Effect of Health on Risk Tolerance and Stock Market Behavior

Shailesh Reddy

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The goal of this paper is to try to gauge the effect that an individual's health has on his risk tolerance and in turn whether he is more or less likely to enter the stock market. There seems to be a slight negative correlation between health condition and risk tolerance, but this is difficult to quantify because risk tolerance takes so many other factors into account. The length of time since an individual was diagnosed with a chronic condition seems to affect his behavior associated with risk tolerance. He becomes more tolerant 5-10 years after diagnosis but, after 10 years, he reverts to the same level as when he was initially diagnosed. Between 1999 and 2003, there was a clear uptrend in the stock market followed by a contraction. Those who entered the stock market have a higher risk tolerance as expected, but this behavior cannot be explained fully in terms of health status as an individual considers other factors such as income when making this decision. Stock market behavior can be predicted by these factors but the magnitude of impact cannot be determined. Thus, using risk tolerance as a predictor of stock market behavior is appropriate because it includes all of the factors that are considered in an individual's decision making process.

I. Introduction

Risk aversion is a crucial aspect of economics because it drives much of the theory behind decision making. While economists know what risk aversion looks like in terms of indifference curves and equations, very little is known about what actually shapes an individuals' risk aversion. In fact, variables that maybe incorporated when an individual forms his attitude toward risk are generally viewed as exogenous. Even if an individual's risk preferences are fixed in response to a change in circumstance he may still exhibit a change in behavior that is reflective of his new situation.

Assuming that individuals are rational, we can make fairly good assumptions as to how an individuals' risk aversion varies in different scenarios. For example, according to the Life Cycle Hypothesis, an individual should become more risk averse, concerning income variation, after he retires than while he is in the workforce. This is because he should be more concerned about financial returns after he retires because he usually has no source of future labor income. Although we can make general statements like this, it is hard to quantify the change in behavior that an individual undergoes in response to a particular scenario because each individual may respond in a different manner. Some may not even respond as the theory suggests.

The purpose of this paper is twofold: first to make a general evaluation an individual's risk aversion as it relates to his health status, and second to see whether this risk tolerance measure shapes transitions into and out of the stock market.

Risk aversion can be demonstrated by the following example. Consider a gamble where an individual can win $100 or $0 with equal probability; the expected payoff of this gamble is then $50. An individual is risk averse if they are willing to accept an amount lower than $50 with 100% certainty over taking the gamble. An individual is risk neutral if they are indifferent

between taking the gamble and taking $50 with 100% certainty. An individual is risk tolerant if the amount of money they are willing to accept with 100% certainty, instead of taking the gamble, is greater than $50. The amount of money that the individual will accept with no uncertainty instead of taking the gamble is called the certainty equivalent. If the certainty equivalent is less than the expected value of the gamble then the individual is risk averse. He is risk neutral if the certainty equivalent is equal to the expected payout and risk tolerant if the certainty equivalent is greater than the expected value of the gamble. Figure 1 shows this using the utility functions of a risk averse and risk tolerant individual in the context of the described gamble.

It should be the case that a rational individual will become more risk averse once he is diagnosed with a serious chronic condition. The change in his condition will change the constraints to which his preferences are bound so that his optimal behavior changes in response to his new circumstance. Figure 2 illustrates this theory by showing how the optimal behavior of an individual with Cobbs-Douglas indifference curves may change in response to diagnosis of a chronic condition. Assume that the individual starts out with the constraint which is tangent to the indifference curve at point A. Once he is diagnosed with a chronic disease, his constraint may change to the one which is tangent to the curve at point B. At point A his optimal bundle includes more of the risky asset than it does at point B. Therefore the change in his health condition caused a change in his behavior leading him to consume less of the risky asset even though the preferences defined by his indifference curve did not change.

I assume that rational individuals will want to avert death as long as possible. This means spending money on medication and procedures which can be very costly. Having been diagnosed with a chronic illness may also make individuals see as dangers life events that they previously

took on with relative confidence. For example, a person may have eaten a certain food for his whole life up to when he was diagnosed with a chronic condition, but after the diagnosis he may not be able to eat that food without further aggravating the symptoms of the condition. A rational individual has an incentive to become more personally and financially risk averse after being diagnosed with a chronic illness because it will lead to a higher probability that he has a longer life expectancy than if he continued living as if fully healthy, but with more risk in terms of maintaining his previous standard of living.

