DECISIONS IN FINANCIAL ECONOMICS:

AN EXPERIMENTAL STUDY OF DISCOUNT RATES

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ABSTRACT

Using three subsamples of subjects that differ in their level of formal education and knowledge in economics, this experimental study of intertemporal discount rates finds that subjective discount rates decrease with the time delay and monetary sum, and are higher for postpone-a-receipt than for a postpone-a-payment scenario. The findings indicate the existence of market segmentation, implicit risk and a weak added compensation. The findings also imply that subjective discount rates are lower and closer to real market rates of interest for subjects having higher levels of formal education and economics knowledge. (JEL D90, G00)

Keywords: Behavioral financial economics; Subjective discount rate; Risk approaches.

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1. INTRODUCTION

The discount rate is one of the central concepts in financial economics. Its exact meaning in economics may vary across economic scenarios and can take such forms as borrowing rate, lending rate, and required return on financial assets such as bonds and stocks. While the discount-rate issue has been examined extensively in the financial economics literature, less attention has been devoted to the behavioral aspects of individuals' subjective (derived) discount rates. In recent years, however, behavioral studies inspired by the pioneering work of Kahneman and Tversky (1979), focus on the psychological rather than the economic aspects of individuals' financial behavior. The objective of this study is to extend this line of research by focusing on subjective discount rates inferred from individuals' financial decisions. More specifically, the purpose of this study is twofold: (1) to reexamine the behavior of subjective discount rates across three dimensions: financial scenario (such as lending and borrowing), time delay and the monetary sum of the cash flow; and (2) to investigate the extent to which the behavior of subjective discount rates is affected by the formal education level of the decision makers and their level of knowledge in financial economics.

For three subsamples of a distinctive group of subjects, who vary with respect to the formal education level (undergraduates and graduates having bachelor's degree, master's degree or higher), and their knowledge level in financial economics, we find a very high similarity with respect to the behavior of their discount rates across the scenario, time and sum dimensions. However, the level of the subjective discount rates is lower for graduates than for undergraduates. The knowledge of financial economics also has a depressing effect on the level of the discount rates inferred from the subject's financial decisions.

The plan of this study is as follows: Section 2 briefly reviews the relevant literature; Section 3 presents the theory and hypotheses; Section 4 discusses the experimental design; Section 5 analyzes the findings; and Section 6 provides a brief summary.

2. LITERATURE REVIEW

Experimental studies of subjective discount rates are reported by Thaler (1981), Benzion, Rapoport and Yagil (1989), Benzion, Granot and Yagil (1992 and 1994), as well as others. Generally, the results of these studies are found to be consistent with psychological models based on the notion of a reference point discussed in Kahneman and Tversky (1979), Loewenstein (1988), Loewenstein and Thaler (1989), and Thaler (1994). One of the features of Kahneman and Tversky's (1979, 1986, 1992) prospect theory is the reluctance to realize losses. This reluctance is examined by Shefrin and Statman (1993 and 1994).

The issue of subjective discount rates studied here is also related to the

overconfidence issue examined recently in the literature. Daniel, Hirshleifer and Subrahmanyam (1998) summarize a large body of evidence from cognitive psychological experiments and surveys, which shows that individuals overestimate their own abilities in various contexts. Based on this premise of investor overconfidence, they develop a theory of security markets. Specifically, they note two well-known psychological biases: investor over confidence about the precision of information and biased self-attribution, which causes asymmetric shifts in investors' confidence. The overconfidence phenomenon has been recently investigated further by Barber and Odean (2000 and 2001), and Gervais and Odean (2001). It is argued there that overconfidence can explain high trading levels and the resulting poor performance of individual investors. Barber and Odean (2001) also find that men are more overconfident and trade more excessively than women. Barberis, Shleifer and Vishny (1998) also note the large body of evidence concerning underreaction and overreaction which indicates that in the short run security prices underreact to news, while in the long run they overreact to consistent patterns of news pointing in the same direction. Their findings, they emphasize, challenge the efficient market theory. They propose a parsimonious model of investor sentiment (how investors form beliefs) that is consistent with available statistical evidence. In a recent study on mental accounting, Barberis and Huang (2001) argue that it is possible to improve our understanding of firm level stock returns by employing the experimental evidence related to Kahneman and Tversky's (1979) "loss aversion", concept which asserts that people are more sensitive to losses than to gains. Another 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 the

tendency to evaluate outcomes frequently. They, as well as Gneezy and Potters (1997), find that the more frequently returns are evaluated, the more at risk investors are. Another related concept is Thaler's (1987) "mental accounting" term, which refers to the process by which people think about and evaluate their financial transactions.

