Individual Discount Rates
and
Credit Rationing
Results of an Experimental Study in India

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Abstract

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Abstract

The discount rates of 96 individuals in two villages in south India were measured using experimental games offering real rewards and hypothetical questions. The results of both the games and the questions revealed discount rates significantly above the highest interest rates paid by the respondents, indicating the presence of binding credit constraints. Wealthier individuals had significantly lower discount rates in several of the experiments, while age had no significant effect. Consistent with previous studies of discount rates, measured discount rates were reduced as the time frame of the experiment was increased and as the size of rewards was increased. These effects do not imply rejection of the discounted utility model of preferences, as some authors have argued, and can be explained by the effects of credit rationing.
Individual Discount Rates and Credit Rationing

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John L. Pender

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The extent to which decision makers discount the future is a critical determinant of savings and investment behavior. Programs designed to reflect concerns about "sustainable development" in third world agriculture may be doomed to fail if the preferences of third world farmers regarding intertemporal trade-offs are not adequately understood.

Standard economic theory predicts that if capital markets are "perfect"--i.e., unlimited borrowing or saving at a single riskless rate of interest is possible--individuals optimally would discount future consumption at the market interest rate (Fisher). However, as Stiglitz and Weiss have argued, problems of imperfect information make credit rationing likely in most capital markets. These problems are exacerbated in many developing countries, including India, where government regulation of financial markets contributes to highly segmented and rationed credit markets (Fry; Walker and Ryan).

Where credit is rationed, individual discount rates are likely to be greater than market interest rates, reflecting the fact that the desire to shift use of wealth to the present is being constrained. Thus, by measuring individual discount rates and comparing them to interest rates, one can investigate the extent of credit rationing in a particular market.

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Other authors have investigated credit constraints by estimating the stochastic Euler equation for a life cycle model with a credit constraint and testing the significance of the Lagrange multiplier associated with that constraint (Zeldes; Morduch). The experimental approach has the advantage of providing more direct evidence of credit rationing without requiring parametric assumptions about the form of the utility function or the nature of the credit constraints, or panel data on consumption.

In addition to credit constraints, I investigate some "anomalies" that have been observed in previous experimental studies of discount rates and interpreted by some authors as inconsistent with the discounted utility model of intertemporal preferences commonly used by economists (Loewenstein and Thaler; Loewenstein and Prelec). Previous studies have found that measured discount rates decreased as the time between the dates when rewards were offered was increased and as the magnitude of rewards was increased (Thaler; Benzion, Rapoport, and Yagil), and that discount rates were higher when the choice involved delaying a reward relative to an early reference date than when the choice involved expediting a reward relative to a later date (Loewenstein; Benzion, et al.).

Most of these results have been documented only in experiments involving hypothetical rewards. In the present study, these effects were investigated using both experimental games involving real rewards and hypothetical questions.

The Theory of Discounting

The idea that individuals discount the future has long been used by economists. Positive real interest rates in an available (but not necessarily perfect) capital market are sufficient to ensure positive discounting under fairly general assumptions about preferences. Consider a two period model of production and consumption with an imperfect capital market in which credit is rationed. The individual seeks to maximize $U(c_1, c_2)$ subject to his
production possibilities

\[ x_2 \leq f(x_1) \quad (1) \]

his intertemporal budget constraint

\[ C_1 + \frac{C_2}{1+r} \leq x_1 + \frac{x_2}{1+r} \quad (2) \]

the borrowing constraint

\[ C_1 - x_2 \leq D_1 \quad (3) \]

and nonnegativity constraints

\[ C_1, C_2, x_1, x_2 \geq 0 \quad (4) \]

Making standard assumptions on the nature of technology (f is concave and decreasing) and on preferences (U is quasiconcave, nonsatiated, and indifference curves do not intersect the axes), we have at an optimum:

\[ \mu \rho_1 - \mu_1 - r + \frac{\lambda}{1+r} = f'(x_1) \quad (5) \]

where \( \mu \) is the lagrangian multiplier associated with the credit constraint and \( \lambda \) is the multiplier associated with the intertemporal budget constraint. Since the utility function is assumed nonsatiated, \( \lambda > 0 \). By the Kuhn-Tucker theorem, \( \mu \geq 0 \) and may be strictly positive if the borrowing constraint is binding. Thus the intertemporal marginal rate of substitution is at least as large as \( 1+r \), implying positive discounting if \( r > 0 \).

Defining the (discrete time) discount rate by the formula

and taking \( s=1 \) and \( t=2 \), we have from equation 5)
That is, the discount rate is at least as large as the interest rate, and may be greater if the borrowing constraint is binding. The difference between the discount rate and the interest rate \((\mu/\Lambda)\) is a measure of the shadow cost of the credit constraint.

It is reasonable to expect the probability of binding credit constraints and hence discount rates to be negatively correlated with individuals' net wealth. Zeldes and Morduch both used this expectation as the basis of their test for credit constraints, splitting their sample by wealth or landholding and assuming that the wealthiest individuals are not credit constrained. Hausman (1979) estimated discount rates based on consumers' purchases of durable goods and found discount rates to be a declining function of household income, which is correlated with wealth. Controlling for wealth, one might expect older individuals to have higher discount rates if they have a finite planning horizon. I test for both wealth and age effects using the results of the experiments.

**Experimental Design**

The study was conducted in two villages in Andhra Pradesh, India—Aurepalle and Dokur—under the auspices of the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). Ninety six respondents participated in the original study, conducted in August, 1989. A follow up study investigating the repeatability of the findings and discount rates using longer time frames was conducted in April and May, 1991. The original forty eight respondents from Aurepalle plus an additional twenty eight Aurepalle residents participated in the follow up study.
A stratified random sample, based on agricultural land area operated, was used to select the respondents. Three-fourths of the respondents are farmers and one-fourth are landless agricultural workers. The majority of the households in the sample are very poor, with an average per capita income of less than $200.

