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Abstract

Intertemporal choice experiments are frequently implemented to make inference about time preferences, yet little is known about the predictive power of resulting measures. This project links standard experimental choices to a decision on the desire to smooth a large-stakes payment — around 10% of annual income — through time. In a sample of around 400 Guatemalan Conditional Cash Transfer recipients, we find that preferences over large-stakes payment plans are closely predicted by experimental measures of patience and diminishing marginal utility. These represent the first findings in the literature on the predictive content of experimentally elicited intertemporal preferences for large-stakes decisions.

JEL classification: D1, D3, D90

Keywords: Structural estimation, Out-of-sample prediction, Discounting, Convex Time Budget

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1 Introduction

Intertemporal choice is prevalent in economic decision making. Explicit characterization of structural discounting models has led to widely appreciated theoretical developments (Samuelson, 1937; Koopmans, 1960; Laibson, 1997; O'Donoghue and Rabin, 2001). Measurement of the broad forces of these models and corresponding utility parameters has received deserved empirical attention as well, with notable contributions in both laboratory and field settings.[1]

A prominent discussion related to the measurement of intertemporal preferences has developed in the last decade. Frederick, Loewenstein and O'Donoghue (2002) note a critical issue: the confounding effects of diminishing marginal utility for making inference on patience. A decision maker who is indifferent between \$45 today and \$50 in one month can be arbitrarily impatient depending on changes in utility over this range.[2] Diminishing marginal utility confounds both quantitative and qualitative predictions of measured discounting models. Erroneous inference on the level of discounting will lead to poor quantitative out-of-sample prediction; while attributing to discounting a behavior that is truly driven by diminishing marginal utility may lead even qualitative predictions to be incorrect.

Recognizing this confounding effect, recent work has developed experimental methodology to identify diminishing marginal utility alongside discounting parameters (Andersen, Harrison, Lau and Rutstrom, 2008; Andreoni and Sprenger, 2012).[3] Although this work shows that estimates of discounting are indeed influenced by the shape of utility, it is unknown whether the corresponding parameters meaningfully predict large-stakes behavior. Given that out-of-

[1]Examples include Hausman (1979); Lawrance (1991); Warner and Pleeter (2001); Harrison, Lau and Williams (2002); Cagetti (2003); DellaVigna and Malmendier (2006); Laibson, Repetto and Tobacman (2007); Andersen, Harrison, Lau and Rutstrom (2008); Mahajan and Tarozzi (2011); Andreoni and Sprenger (2012); Fang and Wang (2015).

[2]An individual indifferent between \$45 received now and \$50 received in one month under exponential discounting reveals $u(45)/u(50) = \delta$. Let $k = u(50) - u(45)$ represent the change in utility between \$45 and \$50, such that $k/u(50) = 1 - \delta$. Normalizing $u(0) = 0$, values of $k \in (0, u(50))$ are consistent with strict monotonicity of $u(\cdot)$. As $k \to 0$, $\delta \to 1$ and as $k \to u(50)$, $\delta \to 0$.

[3]The methodologies of Andersen, Harrison, Lau and Rutstrom (2008) and Andreoni and Sprenger (2012) share a common objective, but reach starkly different conclusions with respect to marginal utility, perhaps due to the source of information used to identify marginal utility. Appendix A contains a detailed discussion of this topic.

sample prediction is a central use for structural estimates, this gap in the literature is potentially important. If experimental choices are reflective of time preferences and diminishing marginal utility, they should predict relevant large-stakes decision-making outside of the experiment. If not, then the growing body of literature making inference on preferences from these designs is missing a critical piece of foundation.[4]

Our project seeks to fill this gap in the literature by linking experimental choices and corresponding preference estimates to a large-stakes decision to smooth intertemporal payments, valuing around 10% of annual income. Our data come from a low-income, low-literacy and low-numeracy sample of 490 participants in Guatemala's "Mi Bono Seguro" Conditional Cash Transfer (CCT) program.[5] In a first task, all subjects completed the modified Convex Time Budget (CTB) tasks of Andreoni, Kuhn and Sprenger (2015). Subjects allocate an experimental budget over two payment dates, one sooner and one later. Choosing interior allocations with smooth payments over the two dates is interpreted as evidence of diminishing marginal utility, while allocating more funds to the sooner date is interpreted as reflecting greater impatience.[6]

Then, in a second task, subjects were entered into a draw with a one-in-thirty chance of receiving GTQ1,200 (around $164). This amount represents at least sixty percent of the monthly household income for most (87%) of our subjects, and more than one month's household income for the median subject. Each subject was asked to choose one of six structured payment plans, which would be implemented if they won the draw. The first payment plan was a single lump-

[4]Other works have examined correlations between experimental measures of discounting and measures such as self-reported smoking, diet and exercise, credit card borrowing and default, short-term effort decisions, small-stakes monetary tradeoffs, take up of savings commitment devices, and tax-filing behavior (Chabris, Laibson, Morris, Schuldt and Taubinsky, 2008b; Meier and Sprenger, 2010, 2012; Andreoni, Callen, Khan, Jaffar and Sprenger, 2018b; Ashraf, Karlan and Yin, 2006; Martinez, Meier and Sprenger, 2017; Andreoni, Kuhn and Sprenger, 2015). Although those works point helpfully towards the predictive content of experimental measures for low-to-moderate stakes with single and repeated decisions, they do not investigate behavior under large stakes, with the exception of Andreoni, Kuhn and Sprenger (2015); Andreoni, Callen, Khan, Jaffar and Sprenger (2018b), and do not utilize methods designed to simultaneously elicit curvature and discounting.

[5]Relative to most laboratory samples, we view these subjects as potentially more likely to be confused by arguably complex experimental designs. Critiques about comprehensibility noted below support the hypothesis that experimental choices are reflective of confusion rather than preferences, which should lead to limited predictive power.

[6]The stakes of the CTB decisions were GTQ100 Guatemalan Quetzales (around USD12.8 at the time of the experiment). These stakes themselves are not insubstantial, representing two-thirds of the monthly transfer for eligible recipients from the "Mi Bono Seguro" program.

sum payment of GTQ1,200 received on a fixed date after the experiment. The other payment plans featured multiple smaller payments with equal total value, such as two GTQ600 payments received three months apart. Diminishing marginal utility and patience should jointly inform plan values. A more patient individual with more rapidly diminishing marginal utility should express a greater desire for multiple payment plans rather than the single payment plan.

We document several results related to diminishing marginal utility, patience and payment plan preferences. First, relative to laboratory samples with college students, our sample shows a much greater desire to smooth their CTB allocations over time. Forty-six percent of CTB choices are interior allocations and only 8.4% of subjects exhibit zero interior choices. For comparison, with a sample of University of California San Diego (UCSD) undergraduates, Andreoni, Kuhn and Sprenger (2015) find only 12% interior allocations and that 60% of subjects exhibit zero interior choices. Corresponding structural estimates of preferences demonstrate marginal utility decreasing substantially over the CTB payment values, reflecting the preference for smooth intertemporal payments.[7] Subjects are estimated to discount the future at around 1.73% per month, or 23.20% per year. Given these estimates of marginal utility and patience, multiple payment plans should be around 20% more valuable on average than the single payment plan. Echoing this aggregate prediction, 78% of subjects actually chose one of these smooth payment plans.

Second, preferences over payment plans are closely in accordance with CTB behavior and estimated preferences. In reduced form, subjects who chose the single payment plan made significantly more impatient and significantly fewer interior CTB allocations than those who chose smooth payment plans. Correspondingly, subjects who chose the single payment plan have estimated discounted utility functions that are significantly less concave and less patient than subjects who chose smooth payment plans. These differential estimates generate starkly different estimated plan values. Subjects who chose the single payment plan are estimated to value the single payment plan around 10% more than the average smooth payment plan. Sub-

[7] Although diminishing marginal utility is estimated to be substantial, it is still very far from estimates informed by risky choice experiments (Andersen, Harrison, Lau and Rutstrom, 2008).

jects who chose smooth payment plans are estimated to value the average smooth payment plan around 35% more than the single payment plan. Individual preference estimates corroborate these findings with sharp differences in estimated preferences and plan values across single and smooth payment choice.

To the best of our knowledge, our findings are the first to examine the predictive content of experimentally elicited measures of discounting and marginal utility for large-stakes decisions. Our specific application yields several additional contributions and implications. First, a literature has recently evolved that questions the use of monetary payments in the measurement of time preferences. When liquidity constraints are absent, monetary discounting choices should reveal nothing about individual consumption preferences, only the interval of borrowing and lending rates (for discussion, see Cubitt and Read, 2007; Chabris, Laibson and Schuldt, 2008a; Andreoni and Sprenger, 2012). Further, in CTB designs these arbitrage arguments imply that only corner solutions, consistent with maximizing present value at the market interest rate, should be observed. Indeed, Augenblick, Niederle and Sprenger (2015); Sprenger (2015) interpret the preponderance of corner solutions in monetary choice for college samples as potential evidence of arbitrage. However, our subjects are particularly likely to be liquidity constrained, as they are uniformly of low income, with 92.2% having no savings in any financial institution and 86.6% reporting never having used a credit card. Indeed, these subjects seem to use both the CTB experiment and the structured payment plans to smooth consumption over time. In the discussion of the use of monetary payments to elicit discounting, it may be particularly valuable to explicitly measure liquidity constraints and examine the proportion of CTB interior solutions to evaluate the plausibility of arbitrage, and hence the plausibility that true intertemporal preferences are being captured in experimental response.

Second, our results examine the link between experimental responses and payment plan choice through both reduced-form and structural lenses. Our structural exercise goes beyond simple correlation of preference estimates with subsequent behavior.[8] Structural estimates are

[8]Examples of such correlational work include Chabris, Laibson, Morris, Schuldt and Taubinsky (2008b); Meier and Sprenger (2010, 2012); Ashraf, Karlan and Yin (2006); Martinez, Meier and Sprenger (2017).

used to predict plan values and whether smooth or single payment plans will be preferred. We demonstrate consistency between predicted values and actual plan choice at the aggregate and individual levels. Providing out-of-sample predictions is one of the major values of structural exercises beyond counterfactual construction and welfare exercises (Card, DellaVigna and Malmendier, 2011). Our project joins a small literature that aims to test the out-of-sample *point* predictions made from experimental estimates of time preferences (Andreoni, Kuhn and Sprenger, 2015; Andreoni, Callen, Khan, Jaffar and Sprenger, 2018b).

Third, contracts such as our structured payment plans are a frequent form of contract choice (examples include lottery payment, lawsuit payment, annuity buyouts, leases, and rent-to-own agreements). Our analysis shows that predicting these temporal contract choices is greatly aided by the measurement of diminishing marginal utility. We make this point concretely in our analysis by demonstrating a sharp drop in predictive value when ignoring differences in marginal utility across subjects.

The paper proceeds as follows: Section 2 describes our study environment and implementation. Section 3 presents results for reduced form analysis, structural estimation and large stake choice predictions and robustness tests. Section 4 concludes.

2 Experimental Design and Structural Estimation

2.1 Environment and Sample

The data that are used in this paper are from an artefactual field experiment conducted in Guatemala in 2013. Our sample consists of 490 participants in Guatemala's "Mi Bono Seguro" CCT program. "Mi Bono Seguro" is a targeted CCT program overseen by Guatemala's Ministry of Social Development. Program participants can receive transfers of GTQ150 (approximately USD19.2) per month for health, education, or both, provided all household members comply with the conditions.

Panel A of Table 1 provides demographic characteristics for our sample of subjects. Due to program requirements, our sample is not representative of the Guatemalan population. Our subjects are primarily married women between the ages of 18 and 76 years (mean 36 years, median 35 years), with children.[9] Our sample is comprised of impoverished households. Panel B of Table 1 shows that roughly sixty percent of our sample reports monthly household earnings of less than GTQ1,000 (USD128).

Panel C of Table 1 documents the levels of financial assets and access among our sample. Around two-thirds of the study participants have never had a savings account, while nearly eighty percent have never had a checking account and almost ninety percent have never used a credit card. This suggests quite limited access to liquidity for our sample. Panel D of Table 1 also provides information on liquidity and recent changes in liquidity. More than 90% of subjects have no formal or informal savings. This suggests limited savings to draw on to smooth consumption. On the day of the study, subjects had received income on average around 10.9 days prior to the study and were expecting income to arrive in another 10.1 days. This indicates that our experiment was not, on average, conducted at a time of particularly extreme liquidity conditions.[10]

2.2 Measuring Time Preferences

We elicit time preferences using the modified CTB design introduced by Andreoni, Kuhn and Sprenger (2015). In each experimental decision, subjects made an allocation to a sooner payment, x_t, and a later payment, x_{t+k}, at a given marginal rate of transformation. Specifically, each allocation is required to satisfy the future value budget constraint

$$Px_t + x_{t+k} = M, \tag{1}$$

[9] As with most CCT programs, funds are usually disbursed to adult women within a recipient household. Exceptions are only made when there is no adult woman present. For instance, if a mother is not yet eighteen years old or has passed away, then funds are disbursed to an adult male in the household.

[10] In subsection 3.3.3, we relate cross-sectional variation in liquidity to experimental behavior.

Table 1: Socio-Demographic Characteristics

Characteristic	Full Sample #Obs	Full Sample Mean [Median] (s.e)	Analysis sample #Obs	Analysis sample Mean [Median] (s.e)
Panel A: Socio-Demographics Information				
Female	490	0.99	408	0.99
Age	470	36.02 [35.04]	390	35.98 [35.22]
		(0.42)		(0.45)
Married or with Partner	490	0.72	408	0.71
Household Size	490	5.84 [5]	408	5.86 [5]
		(0.10)		(0.11)
Number of Children	490	3.04 [3]	408	3.07 [3]
		(0.07)		(0.08)
Head of Household	490	0.39	408	0.37
Panel B: Monthly Household Income				
< GTQ500 (USD64)	490	0.22	408	0.21
GTQ501 - GTQ1,000 (USD64-USD128)	490	0.39	408	0.39
GTQ1,001 - GTQ2,000 (USD128-USD256)	490	0.26	408	0.26
GTQ2,001 - GTQ3,000 (USD256-USD384)	490	0.07	408	0.07
> Q3,001 (USD384)	490	0.01	408	0.01
Panel C: Financial Access Information				
Never Had Savings Account	490	0.66	408	0.66
Never Had Checking Account	490	0.77	408	0.78
Never Used Credit Card	490	0.86	408	0.88
Never Applied for a Loan	490	0.63	408	0.63
Panel D: Liquidity and Changes to Liquidity				
Any Formal Savings	485	0.08	405	0.09
Formal Savings > GTQ500 (USD64)	490	0.07	408	0.08
Any Informal Savings	487	0.07	406	0.08
Informal Savings > GTQ500 (USD64)	490	0.07	408	0.08
Any Savings Plan	490	0.06	408	0.06
Days Since Last Income (Self)	490	10.87 [5]	408	10.98 [5]
Days Since Last Income (Household)	490	9.31 [5]	408	9.17 [5]
Days Until Next Income (Self)	490	10.11 [5]	408	10.37 [5]
Days Until Next Income (Household)	490	8.71 [5]	408	8.88 [5]

Notes: Demographic characteristics measured from self-reports in end-of-experiment survey. Our Analysis Sample excludes 29 individuals who showed no variation in all 24 choices, 45 individuals who showed more than 4 non-monotonic choices that differed by more than one category, and 8 individuals who chose custom payment plans.

where M is the total budget to be allocated, and P captures the rate at which money delayed from the sooner, t, to the later payment date, $t + k$, is transformed. The central difference between the modified CTB design and the original CTB is that subjects' allocation options were restricted to a subset of six points along the budget rather than having a continuum of available options. Participants were instructed to choose their most preferred option. Figure 1 contains a sample question, as it was presented to participants, with $P = 1.25$. Each option specified the amount at time t, the amount at time $t + k$, and the total amount. Since many participants had low levels of literacy and numeracy, we presented all choices in the CTB using both numbers, and pictures of the associated quantities of money. The CTB followed the procedure used in Andreoni, Kuhn and Sprenger (2015), for which amounts were denominated in local currency (GTQ) and scaled up by a multiple of 5.[11] Following Andreoni, Kuhn and Sprenger (2015), we consider $t \in \{0, 35\}$, and $k \in \{36, 63\}$, for a total of four combinations of t and $t + k$. For each of these combinations there were six budgets, each with a different value of P. These parameters are summarized in Table B.1 of Appendix B.

