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Can Hypothetical Time Discounting Rates Predict Actual Behaviour:

Evidence from a Randomized Experiment

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Abstract

This paper estimates time preference parameters using commonly-applied methodologies, with the aim of investigating the link between these measures and actual economic behaviour. An experiment was conducted in the city of Thies, in Senegal, using the unique reference numbers of banknotes as a means of determining an individual’s willingness to save money. The findings of this experiment provide an innovative comparison between real choices, and choices made in the presence of hypothetical rewards. Our research indicates that individuals display a far greater degree of patience, when the possibility of genuine financial gain is made available to them. Our results show that hypothetical time preferences parameters are poor predictors of actual behaviour, prompting questions over the validity of commonly used measurements.

Keywords: Time Preferences, Randomized experiment, Senegal.

1. Introduction

Measuring the rate at which an individual discounts rewards over time has generated a vast literature encompassing both behavioural economics and experimental psychology (see Frederick et al. (2002), for a general overview). However, field and laboratory research has progressed significantly whilst leaving one question with relatively few answers. Do an individual's responses to hypothetical questions truly represent their preferences? This paper offers an indirect answer to that question by presenting an innovative field-study aimed at testing if standard hypothetical techniques can help in predicting an individual's observable behaviour.

The current opinion remains divided regarding the reliability of intangible rewards in eliciting discount rates. Benhabib et al. (2010) suggest that the extent to which hypothetical bias influences results is minimal. Whereas, Cummings and Taylor (1999) and Anderson et al. (2011) argue that experiments conducted under hypothetical conditions cannot be relied upon to produce robust results, without specifically accounting for this potential source of bias. Kirby and Maraković (1995) use two treatment groups to compare hyperbolic and exponential discount functions and find a lower discount rate for hypothetical responses. One of the two groups was incentivised with real monetary rewards, whereas the other gave responses to purely hypothetical questions.[1] Coller and Williams (1999) also provided a comparison of real versus hypothetical responses through a separate treatment group. They report that hypothetical discount rates were relatively higher than those for individuals who received real financial rewards. It is important to note that these studies were comprised of a relatively small number of participants (and for some of university students) and crucially, that actual and hypothetical rates were estimated for two separate groups of individuals thus making a direct comparison between both rates at the individual level difficult. Ubfal (2015) provides another basis for comparison, through field-research conducted in Uganda. His work focusses on ascertaining the difference in discount rates between various goods (including money) and, although initial discount rates were obtained using hypothetical questions, a small sub-sample were re-interviewed with the possibility of obtaining real rewards from one of their responses randomly selected. The paper concluded no significant variation between the two elicitation methods, suggesting the original responses were not subject to hypothetical bias[2].

Our interest in this question sprang from evidence we collected in a large-scale survey we conducted in Senegal in 2012. Our measure of hypothetical time preference was obtained via the standard hypothetical 'Multiple Price-list' (MPL) format (see Anderson et al. 2006). Given the size of the rewards offered and the time frames under consideration, individuals appeared to display high levels of impatience (nevertheless in line with Harrison et al. 2002; Botelho et al 2006; Tanaka et al. 2010).

[1]The experimental procedures were not identical for the two test groups however, as the non-hypothetical experiment incorporated controls to prevent over-declaring by participants aiming to gain a higher reward (Kirby and Maraković, 1995).

[2] Andersen et al. (2014) suggest that, the estimated discount rate under random allocation of the real rewarded task depends on the assignment probability.

This paper compares discount factors measured with hypothetical and real money experiment on the same group of individuals. We investigate whether the expected consistency in behaviour can be observed when comparing results from these two distinctly different experimental procedures. In order to do this, we developed a 'banknote experiment', whereby individuals were given a banknote of 1000 CFA francs (USD 2) (with the serial-number recorded) and informed that if they chose to retain this specific note for a designated period of time (2, 7 or 14 days) they would receive a second banknote, therefore doubling their initial endowment (more details on our experimental designs can be found below). We use the MPL elicited discount factors to predict the results of our experiment and see if they correlate with incentivized behaviour with real money. Our research concluded that the hypothetical time-preference choices provided little prediction of an individual's behaviour within the context of the banknote experiment.

It is worth noting that, although our experiment provided us with a direct means of measuring individual discount rates, it also has confounding factors and generated new potential sources of bias. For example, the inherent fungibility of money may have led participants, who would otherwise spend the banknote, to substitute the equivalent amount of money from alternative household or relative's savings. Responses may also have been subject to a 'reputation effect', where individuals may have viewed the experiment as a test of their personal credibility, and adjusted their behaviour accordingly. We discuss these issues below and attempt to present robust estimates.

The next section presents an overview of the theoretical framework. The following section describes the context of our study, our elicitations methods and our experimental design. We then present our econometric models and discuss our results. A discussion of the measures taken to assess possible sources of bias follows with the concluding remarks.

2. Theoretical framework

Economic models relying on a constant, exponential discount rate, preferences are often rejected by experimental data. It is commonly observed that discount rates actually decline as the period between payments increases (Thaler, 1981; Benzion et al. 1989; Ainslie, 1992). This decline may lead to 'preference reversal', whereby an individual's choice over two identical reward-pairs may reverse, as a result of changes in the time-horizon in which the two rewards are offered. As an alternative, a pure hyperbolic discounting specifications was used to account for a declining discount rate and a potential preference reversal. However, this functional form also displays some drawbacks. Primarily this form of model does not explicitly account for present-bias, despite the fact that individuals commonly exhibit a 'passion for the present' when they are exposed to choices over monetary amounts (Andersen et al. 2008). In addition, many studies have indicated a 'magnitude effect', resulting in larger amounts being subjected to a lower discount rate than smaller ones (Thaler, 1981; Benzion et al. 1989; Kirby et al. 1995; 1999).[3] The presence of

[3] It has also been noted that losses are often discounted at a lower rate than gains (Thaler, 1981; Benzion et al. 1989), resulting in inconsistent preferences due to a 'Sign Effect'.

discounting anomalies such as these, has forced a re-assessment of the assumptions regarding time preference and the extent to which individuals discount future rewards (Frederick et al. 2002).

From the first models of time-inconsistent preferences, proposed by Stroltz (1956), various specifications have been considered that allow for relative impatience over short-term rewards. Many of these models are based around 'hyperbolic' or 'quasi-hyperbolic' functional forms (see Laibson, 1994; 1997), and have often been found to fit the data more accurately than standard, exponential discounting.[4] The later, in particular, has received much attention in the more recent literature (see Frederick et al. 2002).

Benhabib et al. (2010) provide a general expression for an individual's discount factor which allows for testing among possible models, namely exponential, hyperbolic and quasi-hyperbolic discounting. We use this formulation as a starting point for our empirical analysis below. The discount factor *D(y, t)* is a function that makes an individual indifferent between two alternative time/reward pairs *(y D(y, t), 0)* and *(y, t)*

$$D(y, t, \beta, r, \theta) \;=\; \begin{cases} 1 & if \quad t = 0 \\ \beta(1-(1-\theta)rt)^{\frac{1}{1-\theta}} & if \quad t > 0 \end{cases} \qquad (1)$$

Where β is a parameter representing present-bias, r represents the underlying discount rate, t the time period and θ parameterizes the curvature of the discount function. Dependent on the restrictions imposed on the parameters, this expression can represent various forms of time preference, through nesting exponential, hyperbolic and quasi-hyperbolic discounting functions (Tanaka et al. 2010).

i) When $\beta = 1$ and θ is approaching 1, equation (1) represents exponential discounting (e^{rt}), whereby the discount factor increases over time at a constant rate.
ii) When $\beta = 1$ and $\theta = 2$, equation (1) represents pure hyperbolic discounting ($1/(1+rt)$). In this case, the discount factor decreases over time, and displays a non-constant absolute rate of change.
iii) When θ is approaching 1, equation (1) displays future rewards under quasi-hyperbolic discounting (Laibson 1994; 1997). $D(y, t, \beta, r, \theta)$ takes on the form βe^{rt}, allowing for an individual to display a 'present-bias' towards immediate reward, with all non-immediate amounts discounted by a factor β.

