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Cashless Payments and Consumer Spending *

Martin Brown Yves Nacht Thomas Nellen Helmut Stix

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Abstract

We examine how payment choice affects discretionary spending for a representative sample of consumers. Our analysis is motivated by a model of intertemporal choice in which intramonth liquidity constraints are endogenously determined by payment choice and cash management. In the model, present-biased consumers overspend if they choose to pay by card, as their spending is not limited by the amount of cash at hand. Our empirical analysis is based on matched payment diary, payment methods and behavioral survey data. We find that present-biased consumers spend more, the more often they use cashless payment instruments. The effect of cashless payments on spending is strong both for low- and high-income consumers but not among young consumers. We find no robust evidence that consumers choose cash payments to self-constrain their spending.

Keywords: Digital payments, cash management, payment choice, present bias, intertemporal choice, preanalysis plan.

JEL Codes: E41, G20, O33, D14

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* Martin Brown: Study Center Gerzensee and University of St. Gallen, Email: martin.brown@szgerzensee.ch; Yves Nacht: Swiss National Bank, Email: yves.nacht@snb.ch; Thomas Nellen, Swiss National Bank, Email: thomas.nellen@snb.ch; Helmut Stix: Oesterreichische Nationalbank, Email: helmut.stix@oenb.at. We thank Daniel Grodzicki (discussant), Andreas Fuster, Nicole Hentschel, Florian Hett, Silvio Schumacher, Andy Sturm and an anonymous referee for helpful comments. We also received helpful comments from participants at the Economics of Payments XI conference at the Bank of Canada, the 2023 Swiss Winter Conference on Financial Intermediation, and seminar participants at ESSEC Paris, Goethe University Frankfurt and the Swiss National Bank. The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the authors. They do not necessarily reflect the views of the Swiss National Bank (SNB), the Oesterreichische Nationalbank and the Eurosystem. The SNB, the OeNB and the Eurosystem take no responsibility for any errors or omissions in, or for the correctness of, the information contained in this paper. Supplementary Material is available at: https://osf.io/epmuv/.

1. Introduction

Digitization has dramatically changed the way consumers pay for goods and services. Digital payments are arguably more convenient than cash payments for most consumers and merchants (Koulayev et al. 2016; Huynh et al. 2020; Brown et al. 2022). However, the digitization of retail payments has also given rise to concerns among policy-makers: Monetary authorities are concerned about their mandate to guarantee safe and reliable payment services to the universe of consumers and their monetary sovereignty (Sveriges Riksbank 2017; Bank for International Settlement 2022). Regulators are concerned about the privacy of consumer transaction data and the potential market power of payment service providers.[2] Consumer protection agencies are concerned that cashless payments encourage vulnerable households to spend beyond their means – especially when combined with instant credit access (e.g., buy-now-pay-later).[3]

In this paper, we show that digital payments may lead consumers to overspend even when they do not come with credit facilities attached. Behavioral models predict that present-focused consumers spend too much, save too little, and engage in costly borrowing (see Ericson and Laibson 2018 for an overview).[4] We show that the mere availability of electronic payment instruments may affect spending by present-biased consumers. The key mechanism underlying our analysis is that cashless payment instruments impose weaker intramonth liquidity constraints on consumers.[5] This affects the spending of consumers with present-focused preferences but not the spending of consumers with time-consistent preferences.

We present a model that studies payment choice, money management and intramonth spending by consumers. In this framework, we compare the choices of consumers with time-consistent vs. present-focused preferences. We assume that consumers make their payment choice and money

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[2] See, e.g., OECD(2020). https://www.oecd.org/finance/Financial-Consumer-Protection-Policy-Approaches-in-the-Digital-Age.pdf

[3] https://www.consumerfinance.gov/about-us/newsroom/cfpb-study-details-the-rapid-growth-of-buy-now-pay-later-lending/.

[4] The prevalence of consumers with present-focused preferences has led to a broad academic and policy discussion on the welfare effects of consumer credit, i.e., revolving credit cards (Meier & Sprenger 2010), pay-day loans (Allcott et al. 2022) or buy-now-pay-later schemes (Di Maggio, Williams, and Katz 2022).

[5] The previous literature has highlighted other mechanisms: The economic psychology literature on decision choice conjectures that consumers experience less "pain of paying" by card as purchase and payment are disassociated (Soman 2001, Prelec & Simester 2001, Broekhoff and van der Cruijsen 2021) or that payment cards facilitate consumer spending via salient cues triggering an impulsive urge to consume (Banker et al. 2021). In the field of economics, one conjecture is that consumers may lose track of their previous expenditures when they pay by card rather than cash (Kalckreuth, Schmidt, and Stix 2014).

management decisions in a planning period and can perfectly commit to these decisions. Under this assumption, we examine how payment choice and money management strategies affect intramonth consumption.

In our model, consumers purchase two types of goods in each subperiod of the month. In the planning period, they decide which of these goods to pay by cash and which to pay by card. Consumers thus choose to be either pure cash payers, pure card payers or mixed payers. For card spending, purchases are limited by the available balance on the consumer's transaction account. For cash spending, purchases are limited by the amount of cash in the consumer's wallet. Choosing to be a cash-only payer and withdrawing cash regularly from an ATM can thus serve as a self-control mechanism: Consumers carry only a proportion of their monthly budget around with them at any time. In contrast, choosing to be a card-only payer implies that a consumer faces no liquidity constraint within the month. Our model predicts that (naïve) present-biased consumers will overspend more, the more goods they choose to pay by card. We further predict that (sophisticated) present-biased consumers may purposely choose to pay goods by cash and withdraw cash regularly from an ATM to self-constrain their spending.

We test these predictions using a proprietary dataset, which links a payment diary survey, a payment methods survey and a behavioral survey for a representative sample of 1,138 Swiss consumers. The payment diary survey records discretionary spending over a 7-day period. Consumers record the day and value of each purchase, the type of good/service and the payment instrument with which the purchase was made. The payment-methods survey provides information on consumers' general use and perceptions of payment instruments as well as their cash management behavior. The behavioral survey provides indicators of present bias as well as measures of discount rates, risk aversion, trust, memory and conscientiousness.

Our empirical analysis follows a preanalysis plan, which has been registered and time-stamped before delivery of the compiled dataset (https://osf.io/epmuv/). The use of a preanalysis plan intends to strengthen the credibility of results, particularly for proprietary data (Coffman and Niederle 2015; Olken 2015). Preanalysis plans are common in randomized control trials but are much less frequently employed in studies using observational data (Burlig 2018).

We present three main findings. First, consumers with high levels of present bias spend more if they pay more frequently by card or another cashless method. The average consumer in our sample spends 78.5 CHF per day on discretionary items (groceries, durables, restaurants and leisure, e-commerce, other services and other out-of-pocket payments).[6] Among consumers with low levels of present bias, daily spending is unrelated to their preferred payment instrument. Among consumers with high levels of present bias, our OLS estimates suggest that a one-standard-deviation increase in the frequency of cashless payments is associated with a 6.5% increase in spending. We confirm this finding in IV regressions in which we instrument a consumer's payment choice with her assessment of the safety, hygiene and convenience of each payment instrument available. The identifying assumption is that – conditional on sociodemographic observables such as income, age, gender and education – a consumer's assessment of each payment instrument affects her discretionary spending only through her actual choice of payment instrument. We account for reverse causality between payment choice and consumption by exploiting survey information on the planned consumption of each consumer during their payment diary reporting period.

Second, we report important heterogeneities in the impact of cashless payments on spending across consumer age groups and income groups. We find that cashless payments are associated with higher spending by present-biased consumers both among low- and high-income households but not among younger consumers.

Third, we find no robust evidence suggesting that consumers strategically choose payment instruments and cash management to self-control their spending: Present bias is not associated with a more frequent choice of cash over cashless payment instruments, nor is it associated with a higher frequency of cash withdrawals. We do, however, find that the sensitivity of the frequency of cash withdrawals to income is lower for households with high levels of present bias than for households with low levels of present bias. Overall, these findings are consistent with previous evidence that reports a weak take-up of costly commitment devices among consumers with self-control issues (Ericson and Laibson 2018).

We contribute to the growing literature that studies the impact of digital payments on consumer choice. These studies provide mixed evidence for overspending when consumers adopt electronic payments. Agarwal et al. (2022) study the 2016 forced demonetization in India and document that consumers spend more in supermarkets after they switch from cash to cashless payments. Bachas

[6] 1 CHF = 1.10 USD or 0.93 EUR at the time of survey in August-October 2020. As discussed further below, the average spending measured in the payment diary data compares well to aggregate household consumption data as well as to consumer expenditure survey data for Switzerland.

et al. (2021) study the staggered roll-out of debit cards to low-income bank clients in Mexico.[7] They document that the receipt of a debit card leads to a reduction in spending and an increase in household savings. Brown et al. (2022) study the staggered roll-out of contactless debit cards in Switzerland and report no notable impact on consumer spending. We contribute to this literature by using matched survey data to examine the association of cashless payments with spending across consumer types. If cashless payments tempt consumers to overspend, we would expect to see a stronger correlation between payment choice and spending for present-focused individuals. Our results suggest that this is the case.

We also contribute to the literature on consumer payment choice and cash management (see Shy 2022). Seminal inventory models of cash management assume consumption patterns to be smooth and exogenous (Baumol 1952; Tobin 1956). Recent models combine payment choice and money management, assuming either smooth consumption patterns (Alvarez and Lippi 2017) or stochastic expenditures for (cash) goods (Telyukova 2013). We add to this literature by providing a framework to think about the joint choice of payment instruments, money management and intertemporal consumption.

We further contribute to the literature on present-focused preferences and intertemporal choice. We add to this literature by examining how the choice of payment instrument and money management may impose self-control on intramonth spending.[8] A distinctive feature of our empirical analysis is that we analyze the discretionary spending of a representative sample of consumers. In contrast, the prior literature focuses on short-term borrowing by financially vulnerable consumers (e.g., pay-day borrowers, consumers with credit card debt). Meier and Sprenger (2010) document that present bias is associated with higher levels of revolving credit-card debt among low-income households. Kuchler and Pagel (2021) show that present-biased consumers tend to deviate from self-set debt paydown plans, whereas sophisticated present-biased consumers stick to their plan. Allcott et al. (2022) document repeated pay-day lending by present-biased consumers in deviation from their planned lending. Gill, Hett, and Tischer (2022) show that present bias is associated with the costly use of overdraft lines on checking accounts.

[7] Jack and Suri (2014) and Suri and Jack (2016) examine how the geographic roll out of mobile-phone based money transfers in Kenya (M-PESA) impacts on household saving and consumption.

[8] We model self-control of upcoming intramonth spending. In contrast, Kalckreuth, Schmidt, and Stix (2014). and Ebner, Nellen, and Tenhofen (2021) present hypotheses about how consumers maintain an overview of the level of past spending.

This literature predicts that sophisticated present-biased consumers may take measures to constrain their future choice set (Thaler and Shefrin 1981; Laibson 1997; Thaler 1999; O'Donoghue and Rabin 2001; DellaVigna 2009). Commitment strategies may explain the holding of illiquid assets (real estate, retirement savings accounts) or the maxing out of available credit limits (Angeletos et al. 2001; Bertaut, Haliassos, and Reiter 2009; Kaplan, Violante, and Weidner 2014). We examine the conjecture that for intramonth consumption choices, the choice of payment instrument and money inventories are a natural commitment device. In line with previous evidence from nonexperimental studies, our results suggest that the take-up rate of this commitment device is negligible.

Finally, we contribute to the recent literature examining the role of liquidity in intramonth consumption patterns (see, e.g., Vellekoop (2018)). Several studies document pay-day effects in consumption expenditures among households with low levels of liquid assets (Mastrobuoni and Weinberg 2009; Gelman et al. 2014; Gelman et al. 2022). We add to this literature by examining how present bias and payment choice are associated with intramonth spending patterns. Our data confirm pay-day effects in discretionary spending. However, we find no evidence that this is related to present biased preferences or payment choice.

2. Model

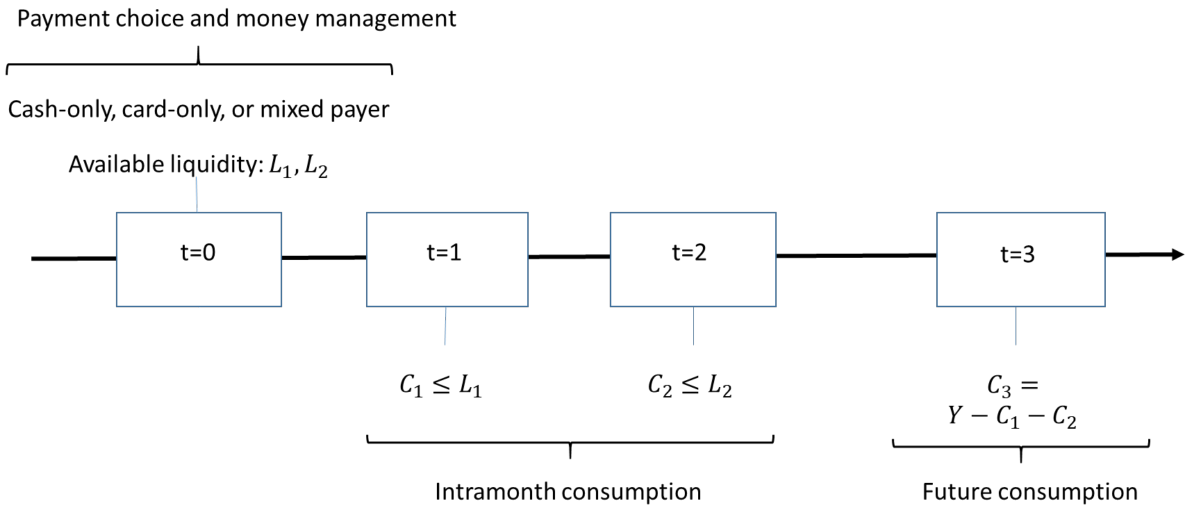
We derive our hypotheses from a model of intertemporal choice in which liquidity constraints are endogenously determined by payment choice and money management. In this framework, we compare the choices of consumers with time-consistent vs. present-focused preferences. We assume that consumers make their payment choice and money management decisions in a planning period and can perfectly commit to these decisions. Under this assumption, we examine how binding payment choice and money management strategies affect intramonth consumption.

Our framework is related to “planner-doer” models (Thaler and Shefrin 1981; Shefrin and Thaler 1988) or an “accountant-shopper” model (Bertaut, Haliassos, and Reiter 2009) in which the planner (accountant) can impose binding constraints on the doer (shopper). To our knowledge, we are the first to apply this model framework to study how payment choice and money management affect consumption. In “planner-doer” or “accountant-shopper” models of intertemporal consumption choice, a key assumption is that the planner/accountant can impose binding liquidity constraints on the discretionary spending of her future self. These constraints may result from the transaction costs of adjusting credit card limits or liquidating illiquid financial assets. In the context of payment choice, the empirical data point to strong habit persistence in payment behavior, whereby the choice of cash vs. cashless payments is strongly dependent on transaction size and location (see our discussion in Section 3 below). Thus, in our context, predetermined payment habits and cash management are likely to serve as the binding constraint on intramonth liquidity.

There are four periods in our model: The current month begins with a planning period t_0. There are two intramonth periods in which consumption occurs: the early period t_1 and the late period t_2. All future months are treated in a reduced form manner as t_3. Consumption in the early period and late period of the current month are subject to endogenous intramonth liquidity constraints. In both the early and the late period of the current month, two different types of goods can be consumed: C_A and C_B. The prices of both goods are normalized to 1. Figure 1 illustrates the timing of the model.

- In the planning period t=0, the consumer can choose to use either cash or card payments for each consumption good: C_A and C_B. The consumer also chooses the money inventories L_1, L_2which will hold in periods t=1 and t=2, respectively.
- In period t=1, the consumer chooses early-period consumption $C_1 = C_{A,1} + C_{B,1} \leq L_1$.
- In period t=2, the consumer chooses late-period consumption $C_2 = C_{A,2} + C_{B,2} \leq L_2$.
- The consumer carries over end-of-month savings $Y - C_1 - C_2$ to be consumed in the future (t=3).

Figure 1. Model timeline



Intertemporal choice

The objective of the consumer is to maximize utility from the current month and future consumption, subject to intramonth liquidity constraints and a resource constraint. From the perspective of the period t=0, t=1, and t=2, the consumer maximizes the following objective function:

$$U_{t=0}(C_1, C_2, L_0, L_1) = \beta u\left(C_{A,1}, C_{B,1}\right) + \beta u\left(C_{A,2}, C_{B,2}\right) + \beta v(Y - C_1 - C_2) - M(C_1, C_2). \quad [1a]$$

$$U_{t=1}(C_1, C_2, L_0, L_1) = u\left(C_{A,1}, C_{B,1}\right) + \beta u\left(C_{A,2}, C_{B,2}\right) + \beta v(Y - C_1 - C_2). \quad [1b]$$

$$U_{t=2}(C_1, C_2, L_0, L_1) = u\left(C_{A,2}, C_{B,2}\right) + \beta v(Y - C_1 - C_2). \quad [1c]$$

Subject to the intramonth liquidity constraints

$$C_1 = C_{A,1} + C_{B,1} \leq L_1$$

$$C_2 = C_{A,2} + C_{B,2} \leq L_2$$

and the resource constraint:

$$Y - C_1 - C_2 \geq 0$$

Y captures total financial resources available to the consumer at the beginning of the current month. Intramonth consumption is given by C_1 (early spending) and C_2 (late spending). $M(C_1, C_2)$ represents the (nonmonetary) costs of intramonth liquidity management.

We assume a strictly concave value function $u(C_t);\ u' > 0, u'' < 0$ for intramonth consumption. The value function *v(.)* captures the (discounted) utility of future consumption out of savings. For simplicity, we assume that this value function is linear: $v' > 0, v'' = 0$.

Consumers may have time consistency, i.e., rational preferences ($\beta = 1$), or they may be present biased ($0 < \beta < 1$). For present-biased consumers, the optimal consumption choice from the perspective of the planning period t=0 may deviate from the actual consumption choice in t=1 and t=2. Sophisticated consumers anticipate this time inconsistency, while naïve consumers do not.

The objective of our model is to show how payment choice and money management may constrain the overspending of present-focused consumers within the current month. For this reason, we abstract from intermonth credit constraints on consumption. We can think of Y as the (discounted) lifetime income of the consumer.

Payment choice and money management

The intramonth liquidity available to the consumer L_1, L_2 depends on the chosen payment instrument and the related money management strategy. At t=0, the consumer can choose to use either cash or card payments for each consumption good: C_A and C_B. In line with static inventory models with payment method choice (e.g., Whitesell 1989), we assume that cash vs. cashless decisions are made at the beginning of the month and bind intramonth payment choice. Similar to Whitesell (1989), consumers choose which goods to pay by cash and which ones to pay by card.[9]

Our model setup is motivated by the observation in payment diary data that the majority of consumers mix their payment method between cash and card (SNB 2020). Importantly, the same consumers choose to pay different expenditures by cash or card depending on transaction size or location. In contrast, the payment method of consumers does not seem to change over time for a given location and transaction size.[10] In Appendix B1, we provide corresponding evidence from the payment diary data of the Swiss National Bank, which we use for our empirical analysis. Additionally, we confirm this pattern of payment behavior for 17 countries in the Euro area based on data from the Study on Payment Attitudes of Consumers in the Euro area (European Central Bank 2022).

All consumers have access to the same financial technology: Banks offer a current account with an attached debit card that enables ATM withdrawals and cashless payments at point-of-sale (POS) terminals. For simplicity, we assume that the bank does not charge any fees for its services and does not pay interest on the current account.

Consider first a cash-only consumer. Cash-only payers manage their intramonth liquidity L_1, L_2 by deciding how much to withdraw from an ATM at t=1 and t=2. Hereby, they can decide at t=0 to withdraw either once or twice during the month. In line with inventory models of cash management, we make the following assumptions for money management costs of cash payers:

[9] See Telyukova (2013) for a model with exogenous (and stochastic) cash and card purchases.

[10] See Alvarez and Lippi (2017) for a dynamic model of payment choice and cash management in which consumers first use up cash-on-hand and then use cards. This model would suggest that regular purchases are sometimes paid by cash and sometimes paid by card, depending on when they take place.

(i) There is a unit transaction cost s for each ATM withdrawal (shoe-leather cost) and (ii) there is a proportional cost $f > 0$ of holding cash (e.g., fear of cash theft or loss).

