Land Economics 94:3, August 2018
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Appendix

1. Elicitation of Time Preferences

Our time preference experimental design follows methods originally developed by Coller and Williams (1999) and Harrison et al. (2002), and allows for the estimation of three parameters—the conventional time discounting parameter (ρ), present-bias (β), and hyperbolicity of the discount function (θ)—in a general time discounting model using nonlinear least-squares, which allows us to test which discounting model fits the data best—exponential, hyperbolic, quasi-hyperbolic, or a more general form (we follow Benhabib et al. 2010; Tanaka et al. 2010).

In the time preference experiment subjects were asked to choose between a real-money payoff today or a larger payoff in the future. To ensure the credibility of a future payment, subjects were told that the future payments would be delivered by China Post, which is the official postal service of the People's Republic of China, an agency with which rural households are very familiar and comfortable using for the delivery of money. Furthermore, we believed the credibility problem to be minimal because our participants were part of a panel survey and this was the second time that the household had been visited by a research team from Peking University. Repeat visits by our research team built trust with and provided reassurance to the participants.[1]

Following the experimental design of Tanaka et al. (2010), the subjects were asked a total of 15 sets of questions with 5 choices each. The subjects were asked to choose Plan A or Plan B for each of the 5 questions. For example, in one series, Plan A was the future payoff plan and it remained the same for each question in the series, while the immediate plan, Plan B, increased its payments from 25 yuan to 125 yuan as the subject moved down the column, in increments of 1/6 of the future payoff. We enforced

[1] We do not specifically isolate the credibility problem in our design, namely that participants may not believe they will receive future payments, and therefore will be biased toward choosing the immediate payoff. However, in much of the behavioral economics literature, a significant proportion of the action seems to revolve around payoffs that are truly immediate versus payoffs that are not immediate (Frederick et al. 2002). Further detail about experimental design and documentation of presented time and risk choices are available from the authors upon request.

monotonic switching within each series, so the point at which an individual switches from immediate reward to future reward provides a bound on his or her discount rate.

We used 15 combinations of future payoff and time in the experiments; that is 15, 60 and 150 yuan with delays of 2 weeks, 3 months, and 6 months and 30 and 120 yuan with delays of 1 week, 2 months and 4 months. The maximum payoff of 150 yuan is equal to roughly 2 to 3 days pay in rural China (CSY 2009). For each future payoff-time combination, we asked 5 questions, with the immediate payoff equal to 1/6, 1/3, 1/2, 2/3, and 5/6 of the future payoff in the 5 question series. Once the subject had completed all 15 sets of questions, one set was randomly chosen for payment. The average payoff in the time experiment was 59 yuan. Fifty-eight subjects received payment immediately, while 45 subjects received a future payment. The average delay for future payments was 68 days.[2]

Table A1 of this Appendix compares the aggregate results of the discount rate estimates. Estimating the full model with unrestricted θ gives a relatively high value of θ=5.16, which is similar to Tanaka et al.'s (2010) estimate of θ=5.07, and influences the estimates of ρ and β but does not improve the R^2 compared with estimations from the quasi-hyperbolic model. While quasi-hyperbolic discounting model seems to fit the aggregate sample best, at the individual level the quasi-hyperbolic model has convergence problems for 32 subjects (31% of our sample), whereas there are no convergence problems for the exponential and hyperbolic models when estimating each subject's time parameters. Therefore, we use the parameter estimates from the hyperbolic model to represent the time preference of each household in our empirical model. We find that on average a subject would be willing to trade 92 yuan today for 100 in 1 week, 74 yuan today for 100 yuan in 1 month and 32 yuan today for 100 yuan in 6 months. This corresponds to an average hyperbolic time discounting parameter of 0.018, indicating a weak preference for income today.

[2] This timeframe does not correspond well with forestry timeframes. The inadequate future time frame was chosen in part for consistency with the approach of Tanaka, Camerer and Nguyen (AER, 2010). Further research is needed to address time preferences that are more relevant for forestry decisions.

2. Non-Parametric Testing for Balance in the Number of Managed Plots

As discussed in the text, a *t*-test for difference-in-means comparing the number of managed plots across households with vs. without any certified plots is subject to a form of base rate neglect. Namely, under the null hypothesis that plots are randomly assigned into treatment, households owning more plots have a higher chance of getting at least one of them selected into treatment. This should cause the mean number of plots per household in the treatment group to appear larger even in the absence of any selection bias. The observed mean difference in our sample, comparing treatment against control, is 2.08, and it is difficult to measure its deviation from random assignment with any closed-form test statistic because the relative size differences that might be observed are dependent on the distribution of plot counts across households.