In the original study, each respondent participated in three experimental games using real rewards and hypothetical questions. Six experimental games were used; with one half of the sample participating in games G1, G2, and G3, and one half participating in games G4, G5, and G6. In each game, participants were offered a series of eight to ten binary choices between a specified amount of rice to be received at a particular date and alternative amounts received at some other date. For example, in game G1, the participant was offered 10 kg. of rice, to be delivered in mid-September, 1989. In the game, the participant faced a series of choices between the 10 kg. in Sept. 1989 or alternative amounts of rice delivered in April 1990:

**Game G1:**

1) 10 kg. in Sept. 1989 or 9 kg. in April 1990
2) 10 kg. in Sept. 1989 or 10 kg. in April 1990
3) 10 kg. in Sept. 1989 or 11 kg. in April 1990
4) 10 kg. in Sept. 1989 or 12 kg. in April 1990
5) 10 kg. in Sept. 1989 or 13 kg. in April 1990
6) 10 kg. in Sept. 1989 or 15 kg. in April 1990
7) 10 kg. in Sept. 1989 or 17 kg. in April 1990
8) 10 kg. in Sept. 1989 or 20 kg. in April 1990

The participant was asked to indicate which alternative he preferred within each choice pair. After all three games were played, the participant would randomly select one of the choices made in the games, this selection determining his reward. This procedure was intended to give participants incentive to reveal their preferences.

In G1, the nominal size of the game is 10 kg. of rice, the time frame is 7 months, and the reference point is September 1989. In the other games, different time frames, sizes of rewards and reference points were used (Table 1). In G1-G3, the reference point was September 1989.
All choices involved delaying consumption relative to a fixed reward at this date. In G4-G6, all choices involved expediting consumption relative to the reference point.

If the participant "crossed over" exactly once from preference for the early reward to preference for the later reward, a range for the discount rate could be inferred. If the participant did not cross over at least once, one could only infer that his discount rate was outside the range of measurement provided by the experiment. In such cases, the measurement was censored and only an upper or lower bound could be placed on the discount rate. If the participant crossed over more than once, nothing, apart from the observation of an inconsistent response, could be inferred about his discount rate. 

The participants also responded to hypothetical questions investigating time frame and magnitude effects.

In the follow-up study conducted in 1991, each respondent participated in four games (H1 through H4). All games offered choices between 10 kg. of rice in September 1991 and alternative amounts at later dates. The time frames were 7 months, 12 months, 19 months, and 24 months in H1 through H4 respectively.
Table 1. Structure and Responses to the Experiments

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Time Frame (months)</th>
<th>Magnitude (kg. rice)</th>
<th>Reference Point</th>
<th>Median Discount Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental games: August 1989</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G1</td>
<td>7</td>
<td>10</td>
<td>Sept. 1989</td>
<td>0.69-0.91</td>
</tr>
<tr>
<td>G2</td>
<td>12</td>
<td>10</td>
<td>Sept. 1989</td>
<td>0.53</td>
</tr>
<tr>
<td>G3</td>
<td>12</td>
<td>50</td>
<td>Sept. 1989</td>
<td>0.26-0.34</td>
</tr>
<tr>
<td>G4</td>
<td>7</td>
<td>14</td>
<td>April 1990</td>
<td>0.96-1.19</td>
</tr>
<tr>
<td>G5</td>
<td>12</td>
<td>14</td>
<td>Sept. 1990</td>
<td>&gt; 0.69</td>
</tr>
<tr>
<td>G6</td>
<td>12</td>
<td>65</td>
<td>Sept. 1990</td>
<td>0.37-0.49</td>
</tr>
<tr>
<td><strong>Hypothetical questions: August 1989</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>12</td>
<td>50</td>
<td>Aug. 1989</td>
<td>0.41</td>
</tr>
<tr>
<td>Q2</td>
<td>60</td>
<td>50</td>
<td>Aug. 1989</td>
<td>0.36</td>
</tr>
<tr>
<td>Q3</td>
<td>12</td>
<td>500</td>
<td>Aug. 1989</td>
<td>0.41</td>
</tr>
<tr>
<td><strong>Experimental games: April/May 1991</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H1</td>
<td>7</td>
<td>10</td>
<td>Sept. 1991</td>
<td>0.69-0.91</td>
</tr>
<tr>
<td>H2</td>
<td>12</td>
<td>10</td>
<td>Sept. 1991</td>
<td>0.59-0.69</td>
</tr>
<tr>
<td>H3</td>
<td>19</td>
<td>10</td>
<td>Sept. 1991</td>
<td>0.58-0.69</td>
</tr>
<tr>
<td>H4</td>
<td>24</td>
<td>10</td>
<td>Sept. 1991</td>
<td>0.58-0.69</td>
</tr>
</tbody>
</table>
Discount rates were calculated by the formula $d = \ln(\Delta y/\Delta x)/(t-s)$, where the individual is indifferent between a reward (loss) of $\Delta x$ at date $s$ and a reward (loss) of $\Delta y$ at date $t$. This formula is a continuous time analog of equation (6). In the experimental games, it was only possible to determine a range for the median discount rate due to the nature of the experiment.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Discount Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0-0.05</td>
<td>10</td>
</tr>
<tr>
<td>0.05-0.1</td>
<td>10</td>
</tr>
<tr>
<td>0.1-0.15</td>
<td>10</td>
</tr>
<tr>
<td>0.15-0.2</td>
<td>10</td>
</tr>
<tr>
<td>0.2-0.25</td>
<td>10</td>
</tr>
<tr>
<td>0.25-0.3</td>
<td>10</td>
</tr>
<tr>
<td>0.3-0.35</td>
<td>10</td>
</tr>
<tr>
<td>0.35-0.4</td>
<td>10</td>
</tr>
<tr>
<td>0.4-0.45</td>
<td>10</td>
</tr>
<tr>
<td>0.45-0.5</td>
<td>10</td>
</tr>
<tr>
<td>0.5-0.55</td>
<td>10</td>
</tr>
<tr>
<td>0.55-0.6</td>
<td>10</td>
</tr>
<tr>
<td>0.6-0.65</td>
<td>10</td>
</tr>
<tr>
<td>0.65-0.7</td>
<td>10</td>
</tr>
<tr>
<td>0.7-0.75</td>
<td>10</td>
</tr>
<tr>
<td>0.75-0.8</td>
<td>10</td>
</tr>
<tr>
<td>0.8-0.85</td>
<td>10</td>
</tr>
<tr>
<td>0.85-0.9</td>
<td>10</td>
</tr>
<tr>
<td>0.9-0.95</td>
<td>10</td>
</tr>
<tr>
<td>0.95-1.0</td>
<td>10</td>
</tr>
</tbody>
</table>
Experimental Results

Results of Experimental Games

The median responses to the experimental games and hypothetical questions are shown in Table 1. The median discount rates are quite high; over 50% in the smaller magnitude games. In contrast, the median value of the maximum interest rate paid on outstanding debt by respondents was 22%. Based on nonparametric sign tests, the discount rate was significantly higher than the maximum interest rate paid by respondents in all games except G3 (Table 2).

