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Bao, Te; Dai, Yun; Yu, Xiaohua

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Memory and Discounting: Theory and Evidence[1]

Te Bao,
Assistant Professor of Economics,
Division of Economics,
School of Humanities and Social Sciences,
Nanyang Technological University,
Singapore
E-mail: baote@ntu.edu.sg

Yun Dai,
Assistant Professor of Finance,
Lingnan College,
Sun Yat-Sen University,
Guangzhou, China
Email: daiy28@mail.sysu.edu.cn

Xiaohua Yu,
Chair Professor of Agricultural Economics in Developing and Transition Countries,
Courant Research Centre "Poverty, Equity and Growth,"
Georg-August-Universität Göttingen,
Germany
Tel: 0049-551-3919574
Email: xyu@gwdg.de

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Memory and Discounting: Theory and Evidence

Abstract:

Heterogeneous memory capacity is largely neglected in the economics literature, although it may have profound economic implications. Adopting the concept of "memory utility" proposed by Gilboa, Postlewaite, and Samuelson (2016), we explore the relationship between memory capacity and individual discounting behavior by building a simple two-period model and comparing its predictions with experimental data. Both theoretical and experimental evidence confirm that memory capacity and discount rates are positively correlated.

Keywords: Memory utility, intertemporal consumption, individual discount rates, time preference.

JEL Classification: C91, D90.

1. Introduction

Economic theory typically assumes that economic agents discount future benefits relative to benefits they can enjoy immediately. The two main explanations for such discounting behavior in the literature are impatience (i.e., a time preference) and fear of future uncertainty, e.g., the risk of death (i.e., a risk preference). Andreoni and Sprenger (2012a,b) argue that time and risk preferences are different, and can be estimated separately, an argument further taken up by Andreoni and Sprenger (2015), Cheung (2015), Epper and Fehr-Duda (2015), and Miao and Zhong (2015).

Differently, we argue that memory may play an important role in explaining discounting behavior. Although the psychological literature has paid ample attention to memory, the economics literature has explored it only in a limited way. Even though as far back as 1759, Adam Smith (2009, p. 152) observed that "we can entertain ourselves with memories of past pleasures," which implies that past pleasant memories can yield current utility, not many works followed Smith's idea by visiting utility generated by recalling happy memory from the past since then. It is only until recently that Gilboa, Postlewaite, and Samuelson (2016) developed the concept of "memory utility/memorable consumption," which posits that current utility depends not only on current consumption, but also on past consumption. The idea of memory utility model is that for each individual, his/her utility is equal to the sum of two parts: utility from (intermediate) consumption and memory utility. While we understand that deriving utility from past consumption is also considered a type of consumption to some economists, for simplicity, we use the term "consumption" for *intermediate consumption* throughout the paper. If pleasure enjoyed today generates long-lasting positive memories for the future, which are then added to future utility, an agent who maximizes his or her total utility during his or her lifetime should naturally consume more of their lifetime wealth ("permanent income") in earlier periods. Memory serves as a premium for consuming today rather than in the future.

In this paper, we take this concept very seriously by searching for empirical and experimental evidence to back it up. We argue that ignoring the heterogeneity in memory capacity could lead to substantial bias, particularly in estimations of discounting behavior. If memory serves as a premium for consuming today rather than in the future, better memory should imply larger premium for consuming today. Therefore, our model predicts that the memory ability is positively correlated with discounting, a prediction supported by our experimental data.

It is well known that experimentally elicited discount rates are often higher than seem reasonable for the economic decision-making perspective, which Andreoni and Sprenger (2012b) attribute to present bias (see also Laibson, 1997; Benhabib, Bisin, and Schotter, 2010; Chark, Chew, and Zhong, 2015). The conjecture that memory capacity and discount rates are correlated would partly explain the high elicited discount rate.

This is not the first study to look at utility from the memory and discounting perspectives. To the best of our knowledge, utility from memory has also been discussed by Loewenstein and Elster (1992), in conjunction with utility from anticipation. More recently, Gilboa, Postlewaite, and Samuelson (2016) established a comprehensive theoretical framework for introducing memory utility to economic analysis. The purpose of exploring such utility in the economics context is to elucidate a wide class of phenomena that pose challenges for standard economic theory on intertemporal consumption. For example, why do some young couples spend one quarter of their combined annual income on a wedding and honeymoon?

