Sticking to Your Plan: Hyperbolic Discounting and Credit Card Debt Paydown *

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Abstract

I use detailed data from an online financial management service to analyze the extent to which present bias can explain why people hold expensive credit card balances. I first measure the sensitivity of consumption spending to paycheck receipt for each user and argue that it provides a proxy for short-run impatience. To distinguish between consumers who are aware (sophisticated) and unaware (naive) of their future impatience, I exploit the fact that the sensitivity to paycheck receipt should vary with available resources for sophisticated agents. I then relate the characteristics of each person's consumption pattern to his planned and actual debt repayment behavior. Consistent with theory, planned paydown is significantly more predictive of actual paydown for sophisticated than for naive agents. In addition, higher measured impatience leads to lower debt paydown for sophisticated agents, whereas naive agents do not reduce their credit card balances substantially, irrespective of their level of impatience. These findings are inconsistent with several alternative explanations considered, such as credit constraints, and support the view that short-run impatience and sophistication play a substantial role in explaining patterns of success and failure in debt paydown.

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1 Introduction

In 2010, nearly 70% of households in the US had at least one credit card. More than half of those households carried significant credit card balances from month to month, averaging around $12,900 of interest bearing debt (Ackerman, Fries, and Windle, 2012). At a median interest rate of 13%, the cost of interest to the average household was more than $140 per month. At such substantial cost it might appear puzzling that many consumers carry large credit card balances for extended periods of time. Previous work has indeed found that standard motives for borrowing such as acute liquidity shortages or a lack of resources cannot account for the full extent of credit card debt observed in the data. Similarly, the discount rates necessary to produce such borrowing in many standard models are unreasonably high relative to empirical estimates (see Laibson, Repetto, and Tobacman (2003)). An alternative explanation for households' borrowing behavior proposed by behavioral economists is present bias or short-run impatience (e.g. Ausubel (1991), Laibson (1997), Heidhues and Kőszegi (2010) and Meier and Sprenger (2010)). According to this explanation, households are overly impatient in the short run relative to their long run preferences. They borrow excessively and may fail to repay their debt later, despite their earlier intention to do so.

In this paper I present an empirical measure for both features of an individual's present bias, the level of short-run impatience as well as whether the individual is aware of his or her impatience, or "sophisticated"(aware) rather than "naive"(unaware), to use the terminology of O'Donoghue and Rabin (1999). Using this measure, I show that considering households' possible present bias can significantly improve our understanding of their debt repayment patterns. I study a sample of consumers who signed up for an online credit card debt management service. The data contain the daily balances and transactions on all bank accounts and credit cards. Upon joining the service, users make a plan on how much they would like to reduce their debt balances each month, which allows me to evaluate success in debt paydown relative to a user's original plan. I present a simple model to suggest a novel way of using the data to measure an individual's short-run impatience as well as the extent to which they are aware of their impatience ("sophistication"). I also describe the implications of possible present bias on an individual's success in sticking to their repayment plan. Finally, I show empirically that the relation between each individual's measures of present bias and their debt paydown behavior is consistent with these theoretical predictions.

A basic model suggests that for an individual who lives "paycheck to paycheck" the time pattern of spending within paycheck periods will be influenced by his short-run impatience: more impatient individuals consume more immediately after receiving the paycheck and their consumption declines until the next paycheck.[1] To measure each household's level of impatience I estimate the degree of such behavior using expenditures for goods which are instantly consumed such as restaurant meals. I filter out the impact of other possible explanations such as short-term credit constraints. The model further implies that sophisticated, unlike naive, agents act more patiently when they have more available resources, and their consumption between paychecks becomes smoother. To estimate how consumption sensitivity to paycheck varies with the level of resources, I exploit within-individual variation in resources over time. I address the potential endogeneity of available resources to consumption patterns by instrumenting with hypothetical balances based on regular, non-discretionary payments. Based on these estimates, I classify households as sophisticated or naive.

I then relate these measures of impatience and sophistication to the individual households' debt repayment behavior. For present biased consumers it is attractive to delay paying down debt from the current to the next pay cycle. It allows them to avoid reducing consumption in the current pay cycle when it is particularly valued. At the same time, the long-run cost of whether debt is paid off two weeks earlier or later is small. Naive consumers are unaware of their future impatience, so they plan to repay their debt in the next pay cycle when they (incorrectly) believe to be more patient. However, they do not realize that, when faced with the same decision in the future, they will repeatedly want to delay debt paydown, and thus will not actually succeed in paying it off. Sophisticated agents are aware of their future impatience and plan accordingly: They reduce their debt levels, but more impatient agents consume more and save less for debt paydown. Empirically, I find that planned paydown is indeed significantly more predictive of actual paydown for households classified as sophisticated relative to naive households. For sophisticated

[1] This behavior has been documented empirically by Shapiro (2005). Other papers have documented the sensitivity of consumption to the receipt of a paycheck (e.g. Stephens (2006), Hastings and Washington (2010)) or other expected payments (e.g. Souleles (1999), Browning and Collado (2001), Hsieh (2003), Parker (1999), Shapiro and Slemrod (1995), Scholnick (2010)), but have often not explicitly attributed this phenomenon to hyperbolic discounting. In a field experiment, Kaur, Kremer, and Mullainathan (2010) randomize when workers are paid and find evidence for self control problems with respect to work effort. Jappelli and Pistaferri (2010) survey this literature on consumption response to income changes.

individuals, higher impatience leads to lower debt paydown. Naive agents pay down very little irrespective of the level of impatience, consistent with the notion that these households repeatedly delay debt paydown. These empirical findings thus confirm the model's predictions for both types and suggest that a household's level of short-run impatience and sophistication are key factors in explaining their debt repayment experiences.

In general, it is usually hard to detect time-inconsistent behavior. My ability to measure success in debt paydown relative to each individual's intent to do so strengthens the interpretion of failure to reduce debt levels as an actual deviation from planned behavior, rather than as driven by ex-ante optimal behavior given unobserved factors.[2] The ability to make realistic plans and follow them is also one of the key theoretical distinctions between sophisticated and naive agents. Empirically confirming this difference in behavior validates not only my empirical measure of sophistication, but also reinforces the importance of distinguishing between the two types.

I consider a number of alternative explanations for both the individual's consumption sensitivity to paycheck receipt and debt repayment behavior. While some possible explanations might be consistent with either one of the observed patterns, no competing explanation can explain the joint behavior of consumption and debt repayment observed in the data. For example, some people might have developed a habit of going out for "date night" every two weeks, and this might by chance overlap with the receipt of their paycheck in a way that is unrelated to short-run impatience. However, if this was driving observed consumption responses to paycheck receipt, one would not expect these agents to also have differential debt repayment behavior. Similarly, many other factors such as non-separabilities in consumption or overoptimism can also not explain the joint patterns of consumption spending behavior and debt paydown. The results are also robust to different approaches to filltering out confounding factors, such as credit constraints, and to variations in measuring short-run impatience and sophistication.

Starting with Laibson (1997), several papers have explored the role of present-biased preferences in explaining a wide range of aggregate consumption and financial decisions using representative agent models. They show that models with present-biased agents, modeled by quasi-hyperbolic discounting, can often explain the data

[2]It does not allow me to rule out that failure to pay down debt is due to shocks users receive after they have made their plan. However, such random shocks are not expected to be systematically related to the observed characteristics of the user.

better than models with standard time-consistent agents. For instance, Laibson, Repetto, and Tobacman (2007) estimate a life-cycle model with liquid and illiquid wealth and find that the simultaneous holding of both types of assets can be explained by a model with present-bias. Shui and Ausubel (2005) show that hyperbolic discounting can explain consumer choices between different credit card offers and Skiba and Tobacman (2008) find that the behavior of payday loan borrowers is better captured by the hyperbolic than the standard model.[3] The current paper complements this literature by showing that cross-sectional variation in repayment behavior corresponds to cross-sectional differences in measured short-run impatience and sophistication.

Several papers have also explored the role of present bias at the individual level. Meier and Sprenger (2010) conduct experiments to measure each subject's impatience and find that more present-biased individuals have higher levels of credit card debt. Ashraf, Karlan, and Yin (2006) elicit time preferences via a survey and find that consumers with a lower discount rate were more likely to use a savings commitment product offered.[4] Rather than determining impatience experimentally or through a survey, I infer the extent of short-run impatience directly from households' observed real-life consumption spending behavior.[5] Most importantly, this empirical approach also allows me to infer whether a person is sophisticated (aware) about the extent of their short-run impatience, something previous papers have not been able to measure. Since data on spending patterns is becoming more commonly available, this idea of inferring a user's level of impatience and sophistication from consumption patterns can also be applied in other empirical settings.

The paper continues as following: Section 2 describes the data and presents summary statistics. Section 3 presents a basic model to provide intuition for how

[3]Paserman (2008), Fang and Silverman (2009) and Fang and Wang (2010) use similar approaches to show the effect of hyperbolic discounting on job search, welfare program participation and women's decision to get a mammogram.

[4]Several other papers have documented the influence of hyperbolic discounting based on consumer's choices between different contracting options. For instance, Madrian and Shea (2001), Choi, Laibson, Madrian, and Metrick (2004) and Carroll, Choi, Laibson, Madrian, and Metrick (2009) document the importance of default options in 401(k) savings plans, which can be attributed to the tendency of present-biased consumers to procrastinate. Present-biased preferences have been shown to also explain consumers' decisions regarding workouts (DellaVigna and Malmendier (2006)) or homework assignments (Ariely and Wertenbroch (2002)). DellaVigna (2009) provides an overview of the empirical evidence.

[5]DellaVigna and Paserman (2005) use a similar approach inferring whether consumers are short-run impatient from a range of behaviors reported in a survey, such as smoking or having unprotected sex. However, they cannot measure the extent of each user's impatience or whether they are sophisticated or naive.

impatience and sophistication are reflected in consumption patterns and to derive the key empirical predictions about debt paydown. Section 4 presents these consumption patterns and how they are used to measure impatience and sophistication empirically. Section 5 presents the main results. Section 6 discusses alternative explanations, Section 7 provides robustness checks and Section 8 concludes by discussing potential policy implications.

2 Data

2.1 Empirical Setting

The data is obtained from an online financial management service, ReadyForZero (www. readyforzero.com), which offers users free help in managing and paying down their debt.[6] When customers sign up they are prompted to make a plan of how much they want to reduce their debt each month. They are encouraged to link their bank accounts and credit cards, which grants the company read access. For each account, the data include daily snapshots of the balance, the credit limit and each transaction that was charged. The transaction data show the amount, the date charged and the description the customer sees on his bank account statement, as well as a code from the data provider which classifies transactions into different categories.

Based on the information they provide, customers receive various advice, ranging from how to distribute their monthly planned payments amongst multiple accounts to warnings about the implications of large expenditures. ReadyForZero also provides a range of additional services, such as regular tips on how to save money, signing up friends to receive reports on the customers' progress or stickers for customers to put on their credit card to remind them not to overspend. Many of the offered services, such as help in calculating how to split payments and tips on how to save money, can presumably appeal to all types of households, irrespective of impatience or sophistication. It is therefore likely that the websites attracts a variety of users who differ in terms of these characteristics. Similarly, while some of the services offered could serve as commitment devices for sophisticated agents, as they may increase the psychological cost of deviating from planned consumption, the website does not actually restrict users' scope of action in any binding way.

[6] ReadyForZero recently introduced a premium version that allows users to make payments through the website for which users have to pay. This option was introduced after the sample period of my current data.

2.2 Sample Selection

I focus on those individuals who (i) have linked their checking account, (ii) receive regular bi-weekly paychecks and (iii) appear to have linked all their active credit card accounts. This excludes a substantial fraction of users, most of whom have only linked their credit card accounts, but not their checking accounts. I further restrict the sample to those users whom I observe for at least 180 days after sign up, and who have credit card debt and made a plan to reduce it.[7] This allows me to measure how successful users are in sticking to their plan to pay off their credit cards. The final sample includes a total of 556 users who fulfilled these criteria in September 2012.[8]

Appendix A describes the sample selection in detail. To select those with regular paychecks, I first identify transactions which are likely paychecks. A transaction is classified as a paycheck if it is classified as such by the data provider, the description contains words indicating a paycheck transactions, such as payroll or salary, or the user regularly receives deposits of a significant and similar amount. A user receives regular bi-weekly paychecks if he receives paychecks of similar amounts about every two weeks (13 to 16 days apart) and at most one paycheck is missed. To be included in the sample, regular paychecks are also required to account for at least 70% of a user's income.[9] I further restrict the sample to users for whom spending over time appears to be primarily financed by the income and changes in assets I observe. This excludes users who most likely have additional sources of income that I do not observe, for example on accounts that are not linked. It also excludes users who have only recently linked all their accounts, so that during their early times in the sample, observed spending or debt balances are known to be incomplete. Finally, I require users to have more than 8 qualifying pay cycles with at least 35 days of spending on consumption goods[10] to allow me to estimate individual level impatience

[7] A few users do not have a credit card account linked and some users do not make an explicit plan to reduce their debt.

[8] One concern may be that users in the final sample are likely to differ from the average user along several dimensions, many of which are unobserved. For instance, it is likely that users who have paychecks deposited into their checking accounts differ from those who have not. However, the users of ReadyForZero are a highly selected group to begin with. They are, though, also uniquely suited to study the effect of potential present bias on debt repayment behavior. Further selecting the subset of users which best allows to do so does not lead to any additional loss in generalizability of the results.

[9] In the 2010 Survey of Consumer Finance (SCF), Ackerman, Fries, and Windle (2012) report that on average 68% of household income is made up of wages.

[10] As explained below, I focus on pay cycles in which users are likely not credit constraint given their remaining cash balances and credit limit.

and sophistication.

2.3 Income, Assets and Debt Paydown

The first panel of Table 1 shows that the median user is observed for over one year (399 days) after sign up in my sample, and almost an additional 90 days before. During this time, the user receives on average 25 paychecks, of which 24 are regular pay cycles where the paycheck arrives on time and no additional payment is received in the same pay cycle. During regular pay cycles the average user receives $3,913 per month and the median user $3,526.[11]

The two lower panels of Table 1 describe users' asset positions at sign up and the changes in their debt levels 3 and 6 months after. The average user in the sample has $15,204 of credit card debt outstanding at sign up, which represents about four and a half times the user's average monthly income. Average debt is therefore slightly higher than the $12,900 households with revolving balances carried in the 2010 Survey of Consumer Finances (see Ackerman, Fries, and Windle (2012)).

On their bank account, users have on average cash balances of $3,954 which corresponds to a little more than the user's regular monthly income. Total available credit is about $27,000 for the average user, so users have substantial borrowing capacity left on their cards, $11,907 on average. There is substantial heterogeneity across users in debt levels, both in absolute, as well as in relative terms: the 25th percentile's debt level is 145% of monthly income while the 75th percentile has five times as much debt as monthly income.

The last panel shows changes in the users' debt levels after sign up. I focus on debt reduction 90 and 180 days after the user originally signed up. The table shows that while the average user plans to pay down $2,747 or almost 30% of his debt in the first three months, most reduce their debt levels by a lot less: only $736 on average in the first 90 days and $1,125 over 180 days. A substantial share of users even increases their credit card debt, as reflected in the increase in debt levels by the 75th percentile. These summary statistics therefore provide a first indication that many users have substantial problems to follow their plans to substantially reduce their credit card debt.

[11] In the 2010 Survey of Consumer Finance (SCF), Ackerman, Fries, and Windle (2012) find a median household income of $45,800 and average household income of $78,500, of which roughly 70% are wages. With median wage income of about $42,000 the users in my sample earn more in wages than the median ($42,000 versus $45,800*.7=32,000), but less than the average ($47,000 versus $78,500*.7 = $55,000) household in the SCF.

2.4 Spending

I use the information on all transactions users pay for with their credit or checking card to measure spending. Each transaction is already classified into one of about 50 different spending categories, such as restaurant meals, groceries or utilities. I also observe cash withdrawals. I distinguish between three different kinds of expenditures: regular payments, discretionary spending and neither regular nor discretionary spending. Regular payments primarily include rent, mortgage and loan interest payments, but also smaller expenses such as magazine subscriptions.[12] Non-regular payments are classified as discretionary or non-discretionary based on the category assigned by the data provider. Discretionary spending are those expenditures where the consumer had a choice of whether or not to incur the expense close to when it had to be paid or had discretion over how much to spend. Non-discretionary spending are expenses where the amount due depends on the accumulated behavior of the consumers in the past, but the consumer has no discretion on how much to pay once the bill arrives. These primarily include utility or cell phone bills and similar expenses. Since consumption is not observed in the data I will use different subcategories of discretionary spending as a proxy for consumption. I consider subcategories of discretionary spending, in addition to total discretionary spending: spending on non-durables, spending on short-run consumables, such as restaurant meals, groceries, gas and entertainment, as well as just restaurant and entertainment expenditures. Appendix A lists the types of expenditures included in each of these categories. Table 2 shows summary statistics of user's monthly expenditures in each of the categories.

