An Analysis Of The Ability Of Individuals To Predict Their Own Risk Tolerance

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ABSTRACT

This paper analyzes the capability of individuals to accurately estimate risk tolerance. Using a database of respondent answers to a psychometrically valid questionnaire, calculated risk tolerance scores are compared to respondent self-assessed risk tolerance scores. In general, gender and education are the most significant factors in explaining the ability of individuals to accurately forecast their own risk tolerance score.

INTRODUCTION

For an investor making portfolio allocation decisions, having a sound understanding of financial risk tolerance is one of several essential components leading to successful investment decisions. Droms (1987) argued that an understanding of risk tolerance was one of several factors necessary for an individual to be able to make optimal portfolio choices in terms of risk-reward trade-offs. The inability to correctly perceive actual tolerance for risk may lead investors to select sub-optimal portfolios. For example, all else equal, by overestimating (underestimating) individual risk tolerance, an investor may select a portfolio that turns out to be too aggressive (conservative).

Choosing a portfolio not consistent with risk tolerance may thus result in investor disappointment. This not only has importance for the investor but also for the investor's financial advisor. The investor may be left with feelings of uneasiness about a portfolio allocation. The advisor may believe that correct advice has been provided when in fact the advice given is not consistent with the investor's true risk tolerance. If the investment outcome then disappoints, the relationship between the investor and advisor may suffer.

The multi-dimensional nature of risk tolerance makes it a challenge to measure. Cutler (1995) classified as "myth" the idea that financial risk tolerance is a simple one-dimensional attribute. According to Cordell (2001), risk tolerance is multi-faceted. It is a function of propensity, attitude, capacity, and knowledge. Of these, attitude and capacity are most significant.

Significant research has attempted to identify the determinants of risk tolerance. In the past twenty years, numerous studies have attempted to identify the demographic factors that determine risk tolerance. A variety of socio-economic variables have been proposed and tested. Research to date, however, has not always provided a consensus regarding the effect of these factors on risk tolerance.

LITERATURE REVIEW

Demographic factors previously proposed and researched as possible drivers of investor risk tolerance include age, gender, marital status, number of dependents, education (or investment knowledge), income, and wealth. The data required for risk tolerance research typically has two sources: investor surveys and actual portfolio choices. For survey data, a random sample of individuals are asked, or volunteer, to answer a variety of risk/return questions. Using actual portfolio choices, researchers will typically examine investor holdings within retirement accounts such as 401(k)'s.

Age

Intuitively, most financial advisors and researchers would hypothesize that age and risk tolerance are negatively related. Indeed, several studies make this conclusion (see Hallahan, Faff & McKenzie, 2004 a & b; Palsson, 1996; Bakshi & Chen, 1994; Morin & Suarez, 1983; and McInish, 1982). Using what can be considered a proxy for age, Sung & Hanna (1996), found that risk tolerance was higher for those individuals 30 or more years from retirement than those individuals close to their expected retirement date. Some recent research, however, has found either no relationship at all (see Cutler, 1995) or a positive relationship (see Grable, 2000; Grable & Lytton, 1998; Grable & Joo, 1997; Wang & Hanna, 1997).

Gender

It has long been assumed that gender was significant to risk tolerance. Specifically, that men are more tolerant of risk than women (see Slovic, 1966). Research has supported this view, that men take more risks than women (see Hallahan, Faff & McKenzie, 2004 a & b; Grable, 2000; Grable & Lytton, 1998; Powell & Ansic, 1997; Bajtelsmit & Bernasek, 1996; and Sung & Hanna, 1996). Some researchers, however, have found evidence to the contrary. Grable & Joo (1999) and Hanna, Gutter & Fan (1998) each found an insignificant relationship between gender and risk tolerance. Roszkowski (1998) suggests that while historically men were more risk tolerant than women, this distinction is becoming less prevalent.

Marital Status and Dependents

Financial advisors tend to believe that marital status affects risk tolerance. As described by Roszkowski, Snelbecker & Leimberg (1993), this may be due to the level of responsibilities faced by a single person vs. a married couple. The married couple is more apt to have greater financial responsibilities and the presence of dependents, thus less risk tolerance. Married couples may also face more social risk, which can be described as the loss of esteem due to investment failure. Married couples with two incomes, however, may have greater risk tolerance driven by a larger degree of risk capacity. Research results are mixed as to the importance of marital status on risk tolerance. Research from Roszkowski, Snelbecker & Leimberg (1993), Sung & Hanna (1996), and Faff, Hallahan & McKenzie (2004 a), supports the view that single persons are more risk tolerant than married couples. Grable (2000) found that married couples were more tolerant of risk than single persons. Others have found no significant relationship between marital status and risk tolerance (see Grable & Joo, 1997; Haliassos & Bertaut, 1995; Masters, 1989; and McInish, 1982).