[4]Some notable examples of studies that reject the exponential discounting form include Rachlin et al. (1991), Kirby and Maraković (1995) and Myerson and Green (1995).

3. Our Data and Experimental Design

3.1 Context of our Study

Our survey is based on household level observations gathered in Thies, Senegal. Thies is one of the largest cities in Senegal, with a population of about 240,000 inhabitants at the time of the experiment. We use data collected between May and July 2012 on 360 randomly selected households across the whole territory covered by the city authorities. This represents an area of approximately 20 square km. We sampled the number of surveyed households across all Thies neighbourhoods according to their respective share of the overall population estimates (based on the 2005 census). More information on our methodology can be found in Appendix A.

For the purpose of this paper, the household is considered as a nuclear unit and consists of spouses, their children and all other members of the family who economically depend on the senior members. Our baseline survey aimed at obtaining information on each household member's religion, level of education, ethnic affiliation. We also gathered information from the respondent concerning his/her work, monthly income, and a number of other factors, which we describe below in greater detail. For 48% of the households surveyed the respondents was the head.[5] In the remaining cases the respondent was most often the spouse or in some cases another adult member of the household. We investigate below the possible consequences of this.

A brief overview of key variables obtained from the sample can be found in the first column of Table 1. To summarize, the majority of the respondents were female (61.6%), averaging approximately 44 years of age. The households chosen contained around 6 members on average. Household income averaged around 213,000 francs CFA per month, which is equivalent to approximately US$443 (on the basis of the exchange rates at the time of survey). Due to the sensitivity of obtaining income and salary levels, respondents were given a choice of 11 income intervals[6]. Therefore, income measures represent the mid-point in each interval, unless respondents provided more precise information. As Senegal is predominantly a Muslim country, this was reflected within the data, and the proportions of the three largest ethnic affiliations within the sample (Wolof, Poular and Sérer) approximately follow those of the country, as a whole (ANSD, 2012).

[Insert Table 1 here]

3.2 Eliciting Discount Rates

The recent literature is often based on the 'Multiple Price-list' approach (MPL), as proposed by Coller and Williams (1999). This method generally presents individuals with an ordered list of trade-offs between a fixed, immediate reward and an increasing future amount, subject to a specific

[5] Different reasons can explain why we could only have half the heads answering the questionnaire. In many cases they do not live on the dwelling visited for work related reasons and only pay regular/irregular visit to the household. A limited number of heads did not have the time to answer and delegated either their spouse or another adult. We did not meet a household who refused to take part in the survey.

[6] During our pilot several individuals refused to give a precise value for their income and felt more incline to answer if the question was presented with multiple braquet choices.

period of delay (see Harrison et al. 2002; Botelho et al. 2006; Tanaka et al. 2010). Given the relative simplicity of communicating this procedure to test-subjects, it is understandable that this approach is often favoured over more complex experimental designs. It has been suggested that discount rates obtained via this method may be susceptible to framing effects, dependant on the design of the price-list employed (Harrison et al. 2005).

We rely on multiple amounts and multiple time delays to mitigate potential framing effects. All the questions used are of a 'yes/no' type, allowing us to ask multiple questions to the same individual over the course of the interview. The set of amounts and time delays used are shown in the appendix in Table A1 and are all hypothetical with no real rewards attached. There are two possible values for the immediate reward: 10000 CFA (approximately US$21) in panel A and 1000 CFA (approximately US$2) in panel B of the table. By way of comparison, we find that the mean of monthly income per-capita for our sample of households is 40995.85 CFA (inclusive of members who are not economically active). Regarding time-horizon, there is no front end delay and the set of choices starts with a delay of two days, which increases up to a period of six months, generating observations over periods of 2 days, 7 days, 14 days, 1 month and 6 months respectively.

The questions are designed to identify when the respondent switches from a (smaller) immediate reward toward a (larger), future reward. The questions were posed as follows: 'If you are sure to receive the sums mentioned at the given time, would you prefer accepting (*X*) francs CFA today or (*Y*) francs CFA in (*t*) days/months?'. The first question proposes 1000 CFA now and in two days. When the interviewee prefers the immediate reward, the amount is increased to 1050 CFA (US$2.19) and they are asked to express their preference again. This process is continued up until the point where the individual switches to the future reward. However, beyond this point we assume that preferences are transitive, such that the switching point is unique for any given initial amount and time delay. Therefore, if an individual prefers a given amount in the future compared to an initial value, (s)he will also prefer larger amounts in the future (given the same time delay).

3.3 Eliciting Risk Preferences

Although this paper focuses primarily on the measurement of time preference, any non-instantaneous choice from which an individual derives utility is likely to be also dependent on levels of uncertainty regarding future outcomes (Anderson et al. 2008; Andreoni and Sprenger 2012). We thus follow Holt and Laury (2002) and administer another set of yes/no questions to elicit the risk preferences of individuals. Each individual was offered the choice between two binary lotteries (A and B) involving gains (panel A) and losses (panel B, not shown), as outlined in Table A2 in the appendix. However, data obtained from panel B was scarce and therefore was not included in the calculation of risk preferences.[7] Lottery A is relatively more risky and has a higher payoff in the case of success. Lottery B is relatively safe and has a subsequently lower payoff in the event of a successful outcome. We set the probability of success the same for both the risky and safe lotteries. We made the assumption of "monotonic switching", in the sense that when an individual switches from lottery A to lottery B, as the probability of success decreases,

[7] This was due to a significant fraction of individuals showing reluctance in providing answer to this part of the experiment as it involved losses, even when we repeatedly explained that the experiment was purely hypothetical.

(s)he cannot switch back to lottery A. We offered monetary payoffs based on a single task selected at random from across the lotteries.

3.4 The Banknote Experiment

Following the baseline questionnaire, each respondent was given a 1000 franc CFA banknote. The unique reference number of this note was recorded and the individual was informed that, if they produced the same banknote when the household was visited on a second occasion, they would receive another 1000 francs, and could retain both notes. The specific date of the second visit was randomly assigned to each household at 2 days, 7 days or 14 days from the initial visit.[8] One household in three was assigned to each of the three possible periods. However, one individual refused to partake in the experiment, reducing the sample size to 359. Table 1 shows the tests for random assignments of treatments, through an F-Test comparison of the mean values for key variables within the three treatment groups (2 days, 7 days and 14 days). From our 17 potential controls, only three significant differences are observed across the groups. These minor differences are related to whether the interviewee holds a savings account in a microfinance institution or in a bank, or is member of a ROSCA.[9] They will be taken into account in the regression analysis which follows.