Total monthly discretionary spending is about $1,700 for the average user, which corresponds to about 48% of the user's regular income. More than half of discretionary spending, $986, is on non-durables and $505 on short-run consumables of which $263 are on restaurant meals and entertainment.[13] Regular monthly payments average $1,178 per month or 32% of users' regular income. Median monthly

[12]The appendix describes the identification of regular payments in detail. A set of transactions is classified as regular payments if the payments are about equal to each other and the payments are mostly 7, 14 or 30 days apart and not more than one payment was missed.

[13]Spending ratios in Table 2 are expressed in terms of a user's regular income. Many users, however, have additional sources of income, such as bonus payments or smaller sources of income that suplement a dominant regular paycheck. Also, returns of purchases are hard to differentiate from additional irregular sources of income. The ratios of spending relative to the agent's regular income may therefore appear relatively high and are likely to overestimate the ratios of actual spending to the agent's total income.

spending is slightly lower in all categories, but shows similar patterns.

3 A Simple Model and Empirical Strategy

This section outlines the predictions of present bias for consumption and debt paydown decisions. I first present a basic model of debt paydown and consumption allocation with pay cycles, nesting both time-consistent and present biased agents. The goal is to provide intuition on how present bias can affect agents' consumption patterns and its effect on debt paydown. When interpreting the empirical results later, I argue that no other explanation produces similar *joint* patterns of consumption choices and paydown decision as outlined in this section, even though each resulting pattern on its own is also consistent with alternative explanations. In Sections 4 and 5 I provide evidence that suggests that present bias does, indeed, play an important role in understanding the joint behavior of consumption and debt paydown of individuals.

3.1 A Simple Framework of Debt Paydown and Consumption Choices

3.1.1 Preferences

The agent has quasi-hyperbolic preferences, a popular way of modeling short-run impatience. Each period the current self discounts payoffs in period τ by $\beta\delta^{\tau}$, where $\beta \in [0,1]$ and $\delta \in [0,1]$.[14] β^E is the agent's expectation of his future impatience factor β. I focus on two extreme cases: a *sophisticated* agent is perfectly aware of his short-run impatience, i.e. $\beta^E = \beta$. A *naive* agent, on the other hand, believes that his future selves' preferences will be identical to his current self's preferences, not realizing that his future selves will become impatient. Hence, $\beta^E = 1$ for naive agents. The model nests a standard, time consistent, exponentially discounting agent with $\beta^E = \beta = 1$. All agents have the same long-term discount factor δ which for simplicity is set to 1.

[14] The agent's discount factor between any two periods is therefore not constant over time. The agent is relatively patient in the long run, applying a discount factor of δ between any two consecutive future periods. In the short run, the agent is impatient and discounts all future periods by more, applying an additional discount factor of β.

3.1.2 Model Setup and the Agent's Choice

The model focuses on one pay cycle consisting of two periods. At the beginning of each pay cycle the agent receives a paycheck Y, which he splits between consumption in the two periods (c_1 and c_2) and debt repayment. The agent receives flow utility $u(c)$ from consumption c, where $u(.)$ is increasing and strictly concave. The benefits of any savings or debt repayment are summarized by $V(s)$, where $s = Y - c_1 - c_2$.[15] I will discuss below how $V(s)$ might depend on β or β^E and hence differ by agent type. Denote the agents' remaining resources in each period of the pay cycle by X_t. Consider two special cases:

1. **Low paycheck and no debt reduction/saving:** When Y is low, it only covers the agent's basic consumption needs and no agent wants to save, i.e. $u'(c_2) \geq V'(X_2 - c_2)$ for all $c_2 \leq X_2$ given all possible $X_1 \geq 0$.

2. **High paycheck and potential debt reduction/saving:** Y is high enough so that all agents (time-consistent, naive impatient, sophisticated impatient) consider saving to pay down debt worthwhile.

3.1.3 Consumption over the Pay Cycle

The agent's optimization problem in the first period is

$$\max_{c_1} u(c_1) + \beta u(c_2) + \beta V(Y - c_1 - c_2)$$

subject to $c_1, c_2 \geq 0$ and $Y - c_1 - c_2 \geq 0$. The agent's optimization problem depends on the consumption and savings decision of his future self in the second period. It is here where the agents' beliefs about their future choices, and hence the differences between naive and sophisticated agents matter. The agent believes that his second period self will choose consumption and savings according to $u'(c_2^E) = \beta^E V'(X_2 - c_2^E)$.

Case 1: Low Paycheck - No Debt Paydown When the agent's paycheck is so low that it only covers his basic consumption needs, saving to pay down debt is not considered worthwhile and $c_2 = X_2$. The optimization problem in the first period

[15] In an infinite horizon model $V(s)$ would represent the agent's continuation value given his current period's savings.

reduces to[16]

$$\max_{c_1} u(c_1) + \beta u(c_2)$$

subject to $c_2 = X_2 = w - c_1$ and the agent's first order condition is

$$\frac{u'(c_1)}{u'(c_2)} = \beta$$

The ratio of first to second period marginal utility is equal to β. The agent hence consumes more in the first period of the pay cycle, and more so when he is more impatient (lower β). Relative to a time-consistent agent, the consumption of present-biased agents is therefore excessively sensitive to paycheck receipt , and the extent of this sensitivity is higher for more impatient agents.

Case 2: High Paycheck - Possible Debt Paydown When the agent receives a high paycheck such that some saving for debt paydown is potentially worthwhile, the agent chooses consumption in the first period given his beliefs about future consumption choices. Using the perceived FOC in the second period, $u'(c_2^E) = \beta^E \delta V'(X_2 - c_2^E)$, the agent's FOC for consumption in the first period is

$$\frac{u'(c_1)}{u'(c_2^E)} = [\beta \frac{\partial c_2}{\partial X_2} + \frac{\beta}{\beta^E}(1 - \frac{\partial c_2}{\partial X_2})]$$

For the naive agent ($\beta^E = 1$) this simplifies to

$$\frac{u'(c_1)}{u'(c_2^E)} = \beta$$

For the naive agent, the ratio between first and second period expected marginal utility is therefore the same as in the case when the agent had low resources and did not even consider paying down debt.

For the sophisticated agent ($\beta^E = \beta$) the FOC reduces to

$$\frac{u'(c_1)}{u'(c_2^E)} = [\beta \frac{\partial c_2}{\partial X_2} + (1 - \frac{\partial c_2}{\partial X_2})]$$

Note that $[\beta \frac{\partial c_2}{\partial X_2} + (1 - \frac{\partial c_2}{\partial X_2})] \in (\beta, 1)$. When the agent receives a low paycheck and does not plan to save in the second period, $\frac{\partial c_2}{\partial X_2} = 1$, and this expression equals β, so that the Euler equation reduces to the one derived for the low paycheck case.

[16] The agent's belief about his future impatience does not matter in this case, since he consumes all remaining resources in the second period (and period 1 self knows this).

As the agent receives additional resources and decides to save some of them at the end of the second period ($\frac{\partial c_2}{\partial X_2} < 1$), the effective discount factor for the sophisticated agent increases and approaches 1. Consumption across the two periods becomes more equal and the excess sensitivity of consumption to paycheck receipt declines.

Intuitively, this is because the agent is more patient in the long run (trade-off between period 2 consumption and savings) than in the short run (trade-off between period 1 and period 2 consumption). Therefore, the first period's self would like future selves to act more patiently and save a larger share of resources than future selves actually do. When resources are high, the declining marginal utility of consumption leads future selves to consume a smaller share of any additional resources passed to them. Hence, future selves act more in the interest of the first period's self. The current self is aware of this reduced conflict in how to allocate future resources, and is thus more willing to pass on additional resources to his future selves. This reduces the current self's consumption reaction to paycheck receipt.

For an alternative intuition for the sophisticated agent's Euler equation, recall that the discount factor applied by a time inconsistent agent between two periods changes: The first period's self discounts payoff from the next period by β. This is the relevant discount factor applied to the (marginal) share of resources consumed in the second period ($\frac{\partial c_2}{\partial X_2}$). Between any two future periods (between period 2 consumption and savings for debt reduction in the model context), the current self discounts payoffs only by $\delta = 1$. Therefore, $\delta = 1$ is the relevant discount factor applied to the (marginal) share of resources saved in the next period ($1 - \frac{\partial c_2}{\partial X_2}$). The effective discount factor period 1 self applies between current and next period's marginal utility is hence a weighted average between the short-run and the long-run discount factor where the weights depend on how resources are used by the next period's self. With additional resources the agent's second period self consumes a lower fraction of available resources, such that a sophisticated agent prefers a higher ratio between first and second period marginal utility, smoothing consumption more between the first and second period and decreasing sensitivity of consumption to paycheck receipt.[17]

[17]Note that hyperbolic discounting will not lead to this effect in all possible settings. For instance, if there is perfect commitment for sophisticated agents, the current self does not have to take any possible deviations of future selves into account. In this case, higher resources will not reduce the (non-existent) conflict of interest and hence affect consumption decisions. Similarly, there may be additional effects for naive agents. Specifically, for naive agents, planned consumption may not equal actual consumption, which affects not planned but realized consumption ratios: in the second period, the naive agent will end up consuming more than he had planned to, decreasing actual

3.1.4 Debt Paydown

To illustrate the agent's trade-off between consumption in the current pay cycle and saving to pay off debt, the first order condition for the naive agent in the first period can be written as

$$\begin{aligned} u'(c_1) &= \beta u'(c_2^E) \\ &= \beta V'(s^E) \end{aligned}$$

and for the sophisticated agent as

$$\begin{aligned} u'(c_1) &= [\beta \frac{\partial c_2}{\partial X_2} + (1 - \frac{\partial c_2}{\partial X_2})] u'(c_2) \\ &= [\beta \frac{\partial c_2}{\partial X_2} + (1 - \frac{\partial c_2}{\partial X_2})] V'(s) \end{aligned}$$

There are two effects, which can cause sophisticated and naive agents to save different amounts: First, the sophisticated agent is aware of his future impatience. He therefore knows that his next period's self is likely to consume some of the resource the current self would prefer him to save for debt reduction. Knowing this reduces the benefit of saving for the sophisticated agent.[18] Second, the naive agent expects his future self to not be present-biased and therefore to save more. This makes saving less attractive for the naive than for the sophisticated agent, who knows he can not rely on his future self for savings. In the model the extent of this effect is reflected by the relative size of $V'(s^E)$ and $V'(s)$. If the agent expects to save more next period ($s^E > s$), the marginal value of savings is lower, encouraging first period consumption.

Which of these effects dominates depends on the specification of $V(s)$, the benefit of saving, and the agent's instantenous utility function $u(c)$. Instead of making specific assumptions on $V(s)$, I outline when the literature has found differences in $V(s)$ between sophisticated and naive agents. The setting considered in this paper resembles settings in which the literature has found substantial differences between the two types of agents.

consumption ratios for the naive agent, as well. Below I will argue that differences in the perceived value of savings will lead the naive agent to plan to save very little, so this effect will be small relative to that for the sophisticated agent.

[18] In the model, this effect is only indirectly reflected in c_2 and s being chosen according to the second period self's short-run impatient preferences, rather than the agent's long-term and more patient preferences, which a naive agent believes to determine his future choices.

The literature has found little difference in the behavior of naive and sophisticated agents in settings in which the agents' future paths depend significantly on how much they save today. An example is an "eat-the-pie" problem (e.g. Tobacman (2007)): if the agent consumes a lot in the current period, his consumption in all future periods will have to be lower, even if future selves are not present-biased and save more. In such cases, naive agents still find it worthwhile to save since they cannot expect their future selves to make up for a lack of current savings. This implies substantial benefits of savings, $V(s)$, which are similar for both types of agents.[19]

Substantial differences between sophisticated and naive agents are found in settings where the agent has to complete a certain task, but can choose in which period to do so. Once the task is completed, the agent's path of future payouts is independent of *when* the task was completed. In this case, it is attractive for naive agents to rely on their future selves to complete the task, since it only delays payouts a little further into the future. This can lead naive agents to repeatedly procrastinate such that they never complete the task.[20]

In my model, an agent's decision of whether or not to pay down debt today is similar to the second setting: Once the debt is paid off, whether this was done two weeks earlier or later does not significantly affect the agent's life time paths of payouts. Saving little or entirely delaying a payment from the current pay cycle to the next is therefore attractive to present-biased agents. This is because, by definition, saving yields payouts in the future but entails current costs in terms of forgone consumption, which a present-biased agent overvalues relative to the future benefits. When delaying to reduce debt to the next pay cycle, this is not the case. Both cost and benefits lie in the future, so cost are not overvalued relative to benefits.

If the agent can follow through with a plan to pay down debt the next pay cycle, the benefit of saving in the current pay cycle rather than delaying ($V'(s^E)$) is very low, i.e. $V'(s^E) \to 0$. A naive agent indeed believes that his future selves will share the long-term preferences of the current self and will follow through with such a

[19] The same holds in models with long model periods. If saving little in the current period means that any savings are deferred by at least a year, the potential downside of doing so is much larger than if doing so means deferring by a couple of days. For instance, Angeletos, Laibson, Repetto, Tobacman, and Weinberg (2001) find little differences in a model of life cycle savings decisions, where the agent lives for 90 periods, each representing a year.

[20] For instance, O'Donoghue and Rabin (1999) study situations like this and find that whether agents are naive or sophisticated substantially affects agents' choices, since naive agents repeatedly delay costly tasks. Rabin and O'Donoghue (1999) also apply these insights to retirement saving decisions and argue that naive agents are likely to procrastinate and not accumulate enough assets for retirement.

savings plan. Hence he plans to save in the next pay cycle. He does not realize, however, that he will be equally impatient in the future and when faced with the same decision, will repeatedly delay and never actually pay off his debt. This is despite the fact that the naive agent considers saving worthwhile and if faced with the choice of saving in the current period or not at all, would prefer to save. Also note that as long as the agent's impatience is high enough to make delaying to pay off by one pay cycle attractive, the extent of the agent's impatience has little influence on his actual paydown: irrespective of the extent of their present-bias, naive agents persistently procrastinate.

Unlike the naive agent, a sophisticated agent is aware of his future impatience and knows that he can not rely on his future self to save. Therefore, saving in the current period yields substantial benefits for the sophisticated agent, i.e. $V'(s) \gg 0$. The trade-off between these (substantial) benefits of savings and current consumption, however, directly depends on the agent's level of short-run impatience: More present-biased agents consume more and save less in the current pay cycle, all else equal.[21] The following two predictions summarize the debt paydown behavior of both types of agents just described:

Prediction 3.1. *Naive agents fail to substantially reduce their debt levels, irrespective of their plans to do so and their level of impatience.*

Prediction 3.2. *Sophisticated agents follow their plan to pay down debt. They pay down less each period the more impatient they are.*

[21]Higher impatience, however also indirectly effects the agent's trade-off between current consumption and saving through two opposing indirect effects: First, if the agent is less impatient, his future selves are less impatient and choose resource allocations which deviate less from the agent's long-run preference. A less impatient agent therefore receives higher utility payoff from the same future cash benefits of savings since he knows his future selves will allocate them more efficiently. Second, if the agent's future selves are more patient, they may also save more. These future savings increase the agent's future level of resources and the utility from additional savings in the current period decreases due to these wealth effects. For the empirical predictions, I assume that the direct effect of impatience dominates in reality such that more impatient agents save more. Theoretically, this assumption need not hold in all cases. For instance, Harris and Laibson (2002) show that consumption functions (and, hence, savings) of hyperbolic discounting consumers need not always be well behaved and this assumption is violated. However, they also find that for empirically sensible calibrations, consumption functions (and hence savings) are well behaved and agents consume more/ save less the more impatient they are (Figure 4 in their paper).

3.2 Joint Patterns of Consumption and Debt Paydown and Empirical Strategy

Having established which factors influence an agent's decision of how much to save for debt paydown, this section summarizes the *joint* patterns of consumption and debt paydown implied by agents' present bias.

Figure 1 illustrates how consumption patterns and debt paydown relate to each other. The two upper panels show the sensitivity of consumption spending to paycheck receipt for both types of agents, as outlined in section 3.1.3. For both sophisticated and naive agents the level of impatience is reflected in the sensitivity of consumption spending to paycheck receipt. More impatient agents spend more in pay weeks relative to non-payweeks. For sophisticated agents, the extent of this sensitivity is lower when resources are high. This is not the case for naive agents.

The two lower panels show planned and actual paydown for the two types as described in section 3.1.4. Sophisticated agents are aware of their future impatience, so they plan accordingly and follow their plans. Therefore, planned paydown is predictive of actual paydown. However, more impatient agents reduce their debt levels less, since they value current consumption more and perceive saving resources for debt paydown as particularly costly. Hence, the paydown of sophisticated agents decreases in the level of impatience as reflected in the sensitivity to paycheck. Naive agents believe they will be time consistent in the future and therefore plan to reduce their debt levels substantially, similar to a time consistent agent. However, when the time to make payments arrives, naive agents' current self prefers to delay doing so by an additional period, leading them to repeatedly procrastinate. A naive agent therefore pays down very little, despite his earlier repayment plans. Planned paydown is substantially less predictive of actual paydown for naive than for sophisticated agents. Moreover, actual paydown for naive agent's is low irrespective of the agent's level of impatience, as long as the agent is present biased enough that he prefers to delay one period.