As described in Andreoni, Kuhn and Sprenger (2015), the inclusion of interior options, in which a participant can receive a positive amount at both time t and time $t + k$, permits identification of diminishing marginal utility from variation in P. A person with more rapidly diminishing marginal utility will exhibit less sensitivity to price, a smaller elasticity of intertemporal substitution. Variation in delay length, k, permits identification of discounting, and comparing behavior in cases where the sooner amount is delayed (i.e., $t = 35$) with cases where it is not (i.e., $t = 0$) identifies present bias.[12]

[11] The average market exchange rate from February to March 2013 was GTQ7.82 per USD. According to the World Development Indicators, 2013 international dollars at purchasing power parity (PPP$), using the conversion factor for private consumption was GTQ4.05 per PPP$.

[12] To explore robustness, we also introduced three between-session variations in the CTB. First, for a given combination of t and $t + k$, we varied the order in which participants saw the six budgets. In a given session, the value of P was either monotonically increasing or decreasing across the six budgets associated with a given t and $t + k$. Second, the options within a given budget were ordered such that the sooner amount was either monotonically increasing or decreasing. Finally, the GTQ25 participation payment which was added to both payments at time t and time $t + k$ was explicitly shown in all CTB options in some sessions. This treatment simply varies the salience of the participation fee, as this information was also given to all participants prior to completing the tasks. The effects of these design features are quite limited and we discuss them primarily in Appendix C.5 on robustness.

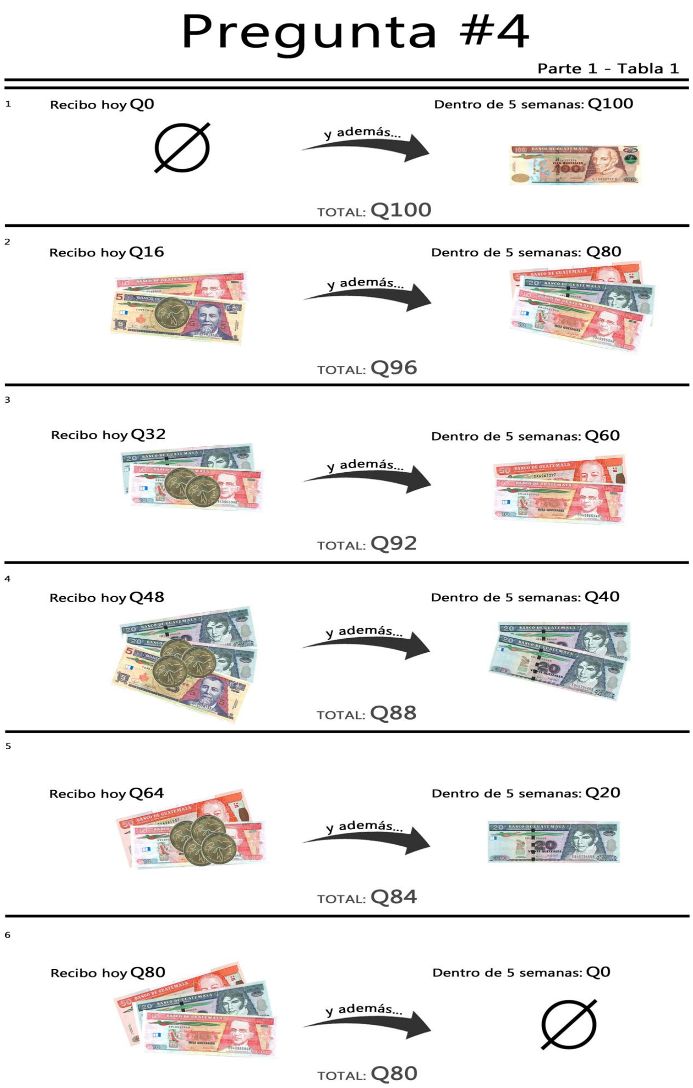

Figure 1: Sample question, as it was presented to participants, with $P = 1.25$.

In total, subjects made allocations in 24 CTB tasks. One task for each subject was chosen at the end of the experiment. Participants additionally earned GTQ50 (about USD6.4) for participation in the experiment. Following Andreoni and Sprenger (2012), half of this participation fee was added to the sooner payment and half was added to the later payment of the randomly selected budget from the CTB. This was intended to help equalize transaction costs between options. Even if a participant was to allocate GTQ0 to a given date, she would still incur any transaction costs associated with receiving this minimum payment at that date. Participants received two checks, each with the date that they could cash it, implied by t and $t+k$ for the randomly selected allocation.[13]

2.2.1 Identifying and Estimating Time Preferences

Andreoni, Kuhn and Sprenger (2015) discuss a number of methodologies for structurally estimating time preferences from CTB data. The method that they implement in their subsequent prediction exercise for small-stakes laboratory and hypothetical decisions is based on simple regression analysis.

Preferences over bundles (x_t, x_{t+k}) are described by a time-separable, quasi-hyperbolically discounted constant relative risk averse utility function,

$$U(x_t, x_{t+k}) = \begin{cases} x_t^\alpha + \beta\delta^k x_{t+k}^\alpha & \text{if } t = 0 \\ x_t^\alpha + \delta^k x_{t+k}^\alpha & \text{if } t > 0 \end{cases}. \tag{2}$$

The parameter δ is the exponential discount factor between periods, and β is the present-bias parameter, which is applied to the later payment in the case that the earlier payment is realized in the present. The parameter, α, captures the degree of utility curvature, and hence, determines diminishing marginal utility, and the preference for smoothness in intertemporal payments.

Maximization of (2) under constraint (1) implies

$$\frac{x_t^{\alpha-1}}{\beta^{t_0}\delta^k x_{t+k}^{\alpha-1}} = P,$$

where t_0 is an indicator for whether $t = 0$. Taking logs and rearranging, one arrives at the

[13] For a few subjects, cashing bank checks did not follow the experimental protocol. Specifically, we have check cashing data for 360 of the 408 subjects in our sample, and find that for 16.4% of participants, CTB checks were cashed prior to their specified payment date. Such early cashing may be problematic if subjects forecasted the ability to do so. Evidence suggests this is not the case as someone who forecasts this ability should simply choose the maximal later payment value in each choice. There is no correlation between the amount allocated to the later date in the CTB and early cashing ($\rho = 0.0124, p = 0.814$).

linear form,

$$\ln\left(\frac{x_t}{x_{t+k}}\right) = \frac{\ln(\beta)}{\alpha-1}t_0 + \frac{\ln(\delta)}{\alpha-1}k + \frac{1}{\alpha-1}\ln(P). \tag{3}$$

Equation (3) makes clear the mapping from the variation of experimental parameters to structural parameter estimates alluded to above. Variation in P identifies the marginal utility parameter, $\alpha - 1$. For a fixed P, variation in delay length, k, identifies the discount factor, δ, and variation in t_0 identifies the present bias parameter, β.

Identifying α from the sensitivity of allocations to variation in prices highlights the connection between diminishing marginal utility and preferences for smoothness in consumption. A person with rapidly diminishing marginal utility will be relatively insensitive to price changes, and prefer smoother interior allocations to budget corners.

Estimation based on equation (3) requires formulation of an error structure. CTB applications generally impose an additive error structure, leaving equation (3) estimable with standard techniques such as ordinary least squares (OLS). Note, however, such an estimation strategy ignores the discretized nature of the modified CTB data where (x_t, x_{t+k}) takes one of six values for each allocation. Andreoni, Kuhn and Sprenger (2015) provide a number of additional estimation strategies accounting for this discreteness, documenting broadly similar estimated parameter values. We follow their approach, basing our predictions primarily on the simple least squares estimator, and we evaluate alternative estimation strategies in Appendix C.3. Note that the log allocation ratio, $\ln(\frac{x_t}{x_{t+k}})$, is not defined for corner solutions where $x_t = 0$ or $x_{t+k} = 0$. We adopt the convention of Andreoni, Kuhn and Sprenger (2015) and set these corner solution values to GTQ0.001 for the purposes of estimation.

An additional issue related to the estimation of time preferences from experimental data is background consumption. Andersen, Harrison, Lau and Rutstrom (2008) and Andreoni and Sprenger (2012) provide estimates of time preferences and marginal utility under assumptions of fixed background consumption. Andreoni and Sprenger (2012) also demonstrate a potential sensitivity of curvature estimates with respect to varying assumptions of background consumption. If, for example, the background consumption is GTQ1,000 in equation (3), then the value

$\ln(\frac{x_t+1000}{x_{t+k}+1000})$ will be relatively insensitive to variation in $\ln(P)$, and α will be estimated close to zero regardless of choice. Following equation (3), background consumption also influences estimates of δ and β, with higher assumed background consumption leading to increases in both δ and β. For our core analysis, we follow the convention (as much of the literature has done) and assume zero background consumption.[14] In Appendix C.3, we evaluate the sensitivity of our results to changes in background consumption.

For behavior in our monetary discounting tasks to be informative of consumption preferences, subjects must have limited access to liquidity. An agent who can borrow (or save) at a better rate than that implied by P should allocate her entire budget to the later (or sooner) date. Behaviorally, one should observe only corner solutions and identify only the interval of borrowing and lending rates, rather than any information about preferences. This point broadly calls into question the use of monetary discounting tasks to identify consumption preferences (Cubitt and Read, 2007; Chabris, Laibson and Schuldt, 2008a; Andreoni and Sprenger, 2012).[15] Table 1 demonstrates that our sample is likely to be liquidity constrained, being both poor and with limited access to formal financial instruments. As such, one might expect our sample's behavior to be more reflective of their consumption preferences than college subject pools. Carvalho, Meier and Wang (2016) show plausible relationships between objective financial situation and behavior in CTB tasks. In subsection 3.3.3 we link liquidity and financial access variables to experimental behavior and find qualitatively similar results for groups where these potential motives are more or less prevalent.

2.3 Large-Stakes Intertemporal Choice

Our experimental methodology identifies time preferences and marginal utility from CTB choices with a future value of GTQ100. These stakes are substantial for our sample; they are

[14] A background consumption parameter of zero is consistent with the literature on mental accounting, specifically related to narrow bracketing (Read, Loewenstein, Rabin, Keren and Laibson, 1999; Thaler, 1999).

[15] On the other hand, Andreoni, Gravert, Kuhn, Saccardo and Yang (2018a) presents evidence that even under favorable conditions (i.e., college students with access to instant bank transfers) choices in the CTB task are far from the perfect arbitrage prediction.

about two thirds of a monthly "Mi Bono Seguro" transfer. Our high-stakes decisions involve twelve times that amount. Each participant was assigned a one-in-thirty chance of winning GTQ1,200. This sum amounts to more than a month of household income for around 60% of individuals in our sample.

After completing the CTB tasks, each participant was asked to specify how they would like to receive these GTQ1,200 over a six month period, supposing that they won the draw. Six payment plan choices were available to subjects, varying the timing of payments. All options had the same date for the first payment, 7 to 20 days after the date of the experiment.[16] Depending on the option chosen, subsequent payments would take place at fixed intervals after the first payment. One payment plan option was to receive a single payment of GTQ1,200 on the 22nd or 8th of the month. The remaining payment plans provided opportunities to smooth intertemporal payments with multiple payment options. Subjects could select two tri-monthly payments of GTQ600, three bi-monthly payments of GTQ400, six monthly payments of GTQ200, 12 bi-weekly payments of GTQ100, or customize a monthly payment schedule. Figure 2 provides an example of the paradigm.[17]

Subjects did not know the outcome of the randomization for their CTB choices prior to making payment plan decisions, and they were not informed of the upcoming plan decisions when making CTB choices, limiting potential pollution across tasks. Furthermore, when payment plan options were being presented, subjects were informed that upon winning, they would have to choose between receiving the payment from the CTB allocation (GTQ100) or from the payment plan (GTQ1,200). This ensures that potential CTB payment dates would not affect choices over payment plan options as subjects knew they would only be paid for one of the two.

[16]The first payment date was set to either the 22nd or 8th of the current or next month, depending on the date of the session, so as to leave at least one week and no more than three weeks between the session and the first payment date.

[17]In order to evaluate robustness of decisions to framing effects, in around half of the sessions, we varied the order in which these options were presented (either increasing or decreasing the number of payments). Behavioral differences are evaluated in Appendix C.5.

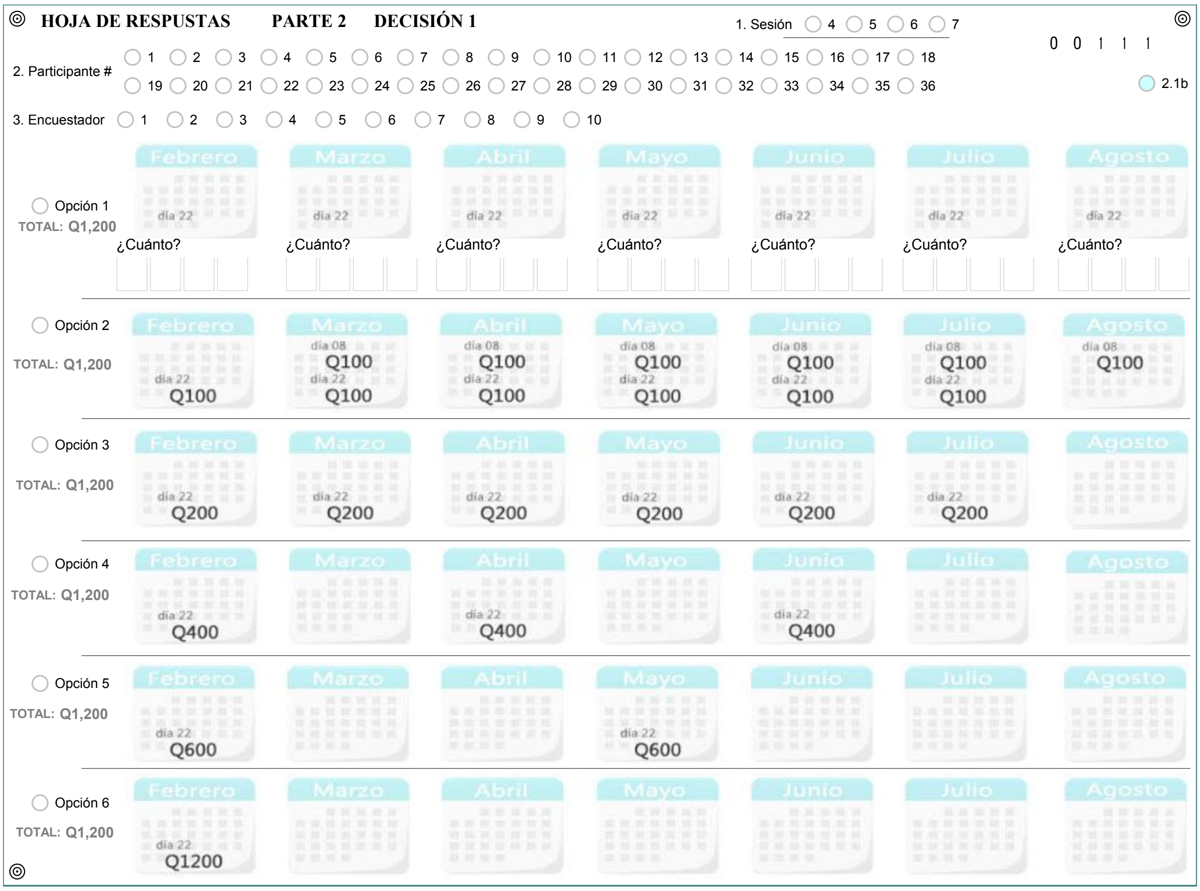

Figure 2: Example of a question about large-stakes intertemporal choice

2.4 Session Protocols

As participants arrived, they were asked to provide (oral) informed consent and were registered before the start of the session. Each session was conducted by a session leader who had a team of assistants. After welcoming the participants, the session leader gave a presentation of the instructions, which was projected in the room. The text of these instructions, translated from the original Spanish, can be found in Appendix D.

Due to participants' low levels of formal education and literacy, we provided individual support to each participant throughout the session. In particular, assistants asked each participant the questions for each experimental task individually, resolved any questions as they arose, and recorded the participants' decisions. In addition, we presented each choice in the experimental tasks with visual aids and the presentation was intended to increase understanding.

Once participants had finished all the experimental tasks, they completed, again with the help of an assistant, a socio-demographic survey. Their answers in this survey were not incentivized. While the surveys were administered, participants received a snack, and something to drink.

