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Ricardo Alberto MARQUES PEREIRA
Dipartimento di Informatica e Studi Aziendali
Università degli Studi di Trento
Via Inama 5, TN 38100 Trento ITALIA
Tel +39-0461-882147 Fax +39-0461-882124
E-mail: ricalb.marper@unitn.it

Construction of time preference: an investigation of the role of elicitation method in experimental elicitation of time preference

by

Oksana Tokarchuk[*]

CIFREM, University of Trento

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Abstract

The idea of preference reversal and construction of preference is not new to literature in decision making. Indeed, several theories have been developed to explain it. (Lichtenstein and Slovic, 2006). The present paper considers heuristics activated in different elicitation procedures applied in time preference research. I show that activation of these rules in correspondence with different elicitation methods leads to observation of a particular pattern most frequently reported in time preference literature: hyperbolic discounting. In particular, I analyze two most diffused elicitation procedures, matching task and two variations of choice task in multiple price list format (MPL). In a series of experiments I demonstrate that matching task is characterized by choice of focal amounts and anchoring to previously reported amount. At the same time, choice in MPL format largely depends on the structure of the list from which the choice is made. I study two widely used structures of MPL choice task format: (a) MPL with nominal structure (Green et al, 1997), where choice alternatives correspond to the same nominal amounts that are available at different time horizons; (b) MPL with interest rate structure (Coller and Williams, 1999), in which monetary alternatives at each time horizon in consideration are constructed as increases corresponding to a fixed interest rate. Although these two elicitation structures activate similar decision processes they lead to observation of qualitatively different results that are in large part defined by the underlying structure of the list of alternatives. I show that matching task and MPL with nominal structure lead to observation of hyperbolic evidence, that could be of different kinds depending on the structure of MPL table. At the same time, elicitation with MPL with interest rate structure leads to observation of rather stable time preference that can be well approximated by exponential discounting.

Introduction

Experimental research in time preference like no other area of experimental literature is characterized by high heterogeneity of results with little methodological progress being made (Frederick et al, 2002). Regardless of plethora of studies being produced on the topic new studies tend to discover new anomalies without providing account of existing ones.

Recent research in intertemporal choice is seeking explanations for these problems in theoretical assumptions that are traditionally made in elicitation of time preference (Frederick et al , 2002, Read, 200). Particular role in this treatment is assigned to the assumption of linear utility function associated with monetary payoffs. This assumption is a necessary condition for identification of discount rate in studies dealing with elicitation of time preference. Joint estimation

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of risk and time preference leads to estimation of lower, almost at the level of market interest rate, discount rates (Andersen et al, 2008). Nevertheless, this estimation method does not explain variability of discount rates observed in literature given that all the methods use the same estimation technique and therefore should lead to the same results, nor does it provide on the true form of discount function.

Another big stream of research has occupied with methodological issues concerned with experimental elicitation of discount rates. Coller and Williams (1999) introduced representation of alternatives with indication of corresponding interest rate as well as conducted study of the effect of real payments in elicitation of time preference with choice task. According to Harrison and Lau (2005) these two features help to eliminate evidence of hyperbolic discounting from data.

Nevertheless, Manzini et al (2008) comparing alternative incentive mechanisms that permit implementation of real payoffs in elicitation of time preference observe evidence of hyperbolic discounting in all three elicitation procedures that were confronted in the study. Moreover, it is demonstrated that discount rates elicited with different elicitation method differ in magnitude even if the rest of experimental procedures is kept constant. In particular, discount rates elicited with choice task appear to be higher than discount rates elicited with matching task. The same conclusion was earlier reached by Read and Roelofsma (2003) in their study with hypothetical payoffs.

Choice task and matching task are the mostly diffused elicitation methods in experimental treatment of time preference (Frederick et al (2002)). Choice task requires subjects to choose between two alternative options. One of them provides smaller payoff but is available at a sooner date while the other is larger but is available for payment at a later date. One single choice task permits only to pose limits on the individual discount rate: if sooner smaller option is chosen subject's discount rate is larger than discount rate associated to the two options of choice. To obtain better estimate of discount rate with choice task subjects are faced with a series of questions similar to the type explained above. Usually payoff associated to sooner smaller or later larger option is kept constant while the other one varies. This elicitation mode received the name of multiple price list format (Coller and Williams, 1999). Subjects are expected to choose sooner smaller option for some values of the option that is changing and switch their choice to later larger option after reaching this value. Elicited discount rate is comprised in the interval of values for which the switch happened.

Matching task faces subjects with a similar situation – two alternative payment options are available at different dates. In this task however one of the payoff values is missing and subjects are asked to indicate value that would provide them with the same satisfaction as a given option.

Contrary to choice task one question in matching task mode of elicitation provides with estimate of the discount rate.

Although choice task and matching task are rather different from the point of view of experimental procedures it can be demonstrated that choice task and matching task provide the same incentive structure to reveal true preferences in experimental setting (Manzini et al, 2008). Nevertheless implementation of the two alternative elicitation methods leads to divergent results as it was mentioned earlier. Variety of elicitation methods implemented in time preference research suggests that possible explanation of observed diversity of discount rates can be found in elicitation methods implemented by various studies.

Comparative analysis of discount rates among studies in experimental literature on time preference is very hard due to large variability of experimental procedures and design features from study to study: incentive structure, amounts of elicitations, elicitation intervals, subject pools are only few of the factors that vary. Meanwhile existing studies that document differences ascribable to elicitation methods were not designed to study these aspects therefore they do not provide enough evidence to reach conclusions.

Present study was explicitly designed to address discrepancies between elicitation tasks that are widely used in time preference research and how these differences influence conclusions on the form of discounting function. The rest of the paper is organized in the following way: next section presents results of Experiment I developed to explore differences between alternative elicitation methods and heuristics that subjects adopt in dealing with them; section 2 discusses results of Experiment II that investigates implications of differences between single elicitation methods on the form of corresponding discounting function; section 3 demonstrates that results observed in Experiment I and Experiment II conform to the evidence observed in literature in correspondence to considered elicitation tasks and demonstrates that decisional rules reported by subjects in experiments lead to construction of rather different discounting functions ranging from exponential to quasi-hyperbolic discounting; section 4 concludes.

Experiment I.

Experimental design

Experiment I was designed to address differences in discount rates elicited with alternative elicitation tasks. 2 main elicitation tasks, matching task and choice task, were taken into analysis.

Existing studies that compare results elicited with choice task and matching task in time preference literature do not reach consensus on the direction of this relationship. Albreht and Weber (1997), Read and Roelofsma (2003) and Manzini et al (2008) find that implementation of choice

task leads to observation of higher discount rates while Tokarchuk (2007) observe that discount rates elicited with choice task are lower than discount rates elicited with matching task. Although both Manzini et al (2008) and Tokarchuk (2007) considered choice task and matching task there were considerable differences in the structure of the tasks adopted by these studies[1]. Both studies presented subjects with choice task in multiple price list format (MPL) although construction of alternatives in a list differed in a significant way.

MPL choice task in Manzini et al (2008) was constructed starting from a fixed value of later larger option for all alternatives on the list. Values corresponding to sooner smaller options instead decreased by regular nominal amounts with each alternative departing from the fixed later larger value and reaching the value of 0. Subjects are asked to choose option A or option B in list of alternatives in which option A corresponds to \$100 while option B to \$100-x, the value of x increases for each successive alternative on the list. Constructed in this way MPL choice task maintains the same nominal values for all elicitation intervals for given amount of elicitation. I will refer to this elicitation structure as nominal MPL format of choice task (or \$-MPL) to underline fixed nominal structure of alternatives. \$-MPL choice task is widely used in elicitation of time preference (Pender (1996), Green et al (1997), Tanaka et al (2007), Slonim et al (2007), etc.). Studies that implement this elicitation structure report evidence compatible with hyperbolic discounting.

Choice task implemented in Tokarchuk (2007) instead is based on MPL method developed in Coller and Williams (1999). In this representation multiple price list faces subjects with a list of alternatives for which sooner smaller option is kept the same. Later larger option is calculated as return on the given initial value of sooner smaller option corresponding to the interval of elicitation. In this case experimenter chooses the range of interest rates, annual returns, to be considered in the study. Subjects are asked to choose between \$100 and \$100+x where x corresponds to annual return on \$100 calculated over given period of elicitation. Contrary to \$-MPL present method faces subjects with alternatives which nominal values change with increase of the period of elicitation. I refer to this structure of choice task as MPL choice task with interest rate structure (or %-MPL) to emphasize that nominal values corresponding to alternatives of choice depend on the range of the interest rates chosen by the researcher. %-MPL choice task received wide acceptance in experimental treatment of time preference in recent years (Harrison et al (2002), Andersen et al (2008), Dohmen et al (2007), Boltelho et al (2006), etc.). Probably not the least important factor of

[1] Albreht and Weber (1997) as well as Read and Roelofsma (2003) did not consider elicitation of time preference in traditional way therefore I skip discussion of particularities associated with these 2 studies in the present study

its popularity is the fact that studies implementing this elicitation task observe lower and more stable discount rates (Andersen et al (2006)).

Given that studies implementing $-MPL choice task report hyperbolic evidence while studies that use %-MPL choice task elicit stable discount rates it is possible that differences associated with the structure of elicitation table lead to elicitation of qualitatively and quantitatively different discount rates. For instance, discount rates elicited in Manzini et al (2008) with $-MPL choice task result to be higher that discount rates elicited in Tokarchuk (2007) with %-MPL elicitation procedure, median discount rates in the first case vary between 124% and 514% while in the second study they reach maximum of 30%. This discrepancy may explain reversal of relation observed between matching task and choice task in two studies. Experiment I compares discount rates elicited with the help of %-MPL and $-MPL choice tasks.

Hypothesis 1a: Discount rates elicited with %-MPL choice task will be lower than discount rates elicited with $-MPL choice task

$-MPL is usually presented in "speed-up" payoff frame, i.e. later larger amount is given and the attempt of the experimenter is to find sooner smaller amount that provides subject with the same satisfaction. Meanwhile %-MPL choice task is constructed in "delay" payoff frame since subject is faced with a sooner smaller option and the goal of elicitation is to find corresponding later larger value that provides with the same satisfaction. Accordingly, there is a need to confront $-MPL choice task with matching task in "speed-up" frame, as in Manzini et al (2008), and %-MPL choice task with matching task in "delay" frame, as in Tokarchuk (2007).

Hypothesis 1b: Discount rate elicited with %-MPL format will be higher than the one elicited with matching task delay receipt frame.

Hypothesis 1c: Discount rates elicited with $-MPL format will be higher than the ones elicited with matching task in speed-up receipt frame.

Delay – speed-up effect, lower discount rates elicited in speed-up frame compared to discount rates elicited in delay frame, is a standard evidence in time preference research (Loewenstein (1989)). Although Hypothesis 1a predicts opposite effect for choice task it is expected that matching task will confirm to the standard evidence given that delay – speed up effect in literature is observed with implementation of matching task (Benzion et al (1989), Benhabib et al (2006), etc.

Hypothesis 1d: Discount rates elicited with MT in delay scenario will be higher than those elicited with anticipating scenario.

Representation of %-MPL choice task introduced by Coller and Williams (1999) and followed by most studies included indication of corresponding to each alternative of choice interest

rate. At the same time there is no evidence of the effect of reporting to subjects corresponding interest rate in other elicitation methods. Although interest rate representation has been demonstrated to be an important design feature in elicitation of time preference (Read et al (2005)) it was preferred to present subjects only with nominal values associated with alternatives of choice to be able to confront results within considered elicitation methods and with existing evidence.

Implementation of real incentives and presentation of sooner smaller alternative with front-end delay (FED) are considered by Harrison and Lau (2005) decisive features that lead to hyperbolic discounting evidence in time. Although these two design features are relatively new to experimental research in time preference vast evidence with their implementation have been accumulated so far. Contrary to interest rate representation, design of Experiment I included both real incentives and FED.