Consider a consumer who at t=0 has decided to pay by cash for both goods and to consume $C_1 = C_2 = C$. This consumer needs to satisfy the liquidity constraints $C \leq L_1, L_2$. She can do so by withdrawing the amount $2C$ at t=1. Alternatively, she can withdraw the amount C at both t=1 and t=2. The average cash balance of the consumer would be $\frac{C}{2}$ if she withdraws twice or C if she withdraws once. The cash payer would choose to withdraw twice if the following condition holds:

$$2s + f\frac{C}{2} \leq s + fC$$

The money management costs of this consumer would amount to

$$M_{cash}(C) = \min\left[2s + f\frac{C}{2}, s + fC\right]$$

Now consider a card-only consumer. She chooses at t=0 to use her debit card to make cashless payments at the point of sale (PoS) for both consumption goods. In line with models of payment choice, we assume that there are also (nonmonetary) costs associated with cashless payments. First, there are expected costs of nonacceptance, terminal outages, or concerns related to the security and privacy of cashless payments, which we assume are proportional to the total expenditures of the consumer: $m(C_1 + C_2)$. Second, card payers can (at t=0) decide to impose limits on PoS expenditures in periods t=1 and t=2. We assume that imposing such limits is associated with a fixed nonmonetary effort cost of $e \geq 0$.

Consider a card-only payer who plans to consume $C_1 = C_2 = C$. Again, this consumer needs to satisfy the liquidity constraints $C \leq L_1, L_2$. The consumer can do so by holding $Y \geq 2C$ on her transaction account and paying by debit card at the point of sale throughout the month. If the consumer does not impose limits on PoS purchases, the money management costs for this consumer would be:

$$M_{card,nolimit}(C) = m2C$$

If the consumer does impose a limit on monthly PoS purchases, the money management costs for this consumer would be:

$$M_{card,limit}(C) = m2C + e$$

A card-paying consumer who does not expect to overspend will never impose limits on intramonth PoS purchases if the costs of doing so are strictly positive ($e > 0$).

Finally, consider a consumer with mixed payment methods. We assume that the consumer pays C_{A} by cash and C_{B} by card. To illustrate the model, we again assume smooth consumption over the early and late periods $C_{A,1} = C_{A,2} = C_{\mathrm{A}}$ and$C_{B,1} = C_{B,2} = C_B$

The cash management costs of this mixed payer would amount to

$$M(C_{\mathrm{A}}) = \min\left[2s + f\frac{C_{\mathrm{A}}}{2}, s + fC_{\mathrm{A}}\right]$$

In addition, the card-based money management costs would again depend on whether the consumer chooses to impose intramonth limits on card spending at the point of sale.

$$M_{nolimit}(C_B) = m2C_B$$

$$M_{card,limit}(C_B) = m2C_B + e$$

Predictions: Rational Consumers ($\beta = 1$).

Due to the concavity of the value function $u(C)$, rational consumers plan a smooth intramonth consumption path at t=0. Moreover, concavity implies that rational consumers plan an identical consumption basket in each subperiod.

$$C_{\mathrm{A},1} = C_{\mathrm{A},2} = C_A^*$$

$$C_{\mathrm{B},1} = C_{\mathrm{B},2} = C_B^*$$

$$C_1 = C_2 = C_A^* + C_B^* = C^*$$

A rational consumer will choose the payment instrument and liquidity-management strategy to minimize the money management costs $M(C^*)$ related to her optimal consumption plan. This consumer anticipates that she will stick to her optimal consumption plan no matter what payment instrument she chooses. At t=0, a rational consumer will thus choose one of three payment and money management strategies to minimize the corresponding money management costs:

Pure cash payer: $M(C^*)_{cash} = \min\left[2s + f\frac{C^*}{2}, s + fC^*\right]$.

Pure card payer:$M(C^*)_{card} = m2C^*$

Mixed payer: $M(C^*)_{mixed} = \min\left[2s + f\frac{C_A^*}{2}, s + fC_A^*\right] + m2C_B^*$

Predictions: Naïve Present-Biased Consumers ($\beta < 1$).

Naïve present-biased consumers also plan a smooth intramonth consumption path at t=0.

$$C_{A,1} = C_{\mathrm{A},2} = C_A^*$$

$$C_{B,1} = C_{\mathrm{B},2} = C_B^*$$

$$C_1 = C_2 = C_A^* + C_B^* = C^*$$

At t=0, naïve present-biased consumers also choose the payment instrument and liquidity-management strategy, which minimizes money-management costs $M(C^*)$.

Naïve present-biased consumers who are card-only payers do not anticipate that they will overspend. They thus do not impose limits on PoS expenditures consistent with their optimal consumption path if the effort costs of doing so are positive ($e > 0$). As a consequence, naïve card payers will consume excessively in the early and late period of the current month.

$$C_1 = C_2 = C^* + \Delta C$$

The degree of excess consumption ΔC – and thus reduced saving for future consumption – depends on the extent of present bias and the elasticity of intertemporal substitution of the consumer (see Appendix B for details).

Naïve consumers who are cash-only payers and withdraw twice are safeguarded against revisions of their consumption plans. The reason is that their (predetermined) liquidity choice constrains consumption $L_1 = L_2 = C^*$. Naïve consumers who use cash and withdraw once per month spend the same total amount as rational consumers. However, as they withdraw all needed liquidity for the month upfront ($L_1 = 2C^*$), their consumption path will be front-loaded. They will consume excessively in t=1 but then have to reduce their consumption by the same amount in t=2.

$$C_1 = C^* + \Delta C, C_2 = C^* - \Delta C$$

Naïve consumers who are mixed payers will overspend on consumption for their "card good":

$$C_{B,1} = C_{B,2} = C_B^* + \Delta C_B$$

In addition, naïve mixed payers may exhibit front-loaded consumption of their "cash good" if they choose to withdraw cash only once per month:

$$C_{A,1} = C_A^* + \Delta C_A, C_{A,2} = C_A^* - \Delta C_A$$

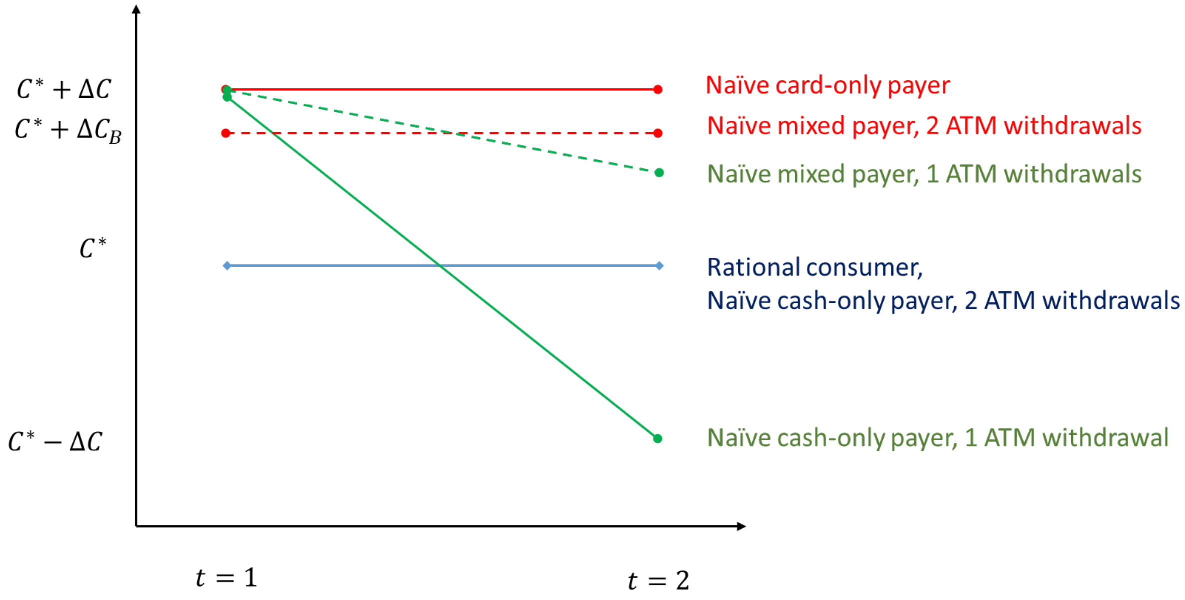
Figure 2 illustrates the predictions of our model for the intramonth consumption of rational consumers vs. naïve present-biased consumers. Note that our predictions for naïve consumers depend strongly on the assumption that cash payers are precommitted to paying a specific consumption good with cash or card. They cannot switch to using their bank card to pay for "cash goods" at the point-of-sale. If naïve cash payers can use their bank card at the point of sale when they run short of cash, the available cash in their wallet no longer binds their consumption. In this case, they would consume excessively in the early and late periods, as would naïve card payers.

Predictions: Sophisticated Present-Biased Consumers ($\beta < 1$).

Sophisticated present-biased consumers also plan smooth intramonth consumption paths. In contrast to their naïve peers, they anticipate that at t=1 and t=2, their "future selves" will overspend. They can self-control within-month consumption patterns by limiting available liquidity.

Cash-only consumers can limit their available liquidity by choosing to withdraw two equal cash amounts at t=1 and t=2. Card-only consumers can limit their available liquidity by imposing limits on PoS expenditures in t=1 and t=2. Mixed payers could apply one or both of these mechanisms. Whether sophisticated consumers adapt their payment choice and money management to self-control their consumption depends on the associated increase in costs of money management compared to the welfare loss that they expect from reduced savings in the future (see Appendix B for details).

Figure 2. Model predictions - Intramonth consumption: rational vs. naïve present-biased consumers



3. Data

Data Sources and Sample

Our data are sourced from three related consumer surveys that were commissioned by the Swiss National Bank (SNB 2021) and conducted between mid-August and November 2020.[11]

The first survey is a payment-methods survey, in which respondents completed a questionnaire on ownership of payment instruments and their use, attitudes toward payment instruments, cash withdrawal behavior and cash holdings, typical payment behavior and socioeconomic information.

Respondents to the payment-methods survey subsequently completed a payment-diary survey for a period of seven days. In this second survey, consumers recorded each discretionary purchase with the purchase day and time, the amount, the payment instrument used and the type of merchant where the purchase was made. A total of 2,126 people were interviewed and returned a fully completed payment diary.[12]

[11] The survey was fielded during the period immediately before (August-September 2020) and at the beginning (October-November 2020) of the second wave of the COVID-19 pandemic in Switzerland. We account for the possible influence of the pandemic on observed discretionary spending and payment behavior by including month*language fixed effects in our main regressions. Interviews were conducted in German, French and Italian. The interview language serves as a regional indicator.

[12] Further details are available in SNB (2021).

The third survey is a behavioral survey that was administered as a follow-up to the payment diary survey. Specifically, after completion of the payment diary, all participants who used the internet were asked to participate in a follow-up online survey.[13] If they agreed, participants received this second survey approximately two weeks (on average) after completion of the first survey. A total of 1,164 respondents participated in the third survey. After data cleaning, the final sample consisted of 1,138 respondents.[14]

For the first survey, a stratified random sample was drawn from a sampling frame provided by the Swiss Federal Statistical Office, which is based on administrative population registers. The strata are based on the characteristics of language region, gender and age. A comparison of sociodemographic characteristics of the payment methods survey and the self-selected behavioral survey sample indicates that selection biases are small (see Appendix A1).

<u>Outcome Variables</u>

We study three primary outcome variables. The variable *Consumption* measures daily discretionary spending in CHF. This variable was measured by accumulating all recorded transactions during the seven days of the payment diary. As reported in Table 1, we have information on discretionary spending in six categories: Consumables (shops selling day-to-day items), Restaurants & Leisure, Durables (shops selling clothes, electronics etc.), E-commerce purchases, Other Services (e.g. hairdressers), and Other spending (incl. person-to-person transfers, payments for in-house services, donations etc.).[15]

Table 1 shows that on average, respondents spend 78.5 CHF per day on discretionary items. Consumables, restaurants and leisure together account for 34.2 CHF of daily spending, while durables and E-commerce together account for a further 17.6 CHF. The ratio of consumable to durable spending in our data (roughly 2:1) is comparable to that reported by Kuchler and Pagel (2021) for their sample of U.S. consumers. Other Services and Other spending average 7 CHF and 19.6 CHF per day across households. Table 1 reveals significant variation in daily spending across

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[13] Only 4.3% of respondents of the "Payment Methods Survey" answered that they never use the internet.

[14] We eliminated persons without recorded payment transactions and person who do not possess cashless payment instruments. For details, see the preanalysis plan. Participants were rewarded for the first survey (100 CHF) and for the second survey (10 CHF).

[15] Purchases are conducted by the survey respondent. The household benefiting from these purchases may consist of additional persons. Household income (HH income) and Household size belong to the set of socioeconomic control variables (see Appendix A2.3).

households with notable outliers in most spending categories. This is unsurprising for payment-diary survey data, which by nature are limited to a short observation period. We account for outliers in robustness tests.

Total discretionary spending in our sample compares well to aggregate private consumption expenditure. We compare annual per capita consumption from national accounts (excluding estimated housing expenditure) with projected annual per capita consumption from the payment diary. This back of the envelope calculation indicates that the payment diary survey covers 75% (93%) of nonhousing National Account private consumption expenditures (depending on whether one uses the adult population or the total population). This diary-to-aggregate-spending ratio is similar to other international payment diary studies (Bagnall et al. 2016; Schuh 2018).

Figure 3 reports average daily spending by income group (Panel A) and age group (Panel B). The figure lends further credibility to the payment diary data we employ for our analysis. Average spending increases with income but does so less for consumables than for Other spending categories. Average spending also increases with age, while the share of spending on Restaurants and Leisure or E-commerce declines with age.

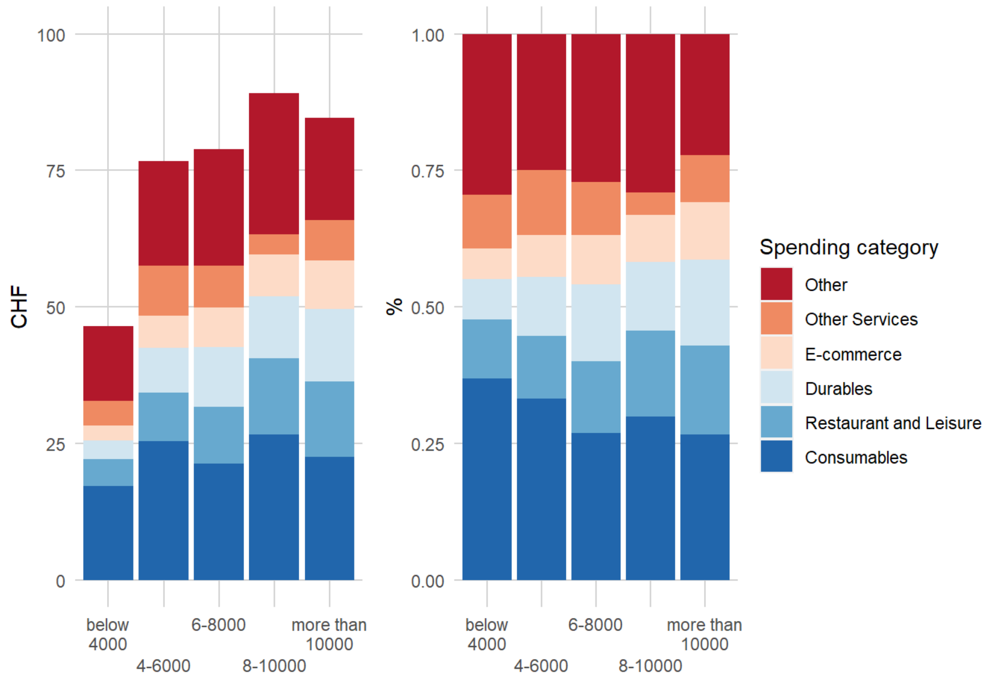
Table 1. Outcome variables

	mean	p50	sd	min	max	n
Main outcome variables						
Consumption	78.47	52.55	104.45	1.03	1293.60	1138
Card Intensity	3.48	4.00	0.95	1.00	5.00	1138
Withdrawal Frequency	5.84	6.00	1.22	1.00	10.00	1081
Consumption by category						
Consumables	22.83	18.16	28.56	0.00	711.97	1138
Restaurants and Leisure	11.41	4.97	18.73	0.00	324.96	1138
Durables	10.50	0.00	32.92	0.00	576.82	1138
E-commerce	7.11	0.00	22.05	0.00	248.26	1138
Other Services	7.02	0.00	28.98	0.00	482.03	1138
Other	19.59	4.55	76.69	0.00	1160.00	1138

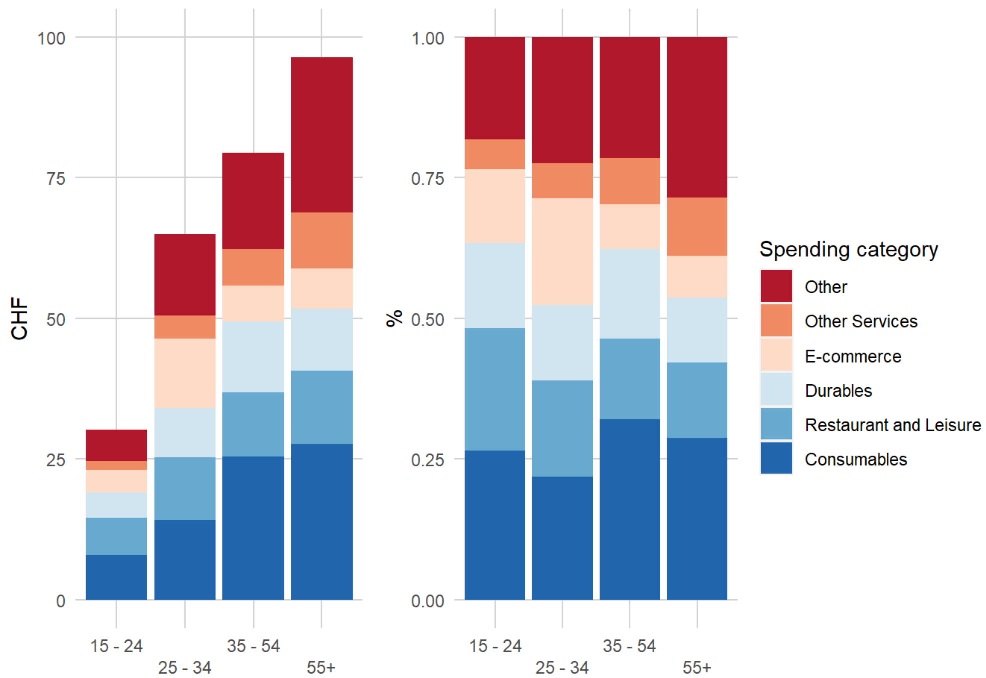
Notes: The table reports descriptive statistics for our outcome variables. Variable definitions are presented in Appendix A2.

Figure 3. Consumption by income and age groups

Panel A. Income groups (in CHF per month)



Panel B. Age groups (in years)



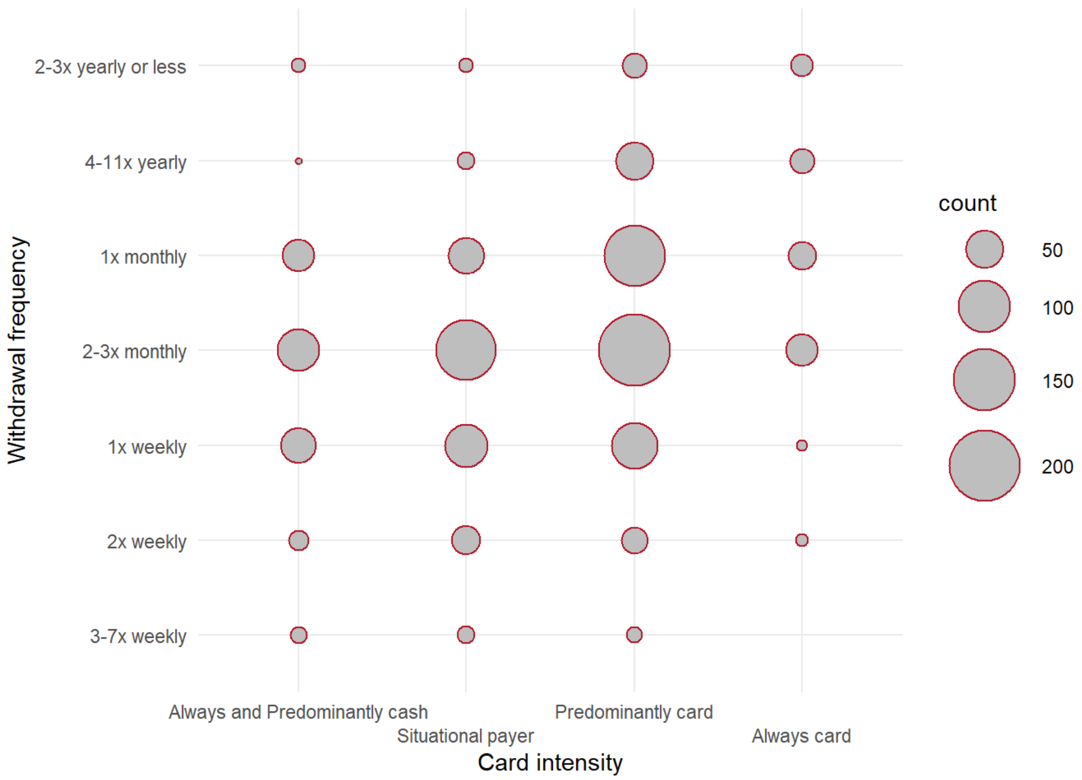
Note: For each subsample, the figure shows average daily spending by category in CHF as well as the average share of spending (in %) per category across households.

