid (easy to sell at a fair price) and infinitely divisible (making it possible to sell in small units). This assumption is clearly problematic for some categories of wealth such as houses and human capital. Residences make up a large share of individual investment portfolios, particularly for those in lower income groups, but the purchase of a house generally requires a large dollar investment, takes two months or more to implement, and involves significant transactions costs (both in dollars and effort).

Human capital is the economic term for the present discounted value of an individual's investment in skills and training, or "earning power." For young people who have not yet accumulated physical assets, human capital is their single most important asset. At that point in the life cycle, an individual's investment of time and education is often solely directed to increasing the value of his or her human capital. By comparison, toward the end of the working career, human capital is generally a small component of wealth relative to financial assets. Since human capital is unique to each individual and non-transferable to others, it is highly illiquid and is sometimes not included in wealth measurement.

When assets are purchased for consumption as well as for investment purposes (e.g., homes, cars, and household consumption goods), inclusion in the household portfolio may overestimate household wealth. For example, you might be able to sell your house to generate cash, but you would have to use some of that cash to pay for shelter. There is no generally accepted way of dealing with these issues, although cars and household goods are generally excluded. Nevertheless, it is important when comparing results across studies to be aware of how wealth is being defined in each case.

Estimation of relative risk aversion. Friend and Blume (1975) conducted one of the earliest studies of risk aversion and wealth and many later studies employ their methodology for estimation of relative risk aversion. While the mathematical details are included in the Appendix, the measure of risk aversion developed in that paper depends on the individual investor's portfolio allocation between risky and risk-free assets. The proportion of net worth that an investor places in risky assets under this formulation depends on the individual's relative risk aversion. The model assumes that all investors face the same market price of risk (i.e., they expect the same additional reward in return for taking on more risk in a diversified portfolio).

Friend and Blume estimate the relationship between risky portfolio allocation and wealth with cross sectional data from the 1962 and 1963 Federal Reserve Board Surveys of the Financial Characteristics of Consumers and Changes in Family Finances. Their results are sensitive to the way that wealth is defined. The narrowest definition of wealth

excludes the value of houses, cars, and human capital. On the basis of this definition of wealth, they find evidence of decreasing relative risk aversion (DRRA), i.e., individuals invest a larger proportion of their wealth in risky assets as wealth increases. When wealth is defined to include the value of houses, cars and human capital, their results are consistent with constant relative risk aversion (CRRA) i.e., individuals maintain a constant proportion of their wealth in risky assets as wealth increases.

Following the methodology of Friend and Blume, several studies find evidence of DRRA. Morin and Suarez (1983), using data from the Canadian Survey of Consumer Finances for 1970, find evidence of DRRA when wealth is defined exclusive of housing. Bellante and Saba (1986), building on the work of Morin and Suarez and using data from the U.S. Department of Labor's Consumer Expenditure Survey for 1972-73, find evidence of DRRA when wealth is defined to include the value of housing but not the value of human capital. When the definition of wealth includes human capital as well, they find that the result of DRRA still holds but is significantly weaker. Confining their sample to less wealthy households, they find evidence of increasing relative risk aversion (IRRA), i.e., individuals invest a smaller proportion of their wealth in risky assets as wealth increases.

Other studies find similar results. Siegel and Hoban (1982) find evidence of DRRA among wealthy households and IRRA among less wealthy households, when wealth is defined exclusive of housing. Riley and Chow's (1992) study of the 1984 panel of the Survey of Income and Program Participation (SIPP) finds evidence of DRRA when wealth is defined inclusive of houses but exclusive of human capital. It should be noted however, that findings of DRRA may be biased by investment inertia. Schieber and Shoven (1997) note that individuals do not adjust their portfolio allocations regularly and thus, in a period of rapidly rising stock prices, investment inertia may make it appear that individuals exhibit DRRA (since the proportion of wealth in risky assets is increasing at a faster rate than the proportion in low-risk assets) when in fact they have CRRA preferences.

Most of these studies estimate the relationship between an individual's investment in risky assets and wealth in a simple equation which excludes the effects of individual and household characteristics. However, the complexity of the question being asked necessitates models that include a wide range of control variables that are hypothesized to influence risky decisionmaking.

Studies of Risk Aversion and Individual Characteristics

Women tend to be more risk averse than men are. Researchers have only recently begun to explore the issue of differences in risk aversion by gender. Anecdotal evidence suggests that women are more risk averse than men and a number of studies have confirmed this finding even when controlling for the effects of other individual characteristics such as age, education, and wealth. Jianakoplos and Bernasek (1998) use the framework of Friend and Blume (1975) to consider gender differences in financial risk taking. They use data from the Federal Reserve's Survey of Consumer Finances (1989) and estimate relative risk aversion by gender. They find that single women were

relatively more risk averse than single men and married couples. The proportion held in risky assets was found to increase with wealth (DRRA) but for single women the effect was significantly smaller than for single men and married couples.

Palsson's (1996) study of Swedish households also finds evidence that women are more risk averse than men when she examines the effects of a wide range of household variables on financial risk taking. Riley and Chow (1992) also look at the effects of a broad range of individual and household variables on risk aversion and find a small but significant gender difference in risk taking with women being more risk averse than men. In their study, never-married women were less risk averse than married women, who were less risk averse than widowed and separated women.

Other studies have explored gender differences in risk aversion in the context of non-financial decisions. These studies also find evidence of women's greater risk aversion. Hersch (1996) finds that, on average, women made safer choices than men in a number of risky consumer decisions such as smoking, seat belt use, preventative dental care and having regular blood pressure checks. Hersch (1998) looks at gender-specific estimates of illness and injury incidence rates for different industries and occupations and concludes that women are more risk averse than men based on the observation that women are paid a higher compensating wage differential for accepting a given job-injury risk. Brinig (1994), analyzing data on speeding convictions, finds that women appear to be less willing than men to be caught and convicted of speeding.

Although several of the studies cited above focus on finding evidence of gender differences in risk aversion, they do not address the question of why such differences exist. Bajtelsmit and Bernasek (1996) suggest a conceptual framework for understanding why it is that women invest differently than men based on their review of the interdisciplinary literature on gender differences in risk taking. They find support for the idea that gender differences in biology and in socialization operate in various ways to explain women's greater risk aversion.

If women are systematically more risk averse than men, the implication is that women will earn lower rates of return on their investments than men at the same wealth level. This implies that they will accumulate less wealth than men over time, a conclusion that is compounded by the fact that women, on average, have lower income and wealth than men and are less likely to have private pensions (Bajtelsmit and Bernasek, 1999). Looking at this issue from the perspective of retirement income adequacy, women will have less accumulated wealth at retirement with which to support a potentially longer retirement period. Although recent evidence from Bajtelsmit and Jianakoplos (2000) suggests that the outlook for younger women based on their private pension accumulations is improving, there is still a large gender gap in retirement accumulations. Ensuring that women are not poor in their retirement years thus requires that we better understand why they are more risk averse than men.

Risk aversion tends to increase with age. Age is a demographic characteristic which has long been hypothesized to affect an individual's degree of risk aversion. The

life-cycle risk aversion hypothesis predicts that risk aversion will increase over the life-cycle–the older a person gets, the more risk averse he or she becomes. The underlying explanation for this lies in the relative importance of future labor income (human capital) and asset income over the life cycle. It is hypothesized that the further a person is from retirement the more risk he or she is willing to accept in his or her investments since the number of paychecks he or she expects to get is large and labor income can offset any adverse investment outcomes. The closer to retirement a person gets, the fewer remaining paychecks he or she has to cover any such adverse investment outcomes.

Several studies that have considered the effects of age on risk aversion claim to test the life-cycle risk aversion hypothesis but, in fact, they do not. Most studies use cross-sectional data (a group of people of different ages at a given point in time) rather than longitudinal data (a group of people followed over time) and therefore can only draw inferences about the differences in risk taking between individuals of different ages, as opposed to considering how individuals' attitudes toward risk change as they age. It is also important to note that these studies vary considerably in their specification of the age variable, some using actual age, and some defining age groups but in no consistent manner.

Morin and Suarez (1983) and Palsson (1996) conclude that risk aversion increases with age such that older people are more risk averse than younger people. Bajtelsmit and VanDerhei (1997) and Hinz et al. (1997) find similar results in the narrower context of pension allocations, using large data sets of a private defined contribution pension plan and a federal government pension plan, respectively.

Riley and Chow (1992) find that risk aversion decreases with age up to 65 years, then increases significantly. Bellante and Saba (1986) attempt to distinguish between the effects of human capital and age on risk aversion and find evidence of increasing relative risk aversion with human capital but decreasing relative risk aversion with age. Although they interpret their results as evidence of a pure life-cycle effect of age that is independent of the human capital effect, the cross-sectional nature of these studies cautions against such strong conclusions. Since age is correlated with wealth acquisition, the decreasing risk aversion with age could be simply the DRRA phenomenon. However, to the extent that empirical studies control for both factors, age may still be a significant factor in risky asset allocation.

In a rare study using time series data, Bakshi and Chen (1994) find evidence to support the life-cycle risk aversion hypothesis. Focusing on the effects of demographic changes on capital markets, they find an increase in the risk premium associated with an increase in the average age of investors.

The effects of age on risk aversion are further complicated by the possibility of cohort effects i.e., different generations have different attitudes toward risk. For example, a study by Brown (1990) examines the effect of the distribution of wealth across age cohorts on security prices taking into account the non-marketability of human capital earnings. He finds that middle age investors were less risk averse than young

investors and that older investors were more risk averse than middle age investors. If age is correlated with wealth until retirement, this makes intuitive sense. Jianakoplos and Bernasek (1998) attempt to disentangle the cross-sectional, life-cycle and cohort effects of age on women's risk aversion. They find that younger women (under age 30) in 1983 and in 1995 are less risk averse than older women in the same years, 30-42 year-old women were less risk averse in 1995 than in 1983, and that in 3 out of 4 stages in the life-cycle, relative risk aversion decreases with age.[1]

The role of race/ethnicity in risk aversion is unclear. Very little research has been done on the effects of race/ethnicity on risk aversion largely due to the inadequacy of available data sources. Although most of the large surveys (e.g., SCF, SIPP, HRS) ask information about race, the number of individuals in each category is often too small to draw statistically significant conclusions.

In her study of risky consumer decisions, Hersch (1996) finds that, overall, whites make safer choices than blacks but that the racial gap closes considerably when education and wealth are controlled for. Within racial categories, women are found to exhibit safer behavior than men. The conclusion Hersch makes is that race is not as important a determinant of risk taking as other individual characteristics such as age, education, and wealth.

Jianakoplos and Bernasek (1998), in their study of financial risk taking, find that black single women are significantly less risk averse than white single women, and are less risk averse than black single men and married couples. This is in contrast to their finding that white single women are more risk averse than white single men and married couples. Comparing classes of MBA students at the University of Houston and the Madrid School of Business, Zinkhan and Karande (1991) find that the Spanish students were less risk averse as a whole than the American students. (This study also finds significant gender differences, an indication that the gender effect exists cross-culturally as well).

Effect of education on risk version is mixed. A number of studies have examined the effects of formal education on risk aversion. A common concern in interpreting the results of these studies is that education, income and wealth tend to be correlated so that inclusion of all three variables in regression equations may tend to bias the results. The effects of education on risk taking are mixed. Riley and Chow (1992) find that financial risk aversion decreases with education. Jianakoplos and Bernasek (1998) find the opposite–risk aversion is higher for those with more than a high school education, without any significant difference between women and men. Hersch (1996) finds that risk aversion increases with education when considering risky consumer choices.