A more intuitive treatment would have been to offer each respondent either a 1000 franc CFA note today or 2000 francs CFA in *t* days during a second visit. This would have represented a replication of the MPL questions. Except that it proved difficult to implement cleanly. During our piloting phase a significant proportion of respondents opted for the immediate reward because they perceived that the likelihood of us returning for the second visit was small. This for all three treatments (2, 7 and 14 days) and despite our numerous attempts at trying to give strong guarantees that our second visit was in no doubt. Our pilot survey indicated that our results were likely to be biased by this lack of trust if we would implement that treatment in our large-scale survey. We also piloted the present treatment. We found during our interviews that by offering initially a note of 1000 CFA surveyed individuals were not inclined to think that our second visit was in doubt and this across delays (2, 7 and 14 days). Somehow offering money during our first visit gave credibility to our experiment and guaranteed our second visit. The present treatment allowed us to avoid any ‘trust’ bias and proved an easy alternative to implement.

We are aware that our treatment not only elicits time preference but will be tainted by how individuals cope with temptations and manage to save cash for a short period (or how good they are at committing). Both are difficult to disentangle but alongside our time preference parameters

[8] Because of organizational, time and resources constraints, it was not possible for the same individual to play many scenarios available in the MPL. Namely, it was not possible to offer the same individual a banknote of 1000 CFA and a banknote of 10000 CFA, and offer second visits over different periods of time. It should also be apparent that any experiments conducted with actual rewards will clearly be limited by financial constraints. For example, were the experiment conducted using a 10000CFA banknote, given the percentage of the sample who retained the note in the 1000CFA case (and noting that this retention rate would, in all likelihood, be higher for the larger payments), the basic costs of conducting this experiment alone would have been, unfortunately, beyond our means.

[9] The reason why we observe these and why our design gave those results is unclear to us. There was no differential refusal rate to participate in the study by treatments. As far as we can tell, none of our enumerators showed strategic behaviour in selecting households and our assignment of treatments was conducted in a proper way that should have prevented this outcome. One can suggest that the differences are likely to be related to the small size of the sample.

we use different measures to attempt to separate these effects (see paragraph below). It is also important to re-emphasize that our treatment is not a direct replication of our MPL questions. As such we are not directly testing the validity of hypothetical against the incentivized time preferences we elicit. Our goal is rather to check if our hypothetical time preferences parameters are good predictors or not of actual incentivized behaviour.

Once the note was given each individual was asked a series of five questions:

Question 1: 'Do you think that you can keep the money until the specified date?'

Question 2: 'Why do you think you can or cannot?'

Question 3: 'Do you think, yes or no, that you will have difficulties coping with the temptations to spend the banknote?'

That question was aimed at determining to what extent the individual believed they could resist temptation during the experiment.

Question 4: 'Do you plan, yes or no, to do something in order to make sure that you will not spend the note?'

Question 5: 'If yes what?'

The last two questions aimed at listing the mechanisms they intended to use to ensure they avoided temptations. They allowed us to check if respondents intended to use any form of commitment device in order to ensure they did not spend the money. It was also designed to evaluate any potential bias in behaviour due to the inherent fungibility of the reward. To uncover the likelihood that participants in the experiment would consider drawing money from an existing pool of cash or borrow, in order to increase their expenditure now, while still managing to retain the specific banknote provided. This form of expenditure-source switching would lead to misleading results.

Our descriptive statistics show that only 1.5% (3 out of 205) of our respondents who answered 'yes' to question 4 planned to use such liquidity (or borrowing) in order to help them to keep the note. Answers indicative of this were: 'I will borrow around me (from friends or acquaintances), if I need, instead of using the note.' None mentioned the use of savings in Roscas, MFIs or bank accounts. With such a small figure we argue that this reasoning may have influenced some individuals' decision but this effect is likely to be marginal. The issue of fungibility is discussed at greater length in section 6.4.

Table 1 shows that of the respondents, those who retained the note (variable 'keeping note') accounted for 78% of the sample. That proportion declines from 87.4% for delay of two days, to 80% (seven days) and 67.5% for fourteen days. The differences are significant between two and fourteen days and seven and fourteen days, but not between two and seven days. 74% of our sample indicated that they think they can keep the note until the specified date (a yes to *Question 1*; variable 'think will keep the note'). Intuitively this proportion is diminishing with the number of days involved in the treatment (63% for 14 day and 79% for 7 and 2 day treatment). Answers to *Question 3* indicate that 26% of respondents think that they will experience difficulties coping with temptations to spend the banknote (variable 'Temptation'). This proportion is significantly larger for those with the 14-day treatment (37%) than for either the 2 or 7 day treatment (21%).

A large majority of answers to question 2 following a positive answer to question 1 highlight the importance of gaining an additional 1000 FCA as motivation. Answers to question 2 from those who declared themselves unable to keep the note mostly indicate that debts needed to be repaid or that other familial urgent needs would prevent them from keeping the note. 61% of our respondents to question 4 said that they would plan to do something in order to make sure that you will not spend the note. Answer to question 5 show that 23% (48 out of 205) of individuals aim at giving the note to somebody else they trust in order to prevent them from using it and 33% (68 out of 205) to hide the note somewhere safe (under their mattress, cupboard, etc.).

We compare below answers to the hypothetical MPL questions and the results from the banknote experiment.

4. Empirical Analysis

Our empirical analysis at the individual level has two components. The first estimates time preferences parameters. The second investigates whether these parameters have any effect on the actual choice made in the banknote experiment.

4.1 Estimation of the Discounting Parameters

A discount rate parameter is estimated for every individual within the sample, using a logistic function of the following specification. The probability that the immediate reward *X* is preferred to the delayed reward *Y*, at time *t*, is modelled as follows.

$$P(x > (y,t)) = \frac{1}{1+ e^{\mu(x-y\beta e^{-rt})}} \qquad (2)$$

In equation (2) the values of *t*, *X* and *Y* are obtained from the time delay and amounts proposed in the various MPL questions, while the parameters of the quasi-hyperbolic discount rate *r* and β are estimated within the model. Attempts to estimate the general form of the discount factor with an unrestricted θ (described in equation (1)) led to high levels of non-convergence at the individual level. As a result, we opted to employ the quasi-hyperbolic discounting specification as in equation (2), with θ approaching 1, which has two unrestricted parameters (r, β). We provide in table A3 and A4 in the appendix further justifications for the use of the quasi-hyperbolic model.[10] The term μ is included as a response-sensitivity (noise) parameter.

The model is estimated using all 90 available observations for each individual using nonlinear least-squares regression. This means we use all time-periods and initial amounts of both 1000 CFA

[10] In that regard our analysis is similar to Tanaka et al (2010). They estimate the full model (1) with unrestricted θ but find that it does not improve R^2 much compared with the estimation of the quasi-hyperbolic model and so focus attention only on the quasi-hyperbolic discounting.

and 10000 CFA. Given our assumptions regarding transitivity, an individual will switch between immediate and future rewards at most once in each time period, this provides only one point of variation in the individual data for each of the given time delays.

4.2 Effects of our Measures on the Banknote Experiment

We run a set of probit regressions to identify the potential determinants of the actual choices made by individuals during the banknote experiment. Within these regressions the dependent variable takes the value 1 when the individual kept the banknote, and waited for the next visit to receive the second payment. Whereas it takes the value zero if the individual could not produce the banknote at the later time. The motivation behind these regressions is to investigate the role played by the estimated risk aversion and time preference parameters in determining observable behaviour.

