THE ENDOWMENT EFFECT AND INTERTEMPORAL CHOICE:
A LABORATORY INVESTIGATION

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Abstract
We present a laboratory study of intertemporal choice (i.e., elicited discount rates) allowing for the influence of the endowment effect. Consistent with the previous literature, we hypothesize that the endowment effect in an intertemporal choice setting results in substantially higher discount rates relative to when individuals treat the resources in question as found money. Our results support this hypothesis and provide a new protocol for conducting choice experiments wherein the endowment effect is an important determinant of behaviour.

Keywords: intertemporal choice, endowment effect, discount rates, experiments

JEL Codes: C91, D91

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1. Introduction

In this paper, we report the results of a laboratory experiment with salient incentives to explore the potential role of the endowment effect in riskless intertemporal decision making. Thaler (1980) termed the endowment effect as resulting when individuals have a sense of ownership legitimacy or endowment to an asset or object. Many experiments testing the endowment effect have been conducted using lotteries and simple objects (e.g., Kahneman, Knetsch and Thaler, 1990; Loewenstein and Issacharoff, 1994; Plott and Zeiler, 2005; Knetsch and Wong, 2009). Often, experimenters ask individuals to earn resources (e.g., Cherry et al, 2002; Loewenstein and Issacharoff, 1994; Oxoby and Spraggon, 2008), with the goal of creating a sense of asset legitimacy or endowment among participants. The endowment effect in these settings has been shown to reduce other-regarding behaviour (i.e., less generosity in simple dictator and ultimatum games) and affect the valuation of objects. However, the present study is, to our knowledge, the first to explore the endowment effect in an intertemporal choice environment. This area of study is important particularly as it relates to savings decisions where a large body of research has identified the lack of appropriate savings behaviour among individuals (e.g., Lusardi, 1999).

The endowment effect is closely related to the concept of reference-dependent preferences and is often associated with loss aversion in individual choice environments. Loss aversion (Tversky and Kahneman, 1991; Kahneman, Knetsch and Thaler, 1991) posits that individuals attach greater weight to losses than commensurate gains relative to a reference state and as a consequence;

“the loss of utility associated with giving up a valued good [which is part of the current reference state] is greater than the utility gain associated with receiving it [when it is not part of the current reference state].”

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The endowment effect can thus be thought of as a consequence of loss-aversion within the realm of reference-dependent preferences.

More germane to our intertemporal choice environment, behavioural explanations for a lack of willingness to accumulate savings include non-exponential discounting models (Loewenstein et al, 1999 and O’Donoghue and Rabin, 2001) which emphasize the potential for overconfidence or over-optimistic expectations regarding one’s ability to save in the future. However, the concept of the endowment effect also points to a disincentive to save: if an individual’s current income is defined as the relevant reference state, then saving out of current income implies a loss relative to that state which is then weighed against a gain received in the future. Any asymmetry between a perceived loss of this nature relative to future gains lowers the incentive to save. Loewenstein and Prelec (1992) suggest that an asymmetry exists in intertemporal decision making with respect to gains and losses, mimicking that in prospect theory (Kahneman and Tversky, 1979). In this explanation, intertemporal utility is concave gains and convex in losses.²

Our objective is to conduct an intertemporal choice experiment allowing for reference-dependence in a risk-free setting. To do this, one must provide a choice environment in which participants trade off less (actual) money today in return for greater amounts of (actual) money in the future. However this poses a problem for laboratory experiments in which, typically, participants are making choices with money provided by the experimenter. Money endowments in the laboratory may be coded by participants as windfall gains, thereby giving participants little attachment to their current reference income. Consequently, when faced with intertemporal choice in the laboratory, participants may not feel any loss relative to their current reference income and thus the possibility of an endowment effect will be muted or foreclosed.