The answer provided by Gilboa, Postlewaite, and Samuelson (2016) is that weddings and honeymoons are memory goods. Although their consumption usually takes place when people are young, utility is derived from them when recalled at later stages of life. Therefore, spending a large amount of money on these non-durable goods may constitute an optimal choice. However, memory utility may make it difficult to postpone consumption and act as if one had a higher discount rate. The aforementioned theoretical framework was further developed by Hai, Krueger, and Postlewaite (2015) to explain the welfare cost of consumption fluctuations. This paper argues one step further: if memory makes people behave as if they are more impatient, then the elicited discount rate should be positively correlated with memory capacity. We adopt the memory span test from the psychological literature (e.g., Miller, 1956) to measure individuals' memory capacity, which is then linked to their discounting rates. Our finding that memory ability is indeed positively correlated with discount rate serves as indirect evidence of the existence of memory utility, as suggested by Gilboa, Postlewaite, and Samuelson (2016).

The remainder of this paper is organized as follows. Section 2 presents the theoretical framework, Section 3 shows the experimental design, Section 4 presents the experimental results, Section 5 provides the results of robustness check, and Section 6 concludes the paper.

2. Theory

- **<u>Benchmark</u>**

We start from a basic two-period consumption model ($t = 0,1$) with a single commodity good. Our model is a simplification (special case) of the model of a two-good economy in Gilboa, Postlewaite, and Samuelson (2016). The total utility for a consumer is

$$U = u(c_0) + \frac{1}{1+r} u(c_1) \quad , \tag{1}$$

with intertemporal budget constraint

$$w_0 = c_0 + \frac{c_1}{1+i}, \tag{2}$$

where $u(c_0)$ and $u(c_1)$ denote the utilities at periods 0 and 1, which are derived from consumption c_0 and c_1, respectively; w_0 denotes total permanent income at period 0; and r and i are the discount rate and market interest rate, respectively. Equation (2) is a typical overlapping generations model without the involvement of memory goods.

- **<u>Model with memory utility</u>**

Following Gilboa, Postlewaite, and Samuelson (2016), consumption at t depends not only on current consumption c_t, but also on consumption in the past, which is defined as memory utility. Equation (1) can be rewritten as

$$U = u(c_0) + \frac{1}{1+r} u(c_1, c_0) \quad . \tag{3}$$

If we assume that $u(c_1, c_0)$ is additive, then

$$u(c_1, c_0) = u(c_1) + \rho u(c_0) \,, \tag{4}$$

where $\rho u(c_0)$ is memory utility, that is, the utility derived from the memory of $u(c_0)$ at period 1. Here, ρ is defined as memory capacity, and $\rho \in [0, 1]$. In the highly cited paper "The Magical Number Seven, Plus or Minus Two," Miller (1956) argues that human beings have limited and heterogeneous memory capacity. It can be speculated that if a consumer has better memory, his or her degree of memory utility is higher.

Combining Equations (3) and (4) yields

$$U = \frac{1+r+\rho}{1+r}\left(u(c_0) + \frac{1}{1+r+\rho}u(c_1)\right). \tag{5}$$

When we maximize the utility in Equation (5) with the budget constraint in Equation (2), the observed discount rate with memory utility for intertemporal choice becomes

$$r^* = r + \rho \,. \tag{6}$$

Equation (6) implies that when memory utility exists, consumers appear to make decisions based on observed discount rate r^*, which is involved in memory effects, rather than the market discount rate, as memory utility cannot be observed. The observed discount rate, in particular, is positively correlated with memory capacity, giving us the following proposition.

Proposition 1: *When a consumer has memory utility, his or her (observed) discount rate is higher when his or her degree of memory capacity is higher.*

The framework that we use to model memory is similar that used by Lahiri and Puhakka (1998) to model habit formation. Lahiri and Puhakka (1998) model the utility of individuals as:

$$V = u(c_0) + \beta(c_1 - \gamma c_0)$$

where c_0, c_1 are the consumption levels in period 0 and 1, β is the discount factor, and γ is the "habit persistence" parameter, the value of which is between 0 and 1. Compare it with equations (3) and (4) of our paper. We can see that the habit term enters the utility in period 1 as a negative term, and while memory enters the utility in period 1 as a positive term. Individuals should consume less in early periods when their habit persistence parameter is larger, while they should consume more in early periods when their memory parameter is lager.

- **Risk aversion**

The current literature also suggests that risk aversion is linked to discount rates, as people fear uncertainty in the future. However, following Andreoni and Sprenger (2012b), we can further extend our theory by specifying a utility function that includes risk aversion. We assume the constant relative risk aversion (CRRA) utility function $u(c)=\frac{c^{a}}{\alpha}$, in which relative risk aversion is measured as $1-\alpha$. When $\alpha<1$, the consumer is risk-averse; when $\alpha=1$, he or she is risk-neutral; and when $\alpha>1$, he or she is risk-loving.