Figure 1 also illustrates that when agents have very low levels of impatience or are completely time-consistent, the distinction between sophisticated and naive agents becomes meaningless. Both types of agents, when only slightly present biased, plan to and indeed do reduce their debt levels substantially.[22]

[22]The implications for my strategy to empirically distinguish naive and sophisticated agents are addressed in detail in Section 7. Specifically, since the distinction between naive and sophisticated agents becomes meaningless for users with low levels of impatience, I conduct robustness checks in

Similar predictions for either the consumption response to paycheck receipt or for differential paydown could be derived from alternative models of household behavior. For example, credit constraints, habits or inseparabilities between different consumption types could also explain why people spend more in the week following a paycheck receipt. Similarly, income shocks or overoptimism could lead users to fail to stick to their plan of reducing debt levels. While some of the explanations, such as the role of credit constraints, can be filtered out directly, other explanations of either phenomenon are harder to exclude. In Section 6 I discuss a large number of possible alternative explanations of either of my two phenomena, and argue that short-run impatience is the only explanation that is *jointly* consistent with both the expenditure sensitivity to paycheck receipt and the differential debt repayment behavior. This leads me to conclude that it is likely that my results are indeed at least partially driven by short-run impatience.

4 Consumption Patterns

In this section, I estimate each user's sensitivity to paycheck and how it is affected by varying resources over time. These consumption patterns capture a user's level of short-run impatience and sophistication, which I relate to debt paydown behavior in the next section.

4.1 Sensitivity of Consumption to Paycheck Receipt

4.1.1 Regression Equation

The average sensitivity of consumption spending to paycheck receipt is estimated based on the following equation:

$$log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + X_{it}\psi_i + \varepsilon_{it} \tag{1}$$

where X_{it} includes month and day of week fixed effects. E_{it} are the user's daily expenditures on either spending on short-run consumables or just restaurant and entertainment.[23] I estimate equation (1) separately for each user. This yields a

which I exclude them from the analysis and the basic results for the differences between sophisticated and naive agents if anything increase in magnitude and significance.

[23] Measuring consumption by expenditures can lead to misleading conclusions, as shown by Aguiar and Hurst (2005). In my setting, I focus on expenditure categories such as restaurant meals and

user-specific estimate of the level of sensitivity of consumption spending to paycheck receipt, captured by the coefficient on payweek, γ_{1i}.

4.1.2 Filtering Out Effect of Credit Constraints

I am interested in capturing the extent of sensitivity to paycheck receipt reflecting a user's level of short-run impatience. However, short-run impatience is not the only factor potentially causing such sensitivity to paycheck receipt. While perfectly rational consumers plan to smooth consumption over the pay cycle, short-run credit constraints can cause increased consumption spending in payweeks. For instance, a user may receive an unexpected expense shock. Unable to cover the expense with the available resources, the user may hold off until his next paycheck to pay for the expense, increasing consumption spending during payweeks. In my sample, it is a valid concern that at least some of the sensitivity may be caused by such a combination of shocks and short-term credit constraints. After all, the users in my sample have substantial amounts of debt and few resources and use up most of their paycheck for their expenses throughout the month. To isolate the effect of short-run impatience, I restrict the sample to those times where such short-run credit constraints are unlikely to play a role.[24] Specifically, I restrict the sample to those times where the user had enough resources (cash in his account and available credit on his cards) to afford each payweek's spending in the previous week. This removes the instances where the consumer may have wanted to spend more but could literally not afford to do so until the next paycheck arrived. For each broad expenditure category

entertainment where expenditures are likely to be a very good proxy for actual consumption. Moreover, I estimate characteristics of spending patterns over several pay cycles in which consumers do not experience substantial income shocks. It is therefore unlikely that the estimated patterns are driven by shifts in behavior from one regime to another in response to a shock.

[24] The fact that users have substantial resources which would allow them to smooth shocks may appear inconsistent with the assumptions of the model that agents live paycheck to paycheck. In the model, agents would indeed run down their resources completely until they are forced to live paycheck to paycheck. Paycheck receipt would not influence consumption smoothing as long as the agent has resources to run down. The model, however, has no uncertainty and therefore abstracts from households' potential desire to keep a buffer stock of resources which even a present-biased self does not want to touch for the purpose of consumption. Specifically, for which purpose additional resources are used may affect the perceived cost of these resources to the user. Users may find consuming out of their paycheck acceptable, but perceive high psychological costs of borrowing for the purpose of consumption. The psychological cost of borrowing may be much lower, however, when the resources are used to pay for an expense shock considered a legitimate spending need, such as the need to pay a doctor's bill or repair a car need to drive to work. Households may therefore live paycheck to paycheck in terms of their consumption spending even when they have substantial borrowing capacity left which they could use to smooth shocks.

(short-run consumables and restaurant and entertainment), the user is classified to have been able to afford next payweek's spending in the given category if his account balances and the available credit on his cards at the end of the week would have been enough to pay for the level of spending of the next payweek. Focusing on pay cycles where credit constraints did not bind therefore filters the potential effect of credit constraints out of the estimated level of sensitivity of consumption to paycheck receipt. In the robustness checks in Section 6.2, I explore the effect of filtering out such times in more detail. Specifically, I show estimates for two more conservative measures of credit constraints, as well as for sensitivity estimated using all observations. The results are robust throughout.

4.1.3 Estimated Sensitivity to Paycheck Receipt

The upper panel of Table 3 shows summary statistics of the sensitivity estimates, γ_{1i}, for the users in my sample. To estimate the sensitivity to paycheck receipt in a given category, I require users to have at least 35 days with positive spending in the respective category. Since short-run consumables is defined more broadly than restaurant and entertainment, fewer users, 510 instead of 556, satisfy these criteria for the latter category. I present results using both categories. Restaurant and entertainment spending are better suited than the broader category of short-run consumables to capture consumption since food and gas are more likely to be stored rather than consumed immediately.[25] However, including spending in these additional categories increases the amount of spending of which sensitivity to paycheck is estimated. Table 3 shows that the average user consumes more during payweeks than non-payweeks. During payweeks, spending on short-run consumables is 6.7% higher and spending on restaurants and entertainment is 4.4% higher. For the median user, both increase about 5% in payweeks relative to non-payweeks. There is substantial variation between users. The 75th percentile increases consumption in both categories by more than 20% in payweeks.

Figure 2 plots the distribution of the estimated sensitivity of expenditures on short-run consumables in the top panel and on restaurant and entertainment in the bottom panel. The two distributions look very similar. As indicated by the summery statistics, the mean of the distributions is shifted upwards from zero and a t-test confirms that it is significantly different from zero, i.e. the average user's

[25] Most of the additional spending in short-run consumables, more than two thirds, is spending on food.

expenditures react substantially to paycheck arrival. The results show that many users in my sample fail to smooth consumption within a pay cycle even when credit constraints are unlikely to play a role and is hence consistent with the notion that the average user exhibits short-run impatience.

4.2 Effect of Resources on Sensitivity to Paycheck Receipt

4.2.1 Regression Equation

The effect of variation in resources on the sensitivity to paycheck receipt is estimated by the following equation:

$$log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it} \tag{2}$$

where, as in equation (1), X_{it} includes month and day of week fixed effects and E_{it} are each user's daily expenditures on either short-run consumables or just restaurant and entertainment. $resources_{it}$ are an agent's available resources, defined as the cash balances on his bank accounts plus the available credit on his credit cards. Again, I estimate equation (2) separately for each user. γ_{3i} therefore captures a user specific estimate of how fluctuations in resources affect consumption patterns.

4.2.2 Wealth Fluctuations due to Regular Payments

To estimate the effect of varying resources I exploit within agent variation in resources over time.[26] However, the level of resources available to the agent at every point in time is not exogenous to the agent's consumption decision. There are two sources of endogeneity. First, expenditures in the beginning of the pay cycle reduce the resources available later in the pay cycle one-for-one. This can be addressed by measuring resources at the beginning of each pay cycle, so that the measured level of resources is unaffected by the consumption profile over the pay cycle. Second, resources in the given pay cycle depend on past consumption. This could be problematic if high prior spending not only reduces the agent's resources, but also his taste for consumption in the current period. For instance, a user who went out

[26] In the literature, the effect of higher resources on the sensitivity of consumption is often estimated across individuals, for instance by Stephens (2006). Using within individual variation instead provides an alternative estimate of the effect of resources which is less likely to be driven by other potential differences between individuals affecting both, resources levels, as well as sensitivity to paycheck receipt, at the same time.

regularly over the last weeks, going to the movies and eating out, has lower resources in the current pay cycle, but he most likely also has a lower taste for additional consumption, having seen the latest movies and been to his favorite restaurants. Such a correlation between the unobserved taste for consumption and the level of resources could lead to a biased estimate of the effect of resources on spending patterns.

To address this endogeneity problem, I exploit variation in the agent's resources which is independent of his prior consumption choices. Specifically, I exploit that users have to make regular payments which occur at different time intervals. Users in my sample are paid twice a month, but have regular *monthly* expenses, such as rent or mortgage payments. These regular payments lead to substantially lower resources during the two-week pay cycle when they are due relative to the other two weeks of the month. Another example are months with three paychecks for users who are paid bi-weekly (rather than twice a month): Since most months are longer than 4 weeks, there are two months in the year during which the user receives 3 paychecks rather than 2, but monthly expenditures such as rent still have to be paid only once. Regular payments therefore cause systematic fluctuations in the level of resources which are unrelated to the agent's prior discretionary spending. I exploit this variation to construct an instrumental variable for the level of resources: Based on the agent's regular payments, I calculate what the agent's resources would have been if all non-regular spending was split evenly across the sample period. These calculated balances therefore isolate the variation in resources caused by regular payments from the variation caused by prior discretionary spending.

Figure 3 illustrates the intuition for the calculated balances used as instrumental variables. It shows actual (upper panel) and calculated balances (lower panel) for an agent who receives regular bi-weekly paychecks (illustrated by upward pointing red arrows) and has to pay rent monthly every other pay date (downward pointing red arrows). In the upper panel, the blue line shows the agent's actual balances given his income, rent payments and actual spending patterns. In the lower panel, the purple line shows the agent's calculated balances. Instead of using the agent's actual spending, spending is assumed to be split equally across all days. Each day's balance is then calculated based on the agent's regular paycheck, regular rent payment and average daily spending. The figure also shows that the monthly regular rent payments lead to substantially lower resources during the pay cycle in which they have to be made compared to the pay cycle where no regular payment is due. The calculated balances isolate this exogenous variation in the agent's level of resources from the

endogenous variation caused by the agent's prior discretionary spending.

4.2.3 Measuring Sophistication by Effect of Resources on Sensitivity

Using the calculated balances based on regular payments as an instrumental variable allows to estimate the effect of resources on the sensitivity of consumption spending to paycheck receipt. The estimated effects for each user, γ_{3i} in equation (2), are shown in the lower panel of Table 3. For the median users, the effect is relatively small in both categories, instant spending and restaurant and entertainment spending. For a substantial number of users, however, additional resources affect the sensitivity to paycheck receipt, increasing it for some and decreasing it for others.

As outlined in Section 3.1.3 additional resources lead sophisticated agents, but not naive ones, to discount future payouts less and to become less sensitive to payment receipt. I split the sample into two groups: Those for whom additional resources reduce sensitivity to paycheck receipt, i.e. γ_{3i} is negative and those for whom this is not the case, i.e. γ_{3i} is non-negative. Assuming that differences in the effect of resources are indeed caused by differences in sophistication, I call the first group 'sophisticated' and the latter one 'naive'. I show below that the joint patterns of consumption spending and debt paydown indeed support this notion. Table 4 shows the classification of users into sophisticated and naive based on estimates using spending on both, short-run consumables, as well as on restaurant and entertainment only. A substantial number of users is classified the same way, irrespective of which spending category the classification is based on. However, for almost a third of users, the classification differs between the two categories. In the following, I therefore present all results using both classifications.

4.2.4 Summary Statistics by Differences in Consumption Patterns

One concern is that agents classified as sophisticated or naive also differ substantially along dimensions other than sophistication, making it hard to disentangle the effects of such other differences from those of sophistication. Specifically, differences in sophistication may not only lead to differences in debt paydown behavior, but may also reflect differences in the level of impatience, as well as lead to differences in asset accumulation, earnings or total spending.

Table 5 shows average and median estimated sensitivity levels for each group, tentatively labeled 'naive' and 'sophisticated'. On average, estimated levels of sensitivity to paycheck receipt are larger for sophisticated agents, when sophistication is

based on short-run consumables, but lower when based on restaurants and entertainment only. There are several factors that could lead sensitivity estimates to differ between the two groups, though none seems to clearly dominate in my sample. First, average sensitivity estimates are biased slightly downwards for sophisticated agents. When resources are high, sensitivity is lower for sophisticated agents than for naive agents with the same level of impatience. Average sensitivity, estimated for times of both low and high resource, will therefore be lower for a sophisticated agents than for naive ones with the same level of impatience. Another factor is measurement error. If sensitivity of consumption to paycheck receipt is relatively low, changes in the level of sensitivity due to resource fluctuations are also small in absolute terms and, when measured with error, less likely to be detected. Sophisticated users with low levels of impatience therefore have a higher likelihood of being incorrectly classified as naive than users with high levels of impatience.[27] Finally, the level of impatience may be directly related to whether a user is aware of his short-run impatience. Users with high short-run impatience may be more likely to eventually become aware of their own time inconsistency relative to users with a relatively minor time inconsistency problem.

In addition to estimated levels of sensitivity, Table 6 shows some key summary statistics on income and debt levels for sophisticated and naive agents. In the first two columns the classification of sophistication is based on short-run consumables, in the last two it is based on restaurant and entertainment only. Income and credit card debt levels are very similar between the two groups. Sophisticated agents on average have slightly higher income than naive agents, \$3,983 relative to \$3,841 when sophistication is based on short-run consumables. They also have slightly lower debt levels on average, \$14,257 relative to \$16,171. When sophistication is based on short-run consumables, income and debt levels are very similar: Sophisticated agents have lower average debt levels and higher income. However, it is the other way around when comparing median instead of average levels.[28]

[27] In the robustness checks below I address this issue and exclude users with low sensitivity estimates who are most likely to be misclassified.

[28] Note that such small differences between sophisticated and naive agents are consistent with theoretical results on assets accumulation of present biased agents. As outlined in Section 3 whether sophisticated and naive agents behave differently depends on the situation modeled. I argued that the debt paydown decision agents face in my setting is prone to lead naive agents to procrastinate repeatedly, leading to the substantial differences in behavior described. However, several papers (e.g. Angeletos, Laibson, Repetto, Tobacman, and Weinberg (2001)) argue that this is not the case in savings and asset accumulation decisions, since such decisions influence the agent's future path substantially. Accordingly, they find small differences between sophisticated and naive agents'

Table 7 shows that naive agents spend slightly more than sophisticated agents, both in absolute terms, as well relative to their income. Basing sophistication on restaurant and entertainment spending, average total discretionary spending is $1,845 or 52% of income, compared with $1,690 or 47% of income for sophisticated agents. Spending in the different sub-categories is, if anything, more similar between the two groups.

In general, the differences between sophisticated and naive agents in assets and spending are relatively small. It is therefore unlikely that the classification into naive and sophisticated agents masks substantial differences between the two groups along these dimensions which could directly account for any differences in the debt repayment behavior between the two groups.

5 The Effect of Present Bias on Debt Repayment

The last section, Section 4, showed that consumption patterns are consistent with at least some users exhibiting present bias and can be used as proxies for the extent of each user's short-run impatience. This section relates these consumption patterns to the user's success in reducing debt levels to test the predictions of present bias illustrated in Section 3. Recall that according to prediction 3.1 naive agents are expected to pay down very little, irrespective of their initial plans to do otherwise and their level of impatience. For sophisticated agents, prediction 3.2 suggests that planned paydown significantly increases actual paydown, but that users with higher levels of impatience pay down less.

5.1 Summary Statistics of Debt Paydown by Type

Table 8 shows summary statistics on planned paydown and actual changes in debt levels 90 and 180 days after sign up. Both sophisticated and naive agents plan to pay down very similar amounts, on average $2,800 in the first 90 days. Actual paydown is substantially lower than planned paydown for both groups. Sophisticated agents pay down more on average, $760 compared to $712 for naifs when sophistication is based on short-run consumables and $723 compared to $666 when based only on restaurant and entertainment. Despite higher average paydown, the median sophisticated user pays down less, $202 or $122, depending on the sophistication measure,

assets.

than the median naive user, who pays down \$300. Within each group, however, there is substantial variation in paydown as reflected in the high standard deviation. This indicates that sophistication alone does not explain substantial differences between the two types of agents. Rather, as expected from the theoretical predictions, differences in planned paydown, initial debt levels and especially impatience levels, need to be taken into account.