Education

Many studies have found a positive relationship between risk tolerance and formal levels of education. The presumption is that with more formal education, an individual is better equipped to assess the risk/return tradeoff of an investment. The result is greater tolerance for risk (see Hallahan, Faff & McKenzie, 2004 a; Grable, 2000; Grable & Lytton, 1998; Sung & Hanna, 1996; Shaw, 1996; Riley & Chow, 1992; and Baker & Haslem, 1974).

Income and Wealth

Income and wealth are regularly believed to have a positive relationship to risk tolerance. Many researchers have found this positive relationship to be significant (see Hallahan, Faff & McKenzie, 2004 a; Bernheim, Skinner & Weinberg, 2001; Grable, 2000; Grable & Lytton, 1998; Schooley & Warden, 1996; Shaw, 1996; and Riley & Chow, 1992). Roszkowski (1998) made note that what these results may be measuring is risk capacity. That is, a higher income or wealth level provides an individual greater capacity to incur risk. Also, it is important to distinguish between absolute and relative risk tolerance. Researchers generally believe that the absolute amount of income or wealth invested in risky assets is a positive function of income or wealth. There is less agreement, however, whether relative risk tolerance (the percentage of income or wealth invested in risky assets) is positively related to income or wealth. Cohn, Lewellen, Lease & Schlarbaum (1975) did find that relative risk tolerance also increases with income and wealth.

METHODOLOGY

Previous research has focused on the identification of those demographic attributes that significantly affect risk tolerance scores. The usual approach is to employ a questionnaire or survey in which respondents answer risk tolerance questions. Results are tallied and respondents are either assigned a risk tolerance score or are classified into risk tolerance groups (low, medium, high). This research differs in that the focus is not on explaining risk tolerance scores but on the ability of individuals to accurately *forecast* their risk tolerance. Suppose in addition to calculating a risk tolerance score, questionnaire respondents are asked to estimate their risk tolerance score. That is, do respondents have an accurate perception of their own risk tolerance? Given that each respondent reveals their perceived risk tolerance, do particular demographic attributes explain the difference between a questionnaire respondent's calculated risk tolerance score (RTS, as measured by the survey) and that respondent's self-assessed risk tolerance score (SRTS, simply a personal guess)?

The catalyst for this paper is the work of Hallahan, Faff & McKenzie (2004 a & b). Using the ProQuest Personal Financial Profiling System and the questionnaire responses of over 20,000 individuals (almost exclusively Australian), the authors analyzed the importance of certain demographic variables on risk tolerance.[1] The last of the twenty-five questions asks the respondent to guess his/her risk tolerance score, prior to seeing the calculated score.[2] Hallahan, Faff & McKenzie (2004 a) reported that of the 20,415 respondents, 4% (803) estimated their risk tolerance score accurately, 23% (4691) overestimated their risk tolerance score (SRTS > RTS), and 73% (14,921) underestimated their risk tolerance score (RTS > SRTS). The authors further reported that based on their analysis, on average, a respondent's SRTS equaled 4.12 + 83.8% of the RTS. The results indicated a high degree of statistical significance between a respondent's RTS and SRTS.

Thus, there appears to be a strong linkage between RTS and SRTS. But there is also evidence that most respondents incorrectly estimate their calculated risk tolerance score. Respondents may therefore not have an accurate assessment of their own risk tolerance.

Without doubt, a good questionnaire (high degree of reliability and validity) is a valuable tool for a financial advisor to better assist clients. Identification of demographic factors that effect actual risk tolerance scores helps the advisor provide better advice. But the advisor may also want to know the likelihood that a particular client has a correct understanding of his/her risk tolerance. Certainly, the greater an individual's self-understanding of risk tolerance, the easier will be the task of educating and advising that client.

Dependent Variable

The difference between RTS and SRTS can be considered an error term. It is not the error term of the functional relationship RTS = F(demographic variables). Rather, given that in usability and norming trials the questionnaire is robust (valid and reliable, meeting psychometric standards), RTS – SRTS is a measure of respondent error when asked to provide a self-assessment. If each respondent gives an unbiased estimate of his/her risk tolerance, the E(RTS-SFTS) = 0. Using RTS-SFTS as the dependent variable allows the exploration of identifying which demographic factors are significant in explaining why respondents make errors in estimating their risk tolerance score.