More formally, consider the function \( V(\cdot) \) representing an individual’s preferences over deviations from their reference level of income. Now suppose that $x is provided by an experimenter. The individual must choose either to keep the amount or

² Abdellaoui et al (2010) provide some experimental support for this result. However, the study by Abdellaoui et al collected responses to hypothetical questions from participants who were paid a small fixed amount of money. Thus participants faced no real loss of income in the choices they made.
forego it in order to receive $y = x(1+r) > x$ with certainty in the future. If the individual regards the endowment of $x$ as a windfall (not part of their current reference income), then both options are in the domain of gains and the individual compares $V(x)$ with $\beta V(y)$ where $\beta < 1$ represents the individual’s preference for immediate consumption. We can then define a value for $r$ ($r = r_1$) such that $V(x) = \beta V(y)$. Note that for an individual to be indifferent between the amounts $x$ and $y$, the return $r_1$ must be such that it directly offsets the individual’s preference for immediate consumption ($\beta$). In contrast, consider an individual who displays the endowment effect and regards the money provided by the experimenter as part of their reference income. Such an individual perceives accepting $y$ in the future as requiring a loss of $x$ from current income. Defining the preference relation in the domain of losses, let $V(-x)$ be represented as $-kV(x)$ where the negative sign turns the concave function $V(.)$ into a convex function in the domain of losses and $k > 1$ indicates that the slope of the function is steeper in the domain of losses relative to the domain of gains (cf. Bowman et al, 1999). The individual thus compares $-k(V(x))$ with $\beta V(y)$. Once again, we can then define a value for $r$ ($r = r_2$) such that $-k(V(x)) = \beta V(y)$. Indifference here requires that the value $r_2$ not only offsets the preference for immediate consumption ($\beta$) but also compensates for the increased slope of utility in the domain of losses ($k$). Given the parameter $k$, we should observe $r_2 > r_1$. That is, the value of $y$ required to persuade an individual to choose $y$ later over $x$ now will be higher for those individuals who regard $x$ as part of their current reference income.

To test for an endowment effect in intertemporal choice we develop an experimental design wherein individuals earn money which they retain for a week prior to participating in an incentive compatible intertemporal choice experiment. As a control, we compare this with an alternative (more standard) design wherein participants make intertemporal choices immediately with money (i) provided by the experimenter or (ii) earned in the laboratory. We hypothesize that when participants make decisions with monies received from the experimenter, the possibility of reference-dependency affecting behaviour is muted or foreclosed as participants will regard
dollars received in the lab as a windfall gain separate from their own current stock of money. On the other hand, when individuals have had possession of the money for a period of time, they are more likely to perceive the act of saving these funds as involving a loss relative to current income and therefore will require a higher rate of return to motivate savings. Our results support this hypothesis: participants who earn and retain money prior to a discount elicitation task display discount rates almost twice high as those in our other treatments. This evidence supports the thesis that reference dependence has a significant effect on elicited discount rates.

2. Experiment

We elicited discount rates from participants using a method common in many studies of intertemporal decision making (Coller and Williams, 1999; Harrison et al., 2002; McLeish and Oxoby, 2007 for example): Participants completed Table 1 indicating whether they preferred option A (a constant amount of money to be received after the laboratory session) or option B (a larger amount of money to be received two weeks after the session) across eleven different alternatives. The same table was used in each of the treatments described below, save for the dates of the individual sessions.

Table 1 presents options to receive money later that increase by 2.5%, representing two-week discount rates ranging from 0% to 27.5%. The point in the table where an individual ceases choosing option A and begins choosing option B (their ‘cross-over’ point) proxies the individual’s two-week discount rate. From this we calculate the variable A-rate, representing the first instance in which a participant chooses option B, thereby proxying the upper-bound on their two week discount rate. Individuals were paid for their participation based on their answers provided in Table 1. At the end of the experiment, one of the twelve questions was randomly selected and the individual was paid according to their response to this question.