Maximizing the utility in Equation (1) in the case of no memory utility yields

$$c_0^{*}=\frac{1}{1+(1+i)^{\frac{\alpha}{\alpha-1}}(1+r)^{\frac{1}{\alpha-1}}}w_0 . \tag{7}$$

Analogously, maximizing the utility in Equation (5) in the case of memory utility under budget constraint (2) gives us

$$c_0^{*}=\frac{1}{1+(1+i)^{\frac{\alpha}{\alpha-1}}(1+r+\rho)^{\frac{1}{\alpha-1}}}w_0 . \tag{8}$$

Comparing Equation (7) with Equation (8) gives us $c_0^{*}>c_0$ for $\rho>0$ and $\alpha<1$ (risk-averse consumer). In other words, we have the following lemma.

Lemma 1: *In the presence of memory utility, a risk-averse consumer tends to allocate more of his or her budget to the current period than in its absence.*

Intuitively, consumers with memory utility can obtain greater utility from allocating larger budgets to period 0, which compensates for the utility loss in period 1 through memory utility.

In addition, when $\alpha<1$, Equation (8) also shows that

$$\frac{\partial c_0^{\ *}}{\partial \rho} > 0,$$

which yields the following lemma.

Lemma 2: *A risk-averse consumer with greater memory capacity allocates more of his or her budget to the current period and saves less for the future when memory utility exists.*

Further, the allocation of a larger portion of his or her budget to the current period implies that the consumer has a higher discount rate. Thus, Lemma 2 is consistent with Proposition 1. In practice, people tend to spend a lot of money on weddings and vacations, particularly young people, because doing so yields ample memory utility that contributes to later utility. From the empirical perspective, Equation (8) demonstrates that risk aversion and the discount rate can be disentangled, with similar results shown in Andreoni and Sprenger (2012b). However, both Equations (5) and (8) show that true discounting behavior r cannot be disentangled from memory capacity ρ, as we can observe only discount rate $r^* = r + \rho$. As Proposition 1 states, the observed discount rate is positively correlated with memory capacity. That proposition is tested in the following experiment, in which we develop a method to elicit the heterogeneity of memory capacity.

3. Experimental Design

- <u>Measuring memory capacity</u>

The psychology literature distinguishes three types of memory, namely, sensory, short-term, and long-term (Kassin 2006, p. 235), in accordance with the human information-processing mechanism. Sensory memory retains information from the senses for a very short time, generally about three seconds. Sensations that do not draw attention tend to be forgotten, whereas those we notice are transferred to short-term memory. Short-term memory fades quickly, but some information is transferred to long-term memory, which can store it for many years.

Short-term memory is the critical chain linking sensory memory and long-term memory. Both sensory and long-term memory is very difficult to measure objectively and accurately, as their information-processing time is either very short or very long, respectively. The bulk of the psychology literature thus focuses on short-term memory capacity is correlated with long-term memory capacity.

Limited by attention resources, short-term memory holds only a small number of items. In the context of the well-known memory span task, Miller (1956) describes short-term memory capacity as “the magical number seven, plus or minus two.” In other words, the average number of items that can be retained in short-term memory is seven, with some individuals able to remember slightly fewer or more (i.e., plus or minus two). Miller’s experiment has been replicated on numerous occasions, with some later studies finding short-term memory capacity to be more limited than Miller suggested (Cowan, 2000). Miller’s experimental design is still widely regarded as a good tool for measuring memory capacity.

Accordingly, following Miller (1956), Baddeley (1992), and Cowan (2000), we conducted a *memory span task* experiment to measure memory capacity. Our subjects were college students, who are believed to have above-average memory capacity, as noted above. We used a computer to generate 13 random number sequences, increasing successively from 2 digits to 14 digits (the number sequences are reported in Appendix 2). Individual PowerPoint slides displaying each of the 13 number sequences were then shown to the subjects one by one, in increasing order by the number of digits. Each slide was shown for two seconds. After each slide, a 10-second pause was provided to allow the subjects to write down the number on the previous slide. A subject’s memory capacity was measured by the number of digits in the longest number sequence he or she was able to write down before the first mistake was made. That is, if he made the first mistake writing down the 7-digit number, his memory is 6, irrespective of whether he writes the 8-digit or longer numbers in the correct way.

- <u>Measuring discounting rates</u>

Individual discount rates cannot be directly observed, but Coller and Williams (1999) developed an experiment to elicit them by asking subjects to compare a list of different payment scenarios with different effective interest rates. Since then, the so-called multiple price list (MPL) has become widely adopted in experimental studies seeking to elicit time preference. Some researchers argue that time preference is often confounded with risk aversion (Holt and Laury, 2002). We will address this question in Section 5 of this paper.