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[1] Fina Metrica Limited (formerly ProQuest Limited) is an Australian company that uses a proprietary computer-based questionnaire to estimate respondent risk tolerance. The questionnaire includes twenty-five questions, scored on a scale from 0 – 100. Higher scores indicate higher risk tolerance. The mean score is 50 and the standard deviation is 10. Respondents also are asked to answer eight demographic questions. Between May 1999 and February 2002, over 20,000 respondents completed the questionnaire. Testing has shown this survey to have a high degree of validity and reliability (see FinaMetrica.com). Many thanks to FinaMetrica Limited and Geoff Davey, Managing Director, for allowing use of this database.

[2] The question is: "The questionnaire is scored on a scale of 0 to 100. In practice, however, the scores range from around 20 to around 80, with the average being 50. When the scores are graphed they follow the familiar bell-shaped curve of the Normal distribution. About two-thirds of all scores are within 10 points of the average. What do you think your score will be? __" (Note, the question does include a graph of a normal distribution with mean = 50 and standard deviation = 10).

Independent Variables

The independent variables are those outlined in Table 1. The formulation of the model follows in the spirit of the work of Hallahan, Faff & McKenzie (2004 a & b).

Table 1: Independent Variables

Gender (GEN)
1 = Male 0 = Female

Marital Status (MAR)
1 = married (or defacto relationship) 0 = single

Family Dependents (DEP)
Number of persons who depend financially on the respondent

Age (AGE)
Actual age of respondent in years

Education (EDU)
1 = Did not complete secondary school
2 = Competed secondary school
3 = Trade school diploma or Associates Degree
4 = Bachelor's degree or higher

Income (INC: Before Tax)
Actual respondent income level

Net Worth (NTW)
Actual household net worth

Model

The general model is:

$$|RTS - SRTS| = \beta_0 + \beta_1 GEN + \beta_2 MAR + \beta_3 DEP + \beta_4 AGE + \beta_5 EDU + \beta_6 INC + \beta_7 NTW + \in \quad (1)$$

The dependent variable is the absolute value of the differences, not the calculated discrepancies. The purpose of the test is to estimate if the error that respondents may make in estimating their RTS can be explained with demographic factors.

Equation 1 is then divided into its component parts: overestimated and underestimated risk tolerance scores. The general model can then be written as:

$$(RTS - SRTS)_{OVER} = \beta_0 + \beta_1 GEN + \beta_2 MAR + \beta_3 DEP + \beta_4 AGE + \beta_5 EDU + \beta_6 INC + \beta_7 NTW + \in \quad (2)$$

and

$$(RTS - SRTS)_{UNDER} = \beta_0 + \beta_1 GEN + \beta_2 MAR + \beta_3 DEP + \beta_4 AGE + \beta_5 EDU + \beta_6 INC + \beta_7 NTW + \in \quad (3)$$

Equations (2) and (3) allow a test of whether there is an explanatory difference in the demographic variables between those respondents who overestimate their RTS (RTS – SRTS < 0) and those respondents who underestimate their RTS (RTS – SRTS > 0).

It is possible that some of the demographic relationships with the dependent variable are not linear. Bajtelsmit & VanDerhai (1997) and Riley & Chow (1992) suggested that risk tolerance and age might have a non-linear relationship. Hallahan, Faff & McKenzie (2004 b) indicated that non-linearity might also exist between risk tolerance and income, net worth, and number of dependents.

Equation (1) is expanded to a standard quadratic non-linear format.

$$|RTS - SRTS| = \beta_0 + \beta_1 GEN + \beta_2 MAR + \beta_3 DEP + \beta_4 DEP^2 + \beta_5 AGE + \beta_6 AGE^2 + \beta_7 EDU + \beta_8 INC + \beta_9 INC^2 + \beta_{10} NTW + \beta_{11} NTW^2 + \in \quad (4)$$

The non-linear model (4) is tested over the entire data set and also only the subsets where respondents overestimate their risk tolerance (RTS – SRTS < 0, equation 5) and where respondents underestimate their risk tolerance (RTS – SRTS > 0, equation 6).

$$(RTS - SRTS)_{OVER} = \beta_0 + \beta_1 GEN + \beta_2 MAR + \beta_3 DEP + \beta_4 DEP^2 + \beta_5 AGE + \beta_6 AGE^2 + \beta_7 EDU + \beta_8 INC + \beta_9 INC^2 + \beta_{10} NTW + \beta_{11} NTW^2 + \in \quad (5)$$

$$(RTS - SRTS)_{UNDER} = \beta_0 + \beta_1 GEN + \beta_2 MAR + \beta_3 DEP + \beta_4 DEP^2 + \beta_5 AGE + \beta_6 AGE^2 + \beta_7 EDU + \beta_8 INC + \beta_9 INC^2 + \beta_{10} NTW + \beta_{11} NTW^2 + \in \quad (6)$$