To gauge the correlation between risk tolerance and stock market behavior, I look at the period between 1999 and 2003. In 1999, investing in the stock market seemed to be a lucrative decision as the bubble began to grow. This growth continued in 2001, but by 2003 the market was on the downturn. It should be the case that those who withdrew from the market during this down period have a lower risk tolerance than those who stayed in to ride out the contraction. I will also look to see whether other factors such as yearly income, education, and health status affect the decision to enter or exit the stock market.

II. Background

Smoking is a major risk factor for several chronic diseases including heart disease and cancer. A recent study showed that a wage gap is present between persistent smokers (those who have no intention of quitting) and nonsmokers. There are several possible explanations for why persistent smokers tend to have lower wages. One reason is that persistent smokers may simply be less productive than nonsmokers and receive lower wages as a consequence. Alternatively, employers who provide health benefits may see persistent smokers as equally productive but more expensive to hire and compensate by giving them lower wages (Stafford, Grafova 2009). Finally, people working in low-wage jobs may not value living as long and do not see smoking

as a great risk to them. This would increase the number of smokers with low wages which would contribute to the observed wage-gap between smokers and nonsmokers.

Assuming that the trend of lower wages as seen in persistent smokers applies to those with other chronic conditions, an individual who is diagnosed with a chronic disease can be expected to have a lower wage. As a consequence, he should avoid other sources of financial risk.

III. Data Selection and Variables

The data used for this study is exclusively from the Panel Study of Income Dynamics (PSID) database. Each of the variable values is derived from survey data collected from a wide panel of people. The following is a list of the variables that I used in this study.

Health Status

This variable quantified the health of the head of the household on a scale of 1 to 5 with increasing values meaning worse health.

Years Since Diagnosed

The diseases I selected are those which are usually regarded as more serious: stroke, diabetes, cancer, and heart disease. Questions about these were asked in 1999, but risk tolerance was asked in 1996. Therefore I used the question "How many years ago were you diagnosed with…?" to see who had these diseases at the time they were asked about risk tolerance. If they answered this question with a response greater than 3 years ago then the implication is that they had the disease prior to 1996. This timing aspect is an important factor because whether or not a person has a disease is hypothesized to shape his reported attitude about risk tolerance. If he had a chronic condition, then under the hypothesis that the preference measure is partly situational in that he should change his behavior given this new circumstance, he should be more risk averse for the reasons mentioned earlier.

Time Dependent Health Shocks

I have also created time shock variables which represent different periods of time when a person could have been diagnosed with a disease. The periods are within five years before being asked about risk tolerance in 1996, five to ten years before 1996, and earlier than ten years before 1996. This is intended to capture whether the length of time that a person has had a disease will impact his judgment about risk tolerance. One hypothesis is that a more recent onset of a serious condition will have a greater impact on reported risk tolerance at a given level of economic resources to accommodate the condition.

Yearly Income

This variable is simply the amount of income earned by the individual in the previous year. It should be the case that a higher income will correspond with a higher reported risk tolerance in the absence of any situational shocks.

Education Level

The individual's education level is measured by numbers from 0 through 17. A 0 indicates that the person has no education, 1-12 corresponds to the highest grade they completed, 13-16 indicates that they have had some undergraduate education, and a 17 means that the person has had some level of graduate education.

Stock Ownership/Portfolio Composition

These variables show whether or not a person owns stocks in a given year and what proportion of his portfolio is composed of stocks as opposed to safer investments such as annuities. Those with higher reported risk tolerances should have a higher percentage invested in stocks rather than bonds which are typically considered safe investments.

Stock data was collected from survey questions which asked about the individual's situation for the current year. For example, the following question was asked to see whether or not the individual owned shares of non-IRA stock in the current year. The question text read:

"Do you (or anyone in your family) have any shares of stock in publiclyheld corporations, mutual funds, or investment trusts--not including stocks in employer-based pensions or IRAs?".

Answering the above question with a "yes" response would indicate that the individual owned stocks in that current year. By looking at the responses in different years one can describe the ownership trends over periods of time.

Net Balance in/out of Stock Market

This variable shows how much a person either put in or took out of the stock market for the year.

