Charging Myopically Ahead:
Evidence on Present-Biased Preferences and Credit Card Borrowing*

Stephan Meier† Charles Sprenger‡

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Abstract

Some individuals borrow extensively on their credit cards. This paper tests whether present-biased preferences, that is a disproportionate preference for immediate consumption, can explain differences in credit card borrowing. In a field study, we elicit individual time preferences through incentivized choice experiments, and match resulting time preference measures to individual credit reports and annual tax returns.

The results show that individuals with present-biased time preferences have significantly higher amounts of credit card debt, even after controlling for disposable income, credit constraints and other socio-demographic characteristics. Present-biased individuals appear to be naive, charging their cards too much given their long-run preferences.

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†Columbia Business School, Columbia University, Uris Hall, 3022 Broadway, New York, NY 10027; sm3087@columbia.edu.

‡Department of Economics, University of California at San Diego, 9500 Gilman Drive, La Jolla, CA 92093; csprenge@ucsd.edu.

1 Introduction

People charge their credit cards extensively. U.S. households who have at least one credit card carried, on average, $3,027 in revolving debt in 2004 (based on the Survey of Consumer Finances). However, there is significant heterogeneity in credit card borrowing. Only 45 percent of card holders report that they, at least sometimes, carry balances on their credit cards. Among these individuals, the average credit card debt is $5,799. These numbers illustrate two important stylized card borrowing facts: first, the level of credit card borrowing is substantial; and, second, some individuals charge their credit card significantly while others accumulate no debt at all. What explains this heterogeneity in credit card borrowing and does it tell us anything about whether the level of credit card borrowing is optimal or whether card borrowers are *charging blindly* into financial trouble?

Using a large field experiment, this paper tests whether heterogeneity in individual time preferences can explain differences in credit card borrowing. In particular, we investigate whether individuals who exhibit present-biased preferences, that is those who show a particular desire for instantaneous consumption, have higher credit card borrowing.

A number of theoretical papers suggest that present bias drives borrowing in general and card borrowing specifically (see, e.g., Laibson, 1997; Fehr, 2002). A disproportionate preference for immediate consumption, or present bias, is argued to decrease individuals' propensity to delay instantaneous gratification and, as a result, increase their borrowing. Previous literature in psychology and economics suggests that significant heterogeneity exists in individuals' present bias, that such differences are stable over time, and that they are an important determinant for specific behavioral outcomes such as educational attainment (e.g., Mischel, Shoda, and Rodriquez, 1989; Coller, Harrison, and Rutstrom, 2005). There has been, however, very little direct evidence to support the behavioral economics view that present-biased individuals have higher credit card borrowing. Previous research on the topic has used one of two approaches, examining either aggregate or self-reported debt measures. Both of these approaches have limitations for answering the question at hand. Studies using the first approach analyze aggregate credit and savings outcomes and show that models of consumer behavior with present-biased preferences predict aggregate consumption behavior better than standard exponential models (Laibson, Repetto, and Tobacman, 2008; Skiba and Tobacman, 2007; Shui and Ausubel, 2005). These studies are important as they indicate that, in the aggregate, present-biased preferences are able to explain why people simultaneously hold credit card debt and liquid assets. The link between borrowing and present bias is, however, indirect and examination of aggregates does not allow for evaluation of individual heterogeneity.

A second approach measures individual time preferences directly (often experimentally), and correlates these measures to *self-reported* individual credit balances or self-reported spending problems. In one such study, Harrison, Lau, and Williams (2002) find that individual long-run discount factors cannot explain borrowing behavior. As this study was not designed to explore the effects of present bias, it remains silent on the association between present bias and credit card borrowing. Dohmen, Falk, Huffman, and Sunde (2006) show that directly measured present bias is associated with individuals' assessment of their own spending problems. Though these studies provide important indications that standard exponential discount factors alone seem not to be important for borrowing behavior and that present bias is associated with spending problems, the accuracy of the self-reported measures from these studies is particularly difficult to assess. People generally either underreport their debt levels or lie altogether (for details, see Gross and Souleles, 2002; Karlan and Zinman, 2008).

In this study we analyze objective data from credit reports on individual credit card borrowing and correlate these objective credit outcomes with directly measured present bias parameters from incentivized choice experiments. This approach provides direct evidence on the link between present bias and credit card borrowing using objective administrative data that eliminates the confounding factor of individual truthfulness in reporting debt levels. Such efforts directly linking experimental results to real world outcomes are methodologically important as they expand our understanding of how preferences influence actual behavior in real life settings (see also Ashraf, Karlan, and Yin, 2006; Karlan, 2005).

The field study presented in this paper was conducted with around 600 individuals in collaboration with the City of Boston over two years. We find that heterogeneity in individual present bias, measured using incentivized choice experiments, is highly correlated with credit card borrowing. Individuals who are present-biased borrow significantly more on their credit cards. Though individuals may not be *charging blindly*, our findings suggest that some are at least *charging myopically* into financial trouble. The result is not driven by credit constraints or differences in socio-demographic characteristics and is robust to the possibility that sophisticated present-biased individuals may restrict their own borrowing activity by either choosing a low credit limit or choosing not to have a credit card at all. Due to the design of the study and the credit information obtained, we are able to verify that the results are robust to controlling for income (taken from individuals tax returns), information on credit constraints and a number of other socio-demographic characteristics (e.g. education).

The finding that present-biased individuals borrow more than others illustrates their naivete. Sophisticated consumers, aware of their own tendency to be present-biased in future periods, would be expected to take actions to restrict their own future borrowing activities. Naive present-biased consumers do not expect, *a priori*, that they will charge their credit cards as much as they actually do. As such, present-biased preferences lead to dynamically inconsistent borrowing behavior. This dynamic inconsistency and the apparent naivete of present-biased consumers have implications for policy makers, firms and academics.

The extra borrowing associated with present bias will be suboptimal in the sense that it may not be in the individual's own long-run interest.[1] Given this 'suboptimal' borrowing, there is an opportunity for policy makers to design policy measures and regulations aimed at improving credit outcomes (for a discussion, see Camerer, Issacharoff, Loewenstein, O'Donoghue, and Rabin, 2003; Sunstein, 2006). Such policy efforts, however, are challenging when individuals are not cognizant of their own present bias.

Linking present bias to borrowing behavior has implications for pricing and contract design in the credit card market. According to the conjecture by Ausubel (1991) and the model by DellaVigna and Malmendier (2004), in the presence of naive present-biased individuals credit card firms have an opportunity to charge prices higher than marginal costs (and make profits). The paper provides, to our knowledge, the first direct evidence that indeed present-biased individuals borrow more on credit cards and might therefore be less sensitive to interest rate changes.

Direct evidence on the association between present bias and borrowing behavior also has implications for consumer behavior theory in general. There are a number of studies that show that individuals are dynamically inconsistent (Frederick, Loewenstein, and O'Donoghue, 2002). We show that such dynamic inconsistencies have real world implications. Because so many consumer decisions (e.g., on saving, mortgages, healthy diets, cell phone plans, ...) involve intertemporal choices, it is critical to ac-

[1] The view that some credit card borrowing is suboptimal is anecdotally supported by the explosion of the credit counseling industry. The National Foundation for Credit Counseling (NFCC) reported a doubling of counseling volume through the 1990s (from 400,000 new clients in 1990 to 880,000 clients in 2000). Notably this increase occurred before changes in bankruptcy law required credit counseling as a precursor to Chapter 7 bankruptcy. Between 2 and 2.5 million individuals overall seek credit counseling each year (see Elliehausen, Lundquist, and Staten, 2007).

count for present bias as an important axis along which behavior may deviate from standard predictions.

The paper proceeds as follows: Section 2 presents conceptual considerations regarding present-biased preferences and credit card borrowing. In doing so, it distinguishes between individuals who are naive or sophisticated about their present-bias. Section 3 discusses the design of the field study, our methodology for eliciting time preferences, and the data. Section 4 presents the results and section 5 concludes.

2 Conceptual Considerations

Modeling individual preferences as present-biased posits that individuals do not discount exponentially – as standard economics assumes – but rather they discount more sharply between the present and a future period than between two subsequent periods in the future. As a result, individuals will be dynamically inconsistent (for a survey of the literature in economics and psychology, see Frederick, Loewenstein, and O'Donoghue, 2002).

