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Reversal and magnitude effects in long-term time preferences: Results from a field experiment[☆]

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HIGHLIGHTS

- We use a MPL approach to elicit the long-term time preferences of French farmers.
- Contrary to the previous literature, we find a reasonable discount rate of 13.6%.
- Discount rates vary with the time delay, which supports a preference reversal effect.
- Discount rates increase with rewards, which contradicts the magnitude effect.

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ABSTRACT

We use a multiple price list approach with real payments to elicit long-term time preferences on a sample of French farmers. Elicited individual discount rates vary with the time delay, which supports the existence of a reversal effect in long-term time preferences, and increase with rewards, which contradicts the usual magnitude effect finding.

1. Introduction

Intertemporal choices defined as decisions involving tradeoffs between costs and benefits occurring at different times have constituted a central part of the economic analysis over the last decades. Understanding intertemporal choices is obviously of great importance to economists and policy makers because they drive many of households economic decisions such as saving, investing in education or health. Those choices are intrinsically linked to individual time preferences of which "discounting" is one attribute.

For a long time the literature on time preferences has been dominated by the exponential discounted utility model despite the various anomalies which have been documented. "Preference reversals" are the most important ones. They occur, for example, when a subject prefers receiving $100 immediately to receiving $120 in a year, but reverses preferences when both rewards are delayed by a common number of periods. Preference reversals reveal a time-inconsistent behavior, which conflicts which the

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Table 1
Experimental design.

Task	Option A		Option B	
	Reward (in euros)	Delay (in years)	Reward (in euros)	Delay (in years)
1	400	1	400, 408, 416, 424, 432 440, 456, 472, 488, 504	2
2	400, 392, 384, 376, 368 360, 344, 328, 312, 296	0	400	1
3	400	1	400, 416, 433, 449, 467 484, 520, 557, 595, 635	3
4	400, 384, 368, 352, 336 320, 288, 256, 224, 192	0	400	2
5	200	1	200, 204, 208, 212, 216 220, 228, 236, 244, 252	2
6	200, 196, 192, 188, 184 180, 172, 164, 156, 148	0	200	1
7	800	1	800, 832, 865, 899, 933 968, 1040, 1114, 1191, 1270	3
8	800, 768, 736, 704, 672 640, 576, 512, 448, 384	0	800	1

exponential model. Another widely observed phenomenon is the "magnitude effect" which corresponds to a discount rate declining with the amount at stake (i.e., greater patience toward larger rewards).

Whereas important intertemporal choices are typically taken over long horizons (e.g., firms' investment decisions, households' education decisions), it is surprising to see that most empirical studies on time preferences (especially those using experimental approaches with monetary incentives) have considered short horizons only. Frederick and Loewenstein (2002) report that among 17 studies having used real payments for eliciting individual time preferences, only 3 feature payments delayed by 2 years or more (Pender, 1996; Warner and Pleeter, 2001; Harrison, 2002). More recent studies such as Benhabib et al. (2010) on U.S. graduate students, Tanaka et al. (2010) on Vietnamese households and Duquette et al. (2012) on U.S. farmers have even considered shorter horizons (respectively 6, 3 and 9 months).

In our paper, we elicit time preferences from a sample of French farmers using an experimental protocol with long-term payments (up to three years). The objective is twofold: provide a better estimate of time preferences in long-term decision making, and assess the existence of preference reversals and magnitude effects in that context.

2. The experiment

2.1. Experimental design and protocol

Our experimental design is similar to the one used by Tanaka et al. (2010) in their time experiment. However, rewards and delays were adapted. Our experiment consists of 8 tasks of the multiple price list (MPL) format. In each task, subjects are asked to make 10 choices between a small reward delivered today or in 1 year (option A) and a larger reward delivered later in the future (option B). Rewards vary between 148 and 1270 euros and the time delay varies between zero (immediate payment) and 3 years (Table 1). The implied exponential discount rates vary from 0% to more than 100% (in task 8). Monotonic preferences are enforced by asking subjects to provide a unique switching point in each task, i.e., the reward for which their preference switches from option A to option B.

