Time Discounting for Primary and Monetary Rewards

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ABSTRACT

This paper reports a positive and statistically significant relation between short-term discount rates elicited with a monetary and a primary reward (chocolate). The relation is most evident among people who like chocolate and are hungry. This finding suggests that high short-term discount rates are related to an underling individual trait, consistent with models of present-biased preferences.

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There is considerable evidence indicating individuals are highly impatient. In particular, they exhibit higher discount rates in the short run than in the long run (Frederick et al., 2002). This result has significant implications for how we model intertemporal decision-making (Strotz, 1955-56).

In most of the experiments, short-term discount rates are measured using monetary rewards delivered at different moments of time (e.g. Thaler, 1981; Kirby, 1997). Unfortunately, since money is fungible, it might be inadequate for this purpose. In particular, access to credit decouples money from consumption, which poses difficulties for how to interpret intertemporal choices (Cubitt and Read, 2007). An alternative is to elicit discount rates using primary goods, which are less fungible.[1] However, goods have important disadvantages: first, immediate consumption of a good easily leads to satiation; second, comparisons between individuals are more complicated as their desire for a good might vary; third, goods introduce additional uncertainty with respect to the future (e.g., I might not know how much I will want a piece of chocolate next Monday afternoon); and fourth, some goods are not easily divisible in small-enough units to provide accurate discount-rate measures.

In this paper, we test whether discount rates elicited with these two different approaches are correlated. This exercise is important for two main reasons. First, a significantly positive correlation between the two suggests that we are indeed measuring an underling characteristic of individuals, which gives support to the use of models of present-biased preferences such as the quasi-hyperbolic discounting model (Phelps and Pollak, 1968; Laibson, 1997) and dual-system models (Bernheim and Rangel, 2004; Fudenberg and Levine, 2006).[2] Second, the existence or not of this

[1] Even with goods, discount rates might not be accurate. Although it is harder, it is still possible to reschedule one's intertemporal consumption with primary rewards (see, Cubitt and Read, 2007).

[2] We do acknowledge that a positive correlation is not necessarily the result of an underlying preference for immediacy. It could also be due to other sources, such as transaction costs. However it does suggest that it is due to individual differences.

correlation can enlighten us on the ultimate source of this present-bias: whether it comes from an impatience for the utility coming from consumption or whether it is an impatience toward instant gratification, even when the source of that gratification is not instant consumption (as in the case of the monetary reward).

In spite of money being fungible, there are reasons to think that discount rates elicited with money and chocolate are correlated. In particular, neurological data suggests that individuals derive utility from receiving money irrespective of whether it is immediately used or not. For instance, the same limbic areas are activated when individuals make intertemporal choices with monetary rewards (Mc Clure et al., 2004) and with an immediate-consumption good (Mc Clure et al., 2007). If money is seen as a carrier of reward that provides a utility jolt when received (i.e., acts like a good, Knutson et al., 2001), then monetary rewards can measure impatience.

There are few papers that elicit discount rates with both monetary and primary rewards. To the best of our knowledge, they all use consumption of addictive substances for addicted people and hypothetical choices. They consistently find that addicts have higher discount rates than non-addicts and that they discount money at a lower rate than the addictive substance (for a survey see, Green and Myerson, 2004). Our study uses a more common good (chocolate) and real instead of hypothetical choices. Most importantly, we look at "normal" MBA students rather than addicts and we concentrate on the relation between the two discount rates as opposed to their respective levels.

1. The Experiment

In order to elicit short-run discount rates, we gave participants two sets of nine choices. Each choice was between an amount x today and a larger amount $(1 + r)x$ in one week. Hence, by gradually increasing the interest rate r, we observe the r at which a participant switches from x today to $(1 + r)x$ in one week. We refer to this switching

point as the participant's discount rate. At the end, one choice was randomly chosen from each set and implemented.

In one set, x was a check for \$50 and r equaled: 0.00, 0.01, 0.03, 0.05, 0.07, 0.09, 0.10, 0.15, and 0.20. Since r = 0.01 already implies an annual interest rate of 67.76%, we expect participants who are exponential discounters to switch between r = 0.00 and r = 0.01. In the other set, x was 5 Leonidas Napolitain chocolates and r equaled: 0.00, 0.05, 0.10, 0.15, 0.20, 0.40, 0.60, 0.80, and 1.00.[3] We used these chocolates because they are a well regarded but not easily available. In this way, choosing the later delivery implied forgoing the consumption of the chocolate that day. Furthermore, the small size of each chocolate made it unlikely that participants would be satiated. Checks and chocolates were received at the end of experiment or one week later after a class scheduled at the same time as the experiment. In addition, participants self-reported their fondness for chocolate and how hungry they felt at that moment.