Present-biased time preferences can be seen as the result of the interplay of two separate decision making systems: the affective system, which values immediate gratification and sharply discounts all future periods; and the deliberative system, which makes long-run plans and displays higher discount factors. This notion is captured in various two-system or dual-self models (for example, Gul and Pesendorfer, 2001; Bertaut and Haliassos, 2002; Bernheim and Rangel, 2004; Loewenstein and O'Donoghue, 2004; Fudenberg and Levine, 2006) and finds support in neuroeconomics studies (McClure, Laibson, Loewenstein, and Cohen, 2004, 2007).

An elegant way to capture the effects of present bias on consumer behavior is to assume a quasi-hyperbolic discounting function (Strotz, 1956; Phelps and Pollak, 1968;

Laibson, 1997; O'Donoghue and Rabin, 1999):

$$U_i = u(c_t) + \beta\delta u(c_{t+1}) + \beta\delta^2 u(c_{t+2}) + \ldots + \beta\delta^T u(c_{t+T}) \tag{1}$$

where c_t is consumption in period t, β is an individual's present bias parameter and δ is the individual's long-run discount factor. When $\beta = 1$, individuals are not present-biased and the quasi-hyperbolic model reduces to standard exponential discounting.

Maximizing the above lifetime utility function subject to a budget constraint yields important borrowing dynamics and testable implications for our empirical efforts. Present-biased individuals borrow more in the present than individuals for whom $\beta = 1$. Furthermore, present-biased individuals borrow more in each period than they would have previously intended. Additionally, sophisticated individuals, cognizant of their own present bias, may be willing to take specific actions to restrict borrowing. We show in a simple three period model of present bias with logarithmic utility how such dynamics are generated.

2.1 Charging Myopically

To illustrate how borrowing can be affected by present bias, we first examine the problem of a naive present-biased individual. Naive individuals believe they will not be present-biased in all future periods while sophisticated individuals recognize the likelihood that they will again be present-biased in the future. Consider a three period model of a naive present-biased individual with the opportunity to borrow at interest rate r and no uncertainty over income, y_t. At time $t = 1$ the individual maximizes the following logarithmic utility function:

$$U(c_1, c_2, c_3) = ln(c_1) + \beta\delta ln(c_2) + \beta\delta^2 ln(c_3) \tag{2}$$

subject to the three period budget constraint:

$$c_1 + \frac{c_2}{(1+r)} + \frac{c_3}{(1+r)^2} = y_1 + \frac{y_2}{(1+r)} + \frac{y_3}{(1+r)^2} \tag{3}$$

The optimization in $t = 1$ of a myopic individual yields the following planned consumption ratios:

$$\frac{c_1}{c_2} = \frac{1}{(1+r)\beta\delta} \tag{4}$$

$$\frac{c_2}{c_3} = \frac{1}{(1+r)\delta} \tag{5}$$

These consumption ratios, combined with the budget constraint, determine the planned consumption of a present-biased individual in each of the three periods. This yields the following level of consumption, c_1:

$$c_1^* = \frac{y_1}{(1+\beta\delta+\beta\delta^2)} + \frac{y_2}{(1+\beta\delta+\beta\delta^2)(1+r)} + \frac{y_3}{(1+\beta\delta+\beta\delta^2)(1+r)^2} \tag{6}$$

Consumption (and borrowing) in $t = 1$ is decreasing in β. As an individual becomes more present-biased, he or she consumes more and, given fixed income, borrowing in $t = 1$ increases. The key prediction to be tested empirically is that present-biased individuals ($\beta < 1$) borrow more than individuals who are not present-biased ($\beta = 1$).

The solution of the above problem represents only the planned values of consumption as of $t = 1$. Though under the assumption of naivete the planned and actual values of consumption will coincide in period $t = 1$, these values will systematically deviate in later periods.

As of $t = 1$, the individual believes the relationship between his second and third period consumption is governed by equation (5). However, when $t = 2$ arrives, he is again present-biased and the equation that actually governs this relationship is:

$$\frac{c_2}{c_3} = \frac{1}{(1+r)\beta\delta} \tag{7}$$

With $\beta < 1$ a naive individual will consume more in $t = 2$ and less in $t = 3$ than he had originally planned in $t = 1$ to consume in these periods. To finance additional $t = 2$ consumption, a naive, present-biased individual will borrow more than he had originally intended.

2.2 Sophisticated Charging

Thus far we've illustrated the case of naive individuals. However, individuals may recognize the fact that they will be present-biased in future periods. That is, the individual recognizes in $t = 1$ that his choices for $t = 2$ and $t = 3$ consumption will be governed by equation (7) and not equation (5). Sophisticated individuals then choose a consumption for $t = 1$ that maximizes total plan utility given the expected consumption response in $t = 2$ and the trivial response of consuming the rest in $t = 3$. In section A.5 in the appendix, we present the solution for the simple case of logarithmic utility with a zero interest rate and unity long run discount factor for such a sophisticated individual.

The model shows that sophisticated individuals may take actions to restrict the behavior of future selves. The simplest, and most severe, of these actions is restricting all future period selves to zero borrowing. There exist parameter values of β for which a sophisticated individual may prefer not to have a credit card in future periods (see appendix for details). One could also imagine a less extreme outcome where a sophisticated individual would choose to have a lower credit limit to restrict future borrowing opportunities. The fact that sophisticated present-biased individuals might restrict their own borrowing in such ways would reduce the expected relationship between card borrowing and present bias as these present-biased individuals would borrow less by construction.

Another factor entering into the relationship between present bias and borrowing is the effect of credit card firms when faced with present-biased consumers. As noted by Ausubel (1991) and DellaVigna and Malmendier (2004), naive present-biased individuals should be less sensitive to interest rate changes than individuals who are not present-biased. Furthermore, as naive present-biased individuals borrow and consume more than others, they may have less available funds to repay, increasing the risk of default. In the presence of such present-biased naive consumers, credit card firms may charge higher rates of interest to compensate for the increased risk or extract the surplus associated with such consumers' lower price sensitivity. In general, individuals are sensitive to increases in their card interest rates to at least some degree (Gross and Souleles, 2002). If present-biased individuals are charged higher rates of interest, this should lower their borrowing and empirically work against finding a difference in card debt levels between present-biased individuals and those who discount exponentially.

The conceptual considerations provide important guidance for our empirical analysis. Present-biased individuals should borrow more on their credit cards. This is the key prediction that we would like to test empirically. Sophisticated individuals might restrict their own borrowing opportunities either by choosing to not have a credit card (restriction on the extensive margin) or by choosing a low credit limit (restriction on the intensive margin). We test empirically whether controlling for these potential restrictions affects the results in the expected way. Firm pricing strategies and interest rates should also play a role in determining borrowing outcomes. We therefore control for a proxy for interest rates in our analysis.

3 Field Study: Credit Bureau Data and Choice Experiments

3.1 Design of Field Study

The field study was conducted with 606 individuals at two Volunteer Income Tax Assistance (VITA) sites in Boston, Massachusetts.[2] During the 2006 tax season, the study was conducted in the Dorchester neighborhood (N=139) and during the 2007 tax season in the Roxbury neighborhood (N=467). The studies in the two years mainly differ in the way in which we elicited time preferences (discussed in detail below).

The setting of the field study allowed us to obtain consent from all participants to access their credit report, to retrieve income information from their tax return, to ask participants further questions about certain socio-demographic variables, and to elicit time preferences using incentivized choice experiments. Of the 606 participants, we obtain a usable measure of time preferences for 541 (see below for details). These individuals represent our primary study sample.

Panel A of Table 1 shows the socio-demographic characteristics of the participants. The average participant has low disposable income of around $18,000, is African-American, female, around 36 years old, with some college experience, and has less than one dependent. The participants do not differ in observable characteristics in the two years the study was conducted – with the exception of age. Participants are younger in 2007 compared to 2006 (not shown here). In the main analysis, missing socio-demographic variables were imputed by taking the value of the majority for the dummy variables gender, race, and college experience. The exclusion of observations

[2] There are currently 22 VITA sites in and around Boston, MA. Coordinated by a city-wide coalition of government and business leaders, VITA sites provide free tax preparation assistance to low-to-moderate income households. Taxes are prepared by volunteers throughout tax season, from late-January to mid-April each year.

with missing variables does not change the results (see section 4.3).

As can be seen in the summary statistics, the study was targeted towards low-to-moderate income (LMI) / subprime borrowers without mortgages. In the terminology of Harrison and List (2004) this study is an "artefactual field experiment" linked to administrative data. The non-standard subject pool used in this study is of particular interest for the research question at hand, as LMI and subprime households' less secure position puts them at great financial risk (see, Bertrand, Mullainathan, and Shafir, 2004). Additionally, there are very few experimental studies focusing solely on the behavior of LMI families in developed countries (an exception is Eckel, Johnson, and Monmarquette, 2005).

