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Risk Aversion Revisited

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ABSTRACT

In order to supply additional empirical evidence of the effect of wealth on relative risk aversion, this study investigates households' demand for risky assets, using analysis of covariance techniques applied to the asset holdings of Canadian individual households. The extent and pattern of life-cycle effects are also examined. Results generally point to decreasing relative risk aversion when housing is either excluded from the definition of wealth or treated as a riskless asset. The investor's life-cycle plays a prominent role in portfolio selection behavior, with risk aversion increasing uniformly with age. Tax differentials do not seem to be an important element in investment decisions with respect to risk. When the sample and wealth definitions are censored in order to approximate those of previous empirical studies, their findings on relative risk aversion are generally corroborated.

THIS STUDY PRESENTS AN empirical investigation of the demand for risky assets of individual Canadian households using data from the Survey of Consumer Finances. The results generally point to decreasing relative risk aversion when housing is either excluded from the definition of wealth or treated as a riskless asset, even when life-cycle effects are controlled. The investor's life-cycle plays a prominent role in portfolio selection behavior, with risk aversion increasing uniformly with age. Cohn-Lewellen-Schlarbaum [6] also found evidence of decreasing relative risk aversion, using a restricted sample of stockowning investors, while Friend-Blume (12) concluded that constant relative risk aversion characterized household behavior. The present study also finds that by restricting the sample and the wealth definitions to approximate those of Cohn-Lewellen-Schlarbaum and those used by Friend-Blume, their empirical findings on relative risk aversion are generally corroborated.

The paper is divided into five sections. The first reviews the literature on risk aversion and the second briefly describes the theory[1] underlying the empirical tests. The third section describes the data and statistical techniques used. The empirical results are presented and discussed in the fourth section, where the aggregate demand for risky assets is estimated and where the role of life-cycle variables is examined. The final section summarizes the main conclusions of the study.

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[1] See Arrow [1], Arrow [2], Pratt [25], Samuelson [28], Stiglitz [30], Cass and Stiglitz [3], Ross [27].

I. Earlier Studies

Relying on cross-section data, Cohn, Lewellen et al. [6] have investigated the effect of wealth on the proportion of individuals' portfolios allocated to risky assets, and find a strong pattern of decreasing relative risk aversion. Controlling for non-wealth variables such as age, marital status, and family size, they show only that inclusion or exclusion of these variables does not alter the pattern of decreasing relative risk aversion. They point out that although their study relates risky asset holdings to total assets, the theoretical relationships are in terms of risky asset holdings and net worth so that ideally risk aversion characteristics should be estimated using portfolio data which contain household liabilities. Their findings are also limited by the fact that their sample is a select group of stock-owning investors; they also ignore human capital and treat bonds as riskless assets.

Friend and Blume [12], in the context of a continuous time model, develop a theoretical model from which demand functions for risky assets both at the household level and the macrolevel are derived.[2] They estimate the parameters of these functions by using cross-sectional household data from the Survey of Financial Characteristics of Consumers (SFCC), and find that constant relative risk aversion is a fairly accurate description of investor behavior, although this conclusion hinges upon the definition of risky and riskless assets.[3] Friend and Blume also use net worth rather than total assets as the wealth variable, but do incorporate human capital in one definition of wealth. When wealth is defined as net worth exclusive of homes and automobiles, households exhibit decreasing relative risk aversion; when wealth includes homes and automobiles, increasing or constant relative risk aversion is obtained, depending on whether homes are treated as risky assets at market value or owner's equity value. If housing is treated as a risk-free asset, the tendency towards decreasing relative risk aversion is reinforced, whether housing is measured by its equity or market value. When human capital is incorporated into net worth, moderate increasing risk aversion is found.

The present study uses a more broadly-based and representative data base in terms of wealth classes, and allows for the effects of age.[4]

II. Theoretical Background

If human capital and taxes are ignored, and assuming that all investment is marketable and is either in riskless assets or in the market portfolio, the optimal proportion of household k's net worth placed in the market portfolio of risky

[2] For a detailed development of the model, see Friend and Blume [12]. Litzenberger [22] provides an alternate theoretical rationale underlying the model.

[3] Landskroner [18] using the same methodology and data-base found that these results cannot be destroyed when the effects of occupation or industry are controlled.

