PORTFOLIO COMPOSITION CHOICE: A BEHAVIORAL APPROACH

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Abstract

This experimental study investigates portfolio composition choice for different types of financial assets and for different levels of wealth. For a distinctive group of financially sophisticated executive MBA students with work experience in capital markets, the findings of this study indicate that the proportion of wealth invested in risky assets increases with wealth for all portfolio compositions examined and increases with the degree of asset risk. This proportion is found to be as much as three times higher for common stocks than for options: for stock portfolios, it increases from 33% to 44% over the five wealth levels examined, while for options it increases from 11% to 17%. These results may imply a decreasing relative risk aversion. Regression results also indicate that those who invest relatively low proportions of their wealth in risky assets possess the following characteristics: do not invest in options in real life; sometimes buy lottery tickets; attach a higher risk level to options relative to common stocks; are female and are employed.

JEL classification: D70, G11

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1. Introduction

While portfolio theory and capital asset pricing have been examined extensively in the literature, less attention has been devoted to the behavioral aspects of individual investors' portfolio composition choice. In recent years, however, behavioral studies, inspired by early works of researchers such as Kahneman and Tversky, have begun to focus on the psychological rather than the economic aspects of individuals' investment decisions[1] Some of the psychological economic phenomena investigated in the behavioral literature include the following: subjective discount rates, overconfidence, overreaction and underreaction, loss aversion and narrow framing, mental accounting, and investors' tendency not to realize losses. The issue of relative risk aversion (RRA) also has been examined but the findings (reviewed in the next section) are inconclusive. Furthermore, the intertwined issues of the RRA, its impact on individuals' portfolio composition choice, and its variation with wealth, asset risk and personal characteristics, have not yet been fully examined experimentally. The objective of this study, therefore, is to fill this gap by focusing on how the proportion of wealth invested in risky assets (RSPR) changes with wealth and asset risk, and the extent to which this risky proportion is affected by personal characteristics.

For a distinctive group of subjects possessing higher formal education, financial sophistication, and work experience in capital markets, the findings of this study may indicate that the degree of RRA decreases with wealth for all portfolio compositions examined. For stock (and risk-free) portfolios, the RSPR increases from 33% to 44% over the five wealth levels examined, and for options portfolios the corresponding proportion increases from 11% to 17%. The RSPR also is found to be as much as three times higher for common stocks than for options. Various personal characteristics integrated into this study are shown to have a statistically significant effect on the degree of RSPR exhibited. Specifically, those who invest relatively low proportions of their wealth in risky assets possess the following characteristics: do not invest in options in real life; sometimes buy lottery tickets; attach a higher risk level to options relative to

common stocks; are female and are employed.

The outline of this study is as follows: Section 2 briefly reviews the relevant literature; Section 3 discusses the research issues; Section 4 describes the experimental design; Section 5 presents the findings and discusses the empirical results; and Section 6 provides a brief summary.

2. Literature Review

Following the von Neumann-Morgenstern (1953) expected utility theory, Arrow (1965) and Pratt (1964) derived two measures of risk aversion: absolute risk aversion (ARA) and relative risk aversion (RRA). Their measures of ARA and RRA are given by - U''(W)/U'(W) and W·ARA, respectively, where W denotes wealth and U(W) is the von Neumann-Morgenstern utility function defined over an individual's wealth, and is assumed to be increasing and differentiable. It is commonly assumed that U'(W) is positive (implying that more wealth is desirable), and U''(W) is negative for risk-averse individuals. The size of the RRA will measure the degree of individual risk aversion (higher RRA implies higher risk aversion) with respect to wealth. The RRA can be decreasing, constant, or increasing. A decreasing RRA indicates that as individual wealth increases, the proportion of wealth invested in risky assets will increase. Thus, the RRA indicates the proportion of risky assets in the portfolio.

The issue of risk perception in psychology and economics is discussed by Arrow (1982). Empirical studies of Arrow-Pratt risk aversion measures are not completely conclusive concerning whether RRA is decreasing, constant, or increasing with wealth. Friend and Blume (1975) find that RRA patterns vary with the definition of wealth. Using a sample of household asset portfolios, Cohn et al. (1975) find strong evidence of decreasing relative risk aversion; as wealth increases, a higher proportion of total wealth is committed to risky assets. They stress, however, that their conclusion must be advanced gingerly, mainly due to the fact that their sample was drawn from household asset portfolios. Graves (1979) concludes that in portfolio situations where the degree of relative risk aversion is important one should prefer the hypothesis of decreasing relative risk aversion over relevant ranges of wealth. Siegel and Hoban (1982) find decreasing