While implementation of real incentives in choice task results straightforward in choice task – subjects are informed that they will be paid the option they choose- real incentives in matching task are not so easy. There are two incentive mechanisms that can be applied to matching task to make it incentive compatible: Becker-De Groot-Marshak mechanism (BDM) (Becker et al, 1964) and auctions (Kirby and Marakovic, 1995). Both mechanisms lead to observation of similar results (Manzini et al (2008). However, BDM mechanism is relatively easier to implement from experimental point of view[2]. It was decided to implement BDM procedure to matching task.

Experimental procedures

Experiment I consists of 3 Treatments presented in table 1. Each treatment includes choice task and matching task in the same frame. Treatment I and Ia addressed choice task in %-MPL format and matching task in delay frame and differed by the order of presentation of choice task and matching task. Treatment II confronted $-MPL choice task with matching task in speed-up frame.

Table 1. Experimental treatments, Experiment I

Treatment	Order of tasks	Number of subjects
Treatment I	$MT_{Delay} - \% - MPL$	20
Treatment Ia	$\% - MPL - MT_{Delay}$	20
Treatment II	$MT_{Speed-up} - \$ - MPL$	16

Experimental procedures were based on procedures by Harrison et al (2002). Subjects were presented with a task in a following way:

[2] BDM is based on individual choice while auction implies participation of more than one subject leading to a need of more complicated experimental software and procedures

"One person in this room will be randomly selected to receive a considerable amount of money. If you are the person selected (Assignee) you could be paid according to two possible options of payment: option A and option B. If you choose option B you will receive a sum of money in 8 months from today. If you choose option A you will receive the sum of money in 1 month from today, but this option A will pay smaller amount of money than option B".

Experiment I was developed to confront elicitation methods rather than discounting functions, therefore it was decided to consider only one elicitation interval corresponding to 6 months. This interval being frequently considered in studies on time preference is of relevant length for the student subjects' pool. FED was fixed at 2 months.

Amount of elicitation was fixed at € 400. This amount is of significant magnitude for students[3].

For %-MPL choice tasks subjects were presented with alternatives presented in table 2. This table was constructed using values from Harrison et al (2002). In $-MPL choice task subjects were faced with alternatives presented in table 3. Poulton (1989) suggests that presentation of alternatives in a form of table can lead to attraction of subjects' choice to the middle table position. To avoid this effect in present experiments alternatives corresponding to the choice task were presented to subjects one at a time in random order.

Table 2 Experimental payoffs, Experiment I and II, %-MPL elicitation table

Alternative	Option A (pays in 2 months)	Option B					Associated interest rate
		(Pays in 8 months)	(Pays in 1 year and 2 months)	(Pays in 3 years and 2 months)	(Pays in 5 years and 2 months)	(Pays in 10 years and 2 months)	
1	€ 400	€ 405	€ 410	€ 431	€ 453	€ 513	2,5 %
2	€ 400	€ 410	€ 420	€ 464	€ 513	€ 657	5 %
3	€ 400	€ 415	€ 431	€ 500	€ 580	€ 841	7,5 %
4	€ 400	€ 420	€ 442	€ 538	€ 655	€ 1.074	10 %
5	€ 400	€ 425	€ 452	€ 579	€ 740	€ 1.370	12,5 %
6	€ 400	€ 431	€ 463	€ 622	€ 835	€ 1.744	15 %
7	€ 400	€ 436	€ 475	€ 669	€ 942	€ 2.218	17,5 %
8	€ 400	€ 441	€ 486	€ 718	€ 1.061	€ 2.816	20 %
9	€ 400	€ 446	€ 498	€ 771	€ 1.195	€ 3.570	22,5 %
10	€ 400	€ 452	€ 510	€ 828	€ 1.345	€ 4.521	25 %
11	€ 400	€ 457	€ 522	€ 888	€ 1.512	€ 5.716	27,5 %
12	€ 400	€ 462	€ 534	€ 953	€ 1.699	€ 7.218	30 %

[3] Corresponds to the maximum monthly payment that undergraduate students can receive as scholarship based on their income and merit while tuition fees amount to €1500 annual

13	€ 400	€ 468	€ 547	€ 1.021	€ 1.908	€ 9.101	32,5 %
14	€ 400	€ 473	€ 559	€ 1.094	€ 2.141	€ 11.461	35 %
15	€ 400	€ 479	€ 572	€ 1.172	€ 2.401	€ 14.414	37,5 %
16	€ 400	€ 484	€ 586	€ 1.255	€ 2.691	€ 18.104	40 %
17	€ 400	€ 490	€ 599	€ 1.344	€ 3.014	€ 22.709	42,5 %
18	€ 400	€ 495	€ 613	€ 1.438	€ 3.373	€ 28.449	45 %
19	€ 400	€ 501	€ 627	€ 1.538	€ 3.773	€ 35.594	47,5 %
20	€ 400	€ 506	€ 641	€ 1.644	€ 4.218	€ 44.480	50 %

Table 3. Experimental payoffs, Experiment I and II, $-MPL elicitation table

Alternative	Option A (pays in 2 months)	Option B (Pays in 8 months)	Associated interest rate				
			6 months	1 year	3 years	5 years	10 years
1	€ 380	€ 400	10 %	5 %	2 %	1 %	1 %
2	€ 360	€ 400	21 %	11 %	4 %	2 %	1 %
3	€ 340	€ 400	33 %	16 %	5 %	3 %	2 %
4	€ 320	€ 400	45 %	23 %	7 %	4 %	2 %
5	€ 300	€ 400	59 %	29 %	10 %	6 %	3 %
6	€ 280	€ 400	73 %	36 %	12 %	7 %	4 %
7	€ 260	€ 400	89 %	44 %	14 %	9 %	4 %
8	€ 240	€ 400	107 %	52 %	17 %	10 %	5 %
9	€ 220	€ 400	126 %	61 %	20 %	12 %	6 %
10	€ 200	€ 400	147 %	71 %	23 %	14 %	7 %
11	€ 180	€ 400	171 %	83 %	27 %	16 %	8 %
12	€ 160	€ 400	198 %	95 %	31 %	18 %	9 %
13	€ 140	€ 400	229 %	110 %	36 %	21 %	11 %
14	€ 120	€ 400	267 %	127 %	41 %	24 %	12 %
15	€ 100	€ 400	312 %	147 %	47 %	28 %	14 %
16	€ 80	€ 400	369 %	172 %	55 %	33 %	16 %
17	€ 60	€ 400	446 %	206 %	65 %	39 %	19 %
18	€ 40	€ 400	561 %	254 %	79 %	47 %	23 %
19	€ 20	€ 400	777 %	340 %	104 %	61 %	30 %
20	€ 10	€ 400	1019 %	432 %	129 %	76 %	37 %

Matching task in delay frame was presented in the following way:

"You are about to receive a sum of money in 2 months from today, option A. How much would you like to receive in 8 months, option B, to be equally satisfied receiving any of these two options"

Subjects were asked to enter amount they preferred to the opposite bar on the screen. This bar corresponded to € 400 in the beginning of the task. Subjects could increase this amount to reach

desirable value by scrolling opposite bar that would increase the value by € 1 at time. Alternatively it was possible to insert desired value. Subjects were not communicated the maximum value that was possible to report on the task, the limiting value necessary for BDM procedure that was equal to € 800. However, they could discover the value of the maximum amount by reaching it with scrolling the bar or inserting higher amount and confirming operation. If amount higher than admissible was inserted and confirmed the program would communicate that inserted amount is higher than admissible and subject was asked to try with lower amount.

For speed-up frame subjects could choose to insert amount between €0 and 400. Presentation of the matching task in speed-up frame and subjects' choice were done in the same manner as for delay frame with obvious adjustments.

Subjects were faced with 21 questions consisting of 20 choice task questions and 1 matching task question.

One subject in each Treatment was selected for payment while all subjects received 8 euro as participation fee. One out of 21 questions was extracted in the end of experiment. In case of the question corresponding to choice task subject was paid according to the option chosen for this question. If matching task was extracted for payment the option of payment was determined by BDM mechanism.

Payment procedures were explained in detail in instructions that were read aloud by experimenter. To be sure that subjects understood experimental procedures trial session was conducted with candies. To explain how payment works for both choice task and matching task a winner for both tasks was selected and paid in the trial session.

Implementation

56 undergraduate students from University of Trento participated in experiment I. Subjects were recruited through CEEL database and were randomly assigned to 3 experimental sessions.

Experiment was conducted on computer with the use of software created ad hoc for this experiment while the questionnaire was performed with pen and paper. Each experimental session lasted around 50 minutes including reading of instructions, trial experiment, experiment itself, compilation of questionnaire and winner selection.

Results

General overview

Table 4 presents median discount rates elicited in Experiment I. Median discount rate elicited with %-MPL format of choice task is at 32.5% in Treatment I and 25% in Treatment II. Meanwhile median discount rates elicited with matching task on these treatments amounts to 67% and 50% accordingly. Wilcoxon matched-pairs ranked test confirms Hypothesis 1b by which

discount rates elicited with %-MPL choice task are lower than discount rates elicited with matching task in delay frame. This result is in line with evidence from Tokarchuk (2007).

Table 4. Results of experiment I

Treatment	Matching task		Choice task (MPL)		Wilcoxon matched-pairs ranked test *(probability associated with one-directional test)*
	Median amount	Median discount rate	Median amount	Median discount rate *(median row)*	
Treatment I ($MT_{Delay} - \% - MPL$)	€ 555	67%	€ 467,5	32,5% *(13)*	z=2,55 *(0,0055)*
Treatment Ia ($\% - MPL - MT_{Delay}$)	€ 500	50%	€ 452	25% *(10)*	z=3,14 *(0,0009)*
Treatment II ($MT_{Speed-up} - \$ - MPL$)	€ 325	43%	€ 260	89% *(7)*	T^{+}=110, *n=15* *(0,0013)*

Median discount rate elicited with $-MPL choice task is 89% while discount rate elicited in the same treatment with matching task is only 43%. Therefore, $-MPL choice task leads to elicitation of the discount rate that is higher than discount rate elicited with matching task in speed-up frame. Wilcoxon matched-pairs ranked test confirms Hypothesis 1c at a significance level of 0,001. This result corresponds to evidence observed in Manzini et al (2008) where the comparison was performed in between subjects design.

Comparison of discount rates elicited with %-MPL and $-MPL choice task provide evidence in favor of Hypothesis 1a, i.e. discount rates observed with %-MPL choice task are lower that discount rates elicited with $-MPL choice task. This result is significant at 0,001 level according to Mann-Whitney test reported in table 5.

Table 5. Results of Mann-Whitney tests

Treatment	%-MPL_Ia	$-MPL	MT_delay_Ia	MT_speed up
MT_delay_I	z=3,58 *(p=0,0003)*	z=-1,91 *(p=0,0561)*	z=1,66 *(p=0,0969)*	z=1,88 *(p=0,0601)*
%-MPL_I	z=0,69 *(p=0,4902)*	z=-4,01 *(p<0,0001)*	z=-4,69 *(p<0,0001)*	z=-1,05 *(p=0,2937)*
MT_delay_Ia		z=-1,98 *(p=0,0477)*		z=1,03 *(p=0,303)*
MT_speed up	z=1,13 *(p=0,2585)*			
%-MPL_Ia		z=-4,39 *(p<0,0001)*		

Last but not least, discount rates elicited with matching task in delay frame, Treatments I and Ia, are higher than discount rates elicited with the same task in speed up frame, Treatment II, see tab. 4. Hypothesis 1d is also confirmed by results of Mann-Whitney test reported in tab. 5.

Analysis of differences between matching task and choice task

The difference between discount rates elicited with matching task and choice task persist regardless of the order of presentation of the task. In Treatment I and II matching task was the first task in the experiment followed by choice task while in Treatment Ia choice task was the first task in the experiment. Regardless of the order of presentation the difference between discount rates elicited with choice task and matching task is significant.