[Table 1 about here]

3.2 Credit Bureau Data

Information on individual credit behavior comes from one of three major credit bureaus in the United States. The credit reports list detailed information on each individual's credit behavior. In particular, credit reports reveal outstanding balances, how much of the available credit limit is utilized (and therefore whether people are credit constrained), and whether accounts are in debt collection (for more details on credit reporting, see Avery, Bostic, Calem, and Canner, 2003). Unlike self-reported data, credit reports give a very detailed, objective picture of individual borrowing behavior.[3]

This paper analyzes outstanding balances on revolving accounts as the amount of borrowing. These are primarily credit card balances and we refer to them as such from

[3]LMI populations frequently resort to non-traditional loan products. For a subset of our sample in 2006 (N = 131), we use self-reported information on loans obtained from pawn brokers, check cashers, payday lenders, friends, family, or on any outstanding balances on bills due to medical providers, landlords, and utilities providers. Non-traditional debt of this type is relatively small, averaging \$372 (s.d. \$827) per person. Adding nontraditional debt to aggregate debt does not influence the results. As people often under-report their real debt level in surveys, we do not present regression analysis using these self-reported debt levels.

here on.

Though balances listed on credit reports are point-in-time measures, we argue that our borrowing measures closely reflect revolving balances and not convenience charges. In general, only around five to ten percent of total balances are convenience charges (Johnson, 2004). To ensure that our measures represent actual borrowing, we implemented a companion survey with questions on payment habits following the Survey of Consumer Finances (N = 174). Individuals who report normally paying the full amount on their credit card at the end of the month, have significantly lower balances on revolving accounts ($1,084 versus $2,998; $p < 0.05$ in a t-test). Furthermore, the conclusion of our results hold when using these self-reported payment habits as the dependent variable or when analyzing credit card balances one year after we elicited individual time preferences.

Panel B of Table 1 illustrates for our participants the two general stylized facts about credit card borrowing: the high level and the large degree of heterogeneity. The average revolving credit card balance is $1,059 (s.d. $2,414) yielding an average revolving debt-to-income ratio of around 9 percent (for individuals with positive income). Relative to the general population, our sample has notably high levels of credit card debt. The average U.S. resident has a self-reported credit card debt to income ratio of only 4.3 percent (authors' calculation based on Bucks, Kennickell, and Moore, 2006). The large standard deviation of credit card balances illustrates the degree of heterogeneity in borrowing. Of all participants, only about half of the participants (44 percent) have any outstanding balances on credit cards. Conditional on having any credit card debt, participants have $2,592 in credit card balances.

Credit reports also provide crucial information on who has a revolving credit account (i.e., credit card) and on individuals' revolving credit limits. In our sample, the average revolving credit limit is $4,764 (s.d. $11,850). Fifty-five percent of the participants cannot currently borrow on revolving accounts listed on their credit report, either because they have no current access to credit or because they have hit the credit limit on their credit cards. As will be shown in the following sections, credit constraints cannot explain either the elicited time preference parameters or, importantly, the association between present bias and borrowing behavior. 53 percent of study participants don't have any revolving account, which might be an explicit decision on part of the participant and will be taken into account in the analysis.

Even though credit reports don't provide information about interest rates on credit cards, the Fair Issac Corporation (FICO) credit score provides a good proxy for the interest rate as most financial institutions use risk-based pricing strategies (see Furletti, 2003). The average FICO score of 610 and the median FICO score of 596 (for subjects who are scored) illustrates that the majority of subjects in this study would be considered subprime borrowers by the commonly used cutoff of 620.

3.3 Measuring Time Preferences

In this paper, individual time preferences are measured using incentivized choice experiments (for similar approaches, see Harrison, Lau, and Williams, 2002; McClure, Laibson, Loewenstein, and Cohen, 2004; Dohmen, Falk, Huffman, and Sunde, 2006; Tanaka, Camerer, and Nguyen, 2007, and for a survey on measuring time preferences, see Frederick, Loewenstein, and O'Donoghue (2002)). Individuals were given three multiple price lists and asked to make various choices between a smaller reward ($\$X$) in period t and a larger reward ($\$Y > \$X$) in period $t+\tau > t$. In order to measure individual discount factors, we keep ($\$Y$) constant and vary ($\$X$) in three time frames: in two time frames t is the present ($t = 0$) and τ is either one ($\tau = 1$) or six months ($\tau = 6$). In the third time frame, t is in six months ($t = 6$) and τ is one month ($\tau = 1$).

The studies in 2006 and 2007 differed in two dimensions. First, the values of $\$X$

and $\$Y$ in the different decisions were varied between 2006 and 2007 to check the robustness of the results to such variation. In 2006, $\$Y = \$80$ and $\$X$ was varied from \$75 to \$30 (see the instructions in Appendix A.2). In 2007, $\$Y = \$50$ and $\$X$ was varied from \$49 to \$14 (see the instructions in Appendix A.3). Second, the presentation of the choice sets was varied between 2006 and 2007. While in 2006 the order of the three price lists was the same for each individual, in 2007, the order was randomized. Additionally, while in 2006, the 139 participants were individually and extensively guided through the details of the price lists, the 467 participants in 2007 received a substantially shorter price list introduction. Most likely, the randomization of the price list order and the shorter introduction increased the noise in measuring time preferences in 2007 compared to 2006. In the results section, we mainly analyze the data from the two years jointly, controlling for the year of study. In the appendix, we report the results separately for the two years. As expected, the standard errors in 2007 are often larger than in 2006, but the results are qualitatively similar.

In order to provide an incentive for the truthful revelation of preferences, 10 percent of individuals were randomly paid one of their choices. This was done with a raffle ticket, which subjects took at the end of their tax filing and which indicated which choice would be effective (if at all). To ensure credibility of the payments, we filled out money orders for the winning amounts on the spot in the presence of the participants, put them in labeled, pre-stamped envelopes and sealed the envelopes. The payment was guaranteed by the Federal Reserve Bank of Boston and individuals were informed that they could always return to the heads of the VITA sites where the experiments were run to report any problems receiving the payments.[4] Money orders were sent by mail to the winner's home addresse on the same day as the experiment (if $t = 0$), or in

[4]In fact, one participant returned to his VITA site, a community health center, almost seven months after the experiment to ask about his payments. He was, however, three days too early and received the payment on time.

one, six, or seven months, depending on the winner's choice. The payment procedure therefore mimicked a front-end-delay design (Harrison, Lau, Rutstrom, and Williams, 2005). The details of the payment procedure of the choice experiments were kept the same in the two years and participants were fully informed about the method of payment.[5]

The multiple price list setup enables us to measure individuals' time preferences. Using information from all three price lists allows us (1) to measure discount factors and (2) to see whether some individuals show a disproportionate preference for present (or future) rewards; that is, whether some individuals are present-biased (or future-biased).

(1) *Individual discount factor (IDF)*: We estimate *IDF* for three different time frames by looking at the point, X^*, at which individuals switch from opting for the smaller, sooner payment to the larger, later payment in a given price list. That is, a discount factor is taken from the last point at which an individual prefers the sooner, smaller payment. For example, if an individual prefers $75 today over $80 in one month, but prefers $80 in one month over $70 today, we take $75 as the switching point and the corresponding monthly discount factor of 0.94. Therefore, individual discount factors are calculated as: $IDF^{\tau} = X^*/Y$. We use the average of the calculated monthly discount factors, $\overline{IDF}$, in the main analysis. Importantly, the research question at hand needs a reliable measure of the heterogeneity in *IDF*s across individuals and not necessarily precise point estimates of the level of the *IDF*. The price lists, however, do not elicit point estimates of the *IDF* but rather ranges of where the *IDF* lie (see Coller

[5]If individuals expect to move in the next seven months, they might question the likelihood that their mail would be forwarded to their new address in a timely manner. As movers might therefore prefer payments in the present for logistical reasons and not for reasons related to their underlying time preference, we ask individuals *"Do you expect to move in the next 7 months?"*. Whether individuals expect to move does not correlate with elicited time preferences and does not affect our results (see Table 7).

and Williams, 1999; Harrison, Lau, Rutstrom, and Williams, 2005, for details).[6]

(2) *Present Bias and Future Bias*: The three time frames allow us to identify individuals who are dynamically inconsistent; that is, they show a bias towards either present or future payouts, becoming more or less patient across price lists. By comparing individual choices in Time Frame 1 ($t = 0$, $\tau = 1$) with Time Frame 2 ($t = 0$, $\tau = 6$) and Time Frame 1 ($t = 0$, $\tau = 1$) with Time Frame 3 ($t = 6$, $\tau = 1$) we obtain two measures for whether individuals are dynamically inconsistent. Based on the range of possible *IDF*s found in Time Frame 1 for a given individual, we find the range of choices in time Time Frames 2 and 3 that the individual would make if they discounted exponentially.[7] If the range of actual choices is higher than the implied range of choices for an exponential discounter, the individual exhibits an increasing discount factor. That is, in a quasi-hyperbolic model, $\beta < 1$ and the individual is present-biased. Similarly if the range of actual choices is lower than the implied range of choices for an exponential discounter, the individual exhibits a decreasing discount factor. In a quasi-hyperbolic model, $\beta > 1$ and the individual is future biased. A small number of individuals exhibit such decreasing discount factors. We classify an individual as being "*Present Bias (=1)*" or "*Future Bias (=1)*" if they exhibit dynamic inconsistency in both measures. As a robustness test, we also report the results for the two measures of dynamic inconsistency separately and measure parameters of β and δ from a quasi-hyperbolic discounting function.