The experiment was conducted in October 2007 with MBA students. The experimental procedures and the instructions are available in Reuben et al. (2008).

2. Results

Figure 1 shows the distribution of discount rates elicited with money (A), which we denote as r_M, and with chocolate (B), which we denote as r_C.

In both cases, we observe a strong preference for immediacy. The average r_M equals 5.46%, and the average r_C equals 28.77%.[4] However, when elicited with money,

[3] The values of r for chocolate differ from those for money because of technical constraints. We could not reliably cut chocolates into smaller fractions than quarters, which implied at least a 5% return. We could have increased the amount of chocolates, but we feared this would cause satiation.

[4] Consistent with other studies, discount rates for the good are higher than for money. Only 15.79% of the participants have switching points that are consistent with discounting chocolate and money at the same rate. The majority (78.95%) discount chocolate at a higher rate than money. This difference could be due to the different ranges of r, or to a "magnitude" effect (\$50 are worth more than 5 chocolates, Green et al., 1997).

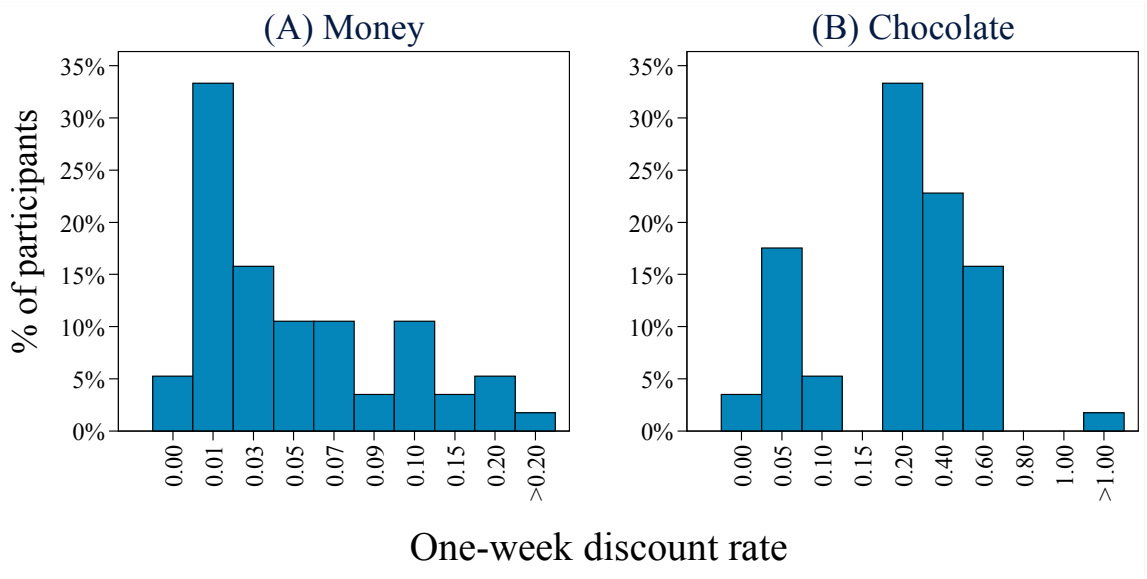

FIGURE 1 – DISTRIBUTION OF DISCOUNT RATES ELICITED WITH MONEY AND CHOCOLATE

there is an important fraction of participants who switch as exponential discounters (it is actually the modal choice): 33.33% switch at r_M = 1%. With chocolate, only 17.54% of the subjects switch at r_C = 5%, and the modal choice is r_C = 20%, which corresponds to waiting a week to receive one additional chocolate. Next, we turn to the main purpose of this study, which is to observe the relationship between r_M and r_G.

We find a positive and statistically significant relationship between r_M and r_C. This can be seen in the first row of Table 1, which presents a regression with r_M as the dependent variable and r_C as the independent variable (plus a constant). The coefficient for r_C is positive and statistically significant.[5] According to the estimate, a one standard deviation increase in r_C is associated with an increase of 0.35 standard deviations in r_M. Figure 2 shows the scatterplot of the data and the estimated regression line.