The possibility that measured discount rates are biased should be considered. In designing the experiments, possible confounding of the discount rate with subjective risk was considered a potential source of bias. If respondents lacked confidence that a promised future reward would actually be paid, they might tend to prefer a current reward irrespective of their actual discount rate. Given ICRISAT's long experience in the villages (since 1975), the familiarity of the respondents with the ICRISAT investigators who conducted the experiments (each of whom lived for several years in the villages), and ICRISAT's record of providing substantial rewards in similar experimental studies, such subjective risk should have been minimal. Nevertheless, all the experimental games offered rewards only at future dates, so that to the extent that any future reward faces the same "credibility" discount, this effect was controlled for. The fact that the finding of high discount rates was repeated in the 1991 study, after the rewards were paid for the 1989 study, is strong evidence that the credibility of future rewards did not significantly bias the estimates.

Negative time frame effects, consistent with the results of previous studies, are evident in the 1989 experiments. Most respondents had lower discount rates in the 12 month games than in the 7 month games, this result being statistically significant at the 5% level in the early reference point games (G2-G1). This finding was repeated in the 1991 experiments (H2-H1).
Interestingly, the negative time frame effect was not evident in comparing the 19 month and 24 month games to the 12 month game (H3-H2 and H4-H2). In fact, there was some evidence of a higher discount rate in the 24 month game, although this difference was not statistically significant.

A statistically significant magnitude effect consistent with earlier findings also was found in the experimental games.

Reference point effects in the games were not consistent with the findings of earlier studies. The later reference point games have higher median discount rates than the early reference point games of comparable time frame and magnitude; i.e., the median discount rate was higher in G4 than G1, higher in G5 than G2, and higher in G6 than G3. None of these comparisons were statistically significant at the 5% level using a Mann-Whitney comparison of the mean ranks in the experiments, although the responses in G6 were significantly higher than in G3 at the 10% level (Table 3). This result may be due in part to a magnitude effect, because I could not assure that the early and late reference point games were of equal magnitude.

The robustness of the experimental results was investigated by repeating G1, G2, and G3 with the Aurepalle respondents several weeks after the initial study, using money rather than rice as the reference good. The discount rates measured in these experiments did not differ significantly from those in the original games. Moreover, significant time frame and magnitude effects consistent with those found in the initial study were again found.
Table 2. Experimental Games—Within Subject Comparisons

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Number with sign of difference</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>G1 - r</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>G2 - r</td>
<td>18</td>
<td>8</td>
</tr>
<tr>
<td>G3 - r</td>
<td>17</td>
<td>1</td>
</tr>
<tr>
<td>G4 - r</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>G5 - r</td>
<td>16</td>
<td>3</td>
</tr>
<tr>
<td>G6 - r</td>
<td>16</td>
<td>3</td>
</tr>
</tbody>
</table>

Discount rate - maximum interest rate

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Number with sign of difference</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>G1 - G2</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>G5 - G4</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>H2 - H1</td>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>H3 - H2</td>
<td>13</td>
<td>14</td>
</tr>
<tr>
<td>H4 - H2</td>
<td>22</td>
<td>9</td>
</tr>
</tbody>
</table>

Time frame effect

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Number with sign of difference</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3 - G2</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>G6 - G5</td>
<td>1</td>
<td>12</td>
</tr>
</tbody>
</table>

Magnitude Effect

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Number with sign of difference</th>
<th>t statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>G3 - Q1</td>
<td>17</td>
<td>27</td>
</tr>
</tbody>
</table>

Comparison to Hypothetical Questions

* indicates statistical significance at the 5% level.

** indicates statistical significance at the 1% level.
Since the discount rate was measured only within ranges in the experimental games, there many comparisons in which the ranges overlapped, resulting in a zero for the sign difference. For hypothesis testing, one half of the zeros were treated as positive and one half as negative. If the discount rate was above or below the range of measurement in both games in the comparison or if an inconsistent response was observed, no comparison was possible and these observations were excluded from the test.

* Computed using the normal approximation \( t = \frac{2(n^* - 0.5N)}{N} \), where \( n^* \) is the number of observations for which the difference is positive (including one-half of the zero observations) and \( N \) is the total number of observations.

* \( r \) is the maximum interest rate on outstanding debt. Those who had no outstanding debt were excluded from the comparison.
Table 3. Mann-Whitney Comparison of Ranks of Discount Rates in Early and Late Reference Point Games

<table>
<thead>
<tr>
<th>Reference Point</th>
<th>GI - G4</th>
<th>G2 - G5</th>
<th>G3 - G6</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean Rank of Discount Rate</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early</td>
<td>43.6</td>
<td>45.4</td>
<td>42.6</td>
</tr>
<tr>
<td>Late</td>
<td>49.5</td>
<td>50.7</td>
<td>52.4</td>
</tr>
<tr>
<td><strong>Significance level</strong></td>
<td>(0.27)</td>
<td>(0.32)</td>
<td>(0.07)</td>
</tr>
</tbody>
</table>
Results of Hypothetical Questions

Within-subject comparisons between the responses to game G3 and hypothetical question Q1 allowed us to investigate the consistency between the two methods of eliciting discount rates, since both of these experiments had the same time frame, magnitude and reference point. Most respondents had lower discount rates when measured by the experimental game, although the sign test was not statistically significant. The variation of responses was much greater in the experimental games than in the hypothetical questions, which had very strong modal patterns of response (Table 4).