As can be seen in Panel C of Table 1, we measure an average *IDF* of 0.86. This discount factor may seem low, but it is in line with previous research, which tends to find low discount factors in experimental studies (see Frederick, Loewenstein, and O'Donoghue, 2002). Decisions on payday loans or used cars imply, however, often much

[6]The results are maintained if we estimate interval regressions (Stewart, 1983) using the range of possible *IDF*s.

[7]We therefore take into account that the choice experiments measure only ranges and not point estimates of *IDF*s.

lower discount factors for subprime borrowers than measured by our experiment (e.g., Skiba and Tobacman, 2007; Adams, Einav, and Levin, 2008). For our measure of dynamic inconsistency: 25 percent exhibit increasing discount factors ("*Present Bias (=1)*" and only 2 percent have decreasing discount factors ("*Future Bias (=1)*"). The *IDF*s are lower in 2007, but in both years, the same proportion of individuals exhibit dynamically inconsistent preferences.

The applied method to measure time preferences with incentivized choice experiments as described above has many advantages over other approaches (Frederick, Loewenstein, and O'Donoghue, 2002), but the method also has challenges which have to be addressed.

First, in order to measure an *IDF* and whether individuals are dynamically inconsistent, an individual must exhibit a unique switching point in each price list. In both years around 11% do not exhibit a unique switching point in one or more price lists. In the main analysis we focus on the 541 individuals who show a unique switching point in all price lists. When we include individuals with multiple switching points in a robustness test by taking their first switching point (see Section 4.3), the results mainly hold.

Second, individuals' decisions in the price lists might be affected by either their outside lending or borrowing opportunities (see Harrison, Lau, Rutstrom, and Williams, 2005). Due to the design of the choice experiments and the implied interest rates offered in the price lists, we should observe that if external borrowing and lending opportunities influenced behavior individuals should be more patient when $\tau = 1$ as opposed to when $\tau = 6$ or should uniformly wait for later payments (see Meier and Sprenger, 2008, for more details). As these patterns are not seen in the data, we find that outside borrowing and lending opportunities do not greatly affect our experimental results.

Third, the measurement of time preference parameters by observing individuals' switching points in price lists implicitly assumes that utility is linear over the payments in question. This procedure simplifies the analysis considerably and is consistent with expected utility theory, which implies that consumers are approximately risk neutral over small stakes outcomes (Rabin, 2000). However, parameters estimated from price lists may also capture differences across individuals in the degree of curvature of the utility function (Andersen, Harrison, Lau, and Rutstrom, 2008).[8] We therefore test whether differences in risk aversion affect our results using a question on general risk attitudes previously validated with a large, representative sample (Dohmen, Falk, Huffman, Sunde, Schupp, and Wagner, 2005). The question reads as follows: *"How willing are you to take risks in general? (on a scale from "unwilling" to "fully prepared").* As the scale of the answer differed from 0 to 7 in 2006 to 0 to 10 in 2007, we rescale the answer to be on an 11-point scale in both years. While risk aversion is correlated with measured time preferences, controlling for it does not affect the results of this paper (see Section 4.3).

Fourth, credit availability (and constraints) might drive the behavior in the choice experiments, as individuals who are credit constrained might prefer earlier, lower payments. The data does not provide support for this possibility. The credit report data permit us to know precisely how much participants are still able to borrow on revolving accounts such as credit cards. If one correlates immediate credit availability, that is the amount individuals can still borrow (in natural logarithm), to present bias, the correlation is small in size, and is not statistically significant. Also, individuals who are credit constrained by this measure do not exhibit different degrees of present bias than individuals who can still borrow on their revolving accounts. Credit constraints are also uncorrelated with measured discount factors, $\overline{IDF}$. Importantly, the results

[8] Attributing our experimental responses to risk preferences alone yields unrealistically high levels of risk aversion. For a discussion of the high stakes implications of even moderate risk aversion over small stakes see Rabin (2000).

of this paper are unchanged when controlling for both disposable income (as a proxy for credit constraints) and an objective measure of credit availability from individual credit reports (see Section 4.3).

In general, our time preference measures are also uncorrelated with proxies for credit experience (whether an individual has sufficient credit experience to have a FICO score, the total number of loan accounts an individual has ever had and the number of revolving credit card accounts an individual has ever had). The fact that all of these indicators of credit constraints and experience are unrelated to measured time preferences supports the claim that differential credit experience also cannot explain heterogeneity of present bias and its correlation with borrowing behavior.

4 Results

We present results exploring the relationship between individual present bias and credit card borrowing in three steps.

In the first step, we examine present bias as it relates to borrowing for all individuals including those without credit cards. For a subsample we additionally examine credit card debt one year after the experiment to ensure that the results are maintained.

As noted above, sophisticated present-biased individuals may choose not to have a credit card in order to restrict their own future behavior. This should weaken the relationship between card borrowing and present bias presented in the first stage. In a second step, we examine card borrowing and present bias only for individuals with credit cards as measured by positive revolving credit limits. We additionally control for the value of individual credit limits as sophisticated individuals may restrict future behavior on both the intensive and extensive margin. We also control for firm pricing effects with individual FICO scores as a proxy for individual interest rates.

In a third stage we show that the results are robust to using different measures of present bias (e.g. a quasi-hyperbolic model) and to adding additional control variables. When interpreting all of these results, particularly the size of the estimated coefficients, one must take into account the low income of the study participants.

To obtain our results, we estimate models of the following form:

$$Borrowing_i = \alpha + \gamma_1 \overline{IDF}_i + \gamma_2 Present\ Bias_i + \gamma_3 Future\ Bias_i + \gamma_4 Y_i + \gamma_5 X_i + \epsilon_i \quad (8)$$

$Borrowing_i$ is individual i's balance on revolving accounts. $\overline{IDF}_i$, $Present\ Bias_i$, and $Future\ Bias_i$ are measures for individual i's time preferences (as discussed above). Y_i is the a dummy for the year of study. The vector X_i reflects individual control variables, such as age, gender, race, and education. We also control for an individual's financial situation by entering disposable income and the number of dependents filed on annual tax returns in the regression. The paper will report results with and without controlling for X_i.

As *Borrowing* is censored at 0, we estimate tobit regressions. The tobit estimator, however, makes the crucial assumption that the same set of independent variables determine whether an observation is censored (for example, whether an individual does not have any debt) and the value of a noncensored observation (for example, how much debt an individual has accumulated)(Cragg, 1971; Lin and Schmidt, 1984). To get a notion of whether the results depend on this assumption, we also report OLS regressions of all the models and discuss potential discrepancies between the two specifications. There are, however, very few differences.

4.1 Present Bias and Credit Card Borrowing

A first indication of the relationship between time preferences and borrowing is the raw correlation between individuals' discount factors and credit card borrowing and a simple comparison of the balances on credit cards for individuals with and without present-biased preferences. The correlation between $\overline{IDF}$ and credit card borrowing is 0.03 and it is far from statistically significant. Similar to the results by Harrison, Lau, and Williams (2002) discount factors alone do not seem to be related to credit card borrowing. On the other hand, individuals exhibiting present-biased preferences have significantly higher balances than individuals with time-consistent preferences. Individuals with time-consistent preferences have, on average, \$855 in outstanding revolving balances, while individuals who exhibit present-biased time preferences (that is, who have increasing discount factors) have, on average, \$1,667 in outstanding balances. The difference is statistically significant at the 1 percent level in a t-test. Individuals who exhibit decreasing discount factors (i.e. are future biased) do not differ from individuals with time-consistent preferences. This result supports the prediction that present-biased individuals borrow more on their credit cards.