Experimental studies suggest that, when doing their mental accounting, people engage in "narrow framing", or narrowly defined gains and losses. Loss aversion and narrow framing have already been applied to the aggregate stock market and retirement investment by Benartzi and Thaler (1995 and 1999). Motivated by their studies, Barberis, Huang and Santos (2001) introduce loss aversion over financial wealth fluctuations into a dynamic equilibrium model, and find that it captures a number of aggregate market phenomena. Another two related studies are Ferris Haugen and Makhija (1988) on investors' reluctance to realize losses and De Bondt and Makhija (1988) on managers' reluctance to terminate economically unviable projects. In his attempt to reconcile market efficiency and behavioral finance, Fama (1998) contends that overreaction of stock prices to information is about as common as underreaction. 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.

This study attempts to extend prior studies of subjective discount rates, such as those by Thaler (1981) and Benzion, Rapoport and Yagil (1989), by reexamining the discount rate behavior with respect to the three dimensions of scenario, time and sum, and investigating the effect of formal education and economics knowledge on both the level and variation of subjective discount rates.

3. THEORY AND HYPOTHESES

The standard relationship underlying discounting and compounding of time-varying cash flows is given by:

$$F = P\,(1+R)^{T} \qquad (1)$$

where F and P are respectively the future and present value of a certain cash flow, R is the discount or capitalization rate, and T is the time factor. Eq. (1) is used to infer the subjective discount rate inherent in intertemporal decisions involving monetary sums. The pure economic meaning of the discount rate is the marginal rate of substitution between current and future consumption. In that respect, the discount rate may depend on time preferences as well as other factors, affecting the utility function. However, given the availability of borrowing and lending in perfect capital markets, the marginal discount rate is equal to the interest rate in the market. This perception is the foundation for what may be called the "classical approach" asserting that in perfect and certain capital markets, the discount rate is identical for all individuals and for all (financial economic) situations or scenarios. Furthermore, it will also be invariable with respect to the monetary sum involved, and the time factor; that is it is time symmetric. A different view regarding the scenario effect is implied by the "market segmentation" approach, which implies that, due to capital market imperfections and the lack of perfect arbitrage, the rate of borrowing will be higher than the rate of lending. Similar to the classical approach, this approach also advocates that in each market segment, the discount rate will be invariant with respect to both time delay and sum of cash flow.

Behavioral studies by Kahneman and Tversley, Thaler, and Loewentstein establish that even when the intertemporal decision problem is formulated in terms of certainty conditions, as in our experiment, the subjects frame it as one involving some implicit degree of risk. The "implicit risk" approach assumes that, in making their intertemporal decisions, individuals believe that there is some probability that delayed receipts will not be paid and delayed payments will not be collected. Benzion and Yagil (1987) offer two hypotheses concerning the effect of risk: the "one-period-realization" (OPR), and the "multi-period -realization" (MPR). By the first hypothesis, the risk associated with a project or an outcome can be incorporated in the first period only, so that subsequent time periods merely reflect the pure time value of money given by the risk-free rate of interest. Formally stated, it is:

$$F = P\,(1+d)(1+\mathrm{i})^{T}, \qquad (2)$$

where *i* is the risk-free rate of interest and *d* is the risk premium. According to the alternative MPR hypothesis, risk is incorporated in the discount rate applicable to each future time period. Formally, it becomes:

$$F = P\,[(1+d)(1+\mathrm{i})]^{T} = P\,(1+d)^{T}(1+\mathrm{i})^{T} \qquad (3)$$

Equations (2) and (3) demonstrate the formal difference between the two competing hypotheses: the power of the gross risk premium $(1+d)$ is 1 and T by the OPR and MPR, respectively. To test these two alternative risk hypotheses empirically, the OPR Eq. (2) can equivalently be written as:

$$Ln\,(F/P) = Ln\,(1+d) + Ln\,(1+\mathrm{i})T, \qquad (4)$$

and the MPR Eq. (3) as:

$$Ln\,(F/P) = Ln\,[(1+d)(1+\mathrm{i})]\,\mathrm{T}. \qquad (5)$$

The resulting estimated regression equation for both the OPR and MPR hypotheses will then be:

$$Ln\ (F/P) = b_0 + b_1 T + e, \qquad (6)$$

where b_0 and b_1 are the ordinary least squares (OLS) coefficients, and e is the error term. By the OPR: $b_0 = Ln\ (1+d)$, and $b_1 = Ln\ (1+i)$, while by the MPR: $b_0 = 0$, and $b_1 = Ln\ [(1+d)(1+i)]$. It then follows that if b_0 is not statistically different than zero, and b_1 is statistically greater than the risk-free rate of interest, it would lend support to the MPR rather than the OPR risk hypothesis.

The "added compensation" approach asserts that, in addition to other factors affecting a temporal monetary decision, there is an added compensation or premium associated with changing one's position or making readjustments. Furthermore, the premium will be positive for a negative position change and negative for a positive position change, where a negative change involves receiving a cash flow in the future instead of in the present, while a positive position change involves paying a loan in the future instead of in the present. Stated differently, individuals will require a compensation for postponing a receipt, but on the other hand, will be willing to offer a premium for postponing a payment.

