Pre-Analysis Plan for:

Eliciting time preferences using high stakes lottery tickets

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Abstract

We investigate the performance of a new approach to measure time preferences. The new approach entails asking individuals to make choices between receiving high stakes lottery tickets at different points in time, in a similar way as conventional time-preference elicitation methods. The study will compare measurements using conventional methods involving low stakes (convex budget sets, Andreoni et al., 2012) with measurements using the new approach, across (i) a sample of students participating in November 2019, (ii) a sample of students participating in February/March 2020 and (iii) a sample of unemployed job seekers participating in 2020 (exact time to be determined). The first sample may face large expenditure shocks due to St Nicholas and Christmas time, the second sample is unlikely to face any expenditure/income shocks, and the third sample is expected to face large income shocks related to finding employment. These features are key to testing the performance of the new time-preference elicitation method.

Trial start date:	November 2019
Intervention start date:	November 2019
Intervention end date:	Differs across samples. The exact timing for the third sample still to be determined, but expected in the first half of 2020.
Trial end date:	Expected: June 2020

Experimental design

Samples 1 and 2 (students) are first and second year students at the School of Business and Economics at the Vrije Universiteit Amsterdam (the samples will not overlap). The recruitment of participating unemployed job seekers is still in progress. All participants will complete an incentivized online survey containing a range of questions to elicit their time preferences, their risk preferences and a range of individual characteristics, including questions on expected changes in future income and expenditures.

Our main focus is on time preferences. To measure time preferences, both a conventional method is used (convex time budget sets with low stakes, Andreoni et al. 2012) and our new method containing intertemporal choices on receiving high stakes lottery tickets. All participants answer both types of questions. Below we provide tables with the exact choices that participants face. For completeness we also elicit risk preferences which are measured using the "bomb risk elicitation task" (Crosetto and Filippin, 2013). Answers are incentivized in a standard fashion: one question is randomly selected for payment. Participants receive an amount ranging between 4 and 24 euro, as well as up to 10 high stakes lottery tickets. The students additionally receive some study credits for participating as participation in academic experiments is a compulsory element in their study program.

In addition a survey collects the following individual characteristics at the end of the survey: gender, age, nationality (Dutch, European country, Other), monthly income, expected income changes, level of expenditures relative to income, expected expenditure changes.

A few questions are sample-specific. The first sample of students completes the survey in November 2019, and is asked about expected expenditures on Christmas/St Nicholas[1] presents and about whether they expect monetary gifts for Christmas/ St Nicholas. The sample of job seekers is asked what their expectation is regarding the duration of their benefits, the duration until they find employment and what their expected relative wage gain from employment over unemployment benefits would be.

The survey is completed online. Monetary payments are transferred directly to participants' bank accounts. If a lottery ticket question was selected, the tickets are sent by mail (for all payment dates chosen). Each participant will therefore provide their bank details (IBAN) and home address. These will only be used for making payments and deleted afterwards (and participants are aware of this).

Randomization method

Since the study entails comparing elicitation methods, there is no treatment.

We will randomize the order of the questions across individuals, to make sure that potential differences in responses are not driven by the question order. In particular, we randomize (1) whether the individual first answers the conventional elicitation questions or first answers our new elicitation method questions, (2) the order of the *blocks* of questions within one method and (3) whether the rate of return increases or decreases within a block. All of these randomizations are implemented using Qualtrics.

Randomization unit: Individual

Was the treatment clustered: No

Experiment characteristics:

- Sample size, planned number of clusters: 1
- Sample size, planned number of observations: 300 (3 samples of 100)
- Sample size by treatment arm: n.a.

Ethical approval

Institutional review board (IRB): not required

IRB approval date: n.a.

IRB approval number: n.a.

[1] In Holland gifts are exchanged both at St Nicholas and Christmas.

Empirical analysis plan

Main outcomes of interest

The main outcomes of interest are measures of present-bias ("beta") and long-term and short-term discount factors ("delta" and beta*delta) obtained from Convex Time Budget Sets (CTB) responses and from the Lottery Ticket Questions (LTQ) responses.

We will construct these measures in the following way:

- For estimating discount factors from CTB responses we will follow the methodology from Andreoni et al. (2012), who outline the estimation of the per-period discount factor delta as well as the estimation of the present-bias parameter beta for each individual. For each individual we will use the point estimates obtained from this methodology, normalized such that delta is the "long-run discount factor" that measures the discounting between options in the future that are five weeks apart, while the "short-term discount factor" beta times delta measures the discounting between the present and five weeks later. We normalize to five weeks as this is the time horizon we use for the LTQ discount measurement.
- For assigning a discount factor for the LTQ method, we follow the method of multiple price lists as reviewed, e.g., in Anderson et al (2006), only that monetary rewards in that paper are replaced by the number of lottery tickets that individuals receive in our setup. In this methodology, for each time horizon, individuals answer several questions whether to take rewards earlier or later, where the amount of rewards for the later choice is increasing across questions. For individuals that switch only once from choosing current rewards to later rewards, the methodology establishes – at the individual level - a range for their short-run discount factor that rationalizes their switching point. This is backed out from questions involving today and five weeks later. The method also gives a range for their long-run discount factor that rationalizes their switching point for questions involving rewards 8 weeks from today and 13 weeks from today (i.e., also five weeks apart but in the future). We choose the mid-point of each interval to assign a short-run and a long-run discount factor. In cases an explicit value for present-bias ("beta") is required, we take the ratio of this short-run discount factor over this long-run discount factor. For individuals with inconsistent answers (people switching "back and forth" between early and late choices involving the same time frame but increasing later rewards), we will consider the lower and upper bounds of the intervals that rationalize these switching points and choose the mid-point of that larger interval as measure of the discount factor.
- When we compare CTB with the LTQ method, it is important to take into account that LTQ assigns discount factors only at a few coarse values. It is of less interest in for our study whether these intervals were chosen optimally as this is easy to vary in later work, but rather whether the new LTQ method picks up the relevant discount factors correctly given these intervals. Therefore, for some of the comparisons it is useful to map the continuous measures of discount factors for the short run and the long run from the CTB method to the discrete

points of the LTQ method. To do this, recall that LTQ assigns intervals of discount factors that would rationalize a single switching point in the answers in the LTQ elicitation. To convert a CTB point estimate, consider first into which LTQ interval the point estimate falls, and then assign the midpoint of that interval as the "coarse CTB discount factor". This can be done both for the short-run and the long-run discount factor. To obtain the "coarse CTB present bias", take the ratio of the coarse CTB short-run discount factor and divide by the coarse CTB long-run discount factor for the individual under consideration. We will only use these coarse values in the analysis where explicitly stated.

Hypotheses

Of main interest is the time discount factor estimated from the Convex Time Budget Sets (CTB) responses and from our Lottery Ticket Question (LTQ) responses. There are two main hypotheses, and for each main hypothesis one test. These are the key predictions that we pre-register. We also have sub-hypothesis, each with one or two key tests, but these are valued less. All other investigations are listed just for completeness.

1) **Hypothesis 1**: In the absence of income or expenditure shocks both methods rank individuals similarly with respect to their discount factor (this applies to both the short and the long-run discount factor). This is useful to make statements about behavior of individuals with higher or lower discount factor in the short or long run.
    a. As a subordinate additional hypothesis, we expect both methods to elicit similar levels of the discount factor in the absence of income or expenditure shocks. According to our theory this should hold especially for the long-run discount factor, though it could also hold for the short-run discount factor.

2) **Hypothesis 2**: Measures taken via the LTQ method are not affected by income or expenditure shocks, while measures taken via the CTB method are affected. In particular, we expect a stronger present bias (lower beta) in sample (i) compared to sample (ii) when measured via CTB. We do not expect this measure to differ across both samples when measured via LTQ.
    a. As a subordinate additional hypothesis, we expect more present-bias (lower beta) in sample (ii) when measured via CTB than when measured via LTQ. We also expect this in sample (iii) when restricted to individuals who expect to find employment quickly with large income gains.

Analysis

Hypothesis testing:

First main hypothesis: Our test of the first main hypothesis is based on the assumption that in sample (ii) the economic conditions are relatively stable, in the sense that there is no a priori reason to believe that students in February have particularly variable income or expenditure streams. This sample seems most consistent with usual experimental samples.

Main test for hypothesis 1: *For the short-run discount factor, we have two measures for each individual, one from LTQ and one from CTB. We test whether these measures correlate positively and significantly. We test the same separately for the long-run discount factor.*

As a subordinate exploration, we also consider only the subsample who report that they do not have income or expenditure shocks from sample (ii); and consider also individuals from sample (i) and (iii) that report no income or expenditure shocks.

Test for sub-hypothesis 1a: We again concentrate on sample (ii). For the following two tests we use the coarse CTB measures (see third bullet in the construction of the main variables of interest).

- We test whether the correlation between the discount factor measured via LTQ and CTB is not statistically different from 1. We test this separately for the long-run and short-run discount factor, and expect this especially for the long-run discount factor.
- We will also test that the distribution of discount factors between CTB method and LTQ method are not statistically significantly different from each other, separately for short-run and long-run discount factor.

As a subordinate exploration, we also consider only the subsample who report that they do not have income or expenditure shocks from sample (ii); and consider also individuals from sample (i) and (iii) that report no income or expenditure shocks.

Second main hypothesis: Our main test for the second hypothesis presupposes that the underlying distribution of time preferences of individuals in sample (i) and sample (ii) are similar. We assume this as these individuals are drawn from the same pool and we did not advertise that we would be making payments to participants. Therefore, we proceed under the assumption that the underlying distribution of discount factors for sample (i) and sample (ii) are identical.

But the measure of our short term discount factor will be based on a choice between an immediate payment and a payment in 5 weeks. In the case of sample (i), the immediate date will correspond to a date before the main December festivities (around 26 November[2]), while the later payment will correspond to a date after December 29th, that is, after St Nicholas (December 6) and Christmas (December 25). The measure of the long term discount factor is based on choices for dates that all fall after the holiday period.