5. Results

5.1 Time Preference Parameters

Table 2 below indicates the proportion of respondents who switched at the corresponding future amounts in the respective time-period, for the sum of 1000 CFA. For the six-month time frame, almost all individuals (96%) preferred the immediate reward to all amounts offered (ranging from 1050 to 3000). What we call this 'no switch' proportion reduces to 84%, when the time delay is reduced to 1 month, and decreases further as the delay approaches the present. Table 2 also indicates that 54% of the sample preferred at least double the initial amount when the time delay was 7 days, while 75% preferred at least 1.5 times the initial amount over the shortest time-period stipulated (2 days). The results seem to show a high degree of impatience. For example, approximately two-thirds of those sampled were unwilling to accept any of the given future rewards in 14 days, even when the opportunity of tripling their initial endowment was proposed.

[INSERT Table 2 HERE]

For each of the participants, MPL questions provided a selection of 45 responses for each of the two initial amounts of money proposed (1000 and 10000 CFA). For each amount there are 5 time periods (2 days, 7 days, 14 days, 1 month and 6 months) and 9 questions per time period. It gives a total of 90 observations per individuals. The measures of β and r are estimated within the quasi-hyperbolic specification from equation (2) for each individual based on these 90 observations. For some individuals we have little variations in their answers provided. For example, highly impatient individuals will not switch for the future reward for most of 90 questions proposed. This led to non-convergence in our estimations and so we could only obtained values for β and r for 327 respondents. This from the overall sample of 359.

Table 3 shows the average values and standard deviation of these estimated parameters for our sample of 327. The mean value of underlying discount rate r is 5.2%, with the majority of individuals in the sample displaying an underlying discount rate lower than 7%. The t parameter in model (2) is in number of days so our rates are daily discount rates. This implies that (on average and if we use quasi-hyperbolic discounting), an individual should be indifferent between: 675.92CFA today and 1000CFA in 2 days; 521.17CFA today and 1000CFA in 7 days; 362.16CFA today and 1000CFA in 14 days. The mean value of the estimated present bias parameter β is 0.75. The extent to which an individual favours the present is negatively related to the estimated parameter β. Thus, table 3 also shows the measure of present bias $(1 - \beta)$ which is used in the following investigations. The term μ, a response-sensitivity (noise) parameter, is estimated but not used in our subsequent analysis.

[INSERT Table 3 HERE]

5.2 Comparing Responses to the MPL and the Banknote Experiment

We first present a simple comparison between the answers provided to the MPL questions and the behaviour observed within the context of the banknote experiment. For each participant, one question within the MPL replicated the exact time frame and reward-pair offered within the note experiment.[11] If one's behaviour is consistent, an individual who prefers, for example, 2000 CFA in two days to 1000 CFA now in the MPL question should keep the banknote and get the additional 1000 CFA in two days. Table 4 shows whether the corresponding MPL question was able to predict an individual's behaviour in the banknote experiment.

[INSERT Table 4 HERE]

Overall answers to MPL questions appear in to be in line with 50% of individual's behaviour in the banknote experiment. Our results also indicate that the ability of the MPL to predict behaviour declines as the time-horizon increases. The consistency between MPL and the banknote experiment is 69% for the two-day frame and decreases to 38% for the fourteen-day frame. An important share of our sample (44%) gave responses to the MPL indicating that they would need a larger retribution than the additional 1000 CFA offered in the banknote experiment to wait for the corresponding time gap (2, 7 or 14 days). The proportion of individuals with such behaviour increases with the time delay. It starts at 24 % for the two-day frame and increases to 59% for the fourteen-day frame. These individuals appear to be more patient than what their MPL response suggest. Table 4 shows that the observed inconsistency stems largely from the individuals who prefer the note now within the MPL but show higher levels of patience within the banknote experiment.

[11] This would be from the selection of questions where X = 1000 CFA and Y = 2000 CFA. One question within this set would ask the subject to choose between these two amounts, over the same period of time as that stipulated in the banknote experiment.

Another way to compare our two key discounting parameters *r* and *β* is to use pooled data. This time these parameters are not specific to a single individual but are based on pooled data from the sample of 359 individuals who participated in the experiment (119 individuals for the two-day framing, 120 for the seven-day and 120 for the 14-day). Column 1 of Table 5 shows the values estimated with this sample using a dependant variable which takes the value 1 if the individual kept the banknote, and received 2000 CFA, or 0 if they could not produce the note on the second visit. By way of comparison, the second column shows estimates of the discounting parameters, obtained only from responses to MPL questions that replicate the exact time frame and reward-pair offered within the banknote experiment for each individual. The initial amount is thus 1000 CFA, compared to a delayed amount of 2000 CFA, and a time delay equivalent to that in the banknote experiment for each participant. So instead of having 90 MPL responses for each individual, we create a sub sample with one observation for each individual who took part in the banknote experiment. That observation contains the result of whether they switched in the corresponding MPL question.

[INSERT Table 5 HERE]

The underlying discount rate (*r*) in the banknote experiment appears to be lower than that displayed in the MPL questions. Our estimates also suggest that the MPL sample display a greater degree of present bias than the estimates shown in column 1. A caveat of importance regarding these results: the standard errors for all coefficients are large. Although largely imprecise, these estimates would appear to lightly support the finding of the response comparison in table 4, which indicate that individuals display a greater degree of patience when presented with real, as opposed to hypothetical, financial decisions.

5.3 Risk Aversion Parameter

As we could expect, the fraction of individuals choosing the risky lottery (A) declines as the probability of the high payout decreases (see the lotteries in table A2). This reflects in part the change in the expected income difference betwe
480 CFA to 180 CFA as the probability of the high payoff falls from 0
expected-utility maximizing individual, with weakly risk averse preferences should switch from choosing the risky to the safe lottery at most once over the course of the six tasks of the gain-frame series.

We make the assumption that the individual's preferences over outcomes in this lottery can be represented by a constant relative risk aversion (CRRA) utility function of the form $u(x) = [x^{1-R}]/[1-R]$. We use that function to place bounds on the CRRA coefficient. An individual choosing the risky lottery in all tasks must have $R \leq 0.22$, whereas an individual choosing the safe lottery in all tasks must have $R \geq 0.82$. Those who switch from risky to safe between tasks 1 and 6 will have an R that can be bounded within a strict subset of the interval (0.22, 0.82). Given that we could only gathered data from the panel of lotteries involving gains we end up with a limited number of observations per individuals. This means that we cannot estimate CRRA parameters by maximum likelihood for each person individually (see e.g.: Harrison et al, 2010).

Those who switch from risky to safe between tasks 1 and 6 will have an *R* that can be bounded within a strict subset of the interval (0.22 ,0.82). Table 6 shows these values and their frequencies within the sample. The mean estimate of *R* is 0.55, with a standard error of 0.17.[12] These statistics are in line with results from Harisson et al (2010). As indicated in table 6, seven percent of individual did not switch at any point in the experiment, the risk aversion parameter for these participants was set at 0.22.

[INSERT Table 6 HERE]

5.4 Effects of our Hypothetical Measures on the Banknote Experiment

We want to check whether each individual's estimated values of 1-β, *r* and *R* (present bias, discount rate and risk aversion respectively) have a significant impact on the behaviour we observe in the banknote experiment. We use these variables as controls in different models estimated with probit regression where the dependant variable represents whether or not the banknote was kept (1 if the note was shown to our enumerator upon the second visit and 0 otherwise).