Method invariance requires that subjects report the same indifference values, from which discount rates are calculated later, on both elicitation methods. Instead, majority of subjects report higher values on matching task compared to values at which the switch from choosing option A to choosing option B happens in choice task.

For instance, 65% of subjects in Treatment I reported higher amount as indifference value on matching task but switched their choice at a lower value: median value chosen in matching task was € 555 while median value at which the switch from choosing option A to choosing option B happened was € 467,5.

2 of these subjects reported indifference value of € 500 on matching task but switched their choice at the value of € 473. Notice that the value of € 500 was available for choice also in %-MPL table (see tab. 2), however, these 2 subjects switched their choice at a much lower value.

At the same time nothing precluded the rest of subjects that on matching task expressed preference for values higher than options available on choice task to choose option A for all alternatives on choice task, this behavior would confirm their choice on the matching task. Instead they switched their choice within the limits imposed by the %-MPL table.

Similar pattern of behavior is observed in Treatment Ia. 90% of subjects in this treatment reported higher amounts on matching task while switched their choice at lower amounts in choice task. Choice task in this treatment was the first task of experiment followed by matching task. Median amount at which the switch occurred in choice task was € 452 while in matching task subjects reported median indifference value of € 500. 55% of subjects in this treatment reported on matching task values that were available for their choice in choice task, € 500, but they chose lower values. While in Treatment Ia such behavior of subjects can be explained by their late regret of choosing too low value on choice task this explanation does not work for behavior of subjects in Treatment I.

Although median values of discount rates are higher in Treatment I compared to Treatment Ia Mann-Whitney test confirms alternative hypothesis that discount rates elicited with choice task in Treatment I are similar to discount rates elicited with choice task in Treatment Ia (see tab. 5). It is also hard to refuse hypothesis that discount rates elicited with matching task in Treatment I and Ia are different given that probability associated with Mann-Whitney test reported in table 5 is equal to 0,1.

In Treatment I amounts reported on matching task vary a lot within the limits available for choice (between € 400 and € 800). In Treatment Ia these amounts are concentrated around a focal value of € 500 although some subjects report much higher amounts. While on matching task subjects could choose any value between € 400 and € 800 the limits on choice imposed by %-MPL table were only between € 400 and € 506 (see tab.2). These different limits on the decision space could have caused observed differences in choice.

Subjects however did not know these limits on either task before they were called to make their choice on corresponding task. On matching task it was possible to discover the upper limit by scrolling corresponding bar and reaching the upper limit or by trying to enter amount lying out of the limits. Only few subjects did explore the limits before performing their choice on matching task. On choice task alternatives were presented to subjects one at a time in randomized order. Therefore, it was not possible for them to know the limits of the table unless they were faced with the last alternative first.

Discovering limits imposed on the task they were faced with first seems to have influence on subjects' behavior although this influence is not statistically significant. In Treatment I subjects probably express their preferences more freely on matching task as the only limit of their choice is the maximum value of € 800 which was not known to them in the beginning of the task. They also tend to perform their switch on choice task at higher values compared to values at which this switch happens in Treatment Ia. Probably subjects in Treatment I anchor their choices on choice task to the value they reported on matching task. Nevertheless, they prefer to switch within the limits of the %-MPL table.

In Treatment Ia exposure to choice task in first place allows subjects to discover the limiting value on the %-MPL table, equal to € 506. This value seems to attract subjects' attention to the amount of € 500 in consecutive matching task. 40% of subjects on Treatment Ia choose this value on matching task compared to only 20% that made this choice on Treatment I. In Treatment Ia only 35% of subjects opt for amounts higher than € 500 compared to 55% of subjects in Treatment I. Clearly, choice task being first imposes limits on the preference structure of subjects and even in situation in which values higher than those proposed for choice on the first task are available they

may choose not to opt for those higher values thinking that limits on choice task are considered "fair" values by the experimenter.

Similarly, in Treatment II subjects record higher amounts in matching task compared to amounts at which they switch in choice task. However, in treatment II this phenomenon leads to observation of lower discount rates observed with matching task compared to discount rates observed with $-MPL choice task. Contrary to Treatments I and Ia matching task and choice task in Treatment II had the same limits on the values that subjects could choose. Notwithstanding this 75% of subjects in Treatment II chose higher amounts on matching task while accepted to receive lower amounts sooner on choice task. As in previously discussed treatments subjects failed to be consistent among elicitation tasks although there were no pause between the tasks.

Different results observed in matching task and choice task could be explained in terms of exposure to different limits on the two tasks. Recall that while on matching task subjects could enter whatever amount between 400 and 800, the choice on choice task was limited to the values of option B varying from € 400 to €506. This opportunity does seem to be a plausible explanation since the switching of the choice within the limits of the underlying MPL table was hardly influenced by the table structure itself given that subjects were not faced with the whole table but were asked to choose between option A and option B for single alternatives that composed the MPL table. Subjects were faced with these single alternatives one at a time and there was no possibility to get back and change the choice on the previous alternative. Moreover, Treatment II faced subjects with the same limits on choice – between € 400 and € 0 – but subjects' choices were not more consistent.

Observed difference between subjects' choices on matching task and choice task can be probably explained by opportunistic motives that matching task may encourage in subjects. While in choice task the only thing subjects can do is to choose the option they prefer between the proposed two in matching task they can express their preference freely. To address this issue BDM mechanism was introduced in matching task to make it incentive compatible. Although subjects were explained how BDM procedure works it is possible that they stated higher values on matching task hoping to receive more money if the matching task was selected for payment. In fact, 3 persons stated the highest possible value in each treatment ignoring the fact that in this case they reduced to 0 probability of getting delayed payment for Treatments I and Ia and being paid on a closer date in Treatment II.

While this can explain subjects' behavior on Treatment Ia, nothing precluded subjects that reported on matching task values higher than €506 in Treatment I, the threshold value for choice task, to always choose option A on consecutive choice task. Sticking to this strategy, to be

consistent within the tasks, was even easier in Treatment II where matching task and choice task had the same upper limit known to subjects. However, these subjects switched their choice within the limits of the table.

On the final questionnaires that subjects filled in before the winner of the session was extracted they were asked to state whether they were happy with the choice they made in experiment on both tasks and how they would change it if they could. Surprisingly, only 2 persons in Treatment I that stated the highest possible value on matching task, € 800, reported they would decrease a little their request on matching task, by € 50-€ 100. Everyone else declared to be satisfied with the choices they made during the experiment. Therefore, it seems that subjects did not realize that they were inconsistent. Even if they did realize this inconsistency they did not want to change it.

Final questionnaires collected subjects' opinions as to whether the winner of the session will be actually paid as promised by the experimenter. All subjects expressed a sure believe that the payment will take place according to conditions of the experiment. This result confirms that CEEL laboratory has very good reputation among student population as to trustworthiness of payment procedure adopted in experiments. Therefore, the results of the experiment can be treated as a truthful revelation of subjects' preferences.

Behavior of subjects in Experiment I suggests that there is a fundamental difference between how subjects perceive choice task and matching task, the difference that does not depend on the order of presentation of the tasks to subjects.

Decision rules implemented in choice task and matching task

Following tradition of research in preference reversal in risky choice where discrepancy between choice and matching is widely observed I search the origin of these differences in representation structure induced by each elicitation method (Lihtenstein and Slovic, 2006). Compatibility principle is believed to explain this discrepancy (Tversky et al 1988). According to this principle characteristics of the task and the response scale attracts attention to the most compatible features of the stimulus. For example, in risky choice pricing of bets is likely to emphasize payoffs more than probability because both the response and the payoffs are expressed in dollars. At the same time it is believed that while choosing between two gambles subjects take into attention both dimensions of the gamble – monetary and probabilistic, therefore it is possible that in pricing gambles with higher payoff and lower probability will be assigned higher price but a gamble wit lower payoff associated to higher probability of winning will be chosen.

Choice task and matching task applied to elicitation of time preference partly recall the same situation. In matching task subjects are asked to express monetary value in euro that makes them

indifferent with a given alternative option, while choice task requires subjects to choose between the two alternatives. However, both in matching task and choice task time dimension is present in both alternatives, whereas in pricing task in risky choice subjects are asked to report certainty equivalent of the bet. In situations of risky choice it is rather plausible to assume that subjects "forget" about risk when they assign certainty value to bets. On the contrary, matching task and choice task in time preference requires consideration of both dimensions of the decision problem, money and time. Therefore, compatibility principle as it is considered in Tversky et al 1988 cannot be applied here.

Extended research in cognitive psychology shows that perceptual systems are designed to enhance the accessibility of changes and differences (Kahneman, 2003). Dimension that is accessible is easy to retrieve from memory and the decision is often based on it. Principle of accessibility permits to draw a drastic distinction between choice task and matching task that are implemented in experimental research in time preference.

Choice task considered in present experiment presents subjects with a series of similar questions in which the only thing that changes is the value of option B in Treatments I and Ia (or option A in Treatment II), see table 2 and 3. In choice task presented this way subjects' attention is attracted to the option that is changing and to the value of this change. This change becomes *accessible* for subjects' perception and the decision can well be made based on the value of the changing option or the difference between the two options. Therefore, the change between the options corresponds to the requirements posed by compatibility hypothesis on the decisive dimension for choice. Thus, we can assume that in MPL format of choice task subjects' attention is attracted to the change between the two options and the decision is made based on a reservation value imposed on the difference that should be reached between the options to be accepted.

On the other hand, matching task consists of a single decision of evaluation of a monetary amount. A single, one-shot evaluation of the amount requires subject to come out with a value having rather little information at hand: starting amount and dates of receiving the two alternative options. This process can well be driven by anchoring and adjustment heuristics (Tversky and Kahneman, 1974). In this case a natural anchor is the given on the task amount while adjustment may depend on the interval of elicitation, other anchors encountered during the experiment, subjects' time preference. Notice that the nature of the decision to be made in matching task is rather different from the decision to be made in choice task. While in the choice task subject is called to decide which option to choose and bases this comparison on the difference between the two options, in matching task there is a need to form an evaluation that provides satisfaction. Although by the principle of invariance of elicitation method these two decisions should not be

different data from the experiments on decision-making provides evidence that this is not the case (Lihtenstein and Slovic, 2006).

In final questionnaires subjects were asked to describe how they chose between the two options on choice task and how did they decide the amount they stated on the matching task[4]. Analysis of these responses together with analysis of data can help to shed some light on the decisional structure implemented in different elicitation procedures.

Analysis of decisional rules in choice task.

Majority of subjects on Treatment I and Ia, corresponding to %-MPL choice task, declared to define a threshold value on the difference that should be reached between option A and option B to accept delayed option. The value of this difference varies between subjects. Among subjects that reported their threshold value most frequent responses were that the difference between option A and option B should reach at least € 50, some report ¼ of option A, others € 100. Several subjects instead declared that they fixed the value that option B should reach to switch their choice from option A to option B. 10% of subjects reported to look at the percentage difference between the two options. 20 % of subjects in Treatment I report that they used amounts stated on matching task as a reservation value for the consequent choice task. Although the values corresponding to option B in alternatives were hardly multiples of 5 or 10 (see tab. 2) subjects report their reservation values as multiples of 50.

All subjects on Treatment II ($-MPL) instead reported that their decision was based on defining a threshold value on option A to be reached to become willing to accept it. In this treatment majority of subjects put their reservation value at € 250 for option A, some state € 150. Few subjects reported to accept no more that ¼ reduction on the principal amount, option B. In $-MPL treatment values corresponding to option A were multiples of 10 by construction of the task (see table 3), however subjects report reservation values as multiples of 50 even if these values were not present among alternatives.

