Asset Allocation and Individual Risk Aversion

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Data on the investments of a random sample of the U.S. population are used to derive relative risk-aversion indexes from actual asset allocations. A comparison of risk-aversion indexes for various demographic and socioeconomic categories reveals distinct differences for three groups—individuals over 65, those with incomes below the poverty level, and the very wealthy.

A model developed to examine the hypothesized relationships between risk tolerance and given variables indicates that relative risk aversion decreases as one rises above the poverty level and decreases significantly for the very wealthy. It also decreases with age—but only up to a point. After age 65 (retirement), risk aversion increases with age.

Asset allocation decision-making is one of the least understood areas of finance. Yet how individuals allocate their wealth provides important insights into individual risk preferences and degrees of risk aversion.

Portfolio theory assumes that investors are rational, utility-maximizing individuals who exhibit differing degrees of **relative risk aversion**, depending on such factors as age, wealth, income and education.[1] Previous studies have employed a variety of approaches to infer individual risk preferences from the proportion of an individual's total wealth allocated to risky assets.[2] Some of these researchers used questionnaires designed to elicit from individuals explicit answers about their risk preferences; others examined individuals' actual asset allocation decisions.

How individuals actually allocate their assets is often far different from how they *say* they would allocate them. Examining an individual's actual pattern of asset allocation is thus a far superior method of determining risk aversion than merely asking individuals to respond to hypothetical scenarios. But the results of these studies have been mixed. Depending on how wealth was defined, studies have found that individuals' risk aversion decreased, remained constant or increased with increasing wealth.

This article reports the results of a study that empirically examined individual asset allocation and risk behavior using financial data for a large random sample of U.S. households. Unlike previous studies, it examined the risk preferences of a sample of individual households, rather than the risk preferences of specific subsets of the general population.[3] Furthermore, the study's data are relatively current (1985) and far superior to data used in previous studies.

The Data

The Survey of Income and Program Participation (SIPP) is a longitudinal survey that provides information on the economic status of U.S. households. Interviews are conducted every four months during a two-and-one-half year period.[4] Table I reports the sample's demographic characteristics. The composite of the typical respondent unit is a 48-year-old, married, white male with a high-school education, an annual income of $23,000 and household wealth of $40,000.

Table II illustrates the distinct differences in sample mean and median income and household wealth across census regions. The average household wealth for the entire sample is $76,860, but this is elevated considerably by a number of very wealthy units. The median wealth figure of $40,395 is more representative of a typical family unit's wealth. The income distribution is less distorted by extreme values, with a mean income of $28,063 and a median value of $23,172.[5]

The study looked at four classes of assets—personal property, real estate, bonds and risky assets. Table III describes how allocations to these assets differ with several demographic and financial variables. Consider how the pattern of allocation differs with age.

Individuals 21 and younger have most of their assets in personal property and checking accounts, with very little in risky assets. As expected, the proportion of wealth invested in personal property decreases with age, and the proportion invested in real estate increases. The proportion in bonds and checking accounts is approximately the same for the under-21 category and the 65-and-older category. The proportion in equity increases consistently with age until the age of 65, then falls. This probably reflects the shift toward fixed income assets after retirement. Asset allocation appears to be relatively inde-

Table I Demographic Characteristics of the Sample

Age:	*Number*	*Per Cent*	*Marital Status*	*Number*	*Per Cent*
<21	228	1.3	Married, Present	10823	61.2
21–34	4883	27.6	Married, Absent	126	0.7
35–44	3442	19.4	Widowed	2195	12.4
45–54	2763	15.6	Divorced	1934	10.9
55–64	2676	15.1	Separated	541	3.1
>65	3705	20.9	Never Married	2078	11.7
Gender:	*Number*	*Per Cent*	*Family Income:*	*Number*	*Per Cent*
Male	12297	69.5	< $5,000	964	5.4
Female	5400	30.5	5,000–9,999	2119	12.0
			10,000–14,999	2289	12.9
Education:	*Number*	*Per Cent*	15,000–19,999	2177	12.3
			20,000–24,999	2039	11.5
<H.S.	4477	25.3	25,000–34,999	3239	18.3
H.S. Grad.	5971	33.7	35,000–49,999	2695	15.2
College	3353	18.9	> 50,000	2175	12.3
Col. Degree	1958	11.1			
Post Grad.	1938	11.0			
Region:	*Number*	*Per Cent*	*Household Wealth:*	*Number*	*Per Cent*
New England	883	5.0	<10,000	4647	26.3
Mid-Atlantic	2820	15.9	10,000–24,999	2353	13.3
East N-Central	3441	19.4	25,000–49,999	2820	15.9
West N-Central	1174	6.6	50,000–99,999	3794	21.4
South Atlantic	2786	15.7	100,000–149,999	1753	9.9
East S-Central	1350	7.6	150,000–199,999	877	5.0
West S-Central	1738	9.8	200,000–249,999	516	2.9
Mountain	886	5.0	250,000–499,999	694	3.9
Pacific	2619	14.8	>500,000	243	1.4
Racial Composition		*Number*	*Per Cent*		
White		15751	89.0		
Black		1572	8.9		
Asian		305	1.7		
Native American		69	0.4		

pendent of education for all asset classes except equity, the allocation to which tends to increase with education.