[4] Friedman [11] investigates Arrow's [1] hypothesis of increasing risk aversion using time-series data. For a critical discussion of Friedman's findings see Tobin [32].

assets, α_k, can be written as

$$\alpha_k = \frac{MPR}{C_k} \tag{1}$$

where *MPR* is the market price of risk, that is, the ratio of the risk premium on the market to the variance of the market rate of return, and C_k is the Pratt coefficient of relative risk aversion for household k.

Since the market price of risk (*MPR*) is the same for all investors under the assumption of homogeneous expectations, the manner in which C_k varies with net worth, W_k, can be inferred from regressions of α_k on W_k, assuming that W_k can be taken as exogenous. If returns from both risky and riskless assets are taxed at the same rates in any tax bracket, Equation (1) becomes

$$\alpha_k = \frac{MPR}{(1 - t_k)C_k} \tag{2}$$

where t_k is the average tax rate for household k.

Distinguishing between marketable wealth and nonmarketable wealth, which is likely to be mainly human wealth and therefore risky, Friend-Blume [12] developed an expression analogous to Equation (2). The demand for risky assets is affected by both the relative value of nonmarketable assets and by the covariation of human capital returns and the returns on the market portfolio of risky assets. The latter effects can be neglected if the relationship between the return of human capital and the return on various marketable assets is weak as Fama and Schwert [9] have suggested.[5] Mossin [24] has suggested that since human capital cannot be estimated accurately, its effect on risk aversion should rather be assessed by resorting to indirect or instrumental methods. In the empirical work to follow, therefore, wealth is defined as marketable wealth. An age variable is explicitly introduced to allow for the effect of the relative value of human wealth on the demand for risky assets, since relative holdings of such assets are likely to be negatively related to age.

III. Data Base and Empirical Analysis

The data for this study are taken from the Survey of Consumer Finances (SCF), which, stratified by geographic areas, was carried out in May 1970 by Statistics Canada [29] and sought information on incomes received in 1969 and on asset holdings and indebtedness at the time of the survey.[6]

The nature of the SCF database may be assessed by comparing some of its characteristics with those used in similar studies, namely: the Federal Reserve

[5] A recent study by Liberman [21] confirms Fama and Schwert's findings that human capital has little to do with the relative prices of capital assets, and that households appear to be able to ignore their own human capital when constructing their portfolio.

[6] The sample covered all private households with minor exceptions; of the 14,034 households sampled, 12,626 could be contacted and of these 9,962 provided complete information which constitutes a 74.9% response rate (Statistics Canada [29]).

Table I

Data Characteristics: A Comparative Analysis

	SFCC Survey	Lease et al. Survey	SFC Survey
Conducted by	U.S. Federal Reserve Board	Lease, Lewellen & Schlarbaum (by mail)	Statistics Canada
Used by	Friend and Blume (12)	Cohn, Lewellen et al (6)	This study
Data	1962	1972	1969
Sample size	3551	3000	14034
Response rate	72%	40%	74.9%
Subsample used in study	52.4%	46.7%	85.0%
Units with wealth of \$100,000 or more	20.8%	n.a.[a]	1.98%
Units with direct stock holdings	16%	98%	14%
Average age of sampled households	49	57	47
Number of households over 55 yrs. of age	39%	56%	32%
Number of wealth groups used	6	4	17

[a] n.a. stands for nonavailable

Board's 1962 Survey of Financial Characteristics of Consumers (SFCC, see Projector and Weiss [26]), and Lease et al. [19]'s survey conducted through a nationwide brokerage firm. Table I presents salient features of the three data bases including the one used in the study.

In summary, the SFCC data base is more representative of the wealthier segment of the population; that of Cohn et al. is limited to active security investors and does not provide a complete cross-section of investors at each wealth level. By contrast, the SCF data base used here is more representative of investors and broad-based in terms of range of wealth covered. Moreover, the much larger sample size of the SCF survey data facilitates the creation of a larger number of wealth groups over a narrower range of wealth, and is likely to result in greater homogeneity within each group. In contrast, the wealth groups used by Friend and Blume and Cohn et al. may be too large to permit comparable group homogeneity.

Wealth is defined throughout this study as net worth, the difference between total asset holdings and total indebtedness. The SCF data base contains for each household information on the market value of all asset holdings and on personal debt which consists primarily of personal loans from financial institutions, and of outstanding mortgage debt on owner-occupied homes.