The formal representation of the added compensation component (Q) can take various mathematical forms, one of which is the following:

$$F = QP\ (1+R)^T \qquad (7)$$

For a negative position change such as a postponing-a-receipt scenario, Q should be greater than unity; while for a positive position change such as a postponing-a-payment scenario, Q should be less than unity (and positive).

Eq. (7) can be rewritten as:

$$Ln\ (F/P) = LnQ + Ln\ (1+R)T \qquad (8)$$

and its regression form is

$$Ln\ (F/P) = b_0 + b_1 T + e \qquad (9)$$

where $Q = e^{b_0}$, implying that b_0 should be positive (negative) for a negative (positive) position change.

These four hypotheses, discussed in more detail by Benzion, Rapoport and Yagil (1989), can be summarized as follows: the classical approach advocates that the discount rate is universally uniform across scenario, time, and sum, while the market segmentation approach asserts that it may differ across financial scenarios, but in each scenario it will be independent of time and sum. The implicit risk approach states that even certain (risk-free) intertemporal decision problems are framed by subjects as involving some degree of risk, causing the inferred discount rate to be higher than the risk-free rate of interest, where the implicit risk will be incorporated either by the OPR or MPR hypotheses. The added compensation approach further asserts that a position change will be associated with an additional compensation or premium. These four hypotheses are tested in the subsequent sections. In addition, we investigate whether the magnitude of the impact on the discount rate implied by each of these hypotheses is related to the levels of formal education and economics knowledge.

4. METHODOLOGY

The questionnaire (fully presented in the appendix) consists of two parts corresponding to two scenarios: postponing a receipt and postponing a payment. As noted in the previous section, these two scenarios are examined in order to test whether the discount rates inferred from the subjects' responses are different, reflecting different levels of risk premium or compensation for a position change. In the first part of the questionnaire (postponing-a-receipt scenario), subjects are asked to state the amount of dollars required to leave them indifferent about receiving this amount in the present or receiving a higher amount in the future. Three time periods are offered 0.5, 2, and 5 years, and three sums of $200, $600, and $5,000. This trade-off between present and future is made with respect to a bank savings account in which the level of risk is practically negligible.

The second part of the questionnaire involves a postponing-of-payment scenario. Subjects are asked to state the dollar amount they would be willing to pay in the future for a bank loan made to them in the present, which will make them indifferent about the difference between the dollar sum in the present, and the higher sum in the future. The same parameter values of time and sum are offered as in the first part of the questionnaire. Finally, the subjects are asked to state their highest academic degree (bachelor's degree, master's degree or higher), and specify the discipline or the field of study.

The questionnaire was distributed to 117 subjects from the Technion (Israel Institute for Technology) and Haifa University. The sample was drawn from the

following populations: undergraduate students in industrial engineering and economics; graduate students from different disciplines, and those who had earned a master's degree or higher in an academic discipline. All questionnaires were filled out in the same week. Out of the 117 subjects who participated in the experiment, 105 completed all questions in the questionnaire, resulting in the following three subsamples: 45 undergraduates, 30 graduates, and 30 having a master's degree or higher. The disciplines of the last two subsamples are social, exact and natural sciences. The proportion of Economics majors was 59% in the bachelor's-degree subsample compared with only 30% in the mater's-degree subsample.

Advantages and disadvantages of experimental studies noted in the literature apply to this study as well. Nonetheless, the questions were examined carefully, and the subjects were given sufficient response time, and were informed of the importance of the topic. Therefore, we believe that the subjects 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 (2000) found in their experimental study that, in contrast to the economic convention, subjects who were offered monetary incentives performed more poorly than those who were offered no compensation. The analysis of our experimental findings also implies that reliable responses appear to have been part of the subjects' utility functions.

5. RESULTS

As noted in the previous section, two decision-making scenarios are tested: (1) postponing a payment, and (2) postponing a receipt. These two scenarios are examined for varying times periods (0.5, 2, and 5 years), varying dollar sums ($200, $600, $5,000), and three subsamples (economics and industrial engineering undergraduates, and two groups of graduates: those who possess a bachelor's degree, and those who possess a master's degree or higher.

The dollar responses of each subject were compiled, and implicit discount rates were derived from the dollar responses. The mean across subjects of the implicit discount rates are presented in Table 1 for the three subsamples by the three dimensions investigated: scenario, time, and sum. A detailed analysis of the pattern of the discount rates with respect to these three dimensions appears in Tables 2, 3 and 4.

TABLES 1, 2, 3, AND 4 ABOUT HERE

Starting with the effect of time on derived discount rates, the major finding exhibited in Table 2 is that the inferred discount rates required decrease with time. The overall mean discount rate across subjects, scenario, and sum (indicated by the last line in Table 2) decreases from 14.73% to 10.90% and 8.99% for 0.5, 2, and 5 years, respectively. This time pattern of inferred discount rates is consistent with previous findings in the literature (e.g. Bezion, Rapoport and Yagil, 1989) and is different from the time pattern of market actual interest rates that generally increase with time. This difference is investigated later in this section. As demonstrated in Table 2, the decrease of discount rates with time holds across the two scenarios examined (postponing a

receipt and postponing a payment), across sum and for all three subsamples. Also, the effect of time on discount rates is found to be decreasing at a diminishing rate. As indicated by the overall mean rate in the last line of Table 2, lengthening the time delay from 0.5 to 2 years results in a reduction of about 4% in the discount rate, while the time change from 2 to 5 years only reduces the discount rate by about 2%. This "diminishing rate" property also holds across all scenarios, sums and subsamples tested (as seen in Table 2).