Clear patterns emerge for asset allocations over income and wealth levels. The proportion in risky assets rises consistently with both income and wealth, as the proportion in personal property falls. The proportion in bonds tends to fall with both income and wealth, while real estate exhibits no clear pattern.

Table IV examines asset allocations across geographic locations. Minor differences exist, but they probably reflect differences in income and wealth levels across regions, rather than differences in risk preferences. The East South-Central region, for example, has the lowest proportion of wealth in equity and the lowest median income in the country. The mid-Atlantic region has the highest proportion in equity *and* the second-highest median income.

Individual Risk Aversion

The coefficient of the Arrow-Pratt relative risk aversion is measured by the ratio of risky assets to wealth.[6] Following Friend and Blume, we estimate the **relative risk aversion index**, RRAI, for the kth investor as follows:[7]

Eq. 1

$$RRAI_k = (1 - \text{Risky Assets/Wealth})$$
$$= (1 - \text{MPR/RRA}),$$

where MPR is the market price of risk, assumed constant across all investors.[8] The RRAI increases (decreases) as wealth grows, indicating that relative risk aversion (RRA) increases (decreases) as

Table II Wealth and Income by Geographic Area

	Household Wealth		*Annual Income*	
Census Region	*Mean*	*Median*	*Mean*	*Median*
New England	$83,299	$53,350	$30,870	$22,233
Middle Atlantic	75,922	46,335	30,040	24,380
East North-Central	70,526	40,552	27,085	23,124
West North-Central	87,895	45,996	27,636	22,232
South Atlantic	73,280	36,430	28,084	22,443
East South-Central	59,094	32,068	22,044	18,123
West South-Central	66,941	30,600	27,433	22,620
Mountain	95,042	46,069	26,805	21,474
Pacific	92,470	44,435	30,392	25,575
Avg. U.S.	$76,860	$40,395	$28,063	$23,172

wealth increases. An increase in RRAI means an increase in risk aversion. A more risk-averse individual will have a greater proportion of her wealth in low-risk assets. Table V examines differences in RRAI across demographic and financial variables.

RRAI decreases with each age category until the 65-and-older category; then it increases significantly. This suggests that individuals generally get less risk averse as they age, until retirement, when they get more risk averse.

Risk aversion appears to decrease with education. However, education, income and wealth are all highly correlated, so the relationship may be a function of wealth rather than education.

The differences in risk aversion and marital status, race and gender appear to be small. Women appear to be slightly more risk averse than men, but this may be more a function of age, income and wealth than gender. Individuals who have never married have a slightly lower RRAI than other categories, with widowed and separated individuals being the most risk averse.

There appears to be a negative relation between risk aversion and income, with RRAI generally falling with income. Very low income families appear to be the most risk averse when measured by RRAI. However, one must be careful in interpreting this finding. Families below the poverty level have little flexibility in their budgets; almost all of their assets are tied up in personal property and housing; this is not because they are very risk averse, but because they have no discretionary income or wealth. Wealth appears to be strongly related to risk aversion, with RRAI falling as wealth increases. The most significant decline comes with very wealthy individuals.

No clear relationships are apparent between RRAI and geographic location. The East South-Central and West South-Central regions have the highest levels of relative risk aversion. This may reflect true regional differences, but it more likely reflects lower average incomes and wealth in these regions.

A Model of Risk Aversion

The evidence in the tables suggests that the level of relative risk aversion is a function of age, education, wealth and income. Interpretation of the tables also suggests differences in relative risk aversion across three distinct categories of individuals—those age 65 and older, those with incomes below the poverty level, and those with very high levels of wealth. These findings suggest the following model:

Eq. 2

$$RRAI = \alpha + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5D_1 + b_6D_2 + b_7D_3$$

where

- α = intercept,
- X_1 = age,
- X_2 = education (highest grade attended),
- X_3 = total household wealth,
- X_4 = annual income of participant,
- D_1 = dummy variable for age; 0 if < 65 and 1 if > = 65,
- D_2 = dummy variable for income; 0 if < $10,989 and 1 if >= $10,989 and
- D_3 = dummy variable for wealth; 0 if < $178, 419 and 1 if >= $178, 419.