Each session lasted between three and four hours. A total of 23 sessions were run. In each of these sessions, between 15 and 24 participants were present. Sessions were conducted during February and March of 2013, and were run in 12 municipalities across 4 counties.

All 490 subjects who were initially selected for the experiment completed both the CTB tasks and their large-stakes payment plan choice. Among the CTB decisions, twenty-nine (5.9%) subjects exhibited no variation in experimental response across all 24 tasks. Additionally 45 subjects (9.8%) exhibited substantial non-monotonicities in demand, increasing their allocation to the sooner payment date by more than one position as P increased 4 or more times in 20 opportunities.[18] These subjects are all removed from the analysis. Among the large-stakes payment plan choice, 8 (1.74%) chose to customize their payment plan. For ease of explication, we ignore this small sub-sample as well. Our final sample of subjects for analysis is 408 subjects. Table 1 shows separate demographic characteristics for the full sample and the analysis sample showing limited demographic differences.

[18] A more extreme measure that may be more familiar to readers, is switching from allocating the entire budget to the later payment to allocating the entire budget to the sooner payment, as P increases. Sixty-seven subjects (14.5%) exhibited such extreme non-monotonicity, at least once. This figure compares favorably to the similar behavior of multiple switching in standard price list experiments (see, e.g., Holt and Laury, 2002; Meier and Sprenger, 2010). In Figure B.1 of Appendix B, we present histograms from the frequency of monotonicity violations across subjects, demonstrating that most of our analysis sample respects monotonicity at high rates.

3 Results

We present the results in three broad sections. In the first subsection, we analyze the reduced-form relationship between choice over structured payment plans and experimental responses. In the second subsection, we present structural analysis linking intertemporal preference parameters to plan choice at both the aggregate and individual levels. In the third subsection, we present robustness tests and additional analyses.

3.1 Reduced-Form Results

Table 2 presents plan choices for the 408 subjects in our analysis sample. Ninety subjects (22%) opted for the single payment plan of GTQ1,200 and 318 subjects (78%) chose one of the smooth payment plans. Among smooth payment plans, a similar proportion of subjects chose two, three, and six payment plans, with only a small minority of subjects opting for twelve bi-weekly payments of GTQ100. Table 2 also provides summaries of experimental choices in the CTB design. We calculate the proportion of allocations that are impatient (the entire budget is allocated to the sooner date), patient (the entire budget is allocated to the later date), and interior. Forty-six percent of allocations are interior allocations, and only 34 of 408 subjects (8.4%) made zero interior allocations in 24 opportunities. These choice patterns differ qualitatively from CTB experiments in college subject pools. For example, with UCSD undergraduates Andreoni, Kuhn and Sprenger (2015) report 12% interior allocations with 60% of subjects making zero interior allocations in 24 opportunities.[19] With non-diminishing marginal utility, one would expect only corner solutions in our CTBs, where the entire budget is allocated to either the sooner or later payment depending on the rate of interest. Similarly, with non-diminishing marginal utility, one would expect a preference for the single payment plan among the payment plan options. Observed choices in both settings suggest an important role for diminishing marginal utility; a preference for smoothing intertemporal payments is observed

[19] In developing country sample, interior allocations appear more frequent. Kramer, Janssens and Swart (2013) and Giné, Goldberg, Silverman and Yang (2012) document in the range of 45% and 69% interior allocations.

in both CTB and payment plan choice.

Table 2: Payment Plan Choice and CTB Response

Payment Plan Choice	# Observations (% of Total)	CTB Choice Impatient	Interior	Patient
Chose Single Payment Plan (GTQ1,200)	90 (22%)	0.22	0.41	0.37
Chose Any Smooth Payment Plan	318 (78%)	0.13	0.47	0.39
Two Payments (GTQ600)	111 (27%)	0.13	0.38	0.48
Three Payments (GTQ400)	84 (21%)	0.14	0.48	0.37
Six Payments (GTQ200)	87 (21%)	0.11	0.56	0.33
Twelve Payments (GTQ100)	36 (9%)	0.14	0.52	0.33
Total	408 (100%)	0.15	0.46	0.39

Notes: plan choice for 408 participants and Convex Time Budget (CTB) Choice. Impatient (Patient) choice reflects subject allocating entire budget to sooner (later) payment.

Table 2 provides separate calculations for the proportion of impatient, interior, and patient CTB behavior for each subgroup of payment plan choice. Interestingly, raw behavior seems to differ by plan choice. Subjects who chose the single payment option make around 9%-age points (70%) more impatient choices and 6%-age points (13%) fewer interior allocations than subjects who chose smooth payment plans.[20] These patterns carry a natural intuition. Greater patience and more rapidly diminishing marginal utility, as conveyed by more interior and more patient allocations, are linked to choosing smooth payment plans.

Figure 3 and Table 3 analyze the relationship between plan choice and experimental behavior

[20]Among subjects choosing smooth payment plans further differences are observed, with a high number of payments correlating with a greater proportion of interior choices and a lesser proportion of patience choices. Among smooth payment plan subjects, the raw correlation between the number of interior and impatient choices a subject made (out of 24) and the number of payments in the structured payment plan is $\rho = 0.16$ ($p < 0.01$) and $\rho = -0.15$ ($p < 0.01$), respectively. We provide further discussion of this variation across groups in Appendix C.2.

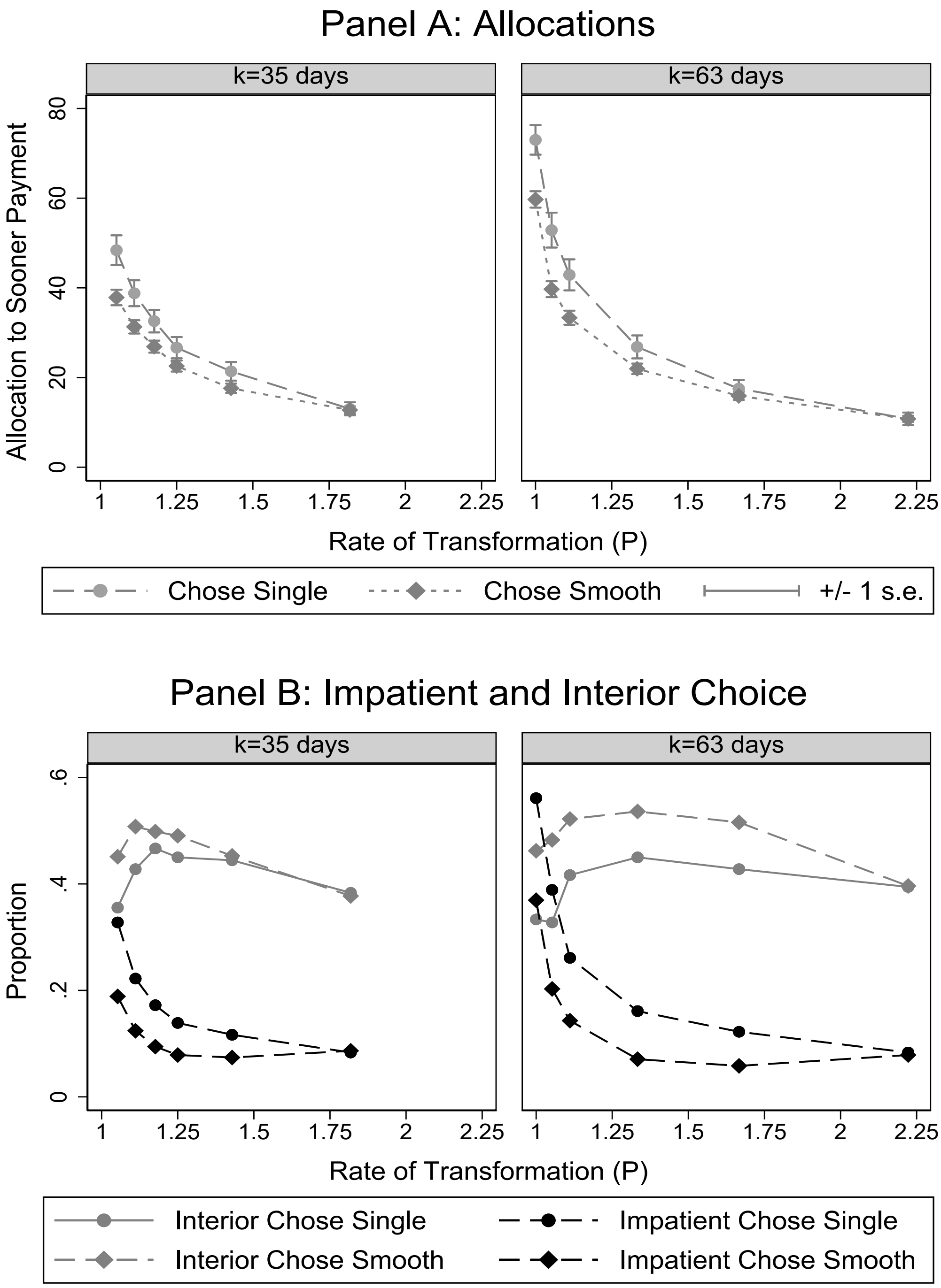

Figure 3: Allocation to the sooner payment date; proportion of impatient and interior choices.

Table 3: Plan Choice and Experimental Behavior

Dependent Variable:	Sooner Allocation		Impatient Choice		Interior Choice	
	(1)	(2)	(3)	(4)	(5)	(6)
Chose Smooth Payment Plan	-6.198***	-17.903***	-0.089***	-0.200***	0.068**	0.076
	(2.197)	(4.904)	(0.025)	(0.061)	(0.034)	(0.076)
Rate of Transformation: P	-33.492***	-42.215***	-0.176***	-0.291***	-0.059***	0.024
	(1.096)	(2.484)	(0.013)	(0.031)	(0.014)	(0.031)
Delay Length: k	0.317***	0.395***	0.003***	0.004***	0.001	-0.001
	(0.027)	(0.068)	(0.000)	(0.001)	(0.000)	(0.001)
Immediate Choice: t_0	-3.575***	-5.913***	-0.015	-0.022	-0.047***	-0.095***
	(0.806)	(1.998)	(0.009)	(0.025)	(0.013)	(0.029)
Chose Smooth × P		11.189***		0.147***		-0.107***
		(2.751)		(0.034)		(0.034)
Chose Smooth × k		-0.100		-0.002**		0.002*
		(0.074)		(0.001)		(0.001)
Chose Smooth × t_0		2.998		0.009		0.061*
		(2.177)		(0.027)		(0.033)
Constant	65.286***	74.412***	0.341***	0.427***	0.480***	0.474***
	(2.684)	(4.276)	(0.031)	(0.057)	(0.040)	(0.068)
R-Squared	0.152	0.155	0.048	0.052	0.007	0.009
# Observations	9789	9789	9789	9789	9789	9789
# Clusters	408	408	408	408	408	408

Notes: Ordinary least squares (OLS) regressions with standard errors clustered on individual level. Standard errors are reported in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

in closer detail. In Panel A of Figure 3, we present the average allocation to the sooner payment date for each value of P for the two delay lengths, $k = 35$ and $k = 63$ days.[21] At each interest rate, subjects opting for smooth payment plans allocate less money to the sooner payment. Additionally, subjects opting for smooth payment plans are less sensitive to variation in P. Columns (1) and (2) of Table 3 provide corresponding statistics. Controlling for the experimental parameters, P, k and t_0, subjects who chose smooth payment plans allocate around GTQ6 less to the sooner payment and are around 20% less sensitive to variation in P than those who chose single payment plans. Panel B of Figure 3 and columns (3) through (6) of Table 3 provide detail on the proportion of impatient and interior choices. Controlling for experimental parameters, subjects who chose smooth payment plans make significantly

[21]For the purposes of the graphic, data from observations with t_0 equal to one and equal to zero are averaged together.

fewer impatient choices and significantly more interior choices than those who chose the single payment plan.

3.2 Structural Results

The results of the prior subsection show important reduced-form linkages between payment plan choice and CTB response. Our structural exercise interprets CTB behavior through the lens of a discounted utility model. Table 4 provides aggregate estimates of α, δ, and β following equation (3) estimated via Ordinary Least Squares. For ease of explication, we discuss estimates of a monthly discount factor, δ^{30}. In column (1) of Table 4, we estimate a curvature parameter of $\alpha = 0.887$ (clustered s.e. $= 0.005$), a monthly discount factor of $\delta^{30} = 0.983$ (0.018), and a present bias parameter of $\beta = 1.164$ (0.028).

Relative to prior CTB studies with college samples, our value of α indicates substantially more concavity of utility. This parameter is informed by the preponderance of interior allocations and the corresponding lack of price sensitivity in our sample. For example, Andreoni, Kuhn and Sprenger (2015) estimate $\alpha = 0.947$ in a sample of college subjects, where only 12% of allocations are interior and 60% of subjects make zero interior allocations.[22] Our estimate of α suggests a greater degree of diminishing marginal utility, with the 1,200th quetzal (above 0) being worth around 75% of the 100th quetzal.[23]

Our aggregate estimate of the monthly discount factor implies that utility is discounted by around 1.7% per month, which lies within the range of prior estimates (Frederick, Loewenstein and O'Donoghue, 2002). In contrast, our estimate of $\beta = 1.17$ suggests aggregate future bias; an infrequent finding in the literature, which has generally found near time consistency or slight present bias in monetary CTB studies (e.g., Imai, Rutter and Camerer, 2019; Sawada and Kuroishi, 2015; Andreoni and Sprenger, 2012; Andreoni, Kuhn and Sprenger, 2015).

Columns (2) and (3) of Table 4 provide separate structural estimates of utility parameters

[22] Our results are closer to the estimates of Sawada and Kuroishi (2015). Using an adaptation of the CTB in the Philippines, those authors report α between 0.74 and 0.85 (depending on the estimation method).

[23] Calculated as $1200^{0.887-1}/100^{0.887-1} = 0.755$.

Table 4: Aggregate Parameter Estimates

	(1) Analysis Sample	(2) Chose Single Plan	(3) Chose Smooth Plan
Curvature: α	0.887	0.911	0.878
	(0.005)	(0.007)	(0.007)
Monthly Discount Factor: δ^{30}	0.983	0.893	1.020
	(0.018)	(0.029)	(0.023)
Present Bias: β	1.164	1.177	1.159
	(0.028)	(0.056)	(0.032)
Plan Value Ratio (PVR):			
Average Smooth Value/Single Value	1.166	0.900	1.306
	(0.059)	(0.064)	(0.085)
# Observations	9,789	2,158	7,631
# Clusters	408	90	318
$H_0 : \alpha_{ChoseSingle} = \alpha_{ChoseSmooth}$		$\chi^2(1) = 12.22$	
		$(p < 0.001)$	
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChoseSmooth}$		$\chi^2(1) = 12.12$	
		$(p < 0.001)$	
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth}$		$\chi^2(1) = 0.08$	
		$(p = 0.781)$	
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth}$		$\chi^2(1) = 14.48$	
		$(p < 0.001)$	

Notes: Estimates based on ordinary least squares (OLS) regression of equation (3) with standard errors clustered on individual level. Relative value of average smooth payment to single payment plan calculated from non-linear combinations of regression coefficients. The standard errors reported in parentheses are calculated using the delta method. Null hypotheses tested after regression of equation (3) with interactions for plan choice with k, t_0 and $\ln(P)$, with standard errors clustered at individual level.

for subjects who chose single and smooth payment plans. Echoing the raw data, subjects who chose smooth payment plans are estimated to have lower values of α and higher values of δ, while estimates of β are indistinguishable across groups. The null hypotheses of equal curvature and monthly discount factors across single and smooth payment groups are rejected at all conventional levels, $\chi^2(1) = 12.2$ ($p < 0.01$) and $\chi^2(1) = 12.1$ ($p < 0.01$), respectively.