Our second outcome variable measures respondents' preferred payment instrument. The variable *Card intensity* measures respondents' self-assessed frequency of use of cash vs. cashless payment instruments. It ranges from 1 to 5, where 5 = "always cashless" and 1 = "always by cash". We choose this survey-based measure rather than the observed payment choice from the payment diary for two reasons. First, this measure captures the general payment behavior of the respondent rather than payment behavior during a specific week. Second, as some purchases may be cashless only (e.g., E-commerce), using the payment diary data to measure consumption and payment choice could lead to mechanical correlations between the two.

Our third outcome variable measures the frequency of cash withdrawals and is again taken from the payment survey. *Withdrawal frequency* is a measure on a ten-point scale with 10 = "daily" and 1 = "never".

Figure 4 illustrates payment behavior and cash management behavior in our sample. The majority of respondents (85%) pay predominantly by card or are mixed (situational) payers. Additionally, most respondents (82%) withdraw cash between once per week and once per month. Unsurprisingly, the use of cash as a payment instrument is positively correlated with the number of cash withdrawals.

Figure 4. Payment choice and cash management



Note: The figure shows the distribution of respondents by their payment behavior (*Card intensity*) and cash management behavior (*Withdrawal frequency*).

Present Bias

We follow previous approaches (e.g., Ameriks et al. 2007; Gathergood 2012) to elicit indicators of present-focused preferences from qualitative survey questions rather than incentivized task choices.[16] The survey instruments employed in the behavioral survey are based on validated scales or on scales that have been used in other large-scale surveys. Appendix A2 contains a definition of all behavioral variables. To measure present bias, we use responses from two qualitative survey questions on impulsivity and procrastination. Ericson and Laibson (2018) document that impulsivity and procrastination are key behaviors associated with the present-focused preferences of consumers.

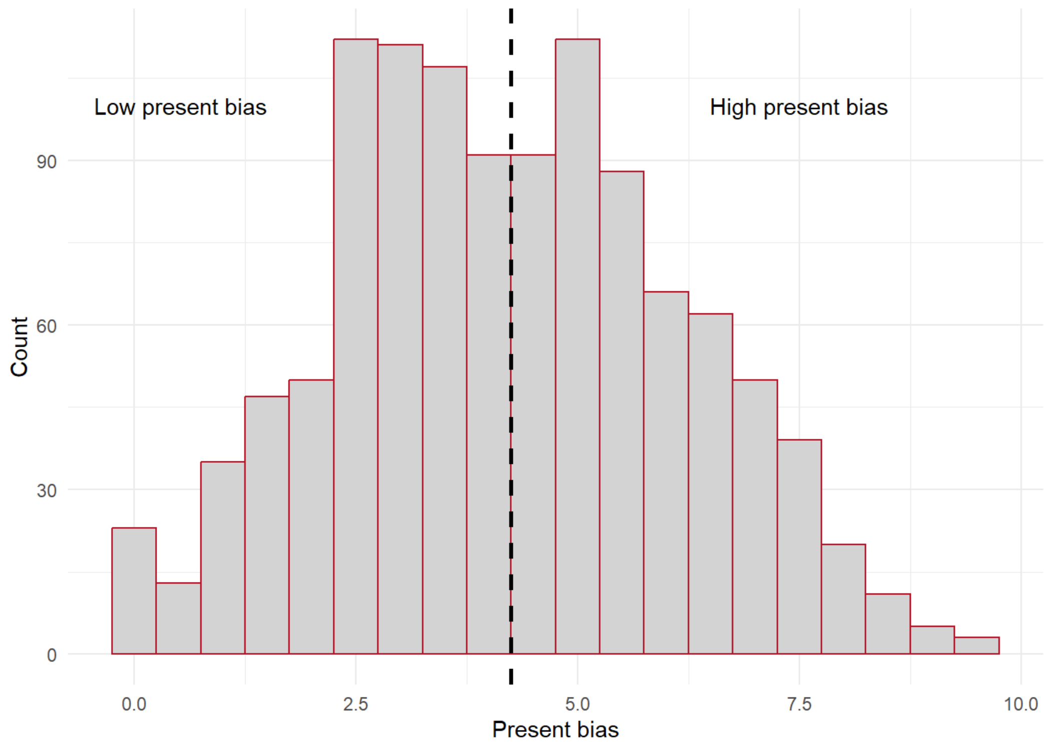
[16] See Imai, Rutter, and Camerer (2021) and Cheung, Tymula, and Wang (2021) for two recent meta-analyses on estimates of quasihyperbolic discounting parameters using incentivized task choices.

Impulsivity: "*How would you describe yourself: Do you generally think things over for a long time before acting – in other words, are you not impulsive at all? Or do you generally act without thinking things over for long – in other words, are you very impulsive? Please answer on a scale from 0 to 10, where 0 means not at all impulsive and 10 means very impulsive*" (own translation). Source: German Socio-Economic Panel 2018, Question 16, Kantar Public (2019).

Procrastination: "*I tend to postpone tasks, even though I know that it would be better to deal with them immediately. Please answer on a scale from 0 to 10, where 0 means 'does not describe me at all' and 10 means 'describes me perfectly'*". Source: Global Preference Survey, Falk et al. (2022), Falk et al. (2018).

The variable *Present bias* is defined as the average response to these two survey questions (a higher value captures stronger present bias). Figure 5 presents the distribution of the variable *Present bias*. We classify respondents into *High present bias consumers* and *Low present bias consumers* depending on whether the score is above or below the median.

Figure 5. Present bias



Note: The figure presents the distribution of the variable Present bias across the full sample. In our empirical analysis, respondents with above-median (below-median) levels are categorized as High or Low present bias consumers.

Note that our model makes different predictions for naïve and sophisticated present-biased consumers compared to rational consumers. However, our elicitation of time preferences does not yield a precise measure of naïveté or sophistication regarding time-inconsistent preferences.[17] One may argue that our direct survey questions on procrastination and impulsivity may yield different answers from naïve vs. sophisticated consumers, conditional on their underlying level of present bias. On the one hand, sophisticated present-bias consumers may be more likely to state that they procrastinate and act impulsively. On the other hand, sophisticated present-bias consumers may be more likely to self-constrain their intertemporal choices and thus report less procrastination or impulsive behavior. In our empirical hypotheses and analyses, we compare the payment choice, money management and intramonth consumption of consumers with high present bias to that of consumers with low present bias, under the assumption that there is a significant share of both naïve and sophisticated present bias consumers.

Intramonth Consumption Pattern

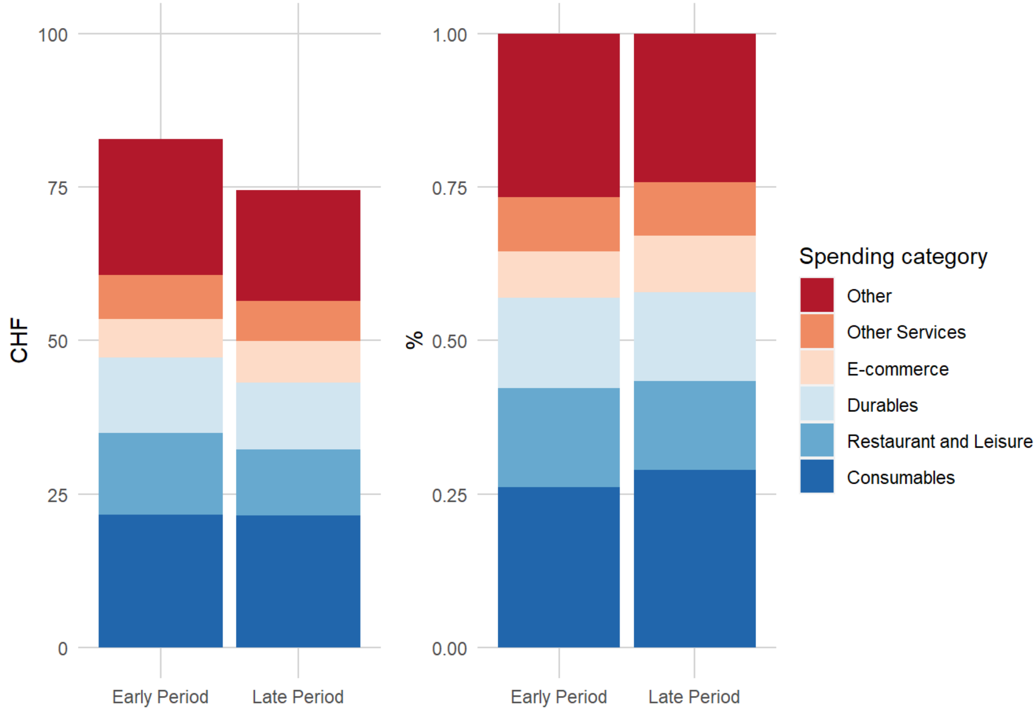
Our analysis of intramonth consumption patterns is based on a between-person comparison for respondents who report their payment diary for the early period of the month to those who report their diary for the late period of the month. Information on the pay day of respondents is not directly available in our surveys. However, in Switzerland, most employees have a pay day around the 25th of the month. For retired persons, the typical disbursement date for pensions is around the 5th day of a month.[18] We use this information to define the dummy variable *Late Period*, which is one if the payment diary was recorded in the latter half of the period between pay days. Figure 6 reports average daily spending by respondents in the early vs. late period of the month. On average, spending falls from 83 CHF for early period observations to 75 CHF for late period observations.

[17] This concords with the majority of the literature: "clean data that permit precise identification of the degree of naïvete has proven hard to find. More often, we see either evidence that indicates at least some sophistication […] or evidence that indicates at least some naïvete" (O'Donoghue and Rabin 2015, p.276). Kuchler and Pagel (2021) separate naïve from sophisticated consumers by measuring whether paycheck sensitivities of consumption are affected by the occurrence of larger, regular payments that affect available resources.

[18] For persons in education, we assumed that pay day is the last day of the month. For all other persons, we cannot assign a pay day. For further details and a discussion, see the preanalysis plan.

Again, lending credibility to the data, the figure reveals that the decline in spending over the month is driven by Restaurants and Leisure, Durables and Other spending.

Figure 6. Consumption by period of the month



Note: The figure compares average daily spending of respondents observed in the early period of the month (after pay day) to those observed in the late period of the month (before pay day). Spending is reported by category in CHF as well as the mean share spending in each category across households.

Covariates

In our regression analysis, we employ a broad set of socioeconomic control variables, as well as a set of behavioral control variables. Socioeconomic controls include age, gender, education, income, household size, labor force status, urban–rural classifications, and language. These are all taken from the payment survey. In addition, we match the location of all survey respondents to public information on the network of ATMs and bank branches in Switzerland. These data provide us with an indicator of the physical distance and travel time to the nearest cash withdrawal point for respondents' municipalities. Appendix A2 provides definitions, and Appendix A3 provides summary statistics of all covariate variables.

Behavioral control variables include the *Discount Rate*, *Risk Taking*, *Memory of Numbers*, *Financial Literacy* and *Trust in Institutions*. These controls are all taken from the behavioral survey. Measures on time discounting and risk preference are based on the validated survey instruments of the Global Preference Survey (Falk et al. 2022) containing both a qualitative and a quantitative component (staircase method). Our survey measure of memory rests on a survey experiment that probes respondents' numeric memory. Validation exercises (see Appendix A4) suggest that the Behavioral Survey delivers reliable estimates of survey respondents' behavioral traits. We compare our results regarding temporal discounting and risk preferences with the results from the Global Preference Survey for Switzerland.

4. Empirical Hypotheses

Motivated by our model in Section 2, we test three hypotheses related to (i) consumption, (ii) payment choice and (iii) cash management. These correspond to the main hypotheses registered in our preanalysis plan.[19]

The main prediction of our model is that payment choice affects discretionary spending for naïve consumers with high levels of present bias, while this is not the case for consumers with low levels of present bias. As discussed in Section 3, our data do not allow us to separate naïve from sophisticated present-biased consumers. Our Hypothesis H1 thus relies on the assumption that a significant share of consumers with high levels of measured present bias are naïve with respect to their self-control problem.

H1 (Consumption): For consumers with high present bias, a higher frequency of cashless payments is associated with higher spending. For consumers with low present bias, discretionary spending is unrelated to payment behavior.

Our model predicts that payment choice is driven by the (nonmonetary) costs of cash withdrawals and cash holdings (fear of loss or theft) compared to the costs of cashless payments (fear of nonacceptance or outages, privacy and security concerns). Moreover, the frequency of cash withdrawals is driven by the relative costs of cash withdrawals to cash holdings. Both of these

[19] Due to comments received on our theoretical predictions as well as due to data limitations, the specification of our hypotheses and the related empirical tests deviate partially from our preregistration.

trade-offs should, however, be less relevant to the choice of sophisticated present-biased consumers. Our model predicts that these consumers may adapt their choice of payment instrument and cash management to limit their intramonth liquidity and, thus, self-control consumption. Again, our data do not allow us to separate naïve from sophisticated present-biased consumers. Our Hypotheses H2 and H3 thus both rely on the assumption that a significant share of consumers with high levels of measured present bias are sophisticated with respect to their self-control problem.

H2 (Payment choice): For consumers with high levels of present bias, the relationship between cash management costs, card payment costs and payment choice is weaker than for consumers with low present bias.

H3 (Cash management): For consumers with high levels of present bias, the relationship between cash management costs and ATM withdrawal frequency is weaker than for consumers with low present bias.

Our model also makes predictions for the intramonth pattern of consumption. In particular, we expect a front-loading (pay-day effect) of spending only for present-biased consumers who impose a one-time liquidity constraint on their spending at the beginning of the month. [20] We do not have the necessary information to identify self-imposed liquidity constraints by card payers (i.e., monthly card spending limits). We do have information on liquidity constraints for cash payers, as we observe the frequency of ATM withdrawals. Cash payers who withdraw from an ATM only once per month are predicted to have front-loaded consumption if they are present biased. As shown in Figure 3 above, however, there are only very few cash payers with infrequent cash withdrawals in our sample. We therefore refrain from testing this prediction. Instead, we report an exploratory analysis in which we test Hypothesis 1 separately for observations in the early/late period of the month.

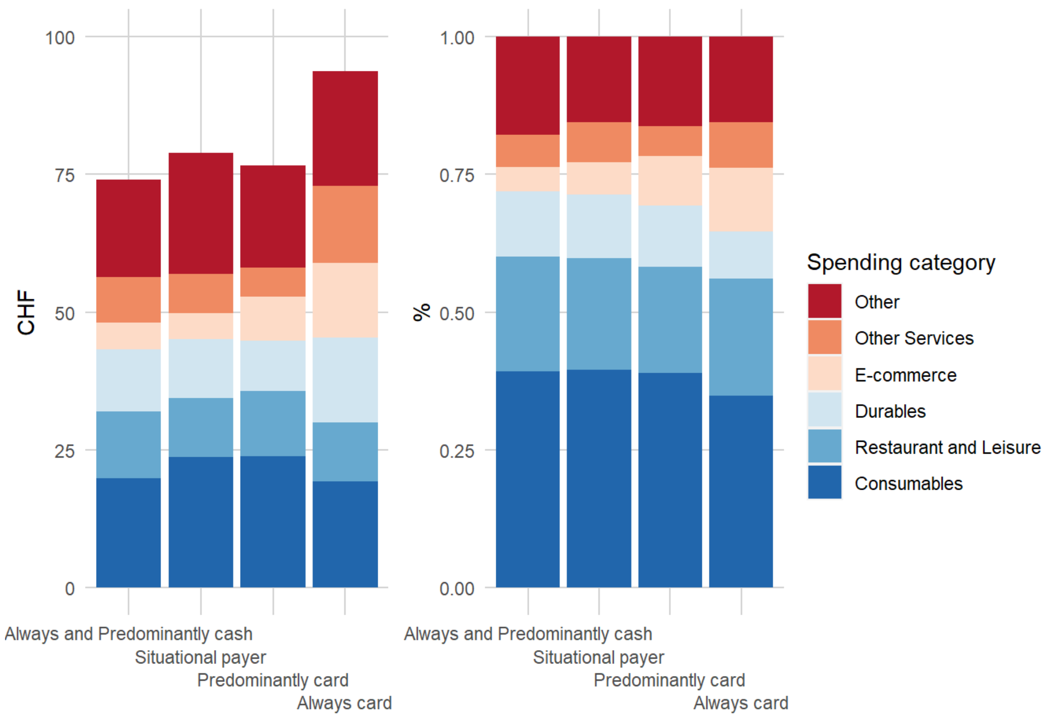
[20] A more general prediction based on our model would be that cash-paying, naïve present-biased consumers who withdraw cash infrequently would display a declining profile of daily spending between cash withdrawals. Unfortunately, our data is not well suited to test this prediction as we observe cash withdrawal and spending behavior for a period of 7 days only, and spending behavior at the daily level is very noisy.

5. Results: Consumer Spending

Our key hypothesis (H1) is that cashless payments lead to an increase in spending among present-biased consumers but not among consumers with low present bias. This hypothesis is derived from our model, which predicts that (naïve) present-biased consumers who pay by card will spend more than they had planned in both the early and late periods of the month (see Figure 2).

Figure 7 reveals that – across all respondents – discretionary spending increases with the card intensity of payment behavior. If we focus on consumables (incl. Restaurant, Leisure) and durable nominal spending (incl. E-commerce) there is a monotonic relationship between *Card Intensity* and discretionary spending.

Figure 7. Payment behavior and discretionary spending



Note: The figure shows average daily spending by category in CHF as well as the average share of spending per category across households by Card Intensity. Due to the low number of observations for Card Intensity="always cash" we combine the first two categories ("always cash", " predominantly cash").

There are at least 2 reasons why we may observe a positive correlation between cashless payments and consumer spending even if payment choice does not causally affect consumption. First, the observed correlation may be spurious, i.e., driven by socioeconomic characteristics that are correlated both with payment choice and discretionary spending. Second, the observed correlation may be driven by reverse causality; consumers may choose to pay cashless because they plan high consumption.

Our first identification challenge is one of the potential omitted variables, leading to a positive spurious correlation between cashless payment choice and consumer spending. However, it is not obvious that a spurious correlation would be positive. On the one hand, (high) education is likely to be associated with digital affinity and thus cashless payments, while education is also correlated with income and spending. On the other hand, age should be negatively correlated with digital affinity but positively correlated with spending (see Figure 3 above). Moreover, note that if there were a spurious positive correlation between cashless payments and spending driven by underlying socioeconomics, we would expect to find this correlation both for consumers with high and low levels of present bias. In contrast, our hypothesis (H1) suggests a causal effect of payment choice on consumption for consumers with high present bias only.

In a first step to tackle the identification challenge of omitted variables, we conduct a multivariate OLS regression that incorporates a broad set of socioeconomic and behavioral control variables from our survey data. Moreover, we estimate regression equation [1] separately for the subsample of consumers with high vs. low present bias.

$$[1]\ Log(Consumption)_i = \alpha + \beta_1 \cdot Card\ Intensity_i + \gamma \cdot X_i + \varepsilon_i$$

The results reported in Table 2 suggest that conditional on socioeconomic covariates, an increase in card intensity by one standard deviation (0.95) is associated with a 6.5% increase in discretionary spending (see column 1).[21] Consistent with our hypothesis, we find that among respondents with high present bias (column 2), the estimated effect is twice the magnitude of that for respondents with low present bias (column 3). These findings are confirmed in specifications with additional behavioral controls (columns 5-7). However, in both sets of specifications, a Wald

[21] A full table of coefficient estimates is provided in Appendix A5. For all estimations involving consumption as the dependent variable, we exclude 20 consumers who stated that they faced unusual restrictions during the payment diary recording week (because they were sick, faced Covid mobility restrictions, chose self-isolation due to Covid, etc.). This sample exclusion deviates from the PAP. Including these consumers would not affect the results qualitatively.

test suggests no statistically significant difference in the coefficient estimates for *Card Intensity* between respondents with high vs. low present bias. In addition to the subsample analyses, we estimate a model in which Card Intensity is interacted with High Present Bias (columns 4 and 8). These specifications are more restrictive than separate subsample regressions, as all but one coefficient is constrained to be equal for High and Low Present Bias individuals. The estimated coefficient for the interaction term is not significantly different from zero, which is in accordance with the Wald test results.