The results of this primary analysis are supported in multivariate regression models – controlling for the year of study and socio-demographic variables. Such tests are important as a third factor might drive the association between present bias and credit card borrowing. For example, cognitive abilities might correlate with time preferences (Benjamin, Brown, and Shapiro, 2006) and with borrowing. The regressions in Table 2 therefore control for two proxies of cognitive abilities: a dummy for college experience and individuals' income from their tax return.

[Table 2 about here.]

Columns (1) and (2) in Table 2 presents results from tobit regressions in which the dependent variable is the outstanding credit card balance with and without individual control variables. The results show that $\overline{IDF}$s are not significantly associated with debt levels. As predicted by the behavioral model outlined above, individuals who exhibit present-biased preferences have substantially higher outstanding balances on revolving accounts. Controlling for socio-demographic characteristics, the effect is statistically significant at the 95 percent level and substantial in size. Computing marginal effects for the tobit model in Column (2) shows that the probability of having revolving debt increases by 14 percentage points for individuals who exhibit present bias and that the amount of debt increases by about $496 conditional on having debt. Columns (3) and (4) show that the results are similar when estimating equation (8) in an OLS framework. As will be shown below, the results are robust to the inclusion of credit limit, controlling for individual risk attitudes, changes in the definition of dynamic inconsistency and changes in the composition of the sample.[9] Table A1 and A2 in the appendix shows that the effects are qualitatively similar in the two years in which we conducted the study but larger and more precisely estimated in year 2006. The coefficients of the control variables in table 2 show that income, age, and gender are significantly correlated with credit card borrowing across the models.

One potential worry about the association between our measures of time preferences and credit outcomes is that both might be influenced simultaneously by recent negative or positive income shocks. One could imagine a negative shock that is unobservable to the researcher, not reflected in taxable income, and simultaneously affects both the individual's credit report and his or her choice experiment responses. We would

[9]Instead of using outstanding balances on revolving accounts as the dependent variable, we can also use a dummy for whether individuals self-report that they normally pay their credit card in full at the end of the month (the question asked for each account in the Survey of Consumer Finances). The results of a probit regression including the control variables for the 147 participants for whom this information is available show that present-biased individuals are 15 percentage points less likely to pay their credit card bill in full. Individuals who exhibit present-biased preferences are therefore more likely to accumulate debt ($p < 0.05$; detailed results are available on request).

erroneously attribute the correlation between measured present bias and borrowing to our hypothesized explanation while it is actually due to this shock.

To check whether such short-lived shocks can explain the association between present bias and borrowing, we obtained the consent of the sample in 2006 to check their report again one year later. Table 3 estimates the same tobit models as before but with credit card borrowing one year after we elicited time preferences. The results show that our measure of present bias can explain credit card borrowing one year later ($p = 0.06$). This is a very strong test of the association between experimentally measured time preferences and credit card borrowing and gives confidence that the choice experiments provide a reliable measure of the heterogeneity in individual present bias; measures which are then able to explain part of the heterogeneity in credit card borrowing.

[Table 3 about here.]

In sum, the results show that experimentally measured individual discount factors are not associated with credit card borrowing from individual credit reports. However, individuals who exhibit present-biased preferences have substantially higher levels of outstanding balances. Even one year after the choice experiments took place, the measure of present-biased preferences predicts higher credit card borrowing. This result supports the notion that individuals with present-biased time preferences have higher credit card borrowing.

4.2 Borrowing Conditional on Having a Credit Card

The analysis so far includes *all* individuals, whether they have a credit card or not. That is, our analysis treats all individuals including sophisticates that may have restricted their own borrowing activity by choosing not to have a credit card. As some present-biased individuals will not borrow due to such a commitment strategy, the analysis presents a conservative test of the association between present bias and credit card borrowing. In the following section, we restrict the sample to individuals who have at least one credit card as measured by a positive revolving credit limit.

Table 4 presents the results for individuals with at least one credit card and controls for the credit limit on all credit cards (in natural logarithm). Consistent with the prediction in the conceptual considerations above, the association between present bias and credit card borrowing becomes stronger and more precisely estimated. Computing marginal effects for the tobit model in Column (2) shows that the probability of having revolving debt increases by 23 percentage points for individuals who exhibit present-biased preferences and that the amount of debt increases by about $1,090 conditional on having debt. The inclusion of individuals' credit limit shows that credit limits are correlated with borrowing (Gross and Souleles, 2002), and also that with the inclusion of credit limit as a control variable the relationship between present bias and card borrowing is maintained.

[Table 4 about here.]

Table 5 extends the analysis by incorporating FICO credit scores. Credit scores reflect individuals' creditworthiness and, as such, are used by lenders to determine the interest rate on debt. We use FICO scores as a proxy for individuals' credit card interest rates. The results based on scored individuals show that, controlling for individual FICO scores, the association between present bias and credit card balances is maintained. Given individual credit limits, FICO scores are negatively associated with credit card borrowing. This could be due either to creditworthy consumers borrowing less or the fact that higher utilization of credit lines decreases one's credit score.

[Table 5 about here.]

In sum, we show that the result that present-biased individuals have higher credit card borrowing is robust to restricting the sample to individuals with positive credit limits and to controlling for FICO scores. In general, the results move in the directions suggested in our conceptual development. Eliminating potentially sophisticated individuals who restrict their own borrowing strengthens the relationship between borrowing and present bias. The relationship between card borrowing and present bias is also maintained when controlling for a proxy for credit card interest rates.

4.3 Robustness

This section tests the robustness of the obtained results (1) to changes in calculating time preferences and (2) to controlling for risk attitudes, expectations of moving, and to relaxing the sample restriction criteria.

Table 6 shows how robust the results are to alternative measures of impatience using outstanding balances on credit card accounts as a dependent variable. The columns show the results for all individuals without and with control variables (Column (1) and Column (2)) and for individuals who have at least one credit card (Column (3)). Panel A and B calculate a measure for *IDF* and dynamic inconsistency based on either Time Frame 1 ($t = 0$, $\tau = 1$) and Time Frame 2 ($t = 0$, $\tau = 6$) or Time Frame 1 ($t = 0$, $\tau = 1$) and Time Frame 3 ($t = 6$, $\tau = 1$). While qualitatively very similar, the two panels show that dynamic inconsistency measured by shifting Time Frame 1 six months into the future (similar to, for example, the approach by Ashraf, Karlan, and Yin, 2006) predicts debt levels better. In Panel C, we fit the choices with a quasi-hyperbolic discounting, $\beta - \delta$, model (for example, Strotz, 1956; Laibson, 1997) and calculate individual βs and δs (see appendix A.4 for details). This robustness test reinforces the obtained results that, controlling for socio-demographic characteristics, present-biased individuals, that is, those with lower βs, have higher credit card borrowing.

[Table 6 about here.]

Table 7 shows the robustness of the results to including individual risk attitudes and whether individuals expect to move in the next seven months as control variables and to changes in the sample restrictions. Panel A shows that the obtained results are robust to controlling for individual attitudes toward risk and whether individuals expect to move in the near future. This provides important suggestive evidence that when controlling for risk attitudes, the association between time preferences and card borrowing is maintained. Finally, Panels B and C explore whether sample restrictions affect the results. In Panel B, we include individuals who exhibit multiple switching points and therefore make it difficult to calculate a discount factor. For these individuals we take their first switching point to calculate their *IDF*s. The results stay qualitatively the same but the standard errors naturally increase. In Panel C, we exclude all the individuals for whom we have missing control variables (and for whom we imputed these variables in the main analysis). The results do not change.

[Table 7 about here.]

5 Conclusions

This paper investigates the relationship between present bias and credit card borrowing at the individual level. We present evidence from a unique field study combining incentivized choice experiments with objective administrative data on credit card borrowing. We find that present-biased individuals borrow significantly more on their credit cards than individuals who are not present-biased. The results hold when controlling for the potential effects of sophistication and firm pricing strategies.

