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Time discounting in the presence of time constraints

Makito Takeuchi
Faculty of Business Administration, Tohoku Gakuin University, Sendai, Japan

Masafumi Tsubuku
Faculty of Economics, Daito Bunka University, Tokyo, Japan

Abstract

This study explores the intertemporal choice between goods in the presence of time constraints. While previous research showed that time preferences in intertemporal decisions can be represented by a decreasing hyperbolic function, we investigate how time preferences respond to the presence of time constraints to consuming goods. The experiment is based on questionnaire data and focuses on two types of products, gift certificates and food. The results show that the time discount rate increases over time in the presence of a time constraint. In addition, for all of the goods treated in this experiment, we confirm that individual tends to be more patient towards larger rewards (magnitude effect), and future negative payoffs are discounted at a lower rate than future positive payoffs (sign effect).

1. Introduction

Analysing time preferences to understand individual intertemporal decision making is a central theme in behavioural economics. Thaler's (1981) seminal work argued that the individual time discount rate is a decreasing hyperbolic function, which contradicts the traditional economic view that treats the time discount rate as a constant. After that, numerous studies tested this result from different viewpoints (See Benzion et al, 1989; Loewenstein and Prelec, 1992; Pender, 1996; Andersen, 2014). Most studies conducted experiments in which participants stated how much they would demand to compensate for a delay in receiving a certain good or service.

However, most studies consider limited situations, in which respondents are assumed to use the money received at any point in time. In reality, there are many exceptions that restrict the spending capacity to some goods within an exogenously determined time limit. Edible goods are one such example since most foods have an expiration date after which the food is potentially unsafe. In this case, we are reluctant to save the food even shortly before its expiration date. As long as the food quality does not significantly deteriorate over time, some people may be unwilling to save the food when the discount rate increases, which contradicts the traditional hyperbolic discount rate. This example highlights the importance of revising the argument for time discounting by incorporating time constraints.[1]

This study incorporates a time limit for goods to be used or consumed for determining the discount rate in the presence of time constraints. In our experiment, participants answer questions about two items that they can consume within a limited time frame. Based on the results of this experiment, we examine whether the features of the individual discount rate, such as hyperbolic discounting, magnitude or sign effects (e.g., Thaler, 1981, Benzion et al, 1989) hold in the presence of time constraints. To confirm the magnitude and sign effects, we test the effects of compensations for the delay, such as money or gift certificates, on the time discount rate and compare the discount rates in the case of payments and receipts for the participants.

So far, previous studies have shown that the individual time preference varies with the individual characteristics (e.g., Kirby et al, 2005; Yamane et al, 2013) or the variety of the analysed goods (e.g., Charlton and Fantino, 2008; Howard, 2013; Ubfal, 2016). Some studies focused on age-related differences in the discount rates, showing that the time discount rate increases as the age rises (e.g., Trostel and Taylor, 2001, Sozou and Seymour, 2003; Read and Read, 2004, Albert and Duffy, 2012). Although these studies do not address time limits directly, the end of a lifespan can be considered as the type of time constraint that we incorporate in our analysis. Hence, older respondents are closer to the time limit and have higher time discount rates compared to the young.

The remainder of this paper is organised as follows. Section 2 describes the content of our experiment. Section 3 reports the empirical results, and Section 4 provides our concluding remarks.

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[1] As widely known, individual decision making about an intertemporal problem covers various issues. Among these, we can observe time constraints on goods other than edible goods. Considering the sufficiently long period, almost all manufactured products have a limited service life, implying that there are time constraints even for durable goods.

2. Experiment

In this study, the experiment was conducted online with 356 undergraduate students (154 males, 202 females), recruited from the Chubu University, Gakushuin University, Kinjo Gakuin University, and Kansai University as participants in exchange for scores towards a course credit.

Our questions reproduced the format of the 'Survey of Living Preferences and Satisfaction' conducted in 2005 by the Osaka University, except that we introduce time constraints. The experiment addresses three items: money, gift certificates, and a snack. The money and gift certificates are received or paid by participants, and the snack is the item to purchase. The gift certificate and the snack are subject to time constraints for their use or consumption, in contrast with money, usually considered in traditional questions about the intertemporal choice. We defined the gift certificate as an item that functions like money but may expire after a certain period.

We first asked participants to answer five questions regarding either money or a gift certificate with an expiration date, TDM1-5 or TDT1-5 (as defined in Table 1). The order of these questions is randomly determined for each participant. Then, all participants answered the questions that are irrelevant to time discounting, and those about the snack (TDS1 and TDS2) in random order. After that, participants answered the five questions about money or gift certificates, TDM1-5 or TDT1-5, which had not been answered yet. Finally, participants were asked to provide some demographic information. We randomly assign the questions, TDM1-5 and TDT1-5, to be answered first to counterbalance this experiment.