The life-cycle theory of asset allocation suggests that individuals become more risk averse as they reach retirement and the need for a fixed income increases. This is reflected in an increasing RRAI after retirement. Presumably, younger individuals have little need for supplementing current income; they thus tend to invest in assets where the potential for capital appreciation is great, thereby delaying taxes and accumulating assets for the future. In addition, younger investors have more time to recover from a bad investment and are not likely to be forced to liquidate an investment at an inopportune time. Earnings are greatest during the middle-age years, as careers are established and wealth is accumulated; the RRAI thus decreases through these years.

As one reaches retirement age, the need for liquidity increases, as does the necessity of having a predictable cash flow from investments. These changes should necessitate a shift toward lower-risk investments, away from equities and toward fixed income securities. To examine this possibility, the model uses an age **dummy variable** D_1. This takes on a value of 0 if the respondent's age is less than 65 and 1 if the age is 65 or older.

Evidence suggests a negative relation between education and risk aversion (decreasing RRAI); how-

Glossary

▶***Dummy Variable:***
Used to handle qualitative variables in statistical analyses, dummy variables represent the absence or presence of a factor by taking on a value of 0 or 1.

▶***Relative Risk Aversion:***
An investor's tolerance for risk, measured relative to his wealth level. Mathematically defined here as the value (risk premium) that must be added to the payoff from a gamble in order to make a risk-averse investor indifferent between the gamble and a "sure bet" of the same actuarial value.

▶***Relative Risk Aversion Index:***
An empirical measure estimated as one minus the ratio of an individual's risky assets to his total wealth.

Table III Asset Allocations and Demographics

	Age					
Asset Category	*<21*	*21–34*	*35–44*	*45–54*	*55–64*	*>64*
Personal Property	56.6	43.9	26.5	17.9	13.6	8.9
Real Estate	10.6	32.6	53.7	61.7	60.2	53.9
Bonds/Checking	30.6	20.2	15.1	15.4	19.9	33.3
Risky Assets	2.2	3.3	4.7	5.1	6.2	4.0

	Education				
Asset Category	*<HS*	*HS*	*Col.*	*Deg.*	*Post.*
Personal Property	24.6	27.0	27.5	21.8	16.0
Real Estate	52.1	49.4	46.9	46.4	52.3
Bonds/Checking	21.3	20.2	20.3	23.9	23.7
Risky Assets	2.0	3.4	5.2	7.9	8.0

	Gender	
Asset Category	*Male*	*Female*
Personal Property	23.7	26.9
Real Estate	52.6	42.8
Bonds/Checking	19.0	26.4
Risky Assets	4.7	3.9

	Racial Composition			
Asset Category	*White*	*Black*	*Asian*	*Native American*
Personal Property	23.6	34.0	31.3	39.8
Real Estate	50.1	47.0	40.5	38.9
Bonds/Checking	21.7	16.7	23.6	18.9
Risky Assets	4.6	2.3	4.5	2.4

	Marital Status					
Asset Category	*Mar. Pres.*	*Mar. Absen.*	*Wid.*	*Div.*	*Separ.*	*Nev. Mar.*
Personal Property	22.1	30.9	9.9	32.8	55.2	37.9
Real Estate	56.0	39.0	55.7	42.4	22.5	24.1
Bonds/Checking	17.3	26.7	31.2	20.7	19.9	32.3
Risky Assets	4.6	3.4	3.2	4.1	2.4	5.7

	Annual Income							
Asset Category	*<5*	*5–10*	*10–15*	*15–20*	*20–25*	*25–35*	*35–50*	*>50*
Personal Prop.	29.1	30.6	30.9	29.1	27.7	24.8	18.7	10.5
Real Estate	47.5	42.1	42.6	44.9	47.5	51.5	56.9	59.9
Bonds/Check.	21.7	25.5	23.8	22.3	21.5	19.3	18.1	19.9
Risky Assets	1.7	1.8	2.7	3.6	3.3	4.3	6.2	9.7

	Wealth								
Asset Categ.	*<10*	*10/25*	*25/50*	*50/100*	*100/150*	*150/200*	*200/250*	*250/500*	*>500*
PP	62.8	26.7	11.9	7.9	5.8	4.7	4.0	3.1	1.8
RE	6.8	48.6	68.8	70.6	67.0	65.7	66.9	66.9	58.3
Bonds	27.8	20.7	16.1	17.5	20.8	22.7	22.0	19.6	22.4
Risky Assets	2.5	4.1	3.2	4.0	6.4	6.9	7.2	10.4	17.5

ever, one would also expect positive relations between the wealth and income variables and education. It is thus difficult to determine whether it is education *per se* or wealth and income that affects risk aversion. Education may enlarge individuals' exposure to the various investment options available to them; one might thus expect more educated individuals to be less risk averse in their asset allocation decisions and have a larger proportion of assets in equities.

