Putting Your Money Where Your Mouth Is: Do Households Optimize Their Investment Portfolios Based on Their Subjective and Objective Risk Tolerance?

This research utilizes 95 cases collected from clients of financial planning students at the Ohio State University. In this course, students utilized the Life Cycle Saving (LCS) program to calculate a real clients' optimal portfolio allocation based on their subjective and objective risk tolerance levels. The results show that about 60% of households do not invest optimally. Of those whose portfolios were sub-optimally allocated, 4.2% invested aggressively, (i.e. they held more stocks than the LCS program suggested) while 55.8% invested too conservatively, holding fewer stocks than the program recommended. About 40% of the households in our sample allocated their portfolio assets optimally.

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Introduction

The purpose of this study was to evaluate household portfolio allocation based on their perceived risk. Hanna and Chen (1997) proposed the notion of optimal portfolio allocation based on objective and subjective risk tolerance. Objective risk tolerance is defined as the ratio of financial assets to total wealth. Total wealth includes net worth and human wealth, which is the lifetime income of an individual. Those with a ratio of financial assets to total wealth less than 20%, are defined as having high objective risk tolerance. Loss of financial assets, such as stock, hurts individuals with low objective risk tolerance more than who are more prone to accept the losses with the gains. Another dimension of investigating objective risk tolerance suggested by Hanna and Chen (1997) is investment horizon. Those who have longer investment horizons are objectively more risk tolerant. Investment horizons are usually classified as 1 year (short term), 5 year (intermediate) and 20 years (long term).

Subjective risk tolerance is used to assess the degree of risk that an individual is willing to assume. Using The Life Cycle Saving (LCS) Program, a series of risky situations are presented to the individuals. Situations become increasingly or decreasingly risky throughout the survey and eventually a risk tolerance level is assigned to the user (e.g. Extremely High, Extremely Low). The resulting risk tolerance level is assigned a number which can be used in the relative risk utility function. The program chooses the asset allocation that produces the highest utility and assigns a corresponding objective risk tolerance level. The effect of subjective risk tolerance is investigated based on subjective risk aversion. In other words, subjective risk tolerance is the reverse of the economic concept of risk aversion. Subjective relative risk aversion is a parameter in the utility function. The utility function is usually assumed to be the constant relative risk aversion (CRRA) utility function (Hanna, Gutter & Fan, 2001). The utility function is shown by the following form:

$$U(C) = \frac{C^{1-A}}{1-A} \; when \; A \neq 1$$

$$U(C) = \ln(C) \; when \; A = 1$$

To determine the relative risk aversion, a set of questions take the following form to the respondent:

Suppose that you are about to retire, and have two choices for a pension. One will have a pension equal to your after-tax family income just before retirement. The other would be 50% chance that it will double your after-tax income and a 50% chance it will cut your after-tax income by (1-L)%. You would have no other source of income, and no chance of employment or help from the family. Which pension would you choose?

When the respondent chooses the risk, the following expected utility equation holds:

$$0.5U(2C) + 0.5U(LC) \geq U(C)$$

Where C is consumption. Through simple mathematics we can determine the function of L.

$$L = (2 - 2^{1-A})^{\frac{1}{1-A}}$$

Then we can observe the corresponding values of L based on the change in A (relative risk aversion), and vice versa. Table 1 shows the corresponding values of L and A. Hanna and Chen (1997) convert relative risk aversion to subjective risk tolerance. Low subjective risk tolerance is considered equivalent to a relative risk aversion level of 10 or more. Moderate subjective risk tolerance is considered equivalent to relative risk aversion levels of 3 to 9. High subjective risk tolerance is considered equivalent to relative a risk aversion level under 3. Therefore, the relationship can be summarized in the following table.

Table 1.
Subjective Risk Tolerance, Relative Risk Aversion, and Income Loss Percentage

Subj. Risk Tol.	Rel Risk Aver	Lamda (L)	Subj Risk Tol	Rel Risk Aver	Lamda (L)	Subj. Risk Tol	Rel Risk Aver	Lamda (L)
High	1	0.5	Mod	6	0.87329	Low	11	0.93307
High	2	0.66667	Mod	7	0.8206	Low	12	0.93895
Mod	3	0.75592	Mod	8	0.90623	Low	13	0.94388
Mod	4	0.81096	Mod	9	0.91722	Low	14	0.94808
Mod	5	0.84759	Low	10	0.92597	Low	15	0.95169

Methodology

Ninety-five cases were included in this study. Those cases were collected in 2000 from an undergraduate family financial management class at The Ohio State University. In this class, students are required to do financial planning for real clients. Basic information of household such as age, occupation, household size, and number of children are asked. Comprehensive financial information such as income sources, spending, financial assets, and liability were acquired. The clients were then asked about their financial goals. Financial goals are high-level statements of financial desires that may be for the short term or the long term (Dalton, 2003). All the information is collected in an aggregate Excel file. Table 2 shows the sample statistics.