RRA when wealth is defined as net worth excluding housing and the population is restricted to the wealthier half of households. Morin and Suarez (1983) present an empirical investigation of the demand for risky assets of individual Canadian households using data from the Survey of Consumer Finances. Their results generally point to decreasing relative risk aversion when housing ownership is either excluded from the definition of wealth or treated as a riskless asset. Szpiro (1986) examines the hypothesis of constant relative risk aversion (CRRA) for 15 countries, using property/liability insurance data. For more than half the cases it is shown that CRRA cannot be rejected. Additionally, he estimates the degree of relative risk aversion and finds that it usually lies between one and two. In his investment experimental study, Levy (1994) finds that decreasing ARA is indeed strongly supported but increasing RRA is rejected. Dalal and Arshanapolli (1993) also show in their empirical study that constant RRA is very plausible. Isaac and James (2000) find that their estimates of the constant-RRA-utility-function parameter are not stable within individuals across the different institutions (in which the individuals act). Donkers et al. (2001) question the assumption (often made in economic studies) that attitudes towards risk do not vary across individuals. Based on questions on lotteries in a household survey, they find significant relationships between risk aversion and age, gender, education level, and income. Employing a Stochastic Dominance methodology, Levy and Levy (2001) find in their experimental study that most individuals are not risk-averse.[2]

This study aims to extend prior studies of decision making under uncertainty. Its purpose is threefold: (1) to examine asset substitution for different "risk-return" asset types across various wealth levels; (2) to investigate how the RRA changes with wealth for different portfolio compositions; and (3) to test the impact of personal characteristics on the proportion of wealth invested in risky assets for different portfolio compositions. Compared to prior experimental studies, this study employs a much wider spectrum of such personal characteristics as sex, marital status, home ownership, and employment. Also, unlike samples used in prior studies, the sample of this study is characterized by both increased formal education in economics and finance and actual investment experience in bonds and stocks as well as in more complex derivative financial instruments, such as options and futures. The underlying aim of this sample selection is

to examine portfolio composition choices and the behavior of the RRA for knowledgeable and financially experienced individuals.

3. The Research Issues

According to portfolio theory and observed investors' behavior, the risky proportion (RSPR) decreases with the risk level of the asset, and increases with the number of types of risky assets in the portfolio[3]. Also, the proportion of individuals investing some positive portion of their wealth in risky assets decreases with the risk level of the assets and increases with the wealth of individuals. In addition to testing for the form and magnitude of the RSPR, the present experiment will also examine the *magnitude* of the change in the RSPR with respect to the risk level of the assets, and the *extent* to which the proportion of individuals undertaking risk changes with wealth and the asset risk.

Portfolio theory also implies that given two portfolios, each consisting of one risk-free asset and one risky asset, the ratio of the risky proportions in the two portfolios, P_i/Pj, will reflect the different risk level of asset i compared to j. Furthermore, since the relative risk ratio for the two risky assets is constant, the resulting risky proportion ratio, P_i/Pj, will be constant over wealth levels. The extent to which this risky proportion changes with wealth will also be tested in this experiment.

The utility function for risk-averse individuals increases at a decreasing rate with wealth; that is: $U'(W) > 0$ and $U''(W) < 0$, such as in the case of the following two utility functions: $U(W) = LnW$; and $U(W) = W^{½}$. Such utility functions, as demonstrated by Arrow and Pratt, will exhibit constant relative risk aversion, which implies that an individual's RSPR will not vary with his wealth. A constant relative risk aversion is also consistent with decreasing *absolute* risk aversion, which implies that the absolute dollar amount of wealth invested in risky assets increases with wealth level. We want to investigate how, if at all, the RSPR changes with wealth and how its variation with wealth depends on the risk-level of the asset.

According to utility theory, the distinct traits and behavior patterns of different individuals are reflected by distinct utility functions, which imply differing investment strategies, degrees of risk aversion,

and patterns of risk aversion. This variety will also be reflected by various RSPR measures, or, equivalently, various portfolio composition choices. In line with Levy and Levy's (2001) claim concerning the importance of heterogeneous expectations, this study investigates the relationship between personal characteristics and the RSPR. Consequently, information regarding five personal characteristics was gathered[4]. These characteristics are defined and described in Table 5, and their expected impact is briefly discussed below. The five characteristics are: OPT; LTRY; RSKR; SEX; and EMPL. The first variable, OPT, is a dummy variable carrying the value of 1 for subjects who in real life invest in such risky assets as options. We therefore expect these subjects to have a higher RSPR. In other words, we expect OPT to have a positive impact on the RSPR. In contrast, we cannot a priori determine the impact on the RSPR of buying lottery tickets (LTRY). Subjects who are aware of the higher risk involved in options compared with common stock (i.e., have higher RSKR values) will likely have lower RSPR values than those who are not. While the impact of the SEX variable cannot a priori be determined, employment (EMPL) is assumed to represent some sort of stability or at least the existence of high opportunity cost for making wrong investment decisions in the face of uncertainty and risk. We therefore expect the sign of this dummy variable to be negative (a value of "1" designates being employed).

To empirically examine the impact of the five personal characteristics on the RSPR, the following regression equation is estimated:

$$RSPR = \alpha + \beta_1 OPT_i + \beta_2 LTRY_i + \beta_3 RSKR_i + \beta_4 SEX_i + \beta_5 EMPL_i + e_i , \qquad (1)$$

where i = 1,2...n subjects, RSPR is the proportion of wealth invested in risky assets, and the five personal characteristics are as defined in Table 5. Based on the preceding discussion we expect the OLS coefficients to carry the following signs: $\beta_1 > 0$; $\beta_2 \gtrless 0$; $\beta_3 < 0$; $\beta_4 \gtrless 0$; and $\beta_5 < 0$.