The effect of the dollar sum involved on the inferred discount rates is demonstrated in both Tables 2 and 3. Focusing first on the overall mean discount rate across time, scenario and subsample, the last line in Table 3 indicates that the effect of sum on discount rates is negative. The discount rates found are 13.95%, 10.75% and 9.92% for dollar sums of $200, $600 and $5,000, respectively. Similar to the effect of time on discount rates, the effect of sum too was found to decrease at a diminishing rate. As seen in the last line of Table 3, an increase in sum from $200 to $600 results in a reduction of about 3% in the discount rate, whereas an increase from $600 to $5,000 only results in a reduction of about 1%. Both the negative impact of sum on discount rate as well as its "diminishing-rate" property holds across all scenarios, time and subsamples tested (as seen in Tables 2 and 3).

Table 4 focuses on the scenario impact on discount rates. Scenario A represents postponing a receipt while scenario B represents postponing a payment. As indicated by the last column in Table 4, the overall mean discount rate is higher for Scenario A (13.03%) than for Scenario B (10.05%). As demonstrated by the other findings in Table 4, this scenario effect holds true across both time and sum, and for each of the three

subsamples. As investigated shortly, risk factor and added compensation component may explain this scenario effect on discount rates.

One of the more important issues examined in this study is whether formal education level and formal economics knowledge affect subjective discount rates derived from temporal decisions made by individuals. Accordingly, as discussed in the previous section, three subsamples were drawn: 1) undergraduates, 2), graduates having a master's degree or higher mostly in disciplines other than economics, and 3) graduates having a bachelor's degree mostly in economics.

The derived discount rates for the three subsamples appear in Tables 1-4. As noted earlier, there is no difference between the three subsamples in terms of the three dimensions investigated: scenario, time and sum; that is, for all three subsamples, discount rates decrease with the time delay and the sum of the cash flow. Also, the discount rates are lower for lending (Scenario B) than for borrowing (Scenario A). Furthermore, for all three subsamples, the effects of time and sum decrease at a diminishing rate. However, the three subsamples do differ with respect to the level of the discount rate. As demonstrated by Tables 1-4, and especially Figures 1 and 2, the level of the discount rates were found to be higher for the undergraduate Subsample 1 than for the graduate Subsamples 2 and 3. The overall mean discount rates across scenario, sum, and time (as indicated by the last column of Table 2) are 16.64%, 10.18%, and 7.80% for Subsamples 1, 2 and 3, respectively. The graduates discount rates, compared with the undergraduates' rates, appear closer to actual interest rates which prevailed in the Israeli capital market at the time the experiment was conducted. This result implies that graduates are more familiar with market rates due probably to higher age, rates of

employment and marital status. As a result, they invest more time in acquiring market financial data. The fact that Subsample 3 had even lower discount rates than Subsample 2 appears to indicate that the higher economics knowledge of Subsample 3 more than offset the higher formal education (mostly in other disciplines than economics) of Subsample 2. In other words, the Economics graduates of Subsample 3 are more familiar with market rates and, therefore, their discount rates are closer to actual rates than Subsample 2. Indeed, the actual market interest rates on dollar savings and loans were found to be similar to Subsample 3's discount rates, particularly for the larger sum of $5,000 and the longer delay time of 5 years.

FIGURES 1 AND 2 ABOUT HERE

Another interesting result indicated by Table 1 is the variation in the coefficient of variation (COV) defined as the ratio of the standard deviation over the mean of the subjective discount rate. The findings in Table 1 demonstrate that not only the level of the mean discount rate but also its coefficient of variation both decrease with the dimensions of time and sum, and are lower for Scenario B than for Scenario A. It is also found to be lower for graduates (Subsamples 2 and 3) than for undergraduates (Subsample 1). These results imply that: (1) the variability across subjects with respect to their required discount rate decreases with both time and sum, and (2) the graduate sample is more homogenous than the undergraduate sample in terms of their intertemporal decisions.

Regression Analysis

The preceding analysis demonstrates the impact on derived discount rates of the three dimensions investigated: scenario, time and sum. Regression analysis reported below tests the hypotheses directly.

