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PROCRASTINATION AND IMPATIENCE

Ernesto Reuben
Paola Sapienza
Luigi Zingales

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ABSTRACT

There is a large body of literature documenting both a preference for immediacy and a tendency to procrastinate. O'Donoghue and Rabin (1999a,b, 2001) and Choi et al. (2005) model these behaviors as the two faces of the same phenomenon. In this paper, we use a combination of lab, field, and survey evidence to study whether these two types of behavior are indeed linked. To measure immediacy we had subjects choose between a series of smaller-sooner and larger-later rewards. Both rewards were paid with a check in order to control for transaction costs. To measure procrastination we use the subjects' actual behavior in cashing the check and completing tasks on time. Our results lend support to the hypothesis that subjects who have a preference for immediacy are indeed more likely to procrastinate.

Ernesto Reuben
Finance Department
Kellogg School of Management
Northwestern University
2001 Sheridan Road Evanston, IL 60208
ereuben@northwestern.edu

Paola Sapienza
Finance Department
Kellogg School of Management
Northwestern University
2001 Sheridan Road
Evanston, IL 60208-2001
and NBER
paola-sapienza@northwestern.edu

Luigi Zingales
5807 South Woodlawn Avenue
Chicago, IL 60637
and NBER
luigi.zingales@gsb.uchicago.edu

There is a large body of experimental literature documenting the tendency for people to exhibit very strong preferences for immediacy (e.g. Thaler, 1981; Benzion et al., 1989; Kirby, 1997; Coller and Williams, 1999; Shui and Ausubel, 2005; Ashraf et al., 2006).[1] At the same time, there is a small, but growing, body of literature showing that people tend to procrastinate (Ariely and Wertenbroch, 2002; DellaVigna and Malmendier, 2006; Choi et al., 2006). O'Donoghue and Rabin (1999a,b, 2001) and Choi et al. (2005) model these behaviors as two faces of the same phenomenon. Highly impatient individuals overweight immediate costs vis-á-vis delayed benefits, procrastinating in activities where costs are upfront, while overindulging in activities where costs are delayed with respect to benefits.

While the link between these two phenomena is really at the heart of this literature, we are not aware of any paper testing the connection. In this paper, we design an experiment to achieve this goal. We ask a large sample of MBAs students who have completed a series of games and won an amount between \$0 and \$300 whether they want to receive this amount now or in two weeks. Instead of paying them in cash, as is common in the literature, we choose to pay them with a check. This enables us not only to keep constant the delivery method, but also to follow the timing of their decision to cash the check and measure their degree of procrastination with the actual behavior in cashing the check.

Payment with the check makes the decision of when to optimally accept the prize less straightforward. In the acceptance decision, a rational individual will take into consideration his/her procrastination in cashing the check. To analyze this problem formally, we apply the Choi et al. (2005) model of 401K enrollment to our context and derive the optimal acceptance decision as a function of the amount of the prize and individual characteristics. In the model, we show that if agents are impatient, as in Laibson (1994) and O'Donoghue and Rabin (1999a), these individuals will also tend to delay the cashing of the check (they tend to procrastinate), even after controlling for the amount of the prize. As in O'Donoghue and Rabin (1999a,b, 2001), the intuition is as follows. Agents with a strong present bias are more likely to postpone the unpleasant task of cashing the check. At the same time, when faced with the decision when to receive the check, they will value more the psychological benefit of receiving it immediately.

We test the predictions of this model with our data. The correlation between impatience and procrastination is positive but not significant. One possible reason for this lack of significance is that procrastination and impatience are indeed not linked. Alternatively, heterogeneity in other

[1] See Frederick et al. (2002) for a recent review.

individual characteristics may cloud the relation of interest. In particular, the model suggests that heterogeneity in the risk of losing the check or in the cost of going to the next ATM to cash it can induce a negative correlation between impatience and our measure of procrastination, which could affect the experimental results.

To address this problem, we use two other measures of procrastination that are not affected by these biases. In the course of the project, we asked the subjects to complete two surveys. One was mandatory as part of a class, the other was optional. Both needed to be completed by a certain deadline in order for them to receive feedback. Hence, as alternative measures of procrastination, we can use the closeness to the deadline each survey is filled.

When we use these measures, we find a positive correlation between impatience and procrastination, regardless of the survey we use. Moreover, since procrastination is measured with noise, as individuals may be busier in some periods or may lose the check, in our last specification, we instrument the procrastination measure of cashing the check with the behavior in filling the surveys. Consistent with O'Donoghue and Rabin (1999a) and Choi et al. (2005), the instrumental variable regression shows a positive and significant relation between procrastination and impatience.

As a final test of the O'Donoghue and Rabin (2001) and Choi et al. (2005) approach, we test whether "naïve" procrastinators behave differently as theory suggests. Not anticipating their future procrastination, naïve subjects should overestimate the future value of the check, increasing the likelihood they would choose to receive it at a later day.

To test this prediction we develop a proxy of naïvité by comparing the subjects' answers to the question "Are you a procrastinator?" to their actual behavior in cashing the check and answering the surveys. The results support O'Donoghue and Rabin (1999a,b, 2001): naïve procrastinators have lower subjective discount rates than sophisticated ones.

The rest of the paper proceeds as follows. Section I describes the experiment and the data used. Section II models the decision to accept the money today or tomorrow in the presence of costs of cashing the check. Section III tests the predictions of the model by using our experimental data. Section IV concludes.

I Experimental Design

In this paper we utilize data from the Templeton Chicago MBA longitudinal study (TCMLS). As part of a long term research project on individual characteristics and economic success, the TCMLS collects data from the entire cohort of 2008 MBA students at the Graduate School of Business of Chicago University (see Reuben et al., 2007).

As part of a required class, all the students were asked to fill a survey and play some games. After that, an additional voluntary survey was administered. While participation to the first two events was mandatory, the Institutional Review Board at the University of Chicago required that subjects be offered the opportunity to opt out from the study by not consenting to the use of their data for research purposes. Out of 550 MBA students, 548 filled the survey and 544 played the games. 502 (92.28%) consented to the use of both their survey and game data. In this paper we use data from these two sources plus admission data obtained from the GSB (also with the students' consent). Each of these data sources as well as the subject pool is briefly described below.

A Surveys and data from the university

In addition to the experiment data, we use data from two surveys and from the admission office of the University. Subjects completed two online surveys. The first was a compulsory survey assigned two weeks before the experiment and due at the time of the experiment. Filling it on time was one of the requirements for passing the course. The second survey was given to them a few weeks after the experiment. This survey was voluntary but, as an incentive, subjects who completed the survey on time received personalized feedback designed to improve their future job performance.

The surveys are designed to acquire demographic data and measure various personality traits (all the questions used are available in Reuben et al., 2007). In this paper we concentrate only on two variables: trust and cognitive ability. We want to control for trust because it is possible that individuals with very low trust do not trust the experimenters. In that is the case, they will be less willing to wait two weeks for payment and more prompt to cash the check. Trust was measured using the standard question from the World Values Survey.[2] Table 1 shows sample statistics for this variable: 54% of the students responded that most people can be trusted.

[2] The answer "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". The other answers are "Can't be too careful" and "Don't know".

In our analysis, we also control for cognitive reflection as it has been shown to be related to discount rates (Frederik, 2005; Benjamin et al., 2006). Following Frederik (2005), we measure cognitive abilities using the Cognitive Reflection Test (CRT). Specifically, we ask four mathematical reasoning problems and use as a score the number of correct answers.[3] Sample statistics for the CRT scores in our sample are in Table 1: The average student answered 2.5 out of 4 questions correctly.

We also kept track of how many days it took students to complete the two surveys. On average, students took 9 days to complete the first (mandatory) survey and 33 to complete the second (voluntary) one.

Finally, we also use information provided by the University. It includes additional demographic characteristics such number of clubs the student is member of, marital status at enrollment, etc.

B Experiment

The main data come from a laboratory experiment, which consisted of two lotteries, four games and an auction played in the following order: lottery with losses, asset market game, trust game, competition game, chocolate auction, social dilemma game, and lottery without losses. The games were programmed in z-Tree (Fischbacher, 2007) and played in four batches in four large classrooms.

In order to give students an incentive to take their decisions seriously, we paid them according to their performance. We randomly drew one of the four games and two lotteries and paid them according to their performance in that game.

At the end of the session, a message on the screen announced to the subjects their final payoffs and offered them to make a final choice between receiving their payment the day of the experiment or receiving a larger amount two weeks later. In total, 544 MBA students participated in the experiment and earned on average $78.32 in addition to a $20 show-up fee.

In this paper we concentrate on two tasks designed to measure impatience: the subject's last

[3] The questions are "1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?"; "2. If you flipped a fair coin 3 times, what is the probability that it would land "heads" at least once?"; "3. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?"; "4. Two cars are on a collision course, traveling towards each other in the same lane. Car A is traveling 70 miles an hour. Car B is traveling 80 miles an hour. How far apart are the cars one minute before they collide?"

choice and the chocolate auction. Both tasks are explained in detail below. A short summary of the procedures and the instructions of these tasks are available in Appendix A. For a description of the other games see Reuben et al. (2007).

B.1 Impatience over money

In order to measure impatience we elicit the subjects' short-run discount rate. This was done by giving subjects a series of simple choices of the following type: receive x dollars today or receive $(1 + r)x$ dollars in two weeks, where x equals their earnings in the experiment. Only the 495 subjects who earned a positive amount made this decision. Of this 495, only 460 consented to the use of their data. Hence, the maximum number of observation in our sample is 460. When additional constraints further limit the size of our sample we will explain them.