From Equation (1), α_k is equal to the product of the market price of risk and the reciprocal of the coefficient of relative risk aversion, and can be used to determine how C_k varies with net worth. Motivated by the previous discussion of the effects of age on risk aversion, we can write:

$$\alpha_k = \frac{MPR}{C_k} = MPR\ [a' + b'W_k + c'AGE_k + d'AGE_k \times W_k + \epsilon'_k] \qquad (3)$$

$$\alpha_k = a + bW_k + cAGE_k + dAGE_k \times W_k + \epsilon_k \quad (4)$$

The functional form to be estimated is a linear model of the form

$$\alpha_k = a + bW_k + \textstyle\sum_{i=1}^{4} c_i AGE_{ik} + \sum_{i=1}^{4} d_i\,(AGE_{ik} \times W_k) + \epsilon_k \quad (5)$$

where

α_k = ratio of risky assets to net worth for household k
W_k = household k's net worth
AGE_{ik} = dummy variable representing the age group of household k, and ($i = 1, \ldots, 4$)
ϵ_k = error term satisfying the standard assumptions of regression analysis.

The five age categories used are: under 35 years of age; 35 to 44; 45 to 54; 55 to 64; and over 65 years of age. The age group $i = 5$, representing households more than 65 years old, is employed as the reference group. The wealth coefficients ($b + d_i$) represent the wealth effect on risk aversion: a positive (negative) coefficient implies decreasing (increasing) relative risk aversion with respect to wealth within the i^{th} age group. The c_i coefficients serve to make intergroup comparisons of risk aversion with respect to age. The tax-adjusted form of the model as embodied in Equation (2) will also be examined in the empirical work to follow.

The dependent variable, α_k, is defined as the ratio of risky assets to net worth. Two asset categories are identified: riskless assets and marketable risky assets. Riskless assets include cash, deposit account balances, Canada savings bonds, and personal property held by consumers. Risky asset categories include stock, bonds,[7] mutual funds, real estate other than owner-occupied home, equity in own business, and loans held.

In defining risky assets, Friend-Blume recognize that investment in owner-occupied residential housing is not consistent with the assumptions underlying Equation (1), as homes are acquired for consumption as well as for investment purposes. They therefore treat homes in three different ways: not as an investment asset; as a risky asset whose value is equal to the household's equity in the home; and as a risky asset measured by the gross market value of the home. Cohn et al. treat housing as a riskless asset because of the low uncertainty of the real stream of benefits it provides. Projector and Weiss [26] consider homes as an altogether different type of asset because the investor cannot shift wealth from his home to other forms of wealth without changing his living patterns, which decision usually precedes the decision to buy one's home. Graves [15] regards homes as a "life-style" choice. In this study, housing is treated as a riskless asset. Comparative results using both Cohn et al.'s and Friend-Blume's risk classification of assets are also presented.

To estimate Equation (5) from the SCF survey data, 8138 households with net worth between \$1 and \$100,000 are initially cross-classified into 17 net worth

[7] Cohn et al., unlike Friend-Blume, treat corporate bonds as riskless assets in their definition of α. There is no compelling reason to depart from the generally accepted practice, namely, to consider the investment in corporate bonds as a risky asset.

groups and five age groups, thus obtaining 85 group means.[8,9] In contrast, Cohn et al. and Friend and Blume use only four and six net worth groups respectively, with a lower degree of homogeneity within each group than the present study. The 194 household units with wealth over $100,000 are treated separately and individually on account of the high positive skewness in the wealth distribution of this group,[10] and to facilitate comparison with the Friend-Blume study which focuses on the wealthier segment of the population. This latter wealth class is labeled as the "wealthy" throughout this study.

IV. Empirical Results

When the simple linear model

$$\alpha_k = a + bW_k + \epsilon_k \tag{6}$$

is first estimated by OLS on the 85 group means, the behavior of the residuals indicates that two distinct wealth classes with different risk aversion behavior patterns are lumped together in the sample.[11] To verify this hypothesis, the sample is divided in two wealth classes with net worth of $12,500 as the common class boundary,[12] and the following regression is performed using the 85 group means and a dummy variable, D, to account for the effect of the grouping into the two broad wealth classes,[13] labeled the "lower wealth" and the "upper wealth"

[8] The survey data were collected under a law which does not allow release of any information at the individual level. Hence, the data can only be accessed either in aggregate form over any desired set of variables or through $(X'X)$ matrices, where X represents a vector of the survey responses for a set of desired variables.