We designed this timing such that we expect students in sample (i) to have to incur expenditures for gifts for St Nicholas and Christmas around the current time while the might expect gifts before the first "future" time that falls after both St Nicholas and Christmas, possibly in cash. Therefore, they might perceive a need for small immediate payments relative to small future payments that stems from credit constraints rather than true differences in discount factors.

[2] The experiment will be open on-line for a few days

Under CTB, we expect these fluctuations in income and expenditure to affect the measure of present bias. LTQ was designed to be unaffected by such expenditure and income changes, and we expect no changes in measured discount factors under LTQ.

For samples (ii) and (iii) all payment dates will be after the December festivities.

Main test for hypothesis 2: *We test the hypothesis that the average present bias parameter beta in sample (i) is not statistically different from that of sample (ii) under LTQ (in a one-sided test that beta in sample (i) is lower). We expect that a similar one-sided test under CTB is rejected, i.e., that the CTB method measures stronger present-bias (i.e., average beta significantly lower) in sample (i) than in sample (ii).*

Additional sub-ordinate tests: tests for equal distributions for the short-run discount factor between sample (i) and (ii) should not be rejected under LTQ, but should be rejected under CTB; and the number of present biased agents (measured as any difference in short-run and long-run discount factor under LTQ or coarse-CTB) should not differ between sample (i) and (ii) under LTQ but be lower under CTB.

Tests for sub-ordinate hypothesis 2a: For the following tests we again use the coarse measure of LTQ (as discussed in the third bullet point in the construction of the main variables of interest). We expect differences between the two methods in the following samples:

- In *sample (i)* we test whether there is more present bias (i.e., average "beta" is lower) under CTB-measurement compared to LTQ-measurement (in a one-sided test).
- For *sample (iii),* apply a test similar to the previous one to individuals who expect to find a job quickly and have high wage gains (as they also need cash now rather than in the future).

As subordinate explorations, to be more consistent with hypothesis 1, for sample (iii) we expect the rank of individuals who expect to find a job quickly and have high wage gains within the distribution of betas of all of sample (iii) to be lower under CTB than under LTQ. Again as subordinate exploration, we will also apply these types of test to individuals in sample (iii) who do not expect to find jobs quickly and expect to run out of unemployment benefits soon, where we expect the present bias measured under CTB to be lower (i.e., average beta higher) than under LTQ, especially in terms of ranks in the distribution.

We will also investigate whether the rank order of questions matter (i.e., whether LTQ or CTB questions were asked first). If this turns out to matter:

- we will rely only on the first set of questions that individuals answer for any question that compares distributions (such as the main test of hypothesis 2).
- we will give less weight to tests that rely on two individual-level observations (though correlations between them should still be observed) and more weight to tests that use distributions. In particular, the main test of the hypothesis 1 relies on multiple observations per person, while the second test of hypothesis 1a only relies on distributions, and so we would elevate the latter to our main test here (and would use the first set of answers only).

Tables of choices

Convex budget sets : choices				
EARLY PERIOD	**TOKEN RATE**		**LATE PERIOD**	**TOKEN RATE**
Today	0.1		5 weeks	0.12
Today	0.1		5 weeks	0.14
Today	0.1		5 weeks	0.16
Today	0.1		5 weeks	0.18
Today	0.1		5 weeks	0.2
Today	0.1		14 weeks	0.12
Today	0.1		14 weeks	0.14
Today	0.1		14 weeks	0.16
Today	0.1		14 weeks	0.18
Today	0.1		14 weeks	0.2
8 weeks	0.1		13 weeks	0.12
8 weeks	0.1		13 weeks	0.14
8 weeks	0.1		13 weeks	0.16
8 weeks	0.1		13 weeks	0.18
8 weeks	0.1		13 weeks	0.2
8 weeks	0.1		22 weeks	0.12
8 weeks	0.1		22 weeks	0.14
8 weeks	0.1		22 weeks	0.16
8 weeks	0.1		22 weeks	0.18
8 weeks	0.1		22 weeks	0.2

Lottery ticket choices				
EARLY PERIOD	**NR. OF TICKETS**		**LATE PERIOD**	**NR. OF TICKETS**
Today	5		5 weeks	6
Today	5		5 weeks	7
Today	5		5 weeks	8
Today	5		5 weeks	9
Today	5		5 weeks	10
Today	5		14 weeks	6
Today	5		14 weeks	7
Today	5		14 weeks	8
Today	5		14 weeks	9
Today	5		14 weeks	10
8 weeks	5		13 weeks	6
8 weeks	5		13 weeks	7
8 weeks	5		13 weeks	8
8 weeks	5		13 weeks	9
8 weeks	5		13 weeks	10
8 weeks	5		22 weeks	6
8 weeks	5		22 weeks	7
8 weeks	5		22 weeks	8
8 weeks	5		22 weeks	9
8 weeks	5		22 weeks	10

References

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