In the context of financial risk taking, it would seem that a more relevant effect to measure would be access to financial knowledge rather than education in general. A study by Bayer, Bernheim and Scholz (1996) examines the effects of financial education

[1] In that study, life stages were defined as: under age thirty; age 30-42; age 43-55; and age 56-68. This formulation allowed the researchers to directly compare groups who were surveyed in 1983 and 1995.

in the workplace on participation in and contributions to voluntary savings plans. They find that measures of savings activity are significantly higher when employers offer retirement seminars and the effects are greater for lower paid employees than for higher paid employees. The Employee Benefit Research Institute (EBRI) and Mathew Greenwald and Associates Retirement Confidence Survey results indicate that individuals with greater financial knowledge are more likely to have realistic expectations regarding their potential retirement and are more likely to have money set aside for retirement other than employer pensions and Social Security (Yakoboski, 1996). More importantly, 85 percent of workers in that survey who had the opportunity to read employer-provided materials or attend seminars took advantage of these opportunities provided by their employers, and, of those who did, almost half (46 percent) reported that it led them to change the allocation of their money among the options available in the plan. Thus, financial education programs in the workplace may have a significant impact on portfolio allocation to risky assets, which is commonly used as the decision variable in studies of risk aversion.

Studies of Individual Investment Allocation

In recent years, many studies of investment allocation have been conducted. However, since they tend to consider a particular aspect of the individual's portfolio, e.g., their defined contribution (DC) pension investments, without considering the whole portfolio, it is problematic to use them as the basis for making broad statements about risk aversion. Studies that have been conducted by private pension providers or sponsors are particularly subject to this criticism since these firms do not typically have access to very detailed information on household income and wealth. The literature reviewed in this section therefore comes with the caveat that the conclusions are largely descriptive and comparative rather than strong evidence of propensity to take risk.

Individuals tend to invest their pension portfolios conservatively. Observation of plan level data has generally yielded a relatively consistent conclusion: individuals tend to pick fairly conservative pension portfolios. A 1993 study by Hewitt Associates found that when guaranteed investment contracts (GICs) were offered, they accounted for almost half of all employee contributions. Equities and balanced funds accounted for only 21 percent and 13 percent respectively. A Fidelity Investments study including over 1500 plans and 2 million participants in 1994, found that when employer stock was offered, it accounted for about 16 percent of plan assets. Nearly half of the funds were allocated to non-employer stock and 28.7 percent in GICs. When employer stock was not available, the percentage in both equities and GICs increased. A survey of plan sponsors conducted by the Institute of Management and Administration and discussed in Sussman (1997) found that 59 percent of plan sponsors were concerned that their DC plan participants were allocating their investments too conservatively to achieve desired retirement income.

Goodfellow and Schieber (1997) tabulate the investment allocations for a sample of more than 36,000 participants in 24 defined contribution plans holding nearly $1.4 billion in total assets. They find that fixed income investments are about 58 percent of

total funds and that stocks represent approximately 28 percent. The percent in fixed income increases with age and the percent in stocks declines. Higher income individuals are more inclined to invest in stocks, as are men. Bajtelsmit and VanDerhei (1997) consider individual plan data on 20,000 employees of a large U.S. firm and find account allocations in that study to be 41 percent employer stock, 14.2 percent equity, and 44.8 percent GICs for the men in the sample. Their regression results indicate that women are less inclined to invest in employer stock and equities.

The largest pension fund in the world, TIAA-CREF (the Teachers Insurance and Annuity Association-College Retirement Equities Fund) has provided participants with investment choices since 1952. In the early years, there were only two choices, the TIAA traditional guaranteed annuity and the CREF equity account. Internal studies over many years indicated that most participants allocated their premiums 50-50 and did not regularly reallocate over time, even when the actual account balances differed substantially from the original 50-50 mix. In more recent years, TIAA-CREF has expanded the asset choice set to include equity accounts of differing risk and return characteristics as well as money market, bond, and real estate choices. At the same time, the firm has attempted to increase participant knowledge through educational programs. The end result is that in 1996, the proportion of participants allocating some portion of their premiums to equities has steadily increased and 22.2 percent are 100 percent in equity. The 50-50 allocation strategy is still popular (24.6 percent) and the proportion investing entirely in the guaranteed fund (9.0 percent) is half what it was in 1986. (TIAA-CREF, 1997). The allocation patterns by age have also changed over the last decade. In 1986, nearly 30 percent of participants over age 55 were invested entirely in the TIAA guaranteed annuity account, whereas in 1996, that percentage had dropped to only 16.1 percent. The younger-aged participants (under 35) are on average less conservative than in 1986 as well, with more than half of that group having at least 50 percent of their premiums allocated to equities (TIAA-CREF, 1997) compared to only 11 percent in 1986.

Hinz, McCarthy, and Turner (1997) examine the 1990 allocation patterns of federal government workers in the Thrift Savings Plan. Although their primary research question was related to gender differences, it is interesting to note that the observed patterns of allocations are very similar to those observed for other types of pensions. These workers were allowed to allocate up to 60 percent of their contributions to common stock and fixed income funds (the remainder to be in a fund of Treasury securities). Only 28 percent of women compared to 45 percent of men participated in the common equity fund. Overall, 13.4 percent of funds were allocated to equities (average 8.9 percent for women and 15.3 percent for men).

Special issues in analysis of portfolio allocation. Empirical analysis of investment allocation presents several special problems given the limitations of currently available data. The studies surveyed in the previous section are based on in-house pension fund data and, as such, lack valuable explanatory information on the participants' overall financial condition. Some specific issues that also deserve mention are the household

versus individual observation unit, gender, age and cohort patterns, and differences between what people say and what they do.

There is some question as to whether studies of financial decisionmaking should have the individual or the household as the unit of measurement. While in many households, spouses or partners keep all finances completely separate, there are many households in which the finances are combined. Therefore, examination of one spouse's pension allocation may show a very conservative allocation of funds, but the other spouse's pension may be in stocks. Consideration of these individuals separately would thus yield incorrect conclusions regarding the risk preferences of the household. The available nationally representative surveys of household decisionmaking do not include any information on who makes financial decisions for the household.

Financial planners often recommend a life-cycle approach to investment allocation. The so-called "Rule of 70" suggests that investors should subtract their age from 70 and invest that percentage of their portfolio in equities with the remainder in fixed income securities. There is actually no theoretical basis for such a rule and, in fact, research on time diversification suggests that the investor's age is less important than his or her investment time horizon (Siegal, 1994). Neither the private pension surveys nor the SCF and CPS data sets are particularly useful for examining investment patterns over the life-cycle. Although each includes information on age of participants, this tells us only what individuals of different ages are doing at a particular point in time. There is no longitudinal survey that follows a nationally representative sample and collects sufficient financial information. While the HRS is collecting appropriate information for a set of older Americans, only four waves of the survey are completed to date. The Panel Study on Income Dynamics (PSID) is longitudinal, but since it oversamples the poorest households, the data must be sample weighted to be nationally representative. Many studies have attempted to draw life-cycle conclusions or inferences based on cross-sectional data. Comparison of cross-sections of the SCF, CPS, or Survey of Income and Program Participation (SIPP) have shown that cohorts do seem to exhibit patterns of wealth accumulation and decumulation. For example, Venti and Wise (1997) use a method of analysis based on "like families" in the SIPP between 1984 and 1991.

Limitations in the financial data make it difficult to make strong conclusions regarding the asset mix. Many of today's financial asset choices were not available until fairly recently. Even if there were a good source of longitudinal data on individual financial decisionmaking, a potential problem is the bias introduced by the researcher. By answering financial questions every few years, the participants in the survey are probably more aware of the issues than the average individual and may tend to make different financial decisions as a result. The psychometric literature shows that once an individual is made aware of a risk, they are more likely to take it into consideration.

As discussed earlier in this report, it is difficult to separate the age effects from cohort effects. For example, the observation that a baby boomer couple carries a higher risk portfolio than their parents at the same age, may be due to their age or it may be to the greater conservatism of people in a cohort that has lived in the post-depression era.

Several studies examine cohort differences in investing and seem to find patterns that support the financial planner models that recommend lower risk at higher ages. Poterba (1997) tabulates 401(k) eligibility and participation data for different cohorts and finds, not surprisingly, that younger cohorts are more likely to be eligible for 401(k) pension plans, with highest eligibility for the 35-45 year old group. However, the participation rates, given eligibility, do not differ substantially across cohorts and average about 70 percent.

The Health and Retirement Study, which has more complete financial information, essentially follows a single cohort through time, from the original survey in 1992 to the present. To the extent that there are some survey participants who are older or younger spouses of the target survey group, there may be some evidence of cohort effects, but the respondent pool does not have a representative sample of those age cohorts. Over time, additional survey participants in the target age group are being added to replace those who have died.

Alternative Theoretical Perspectives

All of the preceding discussion has focused on models and studies that have their foundation in expected utility theory, which is the prevalent model of risky decisionmaking. However, a review of this body of literature would be incomplete if it did not include a summary of the critiques of this model, alternative perspectives, and a review of empirical studies testing the relationship of expected utility to actual behavior. While by no means a complete discussion of these issues, this section outlines the most important components of that literature. Machina (1992) provides a more complete review of these alternative perspectives and multiple articles on these topics are compiled in Kahneman et al. (1987) and Goldstein and Hogarth (1997).

Models assuming non-linear preferences. There have been several critiques of the key assumption of expected utility theory—that it can be estimated as a weighted average of the utilities of the outcomes (i.e., expected utility is linear in the probabilities). One of the important questions raised by these critiques is whether we are attempting to explain what people *actually* do or what they *should* do. The predictions of expected utility theory are largely normative in that they tell us what people would do if they applied the accepted model of rational behavior. Thus, most of the alternative theoretical paradigms for explaining choice under uncertainty arise out of observations of behavior that seem to violate the rationality of the expected utility paradigm. The resulting models are designed to explain the observed behaviors, even when those behaviors do not seem logical.

The well-known Allais Paradox, first identified in 1953 (in French) and later explained in Allais (1979), uses an experimental design (choice between constructed gambles) that demonstrates that individual decisions violate the linearity property, a result that has been verified in many other studies. The traditional model predicts that individuals will trade risk in a consistent pattern, represented by an indifference curve. An indifference curve represents all the sets of risky choices that give an individual

equivalent utility. An individual is assumed to be able to rank all possible choices such that they lie on one indifference curve or another. As the opportunity set changes, it is hypothesized that individuals will make predictable choices, trading additional risk for some amount of additional expected wealth. Although decision theorists rarely explain this in an investment context, the following example can illustrate this concept:

> *Example of inconsistent choices:*
> Assume that an investor is offered two investment options: a savings account that pays a guaranteed 3 percent return on investment or a money market account that pays a market determined rate of return for low risk securities. Assume that the money market investment will pay 3½ percent interest with 50 percent probability and 2½ percent interest with 50 percent probability. If an investor chooses the guaranteed account, we might reasonably conclude that the investor would also opt for a guaranteed 4 percent account over an account yielding 4½ percent or 3½ percent with 50/50 probability of each. Although this example is fairly simplistic, expected utility suggests that individuals should rationally make consistent decisions. If an individual were to choose the guaranteed account in one case but not the other, we could say that this was "irrational."

Another example of economic irrationality in practice is the differential treatment of gains and losses. In making choices between different sets of options, individuals have been shown to be more risk averse with respect to losses than they are with respect to gains. If the difference were simply the effect of diminishing marginal utility, as described earlier in this report, this would not be inconsistent with the model. However, this behavior has been shown to exist in cases where the constructed gambles are exactly identical but the questions are worded as losses instead of as gains. Psychologists, on the other hand, might not regard this behavior as irrational.