The market segmentation approach goes beyond the classical approach by allowing the discount rate to vary across scenarios but implying no time or sum effects. In a regression form:

$$R = b_0 C + b_1 T + b_2 S_A + b_3 S_B + e \qquad (10)$$

where R = discount rate, C = cashflow sum, T = time, S_A = Scenario A, S_B = Scenario B, b's are the OLS coefficients, and e is the error term. By the segmentation hypothesis: $b_0 = b_1 = 0$, and $b_2 > b_3 > 0$. The regression test results of Eq. (10) are presented in Table 5. The findings reestablish the negative impact of both time and sum, and the positive impact of scenario. The level of relationship is relatively low, as indicated by R-squared, but statistically significant at 1%. Also, the impact of Scenario A (postponing a receipt) is higher than that of Scenario B (postponing a payment). These findings confirm the existence of a scenario (segmentation) effect, but do not fully support the segmentation hypothesis, which asserts no further impact on discount rates such as that of time and sum.

TABLES 5 ABOUT HERE

As stated in the previous section, although the experiment is formulated in terms of certainty conditions, the subjects apparently frame it as involving some degree of risk.

This may explain the relatively high discount rates found particularly for small sums, short time periods and a postponing-a-receipt scenario. The question is whether the subjects in our experiment incorporate risk in line with the one-period-realization (OPR) risk hypothesis, or the multi-period-realization (MPR) risk hypothesis.

The regression form of both Eq. (4) for the OPR hypothesis, and Eq. (5) for the MPR hypothesis is:

$$\ln(F/P) = b_0 + b_1 T + e \qquad (11)$$

where, as stated earlier, H_0 by the OPR is:

$$b_0 = \ln(1+d), \; b_1 = \ln(1+i)$$

while H_0 by the MPR is:

$$b_0 = 0, \text{ and } b_1 = \ln(1+d)(1+i)$$

Eq. (11) was estimated seven times for both Scenario A and Scenario B, and for each of the three subsamples as well as for the total sample. The statistical results are summarized in Table 6 and they indicate first that the intercept (b_0) is not statistically different from zero in all seven regressions. Both its relatively low level and absence of significance level give support to the MPR than the OPR in which, as stated before, the risk premium (d) is incorporated in the first period only, while by the MPR, it is incorporated in every single time period. The slope (b_1) by the OPR represents the risk-free rate of interest (i) where $i = e^{b_1} + 1$, while, by the MPR, the slope represents the discount rate (R) that consists of both the risk premium (d) and the risk-free rate (i); i.e., $R = e^{b_1} + 1$. The findings in Table 6 indicate that b_1 is positive and highly statistically significant. The mean value of the discount rate implied by the OLS b_1 coefficient,

which is the risk-free rate (i) by the OPR and the risky rate (R) by the MPR, is 8.43% across the six regressions in Table 6, ranging between 11.6% to 6.18%. This mean value is also close to the 8.33% value implied by b_1 for the total sample regression ($e^{b_1} + 1 = e^{0.08} + 1 = 8.33\%$). This mean value is slightly higher than the interest rate on dollar denominated bank savings in Israel at the time of the experiment. This mean value of 8.33%, however, is quite close to the mean discount rate implied by the subjects' responses, particularly for high values of time and sum. As indicated by the last column of Table 1 for the total sample, the mean (across subjects) discount rate for Scenario B is 9.06%, 7.83% and 7.66% for sums of \$200, \$600 and \$5,000, respectively. For Scenario A (postponing a receipt), the corresponding discount rate values are 11.78%, 8.95% and 8.70%. Recalling the null hypothesis concerning b_1 by the OPR and the MPR, these findings in conjunction with values of both b_0 and b_1 (see Table 6) appear to lend more support to the MPR rather than the OPR hypothesis.

TABLES 6 ABOUT HERE

To test the added compensation hypothesis (ACH), let us rewrite the formal relationship representing this hypothesis:

$$\ln(F/P) = \ln Q + \ln(1+R)T = b_0 + b_1 T, \qquad (12)$$

where H_0 by the ACH as discussed earlier, is:

$$b_0 = \ln Q, \text{ and } b_1 = \ln(1+R),$$

Equivalently, $Q = e^{b_0}$, and $R = e^{b_1} + 1$. The regression results of Eq. (12) appear in Table 6, and they demonstrate that the added compensation component (Q) is positive but not statistically significant. The mean value across the first six regressions in Table 6 of the

added compensation component (Q) implied by the b_0 values is 2.96% (where $Q = e^{b_0}$), ranging between 0.16% and 6.18%. The Q value for the total sample (Line 7 in Table 6) is 3.34%. Both the level of Q and its low significance level imply a weak existence of an added compensation component. This result is also consistent with the reasonable level of derived discount rates found for our sample, particularly for high values of time and sum.

6. SUMMARY AND CONCLUSION

This paper reexamined the behavior of subjective discount rates across three dimensions: financial scenario, time delay and the monetary sum of the cash flow, and investigated the extent to which the behavior of subjective discount rates is affected by the formal education level of the decision makers and their knowledge of financial economics.

The behavior of the subjective discount rates is examined in the context of four hypotheses: the classical approach advocating universal uniformity of the discount rate; the market segmentation approach allowing for scenario effect, but no time or sum effects; the implicit risk approach stating that, due to mental framing, a risk premium is inherent in the subjective discount rate, and the added compensation approach asserting that position change will be associated with an additional compensation.

