# Outcome-Dependent and Sign-Dependent Time Preferences: A Study on Incentivized Intertemporal Choices Involving Effort and Money

**Shohei Yamamoto[a]  Shotaro Shiba[b]  Nobuyuki Hanaki[c]**

## Abstract

Previous research consistently identified differences in time preferences between effort and monetary decisions. However, the root cause of this difference—whether it stemmed from the intrinsic nature of the outcomes or the associated pleasurable or unpleasurable experiences—remained undefined. In response, we devised a novel two-stage experiment employing a 2x2 design contrasting outcomes (money and effort) and domains (pleasant and unpleasant). This approach allowed for the incentivization of all decisions, including those involving future monetary losses. Our study has unveiled sign-dependent preferences as well as outcome-dependent preferences, suggesting that both the type of outcome and the domain influence the divergences in time preferences observed in monetary and effort choices. Surprisingly, our research did not affirm the previously documented presence of a present bias in effort choices. A plausible explanation for this could be the propensity for selective reporting, leaning towards an exaggerated declaration of present bias in studies employing real-effort tasks, a concern raised by Imai et al., (2021).

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[a] Hitotsubashi Business School, syamamoto@ics.hub.hit-u.ac.jp
[b] Waseda University, sibasyou2001@gmail.com
[c] University of Osaka, nobuyuki.hanaki@iser.osaka-u.ac.jp

1. Introduction

The exploration of time preferences has traditionally concentrated on time-dated monetary rewards (e.g., Tanaka et al., 2010). However, in the current landscape of literature, an increasing focus has been placed on not only monetary rewards but also effort choices. This shift acknowledges the potential issue of arbitrage in monetary outcomes (Cohen et al., 2020), emphasizing the need to consider the gap between the timing of reception and actual consumption in monetary contexts. In contrast, the time dedicated to specific tasks may serve as a more immediate reflection of consumption. As a result, individuals may exhibit more pronounced present bias, or overvaluation of present outcomes, in effort choices compared to monetary choices (Imai et al., 2021).

However, a clear distinction must be drawn between monetary rewards and effort exertion, given their inherent differences in types of outcomes and the associated pleasant or unpleasant experiences. The question that remains unexplored is whether it is the type or sign of outcomes that account for the observed differences in time preferences.

Added complexities arise when considering the common practice of estimating these preferences through hypothetical scenarios, a method susceptible to hypothetical bias (Frederick et al., 2002). Monetary losses present a particular challenge for experimenters, as it is generally not feasible to directly extract money from participants.

Our novel two-stage incentivized study first decomposes intertemporal choices involving effort and money into two distinct categories: those involving pleasant and unpleasant domains, and those concerning the outcomes of money and effort. This delineation allows for a focused investigation of outcome-dependent preferences by facilitating a direct comparison of time preferences in choices pertaining to effort and money within the same domain. Furthermore, it enables an analysis of sign-dependent preferences through a comparison of time preferences between pleasant and unpleasant domains, holding the outcomes constant.

2. Model and Experiment

2.1. Experimental Method

**Participants.** We recruited 200 university students at Osaka University. Their compensation was contingent upon the decisions they made and the specific treatments they were assigned to, with the average reward of 2,000 yen. In addition, participants who completed all the experiment sessions were granted an item of their choice, valued at approximately 5,000 yen.

**Design and Procedure.** The participants will be randomly allocated to one of two treatments: the monetary choice group (treatment M) and the effort choices group (treatment E). All sessions will be conducted online to facilitate seamless operations. Monetary transactions between the researchers and the participants will be handled through PayPay, a popular mobile payment service in Japan, effectively reducing delays and guaranteeing smooth transactions.

The experimental protocol spanned a duration of 5 weeks, necessitating participants to be actively involved in sessions delineated for Weeks 1, 3, 4, and 5.

**Week 1:**

> **Treatment M:** Participants were tasked with transcribing 4,000 numbers displayed on a screen, rewarded with a payment of 2,000 yen, which was spendable anytime.

> **Treatment E:** Participants agreed to transcribe 2,000 random numbers in both Weeks 4 and 5 for a compensation of 2,000 yen.