Table 7 presents the estimated effects. In Column 1, only the time frames are controlled for on the right-hand side of the regression, with the base category set as the 2-day frame. In column 2, estimated individual discounting parameters (discount rate and present bias) are added as explanatory variables and column 3 also accounts for the effect of the estimated risk aversion measure. Column 4 reports the effects of the variables our hypothetical measures without controlling for the time delays. The final model in table 7 controls for a number of additional household and individual characteristics, which could intuitively be expected to exert some influence over the outcome of the experiment. Gender and whether or not the respondent is in couple have no significant impact on our dependent variable.

[INSERT Table 7 HERE]

Across models, the 14-day frame is strongly and consistently negatively related to the probability of the note being kept. The seven-day frame displays the expected sign but is not significant. These results are in line with the descriptive stats we show in table 1. Individually, the estimated effects of the discount rate and present-bias measure are never significant in all our models.[13] The same result applies when we test for their joint significance: the different tests for joint restrictions using

[12] We are aware that results are highly dependent on the set of lotteries chosen and the range of values used. The monetary values in this game (600 CFA ≈ US$1.2) are small compared to the mean of household income shown in table 1 (210700 CFA).

[13] One can argue that since our hypothetical time preferences parameters appear noisy (see table 3) this may explain why they are less likely to predict actual behavior. This could be one explanation of the lack of correlation in our data.

a χ^2 distribution show p-values largely above 10% throughout. Our measure of risk aversion seems also irrelevant across our models.

Amongst the additional variables added in column 5, none seem to be related to the probability that the banknote would be retained. The other potential controls listed in table 1: ethnic group, home-owner, marital status, number of young children, lived in Thies for less than 2 year and neighborhood fixed-effects were also included. Their coefficients were not significant and not reported. Our results remain robust to different variations in the specification presented in model 5.

In order to estimate the parameters of time preferences with a reasonably high level of convergence with the non-linear model we needed to use all available data for each individual. That is to say for both initial amounts of 1000 and 10000 and all five time frames. To check whether the results in table 7 are robust to changes in the data used to estimate the time preference parameters, the models were estimated using measures of β and r based on 1) MPL responses for the initial payment of 1000 CFA, and 2) MPL responses for time-delays of 14, 7 and 2 days (providing a closer comparison to the framing of the banknote experiment). However, the subsequently smaller number of observations reduced the number of individuals for which these parameters could be estimated from 327 to 294. If we used this smaller sample our results remain similar. The estimated measures of time preference and risk aversion are both individually and jointly insignificant for all of the proposed specifications in table 7. We also look at various heterogeneous effects from the discount rate and present bias on the likelihood of keeping the note. We find none that could be linked to income or gender.

It is plausible that the respondent, who in 52% of cases was not the head of the household, consulted with their spouse or somebody else in the household in order to decide what to do with the note. It seemed to us that most respondent dealt with the experiment largely privately and we do not have anecdotal evidence relating such behaviour. However, if that was the case, we could expect gender, whether a respondent lives in couple and whether the respondent is head of household to have an effect on our dependent variable. In our Senegalese context, men tend to have greater say over household finance management than women. A head of household or male respondent would be more likely to make such decision unilaterally. Whether this should impact positively on keeping the note or not is not obvious. Our results show that this seems not to play a significant role: model 5 shows that gender, whether the respondent lives in couple and is the head of household are all not significant. These results also seem to indicate that potential differences in preferences towards keeping the note between men and women do not to play a significant role in our context.

6. Discussion

6.1 Narrow bracketing

We have estimated discounting parameters under the assumption that, individual abstract from the actual living conditions when answering to the MPL questions. This is the narrow bracketing assumption in laboratory experiments. This assumption has been challenged notably by Dean and Sautmann (2015). In Table 8, we investigate whether estimated parameters are correlated to individual's characteristics. The first two columns of table 8 show OLS estimated correlates for the discount rate while the next two are for the parameter β. The results indicate that there is a significant correlation between individual owning a bank account and higher discount rate (r). Individuals who discount more heavily the future are more likely to value future spendings and hence more likely to save to achieve them. This reasoning may explain the significant correlation between the two. If the respondent lives in couple he/she is likely to have a lower discount rate.

[INSERT Table 8 HERE]

The results show a positive effect from being member of ROSCA on parameter β. Individuals who are ROSCA members seem to be less biased toward the present while those who are unable to resist to the temptation of using immediately a banknote are more biased. It has been shown that ROSCAs can be used as commitment device (Dagnelie et al., 2012) and in our case membership may impact on present biasness this way. Similarly, experiencing an episode of sickness last year reduces significantly present bias. Such episodes may require unexpected health expenditures and as such can show an individual the importance of savings in case of negative shocks. This may modify one's time preference and put more emphasis on prevention and accumulation for the future and hence reducing present time bias. Our results seem to indicate that narrow bracketing may be too strong an assumption.

An alternatively way of estimating our discounting parameters would be to estimate equation (2) by incorporating demographic variables in the logistic function as in Tanaka et al. (2010). This is done by defining $\beta = \beta_0 + \Sigma\, \beta_i X_i$ and $r = r_0 + \Sigma\, r_i X_i$ where X_i are demographic variables and β_i and r_i are the associated coefficients. Table 9a shows the results from regressing estimates of the quasi-hyperbolic discounting model, allowing β and r to depend on demographic variables. Column 1 and 2 show that several demographic variables are significantly related to our time preferences parameters. This again contradicts the narrow bracketing assumption.

Table 9b shows the second stage where we estimate a value for β and r for each individual on the basis of the coefficients obtained in table 9a. These values are broadly in line with those obtained in table 3 except that they display a significantly larger degree of precision with much smaller standard deviation. If we use these estimates in our different models presented in table 7 we get similar results: individually, the estimated effects of the discount rate and present-bias measure are never significant in all our models (this table is not shown but available upon request). Thus, whether we estimate our discounting parameters with or without demographic variables we find no significant correlations between hypothetical time discounting rates and actual behaviour in our experiment.

6.2 Enumerator effects

One undesirable effect that we identified in a small number of our questionnaires, during our pilot before we initiated our large scale survey, was that some interviewee interpreted the allocation of the banknote as a test of his/her trustworthiness in the eyes of the enumerator. Answers suggesting such reputation effects were: 'Because I want to show you (the enumerator) my value' with alternative versions such as: 'I want to show you how I am capable of saving, or to show my patience'.

We made every effort to eliminate that perception by emphasising that this note was theirs and that the use they would make of it was not to be judged or commented upon. Answers to the question 2 *('Why do you think you can or cannot (keep the money until the specified date)?')* suggest that we were able to minimize this effect, as only 1.4% (5 out of 359) of our recipients mentioned anything related to this 'reputation effect' as a potential influence on their decision of whether or not to keep the note until the second visit.

Although every effort was taken to minimise these, possible differences in either the methods or style used by the enumerators during the interview, or the characteristics of the enumerators themselves may have marginally impacted on the outcome of our banknote experiment. We test whether the characteristics of the enumerator influenced the responses of the individuals, by re-estimating the regressions in table 7 with the inclusion of enumerator fixed-effects. The results were qualitatively similar to those presented earlier and, following a test of the joint significance of the nine enumerator dummy variables, we were unable to reject the null-hypothesis, that the specific characteristics of the enumerators did not unduly influence responses. This would suggest that these potential effects are not present in the data.