Each subject answered thirteen questions where r varied from 0 to 0.12 in steps of 0.01. Thereafter, one of the questions was randomly selected to be paid.

If, for a given r and x, a subject prefers x dollars today, we can infer that she is willing to sacrifice $r\%$ of earnings in order to receive the payment today instead than in two weeks. Thus, by varying r and observing the point where subjects switch from payment today to payment in two weeks we get a precise measure of each subject's discount rate. We chose this procedure as it is not only incentive compatible, but also simple to understand.

Figure IA plots the discount rate (over two weeks) at which students switched towards the late delivery. Roughly one third of the students switch at 1%, which is the level a rational exponential discounter is expected to choose. Two thirds, however, exhibit a very large discount rate with roughly 10% of the students not switching even at the 12% rate, which in annual terms corresponds to a discount rate of 3,686%. Table 1 reports the summary statistics for this variable, where we impose a discount rate equal to 13% to all the students who do not switch even for $r = 12\%$.

Since students confronted this choice with a different amount of money at stake, to isolate the difference in their impatience we need to partial out the effect of the initial amount of cash. Indeed, when we run a regression (not reported) of the discount rate on the level of money at stake, the switching point choice is heavily influenced by the amount of money at stake: the larger the amount, the lower the discount rate. Figure IB and Figure IC show that this relationship is non-linear: the best fit is obtained using the logarithm of the level of money at stake rather than the level. Hence, in the remaining part of the paper whenever we will use the switching point as a measure of impatience, we will control for the logarithm of the amount of money at stake.

Interestingly, the percentage of people switching at a 1% rate (i.e., supposedly rational exponential discounters) does not change with the amount of money at stake. This amount only impacts the switching point of the subjects with high discount rates.

B.2 Time to cash a check

In order to keep the transaction costs constant over both payment options we paid subjects by dropping a check in their mailfolders. Checks were distributed either the same day of the experiment or two weeks later at the same time of day. Note that payment was always done during a day in which subjects had to attend class and thus be present at the university. Mailfolders are easily accessed and are usually checked on a daily basis. Utilizing a check not only homogenizes transaction costs, it also gives us a measure of procrastination. Namely, the number of days a subject takes to cash the check.

The values for this variable are reported in Figure IIA. On average it takes 3.7 weeks for a student to cash the check. The last check was cashed after 205 days. 37 students (7%) did not cash the check. We set the cashing date for these students at 206 days.

As we will discuss in the model, the time to cash a check is not a pure measure of procrastination. First of all, the economic incentive to cash the check in the presence of a cost of going to the bank will be affected by the amount of money at stake. Second, people might differ on how busy they are and how costly it is to go to the bank.

Figure IIB plots the check cashing time on the level of money at stake, while Figure IIC plots the check cashing time on the logarithm of the level of money at stake. Not surprisingly, people with a larger check cash it sooner. As Figure IIC shows, a good fit is obtained using the logarithm of the level of money at stake. This impression is confirmed by a formal regression test (not reported). Hence, in the following whenever we will use the switching point as a measure of impatience we will control for the logarithm of the level of money at stake.

In Table 2 we regress the time to cash the check on the logarithm of the amount of money at stake and a measure of how busy these students are, proxied by the number of clubs in which they are involved (column II). As expected, the busier they are the longer it takes for them to cash the check. In column III we insert their gender and their marital status (interacted with their gender). Consistent with the most trite stereotype, males who are married are less busy and cash their checks sooner, while females who are married are more busy and cash their checks later (albeit this latter effect is not statistically significant). Another reason that might induce students to cash early is the fear that the amount of money will not be paid. To this purpose we use their level of trust, which we measured in the survey asking them the typical World Value Survey question. People who trust more cash their checks later, but this effect is not statistically significant.

After partialling out the level of busyness, the time it takes to cash a check can be interpreted as a measure of procrastination. To check whether this is the case in column IV and V we insert two different measures of procrastination: the time it took a student to fill in the first survey and the time it took to fill in the second one. Notice that these surveys are administered at different times, so idiosyncratic commitments should cancel out. As the last two columns suggest, the level of procrastination seems to be correlated across activities. We will return to this issue later.

B.3 Impatience over goods

There is a debate in the literature on how best to measure present-biased preferences. Of the 23 papers we were able to locate that attempt to measure this bias from subjects' real (not hypothetical) choices, 14 use money. Measuring present-bias with money, however, has a major drawback. As long as subjects have access to the credit market (and we know that 90% of our students do because we asked them whether their credit card was maxed out), they are strictly better off leaving their award money with us and borrowing on their credit card to finance any consumption needs for an amount equal to the prize money. That two thirds of Chicago MBA students (who are pretty good at spotting arbitrage opportunities) exhibit a strong preference to receive the money now suggests other forces are at play.

One possibility is that the impatience measured with money is pure noise. Another hypothesis is these choices reflect the level of impatience individuals have in receiving a reward. McClure et al. (2004), for instance, find that subjects' brain exhibit the typical reaction of satisfaction when a subject receives an Amazon gift certificate, which he cannot immediately turn into consumption. They interpret this finding as evidence that the brain of impatient people responds to receiving the reward, independent of the consumption associated with it. If this is the case, monetary rewards are as good as rewards in kind.

An alternative approach to measure impatience is to use a consumption good. In doing so, however, there are two problems. The first is that we cannot use the same strategy used with money because the marginal utility of consumption of a specific good might drop fast. For this reason, instead of asking whether you prefer one piece of chocolate today to 1.1 pieces of chocolate in two weeks, we chose to auction a large Toblerone chocolate bar (market value of approximately \$3.00) with different delivery dates.[4]

In Table 1, we report the students' bids for chocolate delivered at different dates. On average, the price offered for a Toblerone with immediate delivery is \$1.83 (well below the market price). The average price offered for a Toblerone in a week is \$1.29 and for a Toblerone in two weeks is \$1.10.

The second problem in measuring impatience with a good is that, while at the aggregate level the data show a very nice behavior, when we come to individual data this is no longer the case. Consider the model of present-biased preferences by Phelps and Pollak (1968) and Laibson (1994), the proper measure of impatience (defined as β) is given by

$$\beta = \frac{P_1/P_0}{P_2/P_1}. \tag{1}$$

Figure III plots the β of chocolate, while Table 1 reports the summary statistics for this variable. Computed with the aggregate data, β equals 0.83, while computed with the individual data, β equals 1.11, i.e., there is no decreasing discount rates on average. In fact, 95 students (almost a third of the sample) exhibit a positive β, which is the opposite of bias toward the present. We attribute this problem to two reasons.

First, there are 148 zero bids, which make it impossible for us to compute β, forcing us to

[4] Subjects were randomly divided into groups of eight and one bar was auctioned within each group. Although only one chocolate per group was auctioned, subjects participated in three second-price seal-bid auctions. The first auction was for a chocolate bar delivered the day of the experiment, the second auction was for a chocolate bar delivered one week later, and the third auction was for a chocolate bar delivered two weeks later. After the third auction, one of the auctions (and thus a delivery time) was chosen at random. Subjects submitted a bid, in dollars, for each of the three auctions. Bids were made sequentially but with no feedback in-between bids. The chocolate was given to the highest bidder of the randomly-chosen auction. The chocolate delivery was organized in the following way: chocolates delivered the day of the experiment were delivered when the experiment finished. Chocolates delivered in later weeks were distributed at the end of a class that coincided with the weekday and time of the experiment. Since the class is mandatory, any costs associated with the consumption of the chocolate at the different delivery times are bound to be very similar. Furthermore, chocolates were distributed at similar situations. Both the experiment and the classes were in the afternoon, last the same amount of time, and require intellectual effort. Thus, for most subjects, the consumption of the chocolate ought to provide a similar utility at all delivery times.

lose almost a third of the sample. Most of these are from people who do not like the chocolate at all or do not like it now (maybe because they are full).

Second, when we measure impatience with a consumption good not equally desired throughout the day, there is an option value implicit in future deliveries. If I am not hungry, I do not value the chocolate now very much, but I might value receiving it in the future, when there is at least a possibility that I will be hungry.

As a result, the data obtained in this way are much more noisy and this noise is likely to be correlated with the taste for chocolate. If we test this we indeed find that the magnitude of the β is negatively and statistically significantly correlated with the desire for chocolate measured by a subject's bid for chocolate at time zero.

In Table 3 we test the correlation between our two measures of impatience, after we control for the amount of money at stake, which has an effect on the monetary measure of impatience. As expected, the impatience rate measured with money is negatively correlated with the β computed from the chocolate bids (more impatient subjects will have a lower βs and higher discount rates). The coefficient, however, is not statistically significant. To see how much this is due to the noise introduced in the chocolate choice by the low bids for chocolate, in column II we include only those observations where the initial bid for chocolate was at least \$1. Consistent with the noise explanation, the coefficient doubles and it is now statistically significant.

These results suggest that these two measures are indeed correlated, but this correlation is garbled by the different (temporary and not temporary) desire for the good. Given this problem and the fact that we lose almost a third of the sample by using the chocolate based measure, in the rest of the paper we will use the monetary measure.

II Model

O'Donoghue and Rabin (1999a) show how present-biased preferences lead individuals to procrastinate costly actions. To test this link we need to formally understand how the two concepts are linked in the context of our experiment. To this purpose we adapt Choi et al. (2005) model of 401K enrollment and analyze the subjects' decision to delay their payment taking into account their own check-cashing behavior.