Risk Tolerance

The measurement of risk tolerance is derived from a survey asking respondents about their willingness to gamble on their lifetime income in hypothetical situations. The first question asked on the survey is:

"Suppose that you are the only income earner in the family, and you have a good job guaranteed to give you your current (family) income every year for life. You are given the opportunity to take a new and equally good job, with a 50–50 chance it will double your (family) income and a 50–50 chance that it will cut your (family) income by a third. Would you take the new job?"

If the answer to the first question is "yes" then they are asked the following question:

"Suppose the chances were 50–50 that it would double your (family) income, and 50–50 that it could cut it in half. Would you still take the new job?"

If the answer to the first question is "no" then they are asked the following question:

"Suppose the chances were 50–50 that it would double your (family) income and 50–50 that it would cut it by 20 percent. Would you then take the new job?"

Based on their answers as they branch through these survey questions, respondents were classified into groups with distinct risk preferences. Figure 2 shows a decision tree which separates the panel into four groups depending on the answers to this survey. For example, those who answered "yes" to both questions were divided into their own group because they have the highest risk tolerance. The quantitative values of the risk tolerance measure were computed conditional on the individual's risk grouping. The important thing to note is that a higher value corresponds to a higher risk tolerance (Barsky et al.1997).

IV. Results

Health and Risk Tolerance

Looking at table 1, there is a small negative correlation (-.0058, p=.818) between an individuals' risk tolerance and a shock to his health. For this analysis, since it would be nearly impossible to come up with an all-encompassing model of health problems for all the families in the panel, I will focus more on the signs and trends of the outcomes rather than their magnitude or significance level. The negative sign in table 1 is consistent with the proposed theory.

A comparison of the means of each of the time shock groups can be used to find a trend. Table 2 shows a t-test comparing the mean risk tolerance for those who experience a health shock less than five years before being asked about risk tolerance and those who experienced a health shock five to ten years before the survey. The risk tolerance of those who have had a health shock for five to ten years already is significantly higher at the 10% level (p=.1010) than those who had their health shock for less than five years. Interestingly, we can see from tables 3 and 4 that those who have had a health shock at least ten years ago have a mean risk tolerance similar to

those who had a health shock less than five years ago (p=.0154). As seen in table 5, the mean risk tolerance for those who did not have a health shock is statistically the same as for those who had a shock within the past five years.

Now that the risk tolerance data has been looked at with respect to health status, I will use this to see whether or not health is a motivating factor for people entering/exiting the stock market. Individuals, however, take more than their health into account when shaping their attitudes about risk tolerance. Therefore, I will include other variables such as income and education level to try and obtain more potential reasons for transitions into and out of the stock market. To gauge the relative importance of these factors is hard because each individual in the panel has a different personal situation which is independent of everyone else in the panel. Since all of the possible motivations are incorporated into the formation of risk tolerance, then transitions into and out of the stock market should be accurately represented by this risk tolerance measure even if the importance of a specific factor is hard to discern.

General Stock Ownership Trends 1999-2003

Table 6 shows the trend of stock market participation between 1999 and 2003. In 1999, 27.74% of people in the panel owned stocks. This increased to 29.20% in 2001 before declining to 27.06% in 2003. Considering stocks as a risky investment, a similar pattern follows for the percentage of people whose portfolios consist mostly of stocks. In 1999, 26.17% of people who owned stocks had a portfolio composed of mostly stocks. A rise to 28.69% occurred in 2001 followed by a decrease to 25.69% in 2003. In 2001 the average balance put into the stock market by stockowners was $73091, an increase from $62441 in 1999. Table 7 illustrates that in 2003 the average balance into the stock market fell to $38473 whereas the average taken out rose to

$66566 from $37057 in 2001. Table 8 shows that the risk tolerance of stock market investors was significantly higher than those who did not own stocks in all three years.

Transitions Into and Out Of Stock Market

The following results can be seen in tables 9 through 14.