6.3 Fungibility

It is possible to speculate that a household who had access to liquidity through their own savings could more easily keep the 1000 CFA note. If this was the case, we would expect systematic differences in behaviour among the 'cash-constrained' and the relatively 'cash-abundant' participants within the sample. Comparing the results of the experiment between income quartiles, we found a non-significant difference of 0.7% in the probability of keeping the note between the lowest and highest quartiles of the sample. The small magnitude of this difference and the fact that the coefficient of income in model 5 in table 7 is not significant suggest that the extent to which liquidity exerted influence on the households' behaviour was negligible (Although, it is plausible that this type of behaviour may have been more prevalent, had the experiment been conducted with larger sums of money). Furthermore, the results (not shown) we get when we add the interaction terms of income and our treatment variable do not tell a story consistent with this hypothesis.

Question 4 *('Do you plan, yes or no, to do something in order to make sure that you will not spend the note?')* and Question 5 *('If yes what?')* allowed us to check if respondents intended to use any form of saving device in order to ensure they did not spend the money. It was also designed to evaluate any potential bias in behaviour due to the inherent fungibility of the reward. We wanted to uncover the likelihood that participants in the experiment would consider drawing money from an existing pool of cash or borrow, in order to increase their expenditure now, while still managing to retain the specific banknote provided. This form of expenditure-source switching would lead to misleading results. Our descriptive statistics show that only 1.5% (3 out of 205) of our respondents considered such tactics in order to help them to keep the note. Answers indicative of this were along this line: 'I will borrow around me (from friends or acquaintances), if I need, instead of using the note.' With such a small figure we argue that this reasoning may have influenced some households' decision but this effect is likely to be marginal at the sample level.

No individual mentioned the use of savings in ROSCAs, MFIs or bank accounts in answering question 4. This is not surprising for ROSCAs given that they are notoriously non-flexible and are used to render savings illiquid. Moreover, we argue that it is unlikely that an agent would visit either her bank or MFIs offices in order to withdraw a relatively small amount specifically for that purpose. The fixed costs of such transaction are likely to represent a significant share of the 1000 CFA note received. We interpret the positive and significant coefficient of having and MFI account (those of ROSCA and bank account are not significant) rather as a sign that such members have an improved self-discipline and financial awareness which help them achieve saving goals.

Finally, it could be argued that both our hypothetical and real tasks may be capturing different things, and thus it is not obvious that they will be correlated. Despite our attempt at minimizing the effects of enumerators, trust, fungibility and temptation (ability to commit) other aspects that we do not control for may have accounted marginally for this lack of correlation between hypothetical and incentivized preferences.

7. Conclusion

The ability to predict real-world behaviour from self-reported responses is questioned by those conducting research in less-developed countries. Our findings indicate a disparity between implied discount rates over hypothetical rewards and observed economic behaviour. Individuals within the banknote experiment displayed a far greater degree of patience than could be expected, based on estimated measures of discount rates, present bias and risk aversion elicited using standard experimental procedures. It could be said that these result present a case of hypothetical-bias in the self-reported responses to the MPL questions (see Cummings and Taylor, 1999).

The possibility of inconsistent results drawn from data obtained using different hypothetical approaches should be of concern when seeking to use research as a means of influencing policy. In this respect, data obtained from direct observation, such as that presented in this paper, should be viewed as an empirical benchmark, against which more experimental procedures can be measured. It is possible that the inconsistency we observe between the real and hypothetical measures of time preferences are due to the context of this study. More similar investigations, in different contexts, are required in order to give a better and more thorough assessment of MPL derived time preferences.

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Table 1: Means of Main Variables used and F test for Equality of Means

	All		2 Day Treatment		7 Day Treatment		14 Day Treatment		F-test	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd	p-values	signif
Household size	6.067	2.686	6.134	2.531	5.908	2.387	6.158	3.101	0.704	
Household income (100'000CFA)	2.107	1.550	2.124	1.648	2.032	1.446	2.164	1.559	0.782	
Durables (# of items)[1]	7.933	4.656	7.546	4.424	7.533	4.231	8.717	5.194	0.103	
Gender (Male =1)	0.370	0.484	0.370	0.485	0.400	0.492	0.342	0.476	0.647	
Age	44.883	13.637	44.664	12.011	45.583	14.214	44.400	14.614	0.794	
Respondent is head of household	0.474	0.500	0.504	0.502	0.508	0.502	0.408	0.494	0.212	
Bank account	0.301	0.459	0.244	0.431	0.283	0.453	0.375	0.486	0.083	*
Education (# of completed grades)	8.131	6.282	8.269	5.956	8.283	6.124	7.842	6.776	0.838	
Savings account in MFI	0.195	0.397	0.134	0.343	0.250	0.435	0.200	0.402	0.067	*
Temptation[2]	0.262	0.440	0.210	0.409	0.208	0.408	0.367	0.484	0.010	**
Keeping note[3]	0.783	0.413	0.874	0.333	0.800	0.402	0.675	0.470	0.001	***
Think will keep the note[4]	0.868	0.339	0.971	0.168	0.858	0.350	0.788	0.410	0.000	***
Member of Rosca	0.393	0.489	0.294	0.458	0.392	0.490	0.492	0.502	0.007	***
Home owner	0.755	0.431	0.756	0.431	0.733	0.444	0.775	0.419	0.756	
Less than 2 years in Thiès	0.156	0.363	0.193	0.397	0.158	0.367	0.117	0.322	0.253	
Ethnic Group: Wolof	0.557	0.497	0.555	0.499	0.533	0.501	0.583	0.495	0.737	
Ethnic Group: Serer	0.106	0.308	0.118	0.324	0.092	0.290	0.108	0.312	0.799	
Ethnic Group: Poular	0.189	0.392	0.185	0.39	0.208	0.408	0.175	0.382	0.801	
Lives in couple	0.866	0.341	0.849	0.36	0.892	0.312	0.858	0.350	0.571	
# of Children under 5	0.972	1.170	0.992	1.108	0.917	1.074	1.008	1.319	0.803	
N	359		119		120		120			

*** p<0.01, ** p<0.05, * p<0.1

[1] This variable is the sum of a list of items owned by the household comprising among others home appliances and furnitures, mobile phone and means of transportation. The full list is: fridge, color tv set, car, freezer, DVD player, sewing machine, gas cooker, stereo, bed (wood or metal), stove (camping stove), couch, clock, electric cooker, bicycle, gas lamp, oven, motorbike, petrol lamp, camera, charrette, electric fan.

[2] Temptation is a dummy variable which takes value one if the respondent answered yes to *Question 3* (0 otherwise): 'Do you think, yes or no, that you will have difficulties coping with the temptations to spend the banknote?'. We expect this variable to be impacted by the number of days of the treatment (either 2, 7 or 14) and as such the difference across groups is expected.

[3] This variable takes value 1 if the respondent did keep the actual note (0 otherwise). We expect this variable to be impacted by the number of days of the treatment (either 2, 7 or 14) and as such the difference across groups is expected.

[4] Think will keep the note is a dummy variable which takes value one if the respondent answered yes to *Question 1* (0 otherwise): 'Do you think you can keep the note until the specified date?'. We expect this variable to be impacted by the number of days of the treatment (either 2, 7 or 14) and as such the difference across groups is expected.