The MPL method proposed by Coller and Williams (1999) was used to measure individual discount rates. Subjects were presented with a table asked to choose between two options of hypothetical payment, A and B. Option A offered 3000 yuan in one month's time, whereas Option B offered 3000 yuan plus an interest payment seven months in the future (the list of choices with different interest rates is reported in Appendix 1). We adopt this design so that the elicited discount rate is free from present bias. The subjects made their choices from 10 rows in which A remained the same and the interest payment for B increased. The point at which they switched from A to B was used to calculate subjects' discount rate. We then calculated the yearly interest rates (YIR) and effective yearly interest rates (EYIR). The time preference question was purely hypothetical, as subjects would receive no money regardless of their choices. Coller and Williams (1999) conducted six sessions in their experiment, including both real and hypothetical payments. They found lower discount rates for the latter, although their sample size was relatively small, and hence their results may not be robust.

- Experiment implementation

Our data were collected in China in March-May 2015 at Nanjing Agricultural University, Jilin Agriculture University, and Jilin University of Finance and Economics. Our sample comprised 587 participants, all of them university students recruited by our research partners in the three universities. After deleting abnormal observations, for instance, those in which participants provided inconsistent answers[2], the sample was slightly reduced to 552. Such a large sample is likely to yield statistically robust results. The experiment was conducted in the three following steps.

Step 1: Collect basic demographic information, such as the participants' age and sex.

Step 2: Elicit participants' individual discount rates using the table in Appendix 1.

Step 3: Display the 13 slides with the number sequences shown in Appendix 2 as a memory span task to reveals the heterogeneities in individual memory capacity.

[2] Here, inconsistent answers refer to the cases where the subjects make more than one switch in the multiple price list.

The duration of each complete experimental session was typically around 40 minutes. The subjects received payoffs based on their decisions in a dictator game played after the experiment.

4. Experimental Results

Table 1 reports the descriptive statistics of the experimental results. Participants' average age was 20.71, with a standard deviation (SD) of 2.17 years, and the majority were women (men = 26.24%). The average number of correct numbers in the memory span task was 9.31 out of 13 (SD = 1.78), a higher number than Miller (1956) recorded[3]. As previously noted, the participants were college students, who are expected to have superior memory capacity given their many years of academic training and, in China, selection through highly competitive college-entrance exams, and hence the discrepancy is unsurprising. Without considering censoring effects, the average YIR was 25.06% (SD = 12.66%), and the average EYIR was 28.20% (SD = 15.30%). These discount rates are slightly higher than those in Coller and Williams (1999), who reported YIR and EYIR in the intervals of 17.5-20% and 19.1-22.1%, respectively. The results are comparable.

[Insert Table 1 here]

To obtain a quick overview of the relation between discounting and memory, we plot the average discount rate at each memory level in Figure 1. There is strong indication of a positive correlation between the two variables. We also show the average discount rate by age and sex. There is indication of a negative correlation between age and the discount rate, and the average such rate is higher for men than women.

[Insert Figure 1 here]

To further illustrate the correlation among discount rate, memory, and age, we present a jittered scatter plot of YIR against memory and age in Figure 2. Jittered scatter plots add spherical random noise to the data to avoid situations in which data points lie on top of one another, which makes it impossible to tell how many observations a plotted point represents. We also fit a scatter plot with regression lines using memory or age as the independent variable. The result

[3] Similarly, Luer et al. (1998) find the Chinese subjects' performance in the memory span task tends to be higher than German subjects.

confirms that the discount rate is positively correlated with memory capacity and negatively correlated with age.

[Insert Figure 2 here]

Next, we regress the discount rate on memory capacity, age, and sex:

$$Discount\_Rate = \beta_0 + \beta_1 memory + \beta_2 male + \beta_3 age + \epsilon \ . \qquad (9)$$

In an econometric model, $Discount\_Rate$ can be proxied by YIR and EYIR. Coller and Williams (1999) propose that there is a censoring mechanism in the MPL method. For instance, if 19 subjects all select Option A, their discount rates are all smaller than 5%, whereas if there are 38 subjects who all select the "B" choices, the implication is that their discount rates are greater than 50%. We adopt the interval regression method proposed by Amemiya (1973) to estimate equation (9). The results for both YIR and EYIR are reported in Table 2.

[Insert Table 2 here]

It can be seen that the results for YIR and EYIR are similar, although the coefficients for the latter are slightly larger. It makes sense that EYIR is higher than YIR. The likelihood ratio tests for model specification are highly significant (1%), which indicates that the interval regression models fit the data very well. The coefficients for memory are 0.76 and 0.92, respectively, for the YIR and EYIR models, and statistically significant at 5%, which provides evidence in support of our hypothesis that memory capacity is positively correlated with discount rates. Controlling for the other variables, a one-digit increase in the memory span task leads to a 0.76% increase in the discount rate.