[9] The loss of efficiency in OLS estimates of regression coefficients due to grouping is minimized whenever at least 10 groups are used, and when the groups are of the same order of size [Malinvaud [23]). Grouping the observations in increasing order of the independent variable will further maximize the between-group variation of the variable in relation to the within-group variation, hence minimizing the loss of efficiency. Hence, the individual observations were arranged in increasing order of net worth, and split into 17 groups of similar sizes, the mean of each group replacing each observation, and were further cross-classified into 5 age groups. This two-way cross-classification further reduces the heteroscedasticity induced by grouping (Johnston [17]).

[10] See Draper and Smith [8], p. 94.

[11] The V-shape pattern of the residuals suggest a potential misspecification. Neither the inclusion of a quadratic term nor the use of alternate nonlinear functional forms improved this pattern, pointing to the presence of two groups with different behavior instead, and a linear relationship (Draper and Smith [8]).

[12] The split point is located by finding the sample value of W which minimizes the unexplained variation in the regression. It can be shown that choosing the sample value of wealth to minimize the sum of squared residuals is a maximum likelihood procedure. Details of the procedure and the proof are available from the authors upon request. Moreover, when the Neyman-Pearson likelihood ratio test is applied to alternate boundary classes, the $12,500–$15,000 wealth boundary class yield the highest likelihood ratio.

[13] The regression run is $\alpha = a + bW + cD + d\,(D \times W) + \epsilon$ where $D = 1$ if the observation is in the lower wealth group, and $D = 0$ otherwise. $(D \times W)$ is a dummy variable in multiplicative form to allow the slopes to differ between the wealth classes. The assumption of heteroscedasticity is tested and rejected using both the Spearman rank correlation between the absolute values of the residuals and the wealth values (Johnston [17]), and the Glejser test [13]. The normality assumption is tested by computing the unit normal deviates of the residuals, which without exception lie within the limits −1.96 to +1.96 (Draper and Smith [8]).

Table II

Effect of Net Worth on Relative Holdings of Risky Assets

$\alpha_k = a + bW_k + \epsilon_k$

Wealth Class	Data	a	b	$\bar{R}^2$	F	n
Lower wealth ($1–12,500)	Grouped[a]	0.171 (25.28)	-7.331×10^{-3} (−4.33)	0.72	18.76	40
	Ungrouped	0.195 (5.22)	-7.605×10^{-3} (−1.38)	0.06	17.86	4,934
Upper Wealth ($12,500–	Grouped	0.020 (2.23)	$+6.667 \times 10^{-3}$ (32.38)	0.99	1050.40	50
$100,000)	Ungrouped	0.014 (1.52)	$+6.660 \times 10^{-3}$ (26.80)	0.16	773.13	3,700
Wealthy[b] > ($100,000)	Ungrouped	0.641 (27.76)	$+1.211 \times 10^{-4}$ (2.51)	0.03	6.54	194

[a] The t-values are in parentheses.

[b] Only microdata can be used to estimate the regression coefficients for households in this wealth group.

class respectively. The dummy variable, D, takes the value of 1 if the household is in the lower wealth class and 0 if in the upper wealth class. The regression results are as follows, with the t-values in parentheses:

$$\begin{aligned} \alpha_k = \ & .0202 + .0067W_k + .0151D - .0140D \times W_k \\ & (2.34) \quad (33.70) \qquad (13.43) \qquad (10.69) \\ & \bar{R}^2 = 0.98 \quad F = 526.10 \end{aligned}$$

The results of a Chow [5] test and analysis of covariance test (Johnson [17]) confirm the presence of two classes of households exhibiting different behavior patterns.[14]

In light of those results, and to estimate Equations (5) and (6) from the SCF survey data, the original classification of households into 17 net worth groups is modified as follows. Households in the lower wealth class, that is, with net worth between $1 and $12,500, are cross-classified into 8 net worth groups and five age groups, thus obtaining 40 group means. Households in the upper wealth class, that is, with net worth between $12,500 and $100,000, are cross-classified into 10 net worth groups and five age groups, thus obtaining 50 group means. The boundary net worth class $12,500–15,000 overlaps both the lower and the upper wealth classes.

OLS estimates of Equation (6) are shown in Table II. Regression coefficients are estimated separately for the lower wealth, upper wealth, and wealth class respectively. In order to examine the efficiency of the estimates from grouped data, the regression coefficients are also estimated using the data supplied by

[14] Both the Chow [5] test and the analysis of covariance test (Johnston [17]) reject the null hypothesis at a 5% level that the two sets of observations come from the same sample, indicating the presence of two distinct household groups.