The finding that directly measured present bias correlates with card borrowing gives critical support to models of present bias for evaluating consumer behavior. Furthermore, the results have important implications for policy makers, firms and economic theory:

The results show that present-biased individuals have higher debt levels on credit card accounts. The instantaneous access to credit offered by credit cards and the instant gratification associated with card purchases leads present-biased individuals to borrow more. The dynamic inconsistency inherent to present-biased preferences indicates that some of this borrowing is suboptimal and too high given individuals' own long-run plan. If borrowing is too high, given individuals' own objectives, then policy makers have an opportunity to design policy to reduce borrowing back to initially planned levels. In order to decide on ways to target this issue, the level of sophistication becomes, however, very relevant. This paper does *not* directly address the question of whether individuals know about their dynamic inconsistency; it only controls for the possibility. As a number of policy implications (as discussed, for example, in Camerer, Issacharoff, Loewenstein, O'Donoghue, and Rabin, 2003) depend on the sophistication of present-biased consumers, future research should investigate who, among the population of present-biased consumers, actually anticipates their own future present bias.

In the presence of naive present-biased consumers, credit card firms could charge higher interest rates in response to lower price sensitivity. We provide direct evidence that indeed present-biased individuals borrow more on credit cards and might therefore be less sensitive to interest rate changes. This evidence provides empirical support for the notion that credit card firms might be able to charge prices above marginal costs (DellaVigna and Malmendier, 2004). For both naive and sophisticated present-biased individuals, higher interest rates may be attractive. The former do not expect to borrow extensively and the latter may view high prices as a commitment device against future borrowing. Such effects of present bias in borrowing might be one reason for the claimed stickiness of credit card rates (e.g Ausubel, 1991). Gabaix and Laibson (2006) show that in the presence of naive, present-biased consumers, competition might also not eliminate such pricing strategies. A natural extension of the empirical research presented in this paper is to investigate whether present-biased individuals are indeed less sensitive to interest rate changes.

Direct evidence on the link between present bias and borrowing behavior has implications for consumer behavior theory. The results in this paper show not only that some individuals have non-standard, present-biased time preferences, but also that individual differences in these preferences have real behavioral effects. Because so much consumer behavior involves intertemporal choice, it is critical that research account for present bias as an important axis along which behavior may deviate from standard predictions.

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Table 1: Summary Statistics

Variable	N	Mean	s.d.
Panel A: Socio-demographic variables			
Age	541	35.9	13.4
Gender (Male=1)	510	0.35	0.48
Race (African-American=1)	491	0.80	0.40
College Experience (=1)	465	0.52	0.50
Disposable Income	541	18,517	13,693
# of Dependents	541	0.52	0.84
Panel B: Credit behavior			
Debt (=1)	541	0.41	0.49
Revolving Balance	541	1,059	2,414
Credit Constrained (=1)	541	0.55	0.50
Revolving Credit Limit	541	4,764	11,850
Amount Able to Borrow	541	3,754	10,709
Having a Revolving Account (=1)	541	0.53	0.50
FICO Score	390	610	84
Panel C: Time preferences			
Unique Switching Point (=1)	606	0.89	0.31
$\overline{IDF}$	541	0.86	0.15
Present Bias (=1)	541	0.25	0.43
Future Bias (=1)	541	0.02	0.14

Table 2: Credit Card Borrowing

	(1) Tobit	(2) Tobit	(3) OLS	(4) OLS
$\overline{IDF}$	1746.343	113.774	61.299	-404.310
	(1604.307)	(1573.015)	(566.145)	(607.434)
Present Bias (=1)	1246.680**	1588.578***	804.212**	948.195***
	(516.997)	(507.844)	(313.103)	(320.095)
Future Bias (=1)	596.836	273.872	-138.749	-157.773
	(1531.442)	(1457.899)	(321.674)	(393.715)
Ln(Disposable Income)		1271.837***		345.707***
		(247.481)		(77.727)
# of Dependents		174.469		201.769
		(264.586)		(155.878)
College Experience (=1)		324.945		121.994
		(503.671)		(224.453)
Age		32.880*		18.186**
		(17.389)		(7.868)
Gender (Male=1)		-1136.614**		-332.440
		(496.319)		(217.561)
Race (African-American=1)		565.238		405.499**
		(545.473)		(190.473)
Year of Study (2007=1)	-222.500	-279.112	17.570	-58.761
	(537.048)	(530.325)	(243.172)	(247.951)
Constant	-3066.034**	-15213.184***	793.256	-3024.791***
	(1525.424)	(2678.887)	(551.239)	(916.059)
LL/R^2	-2352.80	-2324.70	0.021	0.090
N	541	541	541	541

Note: Dependent variable: Outstanding balance on revolving accounts. (Robust) standard errors in parentheses. Dummies for imputed education, gender and race are omitted.
Level of significance: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 3: Credit Card Borrowing One Year After Choice Experiment

	(1)	(2)
$\overline{IDF}$	5613.736	2229.050
	(7568.913)	(7099.805)
Present Bias (=1)	3069.762*	3013.868*
	(1649.718)	(1595.827)
Future Bias (=1)	1875.382	5529.135
	(5313.317)	(5188.061)
Control Variables	No	Yes
LL	-701.50	-694.10
N	123	123

Note: Dependent variable: Outstanding balance on revolving accounts one year after choice experiment. Coefficients of tobit regressions. Standard errors in parentheses. The sample consists of participants in 2006. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, a constant term and dummies for imputed gender, race, and education.
Level of significance: $^{*}p < 0.1$

Table 4: Credit Card Borrowing Conditional on Having a Revolving Account

	(1) Tobit	(2) Tobit	(3) OLS	(4) OLS
$\overline{IDF}$	-332.459	-747.800	-667.538	-1006.841
	(1565.758)	(1282.354)	(974.128)	(868.840)
Present Bias (=1)	1651.144***	2033.051***	1459.439***	1695.379***
	(509.402)	(422.587)	(519.154)	(427.035)
Future Bias (=1)	-725.862	-69.220	-672.173	-296.529
	(1356.060)	(1083.501)	(442.400)	(526.651)
ln(Credit Limit)		1290.379***		958.043***
		(114.640)		(101.723)
Dummy for Year of Study	Yes	Yes	Yes	Yes
Control Variables	No	Yes	No	Yes
LL/R^2	-2141.73	-2076.86	0.048	0.366
N	285	285	285	285

Note: Dependent variable: Outstanding balance on revolving accounts. (Robust) standard errors in parentheses. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, a constant term and dummies for imputed gender, race, and education.
Level of significance: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Table 5: Credit Card Borrowing Controlling for FICO Score

	(1) Tobit	(2) Tobit	(3) OLS	(4) OLS
$\overline{IDF}$	-147.858	-234.196	-482.399	-631.262
	(1586.510)	(1316.621)	(1003.892)	(926.804)
Present Bias (=1)	1842.106***	2101.634***	1590.361***	1713.938***
	(526.882)	(432.810)	(554.633)	(469.279)
Future Bias (=1)	-833.397	-260.960	-745.611*	-434.535
	(1351.937)	(1076.460)	(449.220)	(435.489)
ln(Credit Limit)		1448.964***		1083.259***
		(137.079)		(116.751)
FICO Score		-6.755***		-5.095**
		(2.579)		(2.137)
Dummy for Year of Study	Yes	Yes	Yes	Yes
Control Variables	No	Yes	No	Yes
LL/R^2	-2057.74	-1993.89	0.054	0.377
N	269	269	269	269

Note: Dependent variable: Outstanding balance on revolving accounts. (Robust) standard errors in parentheses. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, a constant term and dummies for imputed gender, race, and education.
Level of significance: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

Table 6: Robustness: Alternative Measures of Dynamic Inconsistency

	(1) Tobit	(2) Tobit	(3) Tobit
Revolving Accounts > 0	No	No	Yes
Control Variables	No	Yes	Yes
Year Dummy	Yes	Yes	Yes
N	541	541	285
Panel A: First and Second Time Frame			
$\overline{IDF}_{1-2}$	1447.659	-742.190	-1910.376
	(1705.416)	(1675.321)	(1359.744)
Present Bias_{1-2} (=1)	653.552	875.819*	1576.719***
	(476.331)	(464.112)	(383.725)
Future Bias_{1-2} (=1)	-1127.577	-1120.086	48.723
	(933.629)	(898.305)	(741.178)
Panel B: First and Third Time Frame			
$\overline{IDF}_{1-3}$	1591.382	413.208	-70.022
	(1225.621)	(1201.873)	(979.399)
Present Bias_{1-3} (=1)	1304.427***	1779.448***	2032.763***
	(476.184)	(468.240)	(384.092)
Future Bias_{1-3} (=1)	-270.458	-487.931	-207.416
	(837.109)	(810.926)	(661.234)
Panel C: Quasi-Hyperbolic Model ($\beta - \delta$)			
$\overline{\beta}$	-1211.270	-2542.883**	-2577.450**
	(1234.870)	(1203.669)	(999.235)
$\overline{\delta}$	4582.104**	3565.656*	2727.911
	(2092.044)	(2061.653)	(1741.288)