> *Example of differential risk assessment of losses and gains:*
> Suppose a person has initial wealth of $1000. They must choose between 1) taking a gamble that will pay $0 or $200 with equal probability and 2) getting $100 for certain. An alternative scenario begins with wealth of $1200 and requires a choice between 1) taking a gamble where you lose $200 or $0 with equal probability or 2) lose $100 for certain. Note that all the outcomes and probabilities in these two examples are the same. When an individual chooses the gamble in the first scenario but not in the second, the difference is not explainable under standard expected utility theory.

A third example is perhaps the most familiar. Millions of people each day participate in state lotteries where they "invest" their dollars in a gamble that has expected value much less than their invested price of the ticket. This is apparently contrary to expected utility theory since these same individuals would not invest larger sums of money in investments with proportionally low expected value. However, the entertainment value of the lottery game may offset the negative value of the gamble.

As the experimental evidence of deviations from the expected utility model has accumulated, decision theorists have attempted to organize these examples by their common features and to provide explanations for the observed outcomes. In addition to organizing the evidence of deviations from the expected utility paradigm, researchers have also attempted to generalize the expected utility model to allow for nonlinear preferences. The critical difference between these models is their treatment of the probabilities. Where the standard expected utility model assumes that the utilities of the outcomes of an uncertain event are weighted by the respective probabilities of those outcomes occurring, the other models allow for the possibility that individuals apply subjective assessments to the probabilities, an idea that is a mathematical formulation of psychometric theory concepts discussed in the next section.

Fortunately, these alternative models do not require abandonment of the theoretical results that have been derived from the expected utility framework. Rather, they have attempted to generalize the results from the prior theory to a larger class of potential utility functions. These studies continue to add value to our knowledge about individual decisionmaking and researchers have identified a number of areas in which individuals seem to depart from the expected utility paradigm.

Psychometric theory. The origins of psychometric theory are in social science studies of risk. The theory is most commonly associated with the work of Slovic, Fishoff and Lichtenstein (1981). Its emphasis on risk *perception* and the role that underlying values and beliefs play in forming an individual's assessment of risk distinguishes it from the expected utility approach. Where expected utility presumes a "correct" answer to any utility maximization problem (subject to the utility function), perception is unique to each individual and is much less predictable or explainable. Despite this, however, psychometric theory accepts as its point of departure a characterization of risk in terms of probabilities and outcomes just as the expected utility approach does. Thus, given the utility function and an understanding of the individual's perception of risk, the optimization process is expected to conform to the general methodology of expected utility theory (i.e., weighting of outcomes by their impact on utility).

The psychometric approach characterizes risk as a complex multi-dimensional concept that is broader than the statistical representation of expected utility theory. Evidence of differences in perceived risk by experts and laypersons is viewed as a reflection of differences in knowledge. Thus, even within the psychometric approach, there is a belief in an underlying absolute standard of risk about which experts are more informed than laypersons. The implication of this difference is that the risk perceptions of laypersons are "incorrect" and can be improved with appropriate education. This is not inconsistent with conclusions that could be drawn on the basis of expected utility theory. Evidence of behavior that is inconsistent with the predictions of expected utility theory would be interpreted as irrational and economically inefficient.

Within the context of expected utility theory, there is little explanation for why "irrational" behavior should occur and hence how it could be altered. The psychology literature suggests that some of the problem lies in the cognitive limitations of the human

mind. When the process of estimating probabilistic outcomes and comparing across alternatives is too mathematically difficult, individuals may develop simplified methods for solving complex problems. These *heuristics*, or rules of thumb, arguably substitute for a full optimization process. Although originally proposed by Simon (1955), the judgment and decisionmaking literature has fully embraced the idea that expected utility theory may be regularly violated by the use of faulty heuristics in application. These heuristics are discussed in detail in Kahneman, et al. (1987).

> *Example of a faulty heuristic rule:*
> A commonly cited heuristic rule for estimating unobservable probabilities is called "availability." Individuals using this heuristic will judge an event more likely if they can easily recall an instance of it occurring. For example, even though most stock market investors understand that the market can go up and down, downturns almost always precipitate a "flight to quality" where investors shift to perceived lower-risk securities.

While it may be logical to assume that easily recalled events occur with higher frequency, the biased reporting of particular events in the media often unduly influence individual perception of probability. For example, the risk of dying in a plane crash is generally over-estimated, particularly after such an event has recently occurred. Similarly, the highly publicized school shooting in Littleton Colorado has increased the perceived probability of school violence.

Cultural theory. The cultural theory of risk represents a more radical critique of expected utility theory than that of psychometric theory. This approach is associated most commonly with the work of Otway and Thomas (1982). The theory rejects the possibility of an absolute standard of risk and instead characterizes risk as a socially constructed concept. It is argued that perceptions of risk come from human experience and, since people have different experiences, their perceptions of risk will necessarily differ.

> *Example of cultural influence on risk aversion:*
> Gender differences in risk taking are sometimes explained under cultural theory to be the result of the historical social context in which women are raised and educated, the woman's role in child-bearing and child-rearing, and childhood experiences related to risk-reward tradeoffs in sports and family life.[2] If women are less inclined to take risk than men, this is arguably due to cultural influences that have caused inherent and culturally induced preferences that place more value on safety and stability.

Proponents of cultural theory argue that individuals have different but equally valid contributions to the analysis and understanding of risk. They do not recognize any legitimate difference in the risk perceptions of experts and non-experts since they reject the idea of an underlying standard of risk. Rather, the risk perceptions of laypersons should be recognized as legitimate, and any assessment of risk should involve two-way

[2] See Bernasek and Bajtelsmit (1996) for a review of this literature.

communication between experts and lay persons. The cultural approach to dealing with different perceptions of risk is to start from the perceiver of risk (rather than the technical attributes of risk as in the other theories of risk) and focus on the social/cultural context within which risk is assessed and managed (Bradbury, 1989). In this way, differences can be negotiated and all individuals can make legitimate contributions to risk assessment and management.

The difficulty with applying the cultural theory to risk taking is the lack of a framework for evaluating differences in risk assessment and their implications. Although the cultural approach rejects the notion of an absolute standard of risk, it is possible to adopt a pragmatic approach that uses the insights of cultural theory to supplement the analysis of risk aversion using expected utility theory. In particular, cultural theory provides valuable insights into understanding how people's understanding of risk is formed. This is something that expected utility theory takes as given.

When we observe systematic differences in risk aversion between different groups of people it becomes important to explain how those differences arise. From a policy standpoint, that is a prerequisite for developing relevant policy interventions, particularly in an era where cultural influences are not static. In the case of gender differences, for example, the cultural influences on women have changed radically over the last three decades. Educational institutions have responded to the early critiques related to differential treatment of girls in school. Girls now have similar opportunities to participate in organized sports, arguably a child's first introduction to risk taking. In addition, women's labor market experiences are improving, although perhaps more slowly than many would like. These changes in the culture of gender will likely reduce or eliminate some of the currently observed differences in decisionmaking for the coming generations.

Testing the Models of Decisionmaking: Experimental Studies

Studies of decisionmaking based on observed outcomes do not allow researchers to ask the "what if?" questions that might allow differentiation among different models of decisionmaking. Another avenue for investigating risky behavior is to observe gaming behavior or to design experimental games that force participants to make decisions under uncertainty. The sample sizes for these experiments are often small (under 50 participants), participants usually face no risk of loss, the test subjects are often students, and the locations (on game shows or in classrooms) are not very similar to normal decision contexts, making the results less generalizable.

Examples of experimental studies include Gertner's (1993) study of risk-taking behavior in the context of the television game show "Card Sharks," Metrick's (1995) study of people's attitudes to risk and their ability to play best-responses in the game show "Jeopardy!", Altaf's (1993) experiment to test the extent to which risk preferences are context dependent, and Levy's (1994) experiment in which students must choose between investing in risky and risk-free assets in a series of ten decisionmaking stages.

The results of these and other experiments are mixed, but most find evidence that people's behavior is inconsistent with the predictions of expected utility theory.

Focusing specifically on risk taking by gender, Brinig (1994) conducts an experimental game that involves drawing a winning ball from one of three jars which represent different risk-return combinations. She finds no difference in the risk-taking behavior of women and men when gender alone is considered. When gender is combined with age however, she finds that women are more risk averse than men before age forty, they are less risk averse until age forty-five, and, beyond age forty-five, women and men are found to have the same tendencies for risk taking. The fact that participants do not face any risk of loss in the experiment cautions against drawing any strong conclusions from Brinig's results.

Jianakoplos and Bernasek undertake an experiment to test for differences in risk taking by gender, which, like Brinig's does not have any possibility of loss. They do not find any statistically significant difference in risk taking by gender. Using the same experimental design as Altaf (1993), they invite students to participate in an experimental game which pays $25 to the winner of the game. Individuals must choose between rolling a die and tossing a coin, each of which involves certain payoffs in the form of points. The objective is to accumulate the greatest number of points in the fewest possible plays of the game. The expected payoffs to a coin toss and a roll of the die are the same, but the variance is different—rolling the die is the riskier option. Their measure of willingness to take risks is given by the proportion of plays of the game that a person chose to roll the die.

Preparation for Retirement

Results of previous studies on accumulation of wealth have important implications for retirement. The aging of the baby boom and the projected insolvency of the Social Security Trust Fund have prompted several government and private studies considering the retirement preparation of Americans. The results differ depending on whether housing wealth is included in the asset portfolio. Bernheim (1993) examined actual savings of a sample of 3,800 baby boom households and found that, not including housing wealth, baby boomers are saving at one-third the rate necessary to maintain their level of pre-retirement consumption after retirement at age 65. With housing wealth included, they are still saving at only 84 percent of the necessary rate. A study by Arthur D. Little (1993), reported in Yakoboski and Silverman (1994), reached similar conclusions in considering the likelihood of meeting a savings goal sufficient to replace 70 percent of pre-retirement income.

Cohort effects: Venti and Wise (1997) analyze the SIPP from 1984 to 1991 and conclude that younger cohorts' real personal assets are substantially larger than those of their predecessors, due in large part to the increase in contributions to IRA, 401(k), and Keogh plans. However, some have suggested that the dissaving that will occur during the baby boom retirement may cause declines in asset value that offset these projected gains. (FRBSF, 1998)

The impact of Social Security: Since these studies all assume that Social Security will maintain its present level of generosity, any decreases in benefits or increases in taxes (which may displace other saving) imply that retirement savings falls even shorter of the goal. In analyzing preparation for retirement, it should be noted that Social Security benefits are a very large component of anticipated retirement income for the poorest households, comprising 42 percent of income for all retirees but more than eighty percent of retirement income for the lowest two income quintiles of retirees in 1992 (Yakoboski, 1994). Gustman and Steinmeier (1999) analyze the HRS households' preparation for retirement, including an estimate of the present value of projected Social Security benefits, and find that Social Security wealth is a substantial component of wealth for many of these households.

In analyzing household portfolio behavior, Social Security has generally been considered to be a relatively low-risk asset. Therefore, estimation of risky allocations of non-Social Security wealth actually understates the risk-aversion level of the household. Bajtelsmit and Turner (1998), using past historical risk and return data on various asset categories in a portfolio optimization model, show that, consistent with observed portfolios, risk-averse households would choose to allocate a substantial portion of wealth to a low-risk government guaranteed investment with low correlation to their other market assets. However, uncertainty about future changes in Social Security benefit calculations and retirement dates increases the risk to the government of this asset and raises the question of whether individuals should modify saving and investment behavior to compensate for this risk.