It is possible that decision based on the difference between the two options was reinforced by the instructions in which choice task was explained as a series of choices between option A and option B, where option A corresponds to €100 and option B to €100+x for %-MPL[5]. The same kind of representation was used in instructions for $-MPL choice task, where option B corresponded to €100 and option A to €100-x. However, majority of subjects faced with choice task in %-MPL format report that they took into consideration the difference between the two options or defined

[4] Responses and values reported by subjects on final questionnaires correspond to their actual choices on the experiment

[5] This representation of the task in instructions follows Coller and Williams (1999) and consecutive studies with implementation of %-MPL choice task

reservation value on the difference between the two options, while subjects faced with $-MPL choice task made their decision defining a reservation value of option A. Given that both MPL formats were explained in the same way in instructions and were presented in a similar way during the experiment, we can conclude that elicitation of time preferences in %-MPL format is more prone to reasoning in terms of "differences" compared to reasoning in terms of threshold value on the option. This can be explained by the fact that for individuals it is easier to perceive the difference as an addition to something fixed rather than a subtraction from something fixed.

A natural concern with implementation of MPL mode of elicitation of preferences in experiments is related to the so-called middle table effect (Andersen et al (2006)). Middle table effect is a bias of choice by which subjects that are called to choose one element from a list of alternatives choose the element located too close to the middle of this list. To check for the presence of this bias in the data collected in Experiment I data points, switching rows, obtained from elicitation with %-MPL and $-MPL choice tasks were tested for middle table effect with Mann-Whitney test. The null hypothesis for this test is that switching row was not different from the middle row of the table, row number 10. Results of this test are reported in tab. 6.

Table. 6 Mann-Whitney test statistics (z) and associated probability of bidirectional test, null hypothesis: the row of switch is the middle of the table (row 10).

Treatment	Statistics z *(associated probability)*
%-MPL, Experiment I	1,34 *(0,18)*
%-MPL, Experiment Ia	0,01 (0,99)
$-MPL, Experiment I	-2,09 *(0,04)*

Notice that both %-MPL and $-MPL elicitation tables consisted of 20 alternatives. As results from table 6 show, %-MPL in Experiments I and Ia is affected by the middle table effect since it is not possible to refuse null hypothesis. At the same time subjects' choices in $-MPL treatment does not seem to be affected by this bias.

Middle table effect is expected to happen when the list is presented to a subject altogether in a table form (Poulton, 1989). Therefore, random representation of alternatives implemented in Experiments I should not lead to observation of middle table effect. The choice of switching point at position 10 of the %-MPL table corresponds to the choice of the person with the threshold

switching value of € 450 or + € 50 on option A. As previous analysis of questionnaires revealed this threshold value was a point of attraction for most of subjects. From the results of the test it is possible to conclude that for %-MPL choice task in present experiment the choice based on the decision rule "+ € 50 on option A" was focal for subjects.

For $-MPL position 10 of the table corresponds to the value of 200 euro. Given that median value of acceptable option A was € 260 (row 7) the value corresponding to row 10 was probably perceived by subjects as being too low.

Analysis of middle table effect together with subjects' self-reports of decisional rules implemented during the experiment presented so far suggest that choice task in MPL format induces subjects to implement decisional rules based on the difference between given options or on reservation value defined over the option that changes.

While subjects appear to implement similar decisional rules on %-MPL and $-MPL choice tasks the results observed with the two elicitation procedures are far from being similar. Discount rates elicited with %-MPL result significantly lower than discount rates observed with $-MPL choice task (results of Mann-Whitney test are reported in tab. 6). This result is contradictory to speed up – delay asymmetry usually observed in time preference (Loewenstein, 1988) by which discount rates elicited in speed-up frame are lower than discount rates elicited in delay frame, pattern observed in discount rates elicited with matching task in the present experiment.

However, this result is not counterintuitive in general. $-MPL is presented in speed-up payoff frame while %-MPL is elicited in delay frame. As it was shown earlier these two methods induce similar decisional rules. If subjects request the same difference between option A and option B to form their switching value discount rate observed in this case with $-MPL will be lower than discount rate observed with %-MPL. For example, suppose that in both situations subjects are happy with € 50 difference between option A and option B, so that they switch their choice from option A to option B for the value of € 450 in %-MPL, and for the value of € 350 in $-MPL. In this case discount rate registered with %-MPL is equal to 22,5 % while the one elicited with $-MPL is 59%. Instead in the experiment subjects are willing to reduce the principal amount by much more in $-MPL to receive this reduced amount sooner than they require to add to the principal amount to receive it delayed in %-MPL. Therefore, difference between discount rates are even larger

Underlying structure of %-MPL table implies that the differences between neighboring alternatives do not exceed € 5 in nominal value or correspond to 2,5% in interest rate terms. While in $-MPL this difference corresponds to € 20 in nominal value and varies from 11 to 242% in terms of interest rates (see tab. 3). Although subjects are faced with 20 alternatives corresponding to each elicitation mode the structure in terms of interest rates corresponding to these alternatives is

strikingly different. Most probably subjects enter the experiment convinced that the "correct" value that experimenter seeks is included among the values they are faced with. Therefore, along the experiment they try to infer this "correct" value. Moreover, possibility of getting paid may reinforce the desire to find the "correct" value since it will assure payment. When alternatives do not differ much between each other as in %-MPL (the difference between alternatives correspond to less than 1,3% of the principal amount) the requests of subjects stay rather limited. When the alternatives differ relatively a lot as in $-MPL (the principal amount is reduced by 5% at a time) the requests increase accordingly. Therefore, final results observed with choice task depend on the structure of the table that subjects are faced with.

To conclude, choice task seems to induce application of decision rule based on the difference between presented options in %-MPL format or based on definition of reservation value on the option A in $-MPL format. The reservation value defined in this way depends on the corresponding values of alternatives with which subjects are faced during the experiment. Subjects defined their reservation values as multiples of 50 although it was not possible to express these values on the task leading to overestimation/underestimation of discount rates elicited with choice task.

Analysis of decisional rules in matching task.

Contrary to choice task in matching task subjects' responses to questionnaires imply that their decision was framed in terms of the "whole" amount as opposed to reasoning in terms of expected "difference" between the two options. This "whole" amount tends to be multiple of 50 or 100. Only around 20% of subjects in each treatment chose amounts that were not multiples of 50. In this case these amounts were multiples of 5 or 10. This choice of amounts is rather surprising given that subjects could report any amount in given limits. To state their indifference amount they could either increase (decrease) the amount starting from the principal of € 400, in this case increases correspond to €1. They could also type the amount they preferred themselves. The amount was accepted by the computer program if it was included in the limits imposed by the task. Most subjects preferred to use the first option and stopped increasing the amount of response as soon as desired amount was reached. Few subjects explored the limits imposed on the task before making their decision. No subject reported on final questionnaire that limits on choice (maximum value of € 800 for Treatments I and Ia) was too low and did not correspond to their preferences.

In Treatment Ia the most frequent amount reported by subjects is €500, 45% of subjects stated this amount. In Treatment I (delay payoff scenario) 60% of subjects chose amount of €500, €600 or €800. In Treatment II (speed-up payoff scenario) the most frequently stated amounts were €250, €300, €350 and €400 as indifference amounts for option A.

Poulton (1989) analyzing representation of data from experiments on quantitative judgments in Psychophysics notices that only few researchers choose median to report their data. This "aversion" to the use of median is motivated by the fact that median heavily depends on the underlying distribution of data and the first quantitative evaluations expressed by inexperienced subjects are biased by preferences to certain numbers. Thus, medians that are around 10 or below will have better chance to be 10 or 5 than any other number in the range. Instead when the median is 20 or higher it is likely to be a multiple of 10. A simple reason is provided to explain this fact. Subjects that are not familiar with the task and do not know the correct response to it will round off their response to the nearest 5 or 10. Therefore, one can expect that matching task activate mechanism that attracts subjects' attention to certain numbers in their evaluations; these numbers are likely to be multiples of 5 or 10.

Although definition of reservation value as multiple of 50 is common to both choice task and matching task reservation amounts themselves differ between the two tasks. In the discussion of choice task it was demonstrated that reservation value in this task is often derived looking at the difference between the options available for choice. This value depends as well on the values that compose choice alternatives. Matching task does not impose structure on subjects' decision-making process encountered in choice task. It requires evaluation of the option that is being matched where this option is likely to be the only piece of information. Therefore this option enters decision process as the value to which the response is anchored. In the case of Treatments I and Ia while in choice task a satisfactory threshold value for option B can be € 450 where € 50 is an acceptable difference between the two options, in matching task € 500 is seen more as a "whole" thing that can be equivalent to € 400. Other such examples can be - € 800, doubling the principle amount, € 600 – principal amount increase by half. In Treatment II values like € 350, € 300 and € 250 were chosen as responses in matching task as opposed to € 250, € 200 or € 150 declared to be reservation values on choice task.

It is worthwhile mentioning here an interesting example of attraction to focal amounts that is observed in data reported by Thaler (1981) and partially reproduced in table 10. Careful analysis of values reported in the table shows that subjects in given study were attracted to amount of $ 300 as providing the same satisfaction of $250 received immediately regardless of the length of interval of elicitation, that was equal to 1, 3 or 6 months. The same tendency is observed towards the amount of $ 1000 for intervals of 5 and 10 years. This pattern of choice can be rarely traced in published data since usually only data corresponding to means of discount rates or corresponding nominal values is reported for the study.

Contrary to what was observed with choice task speed up-delay asymmetry registered in matching task follows traditional pattern: discount rates elicited in speed up frame are significantly lower than discount rates elicited in delay frame (Mann Whitney test, see tab. 5). Opposed to what was observed in choice task in matching task subjects are less willing to reduce the principal amount in speed-up frame (median amount is € 325) compared to how much they are willing to increase it in delay scenario (median ranges from € 500 to € 550). It appears that in the case of matching task where the only structure imposed on the decision is composed of limits of the task losses are given higher weight in the decision process than gains.

In this light conditioning of the decision process by the structure of the table in $-MPL choice task is even more evident. Matching task and choice task in this case go in opposite directions. While responses on matching task are close to the principal amount switching points registered with $-MPL choice task distance from this amount a lot.

To conclude, matching task appears to be governed by different decision rule compared to choice task. Subjects faced with matching task tend to report a focal amount that is multiple of 50. As data from Thaler (1981) show it is possible that subjects report amounts regardless considerations of the length of elicitation period or considering this period in a rather different way from conventional rule prescribed by rational choice.

Results observed in Experiment I demonstrate that implementation of different elicitation methods effectively leads to generation of significantly different discount rates. Given that elicitation structures compared in this experiment are the most representative of experimental research in time preference it is possible to conclude that heterogeneity of discount rates observed in literature (Frederick et al 2002) can be explained by implementation of different elicitation procedures that are governed by different decision rules.

Experiment II.

Previous section defined possible heuristics that subjects may follow when faced with different elicitation procedures. In this section I explore how these heuristics affect discount functions elicited with considered elicitation methods. As in previous section comparison is performed between 3 elicitation procedures: %-MPL choice task, $-MPL choice task and matching task in delay payoff scenario.

The interest of Experiment II is in the form of the discounting function over time depending on the elicitation method used to construct it. Although there exists extended evidence on each elicitation method considered in present experiment this evidence has been obtained under very different experimental conditions: the amount of elicitation, time horizons and other experimental

procedures differ dramatically from study to study. Different experimental procedures used to elicit discount rates in each study make it impossible to confront results from different studies since it is not know whether a certain result is due to experimental procedures, elicitation method or subjects sample. The idea of the present experiment is to compare discount rates elicited with different elicitation methods under the same experimental conditions.

The structure of %-MPL format of choice task does not permit elicited discount rates to overcome values of the interest rates that were used for it's construction. Moreover, results from experiment I demonstrated that subjects tend to make choices within the limits of the proposed table avoiding choosing values that correspond to limits of the table. Therefore, discount rates elicited with %-MPL are expected to be rather stable and assimilate constant, exponential, discounting pattern. In experiment II is maintained implementation of %-MPL table from Harrison et al (2002) that is widely used nowadays in experimental research in time preference. As in experiment I it was chosen to present alternatives without specifying corresponding to the alternative interest rate to keep this procedure similar to the other two elicitation modes frequently implemented in research: $-MPL and matching task.