5.2 Regression Equation

To analyze the effect of potential present bias as captured by consumption patterns on debt paydown, I estimate the following regression:

$$\begin{aligned} Paydown_i = \mu_0 &+ Sensitivity_i \mu_{1n} + PlannedPaydown_i \mu_{2n} \\ &+ Sensitivity_i * Sophist_i \mu_{1s} + PlannedPaydown_i * Sophist_i \mu_{2s} \\ &+ X_i' \lambda + \nu_i \end{aligned} \tag{3}$$

where $Sensitivity_i$ is each agent's estimated sensitivity of spending to paycheck receipt, estimated by equation (1).[29] $PlannedPaydown$ is the amount the user originally had planned to pay down and X_i is a set of control variables, including the debt levels at sign up and the user's monthly income. Debt paydown is measured by the trend in debt balances over the given time horizon. Relative to the simple difference in debt levels, this measure filters out the fluctuations in users' debt levels caused by the use of credit cards for transactions.[30] To make estimates comparable over the different time horizons, 90 and 180 days, debt paydown and planned paydown are

[29] Instead of using the average sensitivity to paycheck receipt estimated by equation (1), an alternative measure would be the base level of sensitivity captured by the coefficient on *payweek* in equation (2). Recall from Section 3.1.3 that when resources are so low that agents do not want to save, the sensitivity of consumption to paycheck receipt only depends on the agent's short run impatience. Assuming that all agents have low resources at some point in the sample, a user's impatience is captured by the coefficient β_1. Average sensitivity, however, depends on whether the agent is sophisticated or naive and therefore makes comparisons across groups biased. Given the same level of impatience, average sensitivity should be lower for a sophisticated than for a naive agent. Using the baseline sensitivity estimated in equation (2) therefore corresponds more closely to the model. However, because of the additional variables and the need to instrument for them, the estimates are much more noisy. Because of this higher precision, I use the average sensitivity in the regression analysis, especially, since the focus is not on inter group, but intra group comparisons.

[30] To measure the trend in debt levels I fit a liner trend for the user's debt balances over the given horizon, such that average daily paydown equals the slope of the estimated trend line. In the robustness checks below I use the simple difference in debt levels and the results are very similar.

measured per day. Users are classified as being 'sophisticated' if their sensitivity of spending is reduced by additional resources, i.e. if γ_{3i} estimated in equation (2) is negative. I present results for estimates of $Sensitivity_i$ and sophistication based on both, spending on short-run consumables and on restaurant and entertainment only. Since the regressors $Sensitivity_i$ and sophistication are estimated from consumption patterns, standard errors in the second stage are bootstrapped. [31]

In addition to the specification in equation (3), I also present results which estimate separate effects for sophisticated agents only for one of the two variables, the level of sensitivity to paycheck or planned paydown. If users differed only in their level of impatience and sophistication, planned paydown would directly reflect the level of short-run impatience, at least for sophisticated agents. It would therefore be highly correlated with sensitivity, which also reflects impatience, making it hard to identify their influence in the regression. Focusing on the differential effect of only one of the two variables addresses this potential concern. Throughout, the estimated results for each variable are slightly stronger when the other one is only included as a control, indicating that such a correlation exists. However, the differences are small and results are similar across all specifications. Hence, planned paydown captures differences between users along multiple dimensions, not just impatience. Specifically, planned paydown captures and helps to control for constraints and objectives affecting paydown which are known to the user (and hence incorporated in their plans), but unobserved to the econometrician.

5.3 Regression Results

Tables 9 and 10 show the regression estimates for equation (3) over time horizons of 90 and 180 days. Naive agents are the omitted category, so the coefficients on *Sensitivity* and *PlannedPaydown* represent the effect for this group. Across specifications, the results are very similar, so I focus on specification III, which is based on equation (3) and jointly estimates differential effects between sophisticated and naive agents for both key variables of interest, *Sensitivity* and *PlannedPaydown*.

For naive agents, an additional dollar in planned paydown increases actual paydown by 14 cents over the first 90 days using both classifications of sophistication.

[31] For each user, I draw a bootstrap sample from the observations of consumption spending and re-estimate the first stage variables for each draw. I then use these estimates in the second stage estimation and compute bootstrapped standard errors based on the second stage results of all draws. Bootstrapped standard errors do not differ much from robust standard errors which do not account for the estimated regressors.

Over 180 days, the effect is 6.8 cents when sophistication is based on short-run consumables and 9 cents when based on restaurant and entertainment spending. The level of sensitivity of consumption spending has no consistent effect. It is often not statistically significant and changes signs, though in most specifications higher sensitivity leads to higher paydown, the opposite of the predicted effect for sophisticated agents.

For sophisticated users, planned paydown is more predictive of actual paydown than it is for naive users: each dollar of planned paydown increases actual paydown by 35 $(14+21)$ cents over 90 days when sophistication is based on short-run consumables and by 30 $(14+16)$ cents when based on restaurant and entertainment only. Over the 90 day horizon, the estimates are of the same magnitude but not statistically significant from those for naive agents at standard significant levels. Over 180 days, the estimated effect of planned paydown for sophisticates is similar and also differs significantly from that for naive agents: 29 $(7+22.5)$ cents using estimates based on short-run consumables and 36 $(9+27)$ cents when based on restaurant and entertainment only. While more predictive for sophisticated than for naive agents, sophisticated agents do not entirely stick to their plan either, as already indicated by the summary statistics in Table 8.

The level of short-run impatience significantly affects paydown for sophisticated agents: consistent with the model's predictions, more impatient agents reduce their debt less. The total estimated effect for sophisticated agents (adding the coefficient on sensitivity to that of its interaction with sophistication) is similar and around -13 in all specifications over 90 days and slightly lower over 180 days. This effect is economically meaningful: moving form the 75th to the 25th percentile of estimated impatience levels increases debt paydown in the first 90 days after sign up by \$360, almost half of average paydown of \$760 by sophisticated agents over this time horizon.[32]

The effect of the control variables, the user's median paycheck and original debt levels, are sensible and similar in magnitude across specifications. An additional \$100 per paycheck increases debt paydown over 90 days by about 25 cents per day, or a total of \$22.5. Over 180 days, debt paydown increases by a little less than 10

[32]The estimated effects do not differ much depending on which spending category the estimates are based on, short-run consumables or restaurant and entertainment only. The difference between the the 25th and 75th percentile for the estimated sensitivity based on short-run consumables spending, as shown in Table 3, is $.34 = 0.227 + 0.115$. Multiplying the direct effect plus the difference for sophisticated agents by this differences yields an estimated effect of \$4.44 per day or almost 400\$ over 90 days.

cents per day for a total of \$18. Similarly, an additional \$1,000 in original debt balances increases debt paydown by about 10 cents per day over both, 90 and 180 day horizon. While statistically significant, differences in income or original debt balances only explain a small fraction of the variation in debt paydown.

The estimated relation between the characteristics of a user's consumption patterns and his debt paydown reflect exactly what one would expect if both were caused by present-bias. This indicates that considering a user's potential present bias indeed helps to explain paydown behavior better. It also reinforces the interpretation of sensitivity to paycheck receipt as a measure of impatience and validate the classification of users as naive and sophisticated: If they did not capture a user's present bias, they should not relate to debt paydown behavior in the way predicted by theory and confirmed in the regression results here.

6 Alternative Interpretations of Results

To interpret the results in Section 5 as evidence for the role of present bias requires that spending patterns and debt paydown are plausibly related only through a user's present bias. This section addresses alternative explanations for some of the patterns and shows that they fail to explain the *joint* behavior of debt paydown and consumption patterns.

6.1 Direct Relation between Paydown and Consumption Patterns

A key concern is that users' spending patterns are directly linked to debt paydown, not just through behavioral biases. Debt paydown by definition requires a reduction in consumption spending, so differences in spending patterns may mechanically lead to lower debt paydown. The characteristics of spending I use as measures of present bias, however, do not pin down the level of debt paydown, but leave enough degrees of freedom to allow identification of potential differences in the amount paid down. Specifically, the sensitivity of consumption spending to paycheck receipt captures only how smooth consumption is over the pay cycle, but is unrelated to the level of consumption which is what affects debt paydown. In terms of the model presented in Section 3, sensitivity of consumption captures the ratio of $\frac{c_1}{c_2}$, but saving for debt paydown depends on the level of consumption spending, i.e. $s = Y - c_1 - c_2$. Agents

can therefore exhibit the same level of sensitivity to paycheck receipt, but have different levels of debt paydown. Similarly, agents with the same amount of debt reduction may choose to split the remaining resources differently between the two periods of the pay cycle, leading to different sensitivity of consumption spending, but equal debt reduction.[33] By the same logic, how the ratio between payweek and non-payweek consumption changes as the agents resources fluctuate is independent of how the level of spending changes as resources increase and hence, how much will be left for debt reduction.

Nevertheless, it could be that alternative models of behavior, that have nothing to do with present bias, lead consumption patterns to be related to debt paydown. For instance, users who smooth consumption more when they have higher resources may also be those who consume a lower share of these additional resources, leading them to save more for debt paydown.[34] A high reduction in sensitivity as resources increase, i.e. a more negative coefficient on the interaction of $payweek * resources$, would therefore lead to higher debt paydown. Classifying users into sophisticated and naives based on this effect would then also lead users classified as sophisticated to, on average, pay down more of their debt. Figure 4 illustrates the prediction under this alternative theory, showing the estimated effect of resources on sensitivity on the horizontal axis and the expected paydown under this alternative hypothesis, which increases as additional resources reduce sensitivity to paycheck receipt. The figure also shows the expected paydown as predicted by the model (and illustrated in figure 1). In the model, the users expected to pay down the most are those with low levels of short-run impatience. Additional resources reduce the already low sensitivity of these users very little. Expected paydown is therefore highest when the effect of resources is close to zero and decreases for users with a high reduction

[33]Consider the following example to illustrate this point: An agent with a paycheck of \$100 can save \$50 and consume \$30 in the first and \$20 in the second period, leading to 50% higher consumption in payweeks. Alternatively the agent can consume \$60 in the first and \$40 in the second period, leading to the same sensitivity of consumption spending, but very different paydown. Similarly, saving \$50 but consuming \$25 each period, leads to the same savings as in the first case, but complete consumption smoothing.

[34]For instance, consider two types of consumers: some would like to go out for dinner each week, but save all remaining resources. Some consumers always spend whatever they have, but more immediately when they get their paycheck. In pay cycles with low resources, both can only afford to go out once and do so in the first week. When they have high resources, the first type of consumers goes out for dinner each week, smoothing consumption and reducing sensitivity to paycheck receipt, and saves all remaining resources. The second type spends all resources and does not reduce sensitivity to paycheck receipt. In this case, the users who smooth more when they have higher resources, also pay down more.

in sensitivity. Therefore, the theoretical predictions of present-bias differ and can be empirically distinguished from an alternative theory where reduction in sensitivity to paycheck receipt also leads users to pay down more. To do so, I estimate the following regression equation.

$$Paydown_i = \mu_0 + (coefficient_on_payweek * resources)\mu_1 + X_i'\lambda + \nu_i \qquad (4)$$

The regressor of interest is the $(coefficient_on_payweek * resources)$ estimated in equation (2), which captures how additional resources affect an agent's sensitivity to paycheck receipt. I estimate equation (4) including no additional controls, as well as including all explanatory variables in the baseline results (based on equation (3)). These additional controls are the sensitivity of spending on short-run consumables to paycheck receipt, planned paydown, median paycheck and original debt levels. Table 11 shows the results. In all specifications, the estimated direct relation between paydown and the reduction in sensitivity with additional resources is weak. None of the coefficients is statistically significant and most are positive, the opposite of what would be expected under the hypothesis that a reduction in sensitivity when resources increase leads to higher debt paydown.

6.2 Alternative Explanations for Sensitivity to Paycheck Receipt

In the empirical analysis I use the sensitivity to paycheck receipt as a proxy for a user's impatience level. Consumption spending, however, may be sensitive to paycheck receipt for other reasons than impatience. This section addresses several such alternative explanations and shows that they cannot explain the joint patterns of consumption spending and debt paydown.

Credit Constraints One possible cause for sensitivity to paycheck receipt are credit constraints. If users receive an expense shock, but lack the resources to pay for the necessary expense and can not borrow, they have to wait until the next paycheck to incur the expense. This leads to spending being sensitive to paycheck receipt. When estimating sensitivity to paycheck receipt in Section 4.1.2, I therefore restrict the sample to those instances when such short-run credit constraints are unlikely to play a role. In this section, I consider two additional, more conservative classification. I first estimate sensitivity and sophistication only based on the times when spending

in the given category, short-run consumables or restaurant and entertainment, would have been affordable without reducing resources below the 5th percentile of observed resources. In the baseline specification, I only required spending to be affordable at all, whereas this alternative restriction takes into account that users may want to hold a buffer stock of resources. Second, I use only those times in the estimation when total discretionary spending rather than just category specific spending of the payweek would have been affordable in the previous week.

Across all users, the baseline specification excludes about 3% of all days with positive spending. Requiring spending to be affordable without resources falling below a hypothetical buffer stock excludes 11% of days with positive spending. Requiring total discretionary spending to be affordable excludes around 5%, though there is heterogeneity between users. The majority of users has substantial borrowing capacity left on their cards, $11,907 on average as shown in table 1 and is never classified as likely constrained. Some users, however, regularly could not have afforded payweek spending in the previous week and for several of them, there are not enough unrestricted pay cycles to estimate the sensitivity to paycheck receipt under the stricter definition of constraints.

Table 12 shows summary statistics of estimated sensitivity to paycheck under different restrictions. For both spending categories, estimated sensitivity decreases as more pay cycles in which the user may have been credit constraint are filtered out. This indicates that at least some of the sensitivity in the unrestrictive sample might be driven by credit constraints. However, the estimated sensitivity would decrease even if credit constraints did not play any role, since the excluded pay cycles are those with the highest spending. On the individual level, the estimated sensitivities are highly correlated. Table 13 shows that, within a given consumption categories, the correlation between sensitivity estimates with different restrictions is more than 90%. Across the two spending categories, short-run consumables or restaurant and entertainment only, the estimates are also similar with correlations between 67% and 70%.

Tables 14 and 15 show the main results, where estimation of sensitivity and sophistication require resources to stay above a hypothetical buffer stock. Tables 16 and 17 show the same results when total discretionary spending would have been affordable in the pre-payweek. Finally, in Tables 18 and 19, sensitivity and sophistication are estimated based on all times, not excluding any times because of possible credit constraints. Throughout, the results are very similar to those in the baseline

specification.

Habits, Non-separabilities in Consumption or Social Coordination Habits coinciding with payweeks are another possible explanation for higher spending during payweeks. For instance, some people may have a habit of going out for "date night" every two weeks, and for some of them this might by chance overlap with the receipt of their paycheck, leading to higher payweek spending unrelated to short-run impatience. Alternatively, some people may rationally coordinate some purchases with when they get paid, such as shopping trips for larger expenditures. This could lead to higher consumption spending in other categories during payweeks, if there are non-separabilities between different types of consumption. For instance consumers may go to see a movie and have dinner out when they drive to the mall anyways to do their shopping, leading to higher consumption spending during payweeks, again unrelated to short-run impatience. Similarly, consumers may want to coordinate consumption spending with their friends. Consumers, who have friends who are short-run impatient and therefore prefer to go out and spend more when they have just received their paycheck, may therefore have similar consumption patterns as their impatient friends without being present-biased themselves. Moreover, some of their friends may be colleagues such that both higher spending and paycheck receipt coincide for a group of friends. However, if the estimated sensitivity of consumption is caused by habits, non-separabilities between consumption or social coordination, there is no reason to expect these users to have differential debt repayment behavior in the way observed in the data. I therefore argue that the estimated sensitivity to paycheck receipt is at least partially driven by short-run impatience. Otherwise, it would not relate to debt paydown in exactly the way predicted by present bias.

Time Consistent Preferences with High Discount Factor For consumers who live paycheck to paycheck time consistent preferences with a very high discount factor could also lead consumption spending to be higher early in the pay cycle. Similarly, consumers with a higher discount rate would also reduce their debt balances less. This is unlikely to be driving the results. First, the discount factor that would be necessary to lead to sensitivity of consumption spending over a two week horizon is so high that it is generally considered to be implausible, given consumers' relative patience in the long-run.[35] Second, time consistent consumers should have no issue

[35] Shapiro (2005) outlines this argument this for the monthly horizon considered in his paper.

to stick to their original plans. In my setting, a time consistent consumer with a high discount factor is likely to be classified as naive. For both time-consistent as well as naive present-biased consumers, the discount factor between any two periods does not vary with the level of resources for time consistent agents, so the sensitivity to paycheck receipt should not change with the level of resources, either. However, I find that these consumers follow their plans substantially less than consumers classified as sophisticated. Such differences in the ability to stick to their plan depending on how sensitivity to paycheck reacts to resources would not be expected if sensitivity was caused by time consistent preferences with high discount factors.

6.3 Alternative Explanations for Failing to Stick to Plan

Loss of Income A substantial loss of income, for instance by losing their jobs, could render households unable to follow their original plan to reduce debt levels. All users in my sample have regular paychecks throughout the sample period and therefore do not experience a substantial reduction in their income which could force them to abandon their original plan.