In the model, we consider the check as the 'carrier of reward'. In other words, as in McClure et al. (2004) utility is derived from receiving the check and is independent of when the check is actually cashed. This assumption is consistent with subjects exhibiting a present-bias preference even over money.

A Cashing the check

Solving the model by backward induction, we first analyze the decision to cash the check. As a result of the above assumption, the cashing of the check becomes simply a chore that has to be done at some point (as the 401K enrollment in Choi et al., 2005). We model the decision of when to cash the check as the result of a dynamic optimization problem in which the individual decides whether to incur the cost of cashing the check today or in some future date.

We assume individuals have quasi-hyperbolic preferences so that their discount function is $D(t) = 1$ if $t = 0$ and $D(t) = \beta\delta^t$ if $t \geq 1$. We further assume that $\delta = 1$ for two reasons. First, long run discounting ought to be negligible in the time framework considered here. Second, at the time of the experiment bank interest rates were extremely low (less of 1% annual rate on the checking account), making the cost of the interest forgone trivial.

Given the absence of a significant interest forgone, we model the cost of not cashing the check as the probability $0 < p < 1$ of losing it. Not only this cost is very realistic (7% of the checks were not cashed after 6 months), but it also captures in a continuous fashion the fact that checks lose validity six months after they are issued.

Finally, we assume that cashing the check has a cost c_t drawn at the beginning of each period t from a uniform distribution with support $[0, \bar{c}]$. As a result, when making her decision in period t, an individual knows the value of c_t but not its future realizations. This assumption is meant to capture some variability in the cost of cashing the check. The day a subject has to go to the bank for other reasons or visit the book store (which is opposite a bank), her cost of cashing can be trivial (even zero). When she is studying for an exam or very busy in other social activity, her cost might be very high.

By assuming that c_t is known at time t the model also captures the possibility that an individual wants to receive the check today because she is afraid to forget about it in the future (this would correspond to a very low c_0).

After receiving the check, in each period t a subject has to decide whether to cash the check that period or to delay the decision to the next period. In other words, after receiving the check for an amount $S > 0$, a subject minimizes the following current discounted loss function V:

$$
(2) \qquad V(\beta, p, S, c_t) = \begin{cases} c_t & \text{if check is cashed} \\ \beta[pS + (1-p)L] & \text{if check is not cashed} \end{cases}
$$

where L is the individual's expected future costs if she does not cash the check and p the probability of losing it.

As we show in Appendix B, the solution for this problem takes the form of a cutoff rule. An individual cashes the check in period t if the realized cost in that period is smaller than c^*, otherwise she postpones the decision until the next period.

Lemma 1 *The optimal cutoff rule is given by*

$$
(3) \qquad c^*(\beta, p, S, \bar{c}) = \frac{\sqrt{(p\bar{c})^2 + 2(1-p)p(2-\beta)\beta S\bar{c}} - p\bar{c}}{(1-p)(2-\beta)}
$$

Proof. See Appendix B.

Given $c^* < \bar{c}$ we can calculate the expected number of future periods that an individual takes to cash the check τ, considering that only checks which are not lost are cashed

$$
(4) \qquad \tau = \frac{(1-p)(\bar{c} - c^*)c^*}{(c^* + p(\bar{c} - c^*))^2},
$$

and the expected value to the individual of receiving a check for an amount S (including the expected cost of cashing it), which we denote as $\sigma(S)$[5]

$$
(5) \qquad \sigma(S) = \frac{c^*}{c^* + p(\bar{c} - c^*)}\left(S - \frac{c^*}{2}\right).
$$

The following proposition follows:

Proposition 1 *If the check is not negligibly small, the lower the β (i.e, the more impatient the individual is) and the smaller the size of the check S, the more time an individual takes to cash the check.*

Proof. See Appendix B.

The main intuition is the same as in O'Donoghue and Rabin (1999a) and Choi et al. (2005). When choosing between cashing today and cashing tomorrow, an impatient individual will discount heavily the cost of cashing tomorrow, so she will resort to cashing the check today only for very low realization of c. Hence, on average, an impatient individual will cash the check

[5]For $c^* \geq \bar{c}$, the check is always cashed in the first period, and therefore, $\tau = 0$ and $\sigma(S) = S - \frac{\bar{c}}{2}$

later. In contrast, the higher the amount of the check, the higher is the cost of losing it. This risk will lead a subject to cash the check earlier.

The reason why the result is not true for all values of S, but only for non-trivial values is that for very small values of S very impatient individuals will postpone the cashing for so long that most of them will lose the check. Hence, the expected cashing time conditional on cashing might be smaller than the expected cashing time conditional of cashing for more patient individuals.

In Appendix B we argue that the condition for Proposition 1 is satisfied in our sample, otherwise at least 51% of the people would have lost the check, while the actual amount is at most 7%.

B Getting the check

Having derived the optimal check-cashing behavior, we now analyze how subjects choose the timing of the reward as a function of their present bias. At the end of the experiment, subjects choose to receive either a check for S right away or a check for $S(1+r)$ the following period, where for simplicity we assume each period to last for two weeks. Clearly, the value of receiving the check today versus a period from now depends upon the optimal cashing behavior. We start by analyzing the choice of a sophisticated individual, i.e., an individual who is aware that in the future she will postpone the cashing decision.

B.1 Sophisticated subjects

If an individual takes the check and cashes it in period 0, she receives $S - c_0$. If she takes the check in period 0 but does not cash it, she receives $(1-p)\sigma(S)$. Finally, if she takes the check in period 1, she receives $\beta\sigma(S+rS)$. Therefore an individual will choose a smaller check in period 0 rather than a larger check in period 1 if and only if

$$\beta < \frac{S - c_0}{\sigma(S+rS)} \text{ or } \beta < \frac{(1-p)\sigma(S)}{\sigma(S+rS)}. \tag{6}$$

Conditions (6) illustrate that there are two reasons to prefer a check today. The first one is that today's realization of the cost c_0 is so low that a subject wants to get the check and cash it now when her cost is low, rather than wait to receive it in the future, when she expects the cost of cashing to be much higher and she runs the cost of losing it. In other words, if I know I have to go to the bank today for other reasons, I prefer to get the check today and cash it rather than wait for two weeks and run the cost of losing it, even if by waiting for two weeks I receive a slightly larger amount. This intuition is not unique to subjects with a present bias, but it is common to rational exponential discounters. So we have

Corollary 1 *Even if offered a positive interest rate r, an individual with $\beta = 1$ will not necessarily delay receiving the check.*

The second reason a subject might choose to receive her check right away is that she has a very high bias toward the present (i.e. a very low β). Indeed, combining (6) with (3), (5) we obtain the following proposition:

Proposition 2 *The lower is the interest rate offered r and the lower is β (i.e, the more impatient a player), the higher is the probability that an individual will prefer a check right away rather than next period.*

Proof. See Appendix B.

Proposition 2 confirms the validity of our method to elicit the degree of present bias in preferences. The interest rate at which an individual will switch is a function of her β. The intuition is straightforward. A higher β makes the delayed delivery more valuable as does a higher interest rate r.

By contrast, the relation between the delivery timing and the amount of the check is not so straightforward. In fact, we have

Corollary 2 *For high interest rates r there is a negative relation between the amount of the check S and the probability of accepting a check right away rather than the following period. For low interest rates this relation is positive.*

Proof. See Appendix B.

For high interest rates, the relation is as expected. Higher amount makes delaying the reward more valuable (because it yields a higher interest) and so makes the delayed choice more likely. This is no longer true for small interest rates because the probability of losing the check becomes relatively more important than the interest accumulated on the check.

B.2 Naïve subjects

All the above results were derived under the assumption that subjects were aware of their degree of present bias in the future (i.e., they were sophisticated). Some individuals, however, can be naïve. That is, they have a $\beta \leq 1$ in all future periods, but they are not aware of this. They think that in the future they will behave as if they had a $\beta = 1$.

Lets denote $\sigma_e(S, \beta_e)$ as the expected value of the check given a belief β_e a subject has about her own future level of impatience. Then we have that a naïve individual will choose immediate delivery over a delayed delivery if and only if

$$\beta < \frac{S - c_0}{\sigma_e(S + rS, 1)} \text{ or } \beta < \frac{(1-p)\sigma_e(S, 1)}{\sigma_e(S + rS, 1)}. \tag{7}$$

Comparing (7) with (6) leads to the following proposition.

Proposition 3 *Generally for $\beta < 1$, the probability that a naïve individual prefers a check right away rather than next period is less than the probability of a sophisticated individual with the same characteristics. All the other comparative statics are the same as for sophisticated individuals.*

Proof. See Appendix B.

Not internalizing their future procrastinating behavior, naïve impatient individuals will think that they will cash the check faster that they actually do and this leads them to value more a delayed delivery than sophisticated impatient individuals.

III Regression Results

The model predicts that there should be a correlation between the rate of impatience inferred from the timing a student chooses to receive her check and her degree of procrastination, computed as the delay in cashing the check. Table 4 tests this hypothesis with the data from our experiment. Since the impatience rate is censored from below at $r \leq 1\%$ and above at $r \geq 13\%$, we estimate these regressions with a Tobit model. Robust standard errors are reported in parentheses.

In column I we regress each student's subjective two-week discount rate on a measure of procrastination. As proxy for procrastination, in this specification we use the number of weeks it took a subject to cash her check, excluding the 31 students who never cashed it (and consented to the study). Students who delayed cashing the check have a higher discount rate, but this effect is both economically small and statistically insignificant. One extra week delay in cashing the check is associated with only a 0.04 percentage points increase in their discount rate.