Despite the volume of work that has accumulated in recent years, there are many questions that remain unanswered with respect to individual risk attitudes, investment decisionmaking, and retirement preparation of Americans. The empirical study presented in the next part of this report uses the Health and Retirement Study to further consider these issues.

Data and Statistical Analysis

The Empirical Questions

Based on the literature that is reviewed in the previous sections of this report, this study considers allocation to risky assets in the context of the total household portfolio (i.e., all assets, including pension and non-pension investments as well as housing wealth). Previous research has suggested that there may be gender differences in allocation of wealth into risky assets as well as gender differences in other demographic and other labor market characteristics that influence risky allocations. This section of the report uses the Health and Retirement Study survey data to examine these questions.

Explanation of the Data

The Health and Retirement Study (HRS) is a nationally representative longitudinal data collection effort begun in 1992 focusing on Americans who are close to

retirement (aged 51-61 in 1992) and their spouses. The survey investigates aspects of these households' finances, health, and retirement decisions. The intent is to follow the same group of respondents through their retirement years and to continue adding age-eligible households each year. For the purposes of this report, the second wave of the survey, conducted in 1994, is used. Future research on these topics will benefit from making use of the longitudinal nature of the survey although there is some risk that the behavior of the households surveyed might be influenced by the survey itself. This survey is particularly well suited to the study of retirement savings since it includes information on all aspects of household wealth and income as well as key demographic information that researchers need for control variables. The investigation of investment risk taking in many previous studies has been limited to examination of particular investment portfolios without consideration of the rest of the household portfolio. Since, the HRS oversampled certain groups, all reported statistics in this report are sample weighted to be representative of the population in the target age group.

Asset, liability, and employment information in the HRS. The HRS survey includes extensive asset and debt information for each of 6,979 households (11,596 individuals). Respondents provide information on their primary residence and second home as well as investment real estate. They also give estimated values for personal property, self-owned businesses and farms, IRA and Keogh accounts, stock and bond investments (outside of tax deferred pensions), checking and savings accounts, money market funds, CDs, government securities, and other assets (including art and jewelry). Household debts, both secured and unsecured, are also summarized.

In addition to asset and debt information, the HRS includes substantial employment and pension information, such as employment history, types of pension plans for current and previous employers, characteristics of pension plans, and the expected retirement benefits. For the current employer, investment allocation and total accumulation is requested for each of the respondent's three most important defined contribution plans, defined as any type of plan in which money is accumulated in an account for the respondent (including 401(k), 403(b), ESOP (Employee Stock Ownership Plan), SRA (salary reduction agreements), thrift/savings, stock/profit sharing, and money purchase plans). For defined benefit plans, in which benefits are based on a formula usually involving age, years of service, and/or salary, respondents are asked to provide information about expected benefits.

As with the Survey of Consumer Finances, the survey is somewhat deficient in its information on defined contribution pension investment allocations. The respondent is simply asked to indicate whether the funds in these plans are invested in "mostly or all stocks," "mostly or all interest earning (or bonds)," or "split (between stock and interest earning investments)."

For investment allocation questions, an important consideration is whether the participants in a plan can direct the investment allocation. Of the 11,596 respondents in 1994, 350 provided information on their "most important" defined contribution plan at their current employer. Only 185 of these plans allowed the participant to choose the

way the money in the account was invested and 129 respondents said that they invested the pension in either a mostly stock portfolio (48) or split between stocks and interest earning investments (81). It should be noted however, that in the Wave 2 1994 survey data, asset allocation questions are only asked about those plans that the respondent reports have had changes in the rules that govern pension benefits or retirement age, so these numbers are meant to be illustrative rather than representative of the entire sample.

Asset Allocation By Marital Status

Table 1 provides summary statistics on the wealth allocations to particular asset categories for households in the survey, separated by marital status: single men, single women, and married couples.[3] The allocation to a particular asset category for each individual is calculated as:

$$\text{Allocation To Asset Category} = \frac{\text{\$ Value in Asset Category}}{\text{\$ Value of Total Assets}}$$

Total assets (as opposed to net worth) includes all assets reported in the HRS study: stocks, bonds, CDs, government securities, collections, checking and savings accounts, DC pension accumulations, real estate, and automobiles. Real estate (both housing—primary residence and second home, and investment) is valued as the value of the real estate less the outstanding mortgage balance. No other debt is subtracted to arrive at total assets. The reported values in the table are the sample-weighted average of all respondents, the sample weighted median value (i.e., the 50^{th} percentile), and the standard deviation. For several asset categories, the means exceed 100 percent of total wealth because many households have negative real estate equity, which makes their positive investments in other asset classes a large multiple of their total net wealth. However, the median investment allocation to most of the asset categories is zero. The standard deviations are also included in the table to illustrate the wide variation in allocations across households in the sample.

These general statistics, while they do not control for other factors, reveal some interesting differences by marital status. Single women have a larger proportion of wealth, on average, in the lower-risk investment categories (CDs and government securities, bonds, checking and savings accounts) than either single men or married couples. But they also have a larger percentage of wealth in some of the high-risk asset categories (non-pension stock and investment real estate (for investment real estate, this does not appear to be the case)). Net housing equity is more than 40 percent of total wealth for both married couples and single women, but only 30 percent for single men.

There is also wide variation in asset allocations within wealth groups. Table 2 provides the asset allocation median allocations, means, and standard deviations for each asset category by wealth quartile, which is based on the household's sample-weighted wealth. Wealth Quartile 1 is the lowest 25 percent of households by wealth and Wealth

[3] The categories of single men and single women include those who were never married, divorced, separated or widowed. Because of small sample sizes it is not possible to analyze these subgroups.

Quartile 4 is the highest 25 percent. This table illustrates some simple facts about wealth allocation. Low-risk securities, bank accounts and housing are a larger proportion of wealth for the lowest wealth households (33.5 percent, 77.5 percent and 42.8 percent respectively) than for the richest households (.7 percent, 1.8 percent and 30.1 percent respectively), whereas pension wealth is a much larger component for the wealthiest households (32.8 percent compared to 5.5 percent for the lowest quartile). Interestingly, while net housing equity does not vary tremendously across wealth quartiles, ranging from a low of 30.1 percent for the wealthiest group to 51 percent for the second quartile, the standard deviation of allocation to residences is extremely high for the wealthiest quartile, which means that the relative importance of housing varies greatly across this group. Another point to note is that allocation to stocks decreases as wealth increases, perhaps because those in higher tax brackets are more likely to hold high return assets in tax-deferred pension accounts.

Retirement Wealth

How well prepared for retirement are the HRS households? Tables 1 and 2 considered allocation of household assets without accounting for household debts (other than mortgage debt). In estimating preparation for retirement, a household's *net* current wealth is the variable of interest, since this will determine the potential for retirement income generation. Unfortunately, many households in this sample have substantial personal debt. This section considers the distribution of net current wealth across and within wealth quartiles.[4]

Net household wealth by quartile. Given the age of the target households (at least one spouse age 51-61 in 1992), one would expect them to have already made substantial progress toward their retirement savings goals. However, examination of the wealth of these households leads to the conclusion that many households have little or no accumulated savings. Table 3 details the mean values of net wealth for this sample by wealth quartile and within wealth quartile. In this table, net wealth is the total value of all assets, including pension accumulations, and real estate equity, net of all reported debt. The households in the bottom quartile, based on net wealth, have less than $77,000 in total net wealth. Fully 50 percent of the sample households have wealth less than $201,000.

Net household wealth by age category. Since the older households in the sample are closer to retirement and have had more years to accumulate wealth to support their retirement, it might be expected that the wealth levels would increase with age. Instead we find that wealth exhibits great variation within age groups as well.

Table 4 details the wealth distribution of the sample by age category. Age of a married household is defined as the average of the ages of the spouses. Since the primary focus of this study is risk taking in asset allocation as a means of accumulating retirement wealth, it is important to consider the influence of life-cycle factors. Where both spouses

[4] It should be noted that important sources of expected future wealth from Social Security, defined benefit pension plans, and inheritances are not measurable with this HRS data.

are of similar age, the choice of proxy for household age makes little difference since both will be at similar points in the earnings stream and will have approximately equivalent years to retirement. However, when the spouses' ages are very different, we assume that the savings and investment behavior of the household will incorporate the needs of both spouses. Therefore, an average of the two ages will account for the differential effect of age on the joint household investment portfolio.

As can be seen from Table 4, the lowest 50^{th} percentile of all age groups has very little accumulated wealth. This is particularly problematic for the households that are very near retirement. An accumulation at age 65 of $200,000 in wealth earning 6 percent per year will provide an annuitized income of only $17,437 for twenty years (without assuming any increase in the cost of living each year). Closer examination of the oldest households in the sample shows that 25 percent of the households have less than $85,200 in net household wealth. This level of wealth will be sufficient to provide an annuity of only $7,428 per year for twenty years.

It should also be noted that while variation in wealth by age exists among households in the bottom 50 percent of the wealth distribution, there is little variation in wealth by age among households in the top 25 percent of the wealth distribution—the top 25 percent of individuals in all age categories have wealth ranging between approximately $500,000 and $30 million.

In light of the descriptive statistics provided above, it seems clear that a better understanding of individual savings and investment behavior is warranted. In the following sections, an empirical methodology is employed which allows evaluation of the investment behavior of this survey group based on household characteristics.

Methodology

Theoretical framework. Expected utility theory implies that the proportion of risky assets in an investor's portfolio will be a function of their wealth and their degree of risk aversion. It is also likely, given previous theoretical and empirical work, that risk aversion is also dependent on wealth in that individuals will have different attitudes toward risk as wealth increases. The empirical model used in this study follows directly from the previous literature discussed in Section II and attempts to measure Pratt-Arrow relative risk aversion (the change in portfolio allocation to risky assets as wealth increases).

As discussed in Section II, Friend and Blume (1975) developed a theoretical and empirical framework for the estimation of relative risk aversion and several other studies have employed their methodology. The model used in this report follows the same general framework with some modifications. Since the model has its foundation in capital market theory, it assumes that financial assets are infinitely divisible and can be traded with zero transaction costs. This is clearly not the case for such assets as housing wealth and human capital. Although pension wealth is also not tradable *per se*, tax laws allow certain individuals to access some pension wealth with a penalty. Consistent with Bernasek and Jianakoplos (1998), human capital is incorporated by reformulating the

Friend and Blume theoretical model to take into account the correlation between return on human capital and the return on the market portfolio.[5]

Empirical Model

The variable of interest is the proportion of net household wealth that is allocated to risky assets. The denominator of this ratio, net household wealth, is defined as in Tables 3 and 4 as all reported asset holdings (risky and non-risky) less the dollar value of household debt. This wealth measure is calculated with and without housing wealth (WEALTH1 and WEALTH2) since it is not clear whether homes are accumulated for investment purposes in addition to their consumption purposes. The regression equation uses the natural log of wealth rather than the dollar value because the natural log measures changes in wealth as opposed to absolute wealth. Therefore, given that the dependent variable is the proportion of wealth in risky assets, the estimated coefficient on the natural log of wealth provides an estimate of the inverse of the coefficient of relative risk aversion (C_k) to a positive multiplicative constant. This formulation also avoids some bias that can be introduced by a small number of extremely large wealth observations. The two definitions of wealth lead to the two variations on the dependent variable, RISKY1 and RISKY2, defined as follows:

$$RISKY1 = \frac{\text{Risky Assets Including Housing Equity}}{\text{Total Net Wealth Including Housing Equity (i.e., WEALTH1)}}$$

$$RISKY2 = \frac{\text{Risky Assets Excluding Housing Equity}}{\text{Total Net Wealth Excluding Housing Equity (i.e., WEALTH2)}}$$

Low-risk assets are defined as those that are fairly liquid, have little or no default risk, and have very little short-term fluctuation in value. They include dollar balances of savings, checking, money market accounts, certificates of deposit, the cash value of life insurance, U.S. savings bonds and Treasury securities. Risky assets include the net value of stock accounts, stock mutual funds, owned businesses, bond accounts (corporate, municipal, government, foreign), pension vehicles (IRAs, Keoghs, 401(k) plans, 403(b) plans) not invested in money market securities, other assets (jewelry, IOUs, collectibles, etc.), equity in investment real estate, and housing equity (included in RISKY1 only). While it may be the case that some of the investments (such as retirement accounts) which are here identified as risky may in fact be invested in fairly low-risk securities, the information reported in the survey does not allow us to distinguish the allocation of assets within these accounts very exactly. Hence, we err on the side of over-estimating actual allocations to risky assets in this study.