Statistics Canada on individual households. Both sets of results are displayed in Table II, except for the wealthy class, where only ungrouped data are used.[15] Both grouped and ungrouped regression estimates yield very similar coefficients.

The results of Table II suggest the following: households with net worth less than $12,500 exhibit increasing relative risk aversion;[16] households with net worth between $12,500 and $100,000 exhibit a strong pattern of decreasing relative risk aversion; and households with net worth over $100,000 exhibit decreasing relative risk aversion, although the decrease is so small that for many practical purposes their relative risk aversion may be considered constant.

A. Risk Aversion and Life-Cycle Effects

In order to investigate the effect of age on relative holdings of risky assets for each wealth class, the full model of Equation (5) is estimated on the sample household data cross-classified by both net worth and age groups,[17] using the group averages in the lower and upper wealth classes, and using all 194 individual observations in the wealthy class. The results are reported in abridged form in Table III. For the lower and upper wealth classes, only the results of the regressions using grouped data are reported, since no perceptible difference between the grouped results and the ungrouped results is encountered, as was the case in Table II. Table III displays the intercept and slope coefficients of the wealth variable, the age variables, and the age-wealth interaction variables. For the set of age and age-wealth variables, statistically insignificant variables appear as zeros; the sign and t-value of the statistically significant variables are shown.

The salient feature of the results of Table III is that the variables AGE_{ik} representing the life-cycle effects proper are generally not significant in any of the three broad wealth classes, while the variables $(AGE_{ik} \times W_k)$, representing interaction effects between wealth and age, are generally significant in all three wealth classes.

For the lower wealth class, four out of the five wealth coefficients are negative,

[15] Since wealth is likely to be measured with error, the use of ranked grouped data instead of individual observations, mitigates the inconsistency of the slope coefficient estimators. If such errors are large, however, and the ranks are correlated with the errors, the use of ranked group data as instrumental variables may be inadequate. Given the close similarity of the slope coefficients estimated from individual and grouped data (see Table II), the measurement error bias is not likely to be prohibitive. See also fn. 17.

[16] One plausible explanation of this finding lies in the extensive use of debt by these households; as their wealth increases, their acquisition of risky assets is dominated by their reduction of debt, resulting in increasing relative risk aversion. For example, the debt-equity ratio decreases from 1.48 for those units with net worth between $1–1,000, to 0.49 for those within the range $1,000–$12,500.

[17] If wealth is measured with large errors, the instrumental variable method can be used to obtain more consistent estimators even though the estimators may not be fully efficient (see Malinvaud [23]). Since data on plausible instrumental variables such as lagged wealth or reported income were not made available on an individual household basis by Statistics Canada, a full-fledged instrumental variable approach could not be implemented. But, given the closeness of the results using individual observations and the grouped data, the measurement error bias is likely to be minor. Grouping the data by connecting the means of ranked net worth across age groups, however, is a plausible instrument, equivalent to assuming that the distribution of the unobservable true wealth variable has an age component structure and using age as an instrument (see Friedman [10]).

Table III

Effect of Age and Net Worth on Relative Holdings of Risky Assets

$$\alpha_k = a + bW_k + \sum_{i=1}^{4} c_i AGE_{ik} + \sum_{i=1}^{4} d_i (AGE_{ik} \times W_k)$$

Wealth Class	a	b	c_1	c_2	c_3	c_4	d_1	d_2	d_3	d_4	$\bar{R}^2$	F	n
Lower	0.141[a]	-5.38×10^{-3}	0	0	+	0	0	0	–	0	0.37	8.81	40
Wealth	(8.83)	(0.25)			(4.64)				(3.84)				
Upper	0.032	$+4.860 \times 10^{-3}$	0	0	0	0	+	+	+	0	0.96	156.22	50
Wealth	(1.67)	(8.76)					(7.50)	(3.92)	(3.12)				
Wealthy	0.600	$+0.012 \times 10^{-3}$	0	0	0	0	+	+	+	+	0.05	6.82	194
	(26.18)	(2.30)					(2.32)	(2.28)	(2.12)	(2.16)			

[a] The t-values are in parentheses.