4. Methodology

The questionnaire (presented in the Appendix) consists of two parts: the first part contains two general questions, while the second part contains personal questions concerning the individual subject's investment activities in reality, attitude toward risk, and such other particulars as age, sex, and employment.

Following a brief introduction of the purpose and nature of the present experiment, the subjects are presented with two questions, the first of which is the following:

Question 1: Suppose your investment horizon is one year (i.e. investing at the beginning of the year and liquidating the investment at the end of the year) and that you plan to invest a certain dollar amount in two distinct types of investment assets: (1) risk-free assets (such as savings accounts, treasury bills, and money market funds), and (2) common stocks. You are given below a matrix containing these two distinct types of assets as well as the following five hypothetical different levels of investment: $10,000; $50,000; $100,000; $500,000; and $1,000,000. For each of these five investment levels, state the *dollar amount* you will invest in each of the two distinct types of assets (risk-free and common stocks), and please make sure that the two dollar amounts you state add up to the *total* dollar amount given below.

Question 2 is similar to Question 1 except that the category "common stocks" is replaced by “call options.”

The second part of the questionnaire attempts to gather information on the subjects' personal characteristics, such as age, sex, and employment. The subjects were also asked their opinion regarding the risk of stocks and options. More specifically, they were requested to state a number (below, above, or equal to 1) that, in their opinion, represents the risk of options relative to the risk of stocks, which is assumed to be equal to a risk level of 1. Subjects were also asked to indicate whether they actually invest in real life in saving plans, stocks, or options, and whether they sometimes buy lottery tickets. These personal questions in the second part of the questionnaire are intended to test the direction and magnitude of the effect of personal characteristics on the degree of risk aversion.

The questionnaire was distributed to 245 executive MBA students at New York University. The students were given, in class, the option to complete only the first or both the first and second parts of the questionnaire. The rationale was to test whether those who did not answer the second part involving the

personal-characteristics questions make different portfolio-composition choices than those who did. Of the 245 subjects who participated in the experiment, 223 completed the first part of the questionnaire (the three general questions), while 133 of them also completed the second part. For comparative purposes, the questionnaire was also distributed to 203 Economics students at Haifa University (Israel); 190 students completed the entire questionnaire.

The advantages and disadvantages of experimental studies noted in the literature apply to this study, too. Nonetheless, the questions were examined carefully, resulting in no notable difference in response pattern. Furthermore, as noted later, no evidence is found for sample segmentation. The questionnaires were distributed during class. The students were given sufficient response time and were informed of the importance of the topic. Therefore, it would seem that the students were positively motivated to complete the questionnaire with necessary care and diligence even without being offered monetary incentives, which psychologists claim do not necessarily improve performance. Gneezy and Rustichini's (2000) findings are consistent with this claim. Loewenstein (1999) also argues that experimental economists should not deceive themselves into believing that the use of such rewards allows them to control the incentives operating in their experiments. The analysis of our experimental findings, too, implies that reliable responses appear to have been part of the subjects' utility functions. This contention seems consistent with Warneryd's (1996) conclusion that questions involving hypothetical risky choices can be used in survey contexts.

5. Results

Given the findings (reported later in this section) that imply a very high similarity between the two US samples and the Israeli sample, the main body of the results analysis will be based on the first U.S. sample, while the results for the second U.S. sample and, especially, the Israeli sample are presented in Table 7 and discussed later in this section.

Insert Table 1 here

5.1 The Pattern of the Risky Proportion (RSPR)

Descriptive statistics of subject responses for the first part of the questionnaire are summarized in Table 1. Investment proportions in risk-free assets vs. risky assets for two types of portfolio composition (hereafter denoted C) and five different levels of wealth ranging from $10,000 to $1,000,000 are given. The portfolio compositions consist of risk-free assets and one of the following two types of risky assets corresponding to the two panels in Table 1: (1) stocks, and (2) options. We will refer first to the *mean* value of the portfolio choice compositions across the five wealth levels, represented by the right-hand column in Table 1. The risky proportion, as shown in Table 1, is a negative function of the risk level of the particular asset. That is, the riskier the asset, the lower the proportion of total wealth invested in it.