For example, suppose after an individual completed Table 1, question 6 was randomly chosen to determine her payment for participation. If her response to this.
question indicated that she preferred $40 to be paid immediately, she received a check dated the day of the experiment for $40. If her response to this question indicated she preferred $45 in two weeks, she received a check on the day of the session for $45 but post-dated for two weeks from the date of that session. This procedure was followed across all the treatments described below. In addition to this payment for participation, individuals were also paid a $5 cash show-up fee for attending the session.3

In our design we chose significantly large discount rates (i.e., larger than those paid by financial institutions) to compensate individuals for any transaction costs (real or imagined) regarding the money. While we used larger interest rates, recall that our primary interest is in the effect of our treatments on the elicited discount rates not the value of the interest rates per se.4 Our experiments also specifically avoided the use of a front-end delay: all options in Table 1 involve money being available immediately rather

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3 The show-up fee was used as an inducement to encourage individuals to attend the experiment. We chose to pay all individuals by check regardless of the implemented option to maintain consistency between those receiving a check dated currently and those receiving a post-dated check. In reviewing the checks used in the experiment, we found that no post-dated checks were cashed before the date indicated on the check.

4 Previous studies (e.g., Coller and Williams, 1999; Harrison et al., 2002) utilized interest rates which more closely mirrored those paid by banks. However, these studies also used much longer time horizons (e.g., choices between amounts to be received in three or six months).
than use payment dates both falling in the future (cf. Coller and Williams, 1999, and McLeish and Oxoby, 2007). We wished to evoke an environment wherein any potential savings behaviour resulted in reductions to consumption in the current period. A front-end delay would mute the effects of savings on current consumption (via pushing all returns into future periods) thereby nullifying the effect of any sense of endowment or entitlement to assets on the part of participants.

Finally, note that we only consider discount rates as a measure of intertemporal preferences. Harrison and Rutström (2008) and Andersen et al (2008) find that discount rates are significantly lower in field experiments when elicited in conjunction with elicitations aimed at identifying risk preferences. Thus, there is reason to jointly elicit time and risk preferences. However, as argued by Keren and Roelofsma (1995), in laboratory experiments where the uncertainty is not made explicit, participants are more inclined to make decisions based on criteria other than risk: Keren and Roelofsma find that only when risk (i.e., the probabilistic aspects of an outcome) are made explicit do individuals focus on the risk aspects of future outcomes; when these probabilities are not made explicit individuals make decisions by focusing on the intertemporal or sequential aspects of the outcomes. As we are primarily concerned with the role of the endowment effect in intertemporal decision making, we have attempted to make the decision environment risk-free. We leave the interrelation between risk and intertemporal preferences in loss situations as future research.

**Treatments**

We conducted three treatments in the experiment. In our *Baseline* treatment individuals were simply asked to complete Table 1 knowing that their payment would be based on their answer to a randomly selected payoff alternative. As such, participants were allocated $40 over which they made intertemporal choices. At the end of the session, participants received a $5 cash show-up fee and a check payable the day of the session for $40 or a post-dated check (dated two weeks from the date of the session) for a larger amount.
In our *Earnings* treatment, participants were given a twenty-question quiz consisting of questions from the Graduate Record Exam (GRE). Participants were told that they could earn either $40 or $20 based on their exam performance: If they answered at least ten questions correctly they would earn $40; if their score on the exam was less than ten questions correctly answered they would receive $20.\(^5\) This earned money was subsequently used when individuals completed Table 1. The central motivation in this treatment was to see if earning the money receivable after the session would create a sense of entitlement or legitimacy of these assets as has been identified in experiments on social preferences (Cherry et al., 2002; Loewenstein and Issacharoff, 1994; Oxoby and Spraggon, 2008) and to see if this sense of entitlement or asset legitimacy affected elicited discount rates. Our hypothesis was that individuals would feel they had earned the $40 being used as the default option in Table 1. As in the baseline treatment, individuals received a $5 cash show-up fee and a check for the amount they chose a randomly selected alternative they had completed in Table 1.