While our survey data provide us with a very rich set of socioeconomic and behavioral covariates, it is feasible that the OLS estimates in Table 2 are still subject to omitted variable bias. To address this issue of unobservables, we complement our OLS analysis with an instrumental variable analysis. We instrument *Card Intensity* with the variable *Cash Rating*, which – as discussed in detail in Section 6 below – captures respondents' subjective assessment of cash vs. card payments on six different dimensions (*Ease of use*, *Acceptance*, (monetary) *Costs*, *Transaction speed*, *Security*, and *Hygiene*). The results in Section 6 reveal a strong correlation between *Cash Rating* and *Card Intensity*. Our identifying assumption is therefore that – conditional on covariates – *Cash Rating* affects discretionary spending only through its influence on payment choice. It seems plausible to assume that the relative assessment of cash vs. cashless payments in terms of convenience and cost has no direct causal effect on total discretionary spending.[22]

The results of the instrumental variable (IV) analysis are reported in Table 3. The full sample estimates confirm a significant positive effect of payment choice on discretionary spending (column 1). The magnitude of the estimate is larger and more precisely estimated for respondents with high present bias (column 2) than for respondents with low present bias (column 3). The difference in estimates for high vs. low present-biased consumers is accentuated when we add behavioral controls (columns 6-7). The interaction term of Card Intensity * High Present Bias is again not significant (columns 4 and 8).[23]

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[22] Note that survey respondents provide a general assessment of payment instruments' attributes before the payment diary. Including *Cash Rating* or individual perception variables (*Ease of use*, *Acceptance*, *Costs*, *Transaction speed*, *Security*, and *Hygiene*) along *Card Intensity* in our model shows that the perception variables are not found to be statistically significant. This provides some evidence in favor of our assumption.

[23] Given the nonstandard nature of the standard errors arising from the instrumental variable regression, we cannot report a cross-equation Wald test, as in Table 2.

Table 2. Card intensity and consumption - OLS estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome variable	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption
Sample	All	High Present Bias	Low Present Bias	All	All	High Present Bias	Low Present Bias	All
Card Intensity	0.07**	0.09**	0.05	0.05	0.07**	0.09**	0.07	0.05
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)	(0.05)
High Present Bias	0.00			-0.17	0.00			-0.18
	(0.06)			(0.14)	(0.06)			(0.16)
Card Intensity * High Present Bias				0.05				0.05
				(0.04)				(0.05)
P-value: Card Intensity			0.080				0.318	
Mean of outcome variable	3.94	3.90	3.98	3.94	3.96	3.92	4.00	3.96
Adj. R2	0.17	0.24	0.10	0.17	0.18	0.26	0.11	0.18
Observations	1019	492	527	1019	899	433	466	899
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	No	Yes	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Note: The table shows the results of OLS regressions. The dependent variable is the log of Consumption. All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (5-8). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. "P-value: Card Intensity" denotes the p-value of a one-sided test whether the coefficient of card intensity is the same in columns 2 and 3 (or 5 and 6, respectively). ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Table 3. Card intensity and consumption - IV estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome variable	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption
Sample	All	High Present Bias	Low Present Bias	All	All	High Present Bias	Low Present Bias	All
Card Intensity	0.21***	0.30***	0.16	0.15	0.20***	0.35***	0.09	0.09
	(0.05)	(0.11)	(0.11)	(0.10)	(0.07)	(0.12)	(0.11)	(0.11)
High Present Bias	-0.01			-0.47	-0.01			-0.82
	(0.07)			(0.61)	(0.06)			(0.63)
Card Intensity * High Present Bias				0.13				0.23
				(0.18)				(0.18)
Mean of outcome variable	3.95	3.90	3.99	3.95	3.96	3.92	4.00	3.96
Kleibergen-Paap rk Wald F statistic	127.27	62.08	44.67	73.28	129.28	50.49	46.33	56.06
Adj. R2	0.16	0.23	0.09	0.16	0.17	0.23	0.10	0.16
Observations	989	478	511	989	872	421	451	872
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	No	Yes	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

Note: The table shows the results of IV (2SLS) regressions. The dependent variable is the log of Consumption. Instrument: Cash Rating (and Cash Rating * High Present Bias in columns 4 and 8). All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (5-8). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Table 4. Card intensity and consumption – IV estimates, accounting for predicted consumption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome variable	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption
Sample	All	High Present Bias	Low Present Bias	All	All	High Present Bias	Low Present Bias	All
Card Intensity	0.16***	0.27***	0.09	0.10	0.16***	0.33***	0.04	0.06
	(0.05)	(0.10)	(0.11)	(0.10)	(0.05)	(0.11)	(0.10)	(0.09)
Predicted Consumption (Log)	0.49***	0.40***	0.54***	0.48***	0.47***	0.38***	0.51***	0.46***
	(0.05)	(0.06)	(0.07)	(0.05)	(0.05)	(0.06)	(0.06)	(0.05)
High Present Bias	0.02			-0.41	0.01			-0.76
	(0.05)			(0.59)	(0.06)			(0.60)
Card Intensity * High Present Bias				0.12				0.22
				(0.17)				(0.17)
Mean of outcome variable	3.95	3.90	3.99	3.95	3.97	3.92	4.01	3.97
Kleibergen-Paap rk Wald F statistic	126.76	45.90	51.99	58.99	126.51	41.48	47.35	48.10
Adj. R2	0.36	0.37	0.35	0.36	0.35	0.36	0.33	0.34
Observations	951	455	496	951	846	405	441	846
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	No	Yes	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS

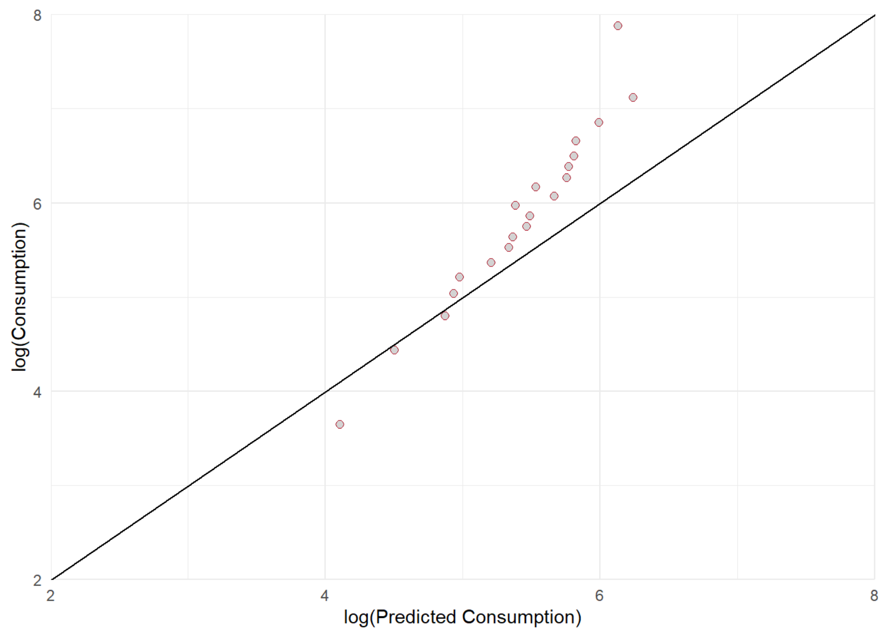
Note: The table shows the results of IV (2SLS) regressions. The dependent variable is the log of Consumption. Instrument: Cash Rating (and Cash Rating * High Present Bias in columns 4 and 8). All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (5-8). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Our second identification challenge relates to two-way causality. Our model suggests that the planned consumption level of consumers should affect their payment choice. In the model, the (nonmonetary) costs of both cash and cashless payments increase with consumer spending. If these costs increase faster for cash than card payments for a specific good, we would expect consumers with high planned consumption for that good to use cashless rather than cash payments. In contrast, the use of cashless payments by naïve present-biased consumers may lead actual spending to exceed planned spending. Moreover, planned consumption should affect payment choice at least as strongly for consumers with low present bias as it does for consumers with high present bias.[24] In contrast, given a level of planned consumption, cashless payments should affect actual spending more for consumers with high present bias.

We address two-way causality by (i) exploiting available information on planned versus actual spending of our respondents and (ii) testing the differential predictions for consumers with high vs. low present bias. For this exercise, we make use of the fact that prior to starting their payment diary, all respondents were asked to give an estimate of the amount of their discretionary spending over the following seven days. We employ this measure of *Predicted Consumption* as an indicator of planned consumption.

[24] If a significant share of sophisticated present-biased consumers exists and if they self-control their spending through costly payment choices, we would expect planned spending to affect payment choice less for consumers with high present bias (see Hypothesis 2).

Figure 8. Actual vs. Predicted Consumption



Note: The figure juxtaposes Predicted Consumption as estimated by respondents before the payment diary recording period and actual consumption by 5% buckets of respondents ordered by Predicted Consumption.

Figure 8 compares predicted consumption to actual consumption in our sample. On average, actual consumption (78 CHF) exceeds average predicted consumption (48 CHF) by 63%, with 73% of consumers spending more than predicted.[25] It is likely that the observed discrepancy between predicted and actual consumption is driven both by noisy assessments of planned spending (prediction error) and by ex-post deviations from (precise forecasts of) planned spending.[26] Note that low-income consumers display the smallest and least frequent discrepancies between predicted and actual consumption.

To account for actual vs. planned consumption, we replicate our IV regression equation [4], adding the logarithm of *Predicted Consumption* as an explanatory variable. The results are reported in Table 4.[27] As with our OLS and IV estimates in Tables 2-3, we find that the estimated coefficient

[25] When writing the PAP, we did not understand the availability of the data on predicted consumption. Therefore, this analysis has not been included in the PAP. As Predicted Consumption is missing for some consumers, the sample average of Consumption for the limited sample slightly deviates from respective full sample results.

[26] For a recent discussion of consumer prediction errors related to inflation see, e.g., D'Acunto, Malmendier, and Weber (2022).

[27] An alternative specification would be to define our dependent variable as log(Consumption) – log(Predicted Consumption). In this case, controlling for log(Predicted Consumption) as a scaling variable yields a linear transformation of our chosen specification.

of *Card Intensity* is larger and more precisely estimated in the sample of respondents with high present bias (column 2) than in the sample of respondents with low present bias (column 3). The results are confirmed when adding behavioral controls in columns (6-7). Overall, the results of Tables 2-4 confirm Hypothesis H1: Cashless payments are associated with higher discretionary spending – and this association is driven by consumers with high present bias.

Robustness tests

Appendix A6 presents robustness tests of our Table 4 results. In Panel (A), we account for measurement error in our diary measure of discretionary spending by (i) excluding consumers with less than 4 reported transactions during the diary week, by (ii) excluding the consumers with the 5% lowest and highest reported spending, by (iv) keeping only observations for consumers who report a normal spending week and by (iv) adding controls for respondents self-reporting a week with higher or lower spending compared to a normal week. In Panel (B), we (i) omit respondents who report that they are situational payers (Card Intensity =3), (ii) omit respondents who report individual transactions of more than 1,000 CHF in their payment diary, (iii) add a control for respondents who report individual transactions of more than 1,000 CHF in their payment diary, and (iv) omit Other spending from the dependent variable. Overall, these robustness tests confirm our Table 4 (columns 6-7) results, although the magnitude of the estimates differ between specifications.

Heterogeneity

Appendix A7 provides a heterogeneity analysis of our Table 4 results (IV estimates). In Panel A, we compare the results for consumable vs. durable spending. Our estimates suggest that for respondents with high present bias, the impact of cashless payments on spending is slightly stronger for durable goods than for consumables.

In Panel B, we compare respondents by age group. Our estimates suggest that among respondents with high present bias, the impact of cashless payments on spending is least pronounced for young consumers.

In Panel C, we compare respondents by income group. Our estimates suggest that among respondents with high present bias, the impact of cashless payments on spending is pronounced both for low- and for high-income consumers.

In Panel D, we compare respondents by whether we observe them in the early period of the month (after pay day) or the late period of the month (before pay day) groups. Figure 6 shows that the discretionary spending of consumers in our sample is higher after pay day than before pay day. Our subsample estimates suggest, however, that this is unrelated to present biased preferences or to payment choice.

6. Payment Choice and Cash Management

Our Hypothesis H2 predicts that the relationship between cash management costs, card-payment costs and payment choice should be weaker for consumers with high present bias than for consumers with low present bias. The reason for this is that some sophisticated present-biased consumers may purposefully choose costly payment methods to self-control their intramonth consumption. We test this hypothesis by estimating equation [2] separately for the subsample of consumers with high vs. low present bias:

$$[2]\ Card\ Intensity_{i,r*t} = \alpha_{r*t} + \beta_1 \cdot Cash\ Rating_i + \beta_2 \cdot Distance\ to\ ATM_i + \beta_3 \cdot Income_i + \beta_4 \cdot Conscientiousness_i + \gamma \cdot X_i + \epsilon_i$$

As discussed in Section 3, our indicator of payment choice *Card Intensity* is a categorical variable based on consumers' self-assessed payment behavior (values range from 1 to 5) – a higher value means more cashless payments. We employ four indicators to capture the relative costs of cash management versus cashless payments. *Cash Rating* is a subjective assessment of cash versus card payments on six different dimensions: *Ease of use*, *Acceptance*, (monetary) *Costs*, *Transaction speed*, *Security*, and *Hygiene*. A higher value of *Cash Rating* indicates a more favorable rating of cash as a payment instrument. We further employ two indicators of cash management costs that are motivated by inventory models of cash demand. *Distance to ATM* is a proxy variable for "shoe-leather" costs of withdrawing cash, and *Income* is a proxy variable for cash holding costs. *Distance to ATM* measures the average distance to the nearest ATM in kilometers for households living in the respondents' municipality of residence. *Income* is a categorical variable for respondents' monthly household income (ranging from 1 to 5). Additionally, we approximate the effort of bank account management by the discrete variable *Conscientiousness*. This variable is derived from two survey questions about respondents' degree of self-organization. We hypothesize that the effort costs of imposing spending limits are lower if someone is well organized. All regressions include a comprehensive set of covariates X_i.

Figure 9 (Panel A) displays the distribution of *Card Intensity* for consumers with high versus low levels of present bias. The figure reveals that there is no notable difference in payment behavior between the two groups.

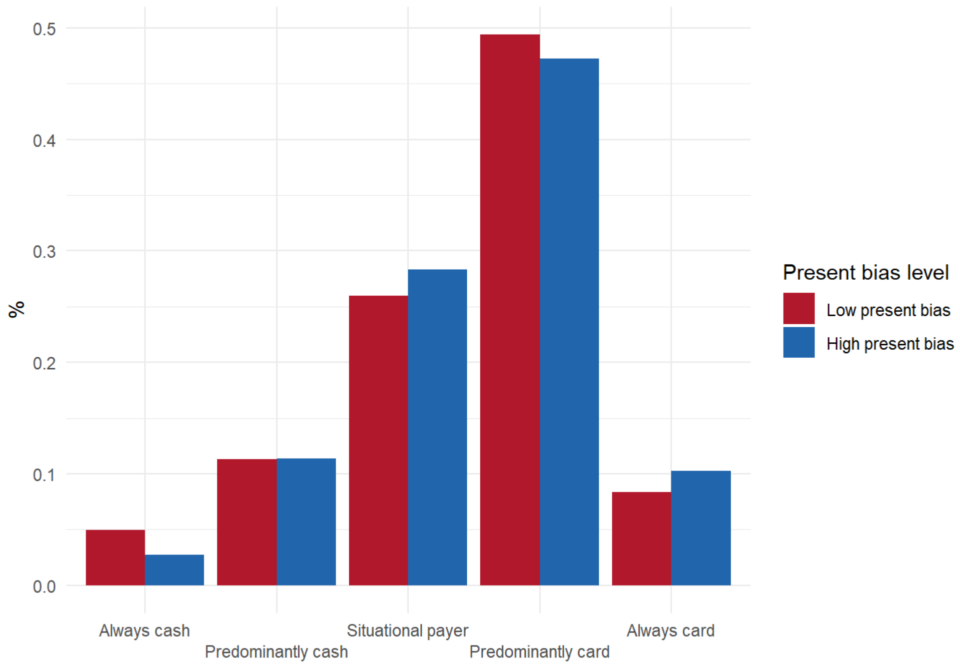
Table 5 reports the OLS regression results for equation [2].[28] The results reveal a strong correlation of payment choice with our subjective measure of the relative convenience and costs of cash vs. cashless payments: Our full sample estimates (column 1) imply that a one-standard decrease in *Cash Rating* (0.10) is associated with a 10% increase in *Card Intensity*. The economic magnitude of this estimate is smaller (9.0%) in the sample of consumers with high present bias (column 2) than in the sample of consumers with low present bias (11.3%, column 3). However, a Wald test suggests no significant difference between the two estimates (see column 3). The Table 5 estimates reveal that objective indicators of shoe-leather costs (*Distance to ATM*) and cash holding costs (*Income*) are unrelated to payment choice. This also applies to our indicator of effort costs to manage cashless payments (*Conscientiousness*). These results are confirmed in specifications that add behavioral controls (columns 4-6) and thus account for any correlation between present bias and risk preferences, discounting or numeracy and financial literacy.

In light of seminal inventory models of cash management, it is somewhat surprising that the distance between a consumer's residence and the nearest ATM has no impact on payment choice. However, there are at least three reasons why this finding seems reasonable in the Swiss context we study. First, the distance between residence and the nearest ATM is small for most households in Switzerland. Second, many ATMs are located close to retail shops, so the extra distance of traveling to an ATM is negligible. Third, many households commute to work by public transport and therefore frequently pass ATMs, which are located at all major train stations.

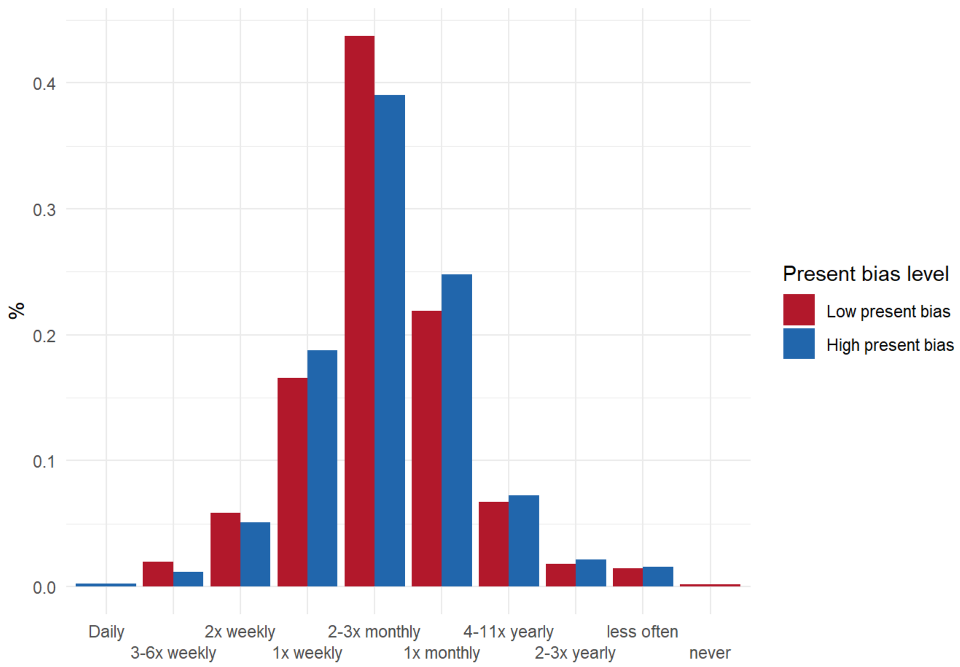
[28] We note that our outcome variable *Card Intensity* is an ordinal variable on the scale of 1-5. We present estimates from OLS regressions for expositional reasons. The use of ordered regressions results in qualitatively similar results.

Figure 9. Present bias, payment choice and cash management

Panel A. Distribution of Card Intensity by present bias level



Panel B. Distribution of Withdrawal Frequency by present bias level



Note: The figure shows the distribution of *Card Intensity* (Panel A) and *Withdrawal Frequency* (Panel B) for consumers with high versus low present bias. Variable definitions are presented in Appendix A2.