Different Interpretations of Meaning of Plan by Users When prompted by ReadyForZero to state by how much they want to reduce their debt each month, users may differ in what they understand a plan to be. For instance, some users may view their planned paydown as an aspirational goal rather than a realistic plan which they are likely to stick to. However, differences in interpreting what a plan means should not affect how consumers smooth consumption over the pay cycle and therefore can not explain the systematic relation between consumption patterns and the extent to which users follow their plan found empirically.

Overoptimism Differences in overoptimism could also lead to differences in the extent that users follow their original plans to reduce debt levels. They may fail to stick to their plan, if they persistently overestimate their ability in raising additional resources, for instance by selling on eBay, or in the amount of money they will save, for instance by bringing lunch to work instead of buying lunch. In addition, such overoptimism could also lead to sensitivity of consumption spending to paycheck receipt, if users overoptimistic about the probability of receiving additional resources in the second week of a pay cycle or underestimate the cost of their first week planned consumption. As a result, they might spend more of the paycheck

when they receive it, and when additional resources fail to materialize, they reduce expenditures. However, there is no reason why the extent of overoptimism should vary systematically with an individual's level of resources or that the extent to which varying resources affect sensitivity of consumption spending should relate systematically to debt paydown. Hence, overoptimism alone does not predict the systematic differences between sophisticated and naive agents observed in the data.

Lack of Financial Literacy Several papers[36] have documented that many consumers lack basic financial literacy and often do not understand the implications of decisions they make. However, a lack of financial literacy would not necessarily lead to sensitivity of consumption to paycheck receipt. Nevertheless, it may be that consumers who understand the implications of their financial decisions better, are also better in planning and allocating resources over their two-week pay cycles, leading them to smooth consumption more. Still, differences in understanding would not predict that consumers's sensitivity to paycheck receipt reacts differentially to the level of resources and that these differences systematically predict which consumers are better able to follow their plan and reduce their debt levels. While lack of financial literacy alone does not explain the relation between consumption patterns and debt paydown documented, the results are consistent with some or even most consumers lacking a thorough understanding of financial matters in addition to some having present-biased preferences. Specifically, while planned paydown is more predictive of actual paydown for sophisticated than for naive agents, most agents fall short of their plan. This could be because consumers are unaware of some of their financial obligations, specifically the high cost of interest payments, and hence overestimate the resources available to debt reduction. Similarly, several of the services offered by ReadyForZero, for instance the help in calculating how to split a payment between several credit card accounts, are likely to appeal to consumers who lack financial

[36] Lusardi and Tufano (2009) shows that households with lower financial literacy more often report excessive debt balances. Bertrand and Morse (2011) and Bertrand and Morse (2009) find a lack of financial literacy amongst payday loan borrowers. Bernheim and Garrett (2003) and Bernheim, Garrett, and Maki (2001) show that financial education increases savings. Behrman, Mitchell, Soo, and Bravo (2010) also find that financial literacy helps to predict wealth accumulation. Hastings and Mitchell (2011) show that while short-run impatience is a strong predictor for retirement savings in Chile, financial literacy is also correlated with the level of savings. Stango and Zinman (2009) show that households who exhibit exponential growth bias, i.e. who tend to linearize exponential functions when assessing them intuitively, borrow more. Agarwal and Mazumder (2012) find that households with higher cognitive ability measured by math scores in standardized tests make fewer financial mistakes, such as suboptimal use of credit cards.

knowledge.

7 Robustness of Results

This section considers a variety of robustness checks to show that the baseline results are not sensitive to the exact specification chosen.

Measuring Paydown In the baseline specification, paydown is measured by the linear trend in a user's debt levels estimated over a horizon of 90 or 180 days to filter out the fluctuations caused by the use of credit cards for transaction purposes. In tables 20 and 21, debt paydown is instead measured by the simple difference in debt levels between the day the user signed up and the day 90 or 180 days later.

Over 180 days, point estimates are very close to the baseline specification and have higher significance levels. Over 90 days, the difference between sophisticated and naive agents in the predictability of planned paydown is estimated to be lower, 12.6 cents for every additional dollar compared to 23 cents in the baseline specification and no longer statistically significant. The differential effect of sensitivity to paycheck receipt for both groups, however, is estimated to be slightly higher if anything. Overall, estimates based on the simple differences in debt levels show a very similar picture to when the fluctuations due to transactions are filtered out.

Identifying Sophistication for Low Impatience Users Section 3.2 pointed out that from a theoretical perspective, the distinction between sophisticated and naive agents becomes meaningless when they have very low or no short-run impatience. Similarly, users with low levels of sensitivity to paycheck receipt are difficult to classify as either sophisticated or naive. With a low level of sensitivity to begin with, any potential reduction in the observed sensitivity which could identify a user as sophisticated is relatively low and therefore less likely to be picked up in the estimation.

Moreover, agents with a low level of impatience should behave very similar irrespective of sophistication. Having low sensitivity agents included in both groups, is therefore likely to reduce the estimated differences between the two groups, since these differences are primarily driven by users with non-negligible levels of impatience.

In tables 22 and 23, I therefore exclude users with low levels of sensitivity. Starting with the baseline sample, I subsequently exclude the users with the 5%, 10%, 15% and 20% lowest estimated levels of sensitivity to paycheck receipt. Despite the reduction in sample size, the estimated differences between sophisticated and naive agents remain statistically significant and the estimated magnitudes, if anything increase.[37] These results indicated that, consistent with theory, the differences between sophisticated and naive agents are indeed driven by those agents with higher levels of short-run impatience rather than those with relatively low or no short-run impatience.

8 Conclusion

In this paper I empirically analyze the role of short-run impatience in explaining why some consumers hold expensive credit card balances and struggle to pay them off despite their intention to do so. I study a sample of users of a debt management website uniquely suited to address this question. Upon joining the website, users make an explicit plan of how much they want to reduce their debt balances each month. It is therefore reasonable to assume that they are unhappy with their current level of credit card debt. Moreover, it allows me to measure each user's success in debt paydown relative to their original intent to do so. In a first step, I measure the extent of each user's potential short-run impatience and classify them as naive and sophisticated based on their patterns of consumption spending over time. Specifically, the level of short-run impatience is captured by the increase in consumption spending during payweeks relative to non-payweeks. Users are classified as sophisticated if this sensitivity to paycheck decreases when the user's resources are higher and as naive if this is not the case. Consistent with present bias, I empirically find that users classified as sophisticated pay down less the higher their measured impatience and that their plans are predictive of their actual debt reduction. Users classified as naive pay down very little, irrespective of their plans and level of measured impatience. I consider a range of alternative explanations and show that none is consistent with the joint patterns of debt paydown and the consumption patterns capturing the extent of present bias and sophistication. Therefore, the results indicate that short-run impatience can indeed help understand why some people have problems paying off

[37] Note that the average level of sensitivity in the sample also changes, so a higher point estimate does not necessarily imply an increased effect.

their debt and end up holding substantial and expensive credit card balances.

The results have important policy implications for the regulation of credit markets. A set of theoretical papers has shown that common features in credit card contracts, such as teaser rates, disproportionally hurt consumers with behavioral biases (see Heidhues and Kőszegi (2010)).[38] By providing empirical evidence that such behavioral biases play a role in explaining credit card debt holdings, the paper provides additional justification for regulation like the Credit CARD Act of 2009. This regulation, for instance, prohibits issuers of sub prime credit cards to backload fees and requires them to be charged upfront when the credit card is issued. This could potentially hurt time consistent consumers if they used such credit cards to bridge acute liquidity shortages and may hence benefit from having fees backloaded. However, it would be very effective in preventing present-biased consumers from borrowing without fully internalizing the cost. Knowing that many consumers hold debt levels because of behavioral biases rather than because they received shocks or consider such debt levels optimal, also has important implications for how to help consumers get out of debt. For instance, mechanisms that make commitment to long-term plans attractive to consumers could be a promising and cost effective way to do so.[39] One possibility would be to allow consumers to select a certain amount to be deducted from their regular paycheck and put towards debt repayment before they receive the money, and to make it costly or complicated to change this selection. In the literature, similar ideas have been explored in helping present-biased consumers save, for instance by Thaler and Benartzi (2004) or Ashraf, Karlan, and Yin (2006).

[38] Ponce-Rodriguez (2008) shows empirically that banks in Mexico structure credit card contracts to exploit potential behavioral biases of customers. DellaVigna and Malmendier (2004) study how firms in general structure contracts with consumers who have self control issues. Several papers have explored the implications of behavioral biases for regulation and policy: Camerer, Issacharoff, Loewenstein, O'Donoghue, and Rabin (2003) argue for the benefits of certain forms of paternalistic regulation in the face of behavioral biases, including potential present bias, by some consumers. Thaler and Sunstein (2008) show how the better understanding of behavioral biases can help improve consumer decisions in a wide range of areas. Mullainathan, Schwartzstein, and Congdon (2012) present a framework for the implications of potential behavioral biases for regulation and public finance. Gruber and Kőszegi (2004) study the implications of time inconsistent preferences for the incidence of cigarette taxes.

[39] Amador, Werning, and Angeletos (2006) explore the trade-off between commitment to overcome temptation and the benefits of flexibility in the face of uncertainty.

References

Ackerman, R., G. Fries, and R. Windle (2012): "Changes in US Family Finances from 2007 to 2010: Evidence from the Survey of Consumer Finances," *Federal Reserve Bulletin*.

Agarwal, S., and B. Mazumder (2012): "Cognitive Abilities and Household Financial Decision Making," *American Economic Journal: Applied Economics*, forthcoming.

Aguiar, M., and E. Hurst (2005): "Consumption versus Expenditure," *Journal of Political Economy*, 113(5), 919–948.

Amador, M., I. Werning, and G. Angeletos (2006): "Commitment vs. flexibility," *Econometrica*, 74(2), 365–396.

Angeletos, G.-M., D. Laibson, A. Repetto, J. Tobacman, and S. Weinberg (2001): "The Hyperbolic Consumption Model: Calibration, Simulation, and Empirical Evaluation," *The Journal of Economic Perspectives*, 15(3), 47–68.

Ariely, D., and K. Wertenbroch (2002): "Procrastination, deadlines, and performance: Self-control by precommitment," *Psychological Science*, 13(3), 219–224.

Ashraf, N., D. Karlan, and W. Yin (2006): "Tying Odysseus to the mast: Evidence from a commitment savings product in the Philippines," *Quarterly Journal of Economics*, 121(2), 635–672.

Ausubel, L. M. (1991): "The Failure of Competition in the Credit Card Market," *American Economic Review*, 81(1), 50–81.

Behrman, J. R., O. S. Mitchell, C. Soo, and D. Bravo (2010): "Financial Literacy, Schooling, and Wealth Accumulation," Working Paper 16452, National Bureau of Economic Research.

Bernheim, B., and D. Garrett (2003): "The effects of financial education in the workplace: Evidence from a survey of households," *Journal of Public Economics*, 87(7), 1487–1519.

Bernheim, B., D. Garrett, and D. Maki (2001): "Education and saving: The long-term effects of high school financial curriculum mandates," *Journal of Public Economics*, 80(3), 435–465.

Bertrand, M., and A. Morse (2009): "What Do High-Interest Borrowers Do with Their Tax Rebate?," *American Economic Review: Papers & Proceedings*, 99(2).

Bertrand, M., and A. Morse (2011): "Information Disclosure, Cognitive Biases, and Payday Borrowing," *Journal of Finance*, 66(6), 1865–1893.

Browning, M., and M. D. Collado (2001): "The Response of Expenditures to Anticipated Income Changes: Panel Data Estimates," *American Economic Review*, 91(3), 681–692.

Camerer, C., S. Issacharoff, G. Loewenstein, T. O'Donoghue, and M. Rabin (2003): "Regulation for Conservatives: Behavioral Economics and the Case for "Asymmetric Paternalism"," *University of Pennsylvania Law Review*, 151(3), 1211–1254.

Carroll, G., J. Choi, D. Laibson, B. Madrian, and A. Metrick (2009): "Optimal Defaults and Active Decisions," *Quarterly Journal of Economics*, 124(4), 1639–1674.

Choi, J., D. Laibson, B. Madrian, and A. Metrick (2004): "Default Effects and 401 (k) Savings Behavior," *Perspectives on the economics of aging*.

DellaVigna, S. (2009): "Psychology and Economics: Evidence from the Field," *Journal of Economic Literature*, 47(2), 315–372.

DellaVigna, S., and U. Malmendier (2004): "Contract Design and Self-Control: Theory and Evidence," *Quarterly Journal of Economics*, 119(2), 353–402.

——— (2006): "Paying not to go to the gym," *American Economic Review*, 96(3), 694–719.

DellaVigna, S., and M. Paserman (2005): "Job search and impatience," *Journal of Labor Economics*, 23(3), 527–588.

Fang, H., and D. Silverman (2009): "Time-inconsistency and Welfare Program Participation: Evidence from the NLSY," *International Economic Review*, 50(4), 1043–1077.

Fang, H., and Y. Wang (2010): "Estimating Dynamic Discrete Choice Models with Hyperbolic Discounting, with an Application to Mammography Decisions," Working Paper 16438, National Bureau of Economic Research.

Gruber, J., and B. Kőszegi (2004): "Tax incidence when individuals are time-inconsistent: the case of cigarette excise taxes," *Journal of Public Economics*, 88(9), 1959–1987.

Harris, C., and D. Laibson (2002): "Hyberbolic Discounting and Consumption," in *Advances in economics and econometrics: Theory and Applications, Eighth World Congress*, ed. by M. Dewatripont, L. P. Hansen, and S. Turnovsky, vol. 1, pp. 258–298. Cambridge University Press.

Hastings, J., and E. Washington (2010): "The First of the Month Effect: Consumer Behavior and Store Responses," *American Economic Journal: Economic Policy*, 2(2), 142–162.

Hastings, J. S., and O. S. Mitchell (2011): "How Financial Literacy and Impatience Shape Retirement Wealth and Investment Behaviors," Working Paper 16740, National Bureau of Economic Research.

Heidhues, P., and B. Kőszegi (2010): "Exploiting Naïvete about Self-control in the Credit Market," *American Economic Review*, 100(5), 2279–2303.

Hsieh, C. (2003): "Do Consumers React to Anticipated Income Changes? Evidence from the Alaska Permanent Fund," *American Economic Review*, 93(1), 397–405.

Jappelli, T., and L. Pistaferri (2010): "The Consumption Response to Income Changes," *Annual Review of Economics*, 2, 479–506.

Kaur, S., M. Kremer, and S. Mullainathan (2010): "Self-Control at Work: Evidence from a Field Experiment," Working Paper.

Laibson, D. (1997): "Golden Eggs and Hyperbolic Discounting," *Quarterly Journal of Economics*, 112(2), 443–478.

Laibson, D., A. Repetto, and J. Tobacman (2003): "A Debt Puzzle," *Knowledge, Information, and Expectations in Modern Macroeconomics: In Honor of Edmund Strother Phelps*, p. 228.

Laibson, D., A. Repetto, and J. Tobacman (2007): "Estimating Discount Functions with Consumption Choices over the Lifecycle," Working Paper.

Lusardi, A., and P. Tufano (2009): "Debt Literacy, Financial Experiences, and Overindebtedness," Working Paper 14808, National Bureau of Economic Research.

Madrian, B., and D. Shea (2001): "The Power of Suggestion: Inertia in 401 (k) Participation and Savings Behavior," *Quarterly Journal of Economics*, 116(4), 1149–1187.

Meier, S., and C. Sprenger (2010): "Present-Biased Preferences and Credit Card Borrowing," *American Economic Journal: Applied Economics*, 2(1), 193–210.

Mullainathan, S., J. Schwartzstein, and W. J. Congdon (2012): "A Reduced-Form Approach to Behavioral Public Finance," *Annual Review of Economics*, 4(1), 511–540.

O'Donoghue, T., and M. Rabin (1999): "Doing It Now or Later," *American Economic Review*, 89(1), 103–124.

Parker, J. A. (1999): "The Reaction of Household Consumption to Predictable Changes in Social Security Taxes," *American Economic Review*, 89(4), 959–973.

Paserman, M. (2008): "Job Search and Hyperbolic Discounting: Structural Estimation and Policy Evaluation," *The Economic Journal*, 118(531), 1418–1452.

Ponce-Rodriguez, A. (2008): "Rate Offers in the Credit Card Market: Evidence from Mexico," Dissertation Stanford University.

Rabin, M., and T. O'Donoghue (1999): "Procrastination in Preparing for Retirement," in *Behavioral Dimensions of Retirement Economics*, ed. by H. Aaron, pp. 125–156. The Brookings Institution.

Scholnick, B. (2010): "Consumption Smoothing after the Final Mortgage Payment: Testing the Magnitude Hypothesis," *Review of Economics and Statistics*, forthcoming.

Shapiro, J. (2005): "Is there a daily discount rate? Evidence from the food stamp nutrition cycle," *Journal of Public Economics*, 89(2-3), 303–325.

Shapiro, M., and J. Slemrod (1995): "Consumer Response to the Timing of Income: Evidence from a Change in Tax Withholding," *American Economic Review*, 85(1), 274–283.