In our *Returning* treatment, individuals attended an initial session and earned money in exactly the same fashion as the *Earnings* treatment but were paid these amounts in cash at the end of the session. Participants were told they had an opportunity to return to acquire additional funds in a session the following week but that they needed to bring the amount they had earned in the current session to the subsequent session.\(^6\) In the subsequent session, participants were asked to put an amount of cash equal to the money they had previously earned ($40) into envelopes that were collected by the experimenter. Then, following their completion of Table 1, participants received a $5 show-up fee and either their envelope containing $40 in cash (option A) or a post-dated check for a larger amount (option B), based on their answer to a randomly selected alternative from Table 1. Our hypothesis in this session was that both the earning

\(^5\)This threshold was chosen based on previous experiments in order to ensure that most participants would earn $40 while still requiring that they exert significant effort. All participants did sufficiently well on the selected questions to reach the $40 threshold.

\(^6\) Strahilevitz and Loewenstein (1998) find that the longer an individual has ownership over an item, the less willing they are to part with that item (i.e., the higher their valuation of the item). This is akin to the effect of earnings behaviour identified by Cherry et al (2002) and Loewenstein and Issacharoff (1994).
behaviour (i.e., the twenty question exam) and the fact that individuals had the money in their possession for a week would create a stronger sense of entitlement which would affect their intertemporal decision making. In this treatment, individuals only received a $5 show-up fee for participation in the final session.

In addition to the data we collected regarding participants’ intertemporal preferences using Table 1, we also asked participants to complete a short questionnaire at the end of each session. In addition to questions regarding demographic information, the questionnaire also included two questions regarding individuals attitudes towards the money used in the experiment:

1. Outcome variable: asset legitimacy 1, AS1:
   I am entitled to the money I received for participating in the experiment. (Answered using a 1 to 7 scale representing ‘strongly disagree’ to ‘strongly agree’.)

2. Outcome variable: asset legitimacy 2, AS2:
   I earned the money I am receiving for participating in the experiment. (Answered using a 1 to 7 scale representing ‘strongly disagree’ to ‘strongly agree’.)

Participants in the returning treatment were also asked the following yes/no questions:

1. Is the cash you brought to today’s experiment the same bills you were given in the previous session?
2. If not, did you spend the cash you were given in the previous session?

Hypotheses

We hypothesise that if individuals feel a sense of endowment or asset legitimacy with respect to the resources in their possession; they will be resistant to putting off current consumption and should require greater compensation for deferring consumption. This greater compensation would manifest itself in Table 1 via individuals choosing higher crossing points (i.e. choosing option A over higher payoff alternatives effectively requiring a higher interest rate to put off current consumption).
Suppose that participants in our experiment have reference-dependent preferences \( V(\cdot) \) over deviations from reference income. If a participant in our Baseline treatment regards the $40 given to her as windfall income (i.e. not part of her reference income), then the elicitation of her discount rate \( (r_1) \) defines

\[
V(40) + \beta V(0) = V(0) + \beta V(R_1, 40)
\]

where \( \beta < 1 \) is the individual’s preference for immediate consumption, \( R_1 = 1 + r_1 \) and \( r_1 \) is the elicited discount rate. Now consider a participant in either our Earnings or Returning treatments. To the extent that earning and/or retaining money cause a participant to regard the funds as part of her reference income, her elicited discount rate \( (r_2) \) will define

\[
V(0) + \beta V(0) = V(-40) + \beta V(R_2, 40); \ R_2 = 1 + r_2
\]

Equations (1) and (2) simplify to (3) and (4):

\[
V(40) = \beta V(R_1, 40)
\]

\[
-V(-40) = \beta V(R_2, 40)
\]

Therefore, as stated earlier, if \( V(\cdot) \) is convex in the domain of losses and is steeper in the domain of losses than in the domain of gains, then \( r_2 \) will exceed \( r_1 \).

**Hypothesis 1**: Participants will experience a greater endowment effect in the Earnings and Returning treatments relative to the Baseline treatment. This should be manifest in higher values of the A-rate (i.e., higher cross-over points) for participants in the Earnings and Returning treatments relative to the Baseline treatment.