Three subsamples of 105 subjects were drawn from undergraduates, graduates, and those having a higher academic degree – all affiliated with the Technion and Haifa

University. The proportion of economics majors was 59% and 30% in the second and third subsamples, respectively.

The pattern of the inferred subjective discount rates found in this experiment is similar to what has been established previously in the experimental literature; that is, the discount rates are decreasing with the time delay and the sum of the cash flow, and are higher for a postpone-a-receipt scenario than for a postpone-a-payment scenario. The depressing effect of time is probably due, as noted by Benzion, Granot and Yagil (1992), to the subjects' misevaluation of the exponential function. The negative impact of sum appears related to both Loewenstein and Prelec's (1992) psychological perception concept, which asserts that individuals are sensitive not only to relative but also to absolute differences between monetary sums, and to Thaler's (1987) mental accounting concept. The scenario effect can be due to Kahneman and Tversky's (1992) "loss aversion" concept, which implies that investors attach higher weights to losses than to gains.

The subjective discount rates, particularly for low values of time and sum, were found to be much higher than the risk-free rate of interest, implying the existence of an implicit risk premium, which is also consistent with the loss aversion concept. Furthermore, regression results lend more support to the multiple-period-realization (MPR) than to the one-period-realization (OPR) hypothesis, particularly for a postponing-a-payment scenario in conjunction with relatively high values of time and sum. For very low values of time and sum, however, the findings concerning the MPR and OPR are mixed. The findings also lend weak support for the added compensation hypothesis.

The comparison of the three subsamples demonstrates that formal education and economics knowledge do not appear to have an impact on the pattern of subjective discount rates with respect to scenario, time and sum. In contrast to this dimensional similarity, the level of the discount rates was found to be lower for graduates than for undergraduates, and this lower rate appears closer to actual capital market interest rates. This finding implies that graduates are more familiar with market rates probably due to their age, rates of employment and marital status. As a result, they tend to invest more time in acquiring market financial data. The experimental findings also indicate that higher formal economics knowledge is associated with lower discount rates that are closer to capital market interest rates. This finding may also be related to the "familiarity" factor examined recently by Huberman (2001).

The overall results concerning the impact of scenario, time and sum, which are not perfectly consistent with established economic theories, may indicate possible links between emotions and economics [Elster (1998) and Loewenstein (2000)], and psychology and economics (Rabin, 1998).

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APPENDIX

A Questionnaire on Problems in Financial Economics Decisions

The purpose of the present experiment is to obtain some estimate of your preferences for paying or receiving an amount of money in the future instead of paying or receiving another amount in the present. 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 which can arise in different areas of one's economic behavior. This questionnaire is anonymous and for research purposes only. We ask you to use your best judgment, and to answer *all* questions sincerely and as best you can.

1. Upon approaching the maturity date of your bank savings plan, the bank manger offers you the opportunity to reinvest the proceeds in a similar savings plan with a different maturity time. What is the amount of dollars the bank would have to offer you at the maturity date of the new savings plan, so that you will be completely indifferent about receiving the relevant sum today or receiving a larger sum in the future? Please state this future amount of dollars for each of the nine savings plans given in the table below (comprising of 3 different sums and 3 different times to maturity).

	Dollar Amount You Require at the End of the Period		
Dollar Amount Today	0.5 a Year Hence	2 Years Hence	5 Years Hence
$200	$	$	$
$600	$	$	$
$5,000	$	$	$

2. You need some amount of dollars today that your bank is willing to lend you. What is the amount of dollars you would be willing to pay back at the end of the period, so that you will be completely indifferent about receiving a certain amount today or paying back a larger amount in the future? Please state this future amount of dollars for each of the nine time and sum options given in the table below.

	Dollar Amount You Are Willing to Pay at the End of the Period		
Dollar Amount Today	0.5 a Year Hence	2 Years Hence	5 Years Hence
$200	$	$	$
$600	$	$	$
$5,000	$	$	$

3. Finally, please circle your highest academic degree earned:

a) Bachelor's degree b) Master's degree or higher

Discipline or field of study: _____

Thank you for your cooperation.