Many of the findings of the experimental games were repeated with the hypothetical questions. As in the games, discount rates measured in all questions were significantly higher than interest rates (Table 5). Statistically significant negative time frame and magnitude effects also were found. The difference between the mean discount rate in the one year question and the five year question (Q2-Q1) was large and negative. However, this is contrary to the finding in the experimental games of no decline in discount rates beyond one year.

As with the experimental games, two of the hypothetical questions were repeated with the Aurepalle sample using money as the reference good. Estimated discount rates averaged 0.07 lower with money as the reference good, this difference being significant at the 5% level.
Table 4. Distribution of Responses to G3 and Q1

<table>
<thead>
<tr>
<th>Range of Discount Rate</th>
<th>G3</th>
<th>Q1</th>
</tr>
</thead>
<tbody>
<tr>
<td>- 0.11 to 0.00</td>
<td>4.3</td>
<td>0.0</td>
</tr>
<tr>
<td>- 0.00 to 0.04</td>
<td>6.4</td>
<td>0.0</td>
</tr>
<tr>
<td>0.04 to 0.08</td>
<td>4.3</td>
<td>0.0</td>
</tr>
<tr>
<td>0.08 to 0.13</td>
<td>8.5</td>
<td>0.0</td>
</tr>
<tr>
<td>0.13 to 0.18</td>
<td>8.5</td>
<td>0.0</td>
</tr>
<tr>
<td>0.18 to 0.26</td>
<td>4.3</td>
<td>5.2</td>
</tr>
<tr>
<td>0.26 to 0.34</td>
<td>10.6</td>
<td>10.4</td>
</tr>
<tr>
<td>0.34 to 0.47</td>
<td>10.6</td>
<td>40.6</td>
</tr>
<tr>
<td>0.47 to 0.69</td>
<td>4.3</td>
<td>43.8</td>
</tr>
<tr>
<td>&gt; 0.69</td>
<td>34.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
Table 5. Hypothetical Questions--Within-Subject Comparisons

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Mean Difference</th>
<th>t-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate - maximum interest rate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1 - r</td>
<td>0.26</td>
<td>+9.15</td>
</tr>
<tr>
<td>Q2 - r</td>
<td>0.12</td>
<td>+7.57</td>
</tr>
<tr>
<td>Q3 - r</td>
<td>0.20</td>
<td>+10.40</td>
</tr>
<tr>
<td>Q4 - r</td>
<td>0.12</td>
<td>+2.90</td>
</tr>
<tr>
<td>Q5 - r</td>
<td>0.34</td>
<td>+9.28</td>
</tr>
<tr>
<td>Time frame effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q2 - Q1</td>
<td>-0.17</td>
<td>-12.36</td>
</tr>
<tr>
<td>Magnitude effect</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q3 - Q1</td>
<td>-0.08</td>
<td>-5.35</td>
</tr>
</tbody>
</table>
Determinants of Discount Rates--Wealth and Age Effects

Ordered probit analysis of variations in discount rates across the sample revealed a significant negative effect of net wealth in G1 through G3 (Table 6). The discount rates of households having net wealth per capita above the median averaged between 25 and 35 percentage points lower than poorer households in these three games. No significant wealth effects were found in the responses to the late reference point games or the hypothetical questions (Table 7).

Wealth may be partly determined by an individual's discount rate as well as being a determinant of the discount rate. Using Hausman's (1978) procedure, exogeneity of net wealth could not be rejected at the 10% level in any of the regressions. ¹⁰

No significant age effects were found in any of the regressions. In most of the experiments, Aurepalle respondents had lower discount rates than Dokur respondents, the difference being statistically significant in one of the games and two of the hypothetical questions. In one of the hypothetical questions however, Aurepalle residents had significantly higher discount rates.

The order in which the experimental games were played was randomly assigned to control for experimental biases due to practice or fatigue. ¹¹ Significant order effects were found in the responses to G1-G3, and these are controlled for in the regressions.
### Table 6. Determinants of Discount Rates in Experimental Games

Estimation Using Ordered Probit

(asymptotic t-statistics in parentheses)

<table>
<thead>
<tr>
<th>Determinant</th>
<th>G1</th>
<th>G2</th>
<th>G3</th>
<th>G4</th>
<th>G5</th>
<th>G6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>1.573**</td>
<td>1.019**</td>
<td>1.026**</td>
<td>0.961**</td>
<td>0.248</td>
<td>0.452</td>
</tr>
<tr>
<td></td>
<td>(4.62)</td>
<td>(4.30)</td>
<td>(3.77)</td>
<td>(3.20)</td>
<td>(0.66)</td>
<td>(1.87)</td>
</tr>
<tr>
<td>Net Wealth</td>
<td>-0.345*</td>
<td>-0.255**</td>
<td>-0.274*</td>
<td>0.103</td>
<td>0.081</td>
<td>0.014</td>
</tr>
<tr>
<td>per Capita</td>
<td>(-2.37)</td>
<td>(-2.58)</td>
<td>(-2.39)</td>
<td>(0.62)</td>
<td>(0.41)</td>
<td>(0.11)</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0030</td>
<td>-0.0022</td>
<td>-0.0035</td>
<td>0.0071</td>
<td>0.0117</td>
<td>0.0032</td>
</tr>
<tr>
<td></td>
<td>(-0.56)</td>
<td>(-0.59)</td>
<td>(-0.82)</td>
<td>(1.17)</td>
<td>(1.46)</td>
<td>(0.70)</td>
</tr>
<tr>
<td>Village</td>
<td>-0.275</td>
<td>-0.119</td>
<td>-0.180</td>
<td>-0.404**</td>
<td>0.037</td>
<td>-0.091</td>
</tr>
<tr>
<td></td>
<td>(-1.81)</td>
<td>(-1.13)</td>
<td>(-1.50)</td>
<td>(-2.60)</td>
<td>(0.20)</td>
<td>(-0.73)</td>
</tr>
<tr>
<td>Order 1</td>
<td>-0.382**</td>
<td>-0.263*</td>
<td>-0.404**</td>
<td>0.039</td>
<td>-0.062</td>
<td>-0.050</td>
</tr>
<tr>
<td></td>
<td>(-2.21)</td>
<td>(-2.25)</td>
<td>(-2.95)</td>
<td>(0.20)</td>
<td>(-0.27)</td>
<td>(-0.33)</td>
</tr>
<tr>
<td>Order 2</td>
<td>-0.164</td>
<td>-0.058</td>
<td>-0.123</td>
<td>0.052</td>
<td>0.058</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>(-0.92)</td>
<td>(-0.48)</td>
<td>(-0.88)</td>
<td>(0.28)</td>
<td>(0.26)</td>
<td>(-0.05)</td>
</tr>
<tr>
<td>Std. error</td>
<td>0.447**</td>
<td>0.294**</td>
<td>0.354**</td>
<td>0.453**</td>
<td>0.536**</td>
<td>0.385**</td>
</tr>
<tr>
<td>of model</td>
<td>(7.20)</td>
<td>(6.80)</td>
<td>(6.87)</td>
<td>(6.02)</td>
<td>(4.87)</td>
<td>(6.00)</td>
</tr>
</tbody>
</table>

* indicates statistical significance at the 5% level.