FINDINGS

Because some respondents did not provide answers to all of the demographic questions and some answers were nonsensical (for example, one respondent indicated having 87 dependents!), the database was reduced from 20,709 to 16,214. Of these, 660 or 4.1% correctly forecast their RTS, 3,672 or 22.6% overestimated their RTS (RTS – SRTS < 0) and 11,882 or 73.3% underestimated their RTS (RTS – SRTS > 0). The mean overestimation was 5.65, with standard deviation of 4.95 and median equal to 4. The mean underestimation was 9.14, with standard deviation of 6.09 and median equal to 8.

Results of statistical tests are reported in Tables 2 – 7 in the appendix. Table 2 shows the results for the linear model using the complete database. The intercept indicates the baseline forecast error (in absolute value). Gender, age, education and income are all significant at the 1% level. The results suggest that males make smaller forecast errors than females and more education leads to smaller forecast errors. Forecast errors appear to increase, however, with age and income.

Table 3 gives the results of the linear model for that group of respondents who overestimated their RTS. The baseline overestimation is 9.935. Education is the only variable significant at the 1% level. More education is associated with less overestimation of RTS. Noteworthy at the 5% level are age, marital status, number of dependents, and net worth. Forecast error reduces with age, being married, and net worth. Having more dependents tends to increase the size of the error.

Table 4 includes the results of the linear model for those respondents who underestimated their RTS. The baseline underestimation is 9.289. Significant at the 1% level are gender, age, education, and income. Marital status is significant at the 5% level. Being male lowers the underestimation error, as does more education and being married. Age and income tend to increase the amount of underestimation.

Tables 5, 6, and 7 give the results of the non-linear estimation procedure. In Table 5, the model is tested with the complete set of observations. The baseline error is 8.247. Significant at the 1% level are gender, education and number of dependents. Being male again suggests a smaller estimation error, as does more education. Interestingly, more dependents indicate less estimation error, and based on the non-linear specification, the decline in error is decreasing at an increasing rate.

In Table 6, the results of the non-linear model are presented for those respondents who overestimated their RTS. The baseline error is –13.922. At the 1% significance level, more education and being older result in less estimation error. Based on the non-linear specification, the affect of age on the error increases at a decreasing rate.

Finally, Table 7 shows the results for the non-linear model where the dependent variable is only those respondents who underestimated their RTS. The baseline error is 8.346. Gender, education, and number of dependents are significant at the 1% level. Again, being male suggests less estimation error, as does more education. As the number of dependents increases, the size of the estimation error declines at an increasing rate.

CONCLUDING REMARKS

Much of the research on risk tolerance in the past twenty years has focused on finding the factors that predict investor risk tolerance. An interesting related matter is appreciation of the factors that cause investors to misunderstand, or conversely to understand, their individual risk tolerance. Using a large database of predominately Australian respondents, this paper examined whether certain demographic attributes can explain investor risk tolerance estimation error.

Results suggest that the most significant factors are gender and formal education. Being male is related to smaller estimation error, as is more education. These results were consistent between the linear and the non-linear model specifications.

Other factors that may be important include age and number of dependents, though it is not clear whether these attributes increase or decrease the estimation error size. Income and net worth appeared to have little influence on the ability of the questionnaire respondents to accurately predict their RTS.

This research has importance to financial advisors. Advisors should understand that some clients are better able to forecast their risk tolerance than others. Forecast accuracy, since it appears to be influenced by education (knowledge), may be a proxy for risk tolerance understanding. As an advisor attempts to enlighten a client about risk and risk tolerance, it is quite possible that certain clients will grasp the concept more readily than others. Obviously, the ability of the client to grasp the concept of risk tolerance is an important factor in how the advisor approaches and manages the client relationship.