In column II we repeat the previous regression including also the students who have not cashed the check, with a value of delay equal to the maximum one (29 weeks). The coefficient almost doubles, but it is still economically small and statistically insignificant.

In column III we control for a measure of cognitive ability. There are several reasons for including this control. First, in experimental research, measures of IQ have been linked to patience and delayed gratification (Mischel, 1974; Shoda et al., 1990; Benjamin et al., 2006). It is possible that individuals with higher cognitive abilities understand the question (implied interest rates) better than individuals with lower cognitive abilities. Alternatively, the causality could be reversed, as Mischel (1974) and Shoda et al. (1990) seem to suggest: individuals who are patient, may work harder, and achieve higher grades. When we introduce the CRT score in our regression we find that, consistent with Frederik (2005), people with higher cognitive ability have lower discount rates.[6] This effect, however, does not impact our coefficient of interest.

In column IV we control for the World Values Survey measure of trust. In spite of our effort to equate the way the delivery of the reward was done, we find that people with higher trust have lower discount rates. Nevertheless, our coefficient of interest is unchanged.

A Alternative measures of procrastination

Table 4 fails to show an economic and statistically significant relation between procrastination and impatience. One possible interpretation is that this reflects the true nature of the data. As suggested by most of the psychology literature, procrastination and impatience might not be two faces of the same phenomenon. Alternatively, this result might be simply the outcome of an excessive amount of noise in the data. In the model we assume that all individuals had the same risk of losing the check (p) and the same distribution of costs of cashing the check (uniform between 0 and $\bar{c}$).

In reality, subjects are likely to differ on both these dimensions. If we introduce this heterogeneity, with people differing in the cost of cashing the check and/or in their absent-mindedness (i.e., in the probability of losing the check), the theoretical model exhibits a negative correlation between the discount rate and the time to cash the check. This suggests that the unobserved

[6] Frederik (2005) suggests an alternative possible interpretation of this correlation between patience and cognitive abilities: CRT problems generate an incorrect "intuitive" answer. Impatient individuals are more likely to respond impulsively and make mistakes. We tested for this effect by isolating the answer to the one question without any intuitive wrong answer (the two cars crashing). The result is the same.

heterogeneity induces an attenuation bias in our estimated correlation between impatience and procrastination.

One solution to this problem is to try to find proxies for heterogeneity in p and $\bar{c}$. In Table 2 we try to control for possible variation in the costs of cashing the check and the probability of losing the check. The low explanatory value of these proxies, however, suggests that we do not have good measures for variation in p and $\bar{c}$. Indeed, when we add these proxies (marital status, club membership) to the specification in Table 4 (not reported), these variables are never significant and do not impact our variable of interest.

An alternative empirical strategy is to find some measures of procrastination which do not suffer from these problems. To this purpose we can use the days it took a subject to complete the two surveys we administered. These measures are likely to be uncorrelated with the cost of cashing the check and also with the probability of losing it.

In the first two columns of Table 5, we report the Tobit regressions of each subject's subjective two-week discount rate on these two alternative measures of procrastination. In the first column we regress each subject's subjective two-week discount rate on the number of days she waited before answering the first survey. One standard deviation change in the completion time of the survey (which corresponds to 5 days) is associated with a 62 basis points increase in the subjective discount rate over the two-week period. The effect is statistically significant at the 10% level. When we use the second survey the effect is economically similar: one standard deviation change in the completion time of the second survey (which corresponds to 17 days) is associated with a 61 basis points increase in the subjective discount rate over the two-week period. The effect is statistically significant at the 5% level.

Since these procrastination proxies are also measured with noise, as individuals may be busier in some periods (the surveys had to be filled in different time periods), we use an alternative specification to verify that our results are robust. In Column III of Table 5, we instrument the procrastination measure of cashing the check with the behaviors in filling the two surveys. The results show a positive and significant relation between procrastination and impatience, confirming our previous results. Consistent with the attenuation bias hypothesis (which should be reduced or eliminated by the instrumental variables), the effect is quantitatively much bigger. A one standard deviation delay in cashing the check (which corresponds to 4.4 weeks) is associated with a 372 basis points increase in the subjective discount rate (73% of the sample mean). The effect is statistically significant at the 10% level.

These results support the link between procrastination and impatience, hypothesized in O'Donoghue and Rabin (1999a,b, 2001).

B Naïvité

As a final test of the O'Donoghue and Rabin (2001) and Choi et al. (2005) models, we elaborate a proxy of naïvité of the subjects. The model suggests that naïve subjects should exhibit a lower discount rate because by underestimating their procrastination they overvalue the delayed delivery.

To test this prediction in the general survey we asked students whether they considered themselves to be procrastinators. We then compare their answer with their actual behavior to determine whether they are naïve in their assessment. Specifically, we use two definitions of naïvité. Naïve procrastinator (survey) is a subject who answers negatively to the question "Do you tend to procrastinate?" and at the same time took more time than the median subject to complete the survey. Naïve procrastinator (survey & check) is a subject who answers negatively to the abovementioned question and at the same time took more time than the median subject to complete both the survey and to cash the check. Table 1 reports the frequency of the subjects who are naïve, according to these two definitions. In the entire sample there are 11% or 7% naïve procrastinators, depending on whether we use the first or the second definition.

Table 6 reports the result of inserting the two different measures of naïvité in the specification of column III of Table 5. As predicted by the model, the coefficients of naïvité are negative and significant in both specifications. The effect is economically large. If we define naïve procrastinators as those who did not consider themselves procrastinators, but behaved as such when cashing the check, being naïve results in a subjective discount rate 291 basis points lower than the discount rate of an otherwise similar subject.

Since this measure of naïvité relies on just one action to classify an individual as naïve, it might be prone to many mistakes. For this reason, in Column II we use a more restrictive definition of naïvité, which relies on two separate actions to classify a person as naïve. Consistent with our first measure being more noisy, the estimated coefficient increases. Naïve subjects now have a discount rate which is 645 basis point lower than the discount rate of otherwise similar subjects.

The insertion of this control does not reduce the coefficient on the procrastination variable.

In fact, consistent with our empirical specification capturing more of the features of the model, the coefficient of procrastination on impatience increases by 37%.

IV Conclusions

One of the main contributions of behavioral economics to the study of human behavior is its *reductio ad unum*, its attempt to explain several phenomena psychologists classify as distinct on the basis of a common underlying principle. Nowhere has this attempt been more successful than in the case of the relation between present-bias preferences and procrastination. As far as we know, however, this relation has not been tested empirically. In this paper we do so, designing a combination of a laboratory and field experiment where the two behaviors can be analyzed and we find evidence supporting this relation.

Another important contribution of the recent behavioral economics literature has been the introduction of the distinction between sophisticated individuals and naïve ones (O'Donoghue and Rabin, 1999a). While extremely appealing, the empirical validity of this distinction has not been tested. This paper introduces the first (as far as we know) empirical proxy for naïvité, comparing subjects' self-reported procrastinating behavior with their own actual behavior and find that, as predicted by theory, the behavior of naïve individuals does differ from that of non-naïve ones.

Put together these results provide a strong empirical support for O'Donoghue and Rabin (1999a) and Choi et al. (2005).

A Instructions and Experimental Procedures

A Experimental procedures

The experiment was run during Tuesday the 3rd and Thursday the 5th of October 2006. Students were randomly assigned to participate in one of the two days. Two sessions were run each day during the afternoon, one starting at 1 o'clock and the other one at 3 o'clock. Due to scheduling conflicts with other activities, all national students (US citizens) participated in the 1 o'clock sessions and international students in the 3 o'clock sessions.

Upon arrival students received a set of materials which included their $20 show-up fee and a unique randomly assigned number that is used to identify each subject. Once all students were seated, the experimenter reminded them not to communicate with one another and that their interaction with others will remain anonymous. Thereafter, students were asked to sign various consent forms. Consenting to the different aspects of the study is voluntary and subjects have the option to opt out of the study at any time. The experiment was run with computers and programmed with zTree (Fischbacher, 2007). It lasted around one and a half hours.

B Instructions for the payment choice

As your last choice, you decide when to receive your payment. For each row below, choose the amount and timing of your payment. If you choose to be paid *now*, a check will be delivered to your mailfolder by the *end of the day*. If you choose to be paid *later*, the check will be delivered to your mailfolder in *two weeks time*. One of the rows will be randomly selected by the computer and that choice will be implemented.

[Example with earnings of $80]

1. Receive $80.00 today or receive $80.00 in two weeks
2. Receive $80.00 today or receive $80.80 in two weeks
3. Receive $80.00 today or receive $81.60 in two weeks
4. Receive $80.00 today or receive $82.40 in two weeks
5. Receive $80.00 today or receive $83.20 in two weeks
6. Receive $80.00 today or receive $84.00 in two weeks
7. Receive $80.00 today or receive $84.80 in two weeks
8. Receive $80.00 today or receive $85.60 in two weeks

9. Receive \$80.00 today or receive \$86.40 in two weeks
10. Receive \$80.00 today or receive \$87.20 in two weeks
11. Receive \$80.00 today or receive \$88.00 in two weeks
12. Receive \$80.00 today or receive \$88.80 in two weeks
13. Receive \$80.00 today or receive \$89.60 in two weeks

C Instructions for the chocolate auction

As part of the LEAD GAME we are auctioning a *large Toblerone milk chocolate bar* (3.52 ounces). The chocolate will be given to the *highest bidder* at a price equal to the *second highest bid.* Note that if you are the winner, the price will be deducted from your final earnings (if your earnings are not enough to cover the price you will have to pay us the difference). The chocolate will be delivered to the winner either now, in one week, or in two weeks (each is equally likely).