The effect of demographic and household characteristics on risky allocation is investigated in a regression that includes all the variables that are hypothesized to influence risky investment allocation (age, education, children, marital status, pensions, income, and race). Explanatory variables, as they appear in the results, are defined as follows: AGE, the age category based on average age of the members of the household

[5] See Appendix B.

(Age<50; Age 50-54; Age 55-59; Age 60-64; Age 65+)[6]; LOWEDUC, the respondent's education level (entered as a dummy variable equal to 1 if the respondent's highest educational level is high school equivalency or less)[7]; KIDS, the number of children under the age of 18; SINGFEM, a dummy variable for single females[8]; HASDB, a dummy variable equal to 1 if the respondent or spouse has one or more defined benefit plans from which they are/will be entitled to receive benefits; HHPENBAL, the total balance of all reported household pensions of the type that accumulate funds in an account for the participant; HHINCOME, the total income of the household, a proxy for human capital discussed in more detail below; and BLACK, a variable equal to 1 if both spouses report race as black.

Human capital is usually defined as the present discounted value of the future stream of earnings discounted at the long-term real rate of interest. Such a measure is certainly appropriate when using broader survey data such as the Survey of Consumer Finances, which represents the full spectrum of adult ages. In the case of the HRS, each household includes at least one individual who is 53 to 63 in 1994 and many are already retired. Because of this, the income-based measure of human capital is highly correlated with household income. As such, we chose to use combined household income as the proxy for human capital since it may also act as a control for consumption-related effects.

Table 5 provides sample weighted summary statistics for selected variables used in this study. The sample used for the empirical analysis was limited to households that had at least $1,000 in net household wealth (leaving 9,927 individuals in the sample, representing 86 percent of the original sample of households). In this group, the mean household age is 58 years, 14 percent are single women, 21 percent have DB plans, and 61 percent have no more than a high school education.

Results

Relative risk aversion: Table 6 presents the estimated coefficients, standard errors, and marginal effects for the regression estimated with and without including housing wealth in total wealth. Since the dependent variable, the percentage of wealth allocated to risky assets, is a naturally censored, i.e., a truncated variable[9], a tobit

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[6] The omitted category in all the regressions including age is the 65 and older age group. The categorical formulation, as opposed to actual age, improved the significance of the model, which may be an indication of a nonlinear age effect. In other words, given the relatively narrow range of ages in this sample, this was not surprising. Regressions using actual age and age-squared yielded less significant results.

[7] Other alternative measures for education include actual years of education, an education category dummy and a dummy for those with higher education. Empirical tests showed the low education dummy reported here and the college education dummy were the most significant in the models. This is an indication that the relationship between risk taking and education is not linear but has a "tail" effect.

[8] This includes those who are separated, divorced, widowed and never married. Although it would seem that the never married group is more likely to exhibit different investment behaviors than the others, there are only a small number of women in the sample who have never been married. Regressions using that variable showed it to be insignificant in determining risky allocation.

[9] A censored variable is one that logically can only take on a particular range of values. Since risky assets are a subset of total wealth, and the sample is restricted to those households which have more than $1,000 in assets, this variable will generally be between zero and 100 percent. To a limited extent, individuals can

regression is used. Because the tobit estimation uses the truncated portion of the data, the estimation procedure also calculates an estimate of the standard deviation of the distribution.[10] To adjust for the truncated portion of the distribution, a scale factor based on the estimate of the standard deviation, is then applied to calculate the marginal effects of explanatory variables, shown as the "slope" in Tables 6 and 7. The marginal effects, or slopes, can be interpreted as the expected value of the predicted independent variable including the truncated portion of the distribution.[11] The interpretation of all explanatory variables is based on slopes rather than on the estimated coefficients, as we would like to include all observations in the sample—even the truncated portion of those who have proportions of risky assets exceeding 100 percent.[12]

The estimated slope (or the marginal effect) of the natural log of wealth provides an estimate of relative risk aversion.[13] The positive slope (and positive and statistically significant coefficient) on this variable in Table 6 indicates that individuals with greater wealth in this sample of older adults allocate a larger portion of their wealth to risky assets than those with less wealth. This finding is consistent with decreasing relative risk aversion as has been found in several previous studies using different samples. In Table 6 and the other tables reporting regression results, those variables that are statistically significant at the 90 percent, 95 percent, and 99 percent levels are indicated by one, two, and three asterisks respectively (*). Coefficients without an asterisk are not significantly different from zero and thus are not important factors in determining allocation to risky assets for this group of individuals.

The slope for ln (HHWEALTH) is .108 when housing is included in the definition of wealth and .093 excluding housing. Thus, a one percent change in wealth results in an increase in allocation to risky assets of 10.8 or 9.3 percentage points. For the average household in the sample with approximately $800,000 in total wealth, not including housing, and a 56 percent allocation to risky assets, this implies that a one percent increase in wealth ($8,000) would result in a 9.3 percentage point increase in risky allocation to 65.3 percent. Since this is an absolute change in the risky allocation, it will be a greater percentage change for those households with lower wealth than for the wealthier households, because lower wealth households will have a lower proportion of assets allocated on a risky basis. Hence, the responsiveness of asset allocation to wealth levels will vary with the initial proportion a household holds in risky assets; the greater

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borrow money to invest in risky assets, but since many are constrained from leveraging to the extent that they might want, the tobit procedure allows for the possibility that, in the absence of credit constraints, there might be individuals who would have chosen to be outside the observed range of risky allocations. The model assumes that the lower limit of the dependent variable is the minimum observed in the data and the upper limit is the maximum but that the error terms are normally distributed.

[10] The standard deviation of the distribution is not shown in Tables 6 and 7.

[11] "Marginal effect" or "slope" may be defined as the expected value of the predicted y*, given y is positive. In our study, since the model is truncated from above, it implies E[y*/y>100 percent].

[12] The assumption made in this analysis is that the slope of a variable is significant if its coefficient is significant—the level of significance of a variable's slope, in contrast to its coefficient, could not be calculated with the statistical package used in this study.

[13] The coefficient estimates the inverse of the coefficient of relative risk aversion discussed in earlier in this report. The sign (positive or negative) can be interpreted as the absolute change in the coefficient of relative risk aversion for a given change in wealth.

the proportion held in risky assets, the lower the percentage shift to risky assets due to a change in wealth level. The slopes on the wealth quartile variables for the regression including housing support this conclusion since they are all significantly greater than the omitted Wealth Quartile 4 category and the slopes are decreasing in wealth.

Control variables: The control variables also provide some interesting information about household portfolio allocations. It should be noted that the interpretation of these slopes or marginal effects is slightly different than that of the wealth variable, because they are not "logged." The marginal effect or slope gives an estimate of the percentage change (as opposed to percentage point change) in allocation to risky assets. Based on the signs and significance of the explanatory variables, the percentage allocation to risky assets is shown to be lower for those with lower education levels and for those with greater pension balances. On average, a person with a high school education or less will have a 1.6 percent (with housing) or 4.6 percent (without housing) lower allocation to risky assets (Table 6). For the average household with a 56 percent allocation to risky assets, the allocation would be 3 percentage points lower (4.6 percent of 56 percent, i.e., 53.4 percent) for the lower educated household.

The effect of the other control variables depends on whether housing wealth is included in the measure of household wealth. When housing is not included in the equation, blacks have lower allocations to risky assets and single women have higher allocations. Blacks are likely to reduce their allocation by 7 percent, when housing is not included, and increase their allocation by only 3 percent if housing is included. On the other hand, single women are likely to increase their allocation by 5.6 percent if housing is not included. When housing wealth is included, single women do not have a significantly different allocation but blacks have a 3 percent higher allocation than non-black households, which can be interpreted to imply that black households tend to have a larger proportion of their wealth in housing equity than other households.[14]

As compared to the omitted age category (65 and older), younger groups allocate a greater proportion to risky assets, with the most significant difference being for those in the under 50 age group. The other age group slopes are not significant at the 5 percent level. If the household is in the under 50 age group, the allocation to risky assets will increase by 6.1 percent (including housing) and 2.8 percent (excluding housing). The other age categories, 50-59 and 60-64, are not statistically significant. The age significance also disappears when this analysis is applied to single men, single women, and married couples. The control variable for homeownership in the regression that excludes housing from wealth is significant and negative. Since allocation to risky assets is lower for homeowners, this may be an indication that households consider their housing to be a risky investment (due to illiquidity, leverage, and uncertainty of future value) and that they reduce their allocation to other risky investments as a result.

Gender differences: Given the significance of the single female dummy in the regression excluding housing wealth, further investigation of this issue was warranted. Table 7 reports the result of regressions run for each marital status category separately

[14] See Myers and Chung (1996) for a discussion of racial differences in home ownership and home equity.

with sample weighting. The reported regression slopes for the single men and married couples equation are also statistically compared to the coefficients for the single women. Any coefficient on this table that is marked with an "@" symbol is significantly different from the single female coefficients at the 90 percent confidence level.

All three groups exhibit statistically significant decreasing relative risk aversion (investing a larger proportion of wealth in risky assets as wealth increases), and single women have a significantly larger coefficient than married couples and single men. This implies that, for a given change in wealth, single women would increase their allocation to risky assets by a larger percentage point increase than married couples or single men, holding all else equal. This is a particularly interesting result, given the findings of previous studies that suggest greater risk aversion for women. Although women clearly have lower-risk portfolios overall, their relative risk aversion is decreasing at a faster rate than that of single men or married couples.

Most of the control variables have the expected effects and are consistent across groups with some notable exceptions. Household income (HHINCOME) is insignificant in all but the single female group where it has a small negative effect on risky allocation. The number of children under age 18 (KIDS) is significant only for the singles where it increases the risky allocation, perhaps due to aggressive saving for college. The age categories are not significant for either single men or single women, except for married couples in age category 60-64. However, ignoring marital status, households in the under 50 age category have a positive and significant impact on asset allocation when housing is included (Table 6). These age categories are not significant but they have proportionately more risky assets than the 65 and older group for the married couples. Since the age category is based on average age of the household, the married couples in each category could both be in that age category, or there could be one older and one younger spouse. Therefore, the comparative results on this variable are difficult to interpret with any degree of reliability.

Respondents with high school or less education (LOWEDUC) have lower allocations to risky assets in all but the single female group, where education is insignificant. Married couples with at least one black spouse have lower-risk household portfolios. Having a defined benefit plan does not impact the risky allocation, but since that variable is defined as equal to one regardless of the size or generosity of the plan, not a lot can be read into that result. The balance in the combined household defined contribution plans (which is included in both the numerator and denominator of the risk allocation variable) has a negative impact on risk allocation for the singles and married couples.