When stocks represent the risky component (C1), the mean value of the RSPR across the five wealth levels is 39%; the remaining 61% is invested in risk-free assets. This risky proportion decreases sharply to 16% for options (C2), and the difference between the two RSPR values is statistically significant[5]. The results for C1 and C2 in Table 1 also support the contention that, given two portfolios, C_i and C_j, each of which contains one risk-free asset and one risky asset, the risky proportion ratio, P_i/P_j, will reflect the relative risk differential of the two risky assets and should therefore be constant over different wealth levels. The risky proportion ratio between C1 and C2 (i.e., stocks vs. options) is about 2.5 and is fairly constant across the five wealth levels examined. These findings can be attributed to Kahneman and Tversky's (1992) "loss aversion" concept, according to which investors attach higher weight to losses than to gains. With the wealth level held constant, losses clearly increase with the riskiness of the asset. The higher RSPR found for stocks than for such financial derivatives as options and futures may not only be attributed to the higher risk level of the latter, but may also be related to the "familiarity" or "home bias" factor examined in different contexts in the literature: Huberman (2001); Coval and Moskowitz (1999); and Grinblatt and Keloharju (2001).

To investigate the variation in the proportion of *individuals* investing in risky assets, the percentage proportion of *all subjects* investing in a specific asset was computed for various wealth levels and

portfolio compositions; the results appear in Table 2. For a wealth level of W = $10,000, the proportion of all subjects (hereafter called the "subject proportion") decreases significantly from 73% for stocks (C1) to 48% for options (C2). The results in Table 2 also show that, for the two portfolio compositions, the proportion of subjects investing some portion of their wealth in risky assets increases with wealth level, and in fact reaches almost 100% for a wealth level of $1,000,000 and moderately risky assets (stocks in C1). For the riskier asset (options (C2), even at the relatively high wealth level of W = $1,000,000, 14% of all individuals will invest *nothing* in the risky asset.

Insert Table 2 here

A related issue is the consistency of the RSPR variation across subjects and across types of risky assets for various wealth levels. We therefore estimate the following regression equation for different wealth levels and different types of risky asset:

$$P_i = \alpha_{ij} + \beta_{ij} P_j + e_{ij}, \qquad (2)$$

where i and j denote portfolio compositions C1 and C2 for stocks and options, respectively, and P denotes the RSPR. This regression equation was estimated for each of the five wealth levels. The number of observations in each regression is 133, which is equal to the number of subjects. Table 3 presents the results for the two extreme wealth levels, W = $10,000 and W = $1,000,000. The results in Table 3 imply a high degree of consistency within subjects. For the W = $10,000 wealth level, R^2 is 0.333, while for W = $1,000,000 R^2 is 0.199; both are significant at 1%.

Insert Table 3 here

We now want to focus on the pattern of the risky proportion (RSPR) with respect to variations in wealth and portfolio composition. The descriptive statistics of this pattern appear in Table 1. The results clearly indicate that as wealth increases, the absolute dollar amount invested in risky assets increases. This result holds true for all types of portfolio composition and for all examined wealth levels, and it appears consistent with decreasing absolute risk aversion (ARA).

The results in Table 1 demonstrate that the RSPR increases with wealth. The values of the RSPR for the two extreme wealth levels (W=$10,000 and W=$1,000,000) are respectively, 33% and 44% for the first portfolio composition (C1) of risk-free assets, and stocks, and 12% and 18% for C2 (options). All these differences are significant at 5%. These results seem consistent with decreasing relative risk aversion (RRA) as well.

Furthermore, among relatively low levels of wealth (W=$10,000 to W=$100,000) the RSPR increases sharply with wealth, while among relatively high levels of wealth (W=$100,000 to W=$1,000,000) the RSPR increases only moderately. This result also holds true for both portfolio compositions C1 and C2.

Like the *mean* proportion of wealth invested in risky assets, its coefficient of variation (COV), defined as the standard deviation over the mean, also declines with wealth. As indicated by Table 1, the decline is sharp for the lower wealth levels (W=$10,000 to W=$100,000), and moderate for the higher wealth levels (W=$500,00 and W=$1,000,000). This result holds across the two types of portfolio compositions, C1 and C2. The level of COV, as demonstrated in Table 1, also increases with the degree of asset risk. These results imply (1) not only does the RSPR increase with wealth, but the variability associated with it decreases, and (2) the RSPR decreases with the degree of asset risk, while its variability increases.

A linear regression test for increasing RSPR is represented by the following regression equation:

$$D_{ij} = \alpha_i + \beta_i P_{ij} + e_{ij};\ i = 2.....5 \text{ wealth levels},\ j = 1.....133 \text{ subjects} \qquad (3)$$

where:

P = RSPR = proportion of wealth invested in risky assets

D = incremental proportion of wealth invested in risky assets

W_i = wealth at level i

Y_i = dollar amount invested in risky assets at wealth level i

$D_i = (Y_i - Y_{i-1})/(W_i - W_{i-1})$; i = 2.....5 wealth levels

e_{ij} = the error term

An increasing RSPR will be implied by a — value greater than unity. Eq. (3) was estimated ten times corresponding to two portfolio compositions (C1 and C2) and four wealth changes. Results across the ten regressions were very similar; hence, only the results for C1 appear in Table 4. For the four regressions corresponding to the four wealth changes reported in Table 4, the value of — ranges between 1.05 and 1.08, the value of R^2 is between 0.82 and 0.99, and both — and R^2 are significant at 1%. As noted above, very similar results were obtained for the second portfolio composition (C2). These results demonstrate that an overall increasing RSPR characterizes the portfolio composition choices of the subjects in the experiment.