There is *a priori* reason to expect a negative relation between income and risk aversion, with higher-income individuals being less risk averse than low-income individuals. As noted, at very low incomes, investment options, other than shelter, are very limited. As income increases, funds available for investment increase, and the RRAI should decline. The *ability* to take on more risk can be expected to translate into the *willingness* to accept more risk, because the consequences of a bad investment decision are less severe if one has income beyond some subsistence level. With more and more disposable income, the ability and willingness to accept a larger amount of risk should result in a larger proportion of equity and a decreasing RRAI.

In 1985, the poverty level for a family of four was $10,989. It is unlikely that families living below the poverty level have disposable income to invest in risky securi-

Table IV Asset Allocation and Geographic Area

	Asset Category				
Census Region	*Personal Property*	*Real Estate*	*Bonds/ Checking*	*Stocks/ Risky Assets*	*Sample*
North Central Region					
New England	20.7	49.8	24.6	5.0	883
Mid-Atlantic	19.4	50.0	25.3	5.3	2820
Mid-West Region					
East North-Central	27.1	47.3	20.9	4.8	3441
West North-Central	22.8	52.4	20.6	4.2	1174
South Region					
South Atlantic	25.0	51.1	19.8	4.2	2786
East South-Central	27.1	54.9	15.2	2.8	1350
West South-Central	29.0	48.5	18.5	4.0	1738
West Region					
Mountain	22.7	51.6	21.4	4.3	886
Pacific	25.7	46.7	23.3	4.4	2619
Average U.S.	24.7	49.6	21.3	4.4	17697

ties. The model thus incorporates an income dummy variable, D_2, that takes a value of 0 if household income is less than $10,989 and a value of 1 if income is greater than or equal to $10,989.

Risk aversion can also be expected to decrease as an individual's wealth increases, independent of income. Someone whose stock of wealth is growing can be expected to become less risk averse, as her tolerance of downside risk increases. The ability and willingness to accept more risk should thus increase with wealth, and RRAI should decline.

Summary statistics comparing asset allocation and wealth indicate that the proportion invested in risky securities doesn't change dramatically until wealth reaches the highest decile (90%), at a value of $178,419. At this level, equity represents 13.5% of assets. The model uses a dummy wealth variable, D_3, that takes on a value of 0 if household wealth is less than $178,419 and a value 1 if wealth is greater than or equal to $178,419.

Table VI gives summary statistics for the regression model run on

Table V Relative Risk Aversion Index and Demographic Characteristics

Age		*Education*		*Marital Status*	
Category	*RRAI*	*Category*	*RRAI*	Category	*RRAI*
<21	97.8	<HS	98.0	Mar., Pres.	95.4
21–34	96.7	HS	96.6	Mar., Absen.	96.6
35–44	95.3	Col	94.8	Widowed	96.8
45–54	94.9	Deg	92.1	Divorced	95.9
55–64	93.8	Post	92.0	Separated	97.6
>64	96.0			Never Mar.	94.3
Racial Composition		*Gender*			
Category	*RRAI*	*Category*	*RRAI*		
White	95.4	Male	95.3		
Black	97.7	Female	96.1		
Asian	95.5				
Nat. Am.	97.6				
Annual Income		*Wealth*		*Geographic Location*	
Category	*RRAI*	*Category*	*RRAI*	*Category*	*RRAI*
<5,000	98.3	<10,000	97.5	NE	95.0
5–10	98.2	10–25	95.9	Mid-Atlantic	94.7
10–15	97.3	25–50	96.8	ENC	95.2
15–20	96.4	50–100	96.0	WNC	95.8
20–25	96.7	100–150	93.6	SA	95.8
25–35	95.7	150–200	93.1	ESC	97.2
35–50	93.8	200–250	92.8	WSC	96.0
>50,000	90.3	250–500	89.6	Mountain	95.7
		>500,000	82.5	Pacific	95.6

Table VI Regression Results

Variable	Coefficient	t-Value
Age X_1	−0.063101	−7.859*
Education X_2	−0.246672	−17.567*
Wealth X_3	−0.000006	−8.990*
Income X_4	−0.000055	−10.747*
Age Dummy D_1	0.905725	2.730*
Income Dummy D_2	−0.536022	−2.148*
Wealth Dummy D_3	−1.134623	−4.682*

* Significant at the 0.05 level of significance.

the entire sample of 17,697 observations. The *a priori* expectation was that the signs of the X_1, X_2, X_3 and X_4 variables and the D_2 and D_3 dummy variables would be negative while the sign for the D_1 dummy would be positive.[9] In fact, this was the case. Over the entire sample, the signs for the age, education, income and wealth variables (X_1, X_2, X_3 and X_4) were negative, and the t-statistic for each variable was significant at the 0.01 level.