Note: Standard errors in parentheses. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, and dummies for imputed gender, race, and education. Additionally, in column (3) ln(Credit Limit) is controlled for.
Level of significance: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

Table 7: Robustness: Additional Control Variables and Sample Restrictions

	(1) Tobit	(2) Tobit	(3) Tobit
Revolving Accounts > 0	No	No	Yes
Control Variables	No	Yes	Yes
Year Dummy	Yes	Yes	Yes
Panel A: Including Risk Attitudes and Moving Expectations			
$\overline{IDF}$	30.345	-1522.860	-1766.761
	(1731.514)	(1709.727)	(1425.559)
Present Bias (=1)	1408.246**	1528.351***	1888.896***
	(552.048)	(540.338)	(462.844)
Future Bias (=1)	1190.198	820.344	231.045
	(1670.256)	(1603.341)	(1201.680)
Risk Attitudes (standardized)	15.375	45.019	-24.757
	(86.005)	(84.024)	(71.787)
Expects to Move (=1)	-113.262	297.523	119.897
	(547.450)	(531.623)	(454.002)
N	430	430	227
Panel B: Including Multiple Switchers			
$\overline{IDF}$	2622.555	910.325	-708.948
	(1824.712)	(1750.144)	(1483.897)
Present Bias (=1)	783.041	1228.418**	1819.752***
	(561.529)	(541.663)	(468.693)
Future Bias (=1)	-1034.985	-921.985	-258.373
	(1521.030)	(1420.553)	(1191.072)
Multiple Switching (=1)	1287.599	2211.191***	2148.583***
	(786.205)	(752.525)	(642.706)
N	606	606	321
Panel C: Non-Missing Control Variables			
$\overline{IDF}$	1425.190	200.191	-926.844
	(1878.143)	(1846.504)	(1480.047)
Present Bias (=1)	1430.333**	1645.808***	2171.736***
	(591.894)	(583.257)	(481.227)
Future Bias (=1)	218.105	124.843	-890.161
	(1807.846)	(1732.871)	(1328.671)
N	420	420	223

Note: Standard errors in parentheses. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, and, in Panel A and Panel B, dummies for imputed gender, race, and education. Additionally, in column (3) ln(Credit Limit) is controlled for. Risk attitudes are from the question *"How willing are you to take risks in general? (on a scale from 0 "unwilling" to 7 (in 2006) or 10 (in 2007) "fully prepared")*. The answered are rescaled to be on an 11-point scale for both years.
Level of significance: $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

A Appendix

A.1 Appendix Tables

Table A1: Credit Card Borrowing for 2006 Sample

	(1) Tobit	(2) Tobit	(3) OLS	(4) OLS
Control Variables	No	Yes	No	Yes
Panel A: Whole Sample				
$\overline{IDF}$	836.140	-1174.086	304.060	-127.061
	(4249.830)	(3991.119)	(1500.409)	(1677.172)
Present Bias (=1)	2438.927***	2637.923***	1480.868*	1494.005**
	(931.501)	(897.304)	(767.402)	(741.706)
Future Bias (=1)	1391.250	4743.372	830.569	2047.394**
	(2974.774)	(2916.859)	(1100.642)	(1012.728)
N	123	123	123	123
Panel B: Sample with Credit Cards				
$\overline{IDF}$	429.007	-2437.233	514.358	-2296.121
	(3994.033)	(3482.816)	(2372.762)	(2355.031)
Present Bias (=1)	2730.657***	2665.444***	2296.968**	2211.976**
	(900.371)	(766.693)	(1145.550)	(955.411)
Future Bias (=1)	2329.624	1859.998	1795.005***	1604.243
	(3059.513)	(2680.167)	(273.637)	(1045.547)
N	70	70	70	70

Note: Dependent variable: outstanding balance on revolving accounts. Standard errors in parentheses. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, and dummies for imputed gender, race, and education. Additionally, in Panel B ln(credit limit) is controlled for.
Level of significance: $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

Table A2: Credit Card Borrowing for 2007 Sample

	(1) Tobit	(2) Tobit	(3) OLS	(4) OLS
Control Variables	No	Yes	No	Yes
Panel A: Whole Sample				
$\overline{IDF}$	2362.155	693.055	211.046	-265.399
	(1801.389)	(1769.580)	(608.232)	(659.033)
Present Bias (=1)	822.200	1182.621*	621.620*	805.948**
	(622.702)	(614.026)	(343.905)	(359.544)
Future Bias (=1)	385.237	-588.247	-377.225	-594.992*
	(1779.566)	(1701.735)	(275.809)	(307.223)
N	418	418	418	418
Panel B: Sample with Credit Cards				
$\overline{IDF}$	-17.806	-83.293	-570.525	-543.522
	(1763.928)	(1425.573)	(1075.277)	(994.508)
Present Bias (=1)	1278.504**	1705.958***	1219.413**	1475.307***
	(618.394)	(509.996)	(595.030)	(504.607)
Future Bias (=1)	-1314.686	-569.352	-1075.472***	-602.008
	(1537.235)	(1225.328)	(361.650)	(568.613)
N	215	215	215	215

Note: Dependent variable: outstanding balance on revolving accounts. Standard errors in parentheses. Control variables include ln(disposable income), number of dependents, age, gender, race, college experience, and dummies for imputed gender, race, and education. Additionally, in Panel B ln(credit limit) is controlled for.
Level of significance: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$

A.2 Instructions of Study 1 (2006)

Please indicate for each of the following 19 decisions, whether you would prefer the smaller payment in the near future or the bigger payment later. The number of your raffle ticket (none or 1 to 19), will indicate which decision you will be paid, if at all.

[Block 1; $t = 0$, $\tau = 1$]: Option A (**TODAY**) or Option B (**IN A MONTH**)
Decision (1): \$ 75 guaranteed **today** - \$ 80 guaranteed **in a month**
Decision (2): \$ 70 guaranteed **today** - \$ 80 guaranteed **in a month**
Decision (3): \$ 65 guaranteed **today** - \$ 80 guaranteed **in a month**
Decision (4): \$ 60 guaranteed **today** - \$ 80 guaranteed **in a month**
Decision (5): \$ 50 guaranteed **today** - \$ 80 guaranteed **in a month**
Decision (6): \$ 40 guaranteed **today** - \$ 80 guaranteed **in a month**

[Block 2; $t = 0$, $\tau = 6$]: Option A (**TODAY**) or Option B (**IN 6 MONTHS**)
Decision (7): \$ 75 guaranteed **today** - \$ 80 guaranteed **in 6 months**
Decision (8): \$ 70 guaranteed **today** - \$ 80 guaranteed **in 6 months**
Decision (9): \$ 65 guaranteed **today** - \$ 80 guaranteed **in 6 months**
Decision (10): \$ 60 guaranteed **today** - \$ 80 guaranteed **in 6 months**
Decision (11): \$ 50 guaranteed **today** - \$ 80 guaranteed **in 6 months**
Decision (12): \$ 40 guaranteed **today** - \$ 80 guaranteed **in 6 months**
Decision (13): \$ 30 guaranteed **today** - \$ 80 guaranteed **in 6 months**

[Block 3; $t = 6$, $\tau = 1$]: Option A (**IN 6 MONTHS**) or Option B (**IN 7 MONTHS**)
Decision (14): \$ 75 guaranteed **in 6 months** - \$ 80 guaranteed **in 7 months**
Decision (15): \$ 70 guaranteed **in 6 months** - \$ 80 guaranteed **in 7 months**
Decision (16): \$ 65 guaranteed **in 6 months** - \$ 80 guaranteed **in 7 months**
Decision (17): \$ 60 guaranteed **in 6 months** - \$ 80 guaranteed **in 7 months**
Decision (18): \$ 50 guaranteed **in 6 months** - \$ 80 guaranteed **in 7 months**
Decision (19): \$ 40 guaranteed **in 6 months** - \$ 80 guaranteed **in 7 months**

A.3 Instructions of Study 2 (2007)

As a tax filer at this Volunteer Income Tax Assistance site you are automatically entered in a raffle in which you could win up to \$50. Just follow the directions below:

How It Works: In the boxes below you are asked to choose between smaller payments closer to today and larger payments further in the future. For each row, choose one payment: either the smaller, sooner payment or the later, larger payment. When you return this completed form, you will receive a raffle ticket. If you are a winner, the raffle ticket will have a number on it from 1 to 22. These numbers correspond to the numbered choices below. You will be paid your chosen payment. The choices you make could mean a difference in payment of more than \$35, so CHOOSE CAREFULLY!!!
RED BLOCK (Numbers 1 through 7): Decide between payment **today** and payment in **one month**
BLACK BLOCK (Numbers 8 through 15): Decide between payment **today** and payment in **six months**
BLUE BLOCK (Numbers 16 through 22): Decide between payment in **six months** and payment in **seven months**

Rules and Eligibility: For each possible number below, state whether you would like the earlier, smaller payment or the later, larger payment. Only completed raffle forms are eligible for the raffle. All prizes will be sent to you by normal mail and will be paid by money order. One out of ten raffle tickets will be a winner. You can obtain your raffle ticket as soon as your tax filing is complete. You may not participate in the raffle if you are associated with the EITC campaign (volunteer, business associate, etc.) or an employee (or relative of an employee) of the Federal Reserve Bank of Boston or the Federal Reserve System.