Table 5. Payment Choice

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable	Card Intensity	Card Intensity	Card Intensity	Card Intensity	Card Intensity	Card Intensity
Sample	All	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias
Cash Rating	-3.46***	-3.03***	-3.77***	-3.56***	-3.15***	-3.89***
	(0.30)	(0.41)	(0.60)	(0.31)	(0.48)	(0.60)
Distance to ATM (log)	0.04	0.05	0.03	0.03	0.01	0.05
	(0.05)	(0.06)	(0.07)	(0.06)	(0.06)	(0.08)
Income	0.00	0.04	-0.03	-0.01	0.04	-0.06
	(0.03)	(0.03)	(0.05)	(0.03)	(0.03)	(0.05)
Conscientiousness	-0.01	0.00	-0.02	-0.02	-0.01	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
High Present Bias	0.07			0.06		
	(0.05)			(0.05)		
P-value: Cash Rating			0.182			0.187
P-value: Distance to ATM			0.389			0.329
P-value: Income			0.127			0.042
P-value: Conscientiousness			0.210			0.199
Mean of outcome variable	3.50	3.55	3.47	3.52	3.55	3.49
Adj. R2	0.21	0.22	0.21	0.21	0.20	0.24
Observations	997	478	519	878	421	457
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS

Note: The table shows the results of OLS regressions. The dependent variable is Card Intensity. All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (4-6). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. "P-value: Cash Rating" denotes the p-value of a one-sided test whether the coefficient of Cash Rating is the same in columns 2 and 3 (or 5 and 6, respectively). Similar for Distance to ATM, Income and Conscientiousness. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Table 6. Cash management

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable	Withdrawal frequency	Withdrawal frequency	Withdrawal frequency	Withdrawal frequency	Withdrawal frequency	Withdrawal frequency
Sample	All	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias
Distance to ATM (log)	0.03	0.10	-0.04	0.03	0.13	-0.06
	(0.06)	(0.08)	(0.07)	(0.07)	(0.11)	(0.09)
Income	0.07***	0.00	0.15***	0.09***	0.02	0.15**
	(0.02)	(0.06)	(0.04)	(0.02)	(0.06)	(0.06)
Card Intensity	-0.29***	-0.26***	-0.27***	-0.29***	-0.27**	-0.24***
	(0.04)	(0.09)	(0.06)	(0.03)	(0.10)	(0.06)
P-value: Distance to ATM			0.034			0.055
P-value: Income			0.041			0.079
P-value: Card Intensity			0.498			0.425
Mean of outcome variable	5.93	5.9	5.95	5.94	5.91	5.96
Adj. R2	0.05	0.04	0.05	0.07	0.08	0.08
Observations	901	423	477	786	369	417
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS

Note: The table shows the results of OLS regressions. The dependent variable is Withdrawal frequency. In all specification the sample is restricted to Card Intensity<5. All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (4-6). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. "P-value: Distance to ATM" denotes the p-value of a one-sided test whether the coefficient of Distance to ATM is the same in columns 2 and 3 (or 5 and 6, respectively). Similar for Income and Card Intensity. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A8 provides a full table of coefficient estimates. Therefore, we confirm that payment choice is strongly correlated with age. Appendix A9 reports the results of a robustness test in which we examine which dimensions of our indicator *Cash Rating* (*Ease of use*, *Acceptance*, (monetary) *Costs*, *Transaction speed*, *Security*, and *Hygiene*) exert the strongest influence on payment choice. We replicate the regression in Table 5, replacing the indicator *Cash Rating* with ratings for each of these dimensions separately. The results suggest that convenience, i.e., ease of use and transaction speed, have the strongest effect on payment choice, while acceptance has the weakest effect. Our results also reveal that hygiene concerns about the use of cash due to fear of COVID-19 transmission and security are significant drivers of payment choice.

Hypothesis H3 stipulates that the cash withdrawal frequency of present-biased consumers should be less sensitive to cash management costs than that of rational cash users. Again, this effect would be driven by sophisticated present-biased consumers who purposefully withdraw often from an ATM to maintain a low cash inventory and thereby self-control their spending. We test this hypothesis by running regression equation [3] separately for respondents with high vs. low present bias. Our indicators of cash management costs *Distance to ATM* and *Income* are motivated by standard inventory models of cash demand. When we add the variable *Card Intensity* as an explanatory variable, as conditional on income and thus planned spending, the cash holding costs are higher for consumers with a larger share of cash payments.

$$[3]\quad Withdrawal\ frequency_i = \alpha_{r*t} + \beta_1 \cdot Distance\ to\ ATM_i + \beta_2 \cdot Income_i + \beta_3 \cdot\ Card\ Intensity_i + \gamma \cdot X_i + \epsilon_i$$

Figure 9 (Panel B) displays the distribution of *Withdrawal Frequency* separately for respondents with high versus low levels of present bias. The figure reveals no notable difference in the frequency of ATM withdrawals between the two groups.[29]

[29] For our analysis of cash management, we exclude 106 respondents (9.3% of our sample) who report that they always pay by card (*Card Intensity* =5).

Table 6 reports the OLS regression results of equation [3]. [30] The full-sample estimates in column 1 confirm that higher cash holding costs, as measured by higher income and lower card intensity, are associated with more frequent cash withdrawals. In contrast, we find no evidence that the physical distance to the nearest ATM affects withdrawal frequency. No effect of cash-holding costs (as measured by income) on the frequency of cash withdrawals is found for the subsample of respondents with high present bias (column 2), whereas a significant positive effect is found for respondents with low present bias (column 3). The difference is also confirmed by a Wald test. Among respondents with low present bias, a one standard deviation increase in income (1.4) is associated with a 3.4% increase in cash withdrawal frequency. Among respondents with high present bias, this effect is almost zero (0.01%). These results are confirmed in specifications that add behavioral controls (columns 4-6).

Taken together, the results reported in this section provide no conclusive evidence that present-biased consumers adapt their payment choice and money management strategy with the possible goal of exerting self-control over their spending. This finding is consistent with previous evidence from nonexperimental studies documenting that present-biased consumers display only weak demand for costly commitment strategies (cf.Ericson and Laibson 2018).

7. Conclusion

The rise of cashless payments has raised the concern that some consumers will be induced to spend beyond their means. In this paper, we examine one channel through which digital payments may lead to overspending: The use of a payment card relaxes intramonth liquidity constraints for consumers, as they have access to their entire bank account balance at all times.

We present a model of intramonth consumption in which liquidity constraints are endogenously determined by payment choice and cash management. Our model predicts that (naïve) present-biased consumers who predominantly pay cashless will overspend, while present-biased consumers who pay by cash will not. Our model also predicts that sophisticated present-biased consumers may choose costly payment behavior and cash management to self-control their spending.

[30] We note that our outcome variable *Withdrawal Frequency* is an ordinal variable on the scale of 1-10. We again present estimates from OLS regressions for expositional reasons. The use of ordered regressions results in qualitatively similar results.

We test these predictions using a proprietary dataset that links a payment-methods survey, a payment-diary survey and a behavioral survey for a representative sample of 1,138 Swiss consumers. Our analysis follows a preanalysis plan. Our main finding is that consumers with high levels of present bias spend more when they pay frequently by card as opposed to paying frequently by cash. For consumers with low levels of present bias, we find that spending is unaffected by payment instrument usage.

Our findings inform policy-makers concerned with the impact of the digital economy on consumer behavior. Our results reveal that digital payments may indeed induce higher discretionary spending by impulsive consumers. At first glance, this would suggest an important role of prepaid payment cards or of mobile-payment applications that allow consumers to manage and restrict their liquidity in a convenient manner. Designers of instant payment services or central bank digital currency wallets may also want to consider such features.

Our representative survey data enable us to provide an analysis of payment choice and discretionary spending for a broad set of consumers. Our heterogeneity tests reveal that the effect of cashless payments on spending is strong both for low- and high-income consumers but not for young consumers. However, the small size of subsamples in our dataset implies that our comparisons across consumer groups need to be interpreted with care. Further research should seek to replicate our findings in larger samples of consumers that are of particular interest to policy-makers, i.e., low-income households and young adults.

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Appendix A:

Cashless Payments and Consumer Spending [1]

This Version: November 2023

Martin Brown Yves Nacht Thomas Nellen Helmut Stix

This Appendix contains definitions of variables, descriptive statistics, a validation of survey instruments and supplementary tables.

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[1] Martin Brown: Study Center Gerzensee and University of St. Gallen, Email: martin.brown@szgerzensee.ch; Yves Nacht: Swiss National Bank, Email: yves.nacht@snb.ch; Thomas Nellen, Swiss National Bank, Email: thomas.nellen@snb.ch; Helmut Stix: Oesterreichische Nationalbank, Email: helmut.stix@oenb.at. We thank Daniel Grodzicki (discussant), Andreas Fuster, Nicole Hentschel, Florian Hett, Silvio Schumacher, Andy Sturm and an anonymous referee for helpful comments. We also received helpful comments from participants at the Economics of Payments XI conference at the Bank of Canada, the 2023 Swiss Winter Conference on Financial Intermediation, and seminar participants at ESSEC Paris, Goethe University Frankfurt and the Swiss National Bank. Supplementary Material is available at: https://osf.io/epmuv/.

Appendix A1. Sample composition of full survey and follow-up survey

	SNB Payment Methods Survey	SNB Behavioral Survey
Observations	2126	1138
Gender = Female (%)	1065 (50.1)	544 (47.8)
Age (%)		
15 bis 34	549 (25.8)	278 (24.4)
35 bis 54	660 (31.0)	394 (34.6)
55+	917 (43.1)	466 (40.9)
Region (%)		
DS	1282 (60.3)	681 (59.8)
WS	532 (25.0)	297 (26.1)
TI	312 (14.7)	160 (14.1)
Urban rural typology (%)		
Intermediate	469 (22.1)	268 (23.6)
Rural	358 (16.8)	177 (15.6)
Urban	1299 (61.1)	693 (60.9)
Income (%)		
unter 4000	237 (12.2)	97 (9.2)
4000-5999	351 (18.0)	181 (17.2)
6000-7999	365 (18.7)	186 (17.6)
8000-9999	340 (17.4)	197 (18.7)
10000+	657 (33.7)	393 (37.3)
Education (%)		
high	902 (42.9)	545 (48.4)
intermediate	1009 (48.0)	494 (43.9)
low	192 (9.1)	87 (7.7)
Labor force status (%)		
Other	62 (2.9)	31 (2.7)
Unemployed	59 (2.8)	35 (3.1)
Employed	1230 (57.9)	694 (61.0)
In Education	211 (9.9)	113 (9.9)
In Pension	561 (26.4)	264 (23.2)
Language (%)		
German	1262 (59.4)	670 (58.9)
Français	550 (25.9)	308 (27.1)
Italiano	314 (14.8)	160 (14.1)

Note: Column percent in parentheses.

Appendix A2. Definition of variables

Data sources of all variables: SNB Payment Methods Survey, SNB Behavioral Survey, SNB Diary (SNB 2021) and Swiss Money Map (https://www.moneymap.ch/).

A2.1 Definition of outcome variables

Data sources of all variables in this section: SNB Payment Methods Survey or SNB Diary (SNB 2021).
We define the following outcome variables that measure consumption and the use of payment instruments. Source: SNB Diary, unless otherwise indicated.

Variable name	Description	Measurement
Main outcome variables:		
Consumption	Average daily consumption in CHF. Total nonrecurrent spending divided by the number of respective diary recording days.	Continuous
Card intensity	Derived from the following question: “I would like to know how you usually pay for your purchases (e.g. shopping)”. =5 if respondent answers “always cashless”, 4= “predominantly cashless”, 3= “it depends, in some payment situations cash, in other payment situations cashless”, 2=“predominantly by cash”, 1=“always by cash”. Source: SNB Payment Methods Survey.	Categorical
Frequent withdrawals	Derived from frequency of cash withdrawals at main withdrawal point (self-assessed by respondent). Dummy=1 if “daily”, “3-6 times per week”, “twice per week”, “once per week”, “2-3 times per month”. 0 if “once per month”, “4-11 times per year”, “2-3 times per year”, “less often”, “never”. Source: SNB Payment Methods Survey.	Dummy

A2.2 Definition of explanatory variables

Our main explanatory variable is the degree of consumers' present bias. In addition, we employ multiple auxiliary explanatory variables to measure the front-loading of consumption, cash management costs or spending limits. Some of these auxiliary variables are also used as control variables in some tests and are therefore defined further below.

Variable name	Description	Measurement
Present bias	Defined as the average response from 2 survey questions: A higher value means stronger present bias. Impulsivity: „*How would you describe yourself: Do you generally think things over for a long time before acting – in other words, are you not impulsive at all? Or do you generally act without thinking things over for long, in other words, are you very impulsive? Please answer on a scale from 0 to 10, where 0 means not at all impulsive and 10 means very impulsive*" (Q2.2.3, own translation). Source: Kantar Public (2019), Question 16. Procrastination: „*I tend to postpone tasks, even though I know that it would be better to deal with them immediately. Please answer on a scale from 0 to 10, where 0 means 'does not describe me at all' and 10 means 'describes me perfectly'*" (Q2.2.2, own translation). Source: Falk et al. (2022), Falk et al. (2018). Source: SNB Behavioral Survey.	Integer 0-10
Present biased consumer (PBC)	Dummy variable=1 if Present bias>4, 0 otherwise. Source: SNB Behavioral Survey.	Dummy
Late period (Dummy)	Dummy variable=1 if the first day of the diary is between pay-day and the 11th day after pay-day, 0 otherwise. See Appendix A. Source: SNB Diary.	Dummy
Distance to ATM	Average distance to the nearest ATM in km for households living in the respondents' municipality of residence. Source: Swiss Money Map.	Continuous
Conscientiousness	Based on average of two survey items: „*How well do the following statements describe your behavior? Please use a scale from 1 to 7, where 1 means „does not describe me at all" and 7 means "describes me perfectly". Choosing values in between allows you to fine-tune your answer.*" a. "*I see myself as someone who does a thorough job*" (Q2.4.10.2)	Continuous

	b. „*Generally, I am someone others would describe as ‘well organized’*" (Q2.4.10.3) Source: SNB Behavioral Survey. Item a: Rammstedt and John (2007). Item b: Muehlbacher and Kirchler (2019).	
Predicted Consumption	Prior to the start of the payment diary, the respondents were asked to give an estimate of the amount of their discretionary spending over the following seven days: “*Please estimate how much Swiss Francs you will spend the coming 7 days. (Please do not consider regular payments like payments for rents, insurance, telephone, subscriptions)*“. Source: SNB Diary.	Continuous

A2.3. Definition of control variables

- **A. Socioeconomic control variables**

We define the following socioeconomic controls. In the estimations, we might convert the categorical variables into individual dummy variables. Source: SNB Payment Methods Survey.

Variable name	**Description**	**Measurement**
Age	Age of respondent in years. In the regressions, we use age groups of 10 years width (15-24, 25-34…)	Continuous
Male	Dummy=1 if respondent is male, 0 otherwise.	Dummy
Education	Level of education: 1 = compulsory; 2 = upper secondary level; 3 = tertiary level. In the regressions, individual dummies for each education level are used.	Dummy variables
(HH) Income	Household income group: 1 = average monthly gross household income below CHF 4000; 2 = income between CHF 4000 and 5999; 3 = income between CHF 6000 and 7999; 4 = income between CHF 8000 and 9999; 5 = income CHF 10'000 and above.	Dummy or categorical variables
Household size	1= 1 person, 2=2-4 persons, 3= more than 4 persons. In the regressions, individual dummies for each group are used.	Dummy variables
Labor force status	1= employed (full, or part-time), 2= unemployed, temporarily out of work, 3= in education, 4= retired, 5=other. In the regressions, individual dummies for each group are used.	Dummy variables

Residential environment	1= Rural, 2= Intermediate, 3= Urban, defined according to the official statistical classification for the municipality of residence. In the regressions, individual dummies for each group are used.	Dummy variables
Language	1= German, 2=French, 3=Italian defined according to the language in which respondents' chose to be interviewed. In the regressions, individual dummies for each group are used.	Dummy variables

- **<u>B. Transaction and consumption structure</u>**

We define the following variables that measure transaction and consumption structure. Source: SNB Diary.

Variable name	Description	Measurement
	Using the transaction data from the SNB Diary we compute for each respondent the expenditure shares (in value terms) for:	
Share consumables	„Daily" goods ("Geschäft/Laden für täglichen Bedarf")	Continuous 0-1
Share durables	Durable goods ("Geschäft/Laden für sonstige längerfristige Anschaffungen")	
Share restaurants	Restaurants/take-away or delivery of food ("Essen und Trinken auswärts / Lieferdienste")	
Share leisure	Leisure activities and out-of-home services ("Freizeitaktivitäten", "Dienstleistungen ausser Haus").	
Share e-commerce	Internet and mail/telephone-order purchases ("Bestellen/Einkaufen im Internet", "Bestellung beim Versandhandel (ausser Internet)")	
Share other	All other goods/services (the sum of expenditures for „Automaten", „Dienstleistungen im Haushalt", „Tankstelle, Tankstellenshops Tankstelle, Tankstellenshops", „Ämter/Behörden / öffentliche Verwaltung", "Ausgaben/Spenden an wohltätige Organisationen", "Ausgaben an Privatpersonen", "Sonstiges", "Unterkunft/Übernachtung")	
Transactions	The number of transactions over the 7-day diary recording period.	Continuous
Avg. amount	The average transaction amount defined as Consumption divided by Transactions.	Continuous
	Using the transaction data from the SNB Diary, we compute for each respondent the expenditure shares (in value terms) by day of the week:	
Share Monday…Share Sunday	The value share of transactions conducted on Monday…	Continuous 0-1

Friday-Saturday	For the within-person regressions we define a dummy variable = 1 if the post pay-day period starts on a Friday or Saturday, 0 otherwise.	Dummy

- **C. Behavioral control variables**

We define several other behavioral variables that are used as control variables. Data source of all variables except Financial literacy: SNB Behavioral Survey. The source for Financial literacy is the SNB Payment Methods Survey.

Variable name	**Description**	**Measurement**
Discount rate	Combined measure of Discount rate quantitative (weight= 0.712) and Discount rate qualitative (weight= 0.288). We (i) compute the z-scores of each survey item at the individual level and (ii) weight these z-scores using the weights according to Falk et al. (2022). A higher value means stronger discounting. Discount rate quantitative: Derived from 5 questions via staircase elicitation method. *“Suppose you were given the choice between receiving a payment today or a payment in 12 months. We will now present to you five situations. The payment today is the same in each of these situations. The payment in 12 months is different in every situation. For each of these situations, we would like to know which you would choose. Please assume there is no inflation, i.e., future prices are the same as today’s prices.” 200 CHF today or 308 CHF in 12 months, … .* Discount rate qualitative: *"In comparison to others, are you a person who is generally willing to give up something today in order to benefit from that in the future or are you not willing to do so? Please use a scale from 0 to 10, where a 0 means you are “completely unwilling to give up something today” and a 10 means you are “very willing to give up something today”* Source: Falk et al. (2022), Falk et al. (2018).	Continuous
Risk taking	Combined measure of Risk taking quantitative (weight= 0.473) and Risk taking qualitative (weight= 0.527). We (i) compute the z-scores of each survey item at the individual level and (ii) weight these z-scores using the weights according to Falk et al. (2022). A higher value means more risk taking. Risk taking quantitative: Derived from 5 questions via staircase elicitation method. *“The next question should help quantifying your risk attitude. We will present to you five different situations.*	Continuous

	What would you prefer: A draw with a 50-percent chance of receiving 750 CHF and the same 50-percent chance of receiving nothing, OR the amount of 400 CHF as a sure payment?" Risk taking qualitative: *"Please tell me, in general, how willing or unwilling you are to take risks, using a scale from 0 to 10, where 0 means you are "completely unwilling to take risks" and 10 means you are "very willing to take risks." You can also use any number between 0 and 10 to indicate where you fall on the scale".* Source: Falk et al. (2022), Falk et al. (2018).	
Memory of numbers	At the very beginning of the SNB Behavioral Survey, three numbers were consecutively displayed. After a number was displayed for two seconds respondents were asked to enter the respective number. The number were: 3.65 CHF, 57.45 CHF and 829.15 CHF. At the end of the survey, respondents were presented with an array of 12 numbers and they had to select the three numbers that were displayed at the beginning of the survey. The ordering of the displayed numbers was randomized. "Memory numeric" is defined as the number of correct answers.	Categorical 0-3
Conscientiousness	Based on average of two survey items: "*How well do the following statements describe your behavior? Please use a scale from 1 to 7, where 1 means „does not describe me at all" and 7 means "describes me perfectly". Choosing values in between allows you to fine-tune your answer.*" a. "*I see myself as someone who does a thorough job*" (Q2.4.10.2) b. "*Generally, I am someone others would describe as 'well organized'*" (Q2.4.10.3) Source: Items a: Rammstedt and John (2007). Item b: Muehlbacher and Kirchler (2019).	Continuous
Financial literacy score	Big three financial literacy questions: Number of correct answers to "big 3 financial literacy questions": interest rate literacy, inflation literacy and portfolio diversification literacy.	Categorical 0-3
Trust in institutions	Average of three items. Each item is coded as 1 (very low), 2, 3 or 4 (very high trust). A higher value is associated with more trust. "*We would be interested in your level of trust in various institutions. Could you say whether your trust is very high, somewhat high, somewhat low or very low*".	Continuous 1-4

	"How much do you trust…" *"…banks in Switzerland?"* *"…your main bank (i.e., the bank with which you mainly conduct your banking transactions)?"* *"…the Swiss Federal Council (Bundesrat)?"* *"…the Swiss judicial system/courts?"*	

- **D. Perceptions of payment instruments**

We define the following variables that measure the perception of payment instrument attributes. Source: SNB Payment Methods Survey.