Table 1 reports the structure of the questions about money, the gift certificate, and the snack. Each question presents two options, 'A' and 'B'. In TDM1 (TDM2), the participants can obtain 10,000 JPY after 2 (90) days if they choose option A, or receive a different amount after 9 (97) days by choosing option B. TDM3-5 are set to confirm the magnitude and sign effects in this experiment. To clarify the effects of magnitude on the discount rate, the amount of money is differentiated between TDM3 and TDM4. In TDM4 and TDM5, participants face a different case concerning the treatment of money. TDM4 asks participants to choose the timing to receive the monetary compensation, while TDM5 asks to choose the timing to pay the amount. The case of the gift certificate presents similar conditions, although the time constraint for option B is closer to that for option A. The questions regarding the snack and the gift certificate are built in a similar fashion, but we ask the participants to image that the snack that will not be available after 100 days and choose between options A and B.

Table 1. Summary of the intertemporal choice questions

Items	Time constraint	Option A		Option B		Case
		Amount JPY	Time	Range of amount JPY (Annual interest rate)	Time	
TDM1		10,000	2 days	9,981 (-10%)～ 11,918 (1,000%)	9 days	receipt
TDM2		10,000	90 days	9,981 (-10%)～ 11,918 (1,000%)	97 days	receipt
TDM3	Money	non	10,000	1 month	9,500 (-5%)～ 13,000 (30%)	13 months	receipt
TDM4		1,000,000	1 month	950,000 (-5%)～ 1,300,000 (30%)	13 months	receipt
TDM5		1,000,000	1 month	950,000 (-5%)～ 1,300,000 (30%)	13 months	payment
TDT1		10,000	2 days (98 days left)	9,981 (-10%)～ 11,918 (1,000%)	9 days (91 days left)	receipt
TDT2	expire after 100 days	10,000	90 days (10 days left)	9,981 (-10%)～ 11,918 (1,000%)	97 days (3 days left)	receipt
TDT3	Gift certificate	10,000	1 month (13 months left)	9,500 (-5%)～ 13,000 (30%)	13 months (1 month left)	receipt
TDT4	expire after 14 months	1,000,000	1 month (13 months left)	950,000 (-5%)～ 1,300,000 (30%)	13 months (1 month left)	receipt
TDT5		1,000,000	1 month (13 months left)	950,000 (-5%)～ 1,300,000 (30%)	13 months (1 month left)	payment
TDS1	Snack expire after 100 days	500	2 days (98 days left)	520 (-209%)～ 100 (4,171%)	9 days (91 days left)	purchase
TDS2		500	90 days (10 days left)	520 (-209%)～ 100 (4,171%)	97 days (3 days left)	purchase

Table 2 shows an example of question regarding the time discount in the presence of time constraints. The participants were required to select their most preferred option in each row. Based on their responses, we estimated the time discount rate as follows. When the individual response changes from A to B at the annual interest rate of 100% (JPY 10,191), the implied respondent's time discount rate was 75%, a middle rate between 50% (JPY 10,096) and 100% (JPY 10,191). This question form is in line with previous studies Read and Read (2004) and Yamane et al. (2013). In the case of the snack, the questions were analysed in the same fashion as in the case of the gift certificate. For the snack, the discounted price under option B was set in a JPY 520 (-209%) to JPY 100 (4,171%) range. However, the participants were supposed to purchase the snack; thus, the price is discounted at a certain interest rate if they choose option B.

Table 2. TDT1 question

TDT1 asked participants to choose when and how much they would like to receive as a gift certificate, which will expire after 100 days. Participants could choose either JPY 10,000 in 2 days or a different amount in 9 days. We explained to the participants that the gift certificate could be used as if it was money until the expiration date.

	A. 2 days (98 days left)	B. 9 days (91 days left)
1	JPY 10,000	JPY 9,981
2	JPY 10,000	JPY 10,000
3	JPY 10,000	JPY 10,019
4	JPY 10,000	JPY 10,038
5	JPY 10,000	JPY 10,096
6	JPY 10,000	JPY 10,191
7	JPY 10,000	JPY 10,383
8	JPY 10,000	JPY 10,574
9	JPY 10,000	JPY 10,959
10	JPY 10,000	JPY 11,438
11	JPY 10,000	JPY 11,918

3. Results

Table 3a provides a comparison between the time discount rates for money and the gift certificate. Since some respondents changed between A and B several times, we excluded all contradictory responses, and this affected the final sample size. In our experiment, number of participants, excluding contradictory responses, is 244 (107 males, 137 females).[2] In Table 3a, the rows represent the time discount rate for each intertemporal choice, and the columns represent the items. The results indicate that the time discount rate for money decreases from 200.3% to 190.0%, and the decrease is not significant. On the other hand, the time discount rate significantly increases from 172.4% to 318.2% in the presence of time constraints, as we expected. We also show that the time discount rate for the snack significantly increases over time, from 557.8% to 658.8%. This implies that the presence of a time constraint the influences individual time preferences, making them more present-oriented.