- If the bar of chocolate is to be delivered *now*: immediately at the end of the session. How much money are you willing to bid for this bar of chocolate?
- If the bar of chocolate is to be delivered in *one week*: at the end of your LEAD class. How much money are you willing to bid for this bar of chocolate?
- If the bar of chocolate is to be delivered in *two weeks*: at the end of your LEAD class. How much money are you willing to bid for this bar of chocolate?

B Proofs

Lemma 1 *The optimal cutoff rule is given by*

$$c^*(\beta, p, S, \bar{c}) = \frac{\sqrt{(p\bar{c})^2 + 2(1-p)p(2-\beta)\beta S\bar{c}} - p\bar{c}}{(1-p)(2-\beta)}$$

Proof. At the cutoff point c^* the individual is indifferent between cashing the check in the current period or delaying the decision:

$$c^* = \beta[pS + (1-p)L(c^*)]. \tag{8}$$

Since the probability that an individual cashes the check in a given period is $\frac{c^*}{\bar{c}}$, and if she does, she pays an average cost of $\frac{c^*}{2}$, we can write $L(c^*)$ as[7]

$$L(c^*) = \sum_{k=0}^{\infty} \left(1-p\right)^k \left(1-\frac{c^*}{\bar{c}}\right)^k \left[\frac{c^*}{\bar{c}}\frac{c^*}{2} + \left(1-\frac{c^*}{\bar{c}}\right) pS\right]$$

$$L(c^*) = \frac{(c^*)^2 + 2p(\bar{c}-c^*)S}{2c^* + 2p(\bar{c}-c^*)}. \tag{9}$$

Note that β does not appear in L as the individual is evaluating tradeoffs between future periods only. Substituting (9) into (8) and solving for c^* gives (3).[8] ■

Proposition 1 *If the check is not negligibly small, the lower the β (i.e, the more impatient the individual is) and the smaller the size of the check S, the more time an individual takes to cash the check.*

Proof. The time to cash the check is positive as long as $c^* < \bar{c}$, which holds if

$$S < \frac{2-(1-p)\beta}{2p\beta}\bar{c}. \tag{10}$$

Since the right hand side of the equation is decreasing in β, it means that more impatient individuals satisfy (10) more easily and thus are less likely to always cash the check in period 0. Furthermore, if this condition is met, the partial derivatives of $c^*(.)$ with respect to S and β equal

$$\frac{\partial c^*}{\partial S} = \frac{p\beta\bar{c}}{\sqrt{(p\bar{c})^2 + 2(1-p)p(2-\beta)\beta S\bar{c}}} \tag{11}$$

$$\frac{\partial c^*}{\partial \beta} = \frac{p\bar{c}\left(p\bar{c} + 2(1-p)(2-\beta)S - \sqrt{(p\bar{c})^2 + 2(1-p)p(2-\beta)\beta S\bar{c}}\right)}{(1-p)(2-\beta)^2\sqrt{(p\bar{c})^2 + 2(1-p)p(2-\beta)\beta S\bar{c}}} \tag{12}$$

which are both positive for $0 < p < 1$, and $0 < \beta \leq 1$. The partial derivative of τ with respect to c^* is

$$\frac{\partial \tau}{\partial c^*} = \frac{(1-p)\left((\bar{c}-2c^*)(c^*+p(\bar{c}-c^*)) - 2(1-p)(\bar{c}-c^*)c^*\right)}{(c^*+p(\bar{c}-c^*))^3} \tag{13}$$

which is positive if $c^* < \frac{p}{1+p}\bar{c}$. Using (3) and given that $\partial c^*/\partial\beta > 0$ and $\partial c^*/\partial S > 0$, it follows that:

$$\text{if } S > \frac{4p - p(1-p)\beta}{2(1+p)^2\beta}\bar{c} \text{ then } \frac{\partial \tau}{\partial \beta} < 0 \text{ and } \frac{\partial \tau}{\partial S} < 0. \tag{14}$$

[7] Note that $c^* > 0$ otherwise the individual never cashes the check and eventually losses it incurring a cost $S > 0$.

[8] The substitution gives a quadratic equation. We use the upper root so that $c^* > 0$.

Note that, for reasonable parameter values, (14) is easily satisfied even by a small S relative to $\bar{c}$. For example if $\beta \geq 0.5$ and $p \leq 0.2$ then (14) holds if $S > \frac{1}{2}\bar{c}$. However, the clearest evidence that this inequality is satisfied in our sample is that if it is not, it implies that a large percentage of subjects never cash the check. To see this, note that the probability that a subject never cashes the check, $P(c^*)$, is given by

$$P(c^*) = \frac{1 - \left(2 - p\right)\left(1 - \dfrac{c^*}{\bar{c}}\right)}{1 - \left(1 - p\right)\left(1 - \dfrac{c^*}{\bar{c}}\right)} \frac{c^*}{\bar{c}}. \tag{15}$$

Given that $P(c^*)$ is decreasing in c^* if (14) is not satisfied, it is easy to verify that the minimum value of $P(c^*)$ in this range is $P\left(\dfrac{p}{1+p}\bar{c}\right) \approx 51\%$. This is much higher than the actual 7% who did not cash the check ■

Corollary 1 *Even if offered a positive interest rate r, an individual with $\beta = 1$ will not necessarily delay receiving the check.*

Proof. An individual with $\beta = 1$ will chose the check today if $c_0 < S - \sigma(S + rS)$.[9] Thus, there is a positive probability that the individual will take the check today as long as the righthand side of this inequality is positive. This is the true for all r that satisfy

$$r < \frac{c^*}{2S} + \frac{p\bar{c}}{c^*} - p \tag{16}$$

It is not hard to find parameter values for which (16) holds. For example, if $S = \$100$, $\bar{c} = \$50$, and $p = 0.01$, an individual with $\beta = 1$ has a positive probability of taking the check today as long as $r < 0.090$ ■

Proposition 2 *The lower is the interest rate offered r and the lower is β (i.e, the more impatient a player), the higher is the probability that an individual will prefer a check right away rather than next period.*

Proof. The probability that an individual prefers a check today is given by

[9] When $\beta = 1$, the second inequality in (6) is never satisfied.

$$\Pi = \begin{cases} 0 & \text{if } \beta > \bar{\beta} \\ \dfrac{S - \beta\sigma(S + rS)}{\bar{c}} & \text{if } \underline{\beta} < \beta < \bar{\beta} \\ 1 & \text{if } \beta < \underline{\beta} \end{cases} \tag{17}$$

$$\text{where } \underline{\beta} = \max\left(\frac{(1-p)\sigma(S)}{\sigma(S+rS)}, \frac{S-\bar{c}}{\sigma(S+rS)}\right) \text{ and } \bar{\beta} = \frac{S}{\sigma(S+rS)}$$

We first show that the probability of taking the check today is decreasing in r and β for the case $\underline{\beta} < \beta < \bar{\beta}$. The derivative of $\sigma(S)$ with respect to c^* is given by

$$\frac{\partial\sigma(S)}{\partial c^*} = \frac{p\bar{c}(S - c^*) - \frac{1}{2}(1-p)c^{*2}}{(c^* + p(\bar{c} - c^*))^2} \tag{18}$$

Using (3) and solving for c^* indicates that (18) is positive if

$$c^* \leq \frac{\sqrt{(p\bar{c})^2 + 2(1-p)pS\bar{c}} - p\bar{c}}{(1-p)}$$

which holds as long as $\beta \leq 1$. Combining this with the positive sign of (11) and (12) ensures that $\partial\Pi/\partial r < 0$ and $\partial\Pi/\partial\beta < 0$.

Note that, since (11) and (18) are positive, it must be the case that $(\bar{\beta} - \beta)$ and $(\underline{\beta} - \beta)$ are decreasing in r. In other words, a high r or β makes it more likely that the individual never takes the check today and less likely that she always takes the check today.

Finally we show that if β is close to $\bar{\beta}$ then $(\bar{\beta} - \beta)$ is decreasing in β, and if β is close to $\underline{\beta}$ then the same is true for $(\underline{\beta} - \beta)$. In the case of $(\bar{\beta} - \beta)$ and $(\underline{\beta} - \beta)$ when $S - \bar{c} > (1-p)\sigma(S)$, this follows immediately from the fact that (12) and (18) are both positive. For $(\underline{\beta} - \beta)$ when $S - \bar{c} < (1-p)\sigma(S)$, this is true as long as $\partial\underline{\beta}/\partial\beta < 1$. Unfortunately we are unable to solve this inequality for a manageable analytical solution. Therefore, to show that this holds in the experiment we calculated $\partial\underline{\beta}/\partial\beta$ for the following parameter values: $p \in [0.005, 0.995]$, $S \in [1, 300]$, $\bar{c} \in [1, 300]$, and $r \in [0, 0.15]$, when $\beta = \underline{\beta}$.[10] We find a maximum value for $\partial\underline{\beta}/\partial\beta$ of 0.0235 which is less than 1. In other words, if β is close to any of the two threshold values, a high β lowers the $\bar{\beta}$ threshold making it more likely that the individual never takes the check today and increases the $\underline{\beta}$ threshold making less likely that she always takes the check today ■

Corollary 2 *For high interest rates r there is a negative relation between the amount of the check S and the probability of accepting a check right away rather than the following period. For low interest rates this relation is positive.*

[10] Calculations where done in steps of 0.005 for p and r, and steps of 1 for S and $\bar{c}$. They are available upon request.