Variable name	**Description**	**Measurement**
	The SNB Payment Methods Survey asks about perceived payment instrument attributes: "*I would like to ask how you rate payment instruments regarding various aspects (e.g. security, acceptance, etc.). It does not matter whether you own or do not own the respective payment instrument.*"	Continuous 0-1
Security	"*First, I would like to ask how you rate the following payment instruments regarding security? Please provide an answer in the range from 1 (very bad) to 7 (very good). (Security means security of use or the security in terms of loss of money)*". Cash, debit cards, credit cards, payment apps and mobile payment methods.	
Acceptance	"*Second, I would like to ask how you rate the following payment instruments regarding acceptance? (by acceptance I mean how often a payment instrument is accepted by merchants, i.e., whether the payment instrument can be used at all locations or only at specific locations)*".	
Ease of use	"*Third, I would like to ask how you rate the following payment instruments regarding ease-of-use? (by ease-of-use I mean how easily a payment instrument can be used or whether there are some problems that inhibit the use of a payment instrument)*".	
Speed	"*Fourth, I would like to ask how you rate the following payment instruments regarding transaction speed? (by transaction speed I mean how fast a payment can be settled, i.e., how long it takes until a payment transaction is finished)*".	
Costs	"*Fifth, I would like to ask how you rate the following payment instruments regarding costs? (by costs I mean the costs associated with the use and the adoption of a payment instrument – e.g. a surcharge fee*	

	if a purchase is conducted by a credit card or the general costs of using the payment instrument (e.g. a monthly credit card fee)".
Expense control	"*Sixth, I would like to ask how you rate the following payment instruments in terms of how well they help you budget. That is, how well you can control your expenses or how well you can keep an overview of your expenses*".
Hygiene	"*Seventh, I would like to ask how you rate the following payment instruments in terms of their hygiene. That is, how hygienically can you pay with the following payment instruments?*".
Relative rating of cash	We compute the rating of cash relative to noncash for consumer *i* as follows: $\text{RelCharacteristics}_{k,Cash,i} = \left(\frac{Characteristics_{k,Cash,i}}{mean(Characteristics_{k,Cash,i}, max(Characteristics_{k,Debit,i}, Characteristics_{k,Credit,i}))}\right)$ where k indices the characteristics. For a given characteristics, this means that we normalize the rating of cash with the average of the rating of cash and the maximum rating of either debit or credit cards. If there is no rating on credit (debit) cards, we use only the rating for debit (credit) cards.

- **E. Other variables**

Variable name	Description	Measurement
Region	Regions reflect the seven NUTS 2 statistical regions of Switzerland. However, due to the limited number of observations for the region Ticino, we merged the regions of Ticino and Lac Leman.	Dummy variables
	Source: SNB Payment Methods Survey.	

Appendix A3. Descriptive statistics of covariate variables

Panel A. Main explanatory variables						
	Mean	p50	SD	Min	Max	N
Present Bias	4.21	4.00	1.96	0.00	9.50	1136
High Present Bias	0.48	0.00	0.50	0.00	1.00	1136
Distance to ATM	1.17	0.80	1.09	0.20	11.60	1138
High Income	0.56	1.00	0.50	0.00	1.00	1054
Conscientiousness	5.43	6.00	1.39	1.00	7.00	1125
Late Period	0.33	0.00	0.47	0.00	1.00	869
Predicted Consumption	47.70	35.71	63.50	0.00	1000.00	1096
Panel B. Socioeconomic control variables						
Age 15-24	0.12	0.00	0.33	0.00	1.00	1138
Age 25-34	0.12	0.00	0.32	0.00	1.00	1138
Age 35-54	0.35	0.00	0.48	0.00	1.00	1138
Age 55+	0.41	0.00	0.49	0.00	1.00	1138
Male	0.52	1.00	0.50	0.00	1.00	1138
Edu High	0.48	0.00	0.50	0.00	1.00	1126
Edu Middle	0.44	0.00	0.50	0.00	1.00	1126
Edu Low	0.08	0.00	0.27	0.00	1.00	1126
Edu NA	0.01	0.00	0.10	0.00	1.00	1138
HH Income -4000	0.09	0.00	0.29	0.00	1.00	1054
HH Income 4000-5999	0.17	0.00	0.38	0.00	1.00	1054
HH Income 6000-7999	0.18	0.00	0.38	0.00	1.00	1054
HH Income 8000-9999	0.19	0.00	0.39	0.00	1.00	1054
HH Income 10000+	0.37	0.00	0.48	0.00	1.00	1054
Income	3.58	4.00	1.37	1.00	5.00	1054
Household Size 1	0.18	0.00	0.38	0.00	1.00	1136
Household Size 2-4	0.75	1.00	0.43	0.00	1.00	1136
Household Size 5+	0.07	0.00	0.26	0.00	1.00	1136
Italian	0.14	0.00	0.35	0.00	1.00	1138
French	0.27	0.00	0.44	0.00	1.00	1138
Urban	0.61	1.00	0.49	0.00	1.00	1138
Intermediate	0.24	0.00	0.42	0.00	1.00	1138
Employed	0.61	1.00	0.49	0.00	1.00	1137
In edu	0.10	0.00	0.30	0.00	1.00	1137
Unemployed	0.03	0.00	0.17	0.00	1.00	1137
Retired	0.23	0.00	0.42	0.00	1.00	1137
Other Labor Force Status	0.03	0.00	0.16	0.00	1.00	1137

Note: See continuation.

Appendix A3. Covariate variables (cont.)

	Mean	p50	SD	Min	Max	N
Panel C. Transaction and consumption structure						
Consumption	78.47	52.55	104.45	1.03	1293.60	1138
Number of Transactions	10.92	10.00	5.44	1.00	36.00	1138
Average Amount per Transaction	52.01	35.87	68.96	2.34	938.31	1138
Spending Share Monday	0.14	0.07	0.18	0.00	1.00	1138
Spending Share Tuesday	0.14	0.07	0.18	0.00	1.00	1138
Spending Share Wednesday	0.15	0.08	0.19	0.00	1.00	1138
Spending Share Thursday	0.15	0.08	0.19	0.00	0.97	1138
Spending Share Friday	0.18	0.11	0.20	0.00	1.00	1138
Spending share Saturday	0.17	0.10	0.21	0.00	1.00	1138
Spending share Sunday	0.08	0.00	0.16	0.00	0.95	1138
Share Durables	0.11	0.00	0.19	0.00	1.00	1138
Share Restaurants	0.17	0.09	0.21	0.00	1.00	1138
Share Leisure	0.03	0.00	0.09	0.00	1.00	1138
Share E-commerce	0.08	0.00	0.18	0.00	1.00	1138
Share Other Services	0.06	0.00	0.14	0.00	0.92	1138
Share Other	0.16	0.08	0.21	0.00	1.00	1138
Panel D. Behavioral control variables						
Discount Rate	0.00	-0.24	0.83	-1.22	2.16	1107
Risk Taking	0.00	-0.05	0.88	-1.75	2.77	1096
Memory of Numbers	2.20	2.00	0.78	0.00	3.00	1138
Financial Literacy Score	2.20	2.00	0.83	0.00	3.00	1138
Trust in Institutions	1.98	2.00	0.45	1.00	4.00	1054
Panel E. Perceptions of payment instruments						
Cash Rating	0.89	0.90	0.10	0.49	1.33	1105
Cash Rating - Security	0.91	0.92	0.20	0.25	1.75	1105
Cash Rating - Acceptance	0.99	1.00	0.13	0.25	1.40	1105
Cash Rating - Ease of use	0.93	1.00	0.16	0.25	1.33	1105
Cash Rating - Transaction speed	0.89	0.92	0.19	0.25	1.40	1105
Cash Rating - Costs	1.06	1.08	0.14	0.25	1.75	1105
Cash Rating - Hygiene	0.57	0.57	0.24	0.25	1.43	1105
Cash Rating - Budget control	1.01	1.00	0.22	0.25	1.75	1105

Appendix A4. Validation of survey responses

To validate our behavioral variables, we compare the results from the SNB Behavioral Survey (SNB) with responses from the Global Preferences Survey (GPS) and the Socio-Economic Panel (SOEP). In the following, all results are weighted.

Risk and time preferences

To measure time preferences/patience and risk-taking, we employ survey scales of the GPS. When comparing the respective measures, please note that the GPS data are normalized with the "world" mean and standard deviation such that we can compare the distribution and the pattern of results for subsamples but not the levels. To center the distributions, we rescaled the GPS measure of risk taking and patience to a mean value of zero.

Table A5.1. Descriptive statistics GPS and SNB

a) Risk-taking

	Survey	
	GPS	SNB
Mean	-0.00	-0.00
25th percentile	-0.60	-0.61
Median	-0.01	0.02
50th percentile	-0.01	0.02
75th percentile	0.61	0.58
Standard deviation	0.91	0.85
Number of nonmissing values	997	1,051

b) Patience

	Survey	
	GPS	SNB
Mean	-0.00	-0.00
25th percentile	-1.00	-0.53
Median	-0.01	0.26
50th percentile	-0.01	0.26
75th percentile	1.08	0.64
Standard deviation	1.17	0.83
Number of nonmissing values	992	1,060

Note: Weighted.

Figure A4.1. Distribution of Risk-taking

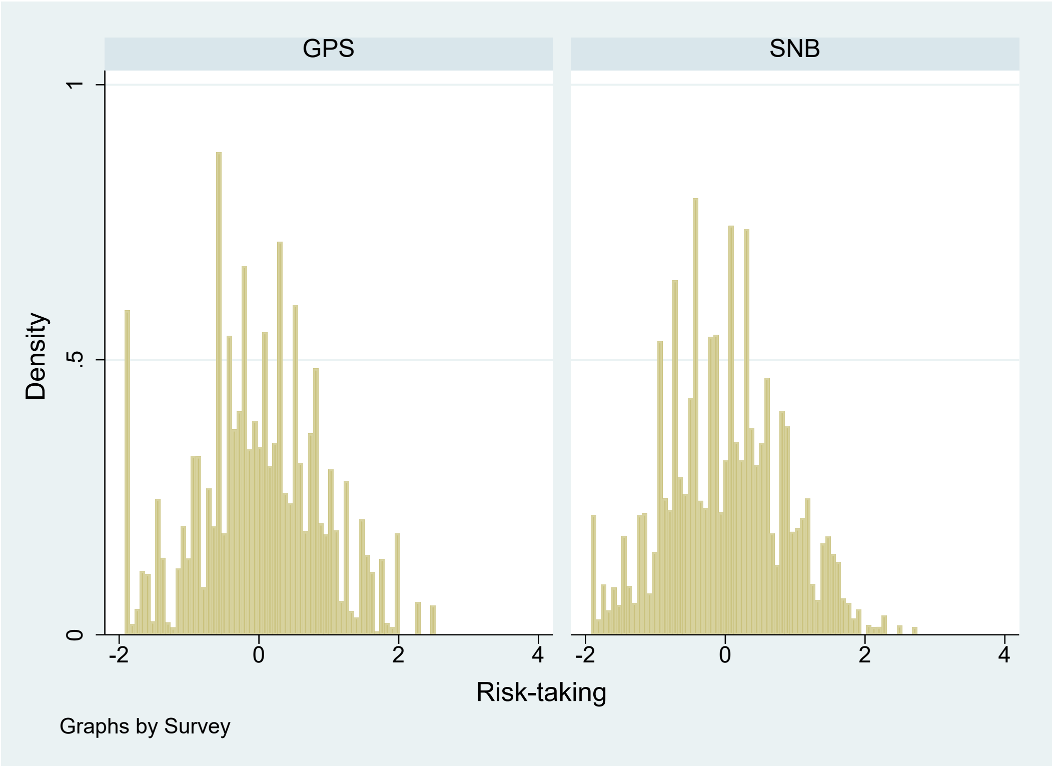


Figure A4.2. Distribution of Patience

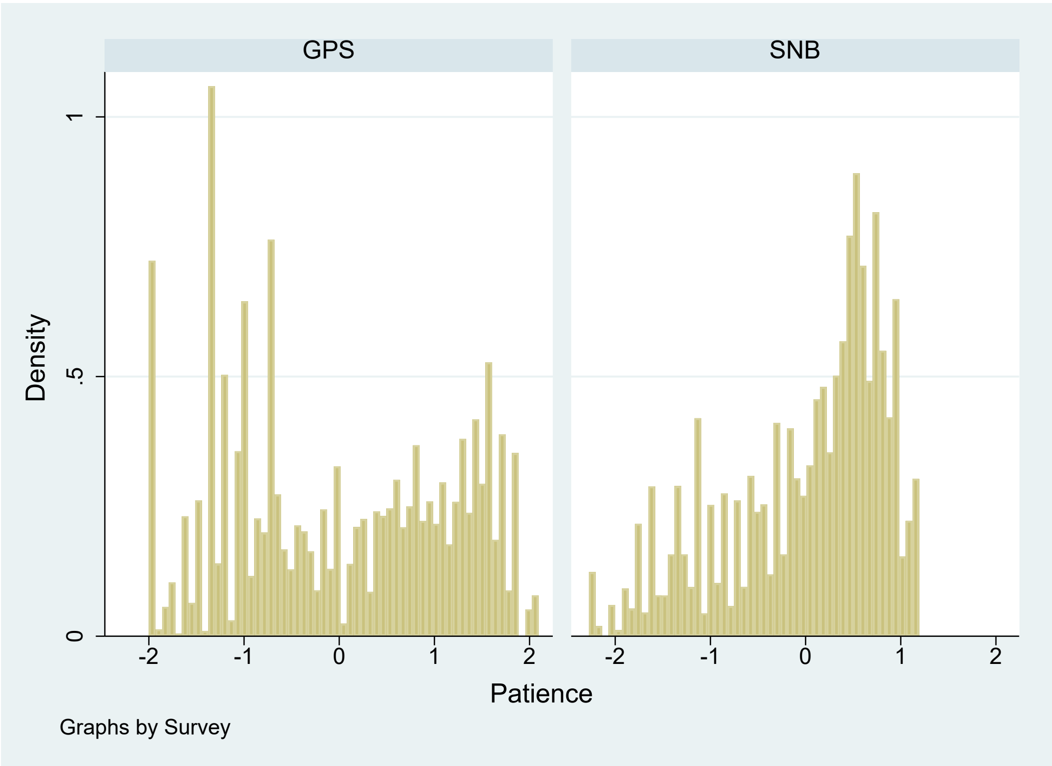


Figure A4.3. Risk-taking by subsamples

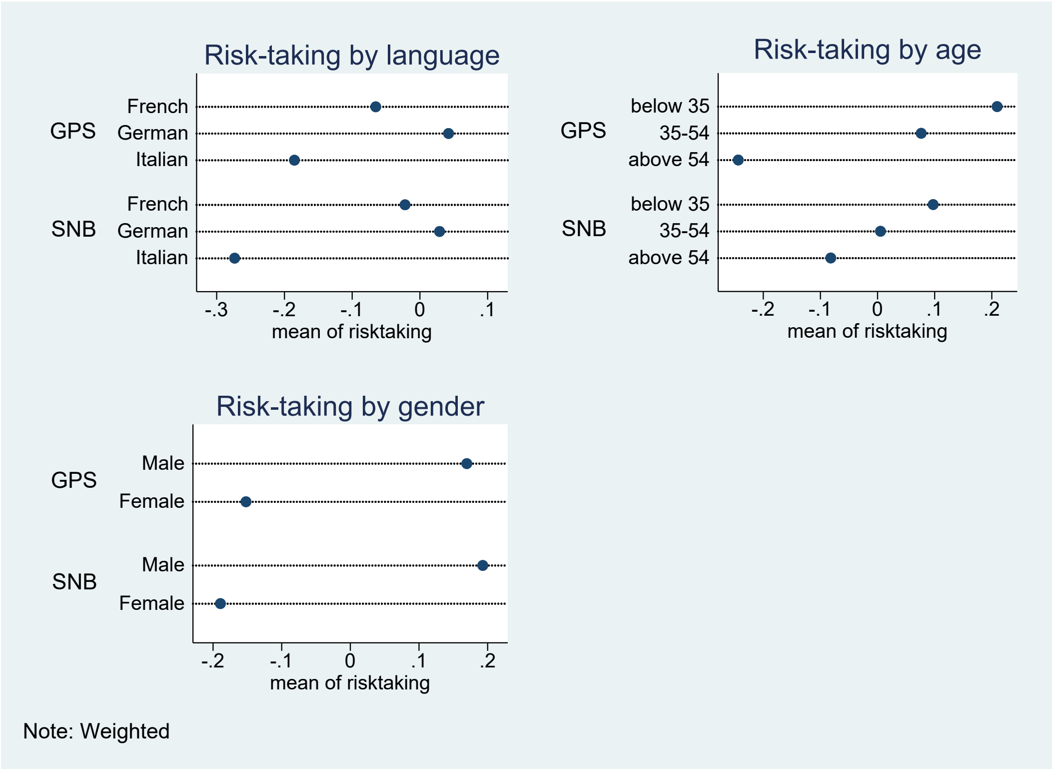
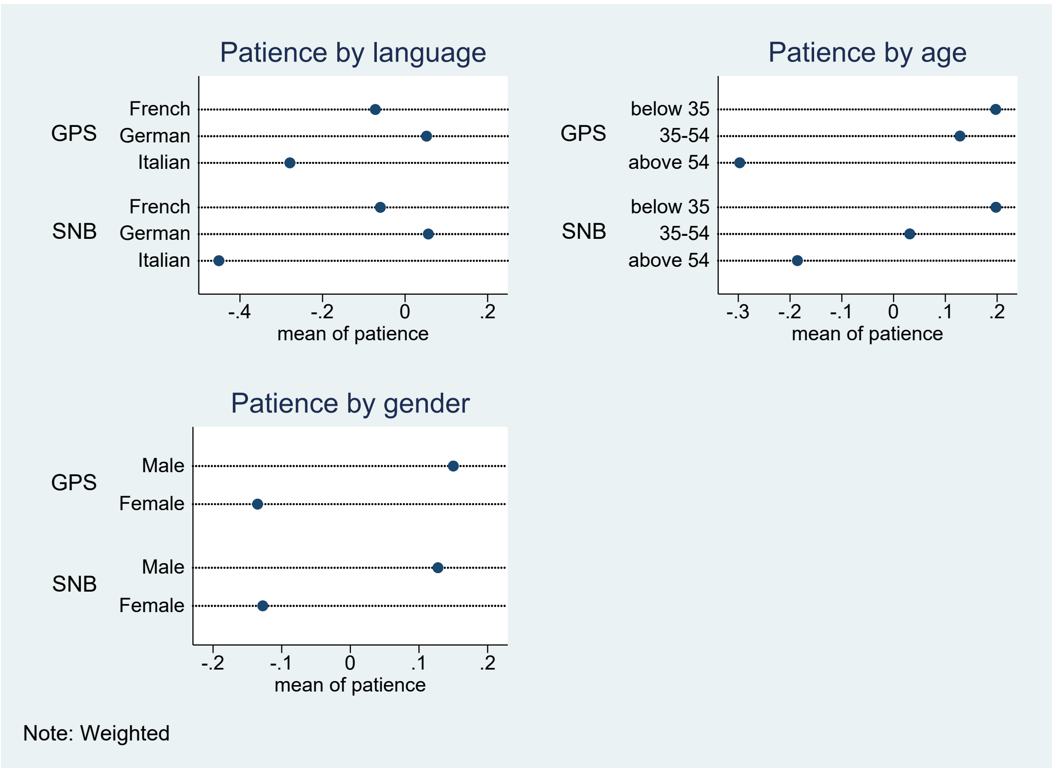


Figure A4.4. Patience by subsamples



Assessment: With respect to risk-taking, the distributions of the SNB survey and the GPS are rather similar. With respect to patience, we find a sizably higher share of patient respondents in the SNB survey than in the GPS (in the SNB, 60% have values larger than zero; in the GPS, the respective value is 49%). As the GPS data were collected in 2012 and the SNB in 2020, we can only speculate that this shift is related to the timing of the surveys. In 2020, the respondents were accustomed to low interest and inflation rates, (cf. Ruggeri et al. 2022) and the COVID-19 pandemic may have had an effect.

Additionally, the differences could be due to the different compositions of the two samples. With respect to language, age and gender subsamples, we find that the SNB survey generates very similar patterns of results as the GPS. In particular, this holds for patience, which corroborates the view that there was a level shift in patience while subsample differences remain unaffected.