We further hypothesize that increasing the sense of asset legitimacy regarding money used in the experiment should increase an individual’s sense of entitlement and therefore increase the magnitude of the endowment effect with respect to deferring current consumption.
Hypothesis 2: Participants’ responses AS1 and AS2 will be higher in (i) the Earnings treatment relative to the Baseline treatment, (ii) the Returning treatment relative to the Baseline treatment, and (iii) the Returning treatment relative to the Earnings treatment.

3. Results

Students from the undergraduate population of the Faculty of Arts at the University of Calgary were recruited using the online recruiting system by Greiner (2004). Seventy-five individuals participated in the study, with 24 and 26 individuals participating in the baseline and earnings treatments. A total of 34 individuals participated in the first session of the returning treatment. Attrition resulted in only 26 individuals participating in the second session in which discount rates were elicited.\(^7\) The experiments were conducted using the software developed by Fischbacher (2007). Participants, across all treatments participants were evenly split across gender (58% male) and ages ranged between 19 and 23.\(^8\)

Table 2 provides the summary statistics from the sessions across treatments. In terms of our primary variable of interest (the variable \(A\)-rate), we find no statistically significant differences in participants’ responses between the baseline and earnings treatments (Mann-Whitney \(p=0.623\)). However, non-parametric Mann-Whitney U-tests reject the hypotheses that \(A\)-rate responses in the returning treatment are drawn from the same distribution as those in the baseline and earnings treatments \((p<0.01\) in each comparison). Thus, we find that individuals in the returning treatment demonstrated significantly higher discount rates than did other participants, partially supporting Hypothesis 1.\(^9\) With respect to the consistency of discount rates, no participants

\(^7\) We found no systematic differences between those who returned and those who did not in terms of gender, age, educational status. The natural implication would be that those individuals who failed to return for the final session had higher discount rates than those who did return. As such, were these individuals to have attended the final session, the distribution of elicited discount rates would be higher than what was obtained. Note that in a follow-up study (discussed in Section 4) we replicate the results from our returning treatment with no attrition. We take this as evidence supportive of our conjecture that the attrition observed here does not affect our results.

\(^8\) In an analysis of the data with respect to demographic information collected, we found no differences across the responses of men and women (cf. Coller and Williams, 1999; McLeish and Oxoby, 2007).

\(^9\) In pooling the data from the earnings and returning treatments, we can reject the hypothesis that pooled data and the data from the baseline treatment are drawn from the same distribution (Wilcoxon \(p=0.046\)).
demonstrated switching behaviour; that is, once a participant started choosing option B in Table 1, they continued to do so for all subsequent decisions in the table.

With respect to Hypothesis 2, we find no differences in participants’ responses regarding whether or not they were entitled to the money they received (i.e., outcome variable AS1) across all groups. However, we find that participants in the earnings and returning treatments felt they earned the money received more than those in the baseline treatment (Mann-Whitney $p<0.05$ for variable AS2 from question 2).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Baseline Treatment</th>
<th>Earnings Treatment</th>
<th>Returning Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$-rate</td>
<td>4.65</td>
<td>4.93</td>
<td>8.18</td>
</tr>
<tr>
<td></td>
<td>(1.17)</td>
<td>(1.55)</td>
<td>(1.74)</td>
</tr>
<tr>
<td>Corresponding Interest Rate</td>
<td>9.13%</td>
<td>12.33</td>
<td>20.45%</td>
</tr>
<tr>
<td></td>
<td>(2.93%)</td>
<td>(3.88%)</td>
<td>(4.35%)</td>
</tr>
<tr>
<td>AS1</td>
<td>4.96</td>
<td>5.00</td>
<td>5.09</td>
</tr>
<tr>
<td></td>
<td>(1.08)</td>
<td>(0.89)</td>
<td>(0.81)</td>
</tr>
<tr>
<td>AS2</td>
<td>4.125</td>
<td>6.11</td>
<td>6.09</td>
</tr>
<tr>
<td></td>
<td>(0.94)</td>
<td>(0.59)</td>
<td>(0.89)</td>
</tr>
</tbody>
</table>

Table 2: Summary statistics by treatment: mean (standard deviation).