The Life cycle saving (LCS) program, which was developed by The Ohio State University, is utilized in this study for conducting financial plans for the client households. Students enter the demographic and financial information into this program. At the end of the data entry process, the retirement question is presented for testing clients' subjective risk tolerance. Given the relationship between L and relative risk aversion, the program determines clients' relative risk aversion. For example, the respondent answers that he is willing to take the risk of cutting his income by 50%. Then, according to Table 1, this respondent's relative risk aversion is calculated and determined be 1. In other words, he has high subjective risk tolerance.

Once the subjective risk tolerance is determined, we need to determine objective risk tolerance. Objective risk tolerance is defined as the ratio of financial assets to total wealth. Generally speaking, those households with objective risk tolerance less than 10% are suggested to have 100% of their portfolio assets invested in stocks. Recall that investment holding period also influences portfolio allocation. The longer the holding period, the more risk the investor can tolerate. However, in the real world, assuming long

holding periods seems unreasonable since households might have short term financial goals. The liquidity requirement might reduce the investment holding period. In the LCS program, the basic holding period assumption is 5 years (Sun, 2001). The assumption is reasonable, since a five year horizon is conservative. In addition, for most levels of relative risk aversion, there is no significant difference between the stock and bond allocation.

The logic flow of determining portfolio allocation is as follows: Objective risk tolerance determines the allocation between risky assets and less risky assets (e.g. stocks vs. bonds). Then subjective risk tolerance determines the allocation between large stocks and small stocks. Subjective risk tolerance might refine the allocation between stocks and bonds. Table 2 shows that the majority (about 79%) of the households have earnings between $25,000 and $75,000. Over half of the households have financial asset holdings greater than $10,000. The distribution of tangible assets, liability and net worth is widely dispersed across the categories. About 38% of the sample have risk tolerance levels above high. The mean age of respondents is 34 and 46% of the samples are single households.

Table 2
Summary Statistics (N=95)

Variable	Percentage
Income	
Earnings < $25,000	3.16
$25,000 ≤ Earnings < $50,000	46.13
$50,000 ≤ Earnings < $75,000	31.58
$75,000 ≤ Earnings < $100,000	6.32
Earnings ≥ $100,000	12.63
Assets	
Financial Assets	
< $10,000	46.32
$10,000 - $30,000	29.47
> $30,000	24.21
Tangible Assets	
< $10,000	29.47
$10,000 - $30,000	18.95
$30,000 - $100,000	11.58
$100,000 - $200,000	39.47
> $200,000	10.53
Liabilities	
< $10,000	32.98
$10,000 - $30,000	17.02
$30,000 - $100,000	30.85
> $100,000	19.15
Net Worth	
< $0	18.95
$0 - $10,000	14.73
$10,000 - $50,000	29.48
$50,000 - $75,000	12.63
> $75,000	24.21

Table 2 Continued

Risk Tolerance	
Extremely High	1.05
Very High	7.37

High	29.47
Moderate	33.95
Low	10.53
Very Low	5.26
Extremely Low	7.37
Percentage in stock	
< 50%	40.00
50%-75%	4.21
> 75%	55.79
Demographic Characteristic	
Age	34.40
Marital status	
Single	46
Married	40
Divorced	14

Results

Figure 1 suggests that there is significant gap between the optimal and actual stock percentage in a households' portfolio based on an individuals' risk tolerance. About 30% of the households in our study who were supposed to have 100% of their financial assets in stocks did not allocate any of their financial assets in that category. In Figure 2, we subtracted optimal stock holdings from actual stock holdings. We defined households with a difference more than zero as irrational aggressive, less than zero as irrational conservative, and equal to zero as rational. Figure 3 presents households with retirement assets. Figure 4 presents the percentage of irrational households versus rational households in terms of their stock allocation. Approximately 60% of the households do not invest optimally. Of these, 4.21% invested aggressively, while 55.79% invested conservatively (i.e. holding fewer stocks than LCS program suggested). About 40% out of the total sample were rational and invested optimally. Figure 5 shows the percentage of irrational versus rational households with retirement assets.