The structure of $-MPL format of choice task does not change in nominal terms between corresponding horizons of elicitation (table 3). The only difference between alternatives corresponding to different time horizons is in the date on which option B is available. This fixed nominal structure extended for several time horizons imposes diminishing limits on the choice in terms of possible discount rates. Given that subjects faced with this elicitation task make their choice as was described in the previous section discount rates elicited with this procedure will present strong hyperbolic pattern for several reasons. First of all, it is expected that subjects discounting is positive, meaning that a certain payoff is worth more today than tomorrow. Positive discounting constraint applied to $-MPL format means that if $100-x today were selected over $100 in 6 months, less than $100-x should be selected over $100 in 1 year. The list of $100-x corresponding to option A is the same for all time horizons considered in elicitation with $-MPL. The discount rate is calculated as

$$dr = \sqrt[t]{\frac{100}{100 - x}}$$

Suppose that subject switched the choice at the value of €280, the median value in Experiment I, corresponding to discount rate of 89% for 6 months horizon. This choice restricts choices available to the subject on consequent time intervals, it is not possible to choose a switching point corresponding to the value higher than €280 for intervals longer than 6 months and respect positive discounting. Suppose that we next elicit preference over 5 years horizon. Subject can only

choose values that are lower than €280, but these values correspond to discount rates lower than 89% elicited on the first period (see tab. 3). Therefore, it is expected that discount rates elicited with $-MPL will tend to decrease with the increase of considered time horizon. Discount rates elicited with $-MPL will start at higher values than for %-MPL choice task and will decrease with increase of the interval of elicitation.

In matching task instead implementation of anchoring and adjustment heuristic over several periods of elicitation may lead to sequential construction bias described in Poulton (1989). Sequential contraction bias refers to situations in which individuals judge magnitude of an event one directly after another. In this case previous magnitude becomes an additional anchor for the current response. Although sequential contraction bias is relevant for all elicitation methods considered so far, e.g. %-MPL and $-MPL choice tasks, it has stronger effect in matching task. In Experiment I it was demonstrated that in %-MPL and $-MPL composition of the options over which elicitation is performed plays the most important role in the magnitude of observed discount rates. From the discussion of matching task in Experiment I it becomes clear that with this elicitation method subjects are more affected by additional anchors. Therefore, nominal value elicited with matching task over consequent time horizons is expected to be too close to previously elicited values. In terms of discount rates it is translated into the decrease of the discount rates with the increase of time horizon: instead of exponential growth of nominal amounts it's linear growth is observed.

Following hypothesis were formed for Experiment II:

Hypothesis 2a. Discount rates elicited with %-MPL will present rather stable pattern that can be approximated by exponential discounting

Hypothesis 2b. Discount rates elicited with $-MPL will decrease with increase of time horizon of elicitation in hyperbolic fashion

Hypothesis 2c. Discount rates elicited with matching task in delay frame will present hyperbolic pattern.

To fully explore the influence of each elicitation mode there is a need to extend elicitation horizon to several years as it was done in first experiments on time preference (Thaler, 1981, Benzion et al 1989, Green et al 1997, etc). However, this extension does not permit to perform elicitation with real payoffs as it does not seem possible to assure subjects that they will be paid in 5-10 years from today. Therefore, Experiment II was run with hypothetical payoffs.

The length of FED imposed on option A is kept the same as in Experiment I and equals to 2 months for all time intervals considered in the experiment.. Elicitation periods chosen for

Experiment II were 6 months, 1, 3, 5 and 10 years, similar to those implemented in Green et al 1997 design and common to studies in time preference with hypothetical payoffs.

Performance of three elicitation methods in between subjects design: %-MPL and matching task in delay payoff scenario and $-MPL choice task in the usual anticipating payoff frame. Experiment was performed with pencil and paper. In choice task subjects were presented with the whole table corresponding to the elicitation period, contrary to one alternative at a time representation in Experiment I. The structure of %-MPL and $-MPL tables was kept the same (see tab. 2 and 3) as in Experiment I except for obvious adjustments for different time horizons. In matching task threshold value was abolished given that there was no need to introduce it due to the implementation of hypothetical payoff structure. Questions in matching task and tables in choice task corresponding to different time horizons were presented to subjects in increasing order of time horizons.

Hypothesis 3a. Discount rates elicited over 6 months period in Experiment II will not be significantly different from discount rates elicited with corresponding elicitation method in Experiment I.

55 undergraduate students at University of Trento participated to Experiment II: 17 of them were assigned to %-MPL treatment, 20 to $-MPL treatment and 18 participated in matching task treatment. They received 5 euro participation fee. Completion of Experiment II took approximately 20 minutes.

Results.

Fig. 1 presents mean discount rates elicited in Experiment II while tab. 7 reports median discount rates corresponding to each elicitation method. As predicted by Hypothesis 2a the median discount rate elicited with %-MPL is rather stable with a slight decrease for the interval of 3 years. Median discount rate elicited with $-MPL decreases with time following familiar hyperbolic pattern. Median of discount rates elicited with matching task presents a strong hyperbolic pattern.

Figure 1.

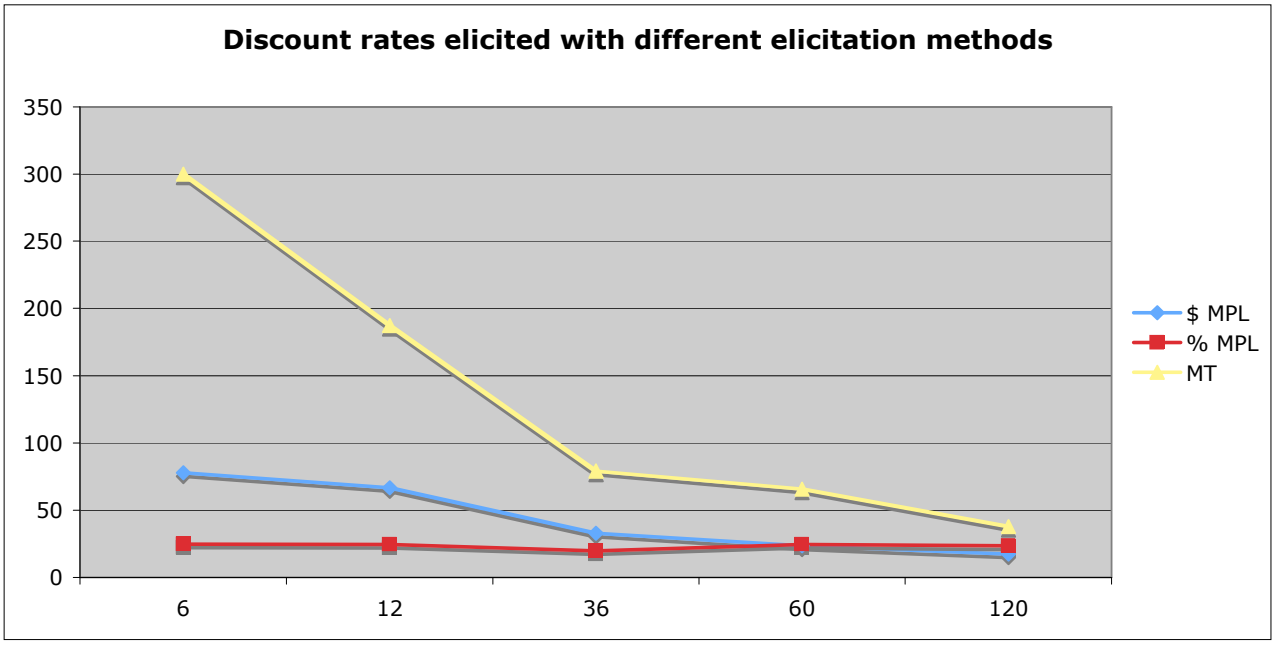

Table 7. Median discount rate (switching row) and corresponding amount for each treatment

Treatment	Length of horizon of elicitation										
	6 months			1 year		3 years		5 years		10 years	
	DR	Amount	M-W test	DR	Amount	DR	Amount	DR	Amount	DR	Amount
	I	II	III	IV	V	VI	VII	VII	IX	X	XI
%-MPL	25% *(10)*	€452	z=-0,47 p=0,64	25% *(10)*	€510	22% *(8)*	€ 718	25% *(10)*	€1345	23% *(9,5)*	€4046
$-MPL	78% *(5)*	€300	z=0,25 p=0,8026	67% *(8)*	€240	33% *(11,5)*	€170	25% *(13,5)*	€130	21% *(17)*	€60
MT	206%	€700	z=-3,54 p=0,0004	150%	€1000	62%	€1700	44%	€2500	29%	€5000

Table 8a reports results of bidirectional Wilcoxon matched-pairs signed rank test performed on discount rates elicited with %-MPL choice task over different horizons with null hypothesis that discount rates are the same across different time horizons. Diagonal of this table corresponds to discount rates elicited over successive time intervals. As it can be seen from table 8a it is not possible to refuse null hypothesis that data points are generated from the same distribution. Not only discount rates elicited over successive time intervals do not differ from each other in significant way (see diagonal of table 8a) but also discount rates elicited over much shorter intervals, 6 months or 1 year, are similar to discount rates elicited over longer periods, 5 to 10 years. Although median discount rate elicited over 3 years and 10 years interval appear to be smaller than the rest of median discount rates this difference is not significant. Therefore, we can conclude that

discount rates elicited with %-MPL choice task remain the same regardless of the length of the interval of elicitation. Hypothesis 2a is confirmed in a significant way.

Table 8a. Wilcoxon matched pairs signed test statistics and associated probability for %-MPL treatment

	1 year	3 years	5 years	10 years
6 months	T^+=24, n=12 *p > 0,5*	T^+=58, n=14 *p=0,76*	T^+=49,5, n=14 *p>0,5*	T^+=55, n=13 *p=0,54*
1 year		z=0,87 *p=0,38*	z=0,43 *p=0,67*	z=1,16 *p=0,26*
3 years			T^+=21, n=7 *p=0,21*	T^+=43, n=13 *p=0,89*
5 years				T^+=27, n=8 *p=0,25*

Table 8b. reports results of one-directional Wilcoxon matched-pairs signed rank test performed over discount rates elicited with $-MPL choice task. Contrary to previously considered case implementation of $-MPL choice task leads to elicitation of discount rates that are significantly different with increase of the length of time horizon of elicitation. Discount rates elicited with this method decrease in a significant way with increase of elicitation period. These results confirm Hypothesis 2b.

Table 8b. Wilcoxon matched pairs signed test statistics and associated probability for $-MPL treatment

	1 year	3 years	5 years	10 years
6 months	z=4,00 *p=0,00003*	z=4,01 *p<0,00003*	z=4,09 *p<0,00003*	z=4,11 *p<0,00003*
1 year		z=4,13 *p<0,0003*	z=4,21 *p<0,00003*	z=4,24 *p<0,00003*
3 years			z=4,21 *p<0,00003*	z=4,25 *p=0,00003*
5 years				T^+=91, n=13 *p=0,0001*

Table 8c presents results of one-directional Wilcoxon matched-pairs signed rank test performed over discount rates elicited with matching task. As for the case of discount rates elicited

with $-MPL choice task discount rates elicited with matching task decrease in a significant way with increase of the horizon of elicitation confirming Hypothesis 2c. Although discount rates elicited with matching task present stronger decreasing pattern than discount rates elicited with $-MPL choice task the significance of the results observed with matching task is not as high as significance observed with discount rates elicited with $-MPL choice task. This fact is explained by higher variance observed in results elicited with matching task.