We identified no differences between the earnings and returning treatments in this regard. Thus we only find partial support for Hypothesis 2 with respect to AS2, but reject the hypothesis with respect to the variable AS1. Interestingly, we find no correlation between individual discount rates and participants’ answers to question AS1 (entitlement to the resources used in the experiment). With respect to participants’ answer to question AS2 (having earned the resources in the experiment), we find a positive correlation of 0.305 ($p<0.01$) suggesting that individuals who perceived

This is due to the “long-tailed” distribution from the returning treatment wherein we find a significant number of responses in excess of one standard deviation above the mean in the earnings treatment.
themselves as having earned the money (those in the earning and returning treatments) displayed higher discount rates.

With respect to the additional questions answered by participants in the returning treatment (i.e., questions 3 and 4), all participants indicated that the cash brought to the second session was not the same as that given in the previous session and 88% of participants indicated that they had spent the money given to them in the first session. This provides some explanation for the higher discount rates elicited in this treatment. If participants had spent the money, this suggests that they considered that money truly to be theirs (as opposed to, say, money belonging to the experimenter). As such deferring use of the money by two weeks would require forgoing current consumption or incurring a loss as suggested by the research of Kahneman et al. (1991). On the other hand, participants in the baseline and earnings treatment may have viewed the money they received as a gain. Since incurring a loss is more costly than the change in well-being initiated by a similarly sized gain, participants in the returning treatment (who could experience a $40 loss to current consumption) required greater compensation for deferring consumption relative to those in the baseline and earnings treatments (where $40 gains were experienced). This greater compensation was manifest through higher required rates of interest to wait two weeks for payment (i.e., higher elicited discount rates).

4. Discussion of Alternative Explanations

In this section we consider alternative explanations beyond the role of the endowment effect that could account for our results. For example, individuals may have assigned monies received in the experiment to different mental accounts as documented by Benartzi and Thaler (1995) with respect to financial portfolios (here, money received today versus money received a week ago). This may have changed the way these

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10 We find no differences between those who did and did not spend the previously received monies. Further, we find no difference between these individuals and those in our follow-up treatment (discussed in section 4) who spent their previously received resources.
resources are considered in decision making as resources in different mental accounts may have been discounted differently.

More specific to our experimental design, we conducted two additional variants of our experiment in order to rule out potential transaction costs induced by our method of payment and by the effect of the delay between our two sessions in the *Returning* treatment.

**Methods of payment**

Our first alternative treatment addresses a concern that our results could have been influenced by a design aspect of our original *Returning* treatment whereby participants chose between a post-dated check and an envelope with cash. Recall that in our Returning treatment, participants initially earned money, were paid in cash and returned the following week for a second session of the experiment. In the second session, individuals put an amount of cash equal to what they earned in the first session in an envelope and then participated in our discount rate elicitation task (Table 1). After completing the second session, those who were selected to be paid according to option A in Table 1 (money now) simply reclaimed their envelope containing $40 in cash, while those selected to be paid according to option B in table 1 (money later) received a post-dated check. Consequently, one might argue that the higher discount rates elicited in our *Returning* treatment are the result of transaction costs associated with cashing a check relative to receiving cash.