As in the more general model, homeownership has a significantly negative effect on risky allocations for all marital status groups, but the effect for singles is significantly different than for the married couples. Homeownership is not "logged." Homeownership decreases risky allocation by 5 percent for single women and 11.6 percent for single men, but has no significant impact on risky allocation for married couples. This can be interpreted as evidence that singles are more likely than married couples to view the

home as a risky investment and alter the rest of their portfolio accordingly. The wealth quartiles are significant only when marital status is ignored. Allocation to risky assets declines when housing is included and increases when housing is excluded. The wealth quartile 3 (from $201,000 to $542,000) has the greatest impact on allocation. Compared to the first quartile, being in the 3rd quartile increases allocations by 14 percent, while being in the 2nd and 4th quartiles increases allocations by 12 and 9.9 percent, respectively (Table 6). When marital status is considered, wealth quartiles have a positive impact only on married couples, while the allocation in risky assets declined for single women in both the 3rd and 4th quartiles (the coefficients are not significant for single men) (Table 7).

Separate regressions were also estimated including housing with similar results but are not reported here. Although the coefficients obviously differed, the significance and signs of explanatory variables were largely comparable. The tests for differences by marital status indicated significant differences between single women and both other groups with respect to the homeownership dummy, again supporting the idea that single women consider homeownership to be a form of risky investing.

Conclusions

Principal Findings of this Study

In this paper, we have reviewed the literature related to investment allocation and risk taking, drawing on a diverse literature from economic theory, consumer science, psychology, sociology, and finance. Although this area of research is in a developmental stage, the bulk of the empirical work suggests that individuals do not generally allocate their portfolios in the ways that might be suggested by theory. In addition, studies indicate that there may be characteristic differences in the allocation decisions made by particular groups, most notably by age and gender.

The analysis presented in this report uses the 1994 Wave of the Health and Retirement Study, a nationally representative survey of households with at least one member aged 51-61 in 1992. This survey includes extensive financial and demographic information, making it possible to consider questions of investment allocation in the context of a complete household portfolio. The results of this study confirm earlier research suggesting that a large proportion of households nearing retirement have relatively low levels of wealth and that demographic characteristics are significant predictors of risky investment behavior.

Half of all households in this survey, sample weighted to be representative of this population segment, have less than $200,000 in net wealth (total value of assets and housing less debt). The lowest 25 percent of this population by wealth have less than $77,000. Without including housing equity, wealth levels are much lower. Although these households may be anticipating future inheritances, defined benefit plan benefits, or Social Security benefits that are not incorporated in our measure of current wealth, the fact that so many have accumulated so little in personal and pension wealth implies that

the "three-legged stool" of retirement income may be insufficient to provide an adequate retirement.

Based on the empirical results of this study, we find that wealthier households tend to have riskier portfolios than those with less wealth, which is evidence of a characteristic known as "decreasing relative risk aversion." Other important factors for investment risk taking include education (those with high school or less are more risk averse), race (blacks have higher-risk portfolios when housing is included in wealth, lower-risk when housing is not included), and marital status (single women have higher-risk portfolios when housing is not included in wealth). Those latter two findings are an indication that, for blacks and single women, net housing equity is a larger component of their portfolio than for others in the sample. Having a defined benefit pension does not have a significant impact on risky allocation.

Compared to those age 65 and older, the younger households have higher allocations to risky assets. As would be expected, the lower wealth quartiles have lower allocations to risky assets than the richest in the sample. However, when housing is included in the definition of wealth and as a risky asset, the households in the lower wealth quartiles have higher overall allocations to risky assets than households in the wealthier quartiles, indicating that housing wealth is a more significant component of their risky portfolio than it is for the wealthiest quartile. This simply reflects the fact that housing comprises a much higher proportion of the wealth of lower income than higher income households.

Comparison of single women to single men and married couples shows that, while all three marital status groups exhibit decreasing relative risk aversion, investing higher proportions of their portfolio in risky assets as their wealth increases, the relative risk aversion of single women is significantly different from that of married couples. For a given increase in net wealth, single men and married couples increase their allocation to risky assets to a lesser degree than do single women. Other characteristics that influence the risky allocation differently for single women compared to other groups are: the number of children under age 18 (increased risk compared to married couples), low education (lower risk compared to single men), pension balance (decreased risk compared to married couples), and homeownership (decreased risk compared to married couples).

Implications for Public Policy

The results of this study are important because they cast light on the behaviors of individuals and households at or near retirement age. Better understanding of investment and savings behavior can help to guide policy toward pension and Social Security reform.

Retirement wealth adequacy: Given that this sample is conservatively within fifteen years of retirement, it seems unlikely that the households in the lower quartiles of wealth will be able to accumulate sufficient savings to adequately fund their retirement income needs. Lower levels of savings might be rational if the households are planning to rely on future bequests from aging parents, Social Security benefits and/or defined benefit pension plan benefits which are not measurable with this data. However, only 21 percent of those in this sample report having a defined benefit pension of any type. For those with parents still living, there may be additional costs associated with long-term care that will erode potential bequests and/or existing wealth. On the other hand, Social Security is designed to be redistributive and replaces over 50 percent of the earnings of a low-wage worker—even higher replacement rates for workers with spouses. Therefore, expected Social Security income may play a role in saving patterns.

Retirement wealth composition: Two points stand out from the examination of these households' wealth. First, thirty to fifty percent of total assets (slightly higher for those in the lowest wealth categories) is in net housing equity (real estate value less mortgage debt). When personal debt is subtracted to arrive at net wealth, housing makes up an even larger proportion of net wealth. Although real estate has yielded fairly good returns over time and also provides consumption benefits, it is not an investment well suited to provision of future retirement income since liquidation of the asset requires that the retiree find alternative housing. Reverse annuity mortgages have not been popular despite their availability for some years. Policies and contractual arrangements aimed at making it easier to access home equity may alleviate some of this problem.

In contrast to the large share of assets in housing equity, defined contribution pension accumulations account for only 12 percent of the asset portfolio on average for this sample and a much smaller share for the less wealthy. While pension sponsorship and participation rates have improved over the years, this age group has not benefited to as large a degree as the population at large because members of this group are less likely to work for firms which offer pensions, and even if they do, they have not had as many years to accumulate pension savings or accrue benefits. It should be noted, however, that IRAs and Keoghs are a large share of wealth in this sample, particularly for single women and for the lowest wealth groups who may be those least likely to have other retirement savings vehicles. As time goes on, the future waves of this survey will be useful for determining whether public policy toward retirement savings is having the desired effect of increasing these components of the household asset portfolio. We strongly recommend policies aimed at increasing incentives for employer pensions, encouraging participation for eligible employees, encouraging rollovers of pre-retirement distributions, and increasing the annual IRA limits.

Risk aversion: This study shows that households in this age range exhibit relative risk aversion in their portfolio allocation, that risk taking increases with wealth, decreases with age and with lower education. Single women tend to have higher-risk portfolios and blacks tend to have lower-risk portfolios. Comparison of portfolio allocations with and without housing wealth implies that individuals tend to consider their residence as a component of the risky portfolio and adjust their risk accordingly. Statistical

comparisons by marital status group show that although all three groups exhibit decreasing relative risk aversion, single women tend to increase their risky allocations, as their wealth increases, to a greater extent than do single men and married couples.

Table 1. Ratio of Selected Asset Classes[1] to Total Assets by Marital Status[2]

Asset Category	Single Men (n=617)			Single Women (n=1364)			Married (n=8848)		
	Median	Mean	Stand. Dev.	Median	Mean	Stand. Dev.	Median	Mean	Stand. Dev.
Residences	0.096	0.295	0.368	0.374	0.414	0.405	0.385	0.414	0.549
Checking/Savings	0.037	2.965	43.689	0.029	8.394	160.717	0.019	0.532	9.744
Automobiles	0.048	0.175	0.287	0.033	0.140	0.269	0.148	0.109	0.233
Stock (Non-pension)	0.000	1.207	17.258	0.000	4.942	89.706	0.000	0.760	31.468
Bonds	0.000	0.064	0.704	0.000	3.381	149.290	0.000	0.027	0.664
CDs, Govt. Securities	0.000	1.018	24.157	0.000	1.123	20.715	0.000	0.115	2.760
IRA, Keoghs	0.000	1.163	7.675	0.000	15.735	457.793	0.000	0.606	21.126
DC Pension Accum.	0.000	0.128	0.307	0.000	0.126	0.303	0.000	0.111	0.279
Investment Real Est.	0.000	24.44	837.126	0.000	11.21	345.542	0.000	1.912	15.231

[1]Total assets includes housing equity, automobiles, stocks, bonds, checking and savings, pension plan balances, and other marketable investments, net of home mortgage. It does not include human capital or Social Security wealth. Columns will not sum to 1.0, i.e., 100%. Large mean ratios are generally due to extreme outliers.

[2] All data are weighted by HRS sample weights.

Source: Authors' tabulations of the Health and Retirement Study Wave 2.

Table 2. Ratio of Selected Asset Classes to Total Net Wealth[1] by Wealth Quartile[2]

Asset Category		Wealth Quartile 1	Wealth Quartile 2	Wealth Quartile 3	Wealth Quartile 4
Residences	Median	0.487	0.519	0.370	0.153
	Mean	0.428	0.508	0.395	0.301
	Stand. Dev.	0.395	0.276	0.219	0.358
Checking & Savings	Median	0.069	0.036	0.026	0.002
	Mean	0.775	0.114	0.069	0.018
	Stand. Dev.	3.430	0.304	0.157	0.050
Automobiles	Median	0.148	0.075	0.046	0.004
	Mean	0.258	0.099	0.061	0.178
	Stand. Dev.	0.287	0.086	0.059	0.037
Stock (Non-pension)	Median	0.000	0.000	0.000	0.000
	Mean	1.777	0.174	0.096	0.039
	Stand. Dev.	30.026	1.004	0.389	0.108
Bonds	Median	0.000	0.000	0.000	0.000
	Mean	0.079	0.032	0.020	0.005
	Stand. Dev.	1.009	0.423	0.378	0.032
CDs, Govt. Securities	Median	0.000	0.000	0.000	0.000
	Mean	0.335	0.049	0.024	0.007
	Stand. Dev.	3.614	0.319	0.099	0.039
IRA, Keoghs	Median	0.000	0.000	0.026	0.001
	Mean	0.876	0.168	0.114	0.038
	Stand. Dev.	4.426	0.531	0.222	0.101
DC Pension Accum.	Median	0.000	0.000	0.000	0.000
	Mean	0.055	0.046	0.038	0.328
	Stand. Dev.	0.186	0.139	0.126	0.449

[1]Total net wealth equals total assets including all investments, defined contribution pensions, and housing equity, net of mortgage debt, but not personal debt. Social Security wealth and defined benefit pension wealth are not included.
Large means are generally due to outliers. Investment Real Estate is not included here because of few observations in the sample for quartiles.
[2] Individuals with less than $1,000 in total net wealth (n=412) are not included. All data are weighted by HRS sample weights.

Source: Authors' tabulations of the Health and Retirement Study Wave 2.

Table 3. Distribution of Net Household Wealth[1] in the Health and Retirement Study by Wealth Quartile[2]

Wealth Quartile	25th Percentile of Wealth Quartile	50th Percentile of Wealth Quartile	75th Percentile of Wealth Quartile	100th Percentile of Wealth Quartile
1 (25%)	$12,359	$32,690	$53,000	$77,000
2 (50%)	$103,600	$130,000	$161,000	$201,000
3 (75%)	$246,851	$306,000	$395,000	$542,000
4 (100%)	$862,610	$9,869,741	$10,100,000	$20,600,000

[1]Total net wealth equals total assets including all investments, defined contribution pensions, and housing equity, net of mortgage debt, but not personal debt. Social Security wealth and defined benefit pension wealth are not included.
[2] Sample limited to those households with at least $1,000 in net wealth. All data are weighted by HRS sample weights.

