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Nonlinear linkages between financial risk tolerance and demographic characteristics

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We explore the nonlinear linkage between financial risk tolerance and demographic characteristics. Our tests support the nonlinear role of age, income and number of dependents.

I. Introduction

There exists an established body of literature focusing on the linkage between financial risk tolerance and demographic characteristics (e.g. gender,[1] age, marital status,[2] education,[3] income/wealth[4]). For example, while age is one of the most prominent factors examined, the evidence is quite mixed. Many studies find that risk tolerance decreases with age (McInish, 1982; Morin and Suarez, 1983; Palsson, 1996), while others either find no linkage or in some cases a positive association (Grable and Joo, 1997; Wang and Hanna, 1997; Grable, 2000). A plausible explanation for these inconsistencies is that the linkage is better captured by a non-linear function such that, depending on which segment of the age spectrum is being examined, the association could be positive, negative or neutral. More generally, the role of several demographics could be nonlinear. Accordingly, in this article we conduct an investigation of these potential nonlinearities, using an extensive sample drawn from psychometrically-derived risk profiles of adult Australians. Our findings suggest that age; number of dependents and income exhibit basic quadratic associations with financial risk tolerance.

II. Analysis

Data and model

Our sample involves 15 916 Australian respondents who completed the survey for the FinaMetrica Personal Financial Profiling system over the period

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[1] Females typically show a lower preference for risk than males – for example, Lewellen *et al*. (1978); Bajtelsmit and Bernasek (1996); Powell and Ansic (1997); Grable (2000); Grable and Joo (2000); Halek and Eisenhaeur (2001).

[2] Roszkowski *et al*. (1993) suggest that single people have higher financial risk tolerance than married individuals because they have less responsibilities than married people, particularly with respect to dependents. However, a number of studies have failed to identify *any* significant relationship between marital status and financial risk tolerance (McInish, 1982; Masters, 1989; Haliassos and Bertaut, 1995).

[3] Higher attained levels of education have been found to be positively related to higher financial risk tolerance – see, for example, Haliassis and Bertaut (1995); Sung and Hanna (1996).

[4] The impact of income and wealth tend to support a positive relationship with levels of risk tolerance – see, for example, Friedman (1974); Cohn *et al*. (1975); Riley and Chow (1992); Schooley and Worden (1996); Shaw (1996); Grable and Lytton (1999).

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Table 1. Nonlinear regression results

Variable	Coefficient	SE	*t*-Statistic	*p*-Value
Constant	59.192**	1.191	49.70	0.000
DFEM	−5.9086**	0.212	−27.93	0.000
DMARR	−4.4117**	0.852	−5.18	0.000
NDEP	−0.6373**	0.188	−3.38	0.001
$NDEP^2$	0.0893*	0.042	2.12	0.034
AGE	−0.0964	0.052	−1.86	0.063
AGE^2	−0.0024**	0.001	−4.40	0.000
EDU	1.1006**	0.103	10.68	0.000
INC	3.5264**	0.413	8.53	0.000
INC^2	−0.3430**	0.076	−4.54	0.000
*DMARR*CINC*	2.0101**	0.538	3.74	0.000
$DMARR{*}CINC^2$	−0.2260**	0.087	−2.61	0.009
NASS	0.8837**	0.106	8.32	0.000
Adjusted $R^2 = 0.247$				
Number of observations	15916			

Notes: This table reports regression results in which the dependent variable is respondent's risk tolerance score (created by FinaMetrica) and the independent variables involve linear and/or quadratic versions of: *DFEM*, a dummy variable taking the value of unity if the respondent is female and zero for males; *DMARR*, a dummy variable taking the value of unity if the respondent is married and zero if unmarried; *NDEP*, a variable measuring the number of family dependents; *AGE*, the respondent's age in years. Ordered categorical variables for education (*EDU*); income (*INC*); combined income (*CINC*) and net assets (*NASS*) are defined in the text. White Heteroskedasticity-Consistent SEs & Covariance are used.
* Significant at the 5% level ** Significant at the 1% level

May 1999–February 2002.[5] The survey is a psychometrically validated attitude test comprising 25 questions, the end product of which is a standardized Risk Tolerance Score (*RTS*) ranging between 1 and 100. *RTS* is our dependent variable and a higher (lower) score indicates higher (lower) risk tolerance. In addition, FinaMetrica collect answers to a range of demographic questions – namely, age, gender, postcode, education, income, marital status, dependents and net assets.