Shui, H., and L. Ausubel (2005): "Time Inconsistency in the Credit Card Market," Working Paper.

Skiba, P., and J. Tobacman (2008): "Payday Loans, Uncertainty and Discounting: Explaining Patterns of Borrowing, Repayment, and Default," Working Paper.

Souleles, N. (1999): "The Response of Household Consumption to Income Tax Refunds," *American Economic Review*, 89(4), 947–958.

Stango, V., and J. Zinman (2009): "Exponential Growth Bias and Household Finance," *The Journal of Finance*, 64(6), 2807–2849.

Stephens, Jr, M. (2006): "Paycheque Receipt and the Timing of Consumption," *The Economic Journal*, 116(513), 680–701.

Thaler, R., and S. Benartzi (2004): "Save More Tomorrow: Using Behavioral Economics to Increase Employee Saving," *Journal of Political Economy*, 112(1), 164–187.

Thaler, R., and C. Sunstein (2008): *Nudge: Improving decisions about health, wealth, and happiness*. Yale University Press.

Tobacman, J. (2007): "The Partial Naivete Euler Equation," Working Paper.

Appendices

A Data Preparation and Classifications

Sample Selection Table 24 illustrates how many users are lost at each step of the data selection process, starting with a random sample of users. In the last step, I require users to have at least 35 days with positive spending in the respective category (short-run consumables or restaurant meals and entertainment) for estimation of sensitivity to paycheck receipt. If a user only has the minimum number of full pay cycles, 8, this amounts to a little over 2 days of positive spending per week.

Paychecks Transactions are identified as paychecks when they are classified as such by the data provider or when their description contains the following words:

- "Payroll", "payroll", "PAYROLL", "PAYRLL", "PAYROL", "PAYPPD"
- "SALARY", "salary", "Salary", "FED SAL"
- "PPD" and one of the following: "DIR DEP", "DIRDEP", "DIRECTDEPOSIT", "DIRECT DEPOSIT", "DIRECT DEP", "DIR.DEPST", "CO ID", "PAYMENTPPD"
- "CO ID"and "INDN" and one of "DIR DEP", "DIRDEP", "DIRECTDEPOSIT", "DIRECT DEPOSIT", "DIRECT DEP"

Even if meeting the above criteria, transactions are not classified as a paycheck if they contain the following words:

- "tax", "Tax", "TAX"
- "PAYPAL", "paypal", "HALF.COM", "Square Inc", "SQUARE INC"

Finally, I classify regular deposits (identified the same way as regular payments described below) of more than $500 as paychecks.

Spending I first distinguish between regular and non-regular payments. Non-regular payments are further distinguished into discretionary spending and non-regular, non-discretionary spending. Discretionary spending are expenses where at the time of the payment the consumer had discretion about i) whether to incur the

payment at all or ii) how much to spend. Payments are classified as discretionary based on the type of expenditure category. Examples of discretionary spending are restaurant meals. Non-discretionary spending are cell phone bills or utility bills, where the amount due depends on past consumption, but there is no discretion once the bill arrives. I further consider two sub-categories of discretionary spending, non-durables and short-run consumables as described below.

Regular Payments To classify transactions as regular payments, they are first grouped into sets of payments which have the same

- exact amount
- amount when cents are truncated
- amount rounded to the next integer
- amount rounded to multiples of $10 when the transaction amount is more than $100

A set of transaction is classified as occurring regularly every two weeks if

- there are at least 7 transactions
- the median difference between payments is between 13 and 16 days
- at most one payment in the sequence was missed, i.e. the maximum amount of time between payments is 31 days

A set of transactions is classified as occurring regularly monthly if

- there are at least 5 transactions
- the median difference between payments is between 28 and 31 days
- at most one payment in the sequence was missed, i.e. the maximum amount of time between payments is 64 days

Non-regular payments are further classified into short-run consumables, non-durables or total discretionary spending. These three broad categories consist of the following categories as assigned by the data provider:

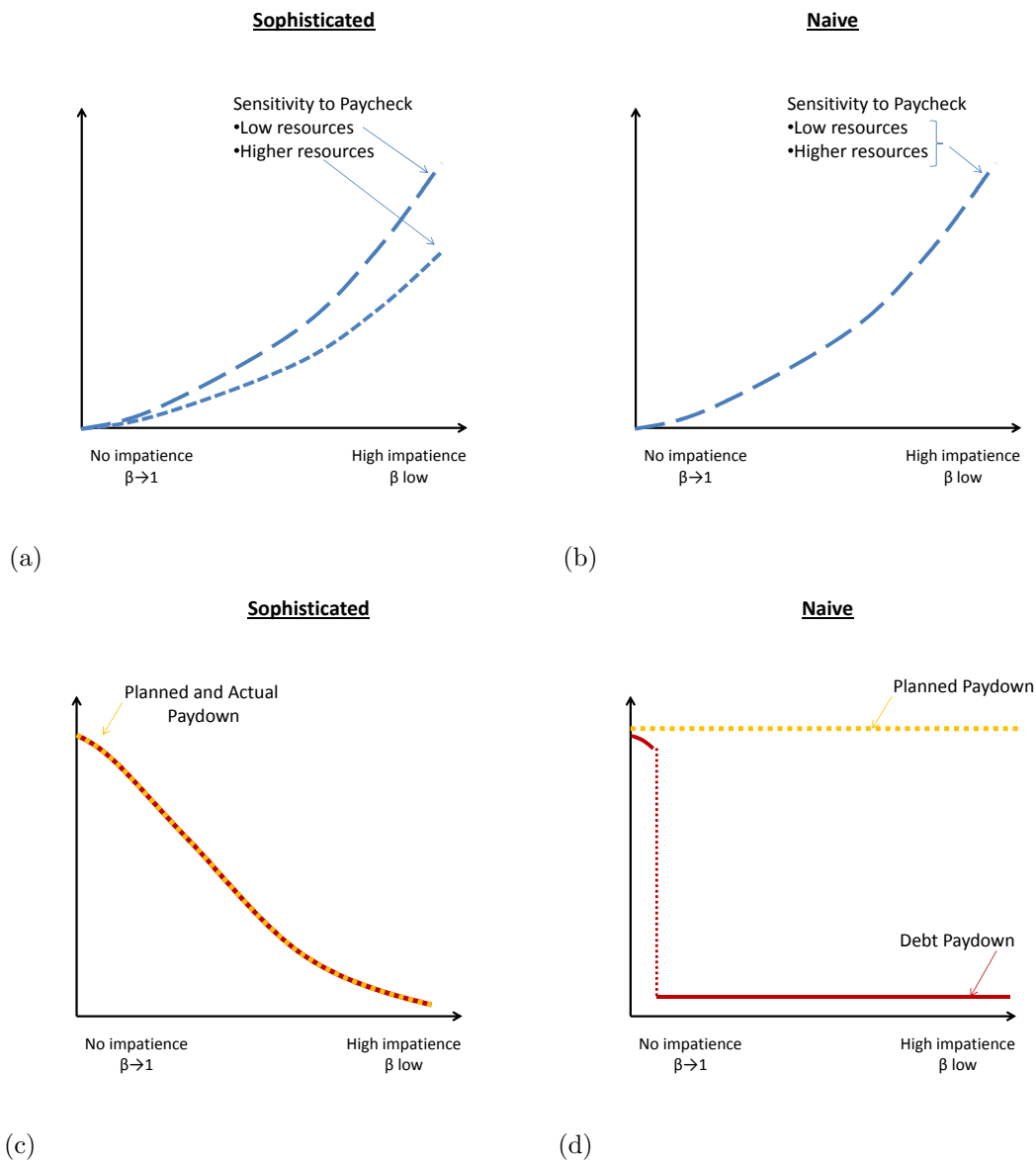
- Short-run Consumables

  - gasoline/ fuel
  - groceries
  - restaurant/ dining
  - entertainment (tickets, Netflix, itunes, video/ DVD rental, computer games, party stores, ect)

- Non-durables
  - short-run consumables
  - travel
  - gifts
  - drugstore purchases/ personal care
  - pet expenditures
  - general merchandise (Target, Walmart, Cosco, ect.)

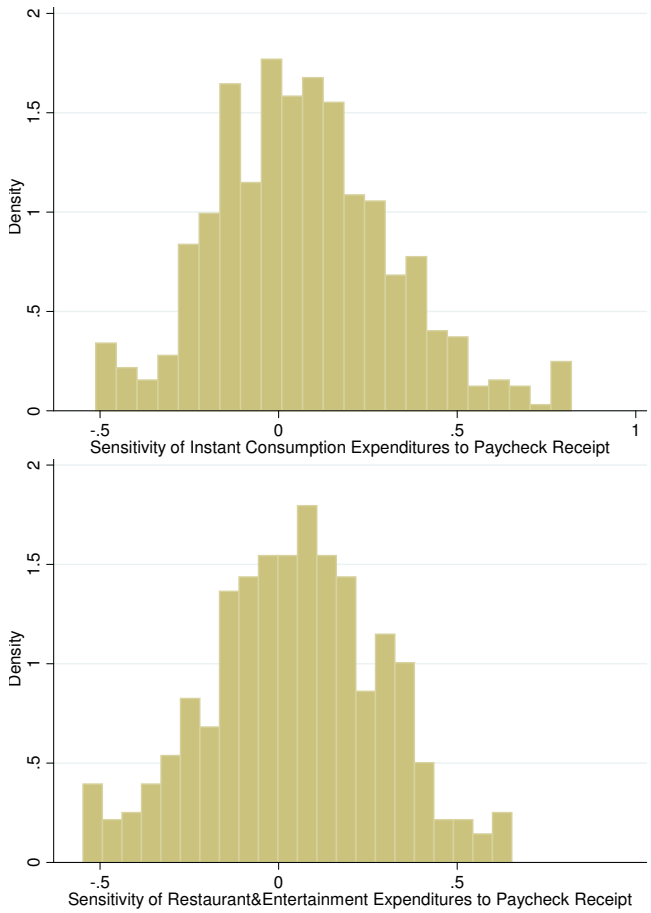
- Total discretionary expenditure
  - non-durables
  - automotive expenditures (excluding car purchases), primarily oil checks and similar expenditures
  - toys and other children products
  - clothing and shoes
  - Healthcare/Medical products
  - Home Maintenance
  - non-regular cable and online services
  - hobby expenditures
  - electronics
  - credit reports or services
  - advertising or custom management services
  - non-regular bills
  - paypal purchases
  - unclassified credit card purchases
  - non-regular uncategorized transactions

Figure 1: Relation of Consumption Patterns to Debt Paydown



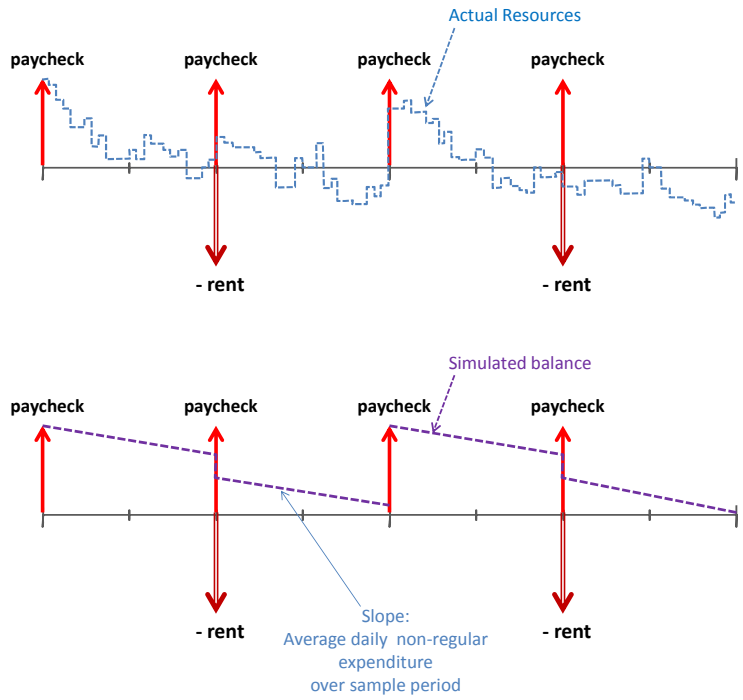
The figure illustrates the predictions for consumption patterns and debt paydown when agents can be present-biased. The two upper panels show the sensitivity of consumption spending to paycheck receipt for both types of agents, sophisticated agents at the left in panel (a) and naive agents at the right in panel (b). The two lower panels show planned and actual paydown for the two types, again sophisticated agents at the left in panel (c) and naive agents at the right in panel (d). In each panel, the horizontal axis shows the level of short-run impatience, starting with very low impatience (or β close to 1) at the origin.

Figure 2: Distribution of Individual Level Sensitivity to Paycheck Receipt



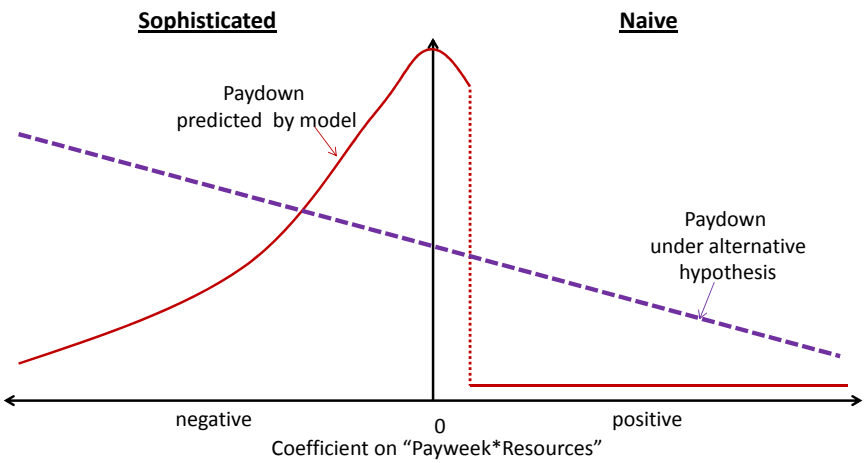
The figure plots the distribution of the estimates of each user's sensitivity to paycheck receipt. Estimates are based on short-run consumables in the top panel and restaurant and entertainment spending in the bottom panel. Sensitivity to paycheck receipt is estimated separately for each user based on equation (1), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + X_{it}\psi_i + \varepsilon_{it}$. Sensitivity to paycheck receipt for each user is captured by γ_{1i}.

Figure 3: Simulated Balances Based on Regular Payments



The figure illustrates the construction of the hypothetical balances used to isolate the variation in resources uncorrelated with an individual's prior spending. Balances are shown for a hypothetical agent who receives regular bi-weekly paychecks (illustrated by upward pointing red arrows) and has to pay rent monthly every other pay date (downward pointing red arrows). The upper panel shows actual balances given actual spending of the hypothetical agent. The lower panel shows the agent's calculated balances based on regular payments and the assumption that spending is split equally across all days. Each day's balance is calculated based on the agent's regular paycheck, regular rent payment and average daily spending.

Figure 4: Effect of Resources on Sensitivity and Debt Paydown



The figure shows the relation between debt paydown and the effect of resources on sensitivity to paycheck receipt under the alternative theory that users who smooth consumption more when they have higher resources also save more for debt paydown. The horizontal axis shows the estimated effect of resources on sensitivity to paycheck receipt, the coefficient γ_{3i} estimated in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Users are classified as sophisticated when the estimated effect is negative and as naive otherwise. The dotted line shows paydown under the alternative hypothesis. The figure also shows expected paydown as predicted by the model in section 3. To the right of the vertical axis, users are classified as naive. Expected paydown is therefore the same as in panel (d) of Figure 1. To the left of the vertical axis, users are classified as sophisticated. Expected paydown is the same as in panel (c) of Figure 1, but mirror inverted to reflect the fact that short run impatience is higher for sophisticated agents with a higher reduction in sensitivity as resources increase.

Table 1: Summary Statistics - Income and Assets

	N	Mean	p25	p50	p75
Users					
Days in sample	556	471	339	442	619
Days in sample after sign-up		399	252	354	562
Nr of paychecks		25	16	23	34
Nr of paychecks - full pay cycles		24	15	22	32
Income					
Avg. monthly income	556	3,913	2,607	3,526	4,669
Median monthly income		3,896	2,571	3,485	4,623
Avg. monthly non-paycheck income		312	0	123	437
Median monthly non-paycheck income		91	0	0	0
Assets					
Credit Card Debt - $	556	15,204	4,962	10,669	19,303
Credit Card Debt - rel. to income		4.52	1.46	3.03	5.10
Cash Balances - $		3,954	637	1,812	4,452
Cash Balances - rel. to income		1.05	0.21	0.53	1.12
Total Credit - $		27,111	9,750	19,875	34,625
Total Credit - rel. to income		7.90	2.97	5.52	9.59
Available Credit - $		11,907	1,776	5,697	16,250
Available Credit - rel. to income		3.39	0.56	1.62	4.32
Debt Paydown					
Change in Debt - 90 days - $	556	-736	-1,332	-234	363
Change in Debt - 90 days - %		0.03	-0.14	-0.02	0.04
Change in Debt - 180 days - $		-1,125	-2,264	-470	553
Change in Debt - 180 days - %		0.25	-0.22	-0.04	0.06
Planned Paydown - 90 days - $		2,747	1,121	1,947	3,484
Planned Paydown - 90 days - %		0.29	0.11	0.19	0.37
Planned Paydown - 180 days - $		5,092	2,084	3,607	6,203
Planned Paydown - 180 days - %		0.48	0.22	0.37	0.73

The table shows mean, median and 25th and 75th percentile for key characteristics of the users in the sample used throughout the paper. The summary statistics for the subsample of users with enough observations to estimate sensitivity based on restaurants and entertainment are similar.