With regard to sex and age, the coefficients for the male dummy variable are 5.28 and 6.43, respectively, for YIR and EYIR, both statistically significant at 1%, which implies that men have a 5.3% higher discount rate than women. The coefficients for age are -1.07 and -1.28, respectively, for YIR and EYIR, both statistically significant at 1%, which implies that younger people exhibit a higher discount rate even when their memory capacity is controlled. Recalling the concept of "memory utility," young people have a longer time to enjoy such utility when expenditures are made at a younger age.

5. Robust Check

As pointed out by one of the referees, Andersen, Harrison, Lau, and Rutström (Econometrica 2008) show that if utility is not linear (if agents are not risk neutral), then it is not possible to elicit time preferences, a la Coller and Williams (1999), without first knowing their risk preferences. One needs to use the Double Multiple Price List (DMPL, Andersen et al., 2008, Andreoni, Kuhn and Sprenger, 2015) approach or the Convex Time Budget approach (CTB, Andreoni and Sprenger, 2013, Andreoni, et al., 2015) to elicit risk and time preference together. Andreoni et al., (2015) conducted an experiment to compare these two methods, and in their model, the utility of an individual can be written as:

$$U(x_t, x_{t+k}) = \begin{cases} x_t^{\alpha} + \beta\delta^k x_{t+k}^{\alpha} & if\ t = 0 \\ x_t^{\alpha} + \delta^k x_{t+k}^{\alpha} & if\ t > 0 \end{cases}$$

where x_t, x_{t+k} are two payments allocated to periods t and $t + k$. They assume preferences over these experimental payments can be captured by a stationary, time-independent constant relative risk averse utility function $u(x_t) = x_t^{\alpha}$. The parameter δ captures standard long-run exponential discounting, while the parameter β captures the specific preference towards payments in the present, t = 0 (in other words, present bias).

In a CTB, subjects are given the choice of ($X, $0), ($0, $Y) or anywhere along the intertemporal budget constraint connecting these points such that $x_t + x_{t+k} = Y$, where $P = Y/X$ represents the gross interest rate. In a DMPL, subjects are faced with only the choice between ($X, $0), ($0, $Y) for the time preference elicitation task, and their risk preference is elicited by another multiple price list like the one by Holt and Laury (2002).

As a robustness check, we recruited 61 subjects from Jilin Agricultural University. For simplicity, we used the same DMPL method as Andreoni, Kuhn and Sprenger (2015) and regressed the estimated annual discount rate r ($r = \delta^{-365} - 1$) for each individual on his/her memory and the same set of control variables. We find that the subjects are indeed on average risk averse, with the mean risk averse parameter α equal to 0.7038 (standard deviation=0.5086). The mean present bias parameter β is 1.2281, with a standard deviation of 0.7507. The mean discount rate r is 0.3272 (32.72%), with a standard deviation of 0.5440 (54.40%). In general, the estimated summary statistics of these parameters in our experiment is similar to those estimated in the experiment by Andreoni et al. (2015). We run the same regression as equation (9) and report the results in Table 3. It turns out that the result of the estimation using the DMPL method is similar to the one we obtained from the MPL method. The estimated coefficient for memory is 0.646 and significant at 5%.

[Insert Table 3 here]

6. Conclusion

Adopting the concept of memory utility proposed by Gilboa, Postlewaite, and Samuelson (2016), which posits that current utility depends on both current consumption and past consumption, we explore the relationship between memory and discounting behavior by building a simple two-period model and comparing its predictions with experimental data. The model predicts that in most cases, the strength of memory capacity is positively correlated with the discount rate, which is well supported by our experimental data. As an extension of Gilboa, Postlewaite, and Samuelson (2016), our work confirms the presence of memory utility.

The current literature on experimental economics generally controls only observed heterogeneities such as sex and age, with differences in such internal and unobserved factors as memory capacity neglected. Such capacity without doubt regulates human decision-making. Hence, neglecting the heterogeneities in memory capacity may well bias experimental results, or render them difficult to explain. The literature often attributes the usually high discount rates observed in experimental studies to unexplainable present bias. Our finding of a positive correlation between memory capacity and discount rates partly explains such bias because experimental subjects are often college students, who usually have superior memory capacity due to their young age and high degree of selection.

Our findings are also potentially useful for explaining the puzzle of the well-documented rising savings rate over time in some regions of Asia (Deaton, 1997; Deaton and Paxson, 1994). In Taiwan, for example, savings rates continue to increase over the lifespan until at least the age of 60. Figure 3 illustrates savings rates and median ages at the country level worldwide. A similar pattern is observed, with those rates indeed increasing with the median age.