Insert Table 4 here

5.2 The Impact of Personal Characteristics on the Risky Proportion (RSPR)

Having analyzed the findings of the pattern of the risky proportion (RSPR), we now turn to the impact of personal characteristics on the RSPR for the two portfolio compositions. A description and statistical summary of the five personal characteristics appear in Table 5. The distributions of these characteristics can be summarized as follows: 28% of the subjects in the experiment invest in options; 62% sometimes buy lottery tickets; 90% think that options are riskier than stocks; 63% are male; and 81% are employed.

Insert Tables 5 and 6 here

Equation (1) concerning the impact of personal characteristics on the RSPR was estimated for portfolio compositions C1 and C2. The statistical results, which appear in Table 6, can be summarized as follows:

– The R^2 values for the two portfolios are statistically significant at 5%. This result implies that the five personal characteristics are statistically related to the subjective proportion of wealth invested in risky assets across individual investors.

– The impact of the "investing in options" (OPT) variable is positive, as expected, and stronger for portfolio C1. However, when confined to investment in options *alone* (C2), clearly the differential impact of this variable is lower.

– Those who sometimes buy lottery tickets have lower RSPR values than those who do not, perhaps partially due to the substitution effect of this type of risky asset.

– The results concerning the "risk" variable (RSKR) indicate that subjects who are aware that options are riskier than stocks have lower RSPR values than do those who are not. The effect of the RSKR variable is negative and significant at 1%.

– Male subjects tend to have higher RSPR values than female subjects for stocks (C1) and for options (C2). This prediction appears consistent with the work of Barber and Odean (2001), who find that men are overconfident and trade more excessively than women.

– The employment variable (EMPL) has a negative impact on the RSPR, perhaps due to the "stability" and/or "opportunity cost" arguments offered in the preceding section.

Overall, these results imply that personal characteristics are related to the RSPR. Individual subjects invest different proportions of wealth in risky assets due to different personal characteristics. At least part of the effect of these characteristics can be explained by the link

between emotions and economics discussed by Elster (1998) and Loewenstein (2000), and the relationship between psychology and economics surveyed by Rabin (1998).

Specifically, the lower level of RSPR found for low wealth levels may be explained by the "loss aversion" (rather than risk aversion) concept incorporated in Kahneman and Tversky's (1979) prospect theory, and recently advanced by many researchers including Rabin and Thaler (2001). Loss aversion, they note, is the tendency to feel the pain of a loss more acutely than the pleasure of an equal gain. The loss aversion can be related to visceral factors (Loewenstein, 2000), which refers to a wide range of negative emotions. To predict or make sense of viscerally driven behavior, Loewenstein concludes, it is necessary to incorporate visceral factors into a model of economic behavior. The incorporation of personal characteristics in the present study is a step in this direction.

5.3 Inter-Sample Comparison

The preceding results are for the first 133-subject sample that answered the personal characteristics questions. To test whether the second 90-subject sample, which elected not to answer these questions, has a different portfolio composition choice involving risky assets, the major findings for the first sample discussed above will be briefly compared to those of the second sample[6]. We will then compare the U.S. executive-MBA sample to the Israeli economic-students sample to test the extent to which changes in RSPR patterns are similar in a (narrow) international perspective.

The major findings of this experiment for the three samples are summarized in Table 7, which exhibits the RSPR for the five wealth levels and the two portfolio compositions discussed in the previous section. The first line in each of the two compositions represents the findings for the first U.S. sample, which already appeared in Table 1. The second and third lines for each of the two compositions are for the second U.S. sample and the Israeli sample, respectively.

A comparison of the first two lines in each of the two compositions in Table 7 clearly demonstrates that the findings for the two U.S. samples are nearly identical. This result implies that the tendency to respond to personal characteristics questions in this study does not have an impact on the pattern of the

RSPR.

Though the findings for the Israeli sample are similar to those of the U.S. sample, there are some interesting differences worth noting. The results for the "mean" column in Table 7 imply that the Israeli subjects in the experiment possess a higher degree of risk aversion than their U.S. counterparts. For the stock portfolios (C1) the Israelis' RSPR is much lower than in the U.S. sample. For the option portfolios (C2), the Israelis' RSPR is a bit higher for low wealth level but similar to the Americans' RSPR for high wealth levels. It appears that the Israeli economics students are perhaps less fully aware of the risk level of derivative securities than are the U.S. executive MBA students. The proportion of subjects actually buying options in real life is 28% in the U.S. sample as opposed to only 14% in the Israeli sample. In contrast, the proportion of subjects buying lottery tickets is lower for the U.S. sample (62%) than for the Israeli sample (71%).

Insert Table 7 here

Another important difference between the U.S. and Israeli samples is that while the former seems to imply a decreasing RRA, the latter appears to have a roughly constant RRA for the two portfolio compositions offered in the experiment. This finding may also be consistent with the Israeli sample's likely higher degree of RRA noted above.