Table 2: Proportion of Respondents Who Opted for the Future Reward at the Indicated Amount with an Initial Option of 1000 CFA (US$2)

Amount	2 days (%)	7 days (%)	14 days (%)	1 month (%)	6 months (%)
'No switch'	18	33	63	84	96
1000	0	0	0	0	0
1050	0	0	0	0	0
1100	1	1	0	0	0
1250	6	1	0	0	0
1500	31	5	2	1	1
1750	8	5	1	0	0
2000	22	19	8	2	1
2500	7	16	10	2	0
3000	6	19	15	10	2
Total	100	100	100	100	100

Table 3: Means of the Estimated Discount Factor Parameters

	Sample size	Mean	Standard deviation	Min	Max
Discount rate (*r* in %)	327	5.20	2.60	-0.34	17.62
Beta (β)	327	0.75	0.14	-0.14	1.09
Measure of present-bias (1-β)	327	0.25	0.14	-0.09	1.14
Noise parameter (μ)	327	-33.80	30.27	-98.99	-0.97

The parameter t in model (2) is in number of days so our rates are daily discount rates.

Table 4: Consistency of the MPL Preference Questions and Behaviour

	All		2 day		7 day		14 day	
	# Ind	%	# Ind	%	# Ind	%	# Ind	%
MPL predicted banknote experiment	179	50	82	68.9	51	42.5	46	38.3
Note saved (predicted)	122	34	76	63.9	36	30	10	8.3
Note spent (predicted)	57	15.9	6	5	15	12.5	36	30
MPL did not predict banknote experiment	180	50	37	30.1	69	57.5	74	61.7
Note saved (not predicted)	159	44	28	23.5	60	50	71	59.2
Note spent (not predicted)	21	5.8	9	7.6	9	7.5	3	2.5
Total	359	100	119	100	120	100	120	100

Table 5: Estimated Discount Factor Parameters for the Banknote Experiment.

Dependant Variable:	Note Kept	Y Preferred
	(1)	(2)
	Banknote Experiment	MPL questions Similar time frame as of banknote X=1000CFA & Y=2000CFA
Noise parameter (μ)	-2.421	-7.418
	(22.04)	(10.49)
Discount rate (r)	0.027	0.037
	(0.162)	(0.058)
Beta (β)	0.95	0.61
	(4.182)	(0.170)
Observations	359	359
Adjusted R-Squared	0.79	0.55

Table 6: Distribution of the Estimated Risk Aversion Parameter (R)

Value for R	Frequency	Percentage
0.22	25	7
0.30	23	6
0.44	99	28
0.56	99	28
0.67	55	15
0.77	13	4
0.82	45	13
Total	359	100

Table 7: Estimated effects of discounting and Risk Parameters (Probit regression) on keeping the banknote or not.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	The dependent variable is Banknote kept =1 (=0 otherwise)				
7 day treatment	-0.2364	-0.2414	-0.2406		-0.3535
	(0.1978)	(0.2017)	(0.2034)		(0.3501)
14 day treatment	-0.5987***	-0.5988***	-0.5968***		-0.8161**
	(0.2012)	(0.2030)	(0.2073)		(0.3754)
Discount rate (r)		-0.4036	-0.4523	-1.6108	-6.1455
		(3.8604)	(3.8769)	(3.7828)	(7.1298)
Present bias (1-β)		0.1359	0.1267	-0.0472	0.2546
		(0.6893)	(0.6945)	(0.6906)	(1.3067)
Risk aversion (R)			-0.0385	-0.2414	-0.6909
			(0.5151)	(0.5079)	(0.9375)
Gender (Male=1)					-0.1165
					(0.6877)
Age					0.0189
					(0.0148)
Respondent is household head					0.1194
					(0.7270)
Household size					-0.0323
					(0.0688)
Income (in 100'000CFA)					-0.0294
					(0.1329)
Durables (# of items)					0.0497
					(0.0397)
Bank account					0.0644
					(0.3901)
Education (# of completed grades)					-0.0082
					(0.0264)
Savings account in MFI'					0.5195
					(0.4782)
Member of ROSCA					0.1748
					(0.3416)
Home owner					0.2737
					(0.4031)
Less than 2 years in Thies					-0.1413
					(0.4344)
In couple					-0.0248
					(0.6720)
# of Children under 5					0.1775
					(0.1786)
Constant	1.1449***	1.1337***	1.1584**	1.0728**	0.0048
	(0.1539)	(0.3707)	(0.4811)	(0.4553)	(1.5890)
Ethnic Group Fixed Effects	No	No	No	No	Yes

Neighbourhood Fixed Effects	No	No	No	No	Yes
Observations	327	327	327	327	327
Bootstrapped Replications	200	200	200	200	200

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

-Bootstrapped standard errors in parentheses. Given that β and r are generated regressors, we use bootstrapping to estimate their standards errors (see Mooney and Duval, 1993). The estimations are carried out according to the following procedure: for each individual all 90 observations from our MPL are used to calculate β and r. We then run a probit on the 327 observations we have at the individual level. We then replicate our results 200 times.

-Concerning the variables 'Savings account in MFI' and 'Member of a Rosca': membership in these saving devices was measured in our baseline survey prior to our treatments. We also know that no individual in our sample either joined an MFI or a Rosca during the 2, 7 or 14 day period of our treatment.

Table 8: Correlates of discounting parameters

	r		β	
VARIABLES	(1)	(3)	(4)	(6)
Gender (Male=1)	0.0077	0.0082	-0.0076	-0.0071
	(0.0068)	(0.0068)	(0.0368)	(0.0368)
Age	-0.0002	-0.0001	-0.0007	-0.0008
	(0.0001)	(0.0001)	(0.0006)	(0.0007)
Respondent is household head	-0.0051	-0.0057	0.0216	0.0212
	(0.0070)	(0.0071)	(0.0378)	(0.0380)
In couple	-0.0124*	-0.0128*	-0.0031	-0.0018
	(0.0067)	(0.0067)	(0.0363)	(0.0363)
Education(# of completed grades)	-0.0003	-0.0003	0.0011	0.0009
	(0.0003)	(0.0003)	(0.0014)	(0.0014)
Bank account	0.0102***	0.0103***	-0.0075	-0.0114
	(0.0035)	(0.0038)	(0.0191)	(0.0203)
MFI Account	0.0053	0.0054	-0.0069	-0.0058
	(0.0037)	(0.0037)	(0.0199)	(0.0199)
Member of ROSCA	0.0024	0.0026	0.0388**	0.0355**
	(0.0030)	(0.0030)	(0.0163)	(0.0164)
Episode of sickness last year		0.0024		0.0419**
		(0.0035)		(0.0187)
Income (in 10000CFA)		0.0012		0.0017
		(0.0011)		(0.0058)
Durables (sum of items)		-0.0004		0.0008
		(0.0004)		(0.0019)
Constant	0.0669***	0.0647***	0.7564***	0.7228***
	(0.0087)	(0.0093)	(0.0472)	(0.0499)
Observations (households)	327	327	327	327
R-squared	0.056	0.063	0.024	0.040