That pattern is anomalous to traditional lifecycle models of savings and consumption, which predict young people to save and older people to "dissave" (Modigliani, 1960). Although the anomaly can in part be explained with reference to "Asian identity" (Benjamin, Choi, and

Strickland, 2010), which is hypothesized to be more patient and thus more conducive to saving and investing, this study provides an additional perspective: that is, people may become more patient as they age due to their declining memory capacity (Rönnlund et al., 2005). Diminished memory capacity equates to less memory utility, meaning that older people behave as if they are more patient, whereas the reverse is true for younger people. [4]

A fruitful future extension of our research would be to compare memory utility for positive versus negative experiences. Chew, Huang, and Zhao (2014) find that people have a strong tendency to forget negative past events and exhibit false memory in favor of positive events. If memory capacity is influenced by the nature of the event, that influence may also translate into different observed discount rates.

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[4] We understand that there are alternative explanations for this phenomenon, e.g. the aged people spend less because they have less social interaction with others, and hence less social pressure to catch up with the Jones, or they only start to be fully aware of the importance to build up saving when retirement is approaching.

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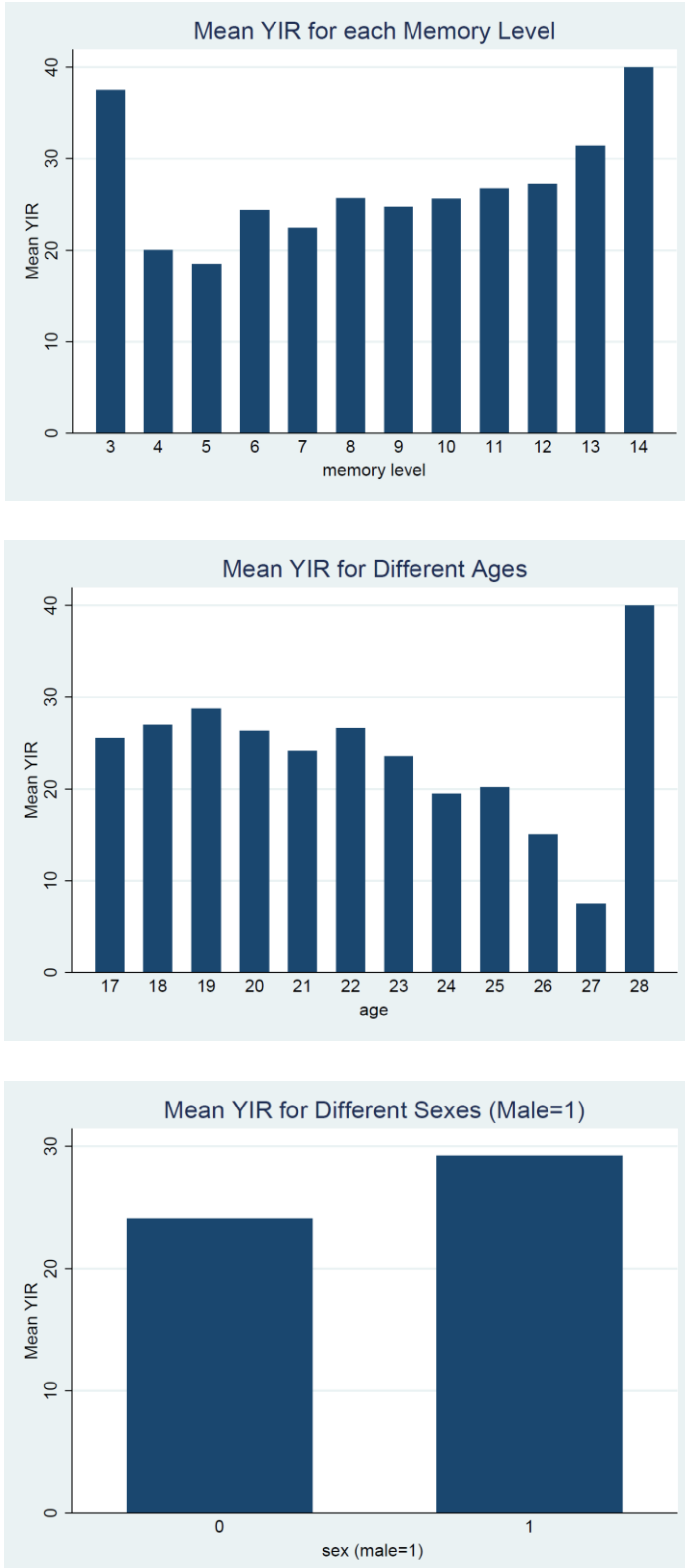
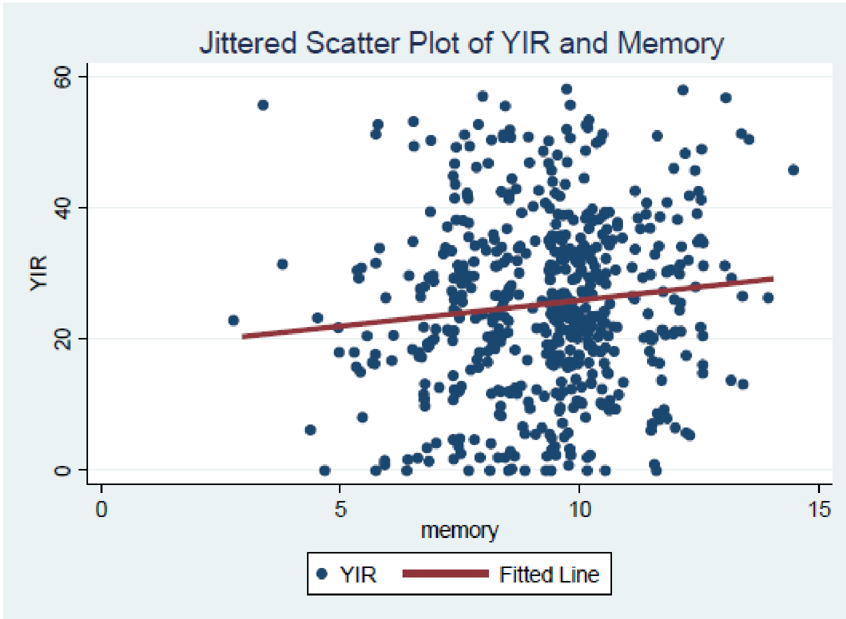