Table 2: Summary Statistics - Spending

	N	Mean	p25	p50	p75
Discretionary Spending					
Total					
Avg. $	556	1,710	996	1,475	2,122
Avg. relative to avg. income		0.48	0.29	0.41	0.60
Median $		1,537	721	1,344	2,071
Median relative to avg. income		0.44	0.22	0.39	0.57
Non-Durable					
Avg. $	556	986	565	845	1,238
Avg. relative to avg. income		0.28	0.17	0.24	0.35
Median $		883	384	758	1,182
Median relative to avg. income		0.25	0.12	0.22	0.34
Short-run Consumables					
Avg. $	556	505	283	430	642
Avg. relative to avg. income		0.15	0.08	0.12	0.18
Median $		447	177	375	623
Median relative to avg. income		0.13	0.05	0.11	0.18
Restaurant&Entertainment					
Avg. $	556	263	138	214	338
Avg. relative to avg. income		0.08	0.04	0.06	0.09
Median $		215	80	175	291
Median relative to avg. income		0.06	0.02	0.05	0.08
Regular Payments					
Avg. $	556	1,178	542	968	1,531
Avg. relative to avg. income		0.32	0.17	0.28	0.41
Median $		1,006	138	581	1,586
Median relative to avg. income		0.28	0.04	0.17	0.45

The table shows mean, median and 25th and 75th percentile for monthly spending of the users in the sample used throughout the paper. If applicable, spending is normalized by the user's average monthly income from his regular paychecks. The summary statistics for the subsample of users with enough observations to estimate sensitivity based on restaurants and entertainment are similar.

Table 3: Sensitivity of Consumption to Paycheck Receipt

	N	Mean	p25	p50	p75
Sensitivity					
Short-run Consumables	556	0.067	-0.115	0.048	0.227
Restaurants&Entertainment	510	0.044	-0.115	0.051	0.202
Effect of Resources on Sensitivity (γ_3)					
Short-run Consumables	556	-0.032	-0.231	-0.002	0.208
Restaurants&Entertainment	510	0.343	-0.263	0.001	0.222

The upper panel shows summary statistics of each user's estimated sensitivity to paycheck receipt, captured by coefficient on *payweek* in equation (1), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (1) is estimated separately for each user and includes day of week and month fixed effects. The lower panel shows summary statistics of the effect of higher resources on the sensitivity to paycheck receipt. For each user this effect is captured by the coefficient on $payweek * resources$ in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (2) is estimated separately for each user and includes day of week and month fixed effects. Resources are instrumented for with calculated balances based on regular payments.

Table 4: Classification by Sophistication

	Restaurant&Entertainment		
	Naive	Sophisticated	Total
Short-run Consumables			
Naive	173	79	252
Sophisticated	83	174	257
Total	256	253	509

The table shows the number of users classified as sophisticated and naive based on estimates using short-run consumable and restaurant and entertainment spending only. In both cases, users are classified as sophisticated if additional resources decrease sensitivity to paycheck receipt, i.e. if the estimated coefficient on $payweek * resources$ is negative in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (2) is estimated separately for each user and includes day of week and month fixed effects. Resources are instrumented for with calculated balances based on regular payments. There are 509 users who have at least 35 days of positive spending in for both categories, short-run consumables and restaurant and entertainment, at times when payweek spending in the respective category would have been affordable in the previous non-payweek. One user has enough observations only for restaurant and entertainment spending, and 45 users have enough observations only for short-run consumables.

Table 5: Sensitivity to Paycheck Receipt by Sophistication

Sophistication based on Short-run Consumables	N	Mean	Median
Sensitivity - Short-run Consumables			
Naive	275	0.049	0.042
Sophisticated	281	0.084	0.062
Sensitivity - Restaurant&Entertainment			
Naive	252	0.032	0.041
Sophisticated	257	0.057	0.066

Sophistication based on Restaurant&Entertainment	N	Mean	Median
Sensitivity - Short-run Consumables			
Naive	256	0.061	0.061
Sophisticated	253	0.057	0.035
Sensitivity - Restaurant&Entertainment			
Naive	256	0.051	0.062
Sophisticated	254	0.038	0.039

The table shows mean and median estimated sensitivity to paycheck receipt separately for users classified as naive and sophisticated. In the upper panel users are classified based on estimates using short-run consumable. In the lower panel the classification is based on estimates using restaurant and entertainment spending only. In both cases, users are classified as sophisticated if additional resources decrease sensitivity to paycheck receipt, i.e. if the estimated coefficient on $payweek * resources$ is negative in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (2) is estimated separately for each user and includes day of week and month fixed effects. Resources are instrumented for with calculated balances based on regular payments. In each panel, the first rows lines show estimated sensitivity to paycheck receipt for spending on short-run consumables. The two lower rows in each panel show sensitivity to paycheck receipt of restaurant and entertainment spending only.

Table 6: Summary Statistics on Income and Assets by Sophistication

	Sophistication based on			
	Short-term Consumables		**Restaurant& Entertainment**	
	Naive	Sophisticated	Naive	Sophisticated
Avg. Paycheck				
Mean	3,841	3,983	3,926	4,029
Median	3,479	3,563	3,610	3,533
Credit Card Debt				
Mean $	16,171	14,257	15,657	15,128
Median $	10,915	10,441	10,113	10,839
Mean, rel. to income	4.56	4.48	4.22	4.79
Median, rel. to income	3.13	2.91	2.97	3.03
N	275	281	256	254

The table shows mean and median average monthly income and credit card debt, both in absolute amounts as well as relative to average monthly income, separately for users classified as naive and sophisticated. In the first two columns users are classified based on estimates using short-run consumables. In the last two columns the classification is based on estimates using restaurant and entertainment spending only. In both cases, users are classified as sophisticated if additional resources decrease sensitivity to paycheck receipt, i.e. if the estimated coefficient on $payweek * resources$ is negative in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (2) is estimated separately for each user and includes day of week and month fixed effects. Resources are instrumented for with calculated balances based on regular payments.

Table 7: Summary Statistics on Spending by Sophistication

	Sophistication based on			
	Short-term Consumables		**Restaurant& Entertainment**	
	Naive	Sophisticated	Naive	Sophisticated
Total Discretionary Spending				
avg. $ - mean	1,729	1,692	1,845	1,690
avg. $ - median	1,519	1,447	1,597	1,447
avg. rel. to income - mean	0.505	0.465	0.517	0.471
avg. rel. to income - median	0.427	0.404	0.437	0.406
Short-run Consumables				
avg. $ - mean	513	498	547	506
avg. $ - median	441	416	477	426
avg. rel. to income - mean	0.151	0.141	0.155	0.145
avg. rel. to income - median	0.123	0.120	0.130	0.120
Restaurant&Entertainment				
avg. $ - mean	267	259	283	271
avg. $ - median	211	217	238	221
avg. rel. to income - mean	0.078	0.073	0.080	0.077
avg. rel. to income - median	0.062	0.062	0.066	0.063
N	275	281	256	254

The table shows mean and median average monthly spending, both in absolute amounts as well as relative to average monthly income, separately for users classified as naive and sophisticated. The first panel shows total discretionary spending, the second spending on short-run consumables and the third spending on restaurant and entertainment only. In the first two columns users are classified as sophisticated and naive based on estimates using short-run consumables. In the last two columns the classification is based on estimates using restaurant and entertainment spending only. In both cases, users are classified as sophisticated if additional resources decrease sensitivity to paycheck receipt, i.e. if the estimated coefficient on $payweek*resources$ is negative in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it}*payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (2) is estimated separately for each user and includes day of week and month fixed effects. Resources are instrumented for with calculated balances based on regular payments.

Table 8: Actual and Planned Debt Paydown by Naive and Sophisticated Agents

	Sophistication based on			
	Short-term Consumables		**Restaurant& Entertainment**	
	Naive	Sophisticated	Naive	Sophisticated
Change in Debt - 90 Days				
mean	-712	-760	-666	-723
median	-312	-202	-300	-122
sd	2,738	3,674	3,029	3,491
Change in Debt - 180 Days				
mean	-969	-1,278	-1,070	-1,227
median	-557	-406	-629	-336
sd	3,634	4,769	3,907	4,688
Planned Paydown - 90 Days				
mean	2,842	2,654	2,800	2,725
median	1,945	1,959	2,094	1,795
sd	3,480	2,449	3,217	2,905
N	275	281	256	254

The table shows the mean, median and standard deviation of the change in debt levels, 90 and 180 days after the user originally signed up, as well as planned paydown for the first 90 days, separately for users classified as naive and sophisticated. In the first two columns users are classified based on estimates using short-run consumables. In the last two columns the classification is based on estimates using restaurant and entertainment spending only. In both cases, users are classified as sophisticated if additional resources decrease sensitivity to paycheck receipt, i.e. if the estimated coefficient on $payweek * resources$ is negative in equation (2), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + resources_{it}\gamma_{2i} + resources_{it} * payweek_{it}\gamma_{3i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (2) is estimated separately for each user and includes day of week and month fixed effects. Resources are instrumented for with calculated balances based on regular payments.

Table 9: Effect of Impatience and Planned Paydown on Actual Debt Paydown by Naive and Sophisticated Agents

	Paydown 90 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	7.824	-3.279	7.346	-5.196	-9.125***	-5.578
	(0.103)	(0.304)	(0.122)	(0.317)	(0.006)	(0.276)
Planned Paydown	0.187***	0.128**	0.136**	0.206***	0.139**	0.142**
	(0.000)	(0.033)	(0.022)	(0.000)	(0.041)	(0.037)
Sensitivity×	-22.509***		-20.411***	-9.087		-7.314
Sophisticated	(0.001)		(0.004)	(0.273)		(0.377)
Planned Paydown×		0.221*	0.208*		0.169	0.165
Sophisticated		(0.072)	(0.089)		(0.209)	(0.219)
Median Paycheck	2.951***	2.577***	2.474***	2.761***	2.590***	2.559***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Original Debt	0.097***	0.102***	0.089***	0.087***	0.105***	0.099***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Sophisticated	0.494	-7.513**	-5.849	0.176	-5.221	-4.783
	(0.862)	(0.048)	(0.123)	(0.953)	(0.223)	(0.265)
Constant	-5.740***	-2.653	-3.064	-5.905***	-3.565	-3.698*
	(0.000)	(0.163)	(0.103)	(0.000)	(0.107)	(0.097)
Nr of Individuals		556			510	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 10: Effect of Impatience and Planned Paydown on Actual Debt Paydown by Naive and Sophisticated Agents

	Paydown 180 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	5.675*	-1.290	5.104	3.678	-2.483	3.106
	(0.098)	(0.509)	(0.132)	(0.345)	(0.265)	(0.416)
Planned Paydown	0.126***	0.061	0.067	0.165***	0.084	0.090
	(0.000)	(0.234)	(0.187)	(0.000)	(0.123)	(0.100)
Sensitivity×	-14.699***		-12.288***	-14.063***		-11.510**
Sophisticated	(0.002)		(0.009)	(0.006)		(0.023)
Planned Paydown×		0.234**	0.225**		0.276**	0.268**
Sophisticated		(0.034)	(0.042)		(0.021)	(0.024)
Median Paycheck	1.356***	0.986***	0.922***	1.183***	0.756***	0.702***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.007)
Original Debt	0.102***	0.103***	0.094***	0.050**	0.047*	0.037
	(0.000)	(0.000)	(0.000)	(0.033)	(0.075)	(0.167)
Sophisticated	1.735	-5.767*	-4.722	1.611	-6.530**	-5.814*
	(0.350)	(0.057)	(0.118)	(0.331)	(0.039)	(0.064)
Constant	-3.075***	-0.089	-0.352	-3.243***	0.338	0.119
	(0.001)	(0.952)	(0.814)	(0.001)	(0.828)	(0.938)
Nr of Individuals		556			510	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 180 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 11: Direct Effect of Sophistication Measure on Debt Paydown

	Paydown 90 Days				Paydown 180 Days			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Short-run Consumables								
Coefficient on	0.13	2.32	-0.03	2.03	-0.20	0.88	-0.31	0.66
Resources*Payweek	(0.83)	(0.08)	(0.96)	(0.13)	(0.67)	(0.25)	(0.52)	(0.39)
winsorized	1%	5%	1%	5%	1%	5%	1%	5%
Controls	·	·	✓	✓	·	·	✓	✓
N				556				
Mean of Regressor				-0.032				
75th - 25th pctile				0.43				
Restaurant&Entertainment								
Coefficient on	0.41	1.59	0.52	1.15	0.25	0.87	0.31	0.56
Resources*Payweek	(0.42)	(0.31)	(0.30)	(0.45)	(0.32)	(0.28)	(0.17)	(0.49)
winsorized	1%	5%	1%	5%	1%	5%	1%	5%
Controls	·	·	✓	✓	·	·	✓	✓
N				510				
Mean of Regressor				0.343				
75th - 25th pctile				0.485				

The table shows regression estimates of equation (4) with p-values in parentheses. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 or 180 days. The regressor of interest is the coefficient on the interaction of *payweek* and *resources* estimated in equation (2) for spending on either short-run consumables or restaurant and entertainment only. Full controls include all regressors included in equation (3), the estimated sensitivity to paycheck receipt, planned paydown, median monthly income and original debt levels. Regression weights are the same as in equation (3), the standard error of the sensitivity estimate.

Table 12: Sensitivity Estimates under Different Restrictions

	N	Mean	p25	p50	p75
Short-run Consumables					
All	557	0.080	-0.090	0.062	0.233
Category Spending Possible (Baseline)	556	0.067	-0.115	0.048	0.227
Category Spending with Buffer	542	0.055	-0.117	0.047	0.221
Total Discretionary Possible	551	0.064	-0.113	0.044	0.223
Restaurant&Entertainment					
All	511	0.055	-0.105	0.060	0.221
Category Spending Possible (Baseline)	510	0.044	-0.115	0.051	0.202
Category Spending with Buffer	490	0.036	-0.120	0.046	0.201
Total Discretionary Possible	501	0.041	-0.122	0.045	0.204

The table shows summary statistics of each user's estimated sensitivity to paycheck receipt under different restrictions. Estimates in the upper panel are based on spending on short-run consumables, estimates in the lower panel on restaurant and entertainment spending only. In each panel, the first row shows sensitivity estimates based on all paycycles the user is observed. The second row shows the baseline estimates which only include paycycles when the spending of the payweek in the respective category, short-run consumables or restaurant and entertainment, would have been affordable in the previous non-payweek given the user's resources. The third row, requires payweek spending in each category to have been affordable without reducing the user's resources below the 5th percentile of observed resources. The fourth row requires total discretionary spending to have been affordable rather than just spending in the respective category. Sensitivity to paycheck receipt is captured by the coefficient on *payweek* in equation (1), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (1) is estimated separately for each user and includes day of week and month fixed effects.

Table 13: Correlation between Sensitivity Estimates

	All	Category Spending Possible	Category Spending with Buffer	Total Discretionary Possible
		Short-run Consumables		
Short-run Consumables				
All	1.000			
Category spending possible	0.9851	1.000		
Category spending with buffer	0.9655	0.9505	1	
Total discretionary possible	0.9866	0.9753	0.9609	1
		Short-run Consumables		
Restaurant&Entertainment				
All	0.6955	0.6904	0.6716	0.6924
Category spending possible	0.6863	0.7011	0.6613	0.6881
Category spending with buffer	0.6588	0.6509	0.6797	0.6608
Total discretionary possible	0.6707	0.6669	0.6547	0.6860
		Restaurant&Entertainment		
Restaurant&Entertainment				
All	1			
Category spending possible	0.9832	1		
Category spending with buffer	0.9561	0.9378	1	
Total discretionary possible	0.9833	0.9707	0.9549	1

The table shows the correlation between the estimates of each user's sensitivity to paycheck receipt under different restrictions. The first panel shows the correlation between estimates under different restrictions when all estimates are based on short-run consumables. The last panel shows the correlation when all estimates are based on restaurant and entertainment spending. The middle panel shows the correlation between estimates based on short-run consumables (columns) and those based on restaurant and entertainment (rows). In each panel, the first row and column show sensitivity estimates based on all paycycles the user is observed. The second row and second column show the baseline estimates which only include paycycles when the spending of the payweek in the respective category, short-run consumables or restaurant and entertainment, would have been affordable in the previous non-payweek given the user's resources. The third row and column require payweek spending in each category to have been affordable without reducing the user's resources below the 5th percentile of observed resources. The fourth row and column require total discretionary spending to have been affordable rather than just spending in the respective category. Sensitivity to paycheck receipt is captured by the coefficient on *payweek* in equation (1), $log(E_{it}) = \alpha_i + payweek_{it}\gamma_{1i} + X_{it}\psi_i + \varepsilon_{it}$. Equation (1) is estimated separately for each user and includes day of week and month fixed effects.