As noted previously, the U.S. sample consists of executive MBA students, while the Israeli sample consists of full-time economics students. The personal-characteristic questions were designed to reflect this difference; the employment question was therefore omitted from the Israeli sample's questionnaire, and was replaced with an age question. Also, the RSKR-variable question in the U.S. study was replaced with a simpler one in the Israeli study, asking the subjects whether they think options are riskier than stocks (without attaching a specific numerical value).

The regression results of the relationship between the RSPR and the five personal characteristics for

the Israeli sample are given by Eq. 4 (for the “Stocks” case).

$$\underset{}{\text{RSPR}} = \underset{}{0.57} + \underset{(7.18)}{0.13}\ \text{OPT} + \underset{(6.50)}{0.02}\ \text{LTRY} + \underset{(1.12)}{0.02}\ \text{RSKR} + \underset{(0.66)}{0.04}\ \text{SEX} - \underset{(2.75)}{0.01}\ \text{AGE} \qquad (4)$$
$$(-3.98)$$

These findings are similar to those for the U.S. sample. The relationship between the risky proportion and the personal characteristics is statistically significant though lower than for the U.S. sample ($R^2 = 0.07$; $F = 10.26$; significance level = 1%). The variables generally carry the expected sign and most of them are statistically significant.

6. Summary

This experimental study investigates the portfolio composition choices of individual subjects for different wealth levels and different types of risky financial assets. The study examines the pattern of the proportion of wealth invested in risky assets (RSPR) across varying levels of wealth, types of financial assets, and portfolio compositions for a highly knowledgeable and experienced group of individual subjects.

A questionnaire was presented to subject samples of executive MBAs in the U.S. and economics students in Israel in an effort to gather information on two interrelated issues: (1) the pattern of the risky proportion (RSPR) across wealth levels and portfolio compositions; and (2) the impact of personal characteristics on the RSPR.

The findings reconfirm actual investment behavior that implies that there exists a negative relationship between the risk level of the assets and the RSPR. This proportion was found to be as much as three times higher for common stocks than for options. The results also support the contention that the risk-proportion ratio for two different portfolio compositions reflects the risk differential of the two risky assets, and will therefore stay constant across different wealth levels. The risky proportion ratio between stocks and options was found to be about 2.5 for all five wealth levels examined. Another type of proportion examined is the "subject proportion," or the proportion of all subjects investing some positive amount in the risky component of the portfolio. This "subject proportion" was found to decrease with the risk level of the asset

and to increase with wealth.

The findings concerning the pattern of the RSPR seem to indicate that the degree of absolute risk aversion (ARA) decreases with wealth. The degree of RRA, implied by the RSPR, also appears to generally decrease with wealth for the U.S. sample, while for the Israeli sample it is rather constant. The values of RSPR for the two extreme wealth levels (W=$10,000 and W=$1,000,000) are, for the U.S. sample, 33% and 44% respectively for C1 (stocks), and 12% and 18% for C2 (options). All these differences are statistically significant at 5%. A decreasing RRA may also be consistent with the high-equity premium observed in the market. By this so-called "equity premium puzzle," stock returns have been historically much higher than treasury-bill returns.

Finally, the relationship between the RSPR and personal characteristics has been investigated, and the regression results indicate that these characteristics are statistically related to the RSPR. For the two-portfolio compositions (C1 and C2), R^2 is significant at 5%, and the five characteristics examined generally carried the correct sign and were found statistically significant. Specifically, those who invest relatively low proportions of their wealth in risky assets possess the following characteristics: do not invest in options in real life; sometimes buy lottery tickets; attach a higher risk level to options relative to common stocks; are female and are employed.

The findings of this experimental study appear consistent with behavioral theories examined in the economic psychology literature and may contain important implications for the investment decision-making process in the real world.

Footnotes

1. For a review of Tversky's contribution to behavioral economics see Laibson and Zeckhauser (1998).
2. The issue of the RRA and portfolio composition choice investigated here is related to other behavioral–economic issues such as: subjective discount rates, investors overconfidence, overreaction and underreaction, loss aversion, and mental accounting. Selected studies of these issues are given here, some of which will be linked to the present study later when the results are discussed. A recent and comprehensive critical review of the discount-rate literature is provided by Frederick, Loewenstein and O'Donoghue (2002). One of the subjective-discount-rate anomalies of decreasing rates with time and monetary sum [e.g., Thaler (1981) and Benzion Rapoport and Yagil (1989)] was found consistent with the notion of reference point [Kahneman and Tversky (1979); Tversky and Kahneman (1986); Loewenstein (1988); Loewenstein and Thaler (1989); and Thaler (1994)]. More recent discount rate studies include Weitzman (2001) and Warner and Pleeter (2001). The overconfidence phenomenon has been recently examined in numerous studies including those of Daniel, Hirshleifer and Subrahmanyam (1998), Barber and Odean (2000 and 2001) and Gervais and Odean (2001). It is argued that overconfidence can explain high trading levels and the resulting poor performance of individual investors, and that men are more overconfident than women [Barber and Odean (2001)]. Barberis, Shleifer, and Vishny (1998) note a large body of evidence supporting the idea that in the short run security prices underreact to news, while in the long run they overreact to consistent patterns of news. Fama (1998) contends that overreaction of stock prices to information is about as common as underreaction. According to Kahneman and Tversky's (1979) loss (rather than risk) aversion concept, people are more sensitive to losses than to gains. This concept, Barberis and Huang (2001) argue, can improve our understanding of firm-level stock returns. A closely related concept is "myopic loss aversion" which, as defined by Thaler, Tversky, Kahneman and Schwartz (1997), is the combination of a greater sensitivity to losses than gains and a tendency to evaluate outcomes frequently. They, as well as Gneezy and Potters (1997),