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[2] The ratio of participants thrown out from the analysis in all the sample sizes is 31% in all the results of this study. Even if the contradictory individuals are included to consider the first switching point as the indicator of those discount rates, almost all the results in this study hold.

Table 3a. Time discount rate for TDM (T/S) 1 and TDM (T/S) 2

	Average time discount rate		t-value (paired)
	TDM1	TDM2	TDM1-TDM2 (decreasing or not)
Money	200.3% (261.6%)	190.0% (259.8%)	0.99
	TDT1	TDT2	TDT1-TDT2 (increasing or not)
Gift certificate	172.4% (263.5%)	318.2% (314.2%)	-8.49 **
	TDS1	TDS2	TDS1-TDS2 (increasing or not)
Snack	557.8% (853.8%)	658.8% (843.6%)	-2.25 *

Numbers in parentheses are standard deviations.
Level of significance: * $p<.05$, ** $p<.01$

Table 3b reports the results regarding the magnitude and sign effects. Compared with the discount rate in TDM 3 (TDT 3) and TDM 4 (TDT 4), the large compensation for the delay induces a low discount rate, which implies the presence of the magnitude effect. In addition, we confirm the sign effects from the comparison between TDM 4 (TDT 4) and TDM 5 (TDT 5), and we showed that the discount rate in the case of receipt is greater than in the case of payment. Thus, even though we introduce a time constraint, the magnitude and sign effects have a significant impact on the experiment.

Table 3b. Time discount rate for TDM (T) 3 – TDM (T) 5

	Average time discount rate			t-value (paired)	
	TDM3	TDM4	TDM5	TDM3-TDM4 (magnitude effect)	TDM4-TDM5 (sign effect)
Money	12.3% (12.1%)	3.4% (6.6%)	1.0% (5.3%)	12.71 **	4.27 **
	TDT3	TDT4	TDT5	TDT3-TDT4 (magnitude effect)	TDT4-TDT5 (sign effect)
Gift certificate	10.1% (11.1%)	4.8% (8.6%)	0.7% (4.5%)	6.98 **	6.84 **

Numbers in parentheses are standard deviations.
Level of significance: * $p<.05$, ** $p<.01$

Why does the time discount rate increase over time in the presence of a time constraint? Time constraints induce individuals to recognise the feasibility of the reward for a delayed receipt in addition to the direct value from the use itself. When the individual faces an intertemporal choice close to the time limit and thus, a lower feasibility of the reward, he/she will discount the future receipt more than in the presence of a sufficiently distant limit or in the absence of time constraints.

In the traditional argument in support of the hyperbolic discounting hypothesis, the discount rate for an object far from the present is lower than that for objects closer to the present because people tend to value future issues as less important than issues that they face at present. On the other hand, our experiment shows that a time limit introduces a future-orientation by warning individuals of the limitation. This implies that the time discount rate is increasing rather than decreasing when time constraints exist. Therefore, the time discount rate for a reward far from the expiration date is lower than that of a reward closer to that date.

4. Conclusions

This study investigated the time discount rate in the presence of time constraints and, in contrast with traditional views, the results show that the time discount rate is increasing with time. Traditional arguments, such as those provided by Thaler (1981), indicate that individuals discount present issues more than the future, implying that patience increases over time. However, this argument does not consider the available time to use a reward when there is a delay in its receipt. Our result indicates that the time discount rate on a gift certificate (snack) far from the expiry date is 172.4% (557.8%), while the time discount rate closer to the expiry is 318.2% (658.8%). This implies that people place a higher value on the present. In addition, we can confirm the magnitude and sign effects in the presence of time constraints. Since a short time limit indicates that the feasibility of using the good is low, people are afraid to sacrifice the limited available time by delaying the receipt and, thus have a present-oriented preference, which leads to a higher discount rate.

In many cases, people face time constraints when making an intertemporal choice. Further research is needed on the relationship between time preferences and time constraints in different settings, and our result can be considered a starting point to analyse other types of intertemporal choices.

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