To address this concern, we conducted a variant of our *Returning* treatment identical in every way except that in the second session, all participants were paid for their decisions via check. That is, after returning to the second session and placing $40 cash in an envelope (collected by the experimenter) participants completed the discount rate elicitation task and then received either a check for $40, dated for the day of the session or a post-dated check dated for a larger amount dated two weeks from the day of the session.
A total of 21 individuals participated in this experiment (with attrition of 1 person, who did not participate in the second session). The average elicited discount rate (A-rate) of from this treatment was 19.60% (7.84). Once again this is significantly higher than the average A-rate in our Baseline treatment and while it is slightly lower than the value observed in our original Returning treatment, the difference is not significant (Wilcoxon p>0.10). With respect to the asset legitimacy questions we asked (AS1 and AS2) we find no differences in this treatment relative to the others (average answers were 4.78 (0.88) and 6.0 (0.65); Wilcoxon p>0.10 in all pair wise comparisons). Moreover, with respect to our questions on the utilization of the cash allocated in the first session, all participants indicated that they had spent the original $40 earned in the initial session and that the money bills they brought to the experiment were not those originally received. This mirrors our results from the original Returning treatment precisely. In summary, we find no evidence that the higher discount rates obtained in our original Returning treatment were biased upwards by the interplay between payments by cash versus post-dated check.

**Immediate versus delayed decisions**

Our second alternative treatment addresses a concern that the higher elicited discount rates in our original Returning treatment (relative to the Baseline treatment) could be due to the delay between the initial session and the second session, rather than participants earning and retaining income. That is, one might posit that similar discount rates could be observed if our Baseline participants also attended two sessions one week apart and completed the discount elicitation task in the second session. Thus, we conducted a variant of our Baseline treatment in which participants also waited one week before completing Table 1. Participants in this alternative treatment did not receive $40 in the first session but instead received a $5 show-up fee and were told that they would receive the $40 in the subsequent session the following week. So, like the participants in our
original \textit{Baseline} treatment, they did not earn the money nor did they have possession of the money in the week prior to the elicitation of discount rates.

In this variant, a total of 24 individuals participated in both sessions of the experiment (0\% attrition). We find responses to our questions of asset legitimacy AS1 and AS2 to be commensurate with those in the other sessions (5.0 (0.90) and 6.00 (0.86); Wilcoxon p>0.10 in pair wise comparisons with the earnings and returning treatments). With respect to the A-rate, once again we find a significant difference in the distribution of elicited discount rates between this session and our original \textit{Returning} treatment. Specifically, we observe average an A-rate of 5.05 (1.60) which is significantly different from that in the original \textit{Returning} treatment (Wilcoxon p<0.02). Further, the distribution of discount rates from this alternative treatment are not statistically different than those in the original \textit{Baseline} and \textit{Earnings} treatments (Wilcoxon p>0.40 in pair wise comparisons). Therefore we conclude that the marked difference in elicited discount rates between our original \textit{Baseline} and \textit{Returning} treatments is not due to the delay between two sessions in the \textit{Returning} treatment. Rather, our results suggest it was the retention of monies between the sessions over the one-week period that explains our results. This retention effectively moves the money from the domain of gains to reference income, thereby creating the potential for the endowment effect to motivate decision making.

\textit{Can our results be explained by expected utility theory?}

One might argue that a standard (i.e. non reference-dependent) expected utility characterisation of the choices facing the participants in our experiment could be sufficient to explain the results. Specifically it could be argued that concavity of the utility function (risk aversion) is sufficient to explain the higher discount rates observed in our \textit{Returning} treatment relative to the \textit{Baseline} treatment. However as demonstrated by Arrow (1971), expected utility theory predicts that individuals will be essentially risk
neutral over small scale changes in wealth. We therefore agree with Rabin and Thaler (2001), who state:

"[E]xpected utility theory tells us that people will be virtually risk neutral in decisions on the scale of laboratory stakes."\textsuperscript{11}

Thus we would argue that expected utility theory predicts the elicited discount rates in our \textit{Baseline} and \textit{Returning} treatments will be the same.