[b] Only microdata can be used to estimate the regression coefficients for households in the wealthy group.

but only the coefficient for the age group 45–54 is statistically significant. For the upper wealth class, all wealth coefficients are positive and four out of five are significant. Moreover, the coefficients d_2 and d_3 are not statistically different, indicating that there is no difference in the behavior of people between 35–44 and those between 45–54. For the wealthy class, the results are analogous to those obtained in the upper wealth class. None of the age variables are significant, while the wealth variable and the age-wealth interaction variables are all positive and significant. Pair-wise comparisons of the regression coefficients reveal that the coefficient for the group <35 is not statistically different from that for the 35–44 group, and that the coefficient for the age group 45–54 is not different from that for the group 55–64; the coefficient for the group >65 is not significant. The latter results attest to the presence of two well defined groups: the "young" (<45) and the "older" (>45).

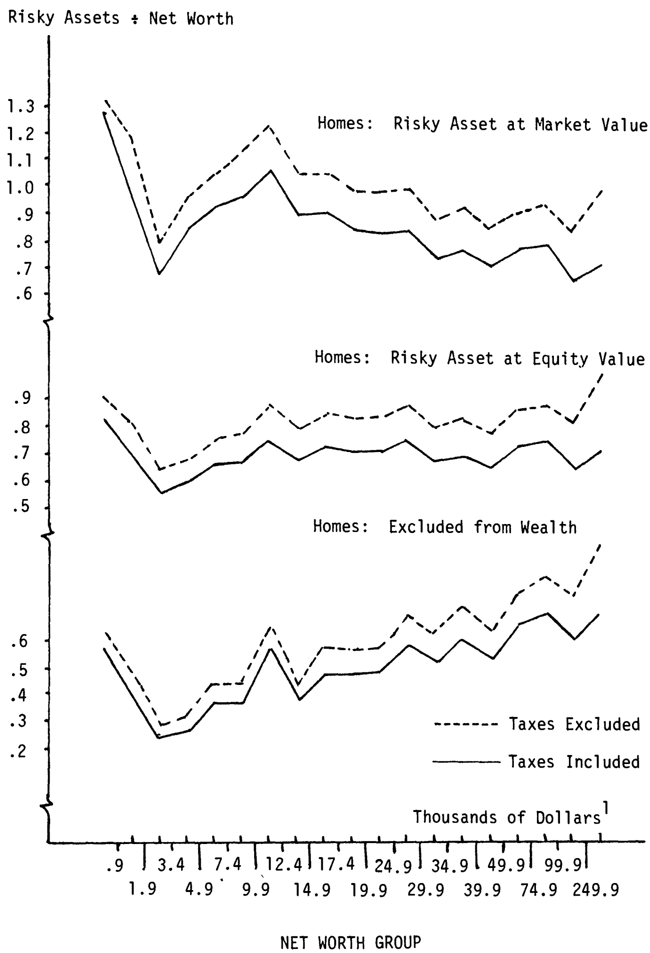
The overall results indicate that the strength of risk aversion increases uniformly with age as evidenced by the decreasing slope coefficients across age groups. The results can be summarized as follows: in the lower wealth group, the data suggest a pattern of increasing relative risk aversion. This pattern is reasonably well upheld within the middle age group (45–54); the behavior in the life-cycle extremes (<45>54) is more erratic. Households in the upper wealth group exhibit a strong pattern of decreasing relative risk aversion, even when the effects of the life-cycle are kept constant. Although wealth remains as the most important variable, the life-cycle stage plays a very important role. In the wealthy group, the data suggest a pattern of slight decreasing relative risk aversion. The slope coefficients of the wealth variables for all age groups are so small however, that risk aversion for wealthy investors may be considered for all practical purposes, constant.

B. Comparison with Prior Studies

To compare the results of the present study with those of Cohn et al., wealth is redefined as total assets, and the proportion of wealth invested in risky assets, α, is redefined accordingly, treating corporate bonds as riskless to conform with Cohn et al.'s classification scheme. Regression results using this measure of wealth are virtually the same as those of Table II and show that as wealth increases, α increases, consistent with Cohn et al.'s findings. Only the wealthy group was used in the latter regressions, since Cohn et al.'s sample of security investors is more representative of the wealthier segment of the population.

In order to test the sensitivity of the results to the inclusion of investment in homes in the definition of net worth, homeowners are excluded from the sample. The results for this subsample of nonhomeowners within the upper wealth group are virtually unchanged. The regression of α on net worth yields a significant slope coefficient equal to $+5.8891 \times 10^{-3}$, compared to $+6.667 \times 10^{-3}$ for the overall sample (see Table II). This coefficient is not statistically different from the one obtained with all households in the sample regardless of whether they own a home or not.