Individuals who chose smooth payment plans are estimated to have higher degrees of diminishing marginal utility and patience. These characteristics deliver a desire to smooth intertemporally, and a willingness to wait for later payments, which should make smooth payment plans more valuable. In order to provide estimates of relative plan values, we calculate each plan's discounted valuation with the estimated parameters, α and δ.[24] That is, for plan j, we calculate its discounted value as

$$V_j = \left[\sum_{k=s}^{l} \delta^{k-s} x_{t+k;j}^{\alpha} \right]^{1/\alpha},$$

where $x_{t+k;j}$ is the payment prescribed by plan j at date $t+k$, s is the soonest date a payment is available (7 to 20 days from the experiment date), and l is the last payment date (around 180 days). This normalizes the discounted value of the single payment plan to the exact amount of GTQ1,200. Similarly, the two-payment plan value is $V_2 = [600^\alpha + \delta^{90} 600^\alpha]^{1/\alpha}$, and the three-payment plan value is $V_3 = [400^\alpha + \delta^{60} 400^\alpha + \delta^{120} 400^\alpha]^{1/\alpha}$. Using these values we construct the Plan Value Ratio (PVR) as the average value of all smooth plans, divided by the value of the single plan,

$$\frac{\frac{1}{4} \sum_{j \in 2,3,6,12} V_j}{V_1}.$$

Table 4 provides estimates of PVRs with standard errors calculated via the delta method. Based upon the aggregate estimates of column (1) smooth plans should have an average discounted value around 17% higher than the single payment plan. PVR estimates differ importantly by plan choice. Individuals who chose the single payment plan are predicted to value smooth payment plans around 10% less on average than the single payment plan; while individuals

[24] Differences in plan values are informed by α and δ. Because present bias alters only the level of all plan values, it has no effect on the relative value of smooth versus single payment plans.

who chose smooth payments are predicted to value smooth payment plans around 30% more on average than the single payment plan. The difference in PVRs between individuals who chose smooth or single plans is significant at all conventional levels, $\chi^2(1) = 14.5$ ($p < 0.01$).

3.2.1 Individual Structural Analyses

Our aggregate findings point to important differences in estimated preference parameters between individuals who chose the single payment plan and those who chose smooth payments plans. Aggregate structural utility estimates are closely consistent the differential choice of payment plans across groups: individuals who chose smooth (or single) plans are estimated to value them more highly. This broad correlation between estimated preferences and large stakes choice for these two groups may mask important individual-level heterogeneity. Heterogeneity in discounting parameters is widely acknowledged, with even homogeneous samples showing substantial variation (see e.g., Harrison, Lau and Williams, 2002; Ashraf, Karlan and Yin, 2006; Meier and Sprenger, 2015). CTB choices and the structural equation (3) allow for individual estimates of utility parameters. We estimate (3) via non-linear least squares restricting $0 < \alpha < 1$. Individual parameters and contract values are estimable for 343 of 408 (84%) subjects in the analysis sample.[25]

Table 5 provides individual parameter estimates and contract values for each group of subjects. For the entire sample, the median [25th-75th %-ile] estimate of α is 0.89 [0.81-0.94], while the median [25th-75th %-ile] estimate of δ^{30} is 0.95 [0.81-1.26]. Echoing the aggregate PVR predictions, the average smooth payment plan is valued around 11% more than the single payment plan and 59% of subjects are estimated to have valued some smooth payment plan more than the single payment plan.[26]

[25]The nonlinear least squares procedure with the box constraint for α was chosen as some individual ordinary least squares estimates yielded values of α outside of these bounds. For the 65 excluded individuals, our estimator fails to recover at least one parameter value leaving an estimated covariance matrix of non-full rank. We base our restriction of the sample on this full rank covariance matrix characteristic.

[26]Because some estimates of plan values are extreme, we topcode the individual PVR variable at 5. The indicator $\mathbb{1}_{Smooth>Single}$ is an indicator for whether any smooth payment plan has a higher estimated value than the single payment plan.

Table 5: Plan Choice and Individual Structural Estimates

Payment Plan Choice	# Obs (% of Total)	α 50 [25-75] %-ile	δ^{30} 50 [25-75] %-ile	β 50 [25-75] %-ile	PVR 50 [25-75] %-ile	$\mathbb{1}_{Smooth>Single}$
		Structural Estimates				
Chose Single (GTQ1,200)	80 (23%)	0.92 [0.86,0.95]	0.86 [0.76,1.20]	1.19 [0.90,1.59]	0.79 [0.64,1.84]	0.43
Chose Any Smooth Payment Plan	263 (77%)	0.88 [0.80,0.93]	0.98 [0.82,1.29]	1.16 [0.91,1.52]	1.21 [0.80,3.20]	0.65
Two Payments (GTQ600)	95 (28%)	0.90 [0.84,0.93]	1.06 [0.85,1.29]	1.16 [0.88,1.40]	1.40 [0.85,2.85]	0.69
Three Payments (GTQ400)	69 (20%)	0.88 [0.81,0.93]	0.97 [0.82,1.28]	1.14 [0.92,1.58]	1.26 [0.80,4.35]	0.65
Six Payments (GTQ200)	68 (20%)	0.87 [0.74,0.94]	0.94 [0.83,1.35]	1.19 [0.95,1.54]	1.07 [0.77,5.00]	0.62
Twelve Payments (GTQ100)	31 (9%)	0.87 [0.72,0.92]	0.89 [0.80,1.21]	1.12 [0.87,1.94]	1.03 [0.78,2.21]	0.55
Total	343 (100%)	0.89 [0.81,0.94]	0.95 [0.81,1.26]	1.16 [0.91,1.53]	1.11 [0.75,2.82]	0.59

Notes: plan choice for 364 of 453 participants with estimable individual preferences for α, δ, and β. PVR represents estimated individual average value of smooth payment contracts relative to the single payment contract. $\mathbb{1}_{Smooth>Single}$ represents an indicator for whether smooth contracts have higher estimated value than single contracts.

Differences between subgroups are readily apparent in Table 5. Individuals who chose the single payment plan have generally higher values of α and lower values of δ than those who chose smooth payment plans. Individual estimates of plan values indicate that 57% of single payment plan choosers should value the single payment plan more than any smooth payment plan, while 65% of smooth payment plan choosers should value a smooth payment plan more than the single payment plan (Fisher's Exact test, ($p < 0.01$)). Figure 4 provides histograms of individual PVRs for these two groups, showing sharp distributional differences in plan values (Mann-Whitney test, $z = 3.44$, ($p < 0.01$)).

The findings of Table 5 and Figure 4 show clear individual differences in estimated preference parameters and plan values that correspond closely with plan choices. Echoing the aggregate results, those individuals that make more patient and interior CTB choices — consistent with having more rapidly diminishing marginal utility and a higher degree of patience — prefer smooth payment plans. The preference for smoothness and willingness to wait revealed from CTB choice is closely reflected in large stakes choices over payment plans.

3.3 Robustness Tests and Additional Exercises

The results presented thus far show reduced-form and structural differences in elicited time preferences between individuals who chose single and smooth large-stakes payment plans. Esti-

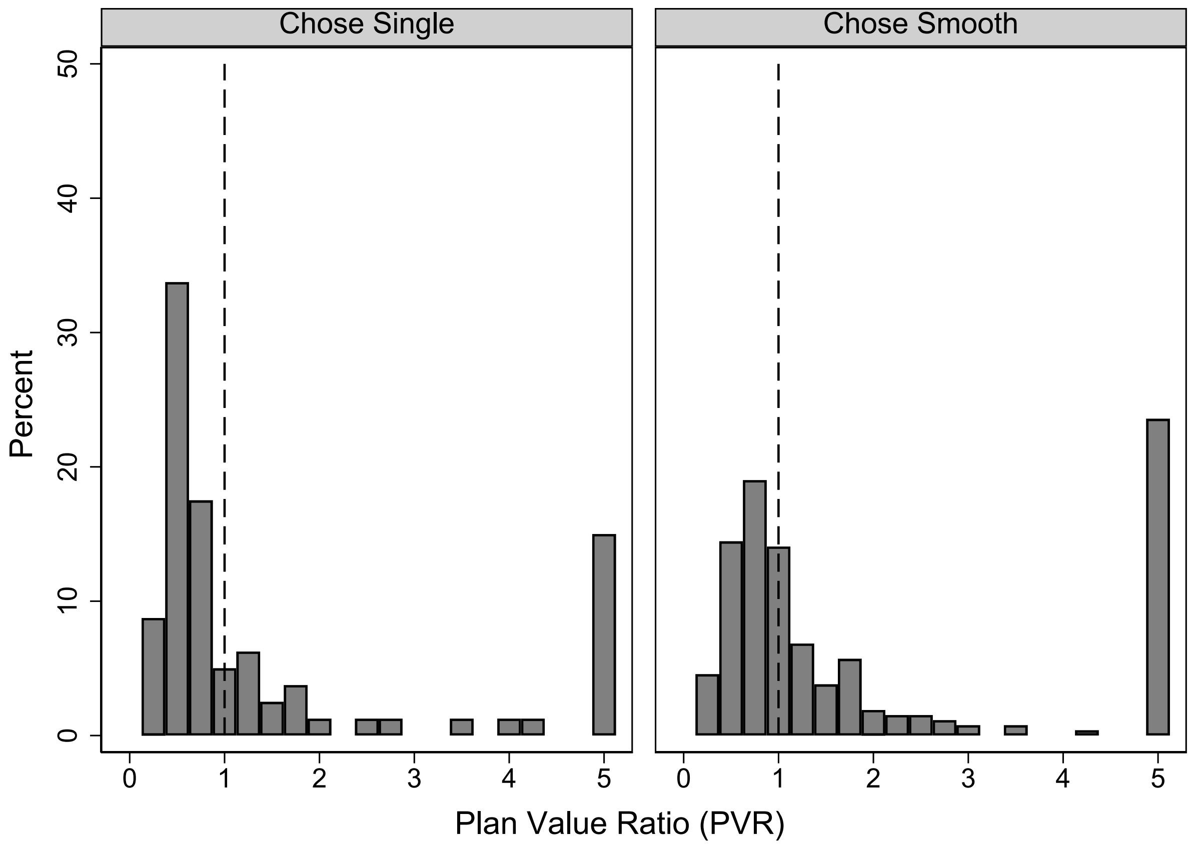

Figure 4: Plan Value Ratios (PVRs) for single and smooth payment groups.

mates of patience and marginal utility from experimental procedures are importantly predictive of large-stakes plan choice. Here, we conduct a number of additional analyses to ensure the robustness of these results.

3.3.1 Individual Measurement Error

Our aggregate and individual exercises show clear differences in CTB responses and estimated preferences between individuals who chose single and smooth payment plans. For our aggregate exercise, the analysis is based on a statistical comparison of behavior and estimated parameters across the two groups. As such, the standard errors of the relevant estimates are a constituent part of the hypothesis testing for equal estimates provided in Tables 3 and 4. In contrast, the distinction in individual PVR values highlighted in section 3.2.1 does not take into account errors in the individual estimates. In Appendix C.1 we account for these errors and the relationship between them explicitly by drawing 1000 simulants for each subject from the multivariate normal distribution established by their individual estimates. We then calculate plan values and the proportion of simulants who carry higher valuations for smooth plans relative to the single plan. Accounting for this measurement error does not change the core message established in section 3.2.1, that individual estimates correlate significantly with plan choice. See Appendix C.1 for detail.

3.3.2 Alternative Rationales for Interior Allocations

We have interpreted interior CTB allocations as evidence of diminishing marginal utility and linked this evidence with a subsequent choice to smooth large-stakes intertemporal payments. There exist several other potential rationales for making interior allocations in the CTB.

First, a number of authors have argued that confusion and miscomprehension may drive interior allocations in the CTB (Harrison, Lau and Rutstrom, 2012; Attema, Bleichrodt, Gao, Huang and Wakker, 2016; Chakraborty, Calford, Fenig and Halevy, 2017).[27] Our data show that not only interior allocations, but also more patient allocations correlate with subsequent plan choice. For such patterns to arise through a common force of confusion, and for the corresponding utility estimates to match the structured payment plan choices seems unlikely. Nonetheless, if non-monotonic choices are taken as evidence of confusion, we can examine only subjects who exhibit few non-monotonicities in choice. In columns (1) and (2) of Table 6, we provide separate analysis for subjects with one or fewer non-monotonicities and those with more than one non-monotonicity. In both sub-samples, we find differences in patience, curvature and payment plan values.[28]

[27]See Appendix A for further discussion of these points.

[28]As evidenced by the notably different levels of curvatures across the subgroups of columns (1) and (2) of Table 6, the total number of interior allocations and the total number of non-monotonicities with respect to P are correlated. For individuals with no interior allocations to exhibit non-monotonicities, they must switch from allocating the entire budget to the sooner payment to the entire budget to the later payment and then back again. That is, non-monotonicities require less extreme behavioral changes to identify when subjects make

Second, interior allocations may be driven by an alternative motive besides diminishing marginal utility. For example, our sample is effectively all women, who may wish to hide funds from their husband or significant other. Although it is not clear a desire to hide funds would necessarily lead to interior allocations, it may be that women expect any money coming into the household to be spent too quickly. Smoothing allocations in the CTB could ensure that at least some funds remain at later dates. A similar motivation could lead to a desire for smooth payment plans. To investigate this hypothesis, we provide separate estimates for women who either report being the head of the household or report not being the head (columns (3) and (4) of Table 6), and for women who report being married or with a partner, and those women who do not report this (columns (5) and (6) of Table 6). Table 6 reports these estimates, which show little difference in estimated preferences or plan values across household-head status and married/partnered status, suggesting that this motivation is not driving interior choices. Further, PVR values continue to differ for those who chose single and smooth plans along the lines previously documented for all subgroups considered.

Third, similar to the overconsumption of another household member, one could imagine forecasting own overconsumption out of experimental payments due to present bias. Individuals could smooth both their CTB allocations and their structured payment plans in order to ensure available funds through time. Although PVRs should, in principle, not depend on the present bias parameter, β, such a motive could lead smooth payment plans to be more desirable for present-biased (and sophisticated) agents. We see no indication of such a motive. The parameter β is statistically indistinguishable across individuals who chose smooth and single payment plans in our core specifications and those presented here.

3.3.3 Liquidity and Arbitrage

As documented in Table 1, our low-income sample has arguably limited access to liquidity, with roughly 90% having no formal savings and 80% having never used a credit card. Although this

interior choices.

Table 6: Aggregate Parameter Estimates by Alternative Rationales for Interior Allocations

	$\leqslant$ 1 Non-Monotonicities		Head of Household		Married	
	No	Yes	No	Yes	No	Yes
	(1)	(2)	(3)	(4)	(5)	(6)
Curvature: α						
Chose Single Payment	0.934	0.881	0.914	0.904	0.896	0.920
	(0.006)	(0.013)	(0.008)	(0.014)	(0.020)	(0.014)
Chose Smooth Payments	0.914	0.838	0.886	0.860	0.862	0.835
	(0.006)	(0.013)	(0.007)	(0.014)	(0.016)	(0.032)
Monthly Discount Factor: δ^{30}						
Chose Single Payment	0.893	0.892	0.885	0.911	0.874	0.986
	(0.040)	(0.041)	(0.034)	(0.054)	(0.065)	(0.081)
Chose Smooth Payments	1.056	0.981	0.972	1.125	1.081	1.096
	(0.036)	(0.028)	(0.023)	(0.054)	(0.056)	(0.095)
Present Bias: β						
Chose Single Payment	1.222	1.120	1.159	1.218	1.111	1.330
	(0.076)	(0.084)	(0.067)	(0.103)	(0.124)	(0.117)
Chose Smooth Payments	1.193	1.121	1.162	1.152	1.149	1.202
	(0.043)	(0.046)	(0.035)	(0.064)	(0.073)	(0.105)
Plan Value Ratio (PVR)						
Chose Single Payment	0.870	0.961	0.880	0.949	0.882	0.905
	(0.081)	(0.194)	(0.072)	(0.133)	(0.150)	(0.070)
Chose Smooth Payments	1.328	1.129	1.136	1.795	1.588	1.222
	(0.129)	(0.163)	(0.072)	(0.301)	(0.271)	(0.083)
# Observations	3,742	6,047	6,190	3,599	2,807	6,982
# Clusters	156	252	258	150	117	291
$H_0 : \alpha_{ChoseSingle} = \alpha_{ChoseSmooth};\ \chi^2(1)$	5.91	5.54	6.87	4.90	1.84	9.89
	$(p < 0.05)$	$(p < 0.05)$	$(p < 0.01)$	$(p < 0.05)$	$(p = 0.18)$	$(p < 0.01)$
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChseSmooth};\ \chi^2(1)$	9.01	3.07	4.29	7.77	5.54	6.21
	$(p < 0.01)$	$(p < 0.10)$	$(p < 0.05)$	$(p < 0.01)$	$(p = 0.19)$	$(p < 0.05)$
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth};\ \chi^2(1)$	0.11	0.00	0.00	0.30	0.07	0.21
	$(p = 0.74)$	$(p = 0.99)$	$(p = 0.96)$	$(p = 0.58)$	$(p = 0.79)$	$(p = 0.65)$
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth};\ \chi^2(1)$	9.06	5.02	6.29	6.59	5.21	8.56
	$(p < 0.01)$	$(p < 0.05)$	$(p < 0.05)$	$(p < 0.05)$	$(p < 0.05)$	$(p < 0.01)$

Notes: Estimates based on ordinary least squares (OLS) regression of equation (3) with standard errors clustered on individual level. Utility estimates and plan values calculated from non-linear combinations of regression coefficients. The standard errors reported in parentheses are calculated using the delta method. Null hypotheses tested after regression of equation (3) with interactions for plan choice with k, t_0 and $\ln(P)$, with standard errors clustered at individual level.

suggests few natural opportunities to arbitrage the experiment, one can further examine the potential forces of arbitrage in the data.