Conclusions

Using the Life Cycle Saving (LCS) program, we first measured individuals' subjective and objective risk tolerance level, and based on those results, we investigated the difference between optimal stock allocation and actual stock allocation of households' portfolios. Based on each investors' risk tolerance, we find that a large percentage of households fail to make rational investment decisions. We are also able to conclude that households with retirement assets are relatively more inclined to take on more risk than is recommended. These conclusions will be helpful for financial planners who may need to make some adjustments to their client's portfolios or suggest more conservative investments for their clients.

References

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Hanna, S., Gutter, M, & Fan J. (2001). A measure of risk tolerance based on economic theory. *Financial Counseling and Planning*, *12(2),* 53-60.

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Figure 1.
Gap between actual stock% and optimal stock% in portfolio

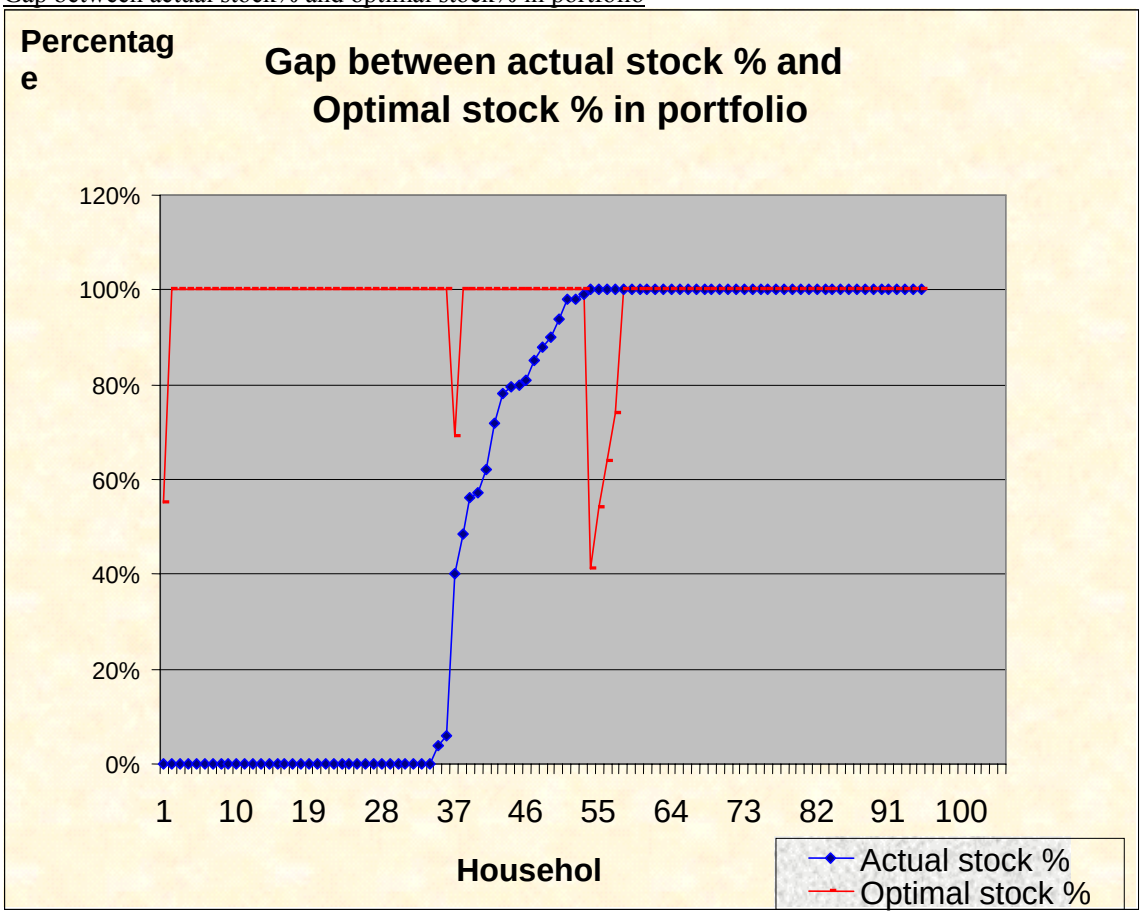


Figure 2.
Rational vs. Irrational Plot Chart

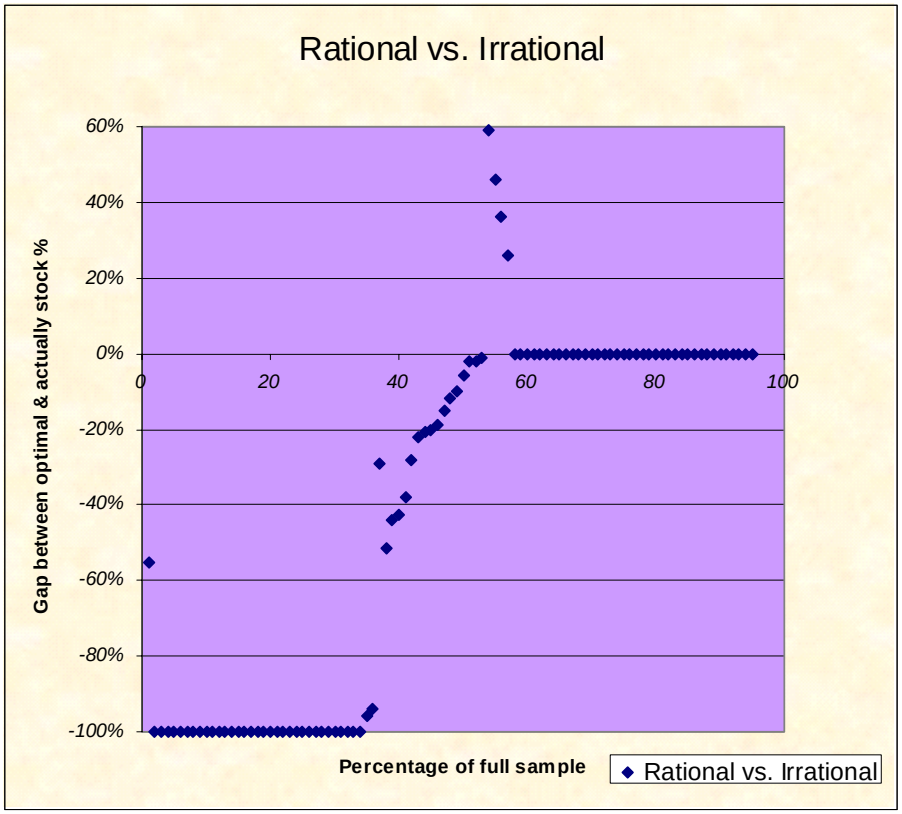


Figure 3.
Rational vs. Irrational w/ retirement assets

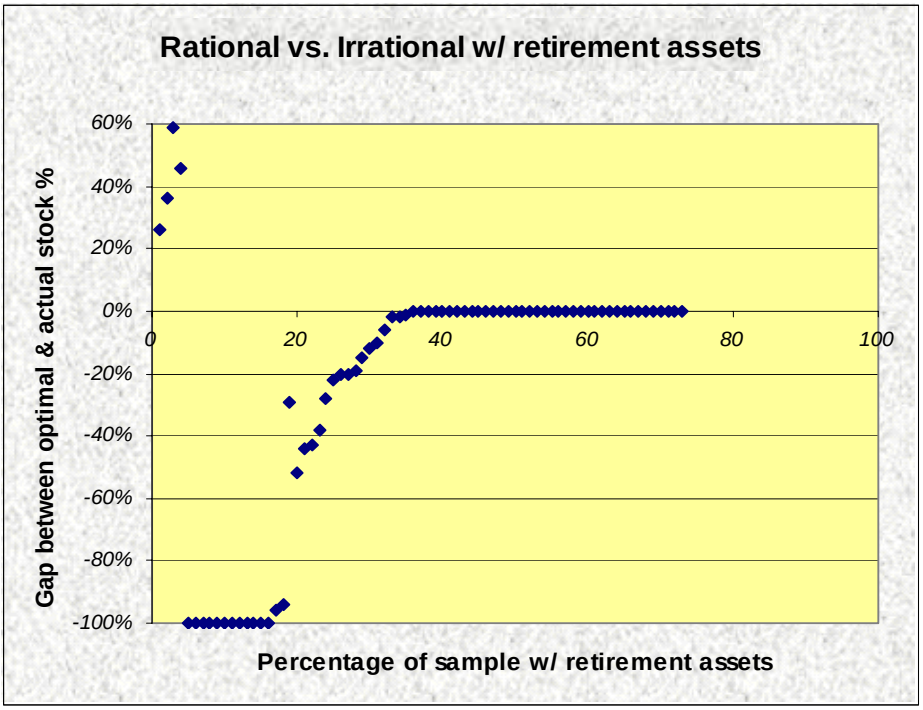


Figure 4.
Rational vs. Irrational Pie Chart

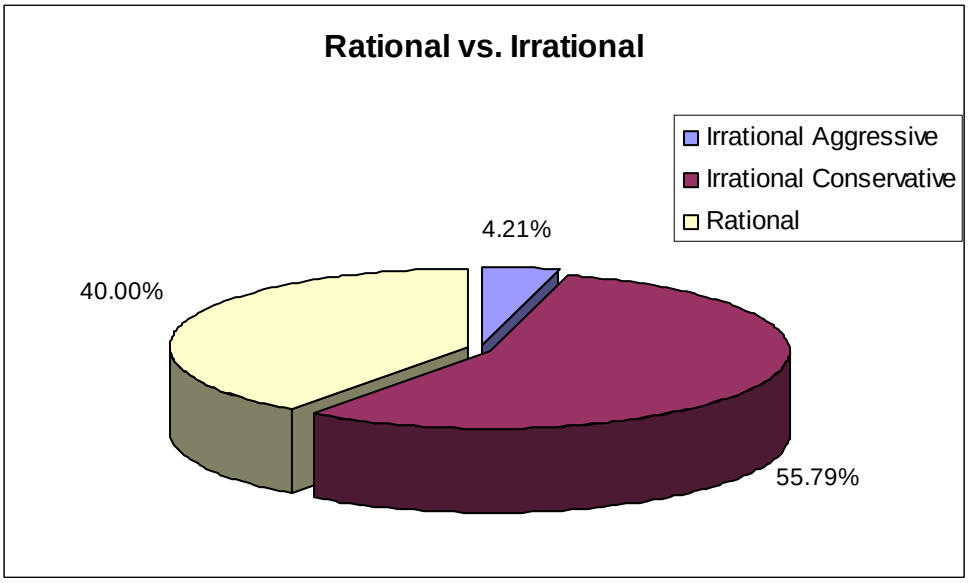
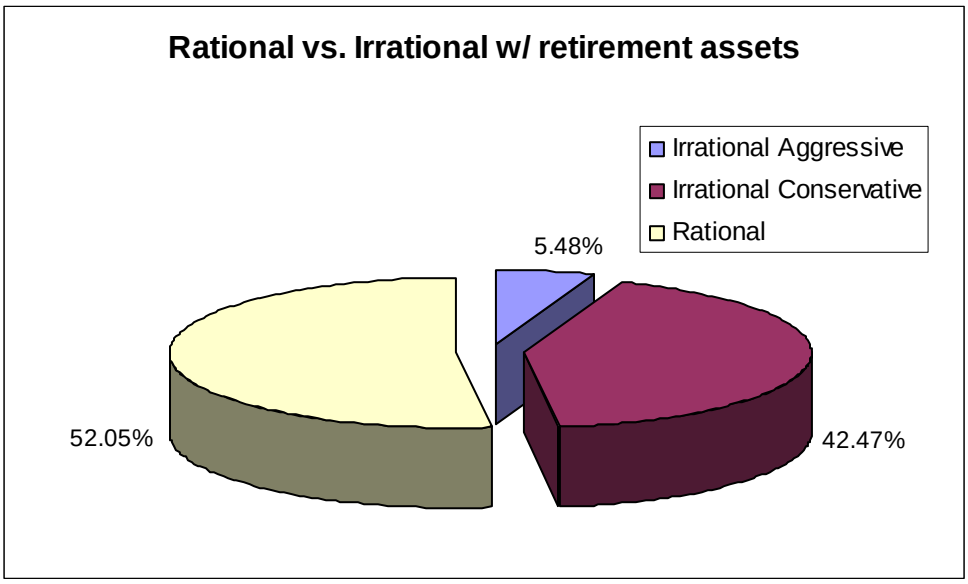


Figure 5.
Rational vs. Irrational w/ retirement assets Pie Chart



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