Table 1

Mean Discount Rates by Scenario, Time, and Sum (%)*

Subsample	Sum	Scenario A - Time			Scenario B - Time		
		0.5	**2**	**5**	**0.5**	**2**	**5**
1	200	35.64 (1.33)	20.88 (0.91)	15.54 (0.64)	22.62 (1.14)	15.23 (0.68)	11.67 (0.60)
	600	23.72 (1.13)	15.55 (0.83)	12.86 (0.70)	17.90 (1.09)	12.22 (0.56)	9.78 (0.63)
	5000	19.22 (0.68)	13.78 (0.68)	10.67 (0.55)	19.06 (0.93)	12.97 (0.67)	10.15 (0.63)
2	200	10.98 (0.97)	12.57 (0.59)	10.79 (0.59)	11.47 (0.69)	12.87 (0.50)	9.00 (0.58)
	600	13.24 (0.72)	9.95 (0.55)	6.38 (0.75)	9.75 (0.60)	9.50 (0.65)	7.68 (0.64)
	5000	10.41 (0.65)	9.11 (0.53)	8.48 (0.59)	8.25 (0.74)	7.75 (0.78)	7.02 (0.79)
3	200	15.03 (0.99)	9.58 (0.73)	9.01 (0.63)	6.94 (0.73)	6.69 (0.55)	6.52 (0.48)
	600	11.13 (0.75)	8.17 (0.69)	7.60 (0.64)	5.93 (0.75)	6.14 (0.59)	6.02 (0.57)
	5000	9.04 (0.57)	7.50 (0.70)	6.94 (0.60)	6.65 (0.90)	5.66 (0.55)	5.80 (0.52)
Total	200	23.22 (1.10)	14.34 (0.74)	11.78 (0.62)	13.68 (0.85)	11.60 (0.58)	9.06 (0.55)
	600	16.03 (0.87)	11.22 (0.69)	8.95 (0.70)	11.19 (0.81)	9.29 (0.60)	7.83 (0.61)
	5000	12.91 (0.63)	10.13 (0.64)	8.70 (0.58)	11.32 (0.86)	8.79 (0.67)	7.66 (0.65)

*Number in parenthesis is the coefficient of variation (cov) defined as the standard deviation over the mean. Scenario A represents postponing a receipt, while Scenario B represents postponing a payment.

Table 2

Mean Discount Rates Across Scenario by Sum and Time (%)

Subsample	Sum	Time			
		0.5	**2**	**5**	**Mean**
1	200	29.13	18.06	13.61	20.27
	600	20.81	13.86	11.32	15.33
	5,000	19.14	13.38	10.41	14.31
	Mean	23.03	15.11	11.78	16.64
2	200	15.22	12.72	9.89	12.61
	600	11.50	9.73	7.03	9.42
	5,000	9.33	8.43	7.75	8.50
	Mean	12.02	10.29	8.22	10.18
3	200	10.98	8.13	7.76	8.96
	600	8.53	7.16	6.81	7.50
	5,000	7.87	6.58	6.37	6.94
	Mean	9.13	7.29	6.98	7.80
TOTAL	200	18.44	12.97	10.42	13.95
	600	13.61	10.25	8.39	10.75
	5,000	12.11	9.46	8.18	9.92
	Mean	14.73	10.90	8.99	11.54

Table 3

Mean Discount Rates Across Time by Sum and Scenario (%)*

Subsample	Scenario	Sum			
		200	**600**	**5,000**	**Mean**
1	A	24.02	17.38	14.56	18.65
	B	16.51	13.30	14.06	14.62
	Mean	20.27	15.33	14.31	16.64
2	A	14.10	9.86	9.33	11.10
	B	11.11	8.98	7.67	9.25
	Mean	12.61	9.42	8.50	10.18
3	A	11.21	8.97	7.84	9.34
	B	6.72	6.03	6.04	6.26
	Mean	8.96	7.50	6.94	7.80
TOTAL	A	16.44	12.07	10.58	13.03
	B	11.45	9.44	9.26	10.05
	Mean	13.95	10.75	9.92	11.54

*Scenario A represents postponing a receipt, while Scenario B represents postponing a payment.

Table 4

Mean Discount Rates Across Sum by Time and Scenario (%)*

Subsample	Scenario	Time			
		0.5	**2**	**5**	**Mean**
1	A	26.19	16.74	13.03	18.65
	B	19.86	13.47	10.54	14.62
	Mean	23.03	15.11	11.78	16.64
2	A	14.21	10.54	8.85	11.10
	B	9.82	10.04	7.90	9.25
	Mean	12.02	10.29	8.22	10.18
3	A	11.75	8.42	7.85	9.34
	B	6.51	6.16	6.11	6.26
	Mean	9.13	7.29	6.98	7.80
TOTAL	A	17.38	11.90	9.81	13.03
	B	12.06	9.89	8.18	10.05
	Mean	14.73	10.90	8.99	11.54

*Scenario A represents postponing a receipt, while Scenario B represents postponing a payment.