First, if subjects were arbitraging our experiments, we should likely see two broad patterns: only corner solutions in the CTB as subjects create for themselves a set of opportunities that dominate those offered in the experiment; and only choices of the single payment plan of GTQ1,200 as subjects can find opportunities that bear positive interest over time. Neither of these are observed with 46% of the CTB data being at budget interiors and 78% of subjects choosing smooth large-stakes payment plans.

Second, if only some subjects were arbitraging we should see different correlational patterns than those observed. Arbitraging subjects should be more patient than non-arbitraging subjects as they would take advantage of the high experimental values of P by allocating the entire budget to the later payment date. If such arbitraging subjects also arbitrage the single payment plan, the researcher would observe more patient, rather than less patient, subjects choosing the single payment. The observed correlation between discounting and plan choice is not consistent with arbitrage.

We also examine the empirical relationship between financial access, liquidity, and experimental behavior. In Table 7, we provide separate estimates of CTB-elicited preferences by access to savings, whether or not an individual has ever used a credit card, and whether or not someone has been paid relatively recently (i.e., splitting at the median time of five days). These estimates show no changes to our core conclusions based on differential access to liquidity. Taken together, these arguments suggest that subjects do indeed use both the CTB and the structured payment plans to smooth consumption over time.

3.3.4 Transaction Costs and Plan Choice

While our CTB paradigm focuses on equalizing transaction costs for sooner and later payments in order to provide credible preference estimates, transaction costs may differ at the different payment dates of our large-stakes payment plans. Individuals may avoid certain plans to avoid

Table 7: Aggregate Parameter Estimates by Liquidity

	Any Savings		Ever Used Credit Card		Low Current Liquidity	
	No	Yes	No	Yes	No	Yes
	(1)	(2)	(3)	(4)	(5)	(6)
Curvature: α						
Chose Single Payment	0.912	0.907	0.914	0.879	0.920	0.898
	(0.008)	(0.015)	(0.007)	(0.028)	(0.008)	(0.013)
Chose Smooth Payments	0.875	0.891	0.877	0.884	0.890	0.862
	(0.007)	(0.015)	(0.007)	(0.018)	(0.008)	(0.011)
Monthly Discount Factor: δ^{30}						
Chose Single Payment	0.888	0.918	0.898	0.848	0.849	0.957
	(0.031)	(0.082)	(0.028)	(0.133)	(0.033)	(0.052)
Chose Smooth Payments	1.029	0.973	1.011	1.085	0.977	1.075
	(0.025)	(0.052)	(0.024)	(0.061)	(0.027)	(0.039)
Present Bias: β						
Chose Single Payment	1.180	1.157	1.178	1.161	1.187	1.162
	(0.062)	(0.130)	(0.056)	(0.254)	(0.077)	(0.080)
Chose Smooth Payments	1.146	1.228	1.166	1.109	1.203	1.105
	(0.034)	(0.085)	(0.035)	(0.071)	(0.043)	(0.047)
Plan Value Ratio (PVR):						
Chose Single Payment	0.890	0.961	0.906	0.853	0.804	1.072
	(0.067)	(0.194)	(0.063)	(0.277)	(0.061)	(0.147)
Chose Smooth Payments	1.345	1.129	1.278	1.520	1.143	1.563
	(0.098)	(0.163)	(0.089)	(0.284)	(0.083)	(0.187)
# Observations	8,349	1,440	8,589	1,200	4,918	4,871
# Clusters	348	60	358	50	205	203
$H_0 : \alpha_{ChoseSingle} = \alpha_{ChoseSmooth};\ \chi^2(1)$	11.94	0.58	14.52	0.03	7.52	4.51
	$(p < 0.01)$	$(p = 0.45)$	$(p < 0.01)$	$(p = 0.86)$	$(p < 0.01)$	$(p < 0.05)$
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChoseSmooth};\ \chi^2(1)$	12.24	0.31	9.02	2.21	8.97	3.18
	$(p < 0.01)$	$(p = 0.58)$	$(p < 0.01)$	$(p = 0.14)$	$(p < 0.01)$	$(p = 0.07)$
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth};\ \chi^2(1)$	0.23	0.21	0.04	0.04	0.03	0.37
	$(p = 0.63)$	$(p = 0.65)$	$(p = 0.85)$	$(p = 0.85)$	$(p = 0.85)$	$(p = 0.54)$
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth};\ \chi^2(1)$	14.66	0.44	11.59	2.82	10.76	4.25
	$(p < 0.01)$	$(p < 0.51)$	$(p < 0.01)$	$(p < 0.10)$	$(p < 0.01)$	$(p < 0.05)$

Notes: Estimates based on ordinary least squares regression of equation (3) with standard errors clustered on individual level. Utility estimates and plan values calculated from non-linear combinations of regression coefficients. The standard errors reported in parentheses are calculated using the delta method. Null hypotheses tested after regression of equation (3) with interactions for plan choice with k, t_0 and $\ln(P)$, with standard errors clustered at individual level.

the requirement of receiving and cashing checks on multiple dates. Such additional transaction costs are not modeled in our assessment of plan values and, hence, are not represented in PVRs. In Appendix C.2, we simulate behavior with a fixed transaction cost per payment. Two findings result from this exercise. First, accounting for transaction costs, PVRs continue to differ notably between individuals who chose smooth and single payment plans. Second, without transaction costs there should be a stark preference for either the single plan or the most smooth plan, 12 payments of GTQ100. With moderate transaction costs (random with mean GTQ15 and standard deviation 10), the intermediate plans with 2, 3, and 6 payments are more frequently chosen.

3.3.5 Additional Robustness Tests and Analyses.

In Appendices C.3-C.5, we undertake a number of additional exercises. In Appendix C.3, we explore alternate estimation strategies for preferences. Following Andreoni, Kuhn and Sprenger (2015), we provide estimates based on the solution function for the sooner allocation in the CTB, rather than the linearized Euler equation. Within this framework, we also provide estimates under different assumptions for background consumption. The qualitative conclusion on differing preference estimates for those who chose single and smooth plans is unaffected by these differing estimation techniques and assumptions. Appendix C.3 provides further discussion of maximum likelihood methods for estimating preferences on CTB data.

Appendix C.4 discusses alternate potential sources of information on marginal utility. Our exercise identifies marginal utility from a desire to smooth intertemporal CTB payments. Alternate procedures to the CTB either identify marginal utility from risky choice tasks or leave it unmeasured. We impose values of utility curvature generally found in risky choice tasks and find broad mispredictions for payment plan choice. Given the substantial risk aversion generally found in experimental risk tasks, smooth plans should be valued much more highly than the single plan by all subjects. Additionally, without information on utility, differences in discounting alone yield less predictive power.

In Appendix C.5, we focus attention on a number of cross-randomized features of our CTB presentation. Between subjects, we randomly varied three features of the presentation to assure robustness of our core findings. First, we altered whether CTB budgets were presented with the all-later allocation at the top of the task (as in Figure 1) or at the bottom of the task. Second, we altered whether consecutive budgets were presented in increasing or decreasing order of P. Third, we altered whether the CTB payment entries included or excluded the subjects' participation payment. Though some presentation effects are documented, our broad finding of different preference estimates and plan values for individuals who chose single and smooth payment plans remains.

4 Discussion and Conclusion

This project seeks to explore the predictive content of experimental measures of time preferences for large-stakes financial decisions. In a sample of CCT recipients in Guatemala, we elicit time preferences using a CTB technique, which allows for estimates of both discounting parameters and marginal utility. We examine large-stakes choices of these same subjects, who are asked how they would like to smooth the payment of around 10% of annual income over a six month period in one of six payment plans. We ask whether CTB parameter estimates meaningfully predict plan choice.

We show that experimental behavior and estimates of discounting and marginal utility from experimental parameters closely predict subsequent plan choice. Subjects that chose to smooth experimental payments over time in the CTB, which corresponds to more rapidly diminishing marginal utility, were more likely to choose smooth payment plans. Similarly, subjects that made more patient choices in the CTB, which corresponds to higher discount factor estimates, were also more likely to choose smooth payment plans with later payments. These features of experimental and plan choice are internally consistent. Subjects who ultimately chose smooth (single) plans are estimated to prefer such plans based upon their experimental choice.

The identification of time preferences from experimental data remains a topic of debate with a number of viewpoints arguing for and against specific methodologies. We hope this work helpfully adds to this discussion. In a sample of low-income, low-literacy and liquidity-constrained subjects, we show that experimentally elicited preferences do what they are supposed to do: predict large-stakes behavior out-of-sample. These findings solidify the foundation of experimental research that simultaneously identifies marginal utility and impatience.

References

Anderhub, Vital, Werner Guth, Uri Gneezy, and Doron Sonsino, "On the Interaction of Risk and Time Preferences: An Experimental Study," *German Economic Review*, 2001, *2* (3), 239–253.

Andersen, Steffen, Glenn W. Harrison, Morten I. Lau, and Elisabet E. Rutstrom, "Eliciting Risk and Time Preferences," *Econometrica*, 2008, *76* (3), 583–618.

Andreoni, James and Charles Sprenger, "Estimating Time Preferences with Convex Budgets," *American Economic Review*, 2012, *102* (7), 3333–3356.

_ **, Christina Gravert, Michael A Kuhn, Silvia Saccardo, and Yang Yang**, "Arbitrage Or Narrow Bracketing? On Using Money to Measure Intertemporal Preferences," Technical Report, National Bureau of Economic Research 2018.

_ **, Michael A Kuhn, and Charles Sprenger**, "Measuring Time Preferences: A Comparison of Experimental Methods," *Journal of Economic Behavior & Organization*, 2015, *116*, 451–464.

_ **, Michael Callen, Yasir Khan, Karrar Jaffar, and Charles Sprenger**, "Using Preference Estimates to Customize Incentives: An Application to Polio Vaccination Drives in Pakistan," *NBER Working Paper No. 22019*, 2018.

Apesteguia, Jose and Miguel A. Ballester, "Monotone Stochastic Choice Models: The Case of Risk and Time Preferences," *Journal of Political Economy*, 2018, *126* (1), 74–106.

Ashraf, Nava, Dean Karlan, and Wesley Yin, "Tying Odysseus to the Mast: Evidence from a Commitment Savings Product in the Philippines," *The Quarterly Journal of Economics*, 2006, *121* (1), 635–672.

Attema, Arthur E., Han Bleichrodt, Yu Gao, Zhenxing Huang, and Peter P. Wakker, "Measuring Discounting without Measuring Utility," *American Economic Review*, 2016, *106* (6), 1476–1494.

Augenblick, Ned, Muriel Niederle, and Charles Sprenger, "Working Over Time: Dynamic Inconsistency in Real Effort Tasks," *The Quarterly Journal of Economics*, 2015, *130* (3), 1067–1115.

Cagetti, Marco, "Wealth Accumulation Over the Life Cycle and Precautionary Savings," *Journal of Business & Economic Statistics*, 2003, *21* (3), 339–353.

Card, David, Stefano DellaVigna, and Ulrike Malmendier, "The Role of Theory in Field Experiments," *Journal of Economic Perspectives*, 2011, *25* (3), 39–62.

Carvalho, Leandro S., Stephan Meier, and Stephanie W. Wang, "Poverty and Economic Decision-Making: Evidence from Changes in Financial Resources at Payday," *American Economic Review*, 2016, *106* (2), 260–284.

Chabris, Christopher F., David Laibson, and Jonathon P. Schuldt, "Intertemporal Choice," in Steven N. Durlauf and Larry Blume, eds., *The New Palgrave Dictionary of Economics*, London: Palgrave Macmillan, 2008.

_ , _ , Carrie Morris, Jonathon Schuldt, and Dmitry Taubinsky, "Individual Laboratory-Measured Discount Rates Predict Field Behavior," *Journal of Risk and Uncertainty*, 2008, *37* (2-3), 237–269.

Chakraborty, Anujit, Evan M. Calford, Guidon Fenig, and Yoram Halevy, "External and Internal Consistency of Choices Made in Convex Time Budgets," *Experimental Economics*, 2017, *20* (3), 687–706.

Cubitt, Robin P. and Daniel Read, "Can Intertemporal Choice Experiments Elicit Preferences for Consumption?," *Experimental Economics*, 2007, *10* (4), 369–389.

DellaVigna, Stefano and Ulrike Malmendier, "Paying Not to Go to the Gym," *American Economic Review*, 2006, *96* (3), 694–719.

Fang, Hanming and Yang Wang, "Estimating Dynamic Discrete Choice Models with Hyperbolic Discounting, with an Application to Mammography Decisions," *International Economic Review*, 2015, *56* (2), 565–596.

Frederick, Shane, George Loewenstein, and Ted O'Donoghue, "Time Discounting and Time Preference: A Critical Review," *Journal of Economic Literature*, 2002, *40* (2), 351–401.

Geary, Roy C., "A Note on 'A Constant-Utility Index of the Cost of Living'," *Review of Economic Studies*, 1950, *18* (2), 65–66.

Giné, Xavier, Jessica Goldberg, Dan Silverman, and Dean Yang, "Revising Commitments: Field Evidence on the Adjustment of Prior Choices," *NBER Working Paper No. 18065*, 2012.

Harrison, Glenn W., Morten I. Lau, and Elisabet E. Rutstrom, "Identifying Time Preferences With Experiments: Comment," *Unpublished Manuscript*, 2012.

_ , _ , and Melonie B. Williams, "Estimating Individual Discount Rates in Denmark: A Field Experiment," *American Economic Review*, 2002, *92* (5), 1606–1617.

Hausman, Jerry A., "Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables," *The Bell Journal of Economics*, 1979, *10* (1), 33–54.

Holt, Charles A. and Susan K. Laury, "Risk Aversion and Incentive Effects," *American Economic Review*, 2002, *92* (5), 1644–1655.

Imai, Taisuke, Tom A. Rutter, and Colin F. Camerer, "Meta-Analysis of Present-Bias Estimation using Convex Time Budgets," *Working Paper*, 2019.

Koopmans, Tjalling C., "Stationary Ordinal Utility and Impatience," *Econometrica*, 1960, *28* (2), 287–309.

Kramer, Berber, Wendy Janssens, and Lisette Swart, "Time Inconsistent Behavior Under Incomplete Markets: Results from a Field Experiment in Nigeria," *Conference Paper, Presented at 11th Midwest International Economic Development Conference. May 2-3, 2014. University of Minnesota, St. Paul MN*, 2013.

Laibson, David, "Golden Eggs and Hyperbolic Discounting," *The Quarterly Journal of Economics*, 1997, *112* (2), 443–478.

_ , Andrea Repetto, and Jeremy Tobacman, "Estimating Discount Functions with Consumption Choices Over the Lifecycle," *NBER Working Paper No. 13314*, 2007.

Lawrance, Emily C., "Poverty and the Rate of Time Preference: Evidence from Panel Data," *Journal of Political Economy*, 1991, *99* (1), 54–77.

Mahajan, Aprajit and Alessandro Tarozzi, "Time Inconsistency, Ecpectations and Technology Adoption: The Case of Insecticide Treated Nets," *Economic Research Initiatives at Duke (ERID) Working Paper No. 105*, 2011.

Martinez, Seung-Keun, Stephan Meier, and Charles Sprenger, "Procrastination in the Field: Evidence from Tax Filing," *Working Paper, Columbia Business School*, 2017.

Meier, Stephan and Charles Sprenger, "Present-Biased Preferences and Credit Card Borrowing," *American Economic Journal: Applied Economics*, 2010, *2* (1), 193–210.

_ and _ , "Time Discounting Predicts Creditworthiness," *Psychological Science*, 2012, *23* (1), 56–58.