Table 8c. Wilcoxon matched pairs signed test statistics and associated probability for matching task treatment

	1 year	3 years	5 years	10 years
6 months	z=3,58 *p=0,0002*	z=3,72 *p=0,0001*	z=3,73 *p=0,0001*	z= *p=*
1 year		z=3,73 *p=0,0001*	z=3,72 *p=0,0001*	z=3,65 *p=0,0002*
3 years			z=3,78 *p=0,0001*	z=3,81 *p=0,0001*
5 years				z=3,73 *p=0,0001*

Discount rates elicited with %-MPL and $-MPL choice tasks in Experiment I are not significantly different from discount rates elicited with corresponding elicitation method over the horizon of 6 months in Experiment II. This result is confirmed by Mann-Whitney test reported in table 7 column III by which distributions of discount rates elicited in Experiment I are similar to corresponding distribution elicited in Experiment II confirming Hypothesis 3. Therefore, subjects seem to report their preferences with MPL choice task in a truthful way regardless of real incentives. Alternatively, elicitation with MPL tables is not influenced by real incentives. These alternative explanations will be discussed later.

Hypothesis 3 is not confirmed for discount rates elicited with matching task. Discount rates elicited with matching task in Experiment I, Treatment I are different, lower, than discount rates elicited in Experiment II (Mann-Whitney test statistics of z=3,54 permits to refuse null hypothesis that data was extracted from the same distribution). It is possible that presence of the limiting value on the amounts to be submitted in Experiments I conditioned in some way subjects' choice. At the same time the fact that only few subjects discovered the value of the threshold on these treatments would suggest that the reason of this difference lies in real payoffs offered on Experiment I. Subjects that participated in Experiment I were possibly driven by incentives of being actually paid

in the end of experiment and probably considered more attentively the question. It is possible that they tried to infer the amount that would be accepted by the experimenter for payment and stayed low in their responses. This explanation is supported by somewhat different amounts reported on matching task in Treatment I and Treatment Ia in Experiment I. In Treatment Ia amounts available on the preceding choice task were more frequently observed in matching task leading to a lower discount rate than in Experiment I (see discussion of results of Experiment I). In Experiment I where matching task was the first task of the experiment amounts reported in the task were higher and there were more choices corresponding to the limiting value. Further discussion of possible reasons for this behavior will be offered later.

Discount rates elicited with matching task result to be the highest discount rates elicited in Experiment II for all intervals of elicitation. Median discount rate elicited with $-MPL format is higher than median discount rate elicited with %-MPL format for the first 3 time horizons, while it reaches in magnitude median discount rate elicited with %-MPL for 5 years horizons and becomes the smallest median discount rate for 10 years interval of elicitation. Mann-Whitney test confirms that discount rates elicited with %-MPL and $-MPL for horizons of 5 and 10 years have equal distributions while discount rates elicited with $-MPL are higher than those elicited with %-MPL for shorter intervals (see tab. 9). Median discount rates elicited with matching task also decrease with increase of the length of elicitation interval although they do not reach discount rates elicited with %-MPL within the time horizons considered in the experiment.

Table 9. Mann-Whitney test statistics and associated probability

	6 months	1 year	3 years	5 years	10 years
Middle table effect %-MPL	z=0,02 *p=0,984*	z=-0,57 *p=0,5687*	z=-2,03 *p=0,0424*	z=0,02 *p=0,984*	z=-0,58 *p=0,5619*
Middle table effect $-MPL	z=4,04 *p=0,0001*	z=-0,53 *p=0,5961*	z=-2,42 *p=0,0078*	z=2,69 *p=0,0071*	z=3,77 *p=0,0002*
%-MPL vs $-MPL	z=4,04 *p=0,0001*	z=2,48 *p=0,0131*	z=1,87 *p=0,0615*	z=-0,03 *p=0,9761*	z=0,16 *p=0,8729*

These patterns of discount rates typical for each elicitation method can be explained by the decision-making strategies that subjects activate in each task.

As it was demonstrated in Experiment I choice in %-MPL table elicitation is characterized by decision rule that looks at the difference between the two options of choice. As it has been noticed above subjects' choices in Experiment I and Experiment II in %-MPL choice task can be considered similar. In Experiment I however subjects were faced with one alternative at a time in

random order while in Experiment II subjects were faced with the whole table of alternatives. Although it is not clear whether the same decision rule is adopted between the two presentations of %-MPL table it can be affirmed that these two representations lead to the same results regardless of incentives.

As it was discussed in Experiment I table representation of %-MPL choice task may be prone to the so-called middle table effect. Median choice of subjects in Experiment II corresponds for all horizons of elicitation except for 3 years to the middle table position. To test significance of this hypothesis observed switching rows for each interval of elicitation were compared to theoretical situation in which the switch happens at the middle table position, row number 10. Results of this test are reported in table 9 and are significant for all time intervals except for discount rates elicited over the period of 3 years. For the period of 3 years switching at position 8 results significant (with Mann-Whitney test statistics equal to -0,62 and associated probability of 0,54).

On the other hand switching at central positions corresponds to application of decision rule that requires increment on the principal amount of € 50 for waiting for 6 months, of € 100 for waiting for 1 year, of € 300 for postponing receipt for 3 years, of € 1000 for 5 years and € 3500-4500 for 10 years. For the first three periods considered in the Experiment II this increment seems to be proportional to the lengths of the period. Notice that if subjects would choose to switch at row number 10 in 3 years horizon the difference would correspond to € 400. Therefore, it seems that for the first 3 intervals of elicitation subjects used the rule of defining a difference between the two options of choice, €100 for each additional year of waiting and increasing it proportionally to the interval of elicitation. This decisional rule explains choice of 31% of subjects over the period of 6 months, 44% for the period of 1 year and 25% over the period of 3 years.

If subjects would follow this rule for all their choices in the experiment they would choose to switch around rows 7-8 in 5 years and at rows 6-7 in 10 years interval, requesting +€ 500 and +€ 1000 for 5 and 10 years of waiting correspondingly. 25% of subjects followed this choice for the interval of elicitation of 5 years and 19% of subjects for interval of 10 years. This kind of choice would lead to observation of hyperbolic discounting, a slight decrease in discount rate would have been observed.

Anyway, for 5 years period median subject chose +€ 1000 and + € 4000 for 10 years, much higher amounts than those predicted by the rule above. Probably the values in the table influenced somehow preferences of subjects and they changed the rule from one period to the other. In general subject's choices over periods of 5 and 10 years are characterized by growing with elicitation period variability in terms of nominal amounts at which the switch happened while standard deviation in

terms of discount rates or switching points is rather stable. Therefore it results rather difficult to individuate a stable rule that would characterize single decision-maker faced with elicitation intervals of 5 or 10 years. This difference is explained by the fact that %-MPL table is constructed in exponential way that poses precise limits on variability of possible switching points and consequently on discount rates while nominal amounts are given larger space for variation.

It is worthwhile mentioning that for short periods, like 6 months and 1 year, there were 2 subjects that always chose option A expressing preference for higher values of discount rate than those that were available for the choice in the table. These subjects were choosing values within limits of the table for longer time intervals. At the same time one person chose always option B for the intervals of 5 and 10 years after choosing values within limits of the table for other periods of elicitation, this choice corresponds to lower discount rate than those available on the table. Both types of behavior correspond to expression of hyperbolic behavior that cannot be accommodated by the %-MPL table implemented in present experiments due to the limits imposed on it.

Analysis of individual patterns of discount rates elicited with %-MPL choice task demonstrates that only 18% of subjects maintain their choice compatible with exponential discounting choosing to switch always at the same row. 59% of subjects instead present behavior compatible with hyperbolic discounting. Some of these subjects increased their discount rate over 5 years elicitation period to decrease it in 10 years. Although majority of subjects behave according to hyperbolic discounting analysis of aggregated result in terms of medians provides more support for exponential discounting.

Subjects' choices on $-MPL table differed in a substantial way from behavior of subjects in %-MPL choice task. Similar to what was observed in %-MPL treatment choices in Experiment I and Experiment II for $-MPL choice task appear to be the same (see table 7 column III). Discount rates in Experiment I were elicited with alternatives being presented one at a time in random order while in Experiment II subjects were presented with the whole table of ordered alternatives. Differences in presentation as well as structure of incentives did not appear to influence subjects' choices in a significant way in elicitation of discount rates with $-MPL choice task.

Choice on the first elicitation interval, 6 months, in $-MPL choice task is far from being centered around the middle of the table as demonstrated by Mann-Whitney test reported in table 9. Only for interval of 1 year subjects' choices can be described as influenced by the middle of the table. Choice of subjects faced with $-MPL choice task in Experiment II can be described by choosing descending rows with increase of the interval of elicitation. This choice strategy is confirmed by results of unilateral Wilcoxon matched pairs test reported in table 8b. Therefore, contrary to what is observed in %-MPL choice task subjects faced with elicitation procedure of the

$-MPL type are forced to switch their choice at always lower amount. This kind of choice respects positive discounting constraint and was followed by 70% of subjects.

Choosing to switch the choice at positions corresponding to lower values than on the preceding elicitation period prevents a sudden drop of discount rates elicited with $-MPL that is expected given the structure of the table itself (see the limits that the table imposes on discount rates in table 3). If subjects were choosing to switch their choice in $-MPL at the same row they were switching in %-MPL, centered on the middle of the table, discount rates elicited with $-MPL would exhibit sharper decline in discount rates with time than the decline observed in the experiment. These discount rates would reach in magnitude discount rates elicited with %-MPL at the period of 3 years while would become much lower for horizons of 5 and 10 years. The rule of choice that follows considerations of positive discounting explains why discount rates elicited with $-MPL format over 5 and 10 years are similar to discount rates elicited with %-MPL format even if the structure of the underlying tables would predict them to be lower.

As it was mentioned above 70% of subjects follow hyperbolic pattern in their choice when faced with $-MPL choice task. 10% of subjects switched at higher positions for shorter horizons than for longer horizons leading to observation of increasing discount rates with increase of interval of elicitation. The rest of subjects followed the usual pattern of switching at higher position corresponding to longer interval. Anyway some of these switches happened at positions lying too close therefore for some periods of elicitation discount rate results higher for longer period than for shorter preceding period. In general patterns in terms of discount rates for these subjects result somewhat confusing being decreasing for some periods and increasing over other periods, even if this choice respects positive discounting in terms of nominal amounts.

Decision rules that could explain subjects' choices in matching task seem to be more heterogeneous demonstrated by much higher standard deviation of discount rates observed in matching task than on other tasks in Experiment II (see fig. 1). Contrary to what was observed for $-MPL and %-MPL choice task elicitation discount rates elicited with matching task in Experiment II are significantly different from discount rates elicited in Experiment I with the same method. Apparently less structure, no limits imposed on choice and hypothetical payoffs lead to observation of rather higher amounts reported with this task.

As in Experiment I responses on matching task tend to be multiples of 100. In Experiment II the most frequent amount reported as value providing the same satisfaction in 6 months are amounts of €600, €700 and €800 as opposed to €500 in Experiment I. Three types of decisional rules can be distinguished in data. One is the rule based on proportional increment: subjects define an increment over the smallest interval of elicitation, the first interval they are faced with in the experiment. The

value reported on successive rounds is built based on this increment increased proportionally to the waiting period. Reported amounts are normally rounded to the closest €500. This strategy is similar to the one adopted on %-MPL choice task although the amount of increase is rather higher in matching task. For example, one subject chose increase of €200 for 6 months period and €400 for 1 year. Following this rule the subject reported €1500 for 3 years corresponding to €1100 increment, €2500 over the period of 5 years with overall increment of €2100 and €4000 for 10 years with €3600 increment over 10 years.