** indicates statistical significance at the 1% level.
* Dummy variable = 1 if net wealth per capita is greater than Rs. 7,000, the median for the sample.

*b Dummy variable = 1 for Aurepalle.

c In games G1, G2, and G3, Order 1 = 1 for respondents who played the games in the order G1-G2-G3 and 0 otherwise. Order 2 = 1 for respondents who played in the order G2-G3-G1. All other respondents in these games played in the order G3-G1-G2. In games G4, G5 and G6, Order 1 = 1 if the order was G4-G5-G6 and Order 2 = 1 if the order was G5-G6-G4. All other respondents in these games played in the order G6-G4-G5.
Table 7. Determinants of Discount Rates in Hypothetical Questions—Estimation Using Least Squares
(Asymptotic t-statistics in parentheses)

<table>
<thead>
<tr>
<th>Determinant</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.577**</td>
<td>0.317**</td>
<td>0.406**</td>
</tr>
<tr>
<td></td>
<td>(11.56)</td>
<td>(14.51)</td>
<td>(9.00)</td>
</tr>
<tr>
<td>Net Wealth per Capita*</td>
<td>0.004</td>
<td>0.000</td>
<td>0.043</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.00)</td>
<td>(1.84)</td>
</tr>
<tr>
<td>Age</td>
<td>0.0002</td>
<td>0.0002</td>
<td>0.0007</td>
</tr>
<tr>
<td></td>
<td>(0.26)</td>
<td>(0.42)</td>
<td>(0.82)</td>
</tr>
<tr>
<td>Villageb</td>
<td>-0.159**</td>
<td>0.029*</td>
<td>-0.047*</td>
</tr>
<tr>
<td></td>
<td>(-6.02)</td>
<td>(2.50)</td>
<td>(-1.96)</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.272</td>
<td>0.033</td>
<td>0.059</td>
</tr>
</tbody>
</table>

* indicates statistical significance at the 5% level.

** indicates statistical significance at the 1% level.

* Dummy variable = 1 if net wealth per capita is greater than Rs. 7,000.

b Dummy variable = 1 for Aurepalle.
Discussion

Credit Rationing

The results of both the experimental games and the hypothetical questions indicate the presence of credit rationing in the villages studied. Measured discount rates were significantly higher than the highest interest rate paid by respondents in all but one of the experimental games and in all of the hypothetical questions. This result is in accord with Morduch’s results for Aurepalle and with observations of the limited and highly segmented nature of credit markets in the study villages (Binswanger, et al. (1985); Walker and Ryan).

The negative effect of net wealth on discount rates in G1-G3 is also consistent with credit rationing and Morduch’s findings. Negative wealth effects were not found in the results of G4-G6 or the hypothetical questions. In G4-G6, a greater share of the responses were censored than in G1-G3, resulting in lower power of the econometric tests. This may account for the finding of very few significant coefficients in the regressions for G4-G6. It may also be that respondents found it more confusing to think in terms of expediting consumption relative to a later date than in terms of delaying consumption relative to an early date, which would contribute to greater variance in responses to G4-G6.

In the hypothetical questions, censoring was not a problem and the choices involved delaying a reward as in G1-G3. It may be that in the hypothetical questions, respondents think in terms of credit market arrangements without thoroughly considering their own situation. For example, seasonal in-kind consumption loans denominated in rice having implicit annual rates of interest of 50% or more are common in the villages. With nothing at stake in a hypothetical question and the question referring to rice as the reference good, respondents may simply use the terms of these loans to respond. That would explain the strong modal pattern in responses to the questions and the lower discount rate when money was the reference good, since in-kind loans
in the informal market are usually at higher interest rates than loans made in cash to more preferred borrowers.

The finding of significant time frame and magnitude effects also implies that credit markets in the villages are not perfect. As discussed below, the nature of credit constraints may account for these effects.

**Time Frame Effects**

Several explanations for time frame effects are possible. These include errors in measuring discount rates, preferences that are inconsistent with the discounted utility model, credit rationing, the term structure of interest rates, and the effects of uncertainty.

Discount rates are a measure of the intertemporal marginal rate of substitution. As such, rewards or losses must be small in an experiment to measure the discount rate. The size of rewards offered in the small magnitude games--about 10 kg. of rice--may be large enough to cause some time frame effects. Pender (1990) has shown that if consumption is constant, a sufficient condition for negative time frame effects to occur in experiments offering significant rewards is that the elasticity of utility \( \frac{d \ln(v(c))}{d \ln(c)} \) increase with \( c \), where \( v(c) \) is the single period utility as a function of consumption. Although such effects are possible, I believe that rewards offered in the small magnitude games are too small to account for the sizable time frame effects observed.

If consumption were constant and deterministic, the existence of time frame effects implies rejection of the discounted utility model with its constant rate of time preference. However, the presence of credit constraints makes constant consumption or even constant consumption growth unlikely. Individuals facing binding credit constraints will be unable to borrow to smooth consumption between periods as much as they would like, resulting in fluctuations in consumption between periods when income is high and periods when income is low.
Consider a two period deterministic model with the discounted utility function defined by

\[ U(C_1, C_2) = v(C_1) + \frac{V(C_2)}{1 + \rho} \] (8)

where \( \rho \) is the rate of time preference.\(^{14}\) From equations (5) and (8) we have the Euler equation

\[ 1 + r + \frac{\mu}{\lambda} = \frac{V'(C_1)}{V'(C_2)} (1 + \rho) \] (9)

If \( v \) is a homogeneous function and \( v'' < 0 \) then

\[ f\left(\frac{C_2}{C_1}\right) = \frac{1 + r + \frac{\mu}{\lambda}}{1 + \rho} \] (10)

where \( f' > 0 \). If there is no credit constraint, consumption growth is determined by the interest rate and the rate of time preference, and will be constant if these are constant. If there is a binding credit constraint in the current period but not in the next period current consumption will be lower and consumption growth will be greater than in an unconstrained case.