People in the panel who did not own stocks in 1999 but owned stocks in 2001 had an average risk tolerance of 1.27; this is higher in magnitude but the difference is not statistically significant from the average risk tolerance of 1.07 for those who owned stocks in 1999 and did not in 2001 (p=.1428). Those who did not own stocks in 1999 but did in 2001 had a higher change in average yearly income from 1999 to 2001 ($13367) than those who owned stocks in 1999 and did not in 2001 ($9586). The average level of education was the same (14 years) for people in both transition categories; however, the minimum education of those who did not own stocks in 1999 and did in 2001 is 4 whereas the minimum is 8 for the other group. For those in the panel who did not own stocks in 1999 but owned in 2001, 15.74% reported having better health while 22.30% experienced a decline in their health. Out of those who owned stocks in 1999 but did not in 2001, 23.62% got healthier and 21.26% had worse health.

It is important to note that the 2001 stock market data was collected before 9/11. This means that those who invested between 1999 and 2001 were investing into a different market scenario than those who invested from 2001 to 2003. The former group of investors was betting on the market continuing to surge and contributed to a growing bubble while the latter group was investing into a market where the bubble had already burst. Therefore it should be the case that those who held stocks from 2001 to 2003 have a higher risk tolerance than those who invested from 1999 to 2001 because of the market situation.

People in the panel who did not own stocks in 2001 but owned in 2003 had, on average, a higher magnitude of risk tolerance (1.24) than those who owned stocks in 2001 but did not in 2003 (1.16, p=.3573). The former group had an average change in yearly income of $1419 from 2001 to 2003 while the latter group had an average change of $2888. Average education level is 14 for both groups; those who did not own stocks in 2001 and owned in 2003 had a minimum education level of 8, but the minimum education level is 4 for the other group. For the group that did not own stocks in 2001 but did in 2003, 20.98% report having better health and 22.32% had worse health. The other group reported that 18.71% of individuals had better health while 22.11% had worse health.

The remaining comparison deals with the group of individuals who did not own stocks in 1999 but owned in 2003 and those who did not own stocks in 1999 and still did not own in 2003. The average risk tolerance for those who owned in 2003 was 1.26, which is significantly higher than the .924 average risk tolerance for those who did not own in 2003 (p=.0033). The average change in annual income for those who owned in 2003 was $16831 whereas the average change in annual income for people who did not own in 2003 was only $8462. The average education level of those who owned in 2003 was 14 and the minimum education level was 8. For those who did not own in 2003 the average education level was 13 and the minimum was 0. Out of those who owned stocks in 2003, 14.97% reported having better health and 28.23% reported having worse health. Those who did not own stocks in 2003 reported 16.24% of people with improved health and 29.26% with worse health.

V. Discussion

Time Dependence of Risk Tolerance After Health Shock

The effect of time dependence of health shocks on risk tolerance follows an interesting pattern. The data show that people's attitude toward risk tolerance does not change much within the first five years of a health shock. The correlation in Table 1 indicates that people will lower their risk tolerance but only very slightly if at all. This could be due to the individual being in denial about his disease and thinking that it will not affect his life. During the five to ten year period after experiencing a health shock, people become more risk tolerant. This result may be best explained psychologically in that people may go through a period of time where they become apathetic to nearly everything in their lives after experiencing a health shock. This would cause them to be willing to take on more risk since they are almost indifferent between the possible outcomes. Past the ten year mark of experiencing a health shock people are better able to cope with their situation and revise their risk tolerance preference back to its original level.

Stock Market Behavior

The pattern for the stock market on which this analysis is based is that the market was on the rise in 1999; therefore, people thought of it as common sense to put money into stocks. In 2001 the market was still growing so people should have continued to put money into stocks. By the time the panel answered these survey questions in 2003, the bubble had burst and the market had begun to contract. People should have started pulling their money out of stocks. The general trends of stock ownership follow this closely as the number of people who owned stock increased in 2001 but then decreased in 2003. Also, the percentage of people whose portfolio consisted mostly of stocks showed a similar pattern. In 2001, there was almost an $11000 increase in the net balance put into the stock market; this was followed by an almost $35000

decrease in 2003. The amount of money taken out of the stock market in 2003 was nearly $30000 per household, on average, more than the amount taken out in 2001. Since stocks are assumed to be a risky investment, it makes sense that the data show stockowners have a higher risk tolerance than nonstockholders.