The experiment was carried out from February to June 2010. It took place after a 2 h face-to-face interview aiming, *inter alia*, at collecting farmer and farm data. The experiment lasted around half an hour and included a risk, an ambiguity and a time experiment. In this paper, we only analyze the results from the time experiment. A comprehensive introduction of methods and goals, as well as examples, were given to respondents prior to the experiment to ensure a good understanding. Subjects were provided with an initial endowment of 15 euros for their participation. After the subject had completed all three experiments, one choice item was randomly selected for real payment. However, respondents only received a predetermined percentage of the rewards (2%). They were advised of the procedure at the beginning of the experiment, but the extent of the reduction was not disclosed.[2]

We also explained how delayed payments would be implemented: "*If the experiment results in a future payment (up to 3 years), we will hand you a contract pre-signed by the funding organization (ADEPRINA). Without any action on your part, you will receive by mail a check on the due date (1, 2 or 3 years from now). The researchers involved in this experiment will ensure that payment dates will be respected. Payment is guaranteed by the duration of the research project (8 years as of 2009).*". This procedure is particularly adapted to long-term payments. First, it reduces the transaction costs for respondents. Second, it makes payments credible, and minimizes the role of risk aversion in discounting the future. It should also be noted that the project was lead by INRA, a well recognized French research institute, and known by most farmers.

2.2. Sample

We used a stratified random sample of farmers from 64 rural towns in *Bourgogne*, in the east of France. Farmers are socio-economically more diversified than students, which enhances the likelihood of detecting heterogeneity in behavior compared to standard laboratory experiments. In the same line, we chose an area where agriculture was diversified. We contacted 232 farmers by mail first, and followed up with a phone call a few days later. Among them, 85 subjects were excluded because of wrong activity

[2] This approach was used by other authors dealing with large rewards in the laboratory, e.g., Abdellaoui et al. (2008). Another approach is to select randomly one respondent to be paid the full monetary reward. This is the approach followed by Harrison (2002).

or contact information. In the end, 107 farmers participated in the experiment, leading to a response rate of 73%. We believe that the induced selection bias is not critical because farmers were not informed about the experiment and the real payments before we met them.[3]

2.3. Eliciting individual discount rates

Following most of the existing literature, we assume time-separable stationary preferences of the exponential form and linear utility. By definition, the discount rate ρ makes the present value of a monetary outcome available in t equal to:

$$M_t = \frac{1}{(1+\rho)^{\tau}} M_{t+\tau} \tag{1}$$

where M_t and M_τ denote the monetary outcome for delivery at time t and τ respectively. For each respondent and each task, we derive from the given switching point an upper and a lower bound for the discount rate. The discount rate is then assumed to be equal to the mid-point of the interval. For extreme choices (always prefer option A or always prefer option B in a given task), only half-bounded intervals can be calculated. In this case, we assume that the discount rate is equal to the upper bound (left-unbounded intervals) or the lower bound (right-unbounded intervals).

3. Results and discussion

The average annual discount rate is 13.6% with a standard deviation of 0.11. The minimum is 0% (for less than 4% of the observations) and the maximum is 94%. The discount rate is greater than 24% for only 10% of the observations. Usually, experimental discount rates are remarkably high, with values over 100% being common (Frederick and Loewenstein, 2002; Andreoni and Sprenger, 2012). For instance, the average discount rates reported by Harrison (2002), Benhabib et al. (2010) and Duquette et al. (2012) are respectively 28%, 472% and 34%. On the contrary, our results show that MPL approaches can lead to reasonable estimates of individual time preferences. This result is robust against our linear utility assumption since assuming a concave utility instead would lead to even lower estimates (Andreoni and Sprenger, 2012).

Table 2 reports the average annual discount rates depending on the delay of the reward in options A and B. We find that the discount rates tend to increase when rewards in options A and B are delayed by a common number of periods, which is compatible with "preference reversals".[4] Indeed, the average annual discount rate for an immediate payment in option A and a 1-year delay in option B is 13.6%. When delaying both options by 1 year, the average discount rate increases to 15.0%. Similarly, the average annual discount rate for an immediate reward in option A and a 2-year delay in option B is 10.7%. When delaying both options by 1 year, the average discount rate increases to 13.4%.

Table 2
Average annual discount rates.

	Delay in Option B		
	1 year	2 years	3 years
Delay in Option A: nil	13.6%	10.7%	n.a.
	(0.14)	(0.11)	n.a.
Delay in Option A: 1 year	n.a.	15.0%	13.4%
	n.a.	(0.08)	(0.08)

Standard errors in parentheses.

Table 3
Average annual discount rates.

	Delay in Option B		
	1 year	2 years	3 years
Low-reward tasks	12.3%	13.8%	n.a.
	(0.12)	(0.10)	n.a.
High-reward tasks	16.7%	13.5%	13.4%
	(0.19)	(0.08)	(0.08)

Standard errors in parentheses.

To detect the presence of a "magnitude effect", we split the 8 tasks into two categories: a *high reward* category if at least one option involves a reward strictly greater than 400 euros (tasks 1, 3, 7 and 8) and a *low reward* category if all rewards are lower than or equal to 400 euros (tasks 2, 4, 5 and 6). Table 3 reports the average discount rates depending on the task category and the delay in option B. There is no clear evidence of the usual magnitude effect.