Source: Authors' tabulations of the Health and Retirement Study Wave 2.

Table 4. Distribution of Net Household Wealth[1] in the Health and Retirement Study by Average Age of the Household[2]

Average Age	25th Percentile	50th Percentile	75th Percentile	100th Percentile
Less than 50	$30,687	$145,519	$453,677	$31,200,000
50-54	$57,500	$158,229	$417,656	$30,100,000
55-59	$55,000	$172,000	$513,000	$30,900,000
60-64	$66,000	$214,700	$563,000	$30,100,000
65+	$85,200	$222,186	$494,500	$30,000,000

[1]Total net wealth equals total assets including all investments, defined contribution pensions, and housing equity, net of mortgage debt, but not personal debt. Social Security wealth and defined benefit pension wealth are not included.
[2] Sample limited to those households with at least $1,000 in net wealth. All data are weighted by HRS sample weights.

Source: Authors' tabulations of the Health and Retirement Study Wave 2.

Table 5. Summary Statistics for Sample of Households[1] from the HRS

Variable	Mean	Stand. Dev.	Minimum	Maximum
HHWEALTH1 Household wealth (including house), in $	1,318,120	3,253,241	1,008	30,400,000
HHWEALTH2 Household wealth (excluding house), in $	754,522	2,506,655	1,008	30,300,000
RISKY1 Percent in risky assets (including house)	0.802	0.266	-1.19	11.96
RISKY2 Percent in risky assets (excluding house)	0.557	0.381	-0.414	11.11
BLACK Percent black	0.094	0.292	0	1
SINGFEM Percent single female	0.142	0.349	0	1
HASDB Household has defined benefit pension	0.214	0.41	0	1
KIDS # of children <18	0.194	0.613	0	12
AGE Avg. age of household members, in years	57.55	5.25	25	84
LOWEDUC Percent with high school or less education	0.607	0.488	0	1

[1] Sample is limited to households with wealth greater than $1,000. All data are weighted by HRS sample weights.

Source: Authors' tabulations of the Health and Retirement Study Wave 2.

Table 6. Censored Tobit Regression Coefficients, Standard Errors, and Marginal Effects (Sample Weighted[1])

Dependent variable = household (HH) portfolio allocation to risky assets (RISKY1 and RISKY2)

Explanatory Variables	Including Housing (n=10,412)			Not Including Housing (n=9,927)		
	Coefficients	**(Standard Error)**	**Slope**	**Coefficients**	**(Standard Error)**	**Slope**
Constant	-0.319***	(-0.056)		-0.967***	(-0.081)	
ln(HHWEALTH)	0.097***	(-0.005)	0.093	0.129***	(-0.008)	0.108
HHINCOME	$1.6x10^{-12}$	$(1.37x10^{-11})$	$1.53x10^{-12}$	$1.02x10^{-12}$	$(1.65x10^{-11})$	$8.5x10^{-13}$
LOWEDUC	-0.017**	(-0.008)	-0.016	-0.055***	(-0.009)	-0.046
SINGFEM	0.009	(0.012)	0.008	0.067***	(-0.015)	0.056
KIDS	-0.007	(0.007)	-0.006	-0.0009	(0.009)	-0.0007
HHHASDB	0.013	(0.008)	0.012	0.006	(0.009)	0.005
HHPENBAL	$-8.5x10^{-9}$***	$(1.5x10^{-9})$	$-7.8x10^{-9}$	$-1.62x10^{-8}$***	$(2.47x10^{-9})$	$-1.35x10^{-8}$
BLACK	0.032**	(-0.014)	0.031	-0.084***	(-0.019)	-0.07
OWNHOME	N/A	N/A	N/A	-0.027*	(-0.014)	-0.022
Age <50	0.064***	(-0.022)	0.061	0.034	(0.028)	0.028
Age 50-54	0.041*	(-0.022)	0.039	0.009	(-0.028)	0.007
Age 55-59	0.037	(0.022)	0.035	-0.028	(0.029)	-0.023
Age 60-64	0.014	(0.029)	0.013	-0.055	(0.036)	-0.046
Wealth Quartile 2	-0.053***	(-0.014)	-0.05	0.145***	(-0.02)	0.121
Wealth Quartile 3	-0.117***	(-0.017)	-0.112	0.169***	(-0.028)	0.141
Wealth Quartile 4	-0.209***	(-0.026)	-0.201	0.118***	(-0.039)	0.099
Pseudo R^2	0.087			0.21		
Log Likelihood	-4959.93			-6576.68		

*Significant at the 10% level **Significant at the 5% level *** Significant at the 1% level

[1] Sample is limited to households with wealth greater than $1,000. All data are weighted by HRS sample weights.

Source: Author's calculations based on the 1994 Wave 2 Health and Retirement Study.

Table 7. Censored Tobit Regression Coefficients, Standard Errors, and Slopes. (Sample Weighted[1])
Dependent variable=portfolio allocation of risky assets not including housing (RISKY2)

Explanatory Variables	Single Men Regression			Single Women Regression			Married Couples Regression		
	Coeff.	(Std. Err.)	Slope	Coeff.	(Std. Err.)	Slope	Coeff.	(Std. Err.)	Slope
Constant	-1.90***	(-0.349)		-2.23***	(-0.279)		-.677***	(-0.09)	
ln(HHWEALTH)	.208***@	(-0.031)	0.15	.259***	(-0.022)	0.197	.099***@	(-0.009)	0.085
HHINCOME	-5.5×10^{-10}	(7.87×10^{-10})	-3.9×10^{-10}	-6.8×10^{-10}*	(3.6×10^{-10})	-5.2×10^{-10}	1.4×10^{-12}	(1.6×10^{-11})	1.2×10^{-12}
LOWEDUC	-.077*@	(-0.039)	-0.055	0.006	(-0.028)	0.004	-.061***	(-0.011)	-0.052
KIDS	.065**	(-0.031)	0.047	.056*	(-0.032)	0.042	-0.013	(-0.009)	-0.011
HASDB	-0.031	(-0.04)	0.022	0.034	(-0.028)	0.025	-0.001	(-.009)	-0.001
HHPENBAL	$-3.7\times10^{8***}$@	(1.1×10^{-8})	-2.7×10^{8}	-5.0×10^{-8}***	(7.6×10^{-9})	-3.8×10^{-8}	-8.9×10^{-9}***@	(2.7×10^{-9})	-7.7×10^{-9}
BLACK	0.071	(-0.062)	0.051	-0.051	(-0.04)	-0.039	-.105***	(-0.022)	-0.09
OWNHOME	-.116***	(-0.039)	-0.084	-.062**	(-0.03)	-0.047	-.004@	(-0.018)	-0.003
Age <50	.146@	(-0.188)	0.106	0.177	(-0.094)	0.134	.028@	(-0.028)	0.023
Age 50-54	.160@	(-0.187)	0.115	0.134	(-0.193)	0.102	.003@	(-0.029)	0.002
Age 55-59	.147@	(-0.188)	0.106	0.108	(-0.193)	0.082	-.045@	(-0.029)	-0.039
Age 60-64	0.402	(-0.567)	0.29	0.208	(-0.2260)	0.158	-.075**@	(-0.037)	-0.065
Wealth Quartile 2	.127@	(-0.079)	0.092	-0.067	(-0.052)	-0.051	.178***@	(-0.023)	0.152
Wealth Quartile 3	.089@	(-0.108)	0.064	-0.245***	(-0.074)	-0.186	.239***@	(-0.031)	0.205
Wealth Quartile 4	-.129@	(-0.161)	-0.094	-0.482***	(-0.108)	-0.366	.232***@	(-0.043)	0.198
N	524			1088			8315		
Pseudo R^2	0.368			0.226			0.196		
Log	-291.21			-743.28			-5512.56		

* Significant at the 10% level ** Significant at the 5% level *** Significant at the 1% level

"@" indicates that coefficients are significantly different from the single female coefficients.

[1] Sample is limited to households with wealth greater than $1,000. All data are weighted by HRS sample weights.

Source: Author's calculations based on the 1994 Wave 2 Health and Retirement Study.

Appendix

Theoretical Models of Risk Aversion

This appendix supplements the main report by providing the more technical details of the models that are described therein. In the sections below, the mathematical foundations for expected utility theory and proposed alternative models of behavior are described. This exposition is intended to provide a better understanding of the models but, given the size and complexity of this developing area of research, it is in no sense complete. The foundations of this literature are compiled in Dionne and Harrington (1992), Kahneman, Slovic and Tversky (1987), and Goldstein and Hogarth (1997).

Expected Utility

As described in the main body of this report, expected utility theory explains human behavior as the result of decisionmaking which attempts to maximize the utility, or satisfaction, that is received as the result of a decision. When the outcomes of decisions are uncertain, the individual will make decisions based on the expected level of utility.

The notion of risk in expected utility theory is analogous to the statistical concept of variance. The expected value (or mean value) of an uncertain event is equal to the weighted sum of the outcomes, where the probabilities serve as weights. The risk or variance measures the variability of outcomes around the mean or expected value. For example, suppose that a person faces a gamble that pays a certain level of wealth W_1 with probability p and a higher level of wealth W_2 with probability $(1-p)$. As the number of times the person is faced with this gamble increases, the expected return from taking the gamble would approach the expected value of the gamble:

$$EV=p*W_1 + (1-p)*W_2 \qquad \text{(A1)}$$

Consider another gamble that pays $2W_1$ with probability p and $2W_2$ with probability $(1-p)$. This gamble and the previous gamble have the same expected value but the second gamble involves greater risk because the variance is larger. A risk averse person when faced with a choice between gamble 1 and 2 would always choose gamble 2 (illustrated in Figure 1 below).

Von Neumann and Morgenstern [1953] hypothesized that individuals do not care directly about the dollar value of the outcomes (e.g. W_1 and W_2 in the example above); they care about the utility derived from those dollars: $U(W_1)$ and $U(W_2)$. Although utility is an abstract concept, it has been hypothesized to have certain general characteristics. For example, individuals are assumed to prefer more wealth to less, so the function must be increasing in wealth.

When faced with risk, individuals are hypothesized to maximize their utility by choosing the option that provides them with the highest level of expected utility. More formally, Von Neumann and Morgenstern developed the concept of an *expected utility function*. If there are only two possible outcomes, this function can be represented as:

$$E[U(W)] = p^* U(W_1) + (1-p)^* U(W_2) \quad \text{(A2a)}$$

More generally, for any risky decision with *i* possible outcomes, expected utility can be represented as:

$$E[U(W)] = \sum_i p_i U(W_i) \quad \text{(A2b)}$$

where p_i is the probability of having W_i wealth level and $U(Wi)$ is the utility value of having W_i in wealth. The expected utility function serves as a way of ranking different events according to a person's preferences. Their preferences for risk are captured in the mathematical form of the utility function $U(W)$.