Another strategy is to define an amount required as compensation for waiting one period and than proportionally increment it to obtain compensation over the next period. This strategy is different from the strategy considered above as in the previous case the increment over principal amount is increased proportionally while in present case the whole amount is proportionally increased. This kind of strategy is frequently observed in responses to questions relative to periods of 6 months and 1 year and between 5 and 10 years. In this case one amount is chosen as response to the first period and then it is doubled to obtain response to the next period. For example, subject that reported indifference amount of €1200 for 6 months period and €2400 for 1 year period would enter this category. This strategy is more frequent for responses to questions considering 5 and 10 years intervals. For 33% of subjects this strategy can be traced from their responses to these time periods. The amounts chosen by these subjects as response for the corresponding time horizons vary a lot among subjects. Most frequent amounts observed for 5 years horizon are €2500, €5000 or €12000, while for 10 years horizon these subjects report €5000, €10000 and €24000. Proportion of subjects that followed this decisional rule reaches 56% if some rounding to focal amounts is considered. Thus, a subject that chose amount of € 9000 for 5 years interval and €20 000 for 10 years interval can enter this category.

Most frequently observed decisional rule for matching task consisted in definition of a rather high value required for waiting the shortest interval of elicitation. This value is increased proportionally to the length of horizon of successive evaluation. The final result is then decreased by some small portion. 30 % of subjects declared in their final questionnaires to have followed a rule by which with the increase of the waiting horizon they required a smaller proportional compensation for waiting. 56% of subjects can be classified in this category. The rest of subjects except for one person followed this rule for the first three horizons of elicitation, 6 months, 1 year and 3 years, but increased the amount of the proportional compensation starting from the 5 years horizon and followed the rule again for 10 years horizon.

It is possible to trace some parallelisms between decisional rules activated in %-MPL choice task and matching task observed in present experiment, i.e. in both elicitation tasks subjects report

to look at the difference between the two options. Nevertheless, while in %-MPL choice task subjects consider a more or less constant increase on the principal value in matching task required increment over the principal value decreases with extension of the horizon of elicitation. Therefore, pattern being observed in discount rates elicited with %-MPL is at most slightly hyperbolic while in matching task discount rates decrease dramatically with the growth of the length of elicitation interval. Considering discount rates at individual level 100% of subjects faced with matching task reported discount rates that are decreasing with increase of elicitation horizon.

Another similarity observed between %-MPL choice task and matching task is that the passage from 3 years to 5 years horizon appears to be somewhat focal for subjects. Elicitation over the interval of 5 years often leads to the adjustment in behavior in the direction of increase of required increment over the principal amount.

To conclude, results of Experiment II confirm initial hypothesis by which different elicitation methods generate qualitatively different patterns of discounting. For instance, implementation of %-MPL choice task leads to elicitation of rather stable in time discount rates that can present a slightly hyperbolic pattern. Elicitation of time preference with $-MPL choice task and matching task generates evidence compatible with hyperbolic discounting.

Table representation of %-MPL and $-MPL choice tasks seem to make subjects less sensitive to the presence of real incentives while matching task demonstrated to be strongly affected by the nature of incentives.

Analysis of decisional rules implemented by subjects in Experiment II confirms results observed in Experiment I. Subjects are more prone to switch around middle table positions in %-MPL choice task rather than in $-MPL. Attraction to middle table positions in %-MPL choice task seems to be a joint effect of several factors among which nominal values associated to each option of choice play the main role.

Fixed nominal values of $-MPL choice task seem to influence a lot the choice of subjects. Most of subjects seem to be moved by considerations of positive discounting. Their choice generates evidence of hyperbolic discounting that is defined by the limits imposed by elicitation table.

Implementation of matching task leads to elicitation of discount rates decreasing in a sharp way with increase of elicitation interval. Subjects' self-reports in final questionnaires evidence that they were not driven by exponential considerations in their decision-making. Decisional rules activated during matching task can be characterized by determination of monetary value as compensation for waiting certain period of time. Generation of this value does not follow exponential considerations. Instead it is characterized by diminishing proportional increments

corresponding to larger elicitation intervals. Values generated by this rule correspond to sharply decreasing discount rates.

Discussion.

Results of experiments reported in present study are in line with evidence observed in experimental literature on time preference.

Discount rates elicited with %-MPL choice task in Experiments I and II correspond in magnitude to average discount rates elicited with the same structure of %-MPL table in literature (see for example results in Harrison et al (2002), Read et al (2005), Dohmen et al (2007), etc.). In present study subjects were not presented with interest rate corresponding to each alternative of %-MPL choice task table, which is a standard procedure for this elicitation method since Coller and Williams (1999). Nevertheless, I obtain results that are similar to discount rates observed with implementation of this method.

Discount rates elicited with $-MPL choice task provide support for hyperbolic discounting that is typically observed in studies that implement this method (see Green et al (1997), Pender (1996), Tanaka et al (2007), Manzini et al (2008)). For $-MPL elicitation structure it is not possible to compare magnitude of elicited discount rates between studies unless the same structure of payoffs and the same elicitation periods were implemented in studies under analysis. The amount of elicitation, the difference between amounts that correspond to alternatives on the table and the length of the interval of elicitation influence discount rates that can be observed in elicitation with a given table.

There is a big variety in the structure of $-MPL choice task that has been adopted in literature. For example, Green et al (1997) adopted decision task that consisted of 20 alternatives and time frames that ranged from 3 months to 20 years. The limits on the discount rates that could be elicited with this elicitation structure are in the range of 4370% - 4% for 3 months period and decrease to 23%-0,05% over elicitation period of 20 years.

Choice tasks in Tanaka et al (2007) consisted of 5 equally spaced alternatives with time frames ranging from 3 days to 3 months. The underlying structure of these type cannot elicit discount rates different from 29825%-2287% over 3 days period and 549%-55% over 3 months period.

In Manzini et al (2008) design subjects were faced with tables of 10 equally spaced in terms of payoffs alternatives that were further divided in 5 sub positions once subject chose the switching point. Time frames corresponded to 1, 2 and 4 months. This structure imposes limits on elicited

discount rates of 10800%-133% over 1 month elicitation interval and 934%-32% over 4 months interval.

As the study of the limits imposed by each study on the values of discount rates shows it is very difficult that different studies could lead to elicitation of discount rates of the same magnitude. At the same time this analysis shows that implementation of $-MPL choice task leads to elicitation of decreasing pattern of discount rates.

Similar to most studies in literature that elicited time preference with matching task (Thaler (1981), Benzion et al (1989), Benhabib et al (2006), Kirby and Marakovic (1995), Kirby (1997), Manzini et al (2008), etc.) results of matching task in the present study provide support for hyperbolic discounting. Results of matching task can be analyzed only in a qualitative way, i.e. discussing the main pattern of discount rates that are elicited with the method, while comparison of magnitude is very hard to perform between studies that implement matching task. As it has been shown in the present study decision-making strategies of subjects in matching task depend on the amount of elicitation and length of elicitation interval. Subjects define compensation for waiting a certain period of time ad-hoc depending on the situation and provided incentives. This decision is influenced by consideration of focal amounts, where by "focal" amounts like 500, 1000, 1500, etc. are understood.

Moreover, as attentive analysis of results presented in Thaler (1981) shows it is possible that the same amount can be requested as compensation for waiting different periods (see table 10). In between subjects design time preference over amount of $250 and different time periods was elicited. As results show subjects chose the same amount of $300 as required compensation for waiting 1, 3 and 6 months and amount of $ 1000 for waiting 5 and 10 years. Time preferences that are expressed in this way necessarily correspond to hyperbolic discounting.

Table 10. Median responses and (continuously compounded rates in percent), Thaler (1981)[6]

Treatment	Amount of early prize	Later prize paid in		
		3 mo.	*1 yr*	*3 yrs*
(A)	$250	$ 300 (73)	$ 350 (34)	$ 500 (23)
		6 mo.	*1 yr.*	*5 yrs*
(B)	$ 250	$ 300 (36)	$ 500 (69)	$ 1000 (28)
		1 mo	*1 yr*	*10 yrs*
(C)	$250	$ 300 (219)	$ 400 (48)	$ 1000 (19)

[6] Only parts of the original table relative to the discussion in the charter are reported here

Present study replicated as well discrepancies between choice task and matching task. As it was observed in Manzini et al (2008) it was found that discount rates elicited with matching task are lower than discount rates elicited with choice task when choice task is implemented in $-MPL format (see results of Experiment I). Meanwhile discount rates elicited with %-MPL choice task are lower than discount rates elicited with matching task, this evidence confirms results observed in Tokarchuk (2007). Discount rates elicited with matching task in Experiment II are higher than discount rates elicited with both formats of choice task. As it was shown above discount rates elicited with choice task depend on the structure of the choice task that is adopted by the study. Therefore, it is possible that implementation of matching task leads to elicitation of higher discount rates than those elicited with choice task as well as the opposite.

Definition of decisional rules adopted by subjects in present experiments permits to undertake analysis of discount functions generated by each elicitation method.

As it was shown above %-MPL choice task evokes decision strategy that defines the threshold value by reaching which the choice switches from option A to option B. This threshold is constructed by subjects with consideration of the increment on initially given amount that provides satisfactory compensation for waiting a certain period of time. Particularity of decisional rules in %-MPL choice task is that this increment seems to be defined by the subject once and then it is proportionally increased depending on the duration of consequent elicitation intervals.

It is possible to represent this rule in the following way: $x_t = x_0 + \Delta t$, where x_t is the threshold value at which the switch from choosing option A to choosing option B happens for elicitation period t, $x_0$corresponds to initial amount, Δ is the increment required by the subject for waiting additional period of time, t – is the duration of the interval of elicitation. The value of Δ depends on the values that are available for choice on the table. This value is expected to correspond to values observed on central positions of the table and is defined by the subject on the first elicitation round.

Discount function that is generated by this decision rule is described in the following way:

$$D(t) = \frac{x_0}{x_0 + \Delta t}$$

Substitute $k = \frac{\Delta t}{x_0}$ then

$$D(t) = \frac{x_0}{x_0 + \Delta t} = \frac{1}{1 + kt} \quad (1)$$

As it is clear from equation 1 decision rule of the form $+\Delta t$ leads to generation of discount function that can be represented by hyperbolic discounting with one parameter (Mazur 1984).

However, this decreasing pattern in the data is very light compared to traditional evidence on hyperbolic discounting. Thus, following the rule in Experiment II subject's choice would correspond to the discount rate of 25% for intervals of 6 months and 1 year and will decrease to 20% over the interval of 3 years. In fact, this was the choice of the median subject on the experiment for the first 3 intervals. Choices of 62% of subjects can be described by this strategy. Given small difference between corresponding discount rates and relatively high variability of choices there is a need of quite large sample to be able to detect this decreasing tendency in data with standard parametric tests (as literature on minimum detectable effect suggests (Bloom, 1995).

Choices on the last two intervals corresponding to 5 and 10 years seem to correspond to this rule as well although the value of Δ is adjusted to increase.

In $-MPL choice task subjects choice was driven mainly by considerations of positive discounting. For instance, if on the round corresponding to elicitation period of 6 months the switch from choosing option B to choosing option A happened at certain value, say € 300, on the next round corresponding to elicitation period of 1 year subject will choose to switch at values equal or lower than the value chosen on the first round. To formalize this decisional rule assume that the table consists of N alternatives that correspond to equally spaced diminishing values of initial amount. That is $x_n = x_0 - n\Delta$, where x_n is the value corresponding to option A at position n of the table, x_0 is the value corresponding to initial amount, option B, and Δ is the value by which option A is decreased from position to position. In the case of experiments presented here N=20, x_0= € 400 and Δ= € 20.

In the case of $-MPL elicitation format subjects can follow two possible strategies that satisfy positive discounting. One is to choose to switch always at the same position, i.e. declaring indifference between the same values of option A and option B regardless of the length of elicitation interval. This situation is described by the following discounting function:

$$D(t) = \frac{x_0 - n\Delta}{x_0} \quad (2)$$

This discounting function corresponds to steeply decreasing discount rates, the decrease is sharper the higher is the position of the switch or the lower is corresponding value of option A at which the switch happens (see tab. 2).