Evidence on consumption in Aurepalle reveals seasonal patterns of consumption consistent with a view that credit is more constrained in the quarter including September than the quarter including April. Consumption from July through September averaged 14% lower than consumption in the following April through June among 15 sample households in Aurepalle from 1977 through 1983, controlling for annual consumption growth.\(^{15}\)

Given that observed variations in consumption in the villages are consistent with tighter credit constraints in September than in April, one should expect to observe higher discounting
between September and April than between September and the following September. It is easy
to imagine preferences of the discounted utility form that are consistent with observed patterns of
discount rates, given the magnitudes of consumption variation that are observed. For example,
consider the following discounted utility function (continuous time version)

\[ U = \int e^{-pt} \frac{C_t^{1-R}}{1-R} dt \]  

(11)

with \( p=0.5 \) and \( R=2.0 \). If consumption growth between each September and the following April
is 10% and annual consumption growth is 5%, then the discount rates in four experiments having
time frames of 7 months, 12 months, 19 months, and 24 months relative to a September reference
point (as in H1 through H4) would be 0.83, 0.60, 0.68, 0.60, respectively.\footnote{6}

Another possible explanation for time frame effects is the term structure of interest rates.
If interest rates are lower on loans of longer term, discount rates should be lower in longer time
frame comparisons, even in the absence of credit constraints. The structure of credit markets in
the study villages is such that seasonal in-kind consumption loans are charged a higher implicit
rate of interest—usually equivalent to about 50% per year—than longer term production credit
which is generally at 18% to 36% in the informal market and about 10% from formal sector
sources.

While it is plausible that the term structure of interest rates contributes to observed time
frame effects, this cannot be the only factor. Since discount rates are above the highest interest
rates paid by most respondents, there must be some credit rationing. In addition, the term
structure alone would not explain the seasonality of consumption that is observed. Since there
is seasonality in consumption, there must also be seasonality in the degree of credit rationing,
contributing to seasonal variation in the discount rate. Finally, the interest rates observed on loans
of different terms likely overstates the true term structure, due to self selection.
The term structure refers to interest rates that would be available to a particular individual for loans of different periods. The rates observed on loans of different terms are in segmented markets serving different clienteles. As Walker and Ryan (p. 203) note in explaining client-moneylender relations in the ICRISAT study villages:

Farmers with a poor credit history can only borrow in the seasonal loan market. In contrast, large farmers with good reputations enjoy a relationship which resembles an open line of credit and can use credit flexibly with regard to repayment terms and purpose in the medium-term loan market.

Thus the term structure relevant to any particular individual may show considerably less variation than the rates observed in the different loan markets.

A final possible explanation for time frame effects is due to uncertainty. Consider a three period expected discounted utility model:

\[ U(c_1, c_2, c_3) = EV(c_1) + \left( \frac{EV'(c_2)}{1+p} \right) + \left( \frac{EV'(c_3)}{(1+p)^2} \right) \]

Considering marginal changes \( dc_1 \) and \( dc_2 \) that are the same in every state of nature, it can be shown that

\[ \left( \frac{dc_2}{dc_1} \right) \left| u= -\frac{EV'(c_1)}{EV'(c_2)} \right( 1+p \right) \]

and similarly if \( dc_3 \) is the same in all states of nature

\[ \left( \frac{dc_3}{dc_1} \right) \left| u= -\frac{EV'(c_1)}{EV'(c_3)} \right( 1+p \right)^2 \]
If the distribution of consumption is the same in the three periods, then the discount rates \( d_{-1} \) and \( d_{-2} \) as defined by equation (6) would be equal to \( \rho \). However, if the distribution of consumption is not the same in the three periods, then even if expected consumption is constant, the discount rates can vary.

For example, suppose that \( v^{**} > 0 \), so that the function \( v' \) is convex. Assume that expected consumption is the same in all periods and that there is no uncertainty in periods 1 and 2 but that consumption is uncertain in period 3. Then by Jensen's inequality

\[
E v'(c_3) > v'(E c_3) - v'(c_2) - v'(c_1) \tag{15}
\]

From equations (13), (14) and (15) and the definition of the discount rate it follows that

\[
d_{3-1} < d_{2-1} - \rho \tag{16}
\]

Thus time frame effects could arise if consumption is becoming more uncertain as one looks further into the future, irrespective of any expected changes in consumption.

**Magnitude Effects**

As with time frame effects, magnitude effects do not imply rejection of the discounted utility model, although they are inconsistent with an assumption of perfect capital markets. As I will show, credit rationing makes some kind of magnitude effect likely, although it need not be negative.

The large magnitude games did not measure the response to marginal changes and therefore did not measure the marginal rate of substitution. Instead, they measured how much of a shift in an individual's consumption possibility set at one date is required for the individual to be indifferent to a shift in his consumption possibility set at another date.

This is pictured in Figure 1. The individual's production possibilities frontier is shown as curve PP and initial consumption possibilities frontier is shown as curve AA. The difference
between the consumption set and the production set is of course due to the possibility of constrained trade in the credit market. A reward of \( \Delta x_1 \) in the first period shifts the consumption frontier to the right by \( \Delta x_1 \) to BB, while a reward of \( \Delta x_2 \) shifts the consumption frontier up by \( \Delta x_2 \) to CC. The early reference point experiments determine the size of \( \Delta x_2 \) given \( \Delta x_1 \) so that both BB and CC are tangent to the same indifference curve (U). The late reference point experiments do the reverse.