Comprehension questions were asked to check their understanding of the payment procedure.

**Weeks 3 and 4:**

Participants engaged in intertemporal allocation exercises to elicit their time preferences. The exercises were orchestrated based on a Convex Time Budget (CTB) methodology delineated in Cheung et al. (2022), encompassing two sets of budget constraint equations. The exercises aimed to map allocation choices in pleasant and unpleasant domains for both treatments using two sets of budget constraints: $(1 + R)x_s + x_l = B$ and $x_s + \frac{1}{1+R}x_l = B$ where $x_s$ and $x_l$ represent amounts of outcome in distinct temporal frames; $B$ denotes a future value budget; and $R$ represents interest rates.

During the exercises in Weeks 3 and 4, participants determined allocations between Weeks 4 and 5. Distinctions in the temporal dynamics of the allocation sessions — one featuring front-end delays and the other devoid of such — facilitated an assessment of potential present bias through a comparative analysis of decision outcomes. Following the sessions, one question from all the questions encountered across Weeks 3 and 4 was chosen to execute the corresponding monetary transaction or work allocation, contingent on the specific treatment and the nature (pleasant or unpleasant) of the selected question.

**Week 5:**

Following a brief survey, the consequences of the randomly selected question from Weeks 3 and 4 were realized. This led to either a financial transaction or the establishment of the task workload, depending on the treatment.

3. Results

We carried out an analysis involving 165 participants who successfully completed all the sessions and passed our attention check.

Figure 1 illustrates the mean proportions of allocations to sooner dates, pertaining to monetary and effort choices across both pleasant and unpleasant domains. These are depicted along with their standard errors for each treatment.

In this study, we determined participants' time preferences through choice-based indices grounded in the proportions of rewards designated to sooner versus later payment dates.

*Impatience*, denoting the general tendency to discount delays takes a value of 1 when a participant
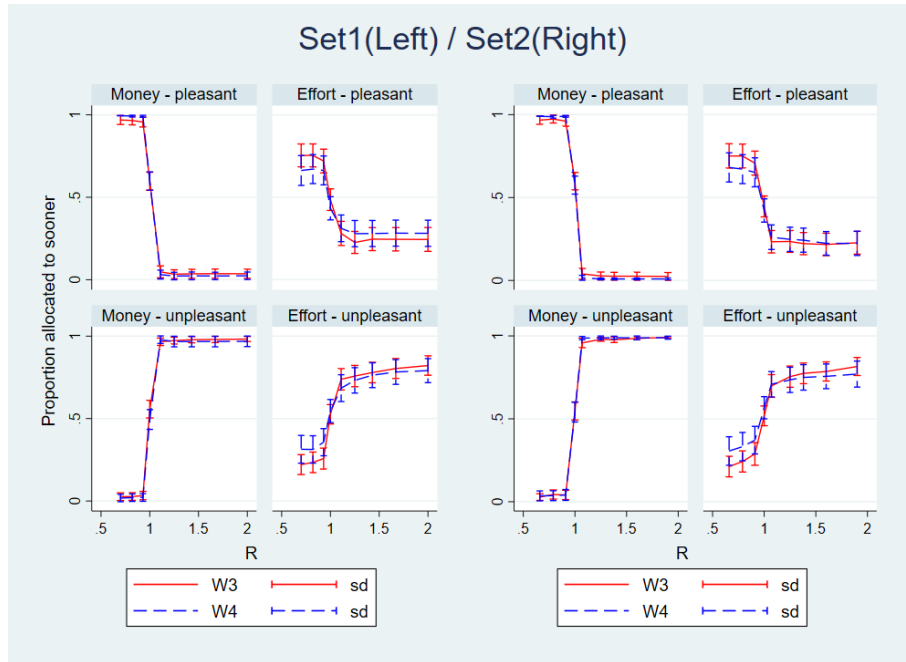
*Figure 1.* Proportions of Allocations in the Four Conditions for Set 1 (left) and Set 2 (right).