Table 14: Debt Paydown 90 Days and Consumption Patterns - Buffer Stock

	Paydown 90 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	0.244	-1.966	-0.157	-12.636**	-7.928***	-13.095***
	(0.959)	(0.427)	(0.974)	(0.011)	(0.009)	(0.009)
Planned Paydown	0.188***	0.142**	0.144**	0.236***	0.149**	0.145**
	(0.000)	(0.032)	(0.031)	(0.000)	(0.040)	(0.047)
Sensitivity×	-5.416		-3.684	8.523		11.056
Sophisticated	(0.480)		(0.629)	(0.274)		(0.151)
Planned Paydown×		0.184	0.182		0.294*	0.300**
Sophisticated		(0.169)	(0.173)		(0.054)	(0.049)
Median Paycheck	3.126***	2.865***	2.861***	2.428***	1.615***	1.702***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.002)
Original Debt	0.111***	0.108***	0.106***	0.079***	0.089***	0.095***
	(0.000)	(0.000)	(0.000)	(0.004)	(0.004)	(0.004)
Sophisticated	1.596	-4.237	-3.972	2.293	-5.988	-6.586
	(0.597)	(0.328)	(0.362)	(0.422)	(0.191)	(0.150)
Constant	-6.722***	-4.630**	-4.722**	-6.635***	-2.718	-2.656
	(0.000)	(0.026)	(0.025)	(0.000)	(0.270)	(0.287)
Nr of Individuals		542			490	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 15: Debt Paydown 180 Days and Consumption Patterns - Buffer Stock

	Paydown 180 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	5.224	0.067	4.606	2.777	-1.479	2.289
	(0.110)	(0.972)	(0.156)	(0.433)	(0.510)	(0.527)
Planned Paydown	0.125***	0.056	0.060	0.178***	0.096	0.100
	(0.000)	(0.341)	(0.309)	(0.000)	(0.139)	(0.127)
Sensitivity×	-11.906**		-9.248*	-10.496**		-8.057
Sophisticated	(0.021)		(0.071)	(0.047)		(0.131)
Planned Paydown×		0.266**	0.258**		0.304**	0.299**
Sophisticated		(0.023)	(0.027)		(0.025)	(0.028)
Median Paycheck	1.542***	1.220***	1.212***	0.982***	0.401	0.335
	(0.000)	(0.000)	(0.000)	(0.000)	(0.187)	(0.287)
Original Debt	0.109***	0.105***	0.099***	0.048*	0.049	0.043
	(0.000)	(0.000)	(0.001)	(0.087)	(0.130)	(0.182)
Sophisticated	0.583	-7.543**	-6.841**	1.131	-7.567**	-7.116*
	(0.756)	(0.018)	(0.037)	(0.544)	(0.038)	(0.054)
Constant	-2.740***	0.223	-0.021	-2.506**	1.141	1.092
	(0.003)	(0.892)	(0.990)	(0.017)	(0.541)	(0.567)
Nr of Individuals		542			490	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 180 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 16: Debt Paydown 90 Days and Consumption Patterns - Paycycles with All Discretionary Spending Possible

	Paydown 90 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	7.673	-3.584	7.053	-4.127	-8.370**	-4.861
	(0.140)	(0.192)	(0.179)	(0.467)	(0.012)	(0.388)
Planned Paydown	0.186***	0.128*	0.137*	0.206***	0.135*	0.138**
	(0.000)	(0.070)	(0.055)	(0.000)	(0.052)	(0.047)
Sensitivity×	-23.777***		-21.645***	-8.560		-7.184
Sophisticated	(0.004)		(0.008)	(0.338)		(0.416)
Planned Paydown×		0.215*	0.201		0.178	0.176
Sophisticated		(0.081)	(0.102)		(0.233)	(0.239)
Median Paycheck	2.985***	2.615***	2.521***	2.784***	2.613***	2.580***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Original Debt	0.096***	0.098***	0.086***	0.083***	0.102***	0.097***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Sophisticated	0.427	-7.414	-5.715	0.097	-5.597	-5.225
	(0.890)	(0.118)	(0.229)	(0.974)	(0.196)	(0.230)
Constant	-5.750***	-2.552	-3.087	-5.994***	-3.446	-3.624
	(0.000)	(0.285)	(0.200)	(0.000)	(0.133)	(0.119)
Nr of Individuals		551			501	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 17: Debt Paydown 180 Days and Consumption Patterns - Paycycles with All Discretionary Spending Possible

	Paydown 180 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	4.135	-1.651	3.443	4.588	-2.270	3.635
	(0.231)	(0.425)	(0.324)	(0.182)	(0.275)	(0.288)
Planned Paydown	0.124***	0.062	0.068	0.167***	0.082	0.089
	(0.000)	(0.365)	(0.328)	(0.000)	(0.143)	(0.114)
Sensitivity×	-12.792**		-10.373**	-13.835**		-12.067**
Sophisticated	(0.016)		(0.047)	(0.012)		(0.026)
Planned Paydown×		0.224*	0.216*		0.276**	0.271**
Sophisticated		(0.061)	(0.071)		(0.029)	(0.032)
Median Paycheck	1.271***	0.887***	0.843***	1.056***	0.651**	0.590*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.042)	(0.065)
Original Debt	0.107***	0.101***	0.095***	0.050*	0.048*	0.039
	(0.000)	(0.000)	(0.000)	(0.053)	(0.093)	(0.173)
Sophisticated	0.792	-6.279*	-5.428	1.289	-6.921*	-6.283*
	(0.671)	(0.079)	(0.132)	(0.519)	(0.037)	(0.063)
Constant	-2.498**	0.491	0.219	-2.989***	0.721	0.419
	(0.011)	(0.786)	(0.905)	(0.008)	(0.662)	(0.802)
Nr of Individuals		551			501	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 180 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 18: Debt Paydown 90 Days and Consumption Patterns - All Paycycles

	Paydown 90 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	4.269	-3.627	3.548	-2.148	-9.052***	-2.519
	(0.366)	(0.205)	(0.449)	(0.661)	(0.003)	(0.611)
Planned Paydown	0.185***	0.125**	0.130**	0.208***	0.149**	0.154**
	(0.000)	(0.045)	(0.037)	(0.000)	(0.034)	(0.029)
Sensitivity×	-16.333**		-14.110*	-15.112**		-13.593*
Sophisticated	(0.030)		(0.059)	(0.038)		(0.062)
Planned Paydown×		0.234*	0.225*		0.146	0.138
Sophisticated		(0.073)	(0.084)		(0.297)	(0.323)
Median Paycheck	3.133***	2.666***	2.632***	2.734***	2.630***	2.594***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Original Debt	0.100***	0.103***	0.096***	0.081***	0.106***	0.093***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
Sophisticated	-1.527	-9.531**	-8.371*	1.796	-3.207	-2.389
	(0.606)	(0.032)	(0.060)	(0.566)	(0.465)	(0.592)
Constant	-5.180***	-1.974	-2.421	-6.647***	-4.630**	-4.912**
	(0.001)	(0.395)	(0.295)	(0.000)	(0.033)	(0.027)
Nr of Individuals		556			510	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 19: Debt Paydown 180 Days and Consumption Patterns - All Paycycles

	Paydown 180 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	3.532	-1.540	2.915	3.811	-2.465	3.249
	(0.270)	(0.437)	(0.375)	(0.229)	(0.230)	(0.309)
Planned Paydown	0.125***	0.072	0.076	0.166***	0.088	0.094
	(0.000)	(0.270)	(0.246)	(0.000)	(0.196)	(0.170)
Sensitivity×	-10.765**		-8.768	-14.331***		-11.878**
Sophisticated	(0.045)		(0.105)	(0.003)		(0.015)
Planned Paydown×		0.194	0.187		0.259*	0.251*
Sophisticated		(0.131)	(0.148)		(0.052)	(0.060)
Median Paycheck	1.442***	1.105***	1.086***	1.194***	0.837**	0.801**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.014)	(0.020)
Original Debt	0.106***	0.107***	0.102***	0.047	0.053	0.040
	(0.000)	(0.000)	(0.000)	(0.116)	(0.114)	(0.234)
Sophisticated	0.464	-5.653	-4.898	1.923	-5.823	-5.080
	(0.825)	(0.112)	(0.177)	(0.332)	(0.107)	(0.165)
Constant	-2.672**	-0.212	-0.503	-3.400***	-0.199	-0.455
	(0.014)	(0.910)	(0.792)	(0.001)	(0.912)	(0.805)
Nr of Individuals		556			510	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 180 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 20: Debt Paydown 90 Days and Consumption Patterns - Paydown Not Smoothed

	Paydown 90 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	11.292**	-2.157	11.077**	-10.457**	-11.282	-10.778**
	(0.019)	(0.458)	(0.022)	(0.037)	(0.000)	(0.031)
Planned Paydown	0.134***	0.101**	0.111***	0.144***	0.090*	0.090*
	(0.000)	(0.012)	(0.006)	(0.000)	(0.085)	(0.085)
Sensitivity×	-26.368***		-25.422***	-2.527		-1.038
Sophisticated	(0.000)		(0.000)	(0.748)		(0.895)
Planned Paydown×		0.110	0.094		0.139	0.139
Sophisticated		(0.209)	(0.284)		(0.183)	(0.185)
Median Paycheck	3.551***	3.465***	3.336***	3.508***	3.344***	3.339***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Original Debt	0.200***	0.213***	0.196***	0.189***	0.199***	0.199***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Sophisticated	2.696	-2.235	-0.162	0.601	-3.626	-3.564
	(0.358)	(0.466)	(0.959)	(0.837)	(0.310)	(0.329)
Constant	-7.301***	-5.584***	-6.095***	-6.338***	-4.465**	-4.484**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.015)	(0.017)
Nr of Individuals		556			510	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is the difference in debt levels on the day the user signed up and 90 or 180 days later, divided by the number of days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 21: Debt Paydown 180 Days and Consumption Patterns - Paydown Not Smoothed

	Paydown 180 Days					
	Short-run Consumables			Restaurant&Entertainment		
	(I)	(II)	(III)	(I)	(II)	(III)
Sensitivity	2.475	-3.495*	1.899	-4.783	-6.486***	-5.370
	(0.448)	(0.070)	(0.555)	(0.180)	(0.002)	(0.129)
Planned Paydown	0.142***	0.077*	0.082**	0.168***	0.090*	0.091*
	(0.000)	(0.052)	(0.036)	(0.000)	(0.062)	(0.059)
Sensitivity×	-12.801***		-10.366**	-4.921		-2.300
Sophisticated	(0.007)		(0.026)	(0.318)		(0.641)
Planned Paydown×		0.235**	0.227**		0.277**	0.275**
Sophisticated		(0.013)	(0.016)		(0.011)	(0.012)
Median Paycheck	1.863***	1.479***	1.425***	1.894***	1.412***	1.401***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Original Debt	0.134***	0.133***	0.125***	0.113***	0.101***	0.099***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Sophisticated	1.458	-5.946**	-5.064**	0.989	-6.778**	-6.635**
	(0.396)	(0.016)	(0.041)	(0.528)	(0.020)	(0.023)
Constant	-4.047***	-1.075	-1.297	-4.373***	-0.877	-0.921
	(0.000)	(0.375)	(0.290)	(0.000)	(0.534)	(0.517)
Nr of Individuals		556			510	

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is the difference in debt levels on the day the user signed up and 90 or 180 days later, divided by the number of days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 22: Low Impatience Excluded - Short-run Consumables

		Exclude individual if sensitivity in the lowest			
	Baseline	5%	10%	15%	20%
Dependent Variable: Paydown 90 Days					
Sensitivity	7.346	7.733	7.176	7.964	9.925**
	(0.122)	(0.110)	(0.152)	(0.102)	(0.044)
Planned Paydown	0.136**	0.141**	0.138**	0.158**	0.193***
	(0.022)	(0.022)	(0.024)	(0.010)	(0.008)
Sensitivity×	-20.411***	-21.745***	-20.623***	-22.933***	-24.005***
Sophisticated	(0.004)	(0.002)	(0.005)	(0.002)	(0.002)
Planned Paydown×	0.208*	0.210*	0.215*	0.219	0.231
Sophisticated	(0.089)	(0.089)	(0.091)	(0.104)	(0.141)
Sophisticated	-5.849	-4.816	-5.803	-4.032	-3.972
	(0.123)	(0.215)	(0.145)	(0.300)	(0.346)
Dependent Variable: Paydown 180 Days					
Sensitivity	5.104	5.700*	5.460	5.456*	6.519**
	(0.132)	(0.086)	(0.108)	(0.086)	(0.046)
Planned Paydown	0.067	0.060	0.056	0.075	0.091
	(0.187)	(0.230)	(0.264)	(0.220)	(0.186)
Sensitivity×	-12.288***	-13.006***	-12.379**	-13.382***	-13.732***
Sophisticated	(0.009)	(0.007)	(0.011)	(0.005)	(0.006)
Planned Paydown×	0.225**	0.218**	0.227**	0.182	0.187
Sophisticated	(0.042)	(0.043)	(0.041)	(0.142)	(0.174)
Sophisticated	-4.722	-3.896	-4.482	-3.093	-3.026
	(0.118)	(0.186)	(0.137)	(0.331)	(0.382)
Controls					
Median Paycheck	✓	✓	✓	✓	✓
Original Debt	✓	✓	✓	✓	✓
Constant	✓	✓	✓	✓	✓
Nr of Individuals	556	528	500	472	444

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 or 180 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 23: Low Impatience Excluded - Restaurant&Entertainment

		Exclude individual if sensitivity in the lowest			
	Baseline	5%	10%	15%	20%
Dependent Variable: Paydown 90 Days					
Sensitivity	-5.578	-4.792	-5.367	-5.758	-8.631
	(0.276)	(0.360)	(0.315)	(0.278)	(0.114)
Planned Paydown	0.142**	0.139*	0.151**	0.137*	0.098
	(0.037)	(0.057)	(0.040)	(0.081)	(0.219)
Sensitivity×	-7.314	-7.866	-8.092	-7.614	-5.165
Sophisticated	(0.377)	(0.345)	(0.336)	(0.367)	(0.543)
Planned Paydown×	0.165	0.185	0.182	0.180	0.244*
Sophisticated	(0.219)	(0.191)	(0.203)	(0.219)	(0.097)
Sophisticated	-4.783	-4.979	-4.912	-4.595	-7.962*
	(0.265)	(0.258)	(0.274)	(0.319)	(0.062)
Dependent Variable: Paydown 180 Days					
Sensitivity	3.106	3.088	3.899	4.003	2.494
	(0.416)	(0.435)	(0.294)	(0.288)	(0.529)
Planned Paydown	0.090	0.071	0.115*	0.107*	0.081
	(0.100)	(0.190)	(0.052)	(0.092)	(0.252)
Sensitivity×	-11.510**	-11.286**	-12.603***	-12.559**	-11.246**
Sophisticated	(0.023)	(0.029)	(0.009)	(0.012)	(0.032)
Planned Paydown×	0.268**	0.284**	0.269**	0.269**	0.320**
Sophisticated	(0.024)	(0.018)	(0.034)	(0.044)	(0.031)
Sophisticated	-5.814*	-6.389**	-6.105*	-6.142*	-8.489**
	(0.064)	(0.046)	(0.071)	(0.080)	(0.026)
Controls					
Median Paycheck	✓	✓	✓	✓	✓
Original Debt	✓	✓	✓	✓	✓
Constant	✓	✓	✓	✓	✓
Nr of Individuals	510	484	459	433	408

The table shows regression estimates of equation (3) with p-values based on bootstrapped standard errors in parentheses. All variables are winsorized at the 1% level. Paydown is measured as the average daily reduction in debt levels, obtained by estimating a linear time trend for credit card debt over the horizon considered, 90 or 180 days. Planned debt paydown is normalized to dollars per day. Short-run impatience is measured as the coefficient β_1 in equation (1) using expenditures on short-run consumables or restaurant&entertainment as the dependent variable. The regression is weighted by the standard error of the impatience estimate. Median paycheck and level of original debt are measured in thousands of dollars. Users are classified as naive if the effect of additional resources on the sensitivity of short-run consumables spending is positive and as sophisticated if the effect of wealth is negative.

Table 24: Paydown Sample Selection

Users with linked checking account in original sample	3653
and observed for at least 180 days after sign up	2558
and all accounts linked at sign up	1897
and have credit card and plan to reduce debt	1691
and at least one paycheck deposited into checking account	1456
and regular bi-weekly paychecks	977
and regular paychecks account for more than 70% of all income	751
and appear to have all relevant accounts linked	734
and at least 8 regular, non-constrained pay cycles	699
and enough days with positive spending to estimate sensitivity	
on short-run consumables	556
on restaurant and entertainment	510