Looking at the period from 1999 to 2001 it should be the case that people who did not own stocks initially and ended up owning have a higher risk tolerance than those who started out as stockholders but dropped out of the market. The risk-tolerance data show that this is true in magnitude but with a large p-value. This statistical insignificance could be attributed to a relatively small sample size of both of these groups; only about one-sixth of the total panel is represented in both groups combined. People who ended up investing in the market in 2001 had a higher change in yearly income than people who dropped out. This could be one reason for people dropping out of the market, because they did not make as much to invest. Even though there is no difference is the average level of education, it is interesting to note that the minimum level of education for people who invested by 2001 is 4 while it is 8 for those who exited the market. This could be an indication of a herding effect and people putting money into stocks blindly just because they hear it is the right thing to do since the market is up. A slightly higher percentage of people reported having worse health from 1999 to 2001 that owned stocks in 2001 than did not. A possible explanation for this is that people who have worsening health need money to pay for medication, procedures, etc. so they invested in the market while it was good so that they can make money to cover these expenses.

The period from 2001 to 2003 has the same risk tolerance situation as the period from 1999 to 2001. People who did not own stocks in 2001 but did in 2003 have a higher risk tolerance than those who owned stocks in 2001 but did not in 2003. The high p-value can again be attributed to

a small sample size as there are even less people in these groups than in the groups from 1999 to 2001. The average change in yearly incomes of both transition groups in this period is far less than they were in the period from 1999 to 2001. Lower incomes could explain why there was a net exit from the stock market in 2003. The education levels are again the same for both groups in this period but this time the minimum education level for those who owned stocks in 2003 is 8 whereas it is 4 for those who exited the market. Again, this could be a sign of herding as people took money out of the stock market just because others did to since the market was down. A higher percentage of people reported having better health from 2001 to 2003 that entered the market than who exited. This could be because those who are in better health feel more comfortable about leaving their money in a down market in hopes that it turns around whereas those with worse health do not want to lose their money since they have to pay for health care costs.

Looking at the whole time range from 1999 to 2003 it is interesting to compare those who did not own stocks in 1999 and did in 2003 with those who did not own stocks in 1999 and still did not in 2003. This comparison is equivalent to comparing those who entered the stock market with those who did not enter at all or entered then exited over the entire range of the sample. The average risk tolerance for those who entered the market was significantly higher than for those who did not; this comparison includes almost the entire panel so there are enough observations to create statistical significance unlike in the previous short-term comparisons. The average change in annual income for those who entered the stock market was about double the income change for those who stayed out. The income difference between these groups could suggest that one of the reasons people entered the market was because they had more disposable income to put into stocks. The average education level for those who entered the market was slightly higher than for

those who did not invest. The minimum education level for investors was 8 whereas it was 0 for nonstockholders suggesting that investing and staying in the stock market is a game played mostly by those who have some understanding of what they are doing and do not follow noise traders. A slightly higher percentage of people whose health deteriorated from 1999 to 2003 stayed out of the market than entered. Though this difference may not be substantial, it could indicate that people are more likely to invest in stocks if they are in good health.

The results obtained are not too different than what should be theoretically expected but it is interesting to see that the panel of people displayed the economic behavior that was predicted. Behavior related to risk tolerance is undoubtedly constrained by many individual factors, but from the analysis it can be said that health status is indeed among those factors. The magnitude of how important health is to risk tolerance will vary depending on the individual therefore the extent of the impact that health has on risk tolerance cannot be determined in general. Stock market behavior is described accurately by risk tolerance measures. Other factors such as income, education, and health can be used to explain entrance or exit from the stock market but these factors should all be included in the risk tolerance measure. Therefore, it makes sense that stock market behavior can be explained by risk tolerance because risk tolerance incorporates the same factors that can also explain stock market behavior. The data from this panel confirm that this is indeed the case.

VI. Appendix

	rt1	headshock
rt1	1	
headshock	-0.0058	1

Table 1- Correlation of risk tolerance measure with health shock of the head of household

Variable	Mean	Std. Error
rt05	0.2812903	0.0204206
rt510	0.3312	0.0342701
diff	-0.0499097	0.0388168
H_0: diff=0	H_a: diff<0	p=0.1010

Table 2- t-Test comparing means of risk tolerance of 0-5 and 5-10 years after health shock

Variable	Mean	Std. Error
rt510	0.3312	0.0342701
rt10	0.2579412	0.0143319
diff	0.0732588	0.0335241
H_0: diff=0	H_a: diff>0	p=0.0154

Table 3- t-Test comparing means of risk tolerance of 5-10 and 10+ years after health shock