Proof. From (17) one can see that, as long as $\underline{\beta} < \beta < \bar{\beta}$, the relation between S and the probability of taking the check today is given by

$$\frac{\partial \Pi}{\partial S} = \frac{1}{\bar{c}}\left(1 - \beta \frac{\partial \sigma(S + rS)}{\partial S}\right) \tag{19}$$

Thus, if $\beta(\partial\sigma(S+rS)/\partial S) < 1$ the relation between Π and S is positive, otherwise it is negative. Writing $c^*(\beta, p, S + rS, \bar{c})$ as c^*, the partial derivative of $\sigma(S + rS)$ with respect to S is

$$\frac{\partial \sigma(S + rS)}{\partial S} = \frac{1 + r - \frac{1}{2}c^*_S}{c^* + p(\bar{c} - c^*)}c^* + \frac{(1 + r)S - \frac{1}{2}c^*}{(c^* + p(\bar{c} - c^*))^2}p\bar{c}c^*_S \tag{20}$$

$$\text{where } c^*_S = \frac{p\beta(1 + r)\bar{c}}{\sqrt{(p\bar{c})^2 + 2(1 - p)p(2 - \beta)\beta(1 + r)S\bar{c}}}$$

which is clearly positive as $\frac{1}{2}c^*_S < (1 + r)$ and $\frac{1}{2}c^* < (1 + r)S$. The derivative of $\partial\sigma(S + rS)/\partial S$ with respect to r is

$$\frac{\partial^2 \sigma(S + rS)}{\partial S \partial r} = \frac{2S(1 - p)(c^* - Sc^*_S) + \left(2 - \frac{1}{1+r}c^*_S\right)pS\bar{c}}{(c^* + p(\bar{c} - c^*))^3}p\bar{c}c^*_S + \frac{(1 + r)S - \frac{1}{2}c^*}{(c^* + p(\bar{c} - c^*))^2}p\bar{c}c^*_{Sr} + \frac{1 - \frac{1}{2}c^*_{Sr}}{c^* + p(\bar{c} - c^*)}c^* \tag{21}$$

$$\text{where } c^*_{Sr} = \frac{p\bar{c} + (1 - p)(2 - \beta)\beta(1 + r)S}{\sqrt[3]{(p\bar{c})^2 + 2(1 - p)p(2 - \beta)\beta(1 + r)S\bar{c}}}\beta(p\bar{c})^2$$

which again is positive as $0 < c^*_{Sr} < 1$, as well as $S > c^* > Sc^*_S$ and $2(1 + r) > c^*_S$. In other words, $\partial\Pi/\partial S$ switches from being (weakly) positive to (weakly) negative as r increases if for a low r it holds that $\beta(\partial\sigma(S + rS)/\partial S) < 1$. In this case, there is an r^* such that for $r > r^*$ it holds that $\partial\Pi/\partial S \leq 0$ and for $r < r^*$ it holds that $\partial\Pi/\partial S \geq 0$.[11] The precise value of r^* is given by the r that solves $\partial\Pi/\partial S = 0$. Although we did not find a meaningful expression for r^*, it is easy to calculate it for various parameter values. For example, if $S = \$80$, $\bar{c} = \$20$, $p = 0.03$, and $\beta = 1$, then $\underline{\beta} = 0.937$, $\bar{\beta} = 1.061$, and $r^* = 0.033$. Similarly, if $S = \$135$, $\bar{c} = \$35$, $p = 0.1$, and $\beta = 0.9$, then $\underline{\beta} = 0.787$, $\bar{\beta} = 1.002$, and $r^* = 0.127$ ■

Proposition 3 *Generally for $\beta < 1$ the probability that a naïve individual prefers a check right away rather than next period is less than the probability of a sophisticated individual with the same characteristics. All the other comparative static is the same as for sophisticated individuals.*

[11] Note that for very low and very high values of r, there might not be a relationship between Π and S as β can fall outside the thresholds $\underline{\beta}$ and $\bar{\beta}$. Thus, this corollary applies strictly only when comparing intermediate values of r.

Proof. Lets define $\underline{\beta}_e\left(\sigma_e(S,\beta_e)\right)$ as the threshold value of β below which an individual with belief β_e strictly prefers to cash the check today:

$$\underline{\beta}_e\left(\sigma_e(S,\beta_e)\right) = \max\left(\frac{(1-p)\sigma_e(S,\beta_e)}{\sigma_e(S+rS,\beta_e)}, \frac{S-\bar{c}}{\sigma_e(S+rS,\beta_e)}\right). \tag{22}$$

Furthermore, note that since (18) and (12) are both positive for $0 < p < 1$ and $0 < \beta \leq 1$, it follows that $\partial\sigma/\partial\beta > 0$.

If $S-\bar{c} > (1-p)\sigma_e(S,1)$, it is clear that an individual for whom $\beta < 1$ has a lower probability of choosing the check today if she is naïve since

$$\frac{S-\beta\sigma_e(S+rS,\beta)}{\bar{c}} > \frac{S-\beta\sigma_e(S+rS,1)}{\bar{c}}. \tag{23}$$

If $(S-\bar{c}) < (1-p)\sigma_e(S,1)$ then the same can be said as long as $\beta > \underline{\beta}_e\left(\sigma_e(S,1)\right)$. In this case, either $\beta > \underline{\beta}_e\left(\sigma_e(S,\beta)\right)$ and (23) holds, or $\underline{\beta}_e\left(\sigma_e(S,\beta)\right) > \beta$ and the probability of cashing the check today for a sophisticated individual equals 1 and for a naïve individual it is strictly less than 1.

If $(S-\bar{c}) < (1-p)\sigma_e(S,1)$, $\beta < \underline{\beta}_e\left(\sigma_e(S,1)\right)$, and $\beta < \underline{\beta}_e\left(\sigma_e(S,\beta)\right)$ then the individual cashes the check today with probability 1 irrespective of whether she is sophisticated or naïve.

Finally, if $(S-\bar{c}) < (1-p)\sigma_e(S,1)$, $\beta < \underline{\beta}_e\left(\sigma_e(S,1)\right)$, and $\beta > \underline{\beta}_e\left(\sigma_e(S,\beta)\right)$ then the individual cashes the check today with probability 1 if she is naïve and with probability less than 1 if she is sophisticated. Thus, this is the only scenario in which a sophisticated individual is more likely cash the check than a naïve one. In order to assess the likelihood that it occurs we calculated for various values of S, $\bar{c}$, p, and r, the range of βs for which this scenario's conditions hold. We used the following parameter values: $p \in [0.005, 0.995]$, $S \in [1, 300]$, $\bar{c} \in [1, 300]$, and $r \in [0, 0.15]$.[10] We find that the largest range occurs for $p = 0.585$, $K = 201$, $S = 240$, and $r = 0.15$, where this scenario occurs for $\beta \in [0.327, 0.332]$. If we further restrict the search to cases where $\beta \geq 0.5$, we find the largest range is $\beta \in [0.500, 0.504]$ for $p = 0.375$, $K = 125$, $S = 84$, and $r = 0.15$.

Given the very small range of values for which a sophisticate individual has a higher probability of choosing the check today compared to a naïve individual with the same characteristics, we conclude that generally, naïve individuals are less likely to accept the check right away.

It is easy to see that the other comparative statics hold for naïve individuals. Proposition 1 holds as check cashing is independent of the level of naïvité. Proposition 2 holds in an even more straightforward manner as $\sigma_e(S,1)$ and $\sigma_e(S+rS,1)$ are independent of the value of β. Lastly, corollaries 1 and 2 depend only on β and not on β_e and hence also hold for naïve individuals ■

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Table 1: Summary Statistics

This table reports the summary statistics for all the variables used in this paper. The two-week discount rate is inferred from a series of choices subjects made between getting $\$x$ today and $\$x(1+r)$ in two weeks ($r \in [0, 0.12]$). The value reported is the level of r at which a subject switched from money today to money in two weeks. The two-week discount rate ≤ 1 is a dummy equal to one if a subject behaves as an exponential discounter, i.e. she chooses to switch at $r = 0$ or $r = 1$. Chocolate now/in one week/in two weeks indicate the subjects' bids in US$ for a Tobblerone chocolate bar to be delivered at one of the respective dates (bids were for a second-price auction). β Chocolate is the value of the parameter β that would rationalize the subjects' bids for the chocolate at the three different delivery times. It is calculated by taking the ratio of the bid for one week to today and dividing it by the ratio of the bid for two weeks to one week (see Laibson, 1994). Weeks to cash the check equals the number of weeks the subject took to cash the check he/she received. Days to answer 1^{st} survey equals the number of days the subject took to answer the mandatory survey. Days to answer 2^{nd} survey equals the number of days the subject took to answer the voluntary survey. Self-reported procrastinator is a dummy equal to one if a subject answered yes to the question "Do you tend to procrastinate?" Naïve procrastinator (survey) is a dummy equal to one if a subject answers no to the abovementioned question and at the same time took more time to complete the survey than the median subject. Naïve procrastinator (survey & check) is a dummy equal to one if a subject answers negatively to the abovementioned question and at the same time took more time to complete the survey and to cash the check than the median subject. Money at stake equals the amount of money in US$ upon which the subject made the decisions used to calculate his/her two-week discount rate. CRT score is the number of correct answers to a series of 4 questions designed to measure a subject's cognitive reasoning skills (see Frederik, 2005). Club memberships equals the number of business school clubs a subject is a member of. Trust is a dummy equal to one if a subject answers "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". The other answers are "Can't be too careful" and "Don't know". Female is a dummy equal to one if the subject is a woman. Married is a dummy equal to one if a subject was married at the time of the experiment. Married male/female is a dummy equal to one if the subject was a married man/woman.