If one were to insist that the utility function is concave over the small-stake wealth changes in our experiment, the implication is a degree of risk aversion that is absurdly high over large-stake changes in wealth [Rabin (2000); Rabin and Thaler (2001)]. To see this, consider the following linear approximation of a concave utility function facing participants in our original \textit{Baseline} treatment, where an individual reveals discount rate $r_1$ satisfying:

\begin{equation}
(I + m40) + \beta I = I + \beta(I + mR_140); R_1 = 1 + r_1
\end{equation}

where $I$ represents the individual’s (non-experiment) income each period, $\beta < 1$ is the individual’s preference for immediate consumption and $m < 1$ represents a linear approximation to the decline in marginal utility associated with additional money. Solving for $R_1$ gives us

\begin{equation}
R_1 = \frac{1}{\beta}
\end{equation}

Similarly, a participant in our \textit{Returning} treatment reveals discount rate $r_2$ which satisfies:

\begin{equation}
I + m40 + \beta I + \beta^2 I = I + m40 + \beta(I - n40) + \beta^2(I + mR_240); R_2 = 1 + r_2
\end{equation}

where $n > m$ is a necessary condition for concavity of the utility function. Solving for $R_2$ we obtain

\begin{equation}
R_2 = \frac{n}{m} \cdot \frac{1}{\beta}
\end{equation}

Comparing (6) and (8) we see that assuming concavity of the utility function ($n > m$) implies $R_2 > R_1$ and therefore $r_2 > r_1$. Letting $R_2 = \gamma R_1; \gamma > 1$, we can also write

\textsuperscript{11} Rabin and Thaler (2001); p224.
The elicited discount rates from our Baseline and Returning treatments define $\gamma = 1.10373$ which from (9) implies that the value of $m$ is approximately 90% that of $n$. This magnitude of declining marginal utility over small-stake changes in wealth implies an excessive degree of risk aversion over large-stake changes in wealth, because large scale changes in wealth will produce arbitrarily small increases in utility, tending asymptotically to zero as income tends to infinity. A simple calibration exercise similar to those reported in Rabin (2000) and Rabin and Thaler (2001) confirms that an individual, with preferences consistent with value of $\gamma$ implied by our results, would refuse to pay a relatively small amount for a fair bet with an infinitely high expected value. Thus to assume that utility is concave over the low-stakes amounts in our experiment is to assume nonsensical preferences.

Lastly, it is worth emphasising that the expected utility explanation of our results assumes (commodity) money is non-durable (is consumed each period). Intuitively, consumption of experimental earnings should be smoothed over time; therefore some of the first session earnings would be carried forward to the second session in the Returning treatment. Thus in reality, participants in either our Baseline or Returning treatments face an identical two-period problem in which they obtain $40 in the first period which they may forego in favour of a larger amount in the second period. In this two-period representation of the problem, we should expect $r_1 = r_2$ in the absence of an endowment effect. The preservation of our results in the alternative Baseline treatment (where the timing of the discount rate elicitation task is identical to the Returning treatment) supports this view.

$\gamma = \frac{1}{n} \cdot m \quad \text{(9)}$

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12 Consider an individual with current income (I) of $100 whose utility of current income is arbitrarily set at $U(100)=100$. If the individual receives $40 additional income from the experimenter, under the assumption of declining marginal utility, $U(140) =139$ at most. Using this minimal amount of concavity and the value of $\gamma$ implied by our results, we can make a linear projection of utility levels as income is increased in $40$ increments. This calibration exercise (details available from the authors) suggests that such an individual would not be willing to pay $290 for a fair bet with a 50% chance of winning $+\infty$ and a 50% chance of winning zero.
5. Conclusion
The results of our intertemporal experiment, which indicate a strong endowment effect, have an important bearing in the study of behavioural aspects of savings decisions. A decision to save is a decision to incur a loss to current consumption in return for future consumption and therefore loss aversion implies that individuals will require greater compensation (i.e., higher rates of return) when making saving decisions from current income.

Beyond intertemporal choice problems, our protocol (whereby participants earn and then retain money prior to making decisions of interest to the experimenter) has wider implications for studies in behavioural economics. Although many experimental designs contain mechanisms for subjects to earn the money they make decisions with, no studies to our knowledge have allowed for retention of this money prior to decision-making. By allowing earned lab dollars to become part of a subject’s reference income opens up the possibility that the endowment effect evident in our study will provide additional insights in many experiments.

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