_ and _ , "Temporal Stability of Time Preferences," *Review of Economics and Statistics*, 2015, *97* (2), 273–286.

O'Donoghue, Ted and Matthew Rabin, "Choice and Procrastination," *The Quarterly Journal of Economics*, 2001, *116* (1), 121–160.

Read, Daniel, George Loewenstein, Matthew Rabin, Gideon Keren, and David Laibson, "Choice bracketing," in Baruch Fischhoff and Charles F. Manski, eds., *Elicitation of preferences*, Springer, 1999, pp. 171–202.

Samuelson, Paul A., "A Note on Measurement of Utility," *The Review of Economic Studies*, 1937, *4* (2), 155–161.

Sawada, Yasuyuki and Yusuke Kuroishi, "How does a natural disaster affect peoples preference? The case of a large scale flood in the Philippines using the convex time budget experiments," in Yasuyuki Sawada and Yusuke Kuroishi, eds., *Disaster Risks, Social Preferences, and Policy Effects: Field Experiments in Selected ASEAN and East Asian Coutries*, ERIA Research Project Report 2013-34, 2015, pp. 57–84.

Sprenger, Charles, "Judging Experimental Evidence on Dynamic Inconsistency," *American Economic Review*, 2015, *105* (5), 280–285.

Stone, Richard, "Linear Expenditure Systems and Demand Analysis: An Application to the Pattern of British Demand," *Economic Journal*, 1954, *64* (255), 511–527.

Thaler, Richard H., "Mental Accounting Matters," *Journal of Behavioral Decision Making*, 1999, *12* (3), 183–206.

Warner, John and Saul Pleeter, "The Personal Discount Rate: Evidence from Military Downsizing Programs," *American Economic Review*, 2001, *91* (1), 33–53.

A Discussion of Utility Curvature and Experimental Procedures

In response to the criticism of Frederick et al. (2002) on the confounding effects of diminishing marginal utility for making inference on patience, new experimental methods have been developed. Some aim to identify patience alone without curvature using either probabilistic payments or streams of common payments (Anderhub, Guth, Gneezy and Sonsino, 2001; Attema, Bleichrodt, Gao, Huang and Wakker, 2016).[29] Other methods aim to identify diminishing marginal utility alongside discounting parameters, either by identifying curvature from independent risk tasks (Andersen, Harrison, Lau and Rutstrom, 2008), or by convexifying the time budget (Andreoni and Sprenger, 2012).

These last two methods that aim to identify diminishing marginal utility have lead to results that differ widely. With concavity informed by risky choice tasks, Andersen, Harrison, Lau and Rutstrom (2008) find rapidly diminishing marginal utility. With concavity informed by subjects choosing to spread intertemporal payments over time in their CTB task, Andreoni and Sprenger (2012) find only modestly diminishing marginal utility measures. Andreoni et al. (2015) reproduce these differences in a single college subject pool. College subjects are both strikingly risk averse in small-stakes risk tasks and do not express a strong desire to smooth their experimental payments through time.

As a result of these differences, a debate has developed on the importance of and the most appropriate experimental methods for measuring marginal utility in intertemporal settings. Our results can shed light on this discussion by refocusing the debate on the empirical predictive power of the marginal utility estimates from the CTB on large stakes intertemporal financial choices.[30]

[29] In the proposed method of Attema, Bleichrodt, Gao, Huang and Wakker (2016), subjects trade off streams of the same payment over time, to elicit discounting without measuring the shape of utility. When trading off streams of the same payment, the utility of that payment is cancelled with respect to any discounted utility calculation if stationarity of utility is assumed.

[30] In a small-stakes settings, Andreoni, Kuhn and Sprenger (2015) show that the CTB task does have enhanced predictive power relative to the method of Andersen, Harrison, Lau and Rutstrom (2008).

In the specific context of CTB designs, researchers have argued that the complexity of the decision environment confuses subjects and confounds inference (Chakraborty, Calford, Fenig and Halevy, 2017; Harrison, Lau and Rutstrom, 2012; Attema, Bleichrodt, Gao, Huang and Wakker, 2016).[31] Chakraborty, Calford, Fenig and Halevy (2017) argue that a design which permits interior allocations can lead to decision errors. Those authors support this point by noting that in the data of Andreoni and Sprenger (2012), when subjects face a CTB and a standard binary choice task with the same payment dates and interest rates, they do not always choose the same option conditional on choosing a corner in the CTB.[32] Harrison, Lau and Rutstrom (2012) and Attema, Bleichrodt, Gao, Huang and Wakker (2016) also argue that the design element of allowing interior allocations renders the CTB too complicated for subjects to understand.

Our results indicate that complexity and potential confusion is not an overwhelming challenge for inference with the CTB. Section 3.1 (especially Tables 2 and 3, and Figure 3) shows that interior choices, the element of the CTB that has been critiqued, correlate highly with subsequent plan choice. The corresponding relationship between estimates of diminishing marginal utility and a preference for smoothness in plan choice is bolstered by additional links between patience and plan choice. For such correlations to arise via some common confusion seems unlikely.

[31] Attema, Bleichrodt, Gao, Huang and Wakker (2016) argue that the complexity of the CTB should favor methods that do not rely on utility measurements: "This method is simpler than existing methods because it does not need information about utility. Consequently, the experimental tasks are easier for subjects, researchers have to ask fewer questions, and the measurements are not distorted by biases in utility." (p. 1490)

[32] It should be stated that the Andreoni and Sprenger (2012) data is far from ideal for making this comparison as their CTB was implemented with choices over experimental tokens on a computer and their binary choices were over money implemented in a paper-and-pencil Multiple Price List (MPL) design. The data of Andreoni, Kuhn and Sprenger (2015) are better suited to making such comparisons, having both CTB and MPL designs with the same interest rates, payment values, and paper-and-pencil interface. There, conditional upon choosing a corner in the CTB, the same bundle is chosen in the MPL in over 90% of observations.

B Additional Tables and Figures Noted in Text

Table B.1: Summary of the parameters for the modified CTB

	1	2	3	4
t	0	0	35	35
k	35	63	35	63
MRT_1	1.05	1.00	1.05	1.00
MRT_2	1.11	1.05	1.11	1.05
MRT_3	1.18	1.11	1.18	1.11
MRT_4	1.25	1.33	1.25	1.33
MRT_5	1.43	1.67	1.43	1.67
MRT_6	1.82	2.22	1.82	2.22

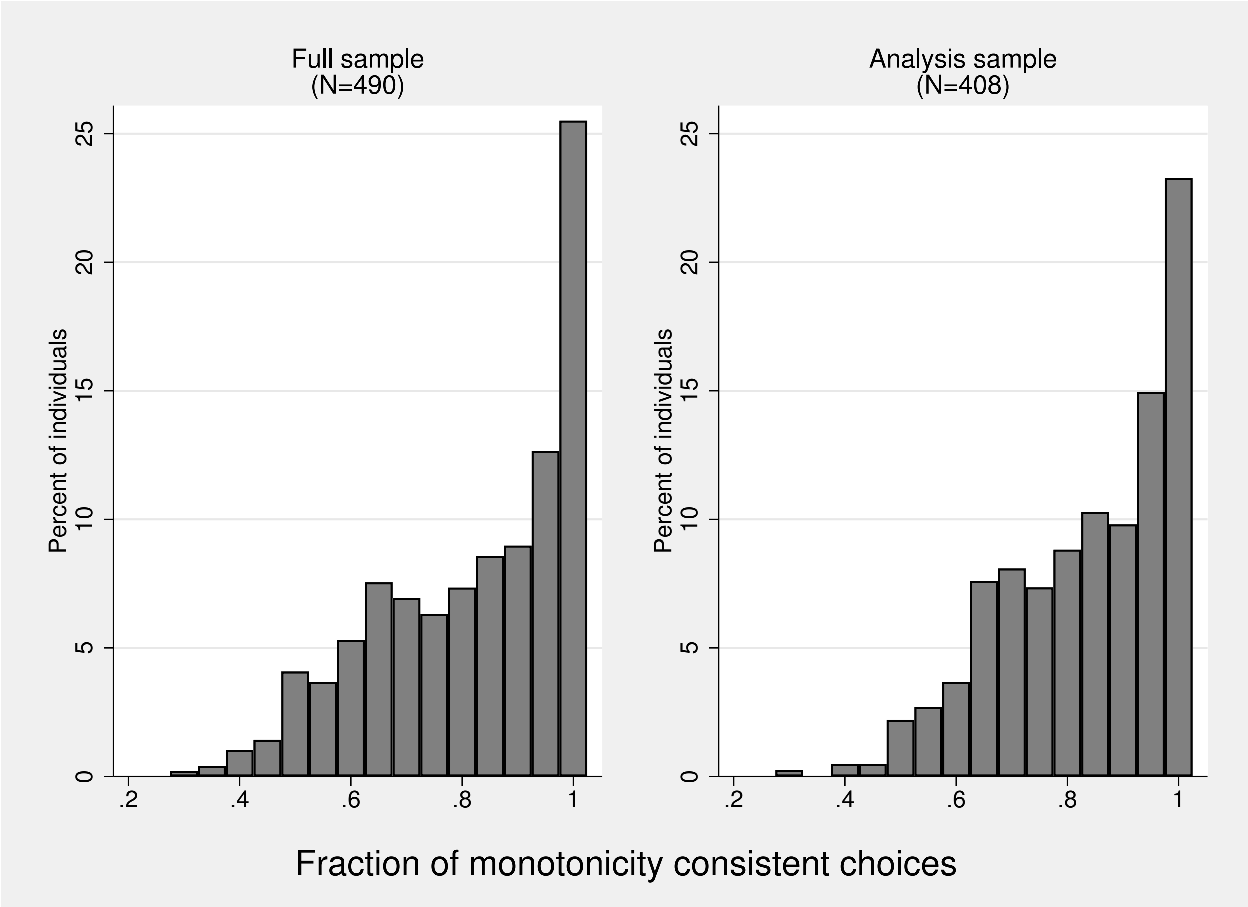

Figure B.1: Histogram of fraction of monotonic choices by individuals for full sample and analysis sample.

C Additional Exercises and Robustness Tests

C.1 Individual Measurement Error

Our aggregate analysis provides statistical comparisons for estimated preference parameters and plan values between individuals who chose smooth plans and those who chose the single plan. As such, this aggregate analysis accounts for estimation error in the preferences and plan values. The individual analysis presented in Figure 4 and Table 5 show differences in preferences and plan values at the *point* estimate of individual preferences. Individual estimation error could potentially alter the conclusions reached.

To evaluate robustness to individual measurement error in preferences we draw 1000 simulants for each of the 348 individuals in our individual analysis. Each simulant has parameter values drawn from a multivariate normal distribution centered at the point estimates for α and δ of the individual with covariance matrix determined by the estimated covariance matrix for the individual. At these simulated parameter values, we construct a simulated Plan Value Ratio (PVR). Figure C.1 recreates Figure 4, graphing the $348 \times 1000 = 348{,}000$ simulated PVR values separately by individuals who chose the single plan or one of the smooth payment plans. Allowing for the variation in PVRs induced by individual estimation errors, we continue to reject the null hypothesis of equal distributions of PVRs across these two groups (Mann-Whitney test, $z = -103.48, (p < 0.001)$).

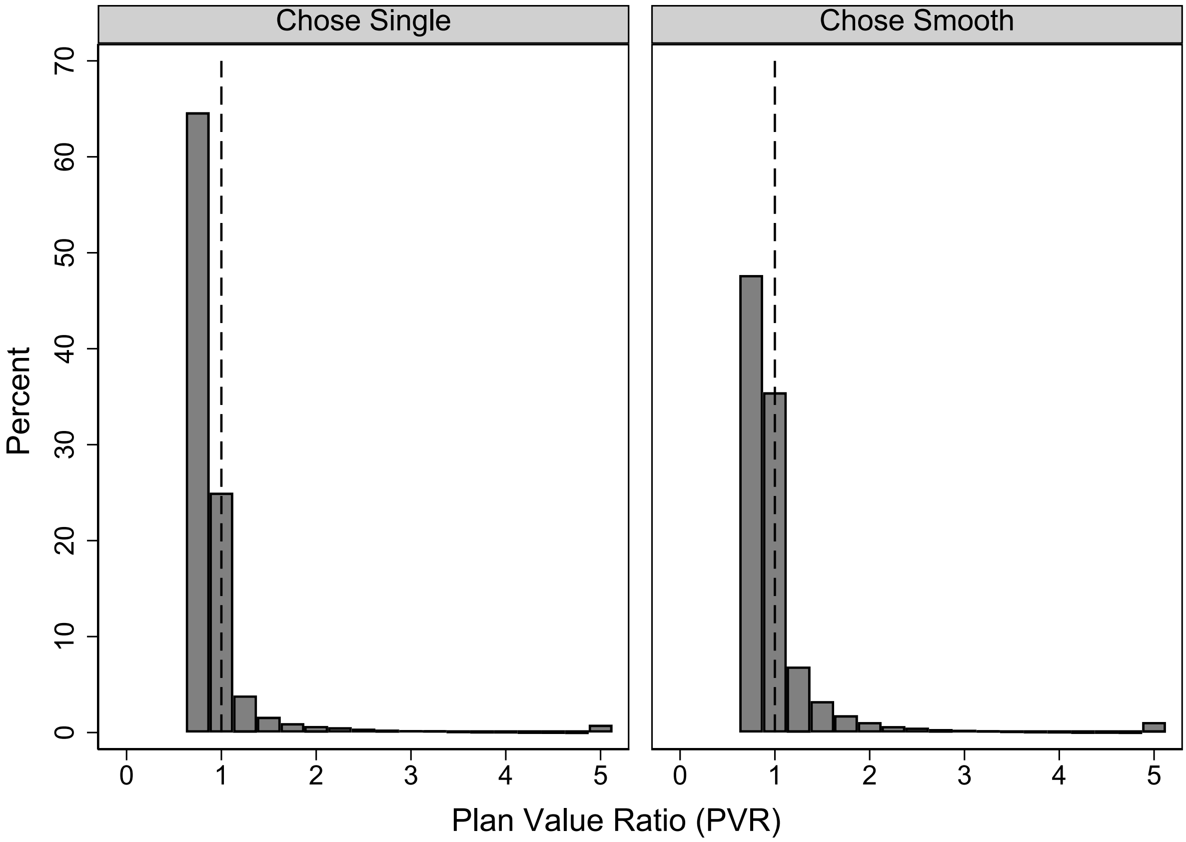

Figure C.1: Simulated Plan Value Ratios (PVRs) for chose single and chose smooth groups.

C.2 Transaction Costs and Plan Choice

Our implemented CTB design for eliciting preferences focuses on equalizing transaction costs at each payment date by providing minimum payments. For payment plan choice, we do not require subjects to receive some minimum payment at every potential date. As such, some payment plans may incur different transaction costs than others. For example, the single payment plan only requires one trip to the bank, while the twelve payment plan requires twelve. These additional transaction costs are not modeled in our main analysis estimating plan values.

In Figure C.2, we incorporate transaction costs into our analysis determining plan values.

First, we generate 10,000 simulants with preference parameters (α, δ) drawn from the multivariate normal distribution with means and standard deviations determined by the variance-covariance matrix of the estimates reported in Table 4. We do this for the full analysis sample (top panel), as well as separately for the group that chose the single payment plan (mid panel) and for the group that chose one of the smooth payment plans (bottom panel). For each simulant, we first calculate plan values absent any transaction costs and provide histograms of which plan has the highest value. Echoing the results of Table 4, the aggregate estimates indicate a preference for smooth plans; and those individuals who chose single or smooth plans are overwhelmingly predicted to so.