Variable	Mean	Std. Error
rt05	0.2812903	0.0204206
rt10	0.2579412	0.0143319
diff	0.0233491	0.0243146
H_0: diff=0	H_a: diff≠0	p=0.3383

Table 4- t-Test comparing means of risk tolerance of 0-5 and 10+ years after health shock

Variable	Mean	Std. Error
rtnoshock	0.2865859	0.0042511
rt05	0.2812903	0.0204206
diff	0.0052956	0.0203951
H_0: diff=0	H_a: diff≠0	p=0.7952

Table 5- t-Test comparing means of risk tolerance of no health shock and 0-5 years after health

Year	% of people who own stocks	% of people whose portfolio composed mostly of stocks
1999	27.74	26.17
2001	29.2	28.69
2003	27.06	25.69

Table 6- Percentage of people who own stocks and percentage of people whose portfolio is composed of mostly stocks given that they are a stockholder

Year	In	Out
1999	62441	34725
2001	73091	37057
2003	38473	66566

Table 7-Net Balance In/Out of Stock Market

Year	Stockowners	Nonowners	p-value
1999	1.14	0.968	0.0354
2001	1.2	0.94	0.0009
2003	1.21	0.939	0.0007

Table 8-Risk Tolerance of Stockholders and Nonowners and p-value of t-test for equality

Variable	Mean	Std. Error
rt9901no	1.27	0.134
rtno9901	1.07	0.133
diff	0.2	0.191
H_0: diff=0	H_a: diff>0	p=.1428

Table 9- t-Test of Risk Tolerance Means from 1999 to 2001 (9901no=owned in 99 not in 01, no9901=did not own in 99, owned in 01)

Group	Change in Annual Income	Education Level	% Better Health	% Worse Health
Did not own in 99, owned in 01	13367	14	15.74	22.3
Owned in 99, not in 01	9586	14	23.62	21.26

Table 10-Data for Transition Groups for 1999 to 2001

Variable	Mean	Std. Error
rt0103no	1.24	0.156
rtno0103	1.17	0.126
diff	0.07	0.098
H_0:	H_a:	
diff=0	diff>0	p=.3573

Table 11-t-Test of Risk Tolerance Means from 2001 to 2003 (0103no=owned in 01 not in 03, no0103=did not own in 01, owned in 03)

Group	Change in Annual Income	Education Level	% Better Health	% Worse Health
Did not own in 01, owned in 03	1419	14	20.98	22.32
Owned in 01, not in 03	2888	14	18.71	22.11

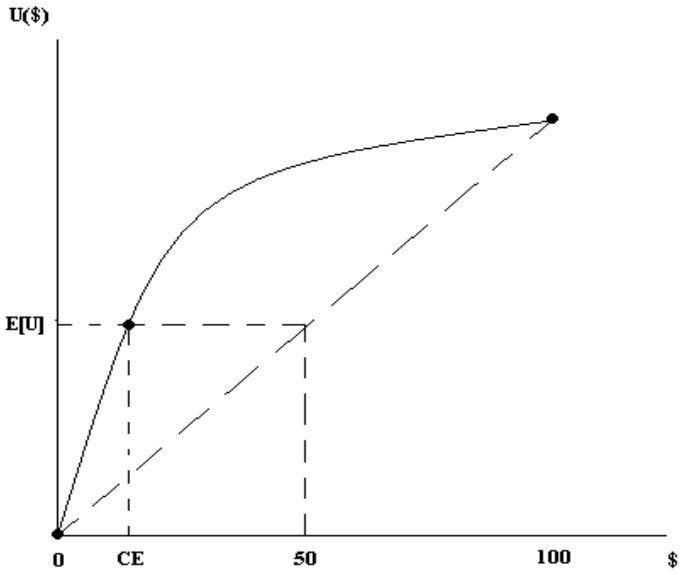
Table 12-Data for Transition Groups for 2001 to 2003

Variable	Mean	Std. Error
rt9903	1.26	0.134
rt9903no	0.924	0.043
diff	0.336	0.041
H_0:	H_a:	
diff=0	diff>0	p=.0033