To assess more formally the presence of "preference reversals" and "magnitude effects", we estimate panel models that explain the individual annual discount rates inferred from the experimental tasks. The explanatory variables include the delay in option A, the time-lag between options A and B, and the fixed reward in either option A or B.[5] We also control for some socio-demographic individual characteristics which were repeatedly shown to impact time preferences: age, education level (dummy set to one if the respondent completed high school), family status (dummy set to one if the respondent has children), and wealth proxied by farm size. In Table 4, we report the fixed effect and random effect estimates.[6]

The coefficient of *Delay in option A* is positive and significant ($p < 0.001$) which reflects the presence of a reversal of time preferences in our data. Hence, for a given *Time-lag between options A and B*, the discount rate increases by 4.1 percentage points per year of delay in Option A. At the sample mean of the individual characteristics and for a *Fixed Reward* equal to 400 euros, the discount rate increases from 10.80% in period 1 to 14.93% and 19.05% in period 2 and 3 respectively. The coefficient of *Time-lag between options A and B* is negative and significant which corresponds to a discount rate declining with the time horizon, a result in line with the existing literature on time preferences and a priori compatible with hyperbolic discounting, (Frederick and Loewenstein, 2002). One should however point out that hyperbolic discounting cannot explain alone that *Delay in option A* and *Time-lag between options A and B* are jointly significant. This time-lag effect implies that the per-period discount rate decreases as the time-lag gets longer, which may be the case if time discounting is subadditive as discussed in Read (2001) and Scholten and Read (2006).

3 Farmers' characteristics in our sample have been compared with those in the *Côte d'Or* French department where most sampled farmers come from. Differences appear to be very limited, for instance, in terms of farm size (on average 169 ha in our sample compared to 156 ha in *Côte d'Or)* or legal status (38% of the farmers in our sample own alone their farm compared to 42% in *Côte d'Or*).

4 A necessary condition for preference reversals is that the discount rate increases over time. Consider for instance a two-period model where ρ_t is the discount rate for period t. An individual will prefer to receive Y at the end of period 1, compared to X immediately, if and only if $Y/(1+\rho_1) > X$. Imagine that the same alternative is proposed but X and Y are both delayed by an additional unitary period. A reversal of time preferences will occur if X is preferred to Y, that is if $X > Y/(1+\rho_2)$. These two inequalities together lead to $\rho_2 > \rho_1$ which corresponds to a discount rate which increases over time.

5 Some other specifications of the last variable, including maximal or average reward across options A and B, have also been considered. Similar estimates have been obtained.

6 A Sargan–Hansen specification test concludes that the random effect model cannot be rejected in favor of the fixed effect model.

Table 4
Estimation results for the individual annual discount rates.

Variable	Fixed effects	Random effects
Delay in option A (in years)	0.038***	0.041***
	(0.009)	(0.009)
Time-lag between options A and B (in years)	−0.024***	−0.022***
	(0.005)	(0.005)
Fixed Reward (in euros)	0.000*	0.000**
	(0.000)	(0.000)
Age (in years)	–	−0.002***
	–	(0.001)
EducHigh (dummy)	–	−0.040***
	–	(0.014)
Children (dummy)	–	−0.037***
	–	(0.009)
FarmSize (in ha)	–	−0.009
	–	(0.006)
Intercept	0.122***	0.275***
	(0.007)	(0.050)
N. obs	640	640
Pseudo R^2	0.072	0.145

Errors clustered on individuals in both models.
* Significant at 10%.
** Significant at 5%.
*** Significant at 1%.

The coefficient of *Fixed Reward* is also significant, with a positive sign, meaning that the higher the reward, the higher the discount rate. Hence, subjects exhibit a greater impatience toward larger rewards, which contradicts again the "magnitude effect". We find the reward effect to be moderate. At the sample mean of the individual characteristics, moving the *Fixed Reward* variable from 400 to 600 euros results in an increase of the discount rate for the first period from 10.80% to 11.50%.

The sign and the magnitude of the coefficients associated with the socio-demographic variables make sense given the existing literature. Similarly to Harrison (2002), we find that discount rates decline with age but are not significantly related to wealth. Highly educated respondents or those having children also tend to be more patient than the average.

4. Conclusion

We use a field-experiment approach to elicit time preferences on a non-standard pool of subjects (French farmers) using long-term payments (up to three years). With this original setting, we find a reasonable annual average discount rate of 13.6%. We demonstrate that the discount rate varies with the time delay, which provides some evidence of possible reversal effects in long-term time preferences. We also find that time preferences depend on the time-lag between payments. These results call for the use of complex models of intertemporal choices, such as the discounting-by-interval model proposed by Scholten and Read (2006). In this model, the discount rate is a function of both how far rewards are removed from the present and how far rewards are removed from one another.

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