	Mean	**Median**	**Std. Dev.**	**Min**	**Max**	**Obs.**
Measures of Impatience						
Two-week discount rate (money)	5.07	4.00	4.40	0.00	13.00	460
Two-week discount rate ≤ 1	0.36	0.00	0.48	0.00	1.00	460
Chocolate now	1.86	1.00	2.47	0.00	20.00	460
Chocolate in one week	1.31	1.00	1.98	0.00	20.00	460
Chocolate in two weeks	1.12	0.50	1.97	0.00	21.00	460
β Chocolate	1.09	1.00	1.45	0.03	25.00	323
β Chocolate $= 1$	0.30	0.00	0.46	0.00	1.00	323
Measures of Procrastination						
Weeks to cash the check	3.70	2.14	4.36	0.00	29.29	429
Days to answer 1^{st} survey	8.96	10.47	5.05	0.37	17.08	460
Days to answer 2^{nd} survey	32.69	29.48	16.84	0.07	69.27	255
Self-reported procrastinator	0.70	1.00	0.46	0.00	1.00	460
Naïve procrastinator (survey)	0.11	0.00	0.31	0.00	1.00	460
Naïve procrastinator (survey & check)	0.07	0.00	0.25	0.00	1.00	460
Other variables						
Money at stake	83.24	78.38	54.34	2.00	260.00	460
CRT score	2.45	3.00	1.33	0.00	4.00	460
Club memberships	3.45	4.00	1.42	0.00	5.00	437
Trust	0.53	1.00	0.50	0.00	1.00	460
Female	0.30	0.00	0.46	0.00	1.00	437
Married	0.27	0.00	0.45	0.00	1.00	423
Married male	0.30	0.00	0.46	0.00	1.00	297
Married female	0.21	0.00	0.41	0.00	1.00	126

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Table 2: Procrastination

The dependent variable is the number of days it took the subject to cash the check he/she received. Money at stake is the logarithm of the amount of money in US$ upon which the subject made the decisions used to calculate his/her two-week discount rate. Club memberships equals the number of business school clubs a subject is a member of. Trust is a dummy equal to one if a subject answers "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". The other answers are "Can't be too careful" and "Don't know". Female is a dummy equal to one if the subject is a woman. Married is a dummy equal to one if a subject was married at the time of the experiment. Married male/female is a dummy equal to one if the subject was a married man/woman. Days to answer 1st survey equals the number of days the subject took to answer the mandatory survey. Days to answer 2nd survey equals the number of days the subject took to answer the voluntary survey. The sample is reduced to 437 and then further to 423 subjects, because some did not consent to the treatment of their career data. This table reports OLS estimates and robust standard errors. The symbols *,**,*** indicate statistical significance at the 10, 5, and 1 percent level.

Weeks to cash the check as the dependent variable						
	I	**II**	**III**	**IV**	**V**	**VI**
Money at stake	-1.527***	-1.512***	-1.545***	-1.555***	-1.523***	-1.505***
	(0.485)	(0.491)	(0.483)	(0.478)	(0.484)	(0.472)
Club memberships		0.493**	0.470**	0.478**	0.489**	0.556**
		(0.231)	(0.237)	(0.236)	(0.233)	(0.233)
Married male			-1.886**	-1.803**	-1.641*	-1.722**
			(0.848)	(0.854)	(0.840)	(0.861)
Married female			0.469	0.533	0.735	1.029
			(1.788)	(1.766)	(1.786)	(1.788)
Female			-0.390	-0.329	-0.181	-0.329
			(0.929)	(0.933)	(0.918)	(0.923)
Trust				0.966	0.962	1.008
				(0.748)	(0.739)	(0.733)
Days to answer 1st survey					0.210***	0.172**
					(0.068)	(0.069)
Days to answer 2nd survey						0.036**
						(0.017)
Constant	11.735***	9.970***	10.583***	10.033***	7.887***	6.177**
	(2.118)	(2.385)	(2.425)	(2.391)	(2.559)	(2.464)
R^2	0.035***	0.043***	0.055***	0.059***	0.078***	0.089***
Obs.	437	437	423	423	423	423

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Table 3: Measures of Impatience

The dependent variable is the subjects' two-week discount rate, which we inferred from a series of choices subjects made between getting $\$x$ today and $\$x(1+r)$ in two weeks ($r \in [0, 0.12]$). The value reported is the level of r at which a subject switched from money today to money in two weeks. β chocolate is the value of the parameter β that would rationalize the subjects' bids for a Tobblerone chocolate bar at three different delivery times (today, in one week, and in two weeks). It is calculated by taking the ratio of the bid for one week to today and dividing it by the ratio of the bid for two weeks to one week (see Laibson, 1994). Money at stake equals the logarithm amount of money in US$ upon which the subjects made the decisions used to calculate their two-week discount rate. In column I we lose 137 observations because at least one of the bids was equal to zero. In column II we restrict the sample only to subjects who bid at least $1 for the chocolate to be delivered right away. The table reports Tobit estimates where the left hand side is censored at $r \leq 1$ and $r \geq 13$. Robust standard errors are in parentheses. The symbols *,**,*** indicate statistical significance at the 10, 5, and 1 percent level.

Two-week discount rate as the dependent variable		
	I	**II**
β Chocolate	-0.268	-0.451*
	(0.260)	(0.272)
Money at Stake	-2.999***	-3.214***
	(0.523)	(0.559)
Constant	16.301***	17.551***
	(2.325)	(2.488)
χ^2	33.156***	33.603***
Log likelihood	-690.055	-568.760
Obs.	323	265

Table 4: Impatience and Procrastination

The dependent variable is the subjects' two-week discount rate, which we inferred from a series of choices subjects made between getting \$$x$ today and \$$x(1+r)$ in two weeks ($r \in [0, 0.12]$). The value reported is the level of r at which a subject switched from money today to money in two weeks. Weeks to cash the check equals the number of weeks the subject took to cash the check he/she received. In the censored version of this variable we attribute to subjects who did not cash the check the highest number of weeks. Money at stake equals the logarithm of the amount of money in US$ upon which the subjects made the decisions used to calculate their two-week discount rate. CRT score is the number of correct answers to a series of 4 questions designed to measure a subject's cognitive reasoning skills (see Frederik, 2005). Club memberships equals the number of business school clubs a subject is a member of. Trust is a dummy equal to one if a subject answers "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". The other answers are "Can't be too careful" and "Don't know". The table presents Tobit regressions censoring at $r \leq 1$ and $r \geq 13$. Robust standard errors are in parentheses. The symbols *,**,*** indicate statistical significance at the 10, 5, and 1 percent level.

Two-week discount rate as the dependent variable				
	I	**II**	**III**	**IV**
Weeks to cash the check	0.036			
	(0.083)			
Weeks to cash the check		0.061	0.067	0.070
(censored)		(0.051)	(0.051)	(0.051)
Money at stake	-2.615***	-2.774***	-2.794***	-2.771***
	(0.519)	(0.485)	(0.483)	(0.480)
CRT score			-0.866***	-0.859***
			(0.272)	(0.271)
Trust				-1.334*
				(0.747)
Constant	14.365***	14.927***	17.096***	17.680***
	(2.298)	(2.169)	(2.291)	(2.297)
χ^2	25.582***	36.135***	44.713***	49.078***
Log likelihood	-925.083	-988.636	-983.903	-982.305
Obs.	429	460	460	460

Table 5: Different Measures of Procrastination

The dependent variable is the subjects' two-week discount rate, which we inferred from a series of choices subjects made between getting $\$x$ today and $\$x(1+r)$ in two weeks ($r \in [0, 0.12]$). The value reported is the level of r at which a subject switched from money today to money in two weeks. Weeks to cash the check equals the number of weeks the subject took to cash the check he/she received. In the censored version of this variable we attribute to subjects who did not cash the check the highest number of weeks. Days to answer 1$^{\text{st}}$ survey equals the number of days the subject took to answer the mandatory survey (which occurred before the experiment). Days to answer 2$^{\text{nd}}$ survey equals the number of days the subject took to answer the voluntary survey (which occurred after the experiment). Money at stake equals the logarithm of the amount of money in US$ upon which the subjects made the decisions used to calculate their two-week discount rate. CRT score is the number of correct answers to a series of 4 questions designed to measure a subject's cognitive reasoning skills (see Frederik, 2005). Trust is a dummy equal to one if a subject answers "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". The other answers are "Can't be too careful" and "Don't know". Columns I and II present Tobit regressions censoring at $r \leq 1$ and $r \geq 13$. In addition, in Column III we instrument the number of weeks to cash the check with the days to answer the 1$^{\text{st}}$ and 2$^{\text{nd}}$ surveys. Standard errors are in parentheses. The symbols *,**,*** indicate statistical significance at the 10, 5, and 1 percent level.