Subsequently, we study the effect of taste and hunger. To study the effect of these variables, we divide participants into those who *like* chocolate (report an above-average

[5] We get very similar estimates if we censor r_M at its maximum and minimum values (Tobit estimates, coefficient = 0.101, p = 0.007) and if we run the regression only for participants with $r_G \geq 20\%$ (i.e., participants who might dislike chocolate fractions, OLS estimates, coefficient = 0.081, p = 0.034).

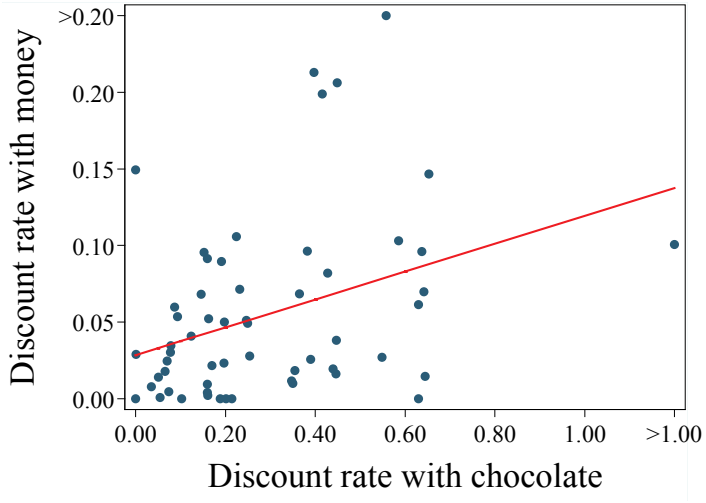

FIGURE 2 – SCATTERPLOT OF THE DISCOUNT RATES ELICITED WITH MONEY AND CHOCOLATE

fondness for it) and those who *dislike* it (below-average fondness). Similarly, we divide participants into those that are *hungry* (above-average hunger) or *not hungry* (below-average hunger).[6] The combined variables have an effect the average r_C: for those who like chocolate and are hungry (not hungry) it equals 29.25% (29.33%) and for those who dislike chocolate and are hungry (not hungry) 30.00% (25.91%).

In Table 1, we show the results of running the previous regression for participants that like/dislike chocolate and are hungry or not. Hunger and fondness for chocolate have an important effect on the relationship between discount rates. For not-hungry participants, regardless of their passion for chocolate, the relationship between discount rates is weaker and no longer statistically significant. For hungry participants who dislike chocolate, the coefficient is of similar magnitude as the ones for not-hungry participants but is (weakly) statistically significant. A marked difference is observed for hungry participants who like chocolate. For these participants the coefficient is much

[6] The questions used were: "how much do you like chocolate?" and "how hungry are you right now?" The answers were given in seven-point scales that ranged from: "not at all" to "my favorite food/extremely hungry".

TABLE 1 – REGRESSIONS OF THE RELATIONSHIP BETWEEN DISCOUNT RATES

Note: OLS regressions with r_M as the dependent variable and r_G as the independent variable. Robust standard errors in parenthesis. ***, **, * denote statistical significance at the 1%, 5%, and 10% levels.

	Coefficient for r_G		Constant		R^2	Obs.
All	0.091 ***	(0.032)	2.840 ***	(0.857)	0.125	57
Not hungry & dislikes chocolate	0.057	(0.035)	4.896 *	(2.297)	0.078	11
Hungry & dislikes chocolate	0.069 *	(0.035)	1.383	(1.164)	0.243	11
Not hungry & likes chocolate	0.076	(0.060)	3.027 *	(1.506)	0.087	15
Hungry & likes chocolate	0.233 **	(0.095)	-0.613	(2.030)	0.306	20

larger—a one standard deviation change in r_C is associated with a change of 0.55 standard deviations in r_M—and statistically significant.[7]

In summary, we find that discount rates elicited with money and discount rates elicited with chocolate are strongly correlated, in particular for participants who both like chocolate and are hungry at the time of the experiment.

3. Conclusions

Consistent with the idea that high short-term discount rates are related to a trait, we show that people who exhibit impatience with monetary rewards also do so with non-monetary rewards, particularly, among people who like the primary reward (chocolate) and are hungry (i.e., those who really want chocolate).

[7] Testing whether the coefficient of hungry participants who like chocolate is bigger than those of other groups, gives the following p-values: vs. not hungry and dislike chocolate $p = 0.05$; vs. not hungry and like chocolate $p = 0.06$, and vs. hungry and dislike chocolate $p = 0.09$.

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