In order to compare the results of the present study with those of Friend-Blume, the above regressions were replicated with homes treated in three different



[1]Upper bound of every net worth group.

Figure 1. Proportion of Individual's Wealth Invested in Risky Assets

ways: not as an investment asset; as a risky asset where investment is measured by the owner's equity in the home; and as a risky asset where the investment is measured by the market value of the home. The resulting relationships of $\alpha(1 - t)$ to net worth for varying treatments of housing[18] are summarized in graphical form in Figure 1. The relationships vary according to whether housing is included and, if included, how measured. If homes are excluded from wealth, α is positively related to net worth, indicating decreasing relative risk aversion. If wealth includes homes as risky assets, α is almost invariant to net worth if housing is measured by its equity value and negatively related to net worth if housing is measured by its market value. The latter findings are consistent with constant

[18] The tax-adjusted version of the model and the computation of the tax estimates are discussed below.

and increasing relative risk aversion respectively. These results are broadly similar to Friend-Blume's results, except for lower wealth groups. Figure 1 shows the erratic nature of the relationships at wealth levels below \$10,000. Friend-Blume also contemplate the possibility that households consider homes to be riskless assets, as was done in the present study.[19] They also find that if housing is treated as a risk-free asset, the tendency towards decreasing relative risk aversion is greatly reinforced, which is consistent with the results of this study. Moreover, when Friend-Blume hold age constant as wealth increases, the decline in $\alpha(1 - t)$ for their broad definition of wealth (homes at market value) is substantially reduced, bringing the results closer to at least constant relative risk aversion.

The various tests described previously were also replicated using the tax-adjusted version of the model in Equation (2). The 1970 personal income tax rates for every income group were computed by dividing the disposable income by the gross income for each group. The latter were obtained from the National Accounts. Values for $(1 - t_k)$ ranged from 0.96 for the lowest wealth group to 0.75 for the highest wealth group. Friend and Blume obtained a similar range in their sample, namely from 0.98 to 0.70. The tests reported in this study were then reproduced, only this time using $\alpha_k(1 - t_k)$ as the dependent variable in order to see whether the individuals' income tax differentials play any role in portfolio allocation decisions. The results on the direction of risk aversion remained unchanged. That is, the slope coefficients from the regression of $\alpha_k(1 - t_k)$ on net worth were not statistically different from the results obtained with the unadjusted model, as shown graphically in Figure 1 which depicts graphically the impact of taxes on the direction of risk aversion using various definitions of wealth in keeping with the Friend and Blume study. These results are consistent with those of Lewellen, Stanley, et al. [20] obtained with U.S. data. Their results were quite insensitive to whether a tax adjustment was made or not. This result was to be expected since their sample was much more homogeneous in terms of overall income than the population as a whole. Friend and Blume on the other hand found that the inclusion of taxes decreased the slope of the regression of α on wealth since tax rates are mildly progressive, shifting the relationship away from decreasing risk aversion towards increasing risk aversion. One plausible explanation for the absence of tax effects on the direction of risk aversion in this study is the absence of capital gains tax in Canada prior to 1971. Since as wealth increases investors commit an increasing proportion of their wealth to risky assets, the mildly progressive impact of tax rates on α may be offset by an increasing tax-free capital gains component in wealthier portfolios.

Also, the model of Equation (2) is predicated on the assumption that tax rates on income earned from different types of assets are the same, when in fact they are not. Friend and Blume show how these tax differentials result in an understatement of C_k, the coefficient of risk aversion, and that this downward bias does not appear to vary appreciably with wealth, at least in the U.S.

While this study assumes that α is linearly related to wealth, all the tests

[19] In the present study, wealth is defined as net worth in an accounting sense. The latter includes the market value of homes in the asset component and the associated mortgage debt in the liability component. Thus, housing is measured at its equity value in the net worth definition.

performed in this study were replicated using alternate functional forms, and the results strongly supported a linear model. The logarithmic form used by Friend and Blume, and the reciprocal form suggested by Litzenberger [22], were both tested and rejected on the basis of lower t and F values, as well as unusual residual patterns.

V. Concluding Remarks

The study analyzes data from the Survey of Consumer Finances in order to supply additional empirical evidence of the effect of wealth on relative risk aversion. It concludes that the assumption of decreasing relative risk aversion is well supported by the data, even when life-cycle effects are controlled. For households with net worth in excess of $100,000, this decrease is small and can be considered zero for most practical applications. These conclusions hold true whether wealth is defined exclusive of housing or whether housing is defined as a riskless asset.