Appendix A5. Card intensity and consumption – OLS estimates, full results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome variable	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption
Sample	All	High Present Bias	Low Present Bias	All	All	High Present Bias	Low Present Bias	All
Age 15-24	-0.57***	-0.53**	-0.59*	-0.57***	-0.64***	-0.55**	-0.76**	-0.64***
	(0.17)	(0.23)	(0.30)	(0.17)	(0.18)	(0.25)	(0.29)	(0.18)
Age 25-34	-0.30***	-0.23*	-0.31**	-0.30***	-0.25**	-0.07	-0.32**	-0.24**
	(0.09)	(0.12)	(0.11)	(0.09)	(0.11)	(0.14)	(0.15)	(0.11)
Age 55+	0.19***	0.14**	0.26**	0.18***	0.20***	0.17**	0.25**	0.19***
	(0.05)	(0.06)	(0.10)	(0.05)	(0.06)	(0.07)	(0.10)	(0.06)
Male	0.01	0.05	-0.04	0.01	-0.03	-0.02	-0.08	-0.03
	(0.06)	(0.05)	(0.08)	(0.06)	(0.07)	(0.06)	(0.11)	(0.07)
Edu Low	-0.21**	0.16	-0.57***	-0.20**	-0.22	0.29	-0.65*	-0.21
	(0.09)	(0.14)	(0.18)	(0.09)	(0.14)	(0.20)	(0.33)	(0.14)
Edu Middle	-0.07	0.00	-0.11*	-0.07	-0.04	0.05	-0.10	-0.04
	(0.07)	(0.11)	(0.06)	(0.07)	(0.08)	(0.13)	(0.07)	(0.08)
HH Income 4000-5999	0.39***	0.50***	0.30	0.39***	0.44***	0.53***	0.37	0.44***
	(0.10)	(0.15)	(0.19)	(0.10)	(0.13)	(0.17)	(0.22)	(0.13)
HH Income 6000-7999	0.47***	0.55***	0.43*	0.46***	0.51***	0.59***	0.51*	0.51**
	(0.15)	(0.19)	(0.23)	(0.15)	(0.18)	(0.21)	(0.25)	(0.18)
HH Income 8000-9999	0.55***	0.66***	0.48**	0.55***	0.53***	0.69***	0.42*	0.53***
	(0.14)	(0.20)	(0.20)	(0.14)	(0.17)	(0.22)	(0.23)	(0.17)
HH Income 10000+	0.65***	0.75***	0.61**	0.65***	0.69***	0.81***	0.63**	0.69***
	(0.12)	(0.15)	(0.23)	(0.13)	(0.16)	(0.17)	(0.26)	(0.16)
Urban	-0.04	0.04	-0.08	-0.04	-0.01	0.01	0.02	-0.02
	(0.09)	(0.09)	(0.13)	(0.09)	(0.08)	(0.08)	(0.11)	(0.08)
Intermediate	0.12	0.18	0.06	0.11	0.09	0.08	0.12	0.09
	(0.12)	(0.12)	(0.20)	(0.12)	(0.12)	(0.14)	(0.17)	(0.12)
Household Size 2-4	-0.16**	-0.25**	-0.04	-0.15**	-0.17*	-0.25**	-0.04	-0.17
	(0.07)	(0.09)	(0.14)	(0.07)	(0.10)	(0.10)	(0.14)	(0.10)
Household Size 5+	-0.18	-0.27	-0.03	-0.17	-0.23	-0.30	-0.07	-0.22
	(0.12)	(0.24)	(0.20)	(0.12)	(0.16)	(0.29)	(0.21)	(0.15)
In edu	-0.43**	-0.80***	-0.01	-0.43**	-0.36	-0.94***	0.23	-0.37*
	(0.18)	(0.22)	(0.37)	(0.19)	(0.21)	(0.23)	(0.36)	(0.21)
Unemployed	-0.01	0.14	-0.17	0.00	-0.01	0.23	-0.22	-0.01
	(0.08)	(0.18)	(0.16)	(0.08)	(0.14)	(0.18)	(0.21)	(0.14)
Retired	0.11	0.14	0.08	0.11	0.12	0.13	0.11	0.12
	(0.07)	(0.09)	(0.13)	(0.07)	(0.08)	(0.11)	(0.13)	(0.08)
Other Labor Force Status	-0.07	-0.04	-0.12	-0.08	-0.08	-0.03	-0.12	-0.08
	(0.09)	(0.15)	(0.18)	(0.09)	(0.11)	(0.16)	(0.21)	(0.11)
Card Intensity	0.07**	0.09**	0.05	0.05	0.07**	0.09**	0.07	0.05
	(0.03)	(0.04)	(0.04)	(0.04)	(0.03)	(0.04)	(0.05)	(0.05)
High Present Bias	0.00			-0.17	0.00			-0.18
	(0.06)			(0.14)	(0.06)			(0.16)
Card Intensity * High Present Bias				0.05				0.05
				(0.04)				(0.05)
Discount Rate					0.04	0.01	0.06	0.04
					(0.03)	(0.04)	(0.05)	(0.03)
Risk Taking					0.02	0.01	0.02	0.02
					(0.04)	(0.04)	(0.05)	(0.04)
Memory of Numbers					-0.02	-0.12	0.05	-0.03
					(0.04)	(0.07)	(0.06)	(0.04)
Financial Literacy Score					0.01	0.06	-0.03	0.01
					(0.05)	(0.06)	(0.06)	(0.05)
Trust in Institutions					0.02	-0.05	0.10	0.02
					(0.07)	(0.13)	(0.08)	(0.07)
Constant	3.40***	3.21***	3.42***	3.48***	3.38***	3.47***	3.08***	3.47***
	(0.21)	(0.27)	(0.36)	(0.22)	(0.33)	(0.48)	(0.42)	(0.38)
P-value: Card Intensity			0.08				0.318	
Mean of outcome variable	3.94	3.90	3.98	3.94	3.96	3.92	4.00	3.96
Adj. R2	0.17	0.24	0.10	0.17	0.18	0.26	0.11	0.18
Observations	1019	492	527	1019	899	433	466	899
Socioeconomic controls	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Behavioral controls	No	No	No		Yes	Yes	Yes	Yes
Transaction structure	No	No	No		No	No	No	No
Method	OLS	OLS	OLS		OLS	OLS	OLS	OLS

Note: The table shows the results of OLS regressions. The dependent variable is the log of Consumption. All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (4-6). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. "P-value: Card Intensity" denotes the p-value of a one-sided test whether the coefficient of Card Intensity is the same in column 2 and 3 (or 5 and 6, respectively).***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A6. Payment choice, present bias & consumption: Robustness

Panel A

Specification (1-2): Sample contains only individuals with more than three recorded transactions in the payment diary.
Specification (3-4): Excluding bottom and top 5% of observations of *Consumption* .
Specification (5-6): Sample is restricted to individuals stating that their expenses during the payment diary reflect a "normal" week.
Specification (7-8): Adding controls for whether respondents state that the payment diary week was a week with higher or lower spending (compared to a "normal" week).

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome variable	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption	Consumption
Sample	> 3 transactions		Excl. bottom/top 5%		Normal week		All	
Specification							+ Higher/lower spending	
	High Present Bias	Low Present Bias	High Present Bias	Low Present Bias	High Present Bias	Low Present Bias	High Present Bias	Low Present Bias
Card Intensity	0.29***	-0.01	0.20**	-0.02	0.36**	0.06	0.34***	0.10
	(0.09)	(0.11)	(0.08)	(0.10)	(0.15)	(0.09)	(0.13)	(0.09)
Predicted Consumption (Log)	0.35***	0.49***	0.33***	0.42***	0.30***	0.47***	0.34***	0.43***
	(0.06)	(0.06)	(0.05)	(0.04)	(0.10)	(0.05)	(0.07)	(0.04)
Week higher spending							0.57***	0.66***
							(0.05)	(0.11)
Week lower spending							-0.13	-0.28*
							(0.12)	(0.16)
Mean of outcome variable	3.96	4.09	3.94	3.98	3.82	3.92	3.92	4
Adj. R2	0.36	0.31	0.3	0.26	0.34	0.37	0.39	0.41
Kleibergen-Paap rk Wald F statistic	35.85	43.52	47.81	45.83	27.66	42.69	40.72	48.4
Observations	395	418	367	399	294	310	399	437
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV	IV	IV	IV

Note: The table shows results from various robustness tests of Specification (6) and (7) of Table 4. For each specification, the first column shows results for High Present Bias and the second column the results for Low Present Bias. All results from IV regressions with Cash Rating as an instrument. All regressions include socioeconomic and behavioral controls. All regressions include Language X Month fixed effects. Online Appendix A2 presents definitions of each variable. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

See cont.

Appendix A6. Payment choice, present bias & consumption: Robustness (cont.)

Panel B

Specification (1-2): Sample omits situational payer (Card Intensity=3).
Specification (3-4): Sample omits persons with transactions of more than 1,000 CHF.
Specification (5-6): Adding control for whether respondents made a transactions larger than 1,000 CHF.
Specification (7-8): The dependent variable omits the category "Other".

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outcome variable	Consumption		Consumption		Consumption		Consumption (w/o Other)	
Sample	Omitting Situational Payers		Ommitting persons with transactions of more than 1,000 CHF		All		All	
Specification					+ Controls for Transactions larger than 1,000 CHF			
	High Present Bias	Low Present Bias	High Present Bias	Low Present Bias	High Present Bias	Low Present Bias	High Present Bias	Low Present Bias
Card Intensity	0.35***	-0.02	0.32***	0.04	0.34***	0.05	0.35***	0.06
	(0.12)	(0.10)	(0.12)	(0.09)	(0.11)	(0.10)	(0.09)	(0.11)
Predicted Consumption (Log)	0.31***	0.56***	0.42***	0.50***	0.39***	0.48***	0.37***	0.47***
	(0.08)	(0.05)	(0.06)	(0.06)	(0.05)	(0.06)	(0.07)	(0.05)
High Transaction					1.68***	1.55***		
					(0.22)	(0.18)		
Mean of outcome variable	3.93	4.02	3.87	3.96	3.92	4.01	3.70	3.77
Adj. R2	0.37	0.36	0.37	0.33	0.43	0.40	0.33	0.30
Kleibergen-Paap rk Wald F statistic	17.38	30.06	41.33	43.85	42.37	46.79	41.77	47.15
Observations	284	319	395	429	405	441	404	440
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV	IV	IV	IV

Note: The table shows results from various robustness tests of Specification (6) and (7) of Table 4. For each specification, the first column shows results for High Present Bias and the second column the results for Low Present Bias. All results from IV regressions with Cash Rating as an instrument. All regressions include socioeconomic and behavioral controls. All regressions include Language X Month fixed effects. Online Appendix A2 presents definitions of each variable. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A7. Payment choice, present bias & consumption: Heterogeneity

Panel A. Consumable vs. durable spending

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable	Consumption of Consumables, Restaurants and Leisure			Consumption of Durables and E-Commerce		
Sample	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias	All
Card Intensity	0.34***	0.12	0.13*	0.43*	0.11	0.11
	(0.12)	(0.09)	(0.08)	(0.24)	(0.19)	(0.18)
Predicted Consumption (Log)	0.25***	0.36***	0.32***	0.49***	0.53***	0.52***
	(0.07)	(0.05)	(0.04)	(0.12)	(0.07)	(0.07)
High Present Bias			-0.55			-0.88
			(0.58)			(0.96)
Card Intensity * High Present Bias			0.17			0.27
			(0.16)			(0.25)
Mean of outcome variable	3.21	3.23	3.22	1.72	1.70	1.71
Adj. R2	0.17	0.24	0.23	0.09	0.07	0.08
Kleibergen-Paap rk Wald F statistic	41.48	47.35	48.10	41.48	47.35	48.10
Observations	405	441	846	405	441	846
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	Yes	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV	IV

Note: The table shows results from robustness tests of Specifications (6-8) of Table 4. In columns (1-3), the dependent variable is the log of (Consumption of Consumables, Restaurants and Leisure plus 1). In columns (4-6), the dependent variable is the log of (Consumption of Durables and E-Commerce plus 1). For each consumption category, the first column shows results for High Present Bias, the second column the results for Low Present Bias and the third column for all consumers. All results from IV regressions (2SLS) with Cash Rating as an instrument (and Cash Rating * High Present Bias in columns 3 and 6). All regressions include socioeconomic and behavioral controls. Online Appendix A2 presents definitions of each variable. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A7. Payment choice, present bias & consumption: Heterogeneity (cont.)

Panel B. By age groups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome variable		Consumption			Consumption			Consumption	
Sample		Age 15-34			Age 35-54			Age above 54	
	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias	All
Card Intensity	-0.12	0.22	0.13	0.41***	-0.23	-0.21	0.45**	0.12	0.18
	(0.28)	(0.29)	(0.16)	(0.12)	(0.15)	(0.17)	(0.21)	(0.14)	(0.13)
Predicted Consumption (Log)	0.81***	0.75***	0.82***	0.32**	0.31***	0.33***	0.32***	0.54***	0.44***
	(0.12)	(0.11)	(0.07)	(0.13)	(0.08)	(0.07)	(0.12)	(0.09)	(0.07)
High Present Bias			1.09			-2.26**			-0.72
			(1.02)			(0.94)			(0.73)
Card Intensity * High Present Bias			-0.31			0.63**			0.21
			(0.29)			(0.26)			(0.21)
Mean of outcome variable	3.29	3.46	3.37	4.03	4.04	4.03	4.19	4.22	4.20
Adj. R2	0.55	0.37	0.49	0.07	0.14	0.08	-0.06	0.30	0.17
Kleibergen-Paap rk Wald F statistic	13.33	11.00	12.13	15.37	23.50	11.92	25.43	30.10	17.35
Observations	96	81	177	145	173	318	164	187	351
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV	IV	IV	IV	IV

Note: The table shows results from various robustness tests of Specifications (6-8) of Table 4 for three age groups. For each age group, the first column shows results for High Present Bias, the second column the results for Low Present Bias and the third column for all consumers. All results from IV regressions (2SLS) with Cash Rating as an instrument (and Cash Rating * High Present Bias in columns 3, 6 and 9). All regressions include socioeconomic and behavioral controls. Online Appendix A2 presents definitions of each variable. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A7. Payment choice, present bias & consumption: Heterogeneity (cont.)

Panel C. By income groups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Outcome variable		Consumption			Consumption			Consumption	
Sample		Income -6,000			Income 6-10,000			Income >10,000	
	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias	All
Card Intensity	0.64**	0.19	0.21	-0.06	-0.05	0.01	0.27*	-0.08	-0.07
	(0.28)	(0.12)	(0.14)	(0.17)	(0.10)	(0.09)	(0.15)	(0.17)	(0.17)
Predicted Consumption (Log)	0.49**	0.42***	0.49***	0.50***	0.45***	0.49***	0.25***	0.60***	0.44***
	(0.20)	(0.12)	(0.13)	(0.05)	(0.09)	(0.07)	(0.08)	(0.06)	(0.08)
High Present Bias			-1.28*			0.06			-1.59*
			(0.73)			(0.85)			(0.93)
Card Intensity * High Present Bias			0.34*			-0.02			0.45*
			(0.20)			(0.24)			(0.26)
Mean of outcome variable	3.77	3.81	3.78	3.94	4.01	3.97	4.01	4.11	4.06
Adj. R2	0.14	0.29	0.28	0.46	0.29	0.35	0.36	0.32	0.30
Kleibergen-Paap rk Wald F statistic	13.31	16.33	7.27	14.56	16.03	17.87	19.04	76.13	15.88
Observations	106	90	196	157	163	320	142	188	330
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV	IV	IV	IV	IV

Note: The table shows results from robustness tests of Specifications (6-8) of Table 4 for three income groups. For each income group, the first column shows results for High Present Bias, the second column the results for Low Present Bias and the third column for all consumers. All results from IV regressions (2SLS) with Cash Rating as an instrument (and Cash Rating * High Present Bias in columns 3, 6 and 9). All regressions include socioeconomic and behavioral controls. Online Appendix A2 presents definitions of each variable. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A7. Payment choice, present bias & consumption: Heterogeneity

Panel D. Early vs. late period

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable		Consumption			Consumption	
Sample		Early Period			Late Period	
	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias	All
Card Intensity	0.39**	0.06	0.12	0.24	0.00	0.01
	(0.17)	(0.25)	(0.23)	(0.24)	(0.18)	(0.13)
Predicted Consumption (Log)	0.38***	0.64***	0.48***	0.39***	0.39***	0.43***
	(0.05)	(0.06)	(0.04)	(0.07)	(0.06)	(0.06)
High Present Bias			-0.46			-0.75
			(1.02)			(0.77)
Card Intensity * High Present Bias			0.12			0.23
			(0.28)			(0.21)
Mean of outcome variable	3.86	4.03	3.94	3.96	3.94	3.95
Adj. R2	0.37	0.35	0.39	0.42	0.4	0.39
Kleibergen-Paap rk LM statistic	42.67	13.55	9.96	17.47	32.39	12.52
Observations	167	182	349	145	146	291
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	Yes	Yes	Yes	Yes	Yes	Yes
Method	IV	IV	IV	IV	IV	IV

Note: The table shows results from robustness tests of Specification (6-8) of Table 4 for Consumption in the early and late period. For each period, the first column shows results for High Present Bias, the second column the results for Low Present Bias and the third column for all consumers. All results from IV regressions (2SLS) with Cash Rating as an instrument (and Cash Rating * High Present Bias in columns 3 and 6). All regressions include socioeconomic and behavioral controls. Online Appendix A2 presents definitions of each variable. Clustered standard errors (Region X Month) in parentheses. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A8. Present bias and payment choice - full results

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable	Card Intensity	Card Intensity	Card Intensity	Card Intensity	Card Intensity	Card Intensity
Sample	All	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias
Age 15-24	0.27***	0.39*	0.20	0.22**	0.35	0.13
	(0.07)	(0.22)	(0.19)	(0.10)	(0.24)	(0.16)
Age 25-34	0.14**	0.05	0.21**	0.15	0.06	0.21**
	(0.06)	(0.13)	(0.08)	(0.09)	(0.16)	(0.08)
Age 55+	-0.10	0.02	-0.21*	-0.09	0.06	-0.22**
	(0.08)	(0.09)	(0.12)	(0.07)	(0.10)	(0.10)
Male	0.01	0.02	-0.03	-0.06	-0.03	-0.11
	(0.08)	(0.08)	(0.10)	(0.08)	(0.09)	(0.11)
Edu Low	-0.19	-0.30	-0.16	-0.25*	-0.38*	-0.11
	(0.11)	(0.20)	(0.21)	(0.13)	(0.22)	(0.21)
Edu Middle	-0.15**	-0.22***	-0.10	-0.13	-0.18**	-0.09
	(0.07)	(0.06)	(0.11)	(0.08)	(0.08)	(0.12)
Urban	0.12	0.34***	-0.06	0.09	0.29**	-0.05
	(0.08)	(0.10)	(0.14)	(0.10)	(0.11)	(0.16)
Intermediate	0.04	0.19**	-0.09	0.02	0.15	-0.07
	(0.09)	(0.07)	(0.14)	(0.08)	(0.09)	(0.14)
Household Size 2-4	-0.01	-0.20**	0.15	-0.06	-0.23**	0.09
	(0.03)	(0.09)	(0.10)	(0.04)	(0.09)	(0.09)
Household Size 5+	0.03	-0.3	0.28	0.02	-0.26	0.25
	(0.13)	(0.22)	(0.19)	(0.15)	(0.25)	(0.24)
In edu	-0.46***	-0.34	-0.63***	-0.45**	-0.3	-0.61***
	(0.11)	(0.22)	(0.17)	(0.18)	(0.27)	(0.20)
Unemployed	-0.29*	-0.27	-0.41*	-0.12	-0.01	-0.25
	(0.15)	(0.25)	(0.21)	(0.16)	(0.15)	(0.26)
Retired	-0.13	-0.17	-0.07	-0.11	-0.15	-0.07
	(0.12)	(0.11)	(0.15)	(0.13)	(0.14)	(0.15)
Other Labor Force Status	-0.26*	-0.03	-0.48**	-0.14	-0.04	-0.26
	(0.14)	(0.20)	(0.19)	(0.19)	(0.20)	(0.32)
Cash Rating	-3.46***	-3.03***	-3.77***	-3.56***	-3.15***	-3.89***
	(0.30)	(0.41)	(0.60)	(0.31)	(0.48)	(0.60)
Distance to ATM (log)	0.04	0.05	0.03	0.03	0.01	0.05
	(0.05)	(0.06)	(0.07)	(0.06)	(0.06)	(0.08)
Income	0.00	0.04	-0.03	-0.01	0.04	-0.06
	(0.03)	(0.03)	(0.05)	(0.03)	(0.03)	(0.05)
Conscientiousness	-0.01	0.00	-0.02	-0.02	-0.01	-0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
High Present Bias	0.07			0.06		
	(0.05)			(0.05)		
Discount Rate				-0.05	0.01	-0.12**
				(0.03)	(0.04)	(0.05)
Risk Taking				0.04*	-0.02	0.07
				(0.02)	(0.04)	(0.05)
Memory of Numbers				-0.09**	-0.05	-0.11*
				(0.04)	(0.05)	(0.05)
Financial Literacy Score				0.07*	0.03	0.10
				(0.04)	(0.04)	(0.06)
Trust in Institutions				-0.08*	-0.06	-0.07
				(0.04)	(0.08)	(0.07)
P-value: Cash Rating			0.182			0.187
P-value: Distance to ATM			0.389			0.329
P-value: Income			0.127			0.042
P-value: Conscientiousness			0.210			0.199
Mean of outcome variable	3.50	3.55	3.47	3.52	3.55	3.49
Adj. R2	0.21	0.22	0.21	0.21	0.20	0.24
Observations	997	478	519	878	421	457
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS

Note: The table shows the results of OLS regressions. The dependent variable is Card Intensity. All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (4-6). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. "P-value: Cash Rating" denotes the p-value of a one-sided test whether the coefficient of Cash Rating is the same in column 2 and 3 (or 5 and 6, respectively). Similar for Distance to ATM, Income and Conscientiousness. ***(**)[*] denotes statistical significance at the 1(5)[10]% level.