OLS estimations; Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 9a: First stage of fitted Discount Parameters

	r	β
VARIABLES	(1)	(2)
μ	-5.5683***	-5.5683***
	(0.1086)	(0.1086)
Gender (Male=1)	0.0158***	-0.0765***
	(0.0010)	(0.0061)
Age	0.0000	-0.0001
	(0.0000)	(0.0001)
Respondent is household head	-0.0158***	0.0687***
	(0.0010)	(0.0065)
In couple	-0.0288***	0.0588***
	(0.0011)	(0.0061)
Education (# of completed grades)	-0.0002***	-0.0007**
	(0.0000)	(0.0003)
Bank account	0.0146***	0.0135***
	(0.0007)	(0.0043)
MFI Account	0.0012*	0.0044
	(0.0006)	(0.0045)
Member of ROSCA	0.0003	0.0061*
	(0.0005)	(0.0036)
Episode of sickness last year	0.0115***	0.1174***
	(0.0006)	(0.0038)
Income (in 100'000CFA)	0.0004**	0.0022*
	(0.0002)	(0.0013)
Assets (sum of items)	-0.0001*	-0.0002
	(0.0001)	(0.0004)
Constant (r0 β0)	0.0613***	0.5713***
	(0.0017)	(0.0093)
Observations	32310	32310
Households	359	359
R-squared	0.479	0.479

Standard errors in parentheses;
*** p<0.01, ** p<0.05, * p<0.1

Table 9b: Means of the Fitted Discount Parameters from a Pooled Estimation

	observations	Mean	Standard deviation	Min	Max
Fitted discount rate (*r* in %)	359	4.75	0.97	2.77	8.71
Fitted Beta (β)	359	0.72	0.05	0.54	0.82
Fitted measure of present-bias (1-β)	359	0.28	0.05	0.18	0.46

Note on the estimation technique:

1. Each replication contains two parts. We start with the sample of 90 observations per individual and estimate the beta and rate parameter (as a fitted value from everyone's data)
2. After each individual has a specific beta and rate value, the sample is reduced to 1 observation for each individual.
3. Secondly, a probit regression is run of these beta and rate values on note kept.
4. The program then restores the original large sample and returns to point 2 to run the second bootstrap replication, continuing so for 200 times.

Appendix

Appendix A: Survey Methodology

An official map of the city was used to randomly select a number of streets spread across each neighbourhood. Each street was assigned a number of households according to its length and density. For every street we used a pseudo-random process by which every fifth lot according to a specific direction was picked. Since many households live on the same lot in semi-detached rooms, enumerators randomly selected one room by lot, according to a clock-wise selection which varied from lot to lot. In the case where a lot was found empty or the head of household was not present, enumerators were instructed to set appointments and revisit the household later. Given the small number of households sampled from such a relatively large area, we argue that spill-overs within the sample are unlikely.

Ten local, independent and qualified enumerators were employed, having previous experience with surveys and field-work. The selected enumerators undertook a two-day training session given by the authors, including special sessions dedicated to translation in to the local language (Wolof) and practical tests to confirm their suitability. In addition, enumerator visits were also assessed ex-post by an experienced local supervisor.

Table A1: Eliciting the Discount Rate

Panel A: Amount proposed for today 10000CFA

1	A	B	A or B?	2	A	B	A or B?
	Today	In 2 days			Today	In 7 days	
1	10000	10000		1	10000	10000	
2	10000	10500		2	10000	10500	
3	10000	11000		3	10000	11000	
4	10000	12500		4	10000	12500	
5	10000	15000		5	10000	15000	
6	10000	17500		6	10000	17500	
7	10000	20000		7	10000	20000	
8	10000	25000		8	10000	25000	
9	10000	30000		9	10000	30000	

Three additional set of choices were offered where the values in A and B were identical but the time delay was 14 days, 1 months and 6 months.

Panel B: Amount proposed for today 1000 CFA

1	A	B	A or B?	2	A	B	A or B?
	Today	In 2 days			Today	In 7 days	
1	1000	1000		1	1000	1000	
2	1000	1050		2	1000	1050	
3	1000	1100		3	1000	1100	
4	1000	1250		4	1000	1250	
5	1000	1500		5	1000	1500	
6	1000	1750		6	1000	1750	
7	1000	2000		7	1000	2000	
8	1000	2500		8	1000	2500	
9	1000	3000		9	1000	3000	

Three additional set of choices were offered where the values in A and B were identical but the time delay was 14 days, 1 months and 6 months.

Table A2: Eliciting Risk Preferences

	# Marbles type1	# Marbles type2	Lottery A		Lottery B		Preference	
			Successful payoff	Unsuccessful payoff	Successful payoff	Unsuccessful payoff		
Panel A: gains								
1-1	8	2	600	0	200	100	A	B
1-2	7	3	600	0	200	100	A	B
1-3	6	4	600	0	200	100	A	B
1-4	5	5	600	0	200	100	A	B
1-5	4	6	600	0	200	100	A	B
1-6	3	7	600	0	200	100	A	B

Table A3: Estimated Discount Parameters for the Pooled Sample

	Exponential	Hyperbolic	Q-Hyperbolic	Full Model
Noise parameter (μ)	-3.703	-5.278	-5.038	-5.178
	(0.0681)	(0.108)	(0.106)	(0.103)
Discount rate (r)	0.0987	0.139	0.098	0.0386
	(0.0004)	(0.0003)	(0.0007)	(0.0017)
Beta (β)			0.818	0.759
			(0.0024)	(0.006)
Theta (θ)				0.861
				(0.105)
Observations	32310	32310	32310	32310
Adjusted R-Squared	0.404	0.4503	0.4262	0.4322

Robust standard-errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table A3 shows the estimated parameters for the pooled sample of individuals. The pooled data contains 32310 observations (90 questions times 359 individuals). It is worth noting that the estimated parameters of the discount factor are broadly comparable to those in Tanaka et al. (2010). The full model, with non-restricted values for Theta (θ), seems to perform only marginally better than the quasi-hyperbolic one. However, as previously noted, the full model proved problematic when applied to individual data (for samples of 90 observations per individual). The adjusted R^2 for the models with pooled estimations suggest, surprisingly, that a greater proportion of the data is explained by the hyperbolic model.

However, if we use the adjusted R^2 at the individual level as a criterion for selection amongst our four models, we find that the largest share of those surveyed had preferences best modelled using the quasi-hyperbolic specification. This result is obtained by first estimating the four possible models (exponential, hyperbolic, quasi-hyperbolic and full nested specifications). The first two columns of table A4 below shows the subsample of individuals for which a given model could be estimated. It is worth noting that exponential and hyperbolic models required fitting two parameters, the quasi-hyperbolic three, and the full specification four, so the quasi-hyperbolic and full-specification will almost certainly have higher rates of non-convergence. For each individual, the adjusted R^2 for any of the given model which both converged and returned an adjusted $R^2>0$ is kept. Then, for each individual we identify the model with the highest adjusted R^2 which becomes the ‘preferred model’ (see columns 3 and 4).

Table A4: Models estimated and preferred model

	Model is estimated		Preferred model	
	# Individuals	%	# Individuals	%
Exponential model	320	89.14	42	11.7
Pure Hyperbolic model	327	91.09	44	12.26
Quasi-Hyperbolic model	327	91.09	156	43.45
Full Nested model (2)	265	73.82	92	25.63
No model	25	6.96	25	6.96
Total	359	100	359	100

Note: The preferred model is based on individual adjusted R-squared; '%' refer to the proportions of # individuals out of the total sample of 359.

Furthermore, because our analysis aims at getting a value for the present bias (1-β) that will be used in predicting the behaviour in our banknote experiment and also for the sake of comparison with previous papers (e.g. Tanaka, 2010) we use the quasi-hyperbolic model.

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