To address this issue, we conduct a simulation test in which we generate the distribution of the absolute value of the mean difference, and test our estimated value of 2.08 non-parametrically against this distribution. The simulation test is conducted 10,000 times, and each replication involves random assignment of treatment to 88 of 295 available plots. The test statistic from each replication is then given by the absolute value of the mean difference (in number of plots) between households with and without any treated plots. Generating the test statistics in this way allows the test to adapt to the existing distribution of plot ownership in our sample, and to remain faithful to the combinatorics involving assignment without replacement instead of being forced to assume independent and identically distributed assignment with replacement.

The non-parametric *p*-value is then estimated to be the percentage of samples more extreme than 2.08. We are performing a one-sided test due to prior knowledge that the number of plots per household in treated-at-least-once group should be biased upwards. The simulated distribution of test statistics under the null hypothesis is depicted in Figure A1 of this Appendix. The estimated *p*-value is 0.805, indicating no evidence that managers of larger numbers of plots have any ability to influence selection of their plots into treatment at levels above those expected under random assignment.

References (not in Manuscript)

Benhabib, J., A. Bisin and A. Schotter. 2010. "Present-Bias, Quasi-hyperbolic Discounting, and Fixed Costs." *Games and Economic Behavior* 69(2): 205-223.

Coller, M. and M. B. Williams. 1999. "Eliciting Individual Discount Rates." *Experimental Economics* 2(2): 107-127.

Harrison, G. W., M. I. Lau and M. B. Williams. 2002. "Estimating Individual Discount Rates in Denmark: A Field Experiment." *The American Economic Review* 92(5): 1606-1617.

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Tables

Table A1: Summary Statistics for Time Preference Elicitations

Comparison of exponential, hyperbolic, quasi-hyperbolic and full discounting models

Parameter	Description	Exponential		Hyperbolic		Quasi-hyperbolic		Full model	
μ	Noise parameter	0.010	***	0.012	***	0.015	***	0.015	***
		(0.001)		(0.001)		(0.001)		(0.001)	
δ	Time discounting parameter	0.009	***	0.018	***	0.002	***	0.006	
		(0.001)		(0.002)		(0.000)		(0.005)	
β	Present-bias	β=1		β=1		0.573	***	0.601	***
						(0.032)		(0.039)	
θ	Hyperbolicity of the discount function	θ=1		θ=2		θ=1		5.162	
								(3.514)	
Observations		3090		3090		3090		3090	
Adjusted R^2		0.510		0.512		0.517		0.517	

Note: *, ** and *** denote significant at the 10%, 5% and 1% level, respectively.
Robust standard errors are in parentheses.

Source: Authors' data.

Table A2 (Supplement to Table 1):
Difference-in-means testing for control group vs. treatment group

Household-level characteristics

Variable	Mean Diff	Pr(|T| > |t|)	Lower 95% CI	Upper 95% CI
Discounting	-0.004	0.948	-0.122	0.114
Risk aversion	0.004	0.959	-0.164	0.173
Loss aversion*	2.838	0.075	-0.296	5.971
Probability weight dummy	-0.013	0.839	-0.143	0.116
Total number of plots managed by household***	-2.076	0.0005	-3.212	-0.939
Household member was a village cadre in 2000	-0.07	0.1603	-0.145	0.024
Household member is a member of the communist party in 2000	-0.050	0.592	-0.237	0.136
Value of livestock died (1000 yuan)	-0.051	0.796	-0.442	0.340
Household asset value per capita (1000 yuan)	3.708	0.515	-7.572	14.99

Plot-level characteristics

Variable	Mean Diff	Pr(|T| > |t|)	Lower 95% CI	Upper 95% CI
Plot has a slope >25 degrees	-0.093	0.143	-0.218	0.032
Plot area (ha)	-0.433	0.286	-1.233	0.366
Distance to home (km)	-0.026	0.892	-0.401	0.349
Distance to road (km)	0.147	0.677	-0.229	0.352
Bamboo	0.078	0.207	-0.043	0.199

Notes: Statistical significance is evaluated for each variable using a two-tailed t-test for difference-in-means. *, **, and *** denote p<0.10, p<0.05, and p<0.01, respectively. As discussed in Table 2, the t-test for number of plots is included for consistency with the other tests but is not an appropriate test for sample balance. Please see the Section 2 of this Appendix for further detail.

Figures

Figure A1:
Simulated distribution of mean difference in managed plots under H0.