find that the more frequently returns are evaluated, the more risk averse investors are. Experimental studies suggest that, when doing their mental accounting, people engage in "narrow framing," which is referred to as narrowly defined gains and losses. Loss aversion and narrow framing have been applied to the aggregate stock market and to retirement investment by Benartzi and Thaler (1995, 1999), and were further studied by Barberis, Huang, and Santos (2001). Another related phenomenon studied is investors' reluctance to realize losses [e.g., Ferris, Haugen and Makhija (1988), and Odean (1998)]. Finally, in a recent survey of investor psychology and asset pricing, Hirshleifer (2001) sketches a framework for understanding decision biases and discusses the importance of investor psychology for security prices.

3. This contention is consistent with both portfolio diversification and a similar effect identified in the economic-psychology experimental literature (e.g., Kahneman and Knetsch, 1992), which implies that if a category is broken down into many subcategories more will be allocated to that category.

4. Though some of these characteristics may not be "personal" in the pure sense, for expositional simplicity we will refer to the whole group of characteristics examined as "personal."

5. Mean differences discussed throughout the analysis are statistically significant unless it is stated otherwise explicitly.

6. As described in the previous section, two U.S. samples are used: the first 133-subject sample who elected to answer both parts of the questionnaire (including the personal questions), and the second 90-subject sample who elected to answer only the first part of the questionnaire.

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Appendix

A Questionnaire on Problems in Financial Decisions

The purpose of the present experiment is to obtain some estimate of your investment preferences in various types of investment assets (instruments) for different hypothetical investment levels. The questions presented below have no unique answer. The answers may differ from one person to another according to his/her own investment preferences and his/her own financial position in the present and in the future. The questions you will be given are chosen from a wide spectrum of simple decision problems that can arise in different areas of one's economic behavior. This questionnaire is for research purposes only. We ask you to use your best judgment and to answer *all* questions sincerely and as best you can.

Question 1: Suppose your investment horizon is one year (i.e. investing at the beginning of the year and liquidating the investment at the end of the year) and that you plan to invest a certain amount of dollars in two distinct types of investment assets: (1) risk-free assets (such as savings accounts, treasury bills, and money market funds) and (2) common stocks. You are given below a matrix containing these two distinct types of assets as well as the following five hypothetical levels of investment amounts: $10,000; $50,000; $100,000; $500,000; and $1,000,000. For each of these five investment levels, state the *dollar amount* you will invest in each of the two distinct types of assets (risk-free and common stocks), making sure that the two dollar amounts you state add up to the *total* dollar amount given below.

Risk-free assets Common Stocks					
Total assets	$10,000	$50,000	$100,000	$500,000	$1,000,000

Question 2: This question is identical to Question 1 above except that the risky asset is not common stocks but call options. For each of the five investment levels given below, state the dollar amount you will invest (buy) in the risk-free asset and the call options, making sure that the two dollar amounts you state add up to the total dollar amount given below.

Risk-free assets Options					
Total assets	$10,000	$50,000	$100,000	$500,000	$1,000,000

Additional Questions

In which types of investment assets did you regularly invest in the past? (Circle your choice) Savings accounts and market instruments? yes ; no ; Stocks? yes ; no ; Options? yes ; no.

Do you sometimes buy a lottery ticket? yes ; no.

If the risk level of stocks is 1, state a number (below, above, or equal to 1) to represent the risk of options *relative* to the risk of stocks; the risk of options is _____ .

Age_____; Sex: M ; F ; Currently employed? yes ; no .

Table 1

The Investment Proportions in Risk-Free Assets vs. Risky Assets
for two Types of Portfolio Composition and Different Levels of wealth (%)*

Wealth ($000) Asset Type	10	50	100	500	1.000	Mean
COMPOSITION 1						
Risk-free	67 (0.45)	62 (0.39)	60 (0.38)	58 (0.42)	56 (0.44)	61 (0.42)
Stocks	33 (0.92)	38 (0.63)	40 (0.57)	42 (0.59)	44 (0.57)	39 (0.65)
COMPOSITION 2						
Risk-free	88 (.23)	85 (.24)	84 (.23)	84 (.22)	82 (.24)	84 (.23)
Options	12 (1.62)	15 (1.35)	16 (1.15)	16 (1.14)	18 (1.11)	16 (1.25)

* Number in parenthesis is the coefficient of variation (COV) defined as the standard deviation (—) over the mean (—).