Figure 1: The average discount rate for different memory levels, ages, and sexes.



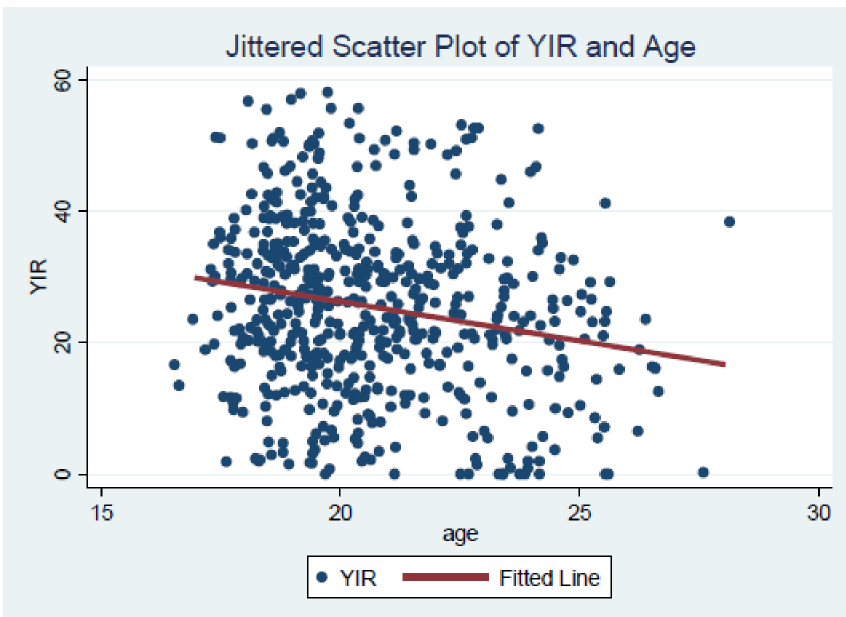


Figure 2: Jittered scatter plots of the discount rate against memory level and age.