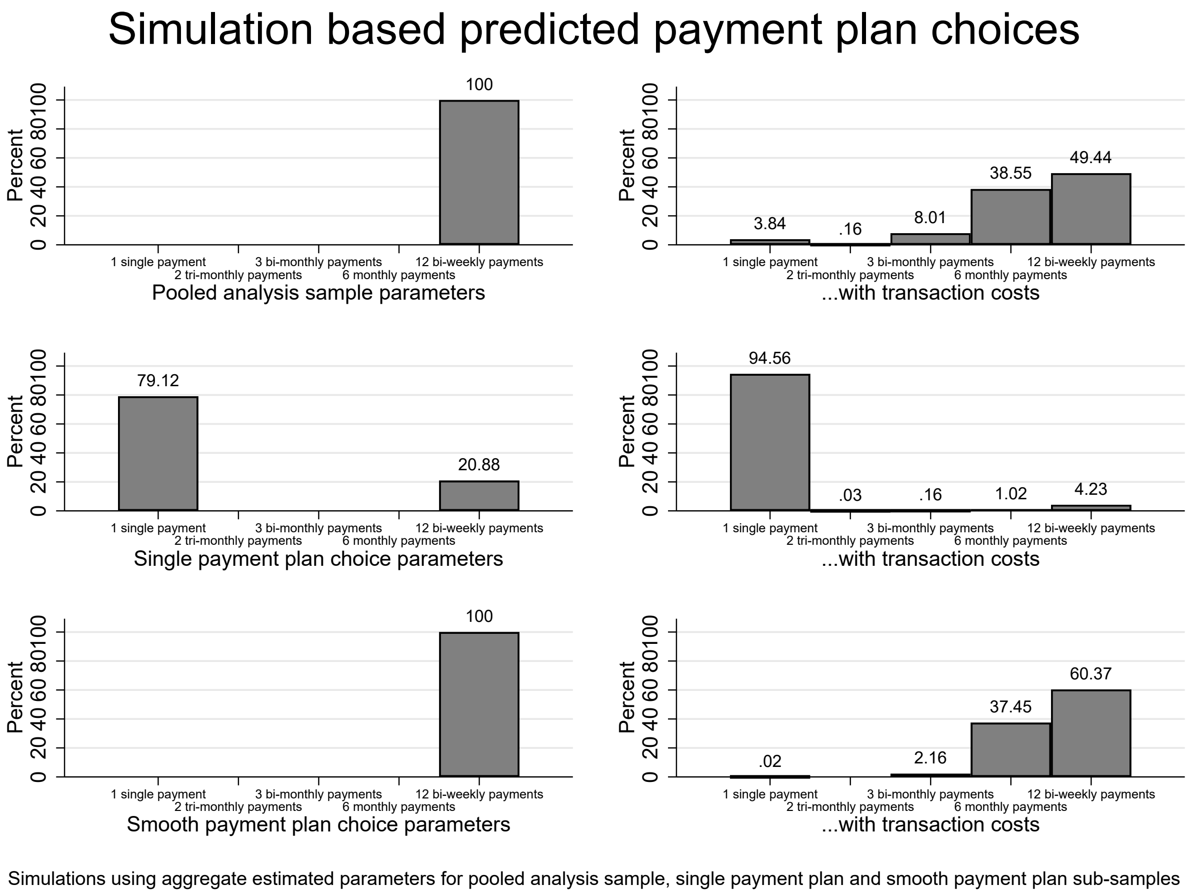

Figure C.2: Predicted plan choices from simulations based on group estimates.

The left hand side of Figure C.2 also reveals a stark prediction. All simulants are either predicted to have the single or the twelve payment plan as the highest value plan. Indeed, within the range of our parameters, a stark cutoff exists in (α, δ) space below which the single plan is predicted to have the highest value, otherwise the twelve payment plan is valued highest. In Figure C.3, Panel A we make this clear by simulating 100,000 preferences from two independent uniform distributions: $\alpha \in [0.1, 1]$ and $\delta \in [0.8, 1.1]$. Either the single plan or the twelve payment plan should be chosen with no intermediate choices generated. Figure C.3, Panel B also plots the next best alternative, with intermediate options of the two and six payment plans being the second highest value plan for large swathes of the parameter space.

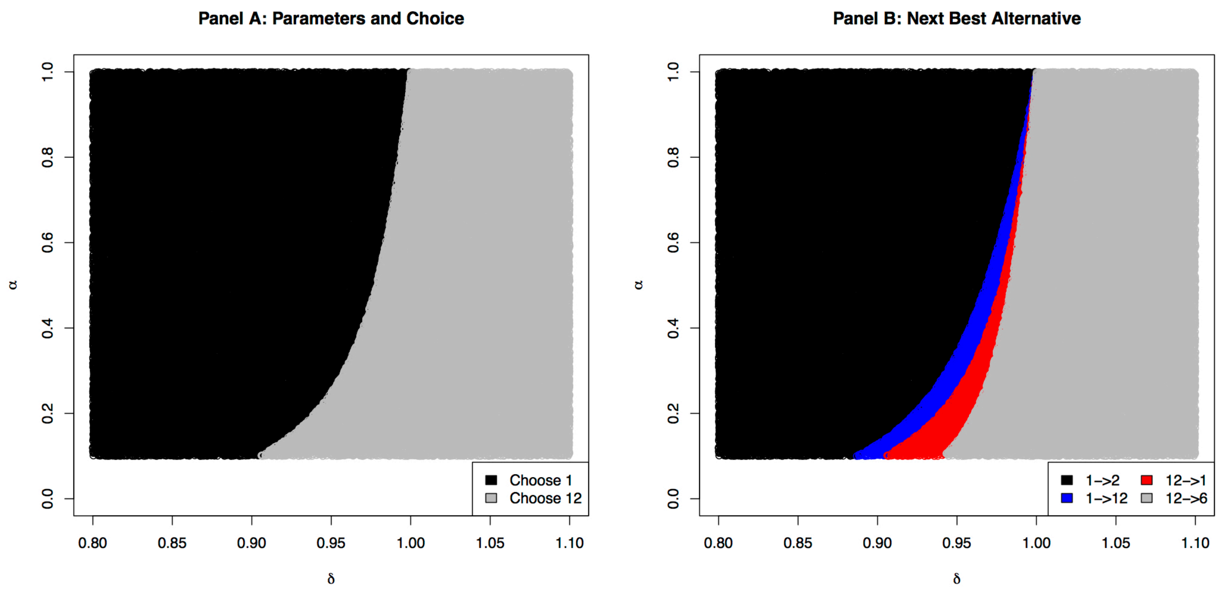

Figure C.3: Simulated Preferences and Plan Choice.

Next, we incorporate transaction costs into the analysis. For each payment date presribed by a plan, we add a single random transaction cost parameter drawn from normal distribution with a mean of GTQ15 and a standard deviation of GTQ10. Any negative cost is set to zero, truncating the distribution.[33] This transaction cost is then included in each simulant's plan

[33]We restrict to non-negative transaction costs by iteratively taking the mass below zero and re-drawing

values.

Using the same simulants that generated the left side of Figure C.2 and transaction costs, we then calculate payment plan values including these transaction costs as:

$$V_{j,i} = \left[\sum_{k=s}^{l} \delta_i^{k-s} (x_{t+k;j} - \mathbf{1}_{x_{t+k,j}>0} * c_i)^{\alpha_i} \right]^{1/\alpha_i}, \tag{4}$$

where i refers to the simulant, and c_i is the simulated transaction cost incorporated into plan j if a payment is prescribed. The right side of Figure C.2 shows the influence of these modest transaction costs. Generally, transaction costs increase the attractiveness of intermediate plans with fewer payments. And, for those individuals who chose the single payment plan, it makes that plan even more attractive.

The analysis to here shows that moderate transaction costs may make intermediate and single plans more attractive, but incorporating such transaction costs into the analysis does not alter our core conclusion. Plan values for individuals who chose single and smooth plans are predicted to deviate substantially.

Interestingly, these transactions costs may actually be an important driver of behavior within the smooth plans. Only a small fraction of individuals actually choose the twelve payment plan. And, following the results in Tables 2 and 5, correlations exist between CTB behavior and plan choice within intermediate plans. For smooth payment plan subjects, the number of payments correlates significantly with estimates of α and δ^{30}.[34] Such correlations would be expected if there was an overarching avoidance of the most smooth plan due to frequent incurrence of transaction costs. As a further investigation of the possibility that plan choice is related to transaction costs empirically, we asked subjects the amount of time it would

for that from a the same normal distribution until there is no mass at negative transaction costs. Naturally, the resulting distribution is shifted slightly to the right (mean of GTQ16.39, median of GTQ15.89), has lower variance (standard deviation of GTQ8.77) and is slightly skewed (skewness of 0.37). These additional simulated costs are arbitrary and non-exhaustive of all possible costs and benefits that can affect payment plan choice in addition to preference parameters.

[34] A regression of number of payments on these two preference parameters and a constant for the smooth payment subsample yields a coefficient for δ^{30} of -0.11 (robust s.e. $= 0.02$) and a coefficient for α of -3.88 (1.64). Both coefficients differ significantly from zero at the one percent level.

take to get to a bank. For the subsample who chose smooth payment plans, regressing the number of payments on an indicator for whether the individual would need more than 30 minutes to get to the bank (controlling for estimated preference parameters) yields a coefficient of -0.495 (robust s.e. $= 0.19$), which is statistically significant at the one percent level.

C.3 Robustness to Alternate Estimation Strategies

Andreoni and Sprenger (2012) and Andreoni, Kuhn and Sprenger (2015) discuss a number of estimation strategies for CTB data. Although we follow Andreoni, Kuhn and Sprenger (2015) in using simple OLS analysis for prediction, our exercise could be conducted with alternative methods. In Table C.1, we provide an analysis using non-linear least squares estimation of the solution function for x_t^*,

$$x_t^* = \frac{\omega + (P\beta^{t_0}\delta^k)^{1/(\alpha-1)}(M-\omega)}{1+(P\beta^{t_0}\delta^k)^{1/(\alpha-1)}},$$

where ω is a Stone-Geary background parameter term (Geary, 1950; Stone, 1954) that is frequently found in the literature and imposed to be either minus some daily level of consumption or a minimum subsistence level (Andersen, Harrison, Lau and Rutstrom, 2008; Andreoni, Kuhn and Sprenger, 2015) or estimated from the data (Andreoni and Sprenger, 2012). With $\omega = 0$, we reproduce the directional differences in curvature and discounting previously observed, although with less precision. And, although differences in plan values are observed across groups, the single payment choice group is estimated to value smooth payment plans more than the single payment plan. Varying the assumption of the background parameter ω, as in Andreoni and Sprenger (2012), alters the conclusions with respect to curvature, discounting and plan values. For example, with $\omega = 10$, curvature estimates are quite similar across the payment groups, while differences in discounting and plan values are broadly in line with our prior OLS estimates. Estimating ω from the data[35] we find ω around GTQ13-14 for each group. Based on monthly income data, this is around one-third to one-half of a day's household income, a

[35] Andreoni and Sprenger (2012) note that unlike the other parameters of interest, there is no experimental variation that identifies ω. It is identified from the functional form.

plausible minimum subsistence level. When estimating ω, we find curvature estimates close to those from our initial specifications similar across groups, clear differences in discounting across groups, and plan values broadly in line with our prior estimates.

Harrison, Lau and Rutstrom (2012) present an alternative estimation strategy rather than the strategies implemented by Andreoni and Sprenger (2012), which yields increasing, rather than modestly diminishing, marginal utility. The estimation strategy is similar to the random choice models of Holt and Laury (2002) and Andersen, Harrison, Lau and Rutstrom (2008), applied to the Andreoni and Sprenger (2012) data.[36] Recent theoretical work has called into question the use of such random choice models for estimating preferences given a demonstrated non-monotonicity in choice probabilities with respect to key parameters of interest (Apesteguia and Ballester, 2018). Nonetheless, Table C.2 compares the results of the Harrison, Lau and Rutstrom (2012) estimator with the OLS estimator presented in Table 4, and the NLS estimator presented in Table C.1. As in Harrison, Lau and Rutstrom (2012), using such Maximum Likelihood (ML) methods on CTB data yields convex utility estimates, as the estimator attempts to match the slight majority (54%) of observations at budget corners. These convex utility estimates are virtually unaffected by the differential price sensitivity across groups, with both single and smooth payment subjects having substantial estimated convexity that cannot be differentiated statistically. Although there are sizable estimated differences in discounting across groups, the ML method overall leads to sharp mispredictions for payment values. Both groups are predicted to value the single payment contract substantially more than smooth contracts.[37]

[36]From this exercise Harrison, Lau and Rutstrom (2012) conclude the following: "And we believe that rejecting concave utility in favor of convex utility, in settings such as these, will strike most economists as a priori implausible, and raise further questions about the comprehension of subjects of this new experimental task." (p. 21)

[37]Estimating the model of Harrison, Lau and Rutstrom (2012) using only subjects that have more than 50% interior allocations yields results in-line with other estimates for the differences between smooth and single payment groups. Results available upon request.

Table C.1: Alternative Estimation Strategies

Estimation Strategy	NLS	NLS	NLS	NLS	NLS
	Background Parameter (ω)				
	$\omega = 0$	$\omega = 10$	$\omega = 5$	$\omega = -5$	Estimated
	(1)	(2)	(3)	(4)	(5)
Curvature: α					
Chose Single Payment	0.762	0.856	0.812	0.711	0.881
	(0.020)	(0.016)	(0.018)	(0.022)	(0.013)
Chose Smooth Payments	0.737	0.867	0.805	0.665	0.904
	(0.013)	(0.010)	(0.012)	(0.015)	(0.006)
Monthly Discount Factor: δ^{30}					
Chose Single Payment	0.924	0.931	0.928	0.922	0.933
	(0.017)	(0.015)	(0.016)	(0.018)	(0.014)
Chose Smooth Payments	0.992	0.983	0.976	0.997	0.982
	(0.009)	(0.006)	(0.008)	(0.011)	(0.005)
Present Bias: β					
Chose Single Payment	1.095	1.075	1.084	1.103	1.070
	(0.029)	(0.024)	(0.027)	(0.031)	(0.023)
Chose Smooth Payments	1.068	1.040	1.054	1.080	1.031
	(0.014)	(0.010)	(0.013)	(0.016)	(0.009)
Background Parameter: ω					
Chose Single Payment					13.352
					(1.336)
Chose Smooth Payments					14.363
					(0.696)
Plan Value Ratio (PVR)					
Chose Single Payment	1.315	1.087	1.179	1.500	1.044
	(0.095)	(0.048)	(0.066)	(0.139)	(0.044)
Chose Smooth Payments	1.729	1.215	1.370	2.252	1.126
	(0.090)	(0.028)	(0.048)	(0.171)	(0.018)
# Observations	9,789	9,789	9,789	9,789	9,789
# Clusters	408	408	408	408	408
$H_0 : \alpha_{ChoseSingle} = \alpha_{ChoseSmooth};\ \chi^2(1)$	1.11	0.30	0.11	2.99	2.57
	$(p = 0.29)$	$(p = 0.58)$	$(p = 0.74)$	$(p = 0.08)$	$(p = 0.11)$
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChoseSmooth};\ \chi^2(1)$	11.90	10.46	7.39	12.52	10.48
	$(p < 0.01)$	$(p < 0.01)$	$(p < 0.01)$	$(p < 0.01)$	$(p < 0.01)$
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth};\ \chi^2(1)$	0.69	1.79	1.05	0.45	2.49
	$(p = 0.41)$	$(p = 0.18)$	$(p = 0.30)$	$(p = 0.50)$	$(p = 0.12)$
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth};\ \chi^2(1)$	9.95	5.31	5.48	11.65	2.99
	$(p < 0.01)$	$(p < 0.05)$	$(p < 0.05)$	$(p < 0.01)$	$(p < 0.10)$

Notes: Estimates based on non-linear least squares (NLS) regression of solution function with alternative values for a Stone-Geary background parameter (ω), with standard errors clustered on individual level. Plan values calculated from non-linear combinations of estimated parameters.