Table 5

Regression Test Result of the Segmentation Hypothesis*

Subsample	b_0 (*t*)	b_1 (*t*)	b_2 (*t*)	b_3 (*t*)	R^2 (*n*)	F (+)
1	-0.00001 (-2.72)	-2.31 (-6.52)	26.03 (18.84)	21.99 (15.51)	0.070 (810)	14.2 (0.01)
2	-0.0006 (-3.71)	-0.726 (-3.95)	14.30 (19.59)	11.98 (16.17)	0.075 (540)	10.2 (0.01)
3	-0.0003 (-2.46)	-0.423 (-2.98)	10.98 (19.31)	7.09 (13.90)	0.083 (540)	12.1 (0.01)
TOTAL	-0.0006 (-4.11)	-1.302 (-7.59)	18.26 (26.70)	15.06 (21.77)	0.053 (1890)	25.1 (10.01)

*The regression equation is given by Eq. (10): $R = b_0C + b_1T + b_2S_A + b_3S_B + e$; where R = discount rate; C = cash flow sum; T = time; S_A = Scenario A; S_B = Scenario B; b's are the OLS coefficients; e is the error term; R^2 = R-squared; F = F statistic; values in parentheses are t-statistic, number of observations (n), and the regression significance level (+). n is given by the product of the 2 scenarios, 3 time periods, 3 sums, and the subsample size, which is 45, 30 and 30 for Subsamples 1, 2, and 3, respectively.

Table 6

Regression Test Result of the OPR vs. the MPR Hypotheses*

Subsample	Scenario	b_0	$t(b_o)$	b_1	$t(b_1)$	R^2	n	F
1	A	0.06	0.26	0.11	16.10	0.40	405	127
	B	0.05	0.26	0.09	16.80	0.43	405	142
2	A	0.03	0.16	0.08	15.60	0.48	270	121
	B	0.02	0.12	0.07	13.40	0.43	270	90
3	A	0.02	0.11	0.07	14.70	0.45	270	108
	B	0.02	0.02	0.06	18.70	0.56	270	168
TOTAL		0.03	0.17	0.08	34.10	0.39	1890	579

*The regression equation is given by: $\ln(F/P) = b_0 + b_1 T + e$; where F = future value; P = present value; T= time; b_0 , b_1 = *OLS coefficients;* e = error term. By the OPR: $b_0 = \ln(1+d)$; $b_1 = \ln(1+i)$; while by the MPR: $b_0 = 0$; $b_1 = \ln(1+d+i)$; where d = risk premium; and i= risk-free rate of interest. Also, *t(b)* = t-statistic; R^2 = R-squared, F = F statistic; and n = number of observations given by the product of 3 time periods, 3 sums, and the subsample size; Scenario A represents postponing a receipt, while Scenario B represents postponing a payment.

Figure 1

Mean Discount Rates Across Scenario and Sum by Time for Three Subsamples

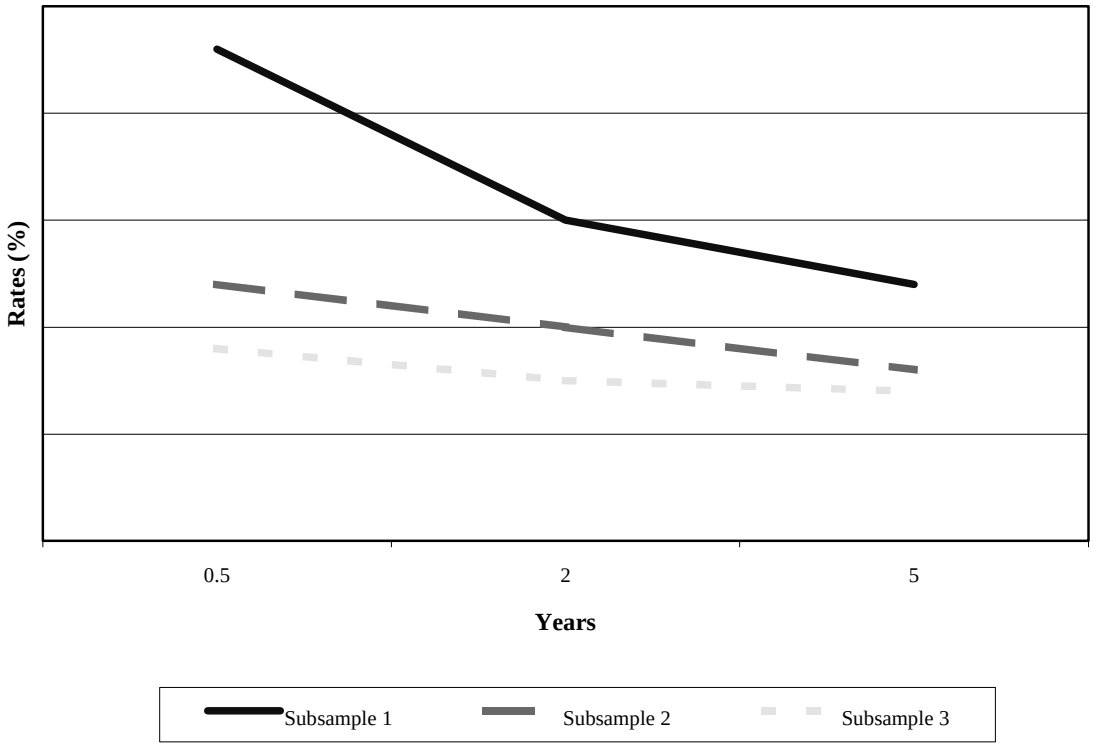

Figure 2

Mean Discount Rates Across Scenario and Time by Sum for Three Subsamples