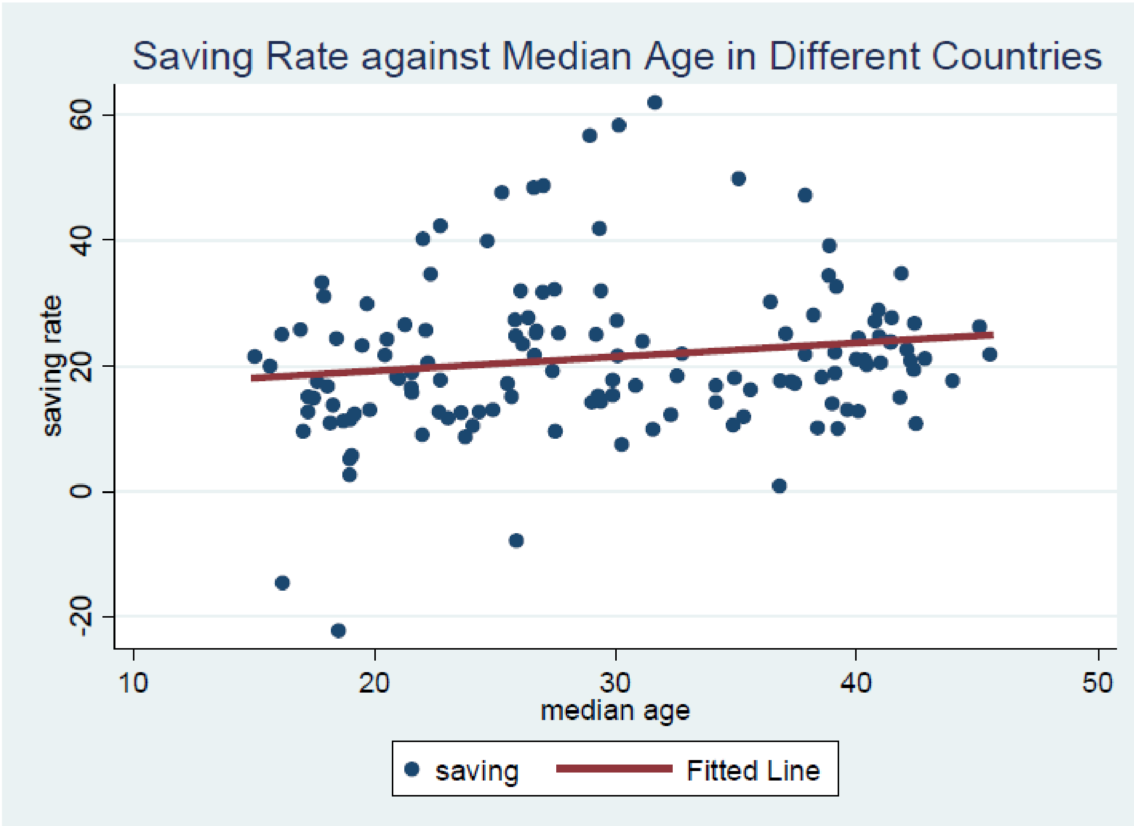


Figure 3: Savings rates plotted against median age for various countries worldwide.

Table 1: Descriptive statistics

Variable	Definition	Mean	Std. Dev.	Min	Max
Age	Age	20.71	2.17	17	28
Sex	Male = 1, Female = 0	0.26	0.44	0	1
Memory	No. of Maximum Digits of Memorized Number	9.32	1.74	3	14
YIR	Yearly Interest Rate (%)	25.06	12.66	0	50
EYIR	Effective Yearly Interest Rate (%)	28.20	15.30	0	60.18

Table 2: Regression results using the MPL method

	YIR		EYIR	
	Coeff.	t-ratios	Coeff.	t-ratios
Memory	0.76	2.44*	0.92	2.41*
Male	5.28	4.27**	6.43	4.24**
Age	-1.07	-4.29**	-1.28	-4.17**
Intercept	41.56	6.78**	47.65	6.34**
LR test for Model Specification	chi2(3) = 41.61**		chi2(3) = 40.32**	

Note: * and ** denote significance levels of 5% and 1%, respectively.

Table 3: Regression results using the DMPL method

	r	
	Coeff.	t-ratios
Memory	0.64	2.00**
Male	-0.53	-4.15**
Age	-0.02	-1.10
Intercept	0.47	1.05
F-test for the model	6.93**	

Note: * and ** denote significance levels of 5% and 1%, respectively.

Appendixes

Appendix 1:

<u>Task to elicit time preference</u>.

Suppose that you are going to receive an amount of money of around 3000 yuan. You have two options for receiving it: Option A allows you to receive 3000 yuan in one month's time, and Option B allows you to receive 3000 yuan plus an interest payment in seven months' time. Please make a choice between A and B in the 10 pairs of choices below.

	Option A	**Option B**	**Yearly Interest Rate**	**Effective Yearly Interest Rate**	**Your Choice**	
	In 1 month Amount	In 7 months Amount	(%)	(%)	(Circle A or B)	
1	3000	3075	5	5.09	A	B
2	3000	3152	10	10.38	A	B
3	3000	3229	15	15.87	A	B
4	3000	3308	20	21.55	A	B
5	3000	3387	25	27.44	A	B
6	3000	3467	30	33.55	A	B
7	3000	3548	35	39.87	A	B
8	3000	3630	40	46.41	A	B
9	3000	3713	45	53.18	A	B
10	3000	3797	50	60.18	A	B

Appendix 2:

Instructions for memory measurement task.

You are now going to watch 13 slides in sequence. A number will appear on each slide. Please write down the numbers on the slides in the right sequence.

Numbers on the slides:

69, 929, 1021, 34634, 943453, 7374885, 69358267, 699875725, 6655803001, 26656897198, 661518840995, 1285246589042, 91431501977497.