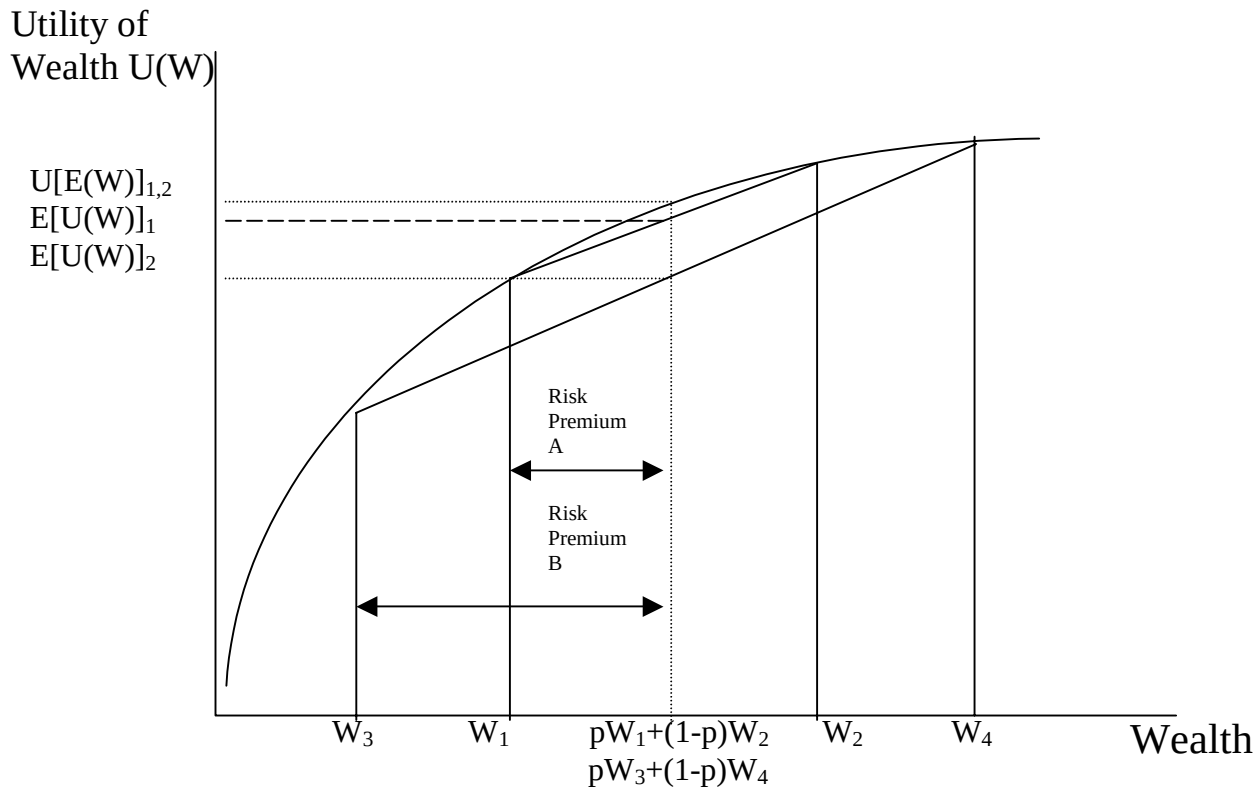
Mathematical Definition of Risk Aversion: People's attitudes towards risk are characterized by the form of their expected utility functions. A person is defined as risk averse if he or she prefers to receive the expected value of some uncertain event for sure, to having to face the uncertain event:

$$U[E(W)] > E[U(W)]$$
$$U(pW_1 + (1-p)W_2) > pU(W_1) + (1-p)U(W_2) \quad \text{(A3)}$$

This definition of risk aversion is analogous to the mathematical concept of concavity. Therefore, it follows that the expected utility function of a risk averse individual is concave in wealth. Although individuals prefer more wealth to less, the extra utility derived from an additional dollar of wealth declines with wealth. A common hypothetical form of the expected utility function of a risk averse individual which satisfies this criteria is the natural logarithmic function: $U(W) = ln(W)$. However, the function can theoretically take other forms as long as they satisfy the concavity requirement.

Risk Premiums: The notion of a risk premium describes the fact that a risk averse investor will have to be compensated with higher return for taking on more risk. The more risk averse an investor is the higher the risk premium will have to be. Risk premiums for two gambles are shown in Figure 1-A below. Gamble 1 has two outcomes: W_1, with probably p, and W_2, with probability (1-p). Gamble 2 also has two outcomes: W_3, with probability p, and W_4, with probability (1-p) such that the expected value of Gambles 1 and 2 are equal. Both gambles have the same utility of expected wealth, but the Gamble 2 has greater standard deviation and yields lower expected utility ($E[U(W)]_2$). This figure illustrates two important points. First, it can be seen that the concavity of the utility function satisfies the requirement of equation (A3). Second, the larger the risk faced by an individual, the larger the risk premium i.e., they will require a greater utility premium for taking on a risky gamble.

Figure 1-A: Illustration of the Expected Utility Concept:
For a risk-averse individual, the utility of the expected value of wealth under uncertainty, $U[E(W)]_1$ is greater than the expected utility of wealth, $E[U(W)]_1$.
Note, for a 2 outcome risky decision:
$U[E(W)] = U[pW_1 + (1-p)W_2]$ and $E[U(W)] = pU(W_1) + (1-p)U(W_2)$



Measures of Risk Aversion: If the utility function illustrated in Figure 1-A were more concave, the risk premia for both gambles would be larger. Thus, the concavity of the utility function is positively related to the level of risk aversion. Arrow (1971) and Pratt (1964) are credited with developing two measures of risk aversion. The first is what is referred to as the Arrow-Pratt measure of absolute risk aversion and is defined as:

$$ar(W) = - U''(W) / U'(W) \qquad \text{(A4)}$$

where U'(W) and U"(W) are the first and second derivatives of the utility function with respect to wealth respectively. The outcomes of an uncertain event are characterized by different absolute dollar amounts of wealth. The coefficient of absolute risk aversion, *ar(W)*, then determines the absolute dollar amount of wealth a person will hold in risky assets. An individual who desires to hold a smaller balance of risky assets relative to others with equivalent wealth is said to be more risk averse.

The second measure of risk aversion is referred to as the Arrow-Pratt measure of relative risk aversion:

$$rr(W) = [- U''(W) / U'(W)]*W \quad \text{(A5)}$$

An individual is said to be relatively more risk averse if he or she desires to hold a smaller proportion of wealth in risky assets as compared to others with similar wealth. In this case, the outcomes of an uncertain event are characterized by different proportions of wealth held in risky assets. Differences in risk aversion across individuals can thus be measured in terms of either their absolute dollar holdings of risky assets for given levels of wealth or their proportional holdings of risky assets for given levels of wealth.

Empirical Estimation of Relative Risk Aversion

One of the earliest studies of risk aversion and wealth is by Friend and Blume (1975). Their measure of risk aversion depends on the individual investor's portfolio allocation between risky and risk-free assets, according to the following:

$$\alpha_k = [E(r_m - r_f)/\sigma^2_m] \ (1/C_k) \quad \text{(B1)}$$

where α_k is the proportion of net worth that investor k places in risky assets, $E(r_m - r_f)$ is the expected difference between the return on the market portfolio of risky assets (r_m) and the return on the risk-free asset (r_f), σ^2_m is the variance of the return on the market portfolio, and C_k is the Pratt-Arrow measure of relative risk aversion.[15]

The equation is simply saying that the proportion of wealth that an investor holds in risky assets will depend upon the investor's degree of risk aversion assuming that all investors face the same market price of risk.

Jianakoplos and Bernasek (1998) used the Friend and Blume methodology with a modification to take into account the dependence of allocation to risky assets on the covariance between the return on the market portfolio (r_m) and the return on human wealth (r_h). This results in the following specification for allocation to risky assets:

$$\alpha_k = \left[\frac{E(r_m - r_f)}{\sigma^2_m} * \frac{1}{C_k(1-h_k)}\right] - \left[\frac{h_k}{(1-h_k)} * \beta_{h,m}\right] \quad \text{(B2)}$$

where h_k is the ratio of investor k's human wealth to net wealth, and $\beta_{h,m}$ is the ratio of the covariance of r_m and r_h to σ^2_m. This equation can be simplified by making use of the findings of Liberman (1980) and Fama and Schwert (1977) that $\beta_{h,m}$ is zero. Then Equation (7) becomes:

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[15] The market risk premium $E(r_m-r_f)$ divided by the variance of the market return is the market price of risk, a term that also appears in the standard Capital Asset Pricing Model. See Elton and Gruber (1991, p. 292) for a discussion of the implications of using the variance as opposed to the standard deviation in the denominator of the CAPM formula.

$$\alpha_k = \frac{E(r_m - r_f)}{\sigma_m^2} * \frac{1}{C_k(1-h_k)} \qquad \text{(B3)}$$

This equation forms the basis for estimating the coefficient of relative risk aversion in household investment portfolios in the following form:

$$\alpha_k = \beta_1 + \beta_2 \ln \text{WEALTH} + \sum_{i=3}^{n} \beta_i X_i$$

where X_i is a vector of explanatory variables. The natural log of wealth measures changes in wealth as opposed to absolute wealth. Therefore, given that the dependent variable is the proportion of wealth in risky assets, the estimated coefficient on the natural log of wealth provides an estimate of the inverse of the coefficient of relative risk aversion (C_k) to a positive multiplicative constant.

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Glossary

certainty equivalent
- an amount of money for certain that will provide an individual with the same level of utility as the expected utility of a particular risky gamble.

cohort
- a group of people in a certain age group at a particular point in time.

concavity
- a mathematical concept that describes the shape of a function such that when a line is drawn between any two points on the function, the line lies underneath the function.

correlation coefficient
- a statistical concept that measures the extent to which two random variables are linearly related to one another.

covariance
- a statistical concept that determines whether or not two random variables are linearly related to one another.

cross sectional data
- observations on a set of variables at a given point in time.

defined benefit pension
- a plan where a person receives a specific amount of money in retirement based on a formula that takes into account age, years of service, and earnings.

defined contribution pension
- a plan where a specific amount of money is accumulated in an account for a person and the amount they receive in retirement depends on the return earned on the investment.

divisibility of assets
- the extent to which assets can be divided for the purposes of buying or selling: the smaller the unit that the asset can be divided into, the more divisible it is said to be.

expected value
- a statistical concept that refers to the mean or average value for a set of outcomes that occur with certain probabilities.

human capital
- the stock of knowledge and skills that a person has that affects their productivity in economic activities: the value of a person's human capital is the present discounted value of their expected earnings over the life cycle.

indifference curve
- a graphical representation all the combinations of outcomes that a person is indifferent between (that yield the same level of satisfaction or utility to the person).

liquidity of assets
- the ease with which assets can be bought and sold: the more easily they can be bought and sold, the more liquid they are said to be.

longitudinal data
- observations on a set of variables at several points in time.

marginal utility
- the additional utility that a person receives from an additional dollar of wealth.

market portfolio
- the portfolio of risky assets which consists of proportionate shares of all assets in the market, with each asset weighted by its share of the total market of risky assets.

market price of risk
- the difference between the expected return on the market portfolio of risky assets and the risk-free asset divided by the variance of returns on the market portfolio.

opportunity set
- the set of all assets that a person can choose to invest in.

optimization
- a mathematical technique for finding the value of independent variables that maximize or minimize the value of a function that depends on those variables.

present discounted value
- what a stream of future earnings is worth in the present.

portfolio allocation
- the allocation of an investor's wealth among different assets.

rational decisionmaking
- in economics this means that a person is assumed to behave as if they were maximizing a utility function.

risk
- as it is used in financial analysis it is analogous to the statistical concept of variance.

risk aversion
- measures a person's attitudes toward risk.

risk premium
- the amount of money a risk-averse person will have to be paid to take a gamble that will yield the same level of utility as they would get from receiving expected value of the gamble for certain.

standard deviation
- a statistical concept that is the square root of the variance.

utility
- the satisfaction a person receives from a certain dollar value of wealth.

utility function
- the mathematical relationship between the amount of wealth a person has and the utility or satisfaction that person gets from that wealth.

variance
- a statistical concept that measures the variability of outcomes of an uncertain event, around the mean.

wealth quartiles
- ranking households in the population from lowest wealth to highest wealth and dividing them into four groups, such that each group contains 25 percent of the households.