The solid lines indicate the proportion of the allocations in week 3 and the dotted lines indicate the proportion of the allocations in week 4. Each bar describes the standard error.

consistently allocates all resources to nearer dates in the pleasant domain (later dates in the unpleasant domain), showcasing extreme impatience, and 0 when they allocate all to later dates in the pleasant domain (sooner dates in the unpleasant domain), indicating utmost patience.

*Preference for smoothing* is characterized as an inclination towards evenly distributing allocations between earlier and later dates. This index ranges between 0 (smoothing-averse) and 1 (smoothing-loving).

The present bias (*PB*) is quantified by the disparity in *impatience* over two intervals. It illustrates the changes in allocations from the front-end-delay to non-front-end-delay questions, oscillating between -1 (severely future-biased) to 1 (severely present-biased). Remarkably, an approximate zero mean *PB* across all four conditions denotes the same level of impatience from weeks 3 to 4 ($p > 0.1$).

We analyzed sign-dependent preferences, comparing time preferences in both pleasant and unpleasant contexts within the scope of monetary or effort choices, to prevent confounding the analysis with regard to the type of outcomes (see Table 1). The results show sign-dependent preferences in both monetary and effort choices. Particularly, participants demonstrated more impatience for pleasant outcomes in treatment M, aligning with the sign effect (Frederick et al., 2002).

In treatment E, however, we observed a reversal of the sign effect, with participants showing a higher patience in the pleasant scenario ($p < 0.05$). However, we did not find difference of *PB* between the domains in both treatments ($p > 0.1$). Additionally, we noticed a stronger preference for smoothing

Table 1

*The Mean Differences of Three Indices by the Descriptive Measures*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Pleasant VS Unpleasant (Money) | Pleasant VS Unpleasant (Effort) | Money VS Effort (Pleasant) | Money VS Effort (Unpleasant) |
| | MD | MD | MD | MD |
| *Impatience* | 0.02*** | -0.02** | -0.01 | -0.06** |
| | (0.01) | (0.01) | (0.40) | (0.00) |
| *PB* | 0.00 | 0.01 | 0.01 | 0.03 |
| | (0.01) | (0.02) | (0.58) | (0.26) |
| *Smooth* | -0.01 | -0.04*** | -0.21*** | -0.24*** |
| | (0.01) | (0.02) | (0.00) | (0.00) |
| Observations | 178 | 152 | 165 | 165 |

Notes: MD stands for mean difference; Standard errors in parentheses; *, ** and *** stand for statistical significance at the 10%, 5% and 1% level respectively.

in the unpleasant scenario of treatment E ($p < 0.01$), a tendency not found in treatment M ($p > 0.1$).

Turning our attention to outcome-dependent preferences, we examined the distinctions in indices related to monetary and effort choices within each domain to circumvent the confounding of pleasant and unpleasant experiences in the analysis

This investigation revealed a higher level of *impatience* in monetary choices compared to effort choices in the unpleasant domain ($p < 0.01$), a pattern not reflected in the pleasant domain ($p > 0.1$). Notably, there was a more pronounced *preference for smoothing* in effort choices compared to monetary choices in both domains ($p < 0.01$), with no significant changes regarding *PB* in either domain ($p > 0.1$ in both cases).

To deepen our understanding, we utilized Maximum Likelihood Estimations (MLEs) for detailed structural analysis to meticulously examine individual time preferences, considering both sign and outcome-dependent preferences. Our results under this method maintained consistency with the findings from our descriptive analysis.

4. General discussion

Past research has consistently identified a distinction in time preferences between effort and monetary decisions. Yet, it was unclear whether this discrepancy originated from the nature of the outcomes themselves or the affiliated pleasurable or unpleasurable experiences. Surprisingly, our research did not affirm the previously documented presence of a present bias in effort choices. However, it did highlight both sign-dependent and outcome-dependent preferences regarding

impatience and a preference for smoothness. That suggests that both the type of outcome and the domain influence the divergences in time preferences observed in monetary and effort choices.

The absence of evidence supporting the presence of a present bias in effort choices can potentially be attributed to a tendency towards selective reporting in the extant literature. This leans towards an exaggerated declaration of present bias in studies employing real-effort tasks, a concern raised by Imai et al. (2021).

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