Appendix

Table 2: Linear Model, Complete data set, N = 16,214, Y = | RTS - SRTS|

Variable	Coefficient	Std. Error	t-test	p value
Intercept	8.349**	0.4048	20.63	0.000
GEN	-0.4236**	0.1094	-3.87	0.000
AGE	0.0141**	0.0048	2.91	0.004
MAR	-0.2595	0.1352	-1.92	0.055
DEP	0.0126	0.0384	0.33	0.744
EDU	-0.2406**	0.5359	-4.49	0.000
INC	0.1537**	0.0519	2.96	0.003
NTW	-0.0482	0.0315	-1.53	0.126

$R^2 = 0.004$ * Significant to the 5% level ** Significant at the 1% level

Table 3: Linear Model, N = 3,672, Y = RTS – SRTS < 0

Variable	Coefficient	Std. Error	t-test	p value
Intercept	-9.935**	0.6659	-14.92	0.000
GEN	0.2460	0.1784	1.38	0.168
AGE	0.0169*	0.0079	2.12	0.034
MAR	0.4813*	0.2294	2.10	0.036
DEP	-0.1396*	0.0679	-2.05	0.040
EDU	0.6585**	0.0854	7.71	0.000
INC	0.1304	0.0877	1.49	0.137
NTW	0.1086*	0.0539	2.02	0.044

$R^2 = 0.03$ * Significant to the 5% level ** Significant at the 1% level

Table 4: Linear Model, N = 11,882, Y = RTS – SRTS > 0

Variable	Coefficient	Std. Error	t-test	p value
Intercept	9.289**	0.4758	19.52	0.000
GEN	-0.4701**	0.1282	-3.67	0.000
AGE	0.0158**	0.0057	2.79	0.005
MAR	-0.3645*	0.1567	-2.32	0.020
DEP	-0.0033	0.0439	-0.07	0.940
EDU	-0.1764**	0.0632	-2.79	0.005
INC	0.1583**	0.0602	2.63	0.009
NTW	-0.0419	0.0366	-1.14	0.251

$R^2 = 0.005$ * Significant to the 5% level ** Significant at the 1% level

Table 5: Non-Linear Model, Complete data set, N = 16,214, Y =| RTS - SRTS|

Variable	Coefficient	Std. Error	t-test	p value
Intercept	8.247**	0.7556	10.91	0.000
GEN	-0.3982**	0.1107	-3.59	0.000
AGE	0.0163	0.0297	0.55	0.584
AGE^2	-0.00002	0.0003	-0.09	0.932
MAR	-0.1639	0.1398	-1.17	0.241
DEP	-0.2421**	0.0775	-3.12	0.002
DEP^2	0.0569**	0.0147	3.87	0.000
EDU	-0.2341**	0.0538	-4.35	0.000
INC	0.2039	0.1920	1.06	0.288
INC^2	-0.0089	0.0339	-0.26	0.792
NTW	-0.0462	0.1117	-0.41	0.679
NTW^2	-0.00004	0.0093	-0.01	0.996

$R^2 = 0.005$ * Significant to the 5% level ** Significant at the 1% level

Table 6: Non-Linear Model, N = 3,672, Y = RTS – SRTS < 0

Variable	Coefficient	Std. Error	t-test	p value
Intercept	-13.922**	1.1534	-12.07	0.000
GEN	0.3470	0.1808	1.92	0.055
AGE	0.2038**	0.0458	4.45	0.000
AGE^2	-0.0018**	0.0004	-4.12	0.000
MAR	0.2433	0.2377	1.02	0.306
DEP	-0.1357	0.1187	-1.14	0.253
DEP^2	-0.0127	0.0208	-0.61	0.539
EDU	0.6645**	0.0855	7.78	0.000
INC	0.0667	0.3144	0.21	0.832
INC^2	0.0018	0.0569	0.03	0.975
NTW	0.0815	0.1857	0.43	0.661
NTW^2	-0.0020	0.0153	-0.13	0.895

$R^2 = 0.035$ * Significant to the 5% level ** Significant at the 1% level

Table 7: Non-Linear Model, N = 11,882, Y =| RTS – SRTS>0

Variable	Coefficient	Std. Error	t-test	p value
Intercept	8.346**	0.9106	9.16	0.000
GEN	-0.4307**	0.1298	-3.32	0.001
AGE	0.0626	0.0356	1.76	0.079
AGE^2	-0.0004	0.0003	-1.34	0.182
MAR	-0.2590	0.1622	-1.60	0.110
DEP	-0.2951**	0.0932	-3.17	0.002
DEP^2	0.0631**	0.0179	3.51	0.000
EDU	-0.1732**	0.0634	-2.73	0.006
INC	0.2932	0.2250	1.30	0.193
INC^2	-0.0272	0.0395	-0.69	0.490
NTW	-0.1641	0.1303	-1.26	0.208
NTW^2	0.0101	0.0108	0.94	0.349

$R^2 = 0.006$ * Significant to the 5% level ** Significant at the 1% level

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Notes