Two-week discount rate as the dependent variable			
	I	**II**	**III**
Days to answer 1st survey	0.122*		
	(0.073)		
Days to answer 2nd survey		0.036**	
		(0.017)	
Weeks to cash the check			0.853*
(censored)			(0.451)
Money at stake	-2.851***	-2.830***	-1.573*
	(0.477)	(0.478)	(0.836)
CRT score	-0.803***	-0.767***	-1.002***
	(0.272)	(0.272)	(0.361)
Trust	-1.307*	-1.263*	-1.800*
	(0.745)	(0.744)	(0.970)
Constant	17.144***	16.284***	9.105*
	(2.316)	(2.479)	(5.386)
χ^2	48.015***	50.790***	41.516***
Log likelihood	-981.991	-981.161	
Obs.	460	460	460

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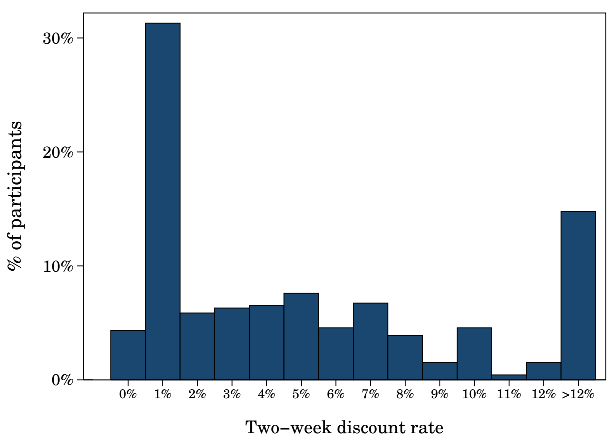
Table 6: Naïvité

The dependent variable is the subjects' two-week discount rate, which we inferred from a series of choices subjects made between getting $\$x$ today and $\$x(1+r)$ in two weeks ($r \in [0, 0.12]$). The value reported is the level of r at which a subject switched from money today to money in two weeks. Weeks to cash the check equals the number of weeks the subject took to cash the check he/she received. In the censored version of this variable we attribute to subjects who did not cash the check the highest number of weeks. Money at stake equals the logarithm of the amount of money in US$ upon which the subjects made the decisions used to calculate their two-week discount rate. CRT score is the number of correct answers to a series of 4 questions designed to measure a subject's cognitive reasoning skills (see Frederik, 2005). Trust is a dummy equal to one if a subject answers "Most people can be trusted" to the question "Generally speaking, would you say that most people can be trusted or that you can't be too careful in dealing with people?". The other answers are "Can't be too careful" and "Don't know". Naïve procrastinator (survey) is a dummy equal to one if a subject answered no to the question "Do you tend to procrastinate?" and at the same time took more time to complete the survey than the median subject. Naïve procrastinator (survey & check) is a dummy equal to one if a subject answers negatively to the abovementioned question and at the same time took more time to complete the survey and to cash the check than the median subject. Tobit regressions censoring at $r \leq 1$ and $r \geq 13$. In both columns we instrument the number of weeks to cash the check with the days to answer the 1$^{\text{st}}$ and 2$^{\text{nd}}$ surveys. Standard errors are in parentheses. The symbols *,**,*** indicate statistical significance at the 10, 5, and 1 percent level.

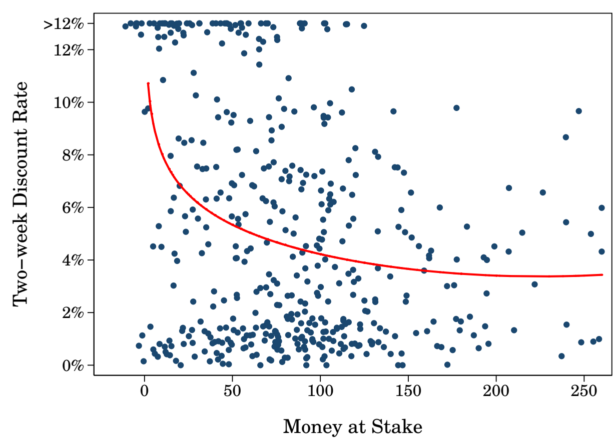
Two-week discount rate as the dependent variable		
	I	**II**
Weeks to cash the check	1.044**	1.166*
(censored)	(0.505)	(0.626)
Money at stake	-1.323	-1.178
	(0.924)	(1.071)
CRT score	-1.048***	-1.076**
	(0.395)	(0.424)
Trust	-1.876*	-1.879*
	(1.061)	(1.126)
Naïve procrastinator	-2.911*	
(survey)	(1.717)	
Naïve procrastinator		-6.448*
(survey & check)		(3.297)
Constant	7.484	6.410
	(5.956)	(7.019)
χ^2	37.801***	33.153***
Obs.	460	460

Figure 1: Impatience

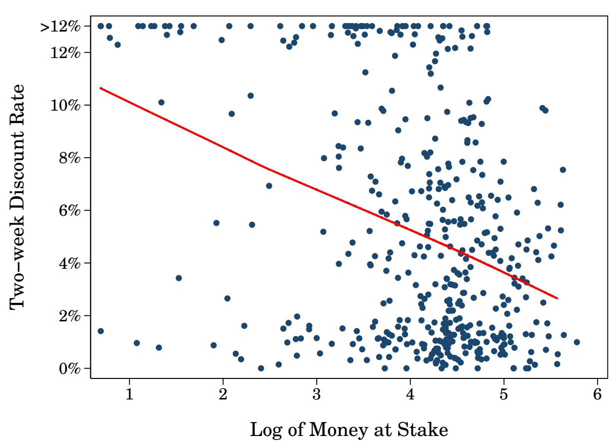
Impatience is the subjects' two-week discount rate, which we inferred from a series of choices subjects made between getting $\$x$ today and $\$x(1+r)$ in two weeks ($r \in [0, 0.12]$). The value reported is the level of r at which a subject switched from money today to money in two weeks. Money at stake equals the amount of money in US$ upon which the subjects made the decisions used to calculate their two-week discount rate. The red line indicates the best-fitting polynomial regression of degree 1.



(A) Histogram of two-week discount rates



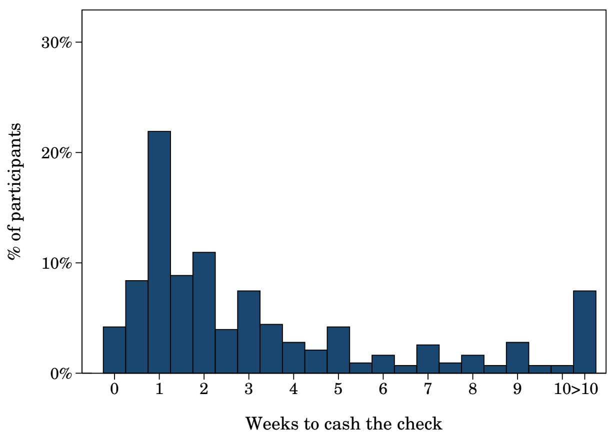
(B) Two-week discount rate and money at stake



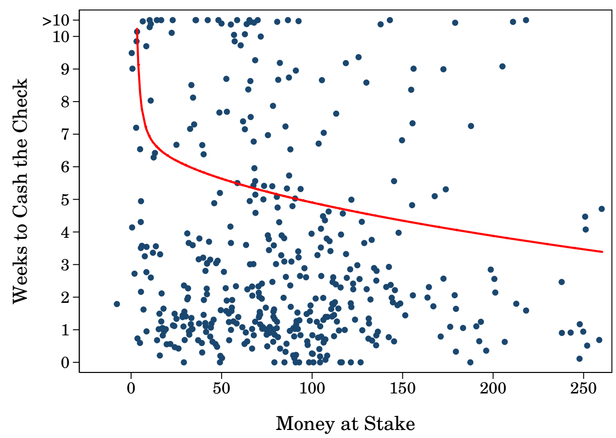
(C) Two-week discount rate and log of money at stake

Figure 2: Procrastination

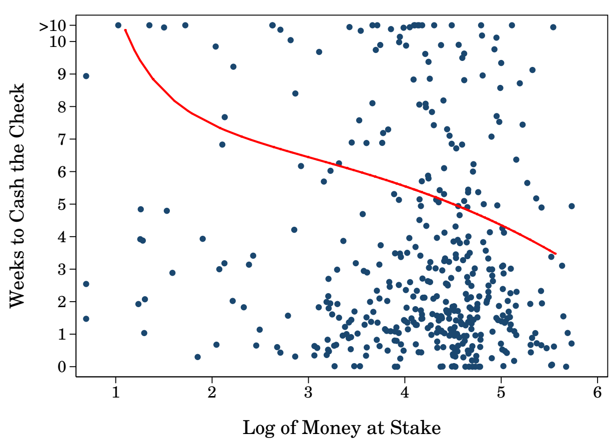
Procrastination is calculated as the number of weeks the subject took to cash the check he/she received. We use the censored version of this variable in which subjects who did not cash the check are given a value equal to the highest number of weeks. Money at stake equals the amount of money in US$ upon which the subjects made the decisions used to calculate their two-week discount rate. The red line indicates the best-fitting polynomial regression of degree 1.



(A) Weeks to cash the check



(B) Weeks to cash the check and money at stake



(C) Weeks to cash the check and log of money at stake

Figure 3: β of Chocolate

β of Chocolate is calculated as the value of the parameter β that would rationalize the subjects bids for a Tobblerone chocolate bar at three different delivery times (today, in one week, and in two weeks). It is calculated by taking the ratio of the bid for one week to today and dividing it by the ratio of the bid for two weeks to one week (see Laibson, 1994).