Table 2

The Percentage Proportion of all Subjects Investing in Specific Assets for Various Wealth Levels and Portfolio Compositions

Wealth ($000) Asset Type	10	50	100	500	1,000
COMPOSITION 1					
Risk-free	93	98	99	99	99
Stocks	73	93	95	97	98
COMPOSITION 2					
Risk-free	98	98	100	100	100
Options	48	67	79	86	86

Table 3

Statistical Results of the Regression Between the Proportion (P)
Invested in stocks and that invested in options
for Two Wealth Levels - $10,000 and $1,000,000*

	$10,000	$1,000,000
—	0.222	0.339
—	0.883	0.566
R^2	0.333	0.199

* The two regressions are as in Eq. (2): $P_i = —_{ij} + —_{ij}P_j + e_{ij}$, where i and j denote portfolio compositions C1 and C2, for stocks and options respectively, and *P* is the proportion invested in the risky asset. The number of observations in each of the two regressions is 133, which is the number of subjects.

All values of —, —, and R^2 are significant at 1%.

Table 4

Statistical Results of the Regression between the Incremental Proportion (D) and the Proportion of Wealth Invested in Risky Assets (P), for Portfolio Composition of Risk-Free Assets and Stocks (C1) at Different Wealth Levels*

W($)	—	t—	—	t—	R^2
50,000	0.011	1.34	1.05	57.4	0.96
100,000	-0.013	-0.65	1.08	24.2	0.82
500,000	-0.015	-3.16	1.05	106.8	0.99
1,000,000	-0.016	-0.96	1.08	31.9	0.89

*The estimated regression is Equation (3): $D_{ij} = —_i + —_i P_{ij} + e_{ij}$, i = 2...5 wealth levels, j = 1...133 subjects.

All the values of —and R^2 are significant at 1%.

Table 5

Personal Characteristics

Variable Number	Variable Name	Variable Symbol	Variable Values		Proportion of Value "1" (%)[a]	Expected Impact[b]
			0	1		
1	Buying call Options	OPT	no	yes	28	+
2	Buying lottery tickets	LTRY	no	yes	62	?
3	Option risk/stock risk	RSKR	less than unity	greater than unity	90	—
4	Sex	SEX	female	male	63	?
5	Employment	EMPL	no	yes	81	—

a) This is the percentage proportion of all 133 subjects whose response was designated by the value "1" of the dummy variable.

b) "+" and "-" designate positive and negative impact respectively.

Table 6

The Impact of Personal Characteristics on the Proportion of Wealth Invested in Risky Assets for Two Types of Portfolio Compositions*

	C1 – Stocks		C2 - Options	
	ß	$t_{ß}$	ß	$t_{ß}$
Intercept	0.517	12.27	0.368	11.41
1. OPT	0.106	5.00	0.004	0.27*
2. LTRY	-0.058	-2.96	-0.027	-1.79
3. RSKR	-0.100	-3.22	-0.186	-7.80
4. SEX	0.076	3.79	0.019	1.21*
5. EMPL	-0.096	-3.81	-0.053	-2.77
R^2 - Adjusted	0.11	15.80	0.09	13.54

* The estimated regression is given by Eq. (1). In each of the two regressions, the dependent variable is the proportion of wealth invested in risky assets (RSPR) and it is computed from the subjects' responses concerning their portfolio composition choices for each of the two portfolio compositions. The definitions of the variables is as follows: 1.OPT = Buying call options (0 = no; 1 =yes); 2. LTRY= Buying lottery tickets (0 = no; 1= yes); 3. RSKR = The ratio of option risk/stock risk (0=less than unity; 1= greater than unity); 4. Sex (0= female; 1 = male); 5. EMPL = Employment (0= no; 1 = yes).

- For all regressions, the first column represents the values of the OLS coefficients, while the second column gives their t-statistic. In the last line, it is R^2 and its F-statistics, respectively.
- For more on the variables, see Table 5.
- In all regressions, R^2 is significant at 5%; the asterisk (*) denotes no significance at 5%.

Table 7

Proportion of Investment in Risky Assets For Two Types of Portfolio Composition and Different Levels of Wealth, for Three Samples (%)*

		Wealth Levels ($000)					
Composition	Asset Type	10	50	100	500	1,000	Mean
		32	36	39	41	43	38
1	Stocks	33	38	40	42	44	39
		31	38	41	43	45	39
		30	29	30	30	31	30
2	Options	12	15	16	16	18	16
		14	15	17	18	19	17
		19	18	18	18	20	19

*This table corresponds to Table 1 except that the risk-free proportion and the coefficient of variation are not given. Table 1 is for the 133-subject sample who elected to answer the personal characteristics questions, while this table presents the results for additional two samples: the 90-subject sample that elected not to respond to the personal characteristics questions, and the 190-subject Israeli sample. Accordingly, the first, second and third line for each of the two asset-type compositions in this table presents the results for these three samples, respectively.