If there is a perfect capital market, the consumption possibilities frontier will be linear with a slope of \(-/(1+r)\) that is unaffected whether it is shifted to the right or upwards. Thus there is no magnitude effect in this case. If there are credit constraints, the consumption frontier will in general be nonlinear on the rationed portion of the frontier (if the production frontier is nonlinear). Thus if an individual is credit rationed, it would only be by coincidence if the slope \(-\Delta x_2/\Delta x_1\) for large rewards were equal to the marginal rate of substitution \(-dx_2/dx_1\).

This argument demonstrates that some type of magnitude effect is likely, but does not explain why such an effect should be predominantly negative. A possible explanation of negative magnitude effects is that individuals view a promise of a reward in the second period as an asset that can be used as collateral for credit taken in the first period.\(^{18}\) As such, it may help release the credit constraint, resulting in an outward as well as upward shift of the consumption frontier (CC). In contrast, the first period reward is not likely to be usable as collateral against loans taken in the first period because the reward may be consumed before the loan is due. The result would be to shift choices in favor of the later reward, contributing to a negative magnitude effect.
Conclusions

Experimental measurement of discount rates in two villages in south India revealed discount rates that were quite high, with median values above 50% in all experiments offering small rewards. Discount rates were significantly above the highest interest rates paid by respondents in nearly all of the experiments, providing direct evidence of credit rationing. Wealthier individuals were found to have significantly lower discount rates in three of the experiments, consistent with evidence of credit rationing in one of the villages provided by Morduch.

Significant time frame and magnitude effects consistent with the findings of earlier studies were observed using both experimental games with real rewards and hypothetical questions. Reference point effects were not significant and were in the opposite direction of that found in previous studies, although this may have resulted from confounding of magnitude effects with the reference point comparison.

The time frame and magnitude effects observed need not imply rejection of the discounted utility model of preferences. They do imply rejection of perfect capital markets and are consistent with the finding of credit rationing among sample respondents. Time frame effects may also be due in part to the term structure of interest rates and the effects of uncertainty, although seasonality of credit constraints likely plays a major role.

Given high discount rates and the presence of binding credit constraints, investments involving relatively small near term benefits such as certain types of soil and water conservation measures are likely to be substantially less attractive to farmers in these villages than those showing immediate returns. Policies can be designed to promote such longer term investments by targeting credit to specific projects, but such targetted programs can result in inefficient allocation of capital and contribute to the problem of credit rationing. A more effective long term
strategy may be to reduce the policy distortions (such as regulated interest rates) that exacerbate the problem of constrained credit. Without policy reforms and continued economic development, concerns about longer term sustainability will continue to be divorced from the reality faced by many in the third world.
Footnotes

1. The author is grateful to ICRISAT for its generous support of this research; to Tom Walker, Rolf Mueller, Dan Sumner, George Loewenstein, Hans Binswanger and Marcel Fafchamps for valuable advice and comments; and to Y. Mohan Rao and V. Bhaskar Rao, who conducted the experiments.

2. This is based on an approach used by Loewenstein (1988).

3. September and April were chosen as delivery dates because of comparable sized rice harvests occurring in those months, to control for seasonal variations in supply and demand. Rice prices are comparable in these months.

4. The choices offered in the experimental games are given in Appendix I.

5. There were seven inconsistent responses in the 1989 study: one in G1, one in G3, three in G4, one in G5 and one in G6. These were excluded from the analysis. There were no inconsistent responses in the 1991 study.

6. See Appendix II for a list of the hypothetical questions.

7. It was not possible to compute or compare mean responses to the experimental games due to the problem of censored data.

8. The nonparametric Mann-Whitney test is approximately 95% as powerful as a t-test (Siegel).

9. For the early and late reference point games to be equal in magnitude, the indifference level from the early reference game would have to be used as the magnitude of the late reference point game. For example, if we knew that an individual would be indifferent between 10 kg. of rice in September and 14 kg. of rice the following April in game G1, an equal magnitude for game G4 would be 14 kg. of rice. It was not possible to assure equal magnitudes, but the magnitudes of the later reference point games were chosen with the aim of being close to the median
indifference level of the comparable early reference point games. The median indifference levels in the early reference point games were 15-17 kg. in G1, 17 kg. in G2, and 65-70 kg. in G3, somewhat higher than the magnitudes of the comparable late reference point games (14 kg. in G4, 14 kg. in G5, 65 kg. in G6).

10. In this procedure, the predicted value of the net wealth dummy was added to the regression, where net wealth was predicted by village, age, age^2, sex, family size, and caste of the respondent. Under the null hypothesis that net wealth is exogenous, the coefficient of predicted net wealth should not be significantly different from zero.

11. Different orders of the games were randomly assigned within each landholding category of the sample. One third of the respondents participating in games G1, G2, and G3 played in the order G1-G2-G3, one third played G2-G3-G1 and one third played G3-G1-G2. Similarly, one third of those playing G4, G5, and G6 played in the order G4-G5-G6, one third played G5-G6-G4 and one third played G6-G4-G5.

12. The share of censored responses in the games were 35% in G1, 42% in G2, 37% in G3, 54% in G4, 62% in G5, and 48% in G6.

13. At prices prevailing in August 1989, 10 kg. of rice was worth about 3 days wages for a typical male agricultural worker. We chose this amount aiming to strike a balance between the need to consider small enough changes to approximate the marginal rate of substitution and the desire to offer significant enough incentives for the respondents to take the experimental games seriously.

14. Note that the rate of time preference is distinct from the discount rate. As a measure of the marginal rate of intertemporal substitution, the discount rate generally depends on consumption levels whereas the rate of time preference does not. If consumption is constant or the single period utility function v() exhibits constant marginal utility, the rate of time preference and the discount rate will be equal (Olson and Bailey).
15. Data from Renkow (1988). The regression estimates using Renkow’s quarterly estimates of nondurable goods consumption are

\[ \text{Consumption} = -4334 + 68.9 \times \text{Crop Year} - 159 \times Q1 - 16 \times Q2 + 85 \times Q3 \]

(t-statistics): (4.33) (-2.04) (-0.21) (1.11)

where Crop Year is the year beginning July 1 (for example, Crop Year = 80 for the year July 1, 1980 to June 30, 1981), Q1 is a dummy variable for the first quarter (July 1 to September 30), etc. Mean consumption for the sample was Rs. 1139.