Appendix A9. Present bias and payment choice - individual perception variables

	(1)	(2)	(3)	(4)	(5)	(6)
Outcome variable	Card Intensity	Card Intensity	Card Intensity	Card Intensity	Card Intensity	Card Intensity
Sample	All	High Present Bias	Low Present Bias	All	High Present Bias	Low Present Bias
Cash Rating - Ease of use	-0.78***	-1.00***	-0.55**	-0.88***	-1.04***	-0.79**
	(0.15)	(0.26)	(0.25)	(0.17)	(0.35)	(0.33)
Cash Rating - Acceptance	-0.12	0.03	-0.21	-0.03	0.10	-0.13
	(0.17)	(0.20)	(0.30)	(0.19)	(0.19)	(0.29)
Cash Rating - Costs	-0.47**	-0.39	-0.48*	-0.47*	-0.36	-0.50*
	(0.21)	(0.36)	(0.28)	(0.24)	(0.39)	(0.27)
Cash Rating - Transaction speed	-0.82***	-0.48*	-1.06***	-0.83***	-0.48	-1.06***
	(0.17)	(0.27)	(0.29)	(0.17)	(0.33)	(0.27)
Cash Rating - Security	-0.50***	-0.54**	-0.45**	-0.51***	-0.55**	-0.45**
	(0.16)	(0.21)	(0.20)	(0.15)	(0.22)	(0.21)
Cash Rating - Hygiene	-0.49***	-0.39**	-0.70***	-0.53***	-0.50**	-0.64***
	(0.13)	(0.16)	(0.17)	(0.13)	(0.20)	(0.18)
Distance to ATM (log)	0.05	0.06	0.04	0.03	0.02	0.05
	(0.05)	(0.06)	(0.07)	(0.06)	(0.07)	(0.08)
Income	0.01	0.04	-0.03	-0.01	0.04	-0.06
	(0.02)	(0.03)	(0.05)	(0.03)	(0.03)	(0.04)
Conscientiousness	-0.01	0.00	-0.02	-0.02	-0.01	-0.04
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
High Present Bias	0.07			0.06		
	(0.05)			(0.05)		
P-value: Distance to ATM			0.360			0.344
P-value: Income			0.117			0.034
P-value: Conscientiousness			0.167			0.165
Mean of outcome variable	3.50	3.55	3.47	3.52	3.55	3.49
Adj. R2	0.21	0.22	0.21	0.22	0.20	0.24
Observations	997	478	519	878	421	457
Socioeconomic controls	Yes	Yes	Yes	Yes	Yes	Yes
Behavioral controls	No	No	No	Yes	Yes	Yes
Transaction structure	No	No	No	No	No	No
Method	OLS	OLS	OLS	OLS	OLS	OLS

Note: The table shows the results of OLS regressions. The dependent variable is Card Intensity. All regressions include socioeconomic controls. Behavioral controls are added in regressions of columns (4-6). All regressions include Language X Month fixed effects. Clustered standard errors (Region X Month) in parentheses. "P-value: Cash Rating" denotes the p-value of a one-sided test whether the coefficient of Cash Rating is the same in column 2 and 3 (or 5 and 6, repectively). Similar for Distance to ATM and Income.
***(**)[*] denotes statistical significance at the 1(5)[10]% level.

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Appendix B:

Cashless Payments and Consumer Spending [1]

This Version: November 2023

Martin Brown Yves Nacht Thomas Nellen Helmut Stix

This Appendix provides the empirical underpinning and derivations of our theoretical model.

Appendix B1: Empirical underpinning

Our model makes two key assumptions regarding payment choice and the money management of consumers.

- First, consumers commit to a specific type of payment instrument for each type of good/purchase that they make. This assumption follows, e.g., Telyukova (2013) in that the same consumer may pay some goods by cash and others by card. However, in contrast to Telyukova (2013) we allow for endogenous choice of payment instrument for different good types rather than assuming that some goods have to be paid by cash.
- Second (and related), we assume that consumers do not change their payment instrument for a specific good within the month, i.e., they do not pay by card for a "cash good" when they run out of cash, or alternatively, they do not pay by cash for a "card good" when they hit a monthly limit on their card expenditures. This assumption stands in contrast to models of dynamic payment method choice and money management (Alvarez and Lippi 2017).

Figure B1.1 provides an empirical underpinning of these two assumptions.

Panel A and Panel B show point estimates from regressions at the level of individual transactions. The dependent variable is Cashless Payment (0/1), which indicates whether a transaction was conducted in cash (=0) or noncash (=1). The explanatory variables comprise a set of transaction-specific variables: the transaction amount (log), dummy variables for the payment locations (type of good/service), the day of the week and an indicator of whether the transaction took place before (Late Period=1) or after the pay day (Late Period=0).

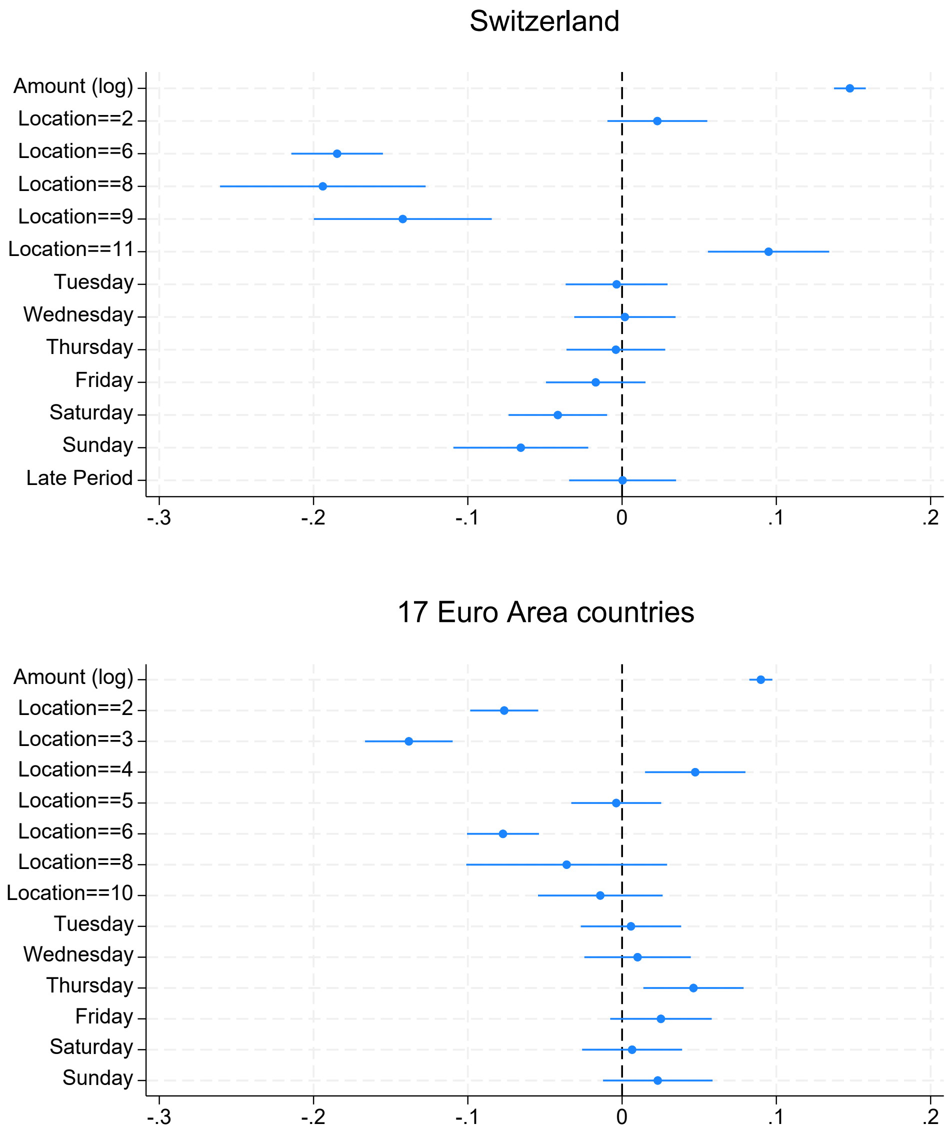
The top panel refers to data from the SNB payment diary used in this paper. The bottom panel refers to payment diary information from 17 euro area countries (European Central Bank 2022).

[1] Martin Brown: Study Center Gerzensee and University of St. Gallen, Email: martin.brown@szgerzensee.ch; Yves Nacht: Swiss National Bank, Email: yves.nacht@snb.ch; Thomas Nellen, Swiss National Bank, Email: thomas.nellen@snb.ch; Helmut Stix: Oesterreichische Nationalbank, Email: helmut.stix@oenb.at. We thank Daniel Grodzicki (discussant), Andreas Fuster, Nicole Hentschel, Florian Hett, Silvio Schumacher, Andy Sturm and an anonymous referee for helpful comments. We also received helpful comments from participants at the Economics of Payments XI conference at the Bank of Canada, the 2023 Swiss Winter Conference on Financial Intermediation, and seminar participants at ESSEC Paris, Goethe University Frankfurt and the Swiss National Bank. The views, opinions, findings, and conclusions or recommendations expressed in this paper are strictly those of the authors. They do not necessarily reflect the views of the Swiss National Bank (SNB), the Oesterreichische Nationalbank and the Eurosystem. The SNB, the OeNB and the Eurosystem take no responsibility for any errors or omissions in, or for the correctness of, the information contained in this paper. Supplementary Material is available at: https://osf.io/epmuv/.

In both panels, we restrict the sample to mixed payers, i.e., persons who state that they use both cash and cards.

In the case of the SNB survey, 87% of survey participants state that they are mixed payers (based on the variable Card Intensity, see Appendix A2). The ECB survey contains only a roughly comparable question on payment preferences in a shop, omitting important spending categories such as services and restaurants; [2] according to this, 22% state that they have no clear preference between cash and cashless payments.

Figure B1.1. The importance of payment characteristics



Note: The figures show point estimates and 95% confidence intervals from a panel regression (Switzerland) and an OLS regression (Euro Area). In each case, the sample is restricted to mixed payers, i.e., payers who use both cash and cards. Note that the payment locations are not harmonized between the

[2] The question is:"If you were offered various payment methods in a shop, what would be your preference?" (Cash/Card or other cashless payment/I have no clear preference between cash and cashless payment).

two datasets. Standard errors are clustered at the person level. The Euro Area survey data are taken from the "Study on the payment attitudes of consumers in the euro area (SPACE)" (European Central Bank 2022).

In both panels, the regression results confirm that the transaction amount and the payment location have the strongest effect on the probability that a transaction is conducted cashless; thus, the payment choice of mixed payers is systematically related to the type of good purchased. Conditional on the type of purchase, we find much weaker variation in payment choice by period of the month or by day of the week.

Technical note: In the case of the Swiss payment diary, persons are observed for 7 consecutive days (SNB 2021). Therefore, we can estimate a panel regression with person-fixed effects, which allows us to control for unobserved heterogeneity across individuals. In the case of the Euro Area, persons are observed for one day only. Therefore, the point estimates are from an OLS regression that contains, in addition to the transaction-specific control variables, a set of basic socioeconomic control variables.

Appendix B2: Consumption distortion due to present bias.

The objective of the consumer is to maximize utility from the current month and future consumption, subject to a resource constraint and intramonth liquidity constraints. From the perspective of the period t=0, t=1, and t=2, the consumer maximizes the following objective function:

$$U_{t=0}(C_1, C_2, L_0, L_1) = \beta u(C_{A,1}, C_{B,1}) + \beta u(C_{A,2}, C_{B,2}) + \beta v(Y - C_1 - C_2) - M(C_1, C_2). \quad [1a]$$

$$U_{t=1}(C_1, C_2, L_0, L_1) = u(C_{A,1}, C_{B,1}) + \beta u(C_{A,2}, C_{B,2}) + \beta v(Y - C_1 - C_2). \quad [1b]$$

$$U_{t=2}(C_1, C_2, L_0, L_1) = u(C_{A,2}, C_{B,2}) + \beta v(Y - C_1 - C_2). \quad [1c]$$

Subject to the intramonth liquidity constraints

$$C_1 = C_{A,1} + C_{B,1} \leq L_1$$

$$C_2 = C_{A,2} + C_{B,2} \leq L_2$$

We assume a strictly concave utility function $u(C_t)$; $u' > 0, u'' < 0$ for intramonth consumption. The value function *v(.)* captures the (discounted) utility of future consumption out of savings, given expectations about future lifetime income. For simplicity, we assume that this value function is linear: $v' > 0, v'' = 0$.

Consider a present-biased consumer, i.e., a consumer for whom$\beta < 1$.

At t=0, the first-order condition for optimal consumption is given by

$$u'(C_{A,1,t=0}) = u'(C_{B,1,t=0}) = u'(C_{A.2,t=0}) = u'(C_{B,2,t=0}) = v'$$

This implies a smooth intramonth consumption path for each good type:

$$C_{A,1,t=0} = C_{A,2,t=0} \equiv C_A^*$$

$$C_{B,1,t=0} = C_{B,2,t=0} \equiv C_B^*$$

At t=1, the first-order condition for optimal consumption is given by

$$u'(C_{A,1,t=1}) = u'(C_{B,1,t=1}) = \beta u'(C_{A.2,t=1}) = \beta u'(C_{B,2,t=1}) = \beta v'$$

This implies:

$$C_{A,1,t=1} > C_{A,2,t=1} \equiv C_A^*$$

$$C_{B,1,t=1} > C_{B,2,t=1} \equiv C_B^*$$

At t=2, the first-order condition for optimal consumption is given by

$$u'\left(C_{A.2,t=2}\right) = u'\left(C_{B,2,t=2}\right) = \beta v'$$

This implies:

$$C_{A,2,t=2} > C_A^*$$

$$C_{B,2,t=2} > C_B^*$$

We define for each good type *i*

$$\Delta C_i \equiv C_{i,1,t=1} - C_i^* = C_{i,2,t=2} - C_i^*$$

We note from above that:

$$u'(C_i^* + \Delta C_i) = \beta u'(C_i^*) = \beta v'$$

and by linear approximation:

$$u'(C_i^* + \Delta C_i) = u'(C_i^*) + u''(C_i^*) \cdot \Delta C_i$$

or:

$$-\frac{(1-\beta)u'(C_i^*)}{u''(C_i^*)} = \Delta C_i$$

Note that the elasticity of intertemporal substitution (EIS) for good *i* is defined as

$$EIS(C_i^*) \equiv -\frac{u'(C_i^*)}{u''(C_i^*)} \cdot \frac{1}{C_i^*}$$

Thus, we have that the relative distortion of consumption for good *i* $\frac{\Delta C_i}{C_i^*}$ depends on the degree of present bias[3] and the elasticity of intertemporal substitution for good *i*.

$$\frac{\Delta C_i}{C_i^*} = (1-\beta) \cdot EIS_i$$

[3] We assume that present bias is a personal trait that applies equally to all goods consumed. See Duckworth and Tsukayama (2015) for a review of the literature on domain-specific impulsivity and self-control.

Appendix B2: Self-control

a) Pure cash payers

As displayed in Figure 2, the consumption path of consumers who are present-biased and pure cash payers will depend on whether they withdraw once or twice from the ATM.

2 ATM withdrawals: $C_1 = C_2 = C^*$

1 ATM withdrawal $C_1 = C^* + \Delta C$; $C_2 = C^* - \Delta C$

Let us define $M(.)$ as the money management costs associated with the payment choice and money management strategy

For a sophisticated present-biased consumer, the ex-ante utility of each of these consumption paths – from the viewpoint of the planning period t=0 – is:

$$U_{ATM=2,t=0} = \beta u(C^*) + \beta u(C^*) + \beta v(Y - 2C^*) - M_{ATM=2}$$

$$U_{ATM=1,t=0} = \beta u(C^* + \Delta C) + \beta u(C^* - \Delta C) + \beta v(Y - 2C^*) - M_{ATM=1}$$

We first approximate the anticipated utility loss due to frontloading or overspending compared to smooth consumption, ignoring money management costs for the moment:

$$U_{ATM=2,t=0} - U_{ATM=1,t=0} = 2\beta u(C^*) - \beta u(C^* + \Delta C) - \beta u(C^* - \Delta C)$$

We note that

$$u'(C^* + \Delta C) = \beta v'$$

$$u'(C^*) = v'$$

We can approximate as follows:

$$u(C^* + \Delta C) = u(C^*) + \Delta C \cdot \beta u'(C^*)$$

$$u(C^* - \Delta C) = u(C^*) - \Delta C \cdot u'(C^*)$$

$$U_{ATM=2,t=0} - U_{ATM=1,t=0} == \beta[2u(C^*) - u(C^* + \Delta C) - u(C^* - \Delta C)]$$

$$= \beta[\Delta C \cdot u'(C^*) - \Delta C\beta \cdot u'(C^*)]$$

$$= \beta[1 - \beta]\Delta C \cdot u'(C^*)$$

$$= \beta[1 - \beta]^2 EIS \cdot C^* \cdot u'(C^*)$$

Consider now the extra cost for a **sophisticated cash-payer** of implementing a smooth consumption path instead of a frontloaded consumption path. This implies withdrawing two times from the ATM rather than once:

$$M_{ATM=2} - M_{ATM=1} = 2s + f\frac{C}{2} - s - fC = s - f\frac{C}{2}$$

A sophisticated cash payer will change her money management strategy to two ATM withdrawals if the additional money management costs are lower than the welfare loss due to frontloaded consumption:

$$\beta[1-\beta]^2 EIS \cdot C^* \cdot u'(C^*) > s - f\frac{C}{2}$$

b) Pure card-payers

The consumption path of consumers who are present biased and pure card payers will depend on whether they withdraw once or twice from the ATM.

With limit on PoS spending: $C_1 = C_2 = C^*$

Without limit on PoS spending $C_1 = C^* + \Delta C\ ;\ C_2 = C^* + \Delta C$

Let us again define $M(.)$ as the money management costs associated with the payment choice and money management strategy

For a sophisticated present-biased consumer, the ex-ante utility of each of these consumption paths – from the viewpoint of the planning period t=0 – is:

$$U_{Limit,t=0} = \beta u(C^*) + \beta u(C^*) + \beta v(Y - 2C^*) - M_{Limit}$$

$$U_{NoLimit,t=0} = \beta u(C^* + \Delta C) + \beta u(C^* + \Delta C) + \beta v(Y - 2C^* - 2\Delta C) - M_{NoLimit}$$

We first approximate the anticipated utility loss due to frontloading or overspending compared to smooth consumption, ignoring money management costs for the moment:

$$U_{Limit,t=0} - U_{NoLimit,t=0} = 2\beta u(C^*) + \beta v(Y - 2C^*) - 2\beta u(C^* + \Delta C) - \beta v(Y - 2C^* - 2\Delta C)$$

We note that

$$u'(C^* + \Delta C) = \beta v'$$

$$u'(C^*) = v'$$

We can approximate as follows:

$$u(C^* + \Delta C) = u(C^*) + \Delta C \cdot \beta u'(C^*)$$

$$U_{Limit,t=0} - U_{NoLimit,t=0} = 2\beta u(C^*) + \beta v(Y - 2C^*) - 2\beta u(C^* + \Delta C) - \beta v(Y - 2C^* - 2\Delta C)$$

$$=2\beta u(C^*) - 2\beta u(C^* + \Delta C) + \beta v' 2\Delta C$$

$$=\beta[v' 2\Delta C - 2\Delta C \cdot \beta(C^*)]$$

$$= 2\,\beta[1-\beta]^2 EIS \cdot C^* \cdot u'(C^*)$$

Consider now the extra cost for a **sophisticated card payer** of implementing a smooth consumption path instead of overspending. The extra cost equals the effort costs of imposing a limit on monthly PoS payments.

$$M_{Limit} - M_{NoLimit} = e$$

A sophisticated card payer will impose spending limits on her debit card if the related additional money management costs are lower than the welfare loss due to frontloaded consumption:

$$2\,\beta[1-\beta]^2 EIS \cdot C^* \cdot u'(C^*) > e$$

c) Mixed-payers

Consider a consumer who is present biased and is committed to paying good C_A by cash and good C_B by card. For self-control of her consumption of the cash good C_A, the consumer will follow the considerations discussed for a pure cash payer above. For self-control of her consumption of the card good C_B, the consumer will follow the considerations discussed for a pure card payer above.

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