The sign for the age dummy variable (D_1) was positive and significant, indicating a tendency for risk aversion to increase after age 65. The sign for the income variable (D_2) was negative and significant, indicating a tendency for risk aversion to decrease as one passes the poverty level. The wealth dummy variable (D_3) was negative and significant, indicating that risk aversion decreases significantly as an individual's wealth rises into the top 10% of the population.[10]

Footnotes

1. *Von Neumann and Morgenstern,* Theory of Games and Economic Behavior *(Princeton: Princeton University Press, 1953).*
2. *See, for example, Cohn, Lewellen, Lease and Schlarbaum, "Individual Investor Risk Aversion and Investment Portfolio Composition,"* Journal of Finance, *May 1975; I. Friend and M. E. Blume, "The Demand for Risky Assets,"* American Economic Review *65 (1975), pp. 900–22; Lease, Lewellen and Schlarbaum, "The Individual Investor, Attributes and Attitudes,"* Journal of Finance, *May 1974; F. W. Siegal and J. P. Hoban Jr., "Relative Risk Aversion Revisited,"* Review of Economics and Statistics *64 (1982), pp. 481–87.*
3. *As in Cohn, Lewellen, Lease and Schlarbaum, "Individual Investor Risk Aversion,"* op. cit.*; Friend and Blume, "Demand for Risky Assets,"* op. cit.*; Lease, Lewellen and Schlarbaum, "Individual Investor Attributes,"* op. cit.*; Lewellen, Lease and Schlarbaum, "Patterns of Investment Strategy and Behavior among Individual Investors,"* Journal of Business, *July 1977; and Siegal and Hoban, "Relative Risk Aversion,"* op. cit.
4. *The data were made available by the Inter-University Consortium for Political and Social Research. The data for* Survey of Income and Program Participation (SIPP) [1984 Panel]: Wave IV Rectangular Core and Topical Module File *were originally collected by the U.S. Bureau of the Census. Neither the collectors of the original data nor the Consortium bears any responsibility for the analyses or interpretations presented here. Our sample differs from that of Lease, Lewellen and Schlarbaum ("The Individual Investor,"* op. cit.*) in several ways. Their sample tends to be older, better educated and wealthier than the general population. Their data are arguably reflective of the typical investor, but not necessarily of the typical household. The largest difference between their sample and the general population as reflected in our data lies in household wealth. Mean household wealth for their sample was $386,000 in 1971; median wealth was $100,000. Our data reveal an average household wealth figure of $76,860 in 1985 and a median wealth of $40,395. In the Lease, Lewellen and Schlarbaum study, wealth more closely approximates total assets, while our figures are closer to net worth.*
5. *Over 17% of the total sample had an annual income under the poverty level ($10,989).*
6. *The Arrow-Pratt relative risk aversion measure of individual investors is defined as $W_k[-U''(W_k)/U'(W_k)]$, where W_k is the kth investor's wealth and $U(W)$ is the utility function of wealth. This measure represents the wealth elasticity of the marginal utility of wealth. See K. J. Arrow,* Essay in the Theory of Risk-Bearing *(Amsterdam: North-Holland, 1971) and J. W. Pratt, "Risk Aversion in the Small and in the Large,"* Econometrica *(1964), pp. 122–36.*
7. *Friend and Blume, "Demand for Risky Assets,"* op. cit.
8. *Equation (1) is derived by maximizing the investor's expected utility of wealth function using truncated Taylor-series expansion to obtain the first-order equation, from which a coefficient proportional to relative risk aversion can be estimated. In this approach, taxation and human capital are ignored, and the wealth of individuals is measured by net worth.*
9. *Regression results for the model run without the dummy variables yielded similarly significant results:*

$$RAI = \underset{(-10.143)}{-0.053471X_1} \underset{(-18.427)}{-0.256369X_2} \underset{(-11.258)}{-0.000006X_3} \underset{(-14.935)}{-0.000067X_4}$$

10. *We thank Linda Culp for her computational assistance.*