16. The discount rate in the 19 month comparison is lower than in the 7 month comparison because the average consumption growth rate is lower in the 19 month comparison; i.e., the 19 month average growth rate combines a smaller annual growth rate with the higher seasonal growth rate.

17. This assumption is consistent with (but not necessary for) increasing partial risk aversion, which Binswanger (1981) found in an experimental study of risk attitudes in six villages, including the two in the present study.

18. I am indebted to Marcel Fafchamps for pointing out this possibility.
References


Pender, J.L. (1990), "Experimental Measurement of Discount Rates in Rural India", Paper
presented at 1990 American Agricultural Economics Association meetings.


Appendix I. The Experimental Games

Below are the choices offered in the experimental games (the continuous time discount rate implied if the respondent is indifferent is given in parentheses).

G1:

1) 10 kg. in Sept. 1989 or 9 kg. in April 1990 (-18%)
2) 10 kg. in Sept. 1989 or 10 kg. in April 1990 (0%)
3) 10 kg. in Sept. 1989 or 11 kg. in April 1990 (16)
4) 10 kg. in Sept. 1989 or 12 kg. in April 1990 (31)
5) 10 kg. in Sept. 1989 or 13 kg. in April 1990 (45)
6) 10 kg. in Sept. 1989 or 15 kg. in April 1990 (70)
7) 10 kg. in Sept. 1989 or 17 kg. in April 1990 (91)
8) 10 kg. in Sept. 1989 or 20 kg. in April 1990 (119)

G2:

1) 10 kg. in Sept. 1989 or 9 kg. in Sept. 1990 (-11%)
2) 10 kg. in Sept. 1989 or 10 kg. in Sept. 1990 (0%)
3) 10 kg. in Sept. 1989 or 11 kg. in Sept. 1990 (10)
4) 10 kg. in Sept. 1989 or 12 kg. in Sept. 1990 (18)
5) 10 kg. in Sept. 1989 or 13 kg. in Sept. 1990 (26)
6) 10 kg. in Sept. 1989 or 15 kg. in Sept. 1990 (41)
7) 10 kg. in Sept. 1989 or 17 kg. in Sept. 1990 (53)
8) 10 kg. in Sept. 1989 or 20 kg. in Sept. 1990 (69)
G3:

1) 50 kg. in Sept. 1989 or 45 kg. in Sept. 1990 (-11%)
2) 50 kg. in Sept. 1989 or 50 kg. in Sept. 1990 (0%)
3) 50 kg. in Sept. 1989 or 52 kg. in Sept. 1990 (4)
4) 50 kg. in Sept. 1989 or 54 kg. in Sept. 1990 (8)
5) 50 kg. in Sept. 1989 or 57 kg. in Sept. 1990 (13)
6) 50 kg. in Sept. 1989 or 60 kg. in Sept. 1990 (18)
7) 50 kg. in Sept. 1989 or 65 kg. in Sept. 1990 (26)
8) 50 kg. in Sept. 1989 or 70 kg. in Sept. 1990 (34)
9) 50 kg. in Sept. 1989 or 80 kg. in Sept. 1990 (47)
10) 50 kg. in Sept. 1989 or 100 kg. in Sept. 1990 (69)

G4:

1) 14 kg. in April 1990 or 7 kg. in Sept. 1989 (119%)
2) 14 kg. in April 1990 or 8 kg. in Sept. 1989 (96)
3) 14 kg. in April 1990 or 9 kg. in Sept. 1989 (76)
4) 14 kg. in April 1990 or 10 kg. in Sept. 1989 (58)
5) 14 kg. in April 1990 or 11 kg. in Sept. 1989 (41)
6) 14 kg. in April 1990 or 12 kg. in Sept. 1989 (26)
7) 14 kg. in April 1990 or 13 kg. in Sept. 1989 (13)
8) 14 kg. in April 1990 or 14 kg. in Sept. 1989 (0)
9) 14 kg. in April 1990 or 15 kg. in Sept. 1989 (-12)
G5:

1) 14 kg. in Sept. 1990 or 7 kg. in Sept. 1989 (69%)
2) 14 kg. in Sept. 1990 or 8 kg. in Sept. 1989 (56)
3) 14 kg. in Sept. 1990 or 9 kg. in Sept. 1989 (44)
4) 14 kg. in Sept. 1990 or 10 kg. in Sept. 1989 (34)
5) 14 kg. in Sept. 1990 or 11 kg. in Sept. 1989 (24)
6) 14 kg. in Sept. 1990 or 12 kg. in Sept. 1989 (15)
7) 14 kg. in Sept. 1990 or 13 kg. in Sept. 1989 (7)
8) 14 kg. in Sept. 1990 or 14 kg. in Sept. 1989 (0)
9) 14 kg. in Sept. 1990 or 15 kg. in Sept. 1989 (-7)

G6:

1) 65 kg. in Sept. 1990 or 35 kg. in Sept. 1989 (62%)
2) 65 kg. in Sept. 1990 or 40 kg. in Sept. 1989 (49)
3) 65 kg. in Sept. 1990 or 45 kg. in Sept. 1989 (37)
4) 65 kg. in Sept. 1990 or 50 kg. in Sept. 1989 (26)
5) 65 kg. in Sept. 1990 or 54 kg. in Sept. 1989 (19)
6) 65 kg. in Sept. 1990 or 57 kg. in Sept. 1989 (13)
7) 65 kg. in Sept. 1990 or 60 kg. in Sept. 1989 (8)
8) 65 kg. in Sept. 1990 or 63 kg. in Sept. 1989 (3)
9) 65 kg. in Sept. 1990 or 65 kg. in Sept. 1989 (0)
10) 65 kg. in Sept. 1990 or 70 kg. in Sept. 1989 (-7)
Appendix II. Hypothetical Questions

Q1: Suppose that you have a 50 kg. bag of rice. What is the smallest amount of rice delivered in one year you would accept in exchange for the one bag you have today?

Q2: Would you trade the 50 kg. bag for two bags delivered in 5 years? What is the smallest amount delivered in 5 years you would accept in exchange for the one you have today?

Q3: If you had ten 50 kg. bags of rice, what is the smallest amount delivered next year you would accept in exchange?