Another possible strategy is to choose to switch at lower amounts (higher positions on the table) as the length of elicitation period increases. Discount function of these subjects is expressed by:

$$D(t) = \frac{x_0}{x_0 - n\Delta}$$

$$D(t+1) = \frac{x_0}{x_0 - (n+k)\Delta}, \quad (3)$$

where Δ is the difference between positions in \$-MPL table, n is the number of the position chosen by subject on elicitation interval t, $n \in [0;N]$; k is the jump in positions when passing to interval t+1, $n+k \in [n;N]$. Discount rates corresponding to this discount function decrease in a less steep fashion than those where the same position is maintained.

Notice that neither discount function represented by equation (2) nor by equation (3) depends on *t*. It depends only on the value of Δ and on the number of alternatives presented in the table. Therefore, the shorter is elicitation period and the larger is Δ the higher will be observed discount rate. Thus, among studies that considered \$-MPL elicitation task the study by Tanaka et al (2007) should lead to observation of the highest discount rates. Unfortunately this study does not report results in terms of elicited discount rates but states that it finds support for quasi-hyperbolic discounting.

These results are not surprising given that elicitation table was composed of only 5 alternatives corresponding to rather large value of Δ, around 17% of initial amount. At the same time the smallest elicitation period considered by the study corresponds to 3 days while the largest to 120 days (40 times larger than the smallest period). Given this elicitation structure it is straightforward to expect that discount rates corresponding to the shortest period will be very high while those corresponding to the largest to be relatively smaller and vary less between larger periods of elicitation compared to the sharp drop observed while passing from the shortest interval of elicitation to the next one (standard deviation of the structure in terms of interest rates of the table corresponding to 3 days is 56 larger than standard deviation of the table corresponding to 120 days, the largest interval).

\$-MPL table considered in the present study instead implemented the value of Δ that is only 5% of the initial amount with 20 positions at which the switch could happen. The largest period of elicitation is only 20 times larger than the smallest. As a consequence discount rates elicited in Experiment II decrease in a stable way without sharp collapses along the way and can be the best approximated by one parameter hyperbolic discounting function of the form of equation 1.

Therefore, implementation of \$-MPL choice task may lead to a variety of observed results depending on the structural choices made by the experimentalist. If the amount of elicitation is relatively large with large Δ compared to the initial amount and interval of elicitation starts at a very short length with sharp proportional increases (it may even not correspond to very long periods of time, what is important is proportional increase) implementation of \$-MPL choice task may lead to observation of quasi-hyperbolic discounting. If instead the magnitude of elicitation amount is not

large and alternatives on the elicitation table do not differ much, leading to a large number of alternatives on the table, and if intervals of elicitation do not differ a lot $-MPL choice task will lead to observation of not so sharply decreasing discount rates.

Matching task in delay payoff frame contrary to choice task in %-MPL and $-MPL formats discussed above is not characterized by strong underlying structure. Subjects are free to express their preference and can report amounts they like. From the analysis of decision rules adopted in Experiment II it emerged that subjects faced with matching task tend to define certain value as compensation for waiting a given period of time. This compensation value is normally seen as an increment required to be added to the initial amount to compensate subject for waiting. This strategy seems to be similar to the one observed in %-MPL choice task. The difference between the two methods lies in the desire to reach threshold value on the difference between the two options in %-MPL choice task while in the case of matching task the value of option B is of biggest concern to subjects. Although this difference may seem insignificant, for rational agent it should lead to the same value attributed to the option B, it is not what was observed in the experiment. Subjects tend to be attracted by "focal" values in definition of these threshold amounts. While in %-MPL choice task € 50 seems to be a reasonable compensation amount for waiting 6 months corresponding to € 450 of option B in matching task this value reaches € 500 or other multiples of 100. Therefore, subjects tend to come out with much higher values attributed to option B on matching task. At the same time subjects report that they proportionally diminish compensation value with the increase of the interval of elicitation.

The amount that is reported by subjects as providing the same satisfaction as option A at time t, option B, can be formalized as: $x_t = x_0 + \Delta(t)t$, where x_t is the amount reported by subject at elicitation interval t, x_0 is the initial amount, $\Delta(t)$ is the compensation required for waiting a period of time t, $\Delta(t)$ is a decreasing function of time. Then corresponding discounting function takes the following form:

$$D(t) = \frac{x_0}{x_0 + \Delta(t) * t}$$

Some subjects follow even simpler rule (Frederick et al (2002)):

$$D(t) = \frac{x_0}{nx_0}$$

Initial Δ in matching task is rather big proportionally to the initial amount and decreases dramatically within the next elicitation period remaining more or less constant for larger elicitation intervals. As it can be seen from fig. 1 discount rate associated to this decision rule is rather high for the first elicitation period after which a more or less sharp decrease is followed. Intuition suggests

that the shorter is the initial elicitation interval and proportionally larger is the next elicitation period the sharper will be the decrease in the discount rate. For example, as previous analysis of table 10 suggests subjects can be attracted to state the same value as required compensation for waiting different (but probably perceived by subjects as similar) intervals of time. At the same time moving from a very short to a longer interval of elicitation produces smaller proportional increase in the stated value of option B compared to moving from a larger starting elicitation interval. For example, on Treatment A and C subjects stated almost the same median compensation value for postponing receipt of the payoff by a year. But their starting elicitation interval was 1 month in Treatment A and 3 months in Treatment B. Therefore, discount rate elicited in Treatment C experienced a very sharp decrease compared to the decrease on Treatment A. Thus, discount rates elicited in Treatment C resemble quasi-hyperbolic pattern while those in Treatment A present less steep hyperbolic trend.

Although matching task imposes less structure on subjects' decision process compared to choice task it presents some regularities as well. The main characteristic of the matching task is propensity of decision makers to choose very high compensation amounts for shorter elicitation intervals and reduce the claims with increase of the length of elicitation period. Therefore, in matching task the choice of the length of elicitation intervals and distance between successive intervals appear to be important elements of experimental design that can lead to observation of more steep, quasi-hyperbolic, decreasing patterns or less dramatic trends in discount rates.

Conclusions

Present study presents a first systematic attempt to study influence of different elicitation methods in experimental elicitation of time preference. Although some sporadic examples of similar efforts can be found in literature (Read and Roelofsma (2003), Tokarchuk (2007), Manzini et al (2008)) existing studies were not developed to address this question and as a consequence provide only partial evidence on the phenomenon. For example, the scope of Manzini et al (2008) was to study the effect of the structure of real incentives, therefore different incentive procedures were compared. Read and Roelofsma (2003) studied implications of subadditive discounting and provided comparisons between matching task and choice task to show that subadditive effect is maintained regardless of elicitation procedure.

Analysis performed in present study permits to explain variation of discount rates from study to study observed in literature review by Frederick et al (2002). I show that magnitude of elicited discount rates depends on the elicitation method that is implemented by the study. Moreover, it is demonstrated that elicited discount rates are very sensible to different features of

experimental design under control by experimentalists: amount of elicitation, number of elicitation periods and their length, limits that are implicitly (for example in elicitation with matching task in speed up frame subject can not choose amount smaller than 0 or larger than amount of elicitation) or explicitly (in elicitation with matching task in delay frame with BDM incentive procedure there is a need to establish the maximum amount) imposed by the experimenter, incentive structure and elicitation task.

This sensitivity of elicited discount rates to experimental design may explain the "lack of methodological progress" to which Frederick et al (2002) refer discussing experimental evidence in time preference. Experiments in time preference can be characterized by a high level of heterogeneity of experimental procedures adapted by each study. Replication and building up on previous results is not a common research strategy in this area of experimental research.

From a study that compares alternative elicitation methods it is probably expected to provide recommendations on which elicitation method is the best or why and when implementation of a certain elicitation task should be made instead of the other. Unfortunately investigation undertaken in present study adds more perplexities than provides answers.

Main concern of methodological inquires on elicitation procedures of time preference so far has been in finding the method that provides correct incentives to subjects (Andersen et al (2006), Manzini et al (2008), etc). Choice task from this point of view is the most appropriate. It is very easy to explain to subjects. $-MPL choice task is considered to be the easiest for subjects to understand, alternatives of choice are seemingly free from researcher influence since the values decrease naturally from the initial amount to the least possible amount usually around 0 (Manzini et al (2008)). As a consequence this method is often implemented in elicitation of time preference in developing countries (Pender, 1996, Tanaka et al 2007). At the same time limits that this method poses on subjects' choices are too strong as it was demonstrated in present experiments. It's implementation leads to observation of hyperbolic discounting a priori.

%-MPL choice task on the other hand strongly depends on the choice of values of corresponding interest rates done by the experimentalist. Subjects perceive values they are faced with on this task as "correct" value among which to choose or values that are admissible by the researcher (Andersen et al (2006)). Most of subjects try to comply with these values. Additionally, to construct reasonable alternatives of choice keeping reasonable interest rate structure there is a need to use relatively high amounts of money as initial amount (Manzini et al (2008)). Therefore, it is not possible to provide payment to each single person but there is a need to introduce additional structure into the payment procedure (as random assignment of the winning amount).

Providing real incentives in matching task is very hard. BDM procedure appears to be very attractive from theoretical point of view. But real subjects demonstrate it to be of hard understanding in practice. Results of present study also show that matching task is more sensitive to real incentives than both choice tasks considered in the study.

Present study instead demonstrates that results of the experiment in time preference strongly depends on the structure of elicitation task that subjects are faced with. Implementation of real incentives does not seem to solve this problem. It is shown that implementation of one elicitation method instead of the other determinates results of the experiment a priori. Moreover, each elicitation task generates particular pattern of discount rates.

Extended theoretical research in time preference has been concentrated on the finding discounting function that accommodates experimental data in the best way. Thus a plethora of possible candidates have been proposed in addition to traditional exponential discounting function (Samuelson 1937). Different formulations of hyperbolic discounting like one parameter hyperbolic discounting (Mazur 1984), quasi-hyperbolic (Laibson 1997), generalized hyperbolic (Loewenstein and Prelec 1992), proportional (Harvey 1994) as well as discounting functions that permit to account evidence of negative time preference (Loewenstein and Prelec (1991)).

Present study demonstrates that experiments can generate a plethora of patterns in experimental data. While it is possible to rationalize each data pattern ex-post it is not clear which pattern is the one that represents the "true" time preference if one exists. Recently reproposed debate on whether discounting is hyperbolic or exponential that involved numerous studies (Benhabib et al (2006), Tanaka et al (2007), etc.) remains without concrete answer as each study proposes different estimates of the same phenomenon.

Classical theoretical arguments, like linearity of utility function associated with monetary payoffs (Frederick et al (2002)) and it's recent treatment (Andersen et al (2008)), which is traditionally expected to solve the problem of variability of discount rates can hardly address the challenge posed by the failure of method invariance. The form of utility function over monetary payoffs is expected to be the same regardless of elicitation method. Therefore even applying utility function different from linear elicited discount rates will maintain different patterns.

Failure of method invariance received extensive treatment in risky choice experimental literature where it received the name of preference reversal (Lichtenstein and Slovic, 1974, Tversky et al 1988, Kahneman et al 1990, etc). Prevalent opinion in this stream of research is that subjects' choice in experiments is not characterized by stable preference relation but is rather constructed based on elements of experimental design (Lichtenstein and Slovic 2006). Discrepancy between choice task and matching task is explained by different decision rules implemented by subjects

faced with these elicitation procedures. Results of present experiments seem to confirm these ideas for time preference.

Accepting preference construction perspective the question of the best elicitation method is related to ecological validity of the method itself, i.e. how well the method represents decisions involving time preference that individuals face in everyday life. Research efforts should concentrate on studying real life decisions of relevance to the field: decisions related to savings, investments, purchase of durables and choice of payment procedure associated with it, etc. Knowledge of features of decision problem as well as representation of problem at the moment of choice will help to obtain more reliable results that will help to explain many behavioral anomalies registered so far in the field: credit card use, too low level of savings, etc.

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