The only exception to this finding is that when attention is restricted to the lower wealth segment of the population, increasing relative risk aversion is found. One potential bias in this latter result is the absence of any asset data on pension funds, life insurance, and other social benefits of a contractual nature. This omission is likely to be more relevant in the lower wealth groups, and the inclusion of contractual savings data would likely dampen or even erase the tendency towards increasing risk aversion.

In contrast to the Friend and Blume study which found that the inclusion of taxes dampened the tendency to decreasing relative risk aversion, investors' tax differentials do not seem to be an important element in investment decisions with respect to risk, owing to the nontaxability of capital gains in Canada prior to 1971.

By restricting the definitions of wealth and censoring the sample to approximate the data used by Cohn et al. and by Friend-Blume, the risk aversion results of this study are modified to resemble the patterns found in these earlier studies, with the exception of tax effects.

The importance of the investor's life-cycle for portfolio selection behavior is equally well supported; the strength of the effects depends on the investor's wealth level. Although the aversion to risk increases uniformly with age, results indicate that the life-cycle plays a more important role for investors with wealth between $12,500 and $100,000. These findings imply that the demand for risky assets changes with respect to the individual's wealth as well as with respect to his life-cycle stage. As a consequence, a utility function with a unique functional form for the market as a whole is not supported by the data.[20]

[20] The utility function implied by the empirical results is in fact a polynomial of the form

$$U(W) = W + \frac{MPR}{b} \ln W + \theta_n$$

where MPR is the market price of risk; b is the slope of the demand for risky assets function; and θ_n is a series of degree $(n-1)$ in $\frac{1}{W}$. This demonstration is available from the authors upon request.

One potential bias in the results is that the data do not allow an unambiguous determination of the true value of the "equity in business/professional interest" asset category. Book value was used in cases where the market value of assets could not be estimated. Since the effect of an inaccurate estimate of "equity in business/professional interests" may be largest in the upper wealth group, this asset category was excluded from the definition of wealth for all the 3700 individuals in the group in order to assess the seriousness of the bias. Since the data show that for the upper wealth group the age group (45–54) alone holds 42.82% of the dollar investments in equity in business, α was regressed on net worth (excluding equity in business) on the 1786 individuals in this age group. The slope coefficient, although still positive, was about 40% smaller than that obtained when equity in business is included. These results suggest that, while the direction of the coefficient of relative risk aversion is definitely unaffected, the asset category, "equity in business/professional interest" is certainly important and deficient estimates may place some qualifications on the overall results, depending on the severity of the deficiencies related to specific estimates. This result also suggests that holders of equity in business carry substantially more risk than investors at large.

One major theoretical drawback of the study is that the cross-sectional tests employed assume the validity of interpersonal comparisons of utility.[21] Even though some of the homogeneity required to make such interpersonal comparisons valid was achieved by controlling for the effects of age, care must nevertheless be exercised in extrapolating cross-sectional findings to descriptions of the characteristics of individuals.

One last pitfall is the omission of nonmarketable assets from the wealth variable necessitated by the operational difficulties in measuring uncertain labor income in terms of observable proxies. Therefore, if permanent wealth including human capital is the appropriate wealth variable in testing risk aversion hypotheses, the results of this study are only valid to the extent that the effects of human capital wealth are accounted for by the age variable, or to the extent that models which include human capital lead to risk estimates for marketable assets that are undistinguishable from those of simpler models (see Fama and Schwert [9] and Liberman [21]).

Since older persons have lower income potential, human capital decreases with age. It can be shown that at a given level of marketable wealth, α inclusive of risky human capital, decreases as age increases. Furthermore, in testing risk aversion using marketable assets only, one would expect a negative age effect on risk-taking behavior if human capital is relevant. And this is precisely what was found empirically. Therefore, if permanent wealth is the appropriate wealth measure, tests using current wealth are far less subject to qualifications if age is held constant.

[21] Theil [30] showed that macroregression coefficients must be nearly identical to the microestimates if estimates based on aggregated data are to be meaningful in a behavioral sense. It is generally accepted that the loss of precision due to grouping is always small whenever there are at least ten groups and so long as the different groups are of the same order of size. See also Malinvaud [23, pp. 283–4] and Cramer [7, pp. 243–4] for more details.

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