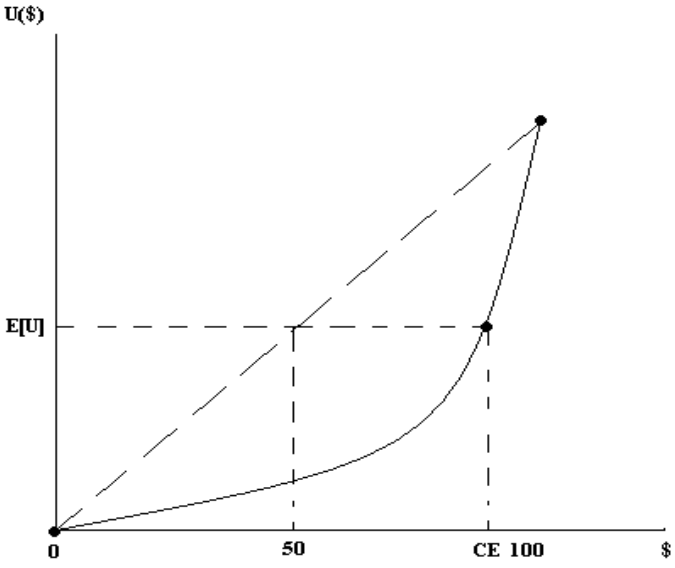
Table 13-t-Test of Risk Tolerance Means from 1999 to 2003 (9903=did not own in 99, owned in 03, 9903no=did not own in 99, did not own in 03)

Group	Change in Annual Income	Education Level	% Better Health	% Worse Health
Did not own in 99, owned in 03	16831	14	14.97	28.23
Did not own in 99, did not own in 03	8462	13	16.24	29.26

Table 14-Data for Groups from 1999 to 2003



(a)- Utility diagram of gamble for risk averse individual



(b)- Utility diagram of gamble for risk tolerant individual

Figure 1- Utility diagrams of risk averse (a) and risk tolerant (b) individual in gamble where he either receives $100 or $0 with equal probability
E[U]- Expected Utility
CE- Certainty Equivalent (amount received with no uncertainty)