[Red Block; $t = 0$, $\tau = 1$]
TODAY VS. ONE MONTH FROM TODAY WHAT WILL YOU DO IF YOU GET A NUMBER BETWEEN 1 AND 7? Decide for **each** possible number if you would like the smaller payment for sure **today** or the larger payment for sure in **one month**? Please answer for each possible number (1) through (7) by filling in one box for each possible number.
Example: If you prefer $49 today in Question 1 mark as follows: ✓ $49 today or $50 in one month
If you prefer $50 in one month in Question 1, mark as follows: $49 today or ✓ $50 in one month
If you get number (1): Would you like to receive $49 **today** or $50 in **one month**
If you get number (2): Would you like to receive $47 **today** or $50 in **one month**
If you get number (3): Would you like to receive $44 **today** or $50 in **one month**
If you get number (4): Would you like to receive $40 **today** or $50 in **one month**
If you get number (5): Would you like to receive $35 **today** or $50 in **one month**
If you get number (6): Would you like to receive $29 **today** or $50 in **one month**
If you get number (7): Would you like to receive $22 **today** or $50 in **one month**

[Black Block; $t = 0$, $\tau = 6$]
TODAY VS. SIX MONTHS FROM TODAY WHAT WILL YOU DO IF YOU GET A NUMBER BETWEEN 8 AND 15? Now, decide for **each** possible number if you would like the smaller payment for sure **today** or the larger payment for sure in **six months**? Please answer each possible number (8) through (15) by filling in one box for each possible number.
If you get number (8): Would you like to receive $49 **today** or $50 in **six months**
If you get number (9): Would you like to receive $47 **today** or $50 in **six months**
If you get number (10): Would you like to receive $44 **today** or $50 in **six months**
If you get number (11): Would you like to receive $40 **today** or $50 in **six months**
If you get number (12): Would you like to receive $35 **today** or $50 in **six months**
If you get number (13): Would you like to receive $29 **today** or $50 in **six months**
If you get number (14): Would you like to receive $22 **today** or $50 in **six months**
If you get number (15): Would you like to receive $14 **today** or $50 in **six months**

[Blue Block; $t = 6$, $\tau = 1$]
SIX MONTHS FROM TODAY VS. SEVEN MONTHS FROM TODAY WHAT WILL YOU DO IF YOU GET A NUMBER BETWEEN 16 AND 22? Decide for **each** possible number if you would like the smaller payment for sure in **six months** or the larger payment for sure in **seven months**? Please answer for each possible number (16) through (22) by filling in one box for each possible number.
If you get number (16): Would you like to receive $49 in **six months** or $50 in **seven months**
If you get number (17): Would you like to receive $47 in **six months** or $50 in **seven months**
If you get number (18): Would you like to receive $44 in **six months** or $50 in **seven months**
If you get number (19): Would you like to receive $40 in **six months** or $50 in **seven months**
If you get number (20): Would you like to receive $35 in **six months** or $50 in **seven months**
If you get number (21): Would you like to receive $29 in **six months** or $50 in **seven months**
If you get number (22): Would you like to receive $22 in **six months** or $50 in **seven months**

A.4 Calculating $\beta - \delta$ parameters using choice experiments

The three time frames in which discount factors are elicited allow to calculate βs and δs from a system equations. From the two time frames, $t = 0$, $\tau = 1$ and $t = 0$, $\tau = 6$, we get two equations and two unknowns: $X^*_{0,1} = \beta\delta^1(Y)$ and $X^*_{0,6} = \beta\delta^6(Y)$. From the choices in time frame 1 and time frame 2, we can calculate β_1 and δ_1.

The two time frames, $t = 0$, $\tau = 1$ and $t = 6$, $\tau = 7$, provide another system of equations: $X^*_{0,1} = \beta\delta^1(Y)$ and $X^*_{6,7} = \delta^1(Y)$. From this system of equation, one can calculate β_2 and δ_2.

For the robustness test, we take the average of β_1 and β_2 and of δ_1 and δ_2 to create the measures of $\overline{\beta}$ and $\overline{\delta}$.

A.5 Borrowing of a Sophisticated Present-Biased Consumer

Consider a three period model of a sophisticated present-biased consumer. For simplicity we take $\delta = 1$, $r = 0$ and $y_1 = y_2 = y_3 = y$. The backwards induction problem is solved as follows:

Period 3. In $t = 3$, the consumer will consume the remainder of his assets:

$$c_3 = 3y - c_1 - c_2 \tag{9}$$

Period 2. Given $t = 3$ behavior, in $t = 2$, the consumer will maximize:

$$U(c_2, c_3) = ln(c_2) + \beta ln(c_3) \text{ subject to } c_3 = 3y - c_1 - c_2$$

This yields:

$$c^*_2 = (3y - c_1)(\frac{1}{1+\beta}) \tag{10}$$

$$c^*_3 = (3y - c_1)(\frac{\beta}{1+\beta}) \tag{11}$$

Period 1. Given the $t = 2$ and $t = 3$ responses, the $t = 1$ problem becomes to maximize:

$$ln(c_1) + \beta ln(c_2) + \beta ln(c_3)$$

subject to:

$$c_2 = (3y - c_1)(\tfrac{1}{1+\beta})$$

$$c_3 = (3y - c_1)(\tfrac{\beta}{1+\beta})$$

This yields:

$$c^*_1 = \frac{3y}{(1+2\beta)} \tag{12}$$

And correspondingly:

$$c^*_2 = \frac{6\beta y}{(1+2\beta)(1+\beta)} \tag{13}$$

$$c_3^* = \frac{6\beta^2 y}{(1+2\beta)(1+\beta)} \tag{14}$$

We determine the plan value of this consumption path as:

$$U_B = ln(c_1^*) + \beta ln(c_2^*) + \beta ln(c_3^*) \tag{15}$$

A sophisticated present-biased individual may be willing to commit future selves to not borrowing. We propose the following commitment device: we allow the individual to borrow in the first period, keeping $t = 1$ consumption the same as previous. He is forced to repay in $t = 2$ and is restricted from further borrowing. He consumes only his income, y, in $t = 3$.[10] The proposed consumption path with this commitment device is:

$$c_1 = c_1^* = \frac{3y}{(1+2\beta)} \tag{16}$$

$$c_2 = y - (c_1^* - y) = 2y - \frac{3y}{(1+2\beta)} \tag{17}$$

$$c_3 = y \tag{18}$$

The plan value from this consumption path is:

$$U_{NB} = ln(c_1^*) + \beta ln(2y - c_1^*) + \beta ln(y) \tag{19}$$

We compare the plan values. A sophisticated consumer would be willing to commit to this device if:

$$U_{NB} > U_B$$

$$ln(c_1^*) + \beta ln(2y - c_1^*) + \beta ln(y) > ln(c_1^*) + \beta ln(c_2^*) + \beta ln(c_3^*)$$

$$ln(2y - c_1^*) + ln(y) - ln(c_2^*) - ln(c_3^*) > 0$$

It can be shown that the roots of this function are $\beta = 0.5$ and $\beta = 1$. For $\beta \in (0.5, 1)$ sophisticated present-biased individuals would strictly prefer to commit the $t = 2$ self to no borrowing. There exist values of β for which a sophisticated present-biased consumer would be willing to commit to restricting future borrowing activities. Furthermore, such a consumer would be willing to pay for such a commitment device.

[10]Note that this commitment device is effectively a restriction to zero second and third period borrowing without allowing the individual to re-optimize his first period behavior. Any re-optimization will only increase the plan value under the commitment device. Allowing for re-optimization only increases the attractiveness of the commitment device for a sophisticated present-biased consumer.