The explanatory demographic variables for which we have data are as follows. *DFEM* is a dummy variable that signifies a respondent is female and zero otherwise. *DMARR* is a dummy variable that takes a value of unity if the respondent is married (legally or defacto) and zero otherwise. *NDEP* is the number of people in the family whom are financially dependent on the respondent. *AGE* is the age (in years) of the respondent. *EDU* is an ordered categorical variable representing the educational background of respondents, 1 (4) representing the minimum (maximum) education level.[6] *INC* is an ordered categorical variable representing the income of respondents, 1 (5) representing the minimum (maximum) income level.[7] *CINC* is an ordered categorical variable representing the combined income of respondents (and their partner), 1 (5) representing the minimum (maximum) income level.[8] *NASS* is an ordered categorical variable representing the net assets of respondents, 1 (5) representing the minimum (maximum) income level.[9]

[5] The FinaMetrica Personal Financial Profiling system is a proprietary, computer-based risk tolerance measurement tool. It has been available commercially to the Australian financial planning industry since 1998 and was introduced in the US in 2002. See www.FinaMetrica.com.au for further information about the FinaMetrica system.

[6] A value of 1 indicates the respondent did not complete high school; a value of 2 that they did complete high school; a value of 3 that they have a trade or diploma education; and a value of 4 that they have a university or higher qualification.

[7] A value of 1 indicates an individual income under $30 000; a value of 2, an income between $30 000 and $50 000; a value of 3, an income between $50 000 and $100 000; a value of 4, an income between $100 000 and $200 000; and a value of 5, an income over $200 000.

[8] A value of 1 indicates a combined income under $30 000; a value of 2, a combined income between $30 000 and $50 000; a value of 3, a combined income between $50 000 and $100 000; a value of 4, a combined income between $100 000 and $200 000; and a value of 5, a combined income over $200 000.

[9] A value of 1 indicates net assets under $50 000; a value of 2, net assets between $50 000 and $150 000; a value of 3, net assets between $150 000 and $500 000; a value of 4, net assets between $500 000 and $1 000 000; and a value of 5, net assets over $1 000 000.

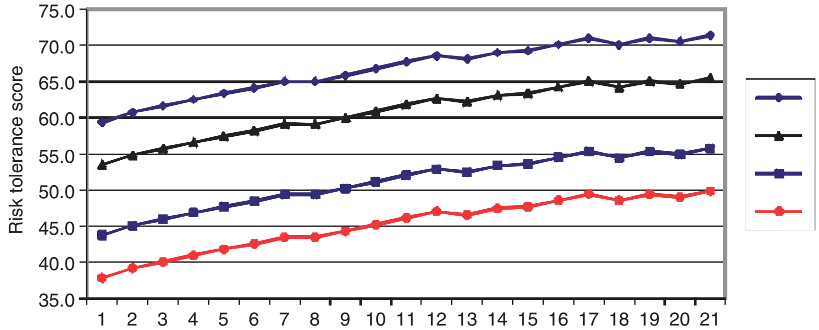

Fig. 1. Predicted RTS from Non-Linear Model across Income/Combined Income/Net Asset Groups
Note: This Figure displays four illustrative cases from the regression equation estimated for Table 1. All four cases are based on (a) a married respondent; (b) one dependent family member; and (c) high school as the highest educational qualification. The Income/Combined Income/Net Asset groups are defined as follows:

I/CI/NA Group	Income	Combined Income	Net Assets
1	< \$30 000	< \$30 000	< \$50 000
2	< \$30 000	\$30 000–\$50 000	< \$50 000
3	< \$30 000	\$30 000–\$50 000	\$50 000–\$150 000
4	< \$30 000	\$50 000–\$100 000	\$50 000–\$150 000
5	< \$30 000	\$50 000–\$100 000	\$150 000–\$500 000
6	\$30 000–\$50 000	\$30 000–\$50 000	\$50 000–\$150 000
7	\$30 000–\$50 000	\$30 000–\$50,000	\$150 000–\$500 000
8	\$30 000–\$50 000	\$50 000–\$100 000	\$50 000–\$150 000
9	\$30 000–\$50 000	\$50 000–\$100 000	\$150 000–\$500 000
10	\$50 000–\$100 000	\$50 000–\$100 000	\$50 000–\$150 000
11	\$50 000–\$100 000	\$50 000–\$100 000	\$150 000–\$500 000
12	\$50 000–\$100 000	\$50 000–\$100 000	\$50 000–\$1 000 000
13	\$50 000–\$100 000	\$100 000–\$200 000	\$150 000–\$500 000
14	\$50 000–\$100 000	\$100 000–\$200 000	\$500 000–\$1 000 000
15	\$100 000–\$200 000	\$100 000–\$200 000	\$150 000–\$500 000
16	\$100 000–\$200 000	\$100 000–\$200 000	\$500 000–\$1 000 000
17	\$100 000–\$200 000	\$100 000–\$200 000	> \$1 000 000
18	\$100 000–\$200 000	> \$200 000	\$500 000–\$1 000 000
19	\$100 000–\$200 000	> \$200 000	> \$1 000 000
20	> \$200 000	> \$200 000	\$500 000–\$1 000 000
21	> \$200 000	> \$200 000	> \$1 000 000

The conventional model typically investigates a linear linkage between risk tolerance score and the various demographic characteristics:[10]

$$RTS = \alpha_0 + \alpha_1 DFEM + \alpha_2 DMARR + \alpha_3 NDEP + \alpha_4 AGE + \alpha_5 EDU + \alpha_6 INC + \alpha_7 (DMARR^* CINC) + \alpha_8 NASS + \varepsilon \qquad (1)$$

An interesting extension of existing research is to test the robustness of the linearity assumption commonly imposed on the model. Given the data we have available, non-linearities are plausible for: *age*; *NDEP*; *INC*; *CINC* and *NASS*.[11] A simple test for the presence of nonlinearities is to introduce quadratic versions of the independent variables. Accordingly, the nonlinear model takes the form:

$$RTS = \gamma_0 + \gamma_1 DFEM + \gamma_2 DMARR + \gamma_3 NDEP + \gamma_4 NDEP^2 \gamma_5 AGE + \gamma_6 AGE^2 + \gamma_7 EDU + \gamma_8 INC + \gamma_9 INC^2 + \gamma_{10} DMARR * CINC + \gamma_{11} DMARR^* CINC^2 + \gamma_{12} NASS + \varepsilon \qquad (2)$$

III. Results

The estimated regression results are presented in Table 1. The significance of all of the estimated coefficients provides clear evidence of nonlinear

[10] The variable *CINC* is interacted with *DMARR*, since it is only validly defined for 'married' respondents.
[11] The nonlinear effect in *NASS* is dropped due to insignificant results.

effects in the relationship between *RTS* and *NDEP*, *AGE*, *INC* and *CINC*. Specifically, we see *RTS* decreasing at a decreasing rate as the number of dependents increases and decreasing at an increasing rate as reported age increases. On the other hand, *RTS* increases at a decreasing rate as income and combined income increase. A more insightful impression of this nonlinearity may be obtained using the estimated coefficients of the model and plotting the predicted *RTS* for a collection of characterized cases. Figure 1 presents a plot of the predicted *RTS* for a young (20-year old) male and a similar female and an elderly (70-year old) male and a similar female who, in each case, are married, have one dependent family member and have completed high school. We observe that age and gender differences are clearly evident and are maintained as income and wealth increase. While our finding of quadratic effects does not guarantee that they are economically important in every situation, it does raise linearity/nonlinearity as a potential issue in these types of models.

IV. Conclusion

In this article, we explore the possible nonlinear linkage between financial risk tolerance and demographic characteristics. Our evidence supports the existence of a quadratic role for age, income and the number of dependents. As such, our evidence suggests that nonlinear effects are worthy of consideration in this area of research.

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