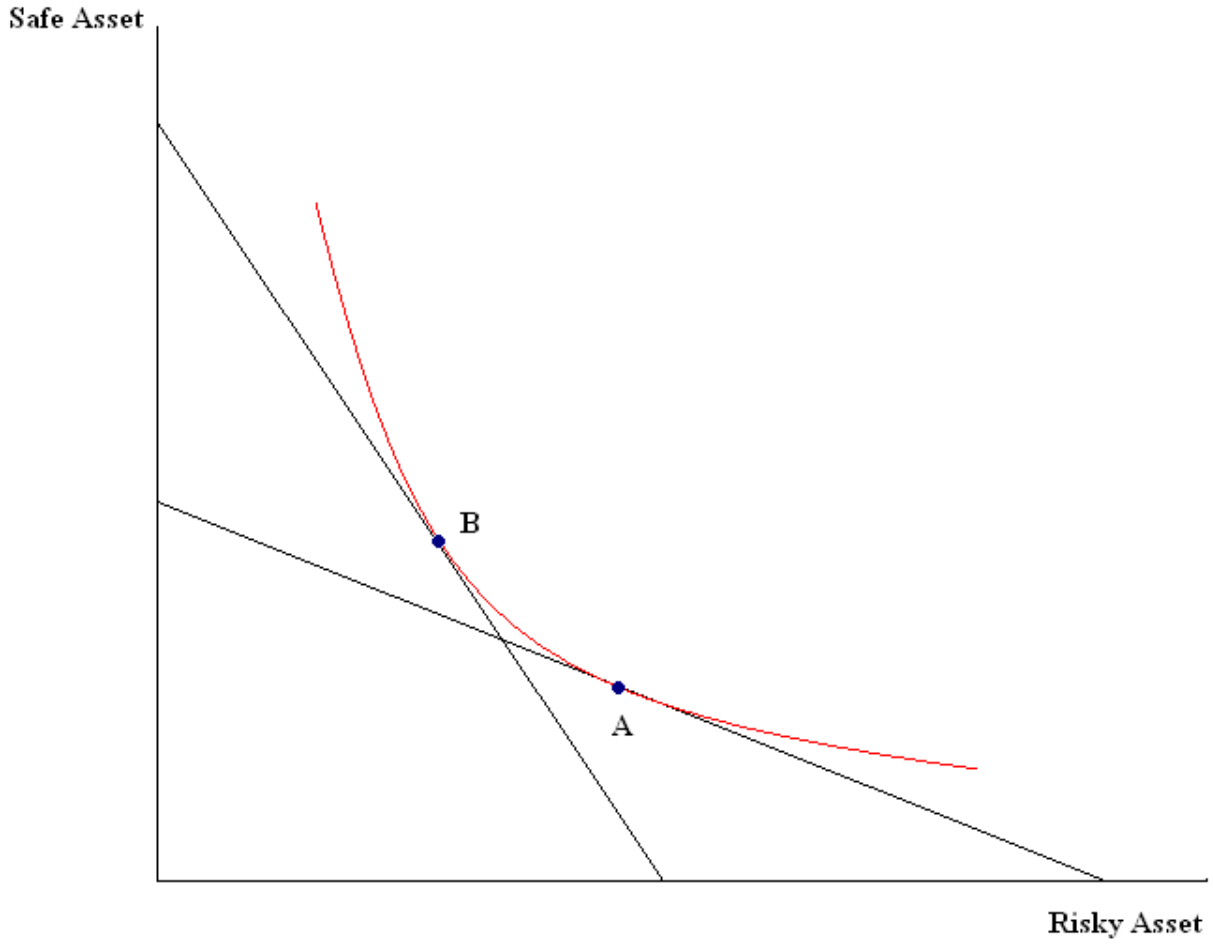


Figure 2- Optimal bundles between safe and risky asset for individual with Cobbs-Douglas preferences.

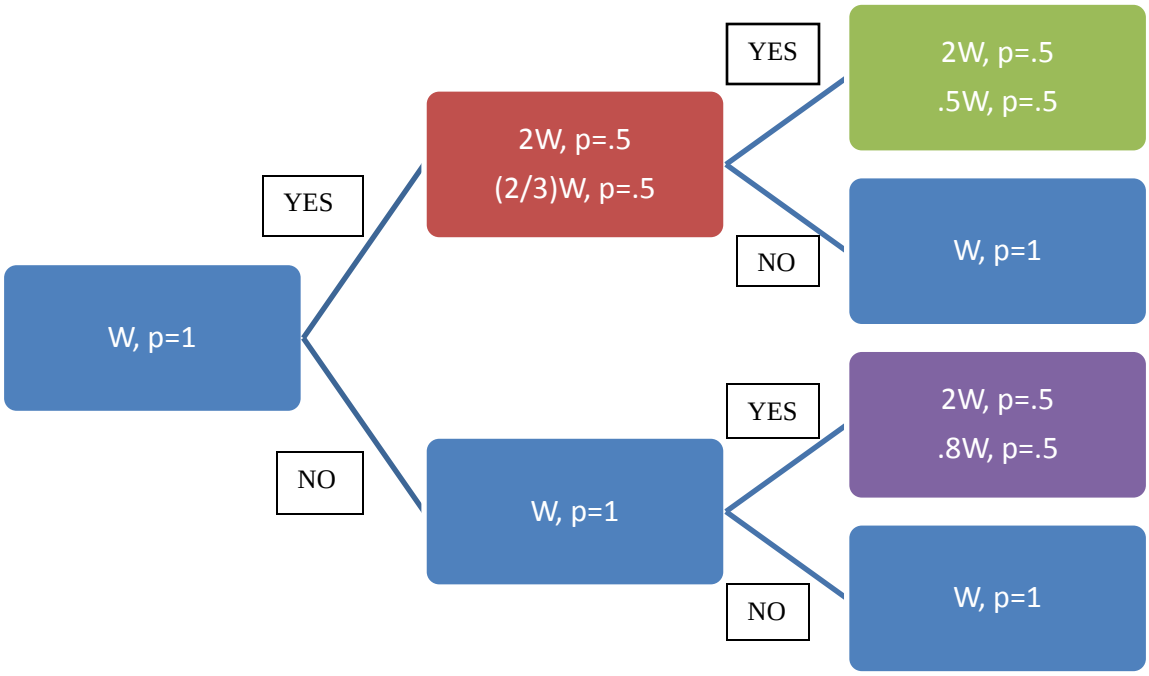


Figure 3- Decision tree showing risk tolerance groupings in terms of initial wealth (W) after survey responses

VII. Works Cited

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