Table C.2: Comparison with ML Methods

Estimation Strategy	HLR (2012) MLE ($\omega = 0$) (1)	OLS ($\omega = 0$) (2)	NLS (estimated ω) (3)
Curvature: α			
Chose Single Payment	1.752	0.911	0.881
	(0.169)	(0.007)	(0.013)
Chose Smooth Payments	1.503	0.878	0.904
	(0.089)	(0.007)	(0.006)
Monthly Discount Factor: δ^{30}			
Chose Single Payment	0.835	0.893	0.933
	(0.043)	(0.029)	(0.014)
Chose Smooth Payments	1.007	1.020	0.982
	(0.023)	(0.023)	(0.005)
Present Bias: β			
Chose Single Payment	1.218	1.177	1.070
	(0.088)	(0.056)	(0.023)
Chose Smooth Payments	1.190	1.159	1.031
	(0.045)	(0.032)	(0.009)
Noise Parameter: μ			
Chose Single Payment	0.426		
	(0.066)		
Chose Smooth Payments	0.427		
	(0.046)		
Background Parameter: ω			
Chose Single Payment			13.352
			(1.336)
Chose Smooth Payments			14.363
			(0.696)
Plan Value Ratio (PVR)			
Chose Single Payment	0.451	0.900	1.044
	(0.038)	(0.064)	(0.044)
Chose Smooth Payments	0.623	1.306	1.126
	(0.040)	(0.085)	(0.018)
# Observations	9,789	9,789	9,789
# Clusters	408	408	408
$H_0 : \alpha_{ChoseSingle} = \alpha_{ChoseSmooth};\ \chi^2(1)$	1.69	12.22	2.57
	($p = 0.19$)	($p < 0.01$)	($p = 0.11$)
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChoseSmooth};\ \chi^2(1)$	12.20	12.12	10.48
	($p < 0.01$)	($p < 0.01$)	($p < 0.01$)
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth};\ \chi^2(1)$	0.09	0.08	2.49
	($p = 0.77$)	($p = 0.78$)	($p = 0.12$)
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth};\ \chi^2(1)$	9.59	14.48	2.29
	($p < 0.01$)	($p < 0.01$)	($p < 0.10$)

Notes: Estimates based on Maximum Likelihood (ML) methods of Harrison, Lau and Rutstrom (2012) (HLR), ordinary least squares (OLS) regression, or non-linear least squares (NLS) regression of solution function with standard errors clustered on individual level. Plan values calculated from non-linear combinations of estimated parameters.

C.4 Exploring Alternative Information on Curvature

Our exercise identifies curvature from a desire to smooth intertemporal payments in the CTB. Experimental designs that leave curvature unmeasured require additional assumptions to make predictions for decisions such as payment plan choice. Table C.3 examines the effects of imposing alternative assumptions for curvature. Specifically, we fix α at different values and show that these assumptions deeply influence the results.

In the first column we impose $\alpha = 0.5$ for all subjects.[38] In line with the discussed confounding effects of curvature, if marginal utility diminishes at the implied rate, individuals are estimated to be extremely patient. Indeed, for the 78% of subjects who choose smooth payments we estimate an aggregate monthly discount factor of around 1.7 and a remarkably high degree of future bias. Furthermore, the implied valuations for smooth payments strain plausibility with both smooth and single payment groups estimated to value smooth payment plans much more than the single payment.[39]

In columns (2) to (5) of Table C.3, we fix α at additional values of $0.75, 0.9, 0.95$, and 0.99. This assumption tunes estimates of patience, payment plan values, and the differences between groups. Based upon the assumption of curvature researchers can predict that both groups will prefer smooth contracts, or both groups will prefer single contracts with potentially indiscernible differences in the strength of preference. Only in special cases of α at around 0.9 will the assumed value of curvature correctly tune patience to successfully differentiate between payment plan groups. Incidentally, as shown in column (6) of Table 7, this is close to what is estimated on aggregate using curvature information inherent to our CTB elicitation strategy.

[38] This is in line with estimates from risky choice tasks such as those estimated by Andreoni and Sprenger (2012); Andreoni, Kuhn and Sprenger (2015).

[39] Given the prior findings on levels of risk aversion and a lack of correlation between risky choice tasks and curvature in CTBs, this suggests that using risky choice information could lead to substantial misprediction for such large-stakes intertemporal choices.

Table C.3: Alternative Curvature Information

	Fixing α					Estimated α
	(1)	(2)	(3)	(4)	(5)	(6)
Curvature: α						
Chose Single Payment	0.500	0.750	0.900	0.950	0.990	0.887
	(-)	(-)	(-)	(-)	(-)	(0.005)
Chose Smooth Payments	0.500	0.750	0.900	0.950	0.990	0.887
	(-)	(-)	(-)	(-)	(-)	(0.005)
Monthly Discount Factor: δ^{30}						
Chose Single Payment	1.051	0.952	0.897	0.879	0.865	0.901
	(0.185)	(0.084)	(0.031)	(0.015)	(0.003)	(0.036)
Chose Smooth Payments	1.718	1.216	0.989	0.923	0.873	1.007
	(0.140)	(0.050)	(0.016)	(0.008)	(0.001)	(0.020)
Present Bias: β						
Chose Single Payment	2.822	1.657	1.204	1.083	0.994	1.238
	(0.785)	(0.231)	(0.067)	(0.030)	(0.006)	(0.077)
Chose Smooth Payments	1.988	1.391	1.122	1.045	0.987	1.144
	(0.226)	(0.079)	(0.025)	(0.012)	(0.002)	(0.029)
Plan Value Ratio (PVR)						
Chose Single Payment	7.434	1.471	0.924	0.824	0.760	0.955
	(6.882)	(0.369)	(0.069)	(0.028)	(0.005)	(0.085)
Chose Smooth Payments	198.778	3.350	1.155	0.909	0.773	1.239
	(128.823)	(0.527)	(0.046)	(0.015)	(0.002)	(0.069)
# Observations	9,789	9,789	9,789	9,789	9,789	9,789
# Clusters	408	408	408	408	408	408
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChoseSmooth};\ \chi^2(1)$	6.49	6.46	6.44	6.44	6.47	6.51
	($p < 0.05$)	($p < 0.05$)	($p < 0.05$)	($p < 0.05$)	($p < 0.05$)	($p < 0.05$)
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth};\ \chi^2(1)$	1.04	1.19	1.30	1.35	1.48	1.29
	($p = 0.31$)	($p = 0.27$)	($p = 0.25$)	($p = 0.25$)	($p = 0.22$)	($p = 0.26$)
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth};\ \chi^2(1)$	2.20	8.54	7.83	7.13	6.61	7.91
	($p = 0.14$)	($p < 0.01$)	($p < 0.01$)	($p < 0.01$)	($p < 0.05$)	($p < 0.01$)

Notes: Not Available (NA). Estimates based on ordinary least squares (OLS) regression of equation (3) with standard errors clustered on individual level. Utility estimates and plan values calculated from non-linear combinations of regression coefficients. The standard errors reported in parentheses are calculated using the delta method. Null hypotheses tested after regression of equation (3) with interactions for plan choice with k, t_0 and $\ln(P)$, with standard errors clustered at individual level.

C.5 Robustness to Alternate Presentation Treatments for CTB

Our CTB design features several, cross-randomized presentation treatments. As noted in Section 2.2, subjects were randomized into seeing budgets either with the sooner amount increasing or the sooner amount decreasing as they moved down the task; seeing budgets in order of increasing or decreasing marginal rate of transformation, P; and seeing the budget options with or without their participation payment included. In Table C.4, we present preference estimates separately for each of these treatments, analogous to Table 4.

Treatments of altering the order of the sooner amount and the marginal rate of transformation do have an influence on behavior and estimated preferences. Decreasing sooner amount, decreasing P, and including participation payments, appear to have made subjects somewhat less sensitive to P and more patient. Importantly, however, differences between single and smooth payment choice groups are observed for all specifications. Individuals who chose smooth payments are estimated to have lower values of α and higher values of δ in every group. Differences in marginal utility and discounting estimates between payment groups are significant at conventional levels in four of the six specifications.

These results help to ensure that the differences between payment groups are not localized to a single type of CTB elicitation. It is important to recognize, however, that the presentational treatments do alter the levels of estimated preferences and so alter the estimated values of smooth and single payment plans. In every specification, individuals who chose smooth payments are estimated to have values for average smooth payment plans that are higher than the value for the single payment plan. However, in two of the six specifications, subjects who chose single payment plans are estimated to value smooth payment plans substantially more highly. This may be instructive for knowing which type of presentation is most well-calibrated for subsequent prediction. Our findings suggest that presentations with sooner amounts increasing within budgets, P increasing across budgets, and participation payments that are absent from the presentation may be best suited for delivering well-calibrated estimates and discernible differences across groups.

Table C.4: Aggregate Parameter Estimates by Treatment

	Sooner Amount		P Order		Participation Payment	
	Increasing	Decreasing	Increasing	Decreasing	Absent	Included
	(1)	(2)	(3)	(4)	(5)	(6)
Curvature: α						
Chose Single Payment	0.925	0.884	0.918	0.898	0.916	0.905
	(0.007)	(0.016)	(0.007)	(0.014)	(0.009)	(0.011)
Chose Smooth Payments	0.901	0.848	0.880	0.875	0.882	0.873
	(0.006)	(0.013)	(0.009)	(0.009)	(0.009)	(0.010)
Monthly Discount Factor: δ^{30}						
Chose Single Payment	0.836	1.013	0.837	0.996	0.852	0.937
	(0.029)	(0.063)	(0.034)	(0.055)	(0.033)	(0.048)
Chose Smooth Payments	1.004	1.040	1.004	1.036	0.973	1.067
	(0.025)	(0.041)	(0.032)	(0.032)	(0.027)	(0.037)
Present Bias: β						
Chose Single Payment	1.124	1.286	1.266	1.039	1.241	1.114
	(0.068)	(0.100)	(0.075)	(0.084)	(0.063)	(0.088)
Chose Smooth Payments	1.135	1.189	1.219	1.102	1.082	1.238
	(0.038)	(0.053)	(0.051)	(0.038)	(0.040)	(0.050)
Plan Value Ratio (PVR)						
Chose Single Payment	0.776	1.268	0.785	1.179	0.814	1.008
	(0.052)	(0.225)	(0.060)	(0.183)	(0.064)	(0.123)
Chose Smooth Payments	1.196	1.469	1.246	1.369	1.148	1.490
	(0.080)	(0.192)	(0.112)	(0.130)	(0.086)	(0.162)
# Observations	4,606	5,183	4,990	4,799	4,631	5,158
# Clusters	192	216	208	200	193	215
$H_0 : \alpha_{ChoseSingle} = \alpha_{ChoseSmooth};\ \chi^2(1)$	6.79	2.97	10.39	1.84	7.43	4.94
	$(p < 0.01)$	$(p = 0.09)$	$(p < 0.01)$	$(p = 0.18)$	$(p < 0.01)$	$(p < 0.05)$
$H_0 : \delta^{30}_{ChoseSingle} = \delta^{30}_{ChoseSmooth};\ \chi^2(1)$	18.15	0.12	12.62	0.40	7.84	4.49
	$(p < 0.01)$	$(p = 0.73)$	$(p < 0.01)$	$(p = 0.53)$	$(p < 0.01)$	$(p < 0.05)$
$H_0 : \beta_{ChoseSingle} = \beta_{ChoseSmooth};\ \chi^2(1)$	0.02	0.74	0.27	0.46	4.52	1.51
	$(p = 0.88)$	$(p = 0.39)$	$(p = 0.60)$	$(p = 0.50)$	$(p < 0.05)$	$(p = 0.22)$
$H_0 : PVR_{ChoseSingle} = PVR_{ChoseSmooth};\ \chi^2(1)$	19.63	0.46	13.16	0.72	9.66	5.62
	$(p < 0.01)$	$(p = 0.50)$	$(p < 0.01)$	$(p = 0.40)$	$(p < 0.01)$	$(p < 0.05)$

Notes: Estimates based on ordinary least squares (OLS) regression of equation (3) with standard errors clustered on individual level. Utility estimates and plan values calculated from non-linear combinations of regression coefficients. The standard errors reported in parentheses are calculated using the delta method. Null hypotheses tested after regression of equation (3) with interactions for plan choice with k, t_0 and $\ln(P)$, with standard errors clustered at individual level.

D Translated instructions

The instructions, translated from the original Spanish, are presented in the following.

D.1 General Instructions

- Now, we will start the experiment. The rules of the experiment are:
    1. You cannot talk to any participant of the session.
    2. You cannot use cellphones.
    3. All the data and answers that you provide to us will be totally CONFIDENTIAL.
- The experiment consists of three parts.
    1. By participating in and completing the three parts of the experiment, you will receive Q50.00. (The Q50.00 will be divided into two payments).
    2. In addition, you can also earn additional money.
- Ways to obtain the payment.
    1. You can choose the method of payment. Check/Deposit in the bank BANRURAL.[40]
    2. The payment will be made on two different dates. A first payment will be made BEFORE (Today or in 5 weeks), and a second payment will be made AFTER (In 5 or 9 weeks after the first payment).

D.2 Instructions for the first part of the experiment: modified CTB

- General Instructions Part 1
    1. The first part consists of 24 questions.

[40] In initial sessions, participants had the option of deposits in their bank account or being paid via postdated checks. Since no participants in these initial sessions opted for deposits, we did not offer this option in later sessions.

2. Each question has 6 options.
3. For each question you should choose the option you prefer.
4. When finished, we will randomly select one of the questions and we will pay the option you chose for that question.

Example:[41]

- Each option is numbered on the bottom. Also, each option represents two quantities you can receive: a first payment (in this case, today), and also a second payment (in this case, in 5 weeks).
- The amounts in each option do not include the payment for participation.
- Option 1
  1. You would receive $Q80$ today.
  2. You would receive $Q0$ in 5 weeks.
- Option 2
  1. You would receive $Q64$ today.
  2. You would receive $Q20$ in 5 weeks.
- Option 3
  1. You would receive $Q48$ today.
  2. You would receive $Q40$ in 5 weeks.
- Option 4
  1. You would receive $Q32$ today.
  2. You would receive $Q60$ in 5 weeks.

[41]The example is modified according to the treatment.

- Option 5
  1. You would receive $Q16$ today.
  2. You would receive $Q80$ in 5 weeks.
- Option 6
  1. You would receive $Q0$ today.
  2. You would receive $Q100$ in 5 weeks.
- You must choose an option. Suppose you chose Option 3. Today, you will receive $Q48$, and also, in 5 weeks, you will receive $Q40$.
- Note that the options in this case allow you to receive up to $Q100$ if you receive it all in 5 weeks, or you can receive a maximum of $Q80$ if you receive everything today. There are also intermediate options. Today you can obtain $Q48$, and in 5 weeks $Q40$, for a total of $Q88$. The total increases as you want to receive more money in FIVE weeks.
- The dates of the first and the second payment vary with the question:
  1. Questions 1-6: In the first 6 Questions you choose between a FIRST payment to receive TODAY, and a SECOND payment to receive in FIVE WEEKS.
  2. Questions 7-12: In Questions 7-12 you choose between a FIRST payment to receive TODAY, and a SECOND payment to receive in NINE WEEKS.
  3. Questions 13-18: In Questions 13-18 you choose between a FIRST payment to receive in FIVE WEEKS, and a SECOND payment to receive in TEN WEEKS.
  4. Questions 19-24: In Questions 19-24 you choose between a FIRST payment to receive in FIVE WEEKS, and a SECOND payment to receive in FOURTEEN WEEKS.
- A draw will be held to determine which question will be paid to you.[42] The 24 questions will not be paid to you. Only the option that is selected in the draw will be paid to you.

[42] At this point, a bingo cage with 24 balls inside is shown to the participants.

- The dates when the FIRST and the SECOND payments are made will depend on the draw results.
- If question 14 is selected in the draw, then the option you choose in question 14 will determine how much you will receive in FIVE WEEKS, and how much you will receive in TEN WEEKS.
- Your payment will be made through Banrural bank, via either deposits to your account or checks. In both cases, the money will be available on the two indicated dates (for your safety, all the dates are business days). The dates will be determined by the question selected in the draw.
- The payment for participating will be divided into two parts, and they will be paid on the dates when the payments of the question selected in the draw are paid.
- So, what will be the amount you receive?
    1. You will receive the amount that the selected option indicates. Also, you will receive $Q50$ for your participation payment. This additional $Q50$ will be split between the first and the second payment.
- At this point, we will do a practice.
- The following three questions will not be among the questions entered into the draw.
- During the practice, you can ask questions at any time.

D.3 General instructions Part 2

- The second part of the experiment consists of a draw.
- The amount is $Q1,200$.
- In the bingo cage, there will be 30 numbered balls. If any person has the number that comes out of the bingo cage, that person will be the winner of the draw.

You can choose:

- A draw where if you win, you will receive $Q1,200$. You should choose how would you like to receive the $Q1,200$, if you are the winner:
    1. Receive it all in one payment.
    2. Receive biweekly payments of $Q100$ for six months.
    3. You can choose $Q400$ every two months for six months, etc.
- All payments add up to $Q1,200$. The only thing that changes is how many payments you receive.
- You will receive the next payment on the 22nd of this month.[43]
- The payments from the draw will be made through Banrural bank, with checks. The amount of payments and the dates to be made will be according to your choice.
- Practice for comprehension of the instructions.
    - At this moment, we will do a practice.
    - The following three questions will not be part of the questions in the draw.
    - During the practice, you can ask questions at any time.

[43] This date varied with the date of the session.

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