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Measuring Time Inconsistency Using Financial Transaction

Data^{*1}

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I. Introduction

In recent years, scholars increasingly analyze the structure and consequences of financial decision-making of individual households (see e.g. Campbell (2006) and Lusardi and Mitchell (2014)). This is with good reason: How individuals spend their income, when and why they use different types of credit as well as how much they save and invest are key questions to understand why households differ in their financial prosperity. In particular, it appears of primary importance to assess the underlying mechanisms through which bad financial decision-making leads to worse financial outcomes.

From a theoretical point of view, a key candidate inducing mistakes in financial decision-making are so called *present-biased preferences*, which are one of the cornerstones of behavioral economics (see DellaVigna (2009) for a review). An important consequence of present-biased preferences is that they induce time-inconsistent behavior in intertemporal decision problems by biasing choices towards present rewards. Put differently, a present-biased individual is more likely to make choices that trigger immediate benefits and delayed costs.² Hence, such households should behave systematically different when it comes to consumption and saving decisions, as they should be more prone to spending too much and saving too little.

This theoretical insight raises the question about the prevalence and severity of present-biased behavior in actual financial decision-making, and the extent to which it can in fact explain differences

* SAFE policy papers represent the authors' personal opinions and do not necessarily reflect the views of the Research Center SAFE or its staff.

¹ We thank our project partner for providing the data in fully anonymized form as well as operational support in data handling and the empirical analysis as well as for many fruitful discussions on the project.

² Importantly, present-bias is not equivalent to impatience, which simply refers to strong intertemporal discounting. The key difference is that present-bias puts an additional weight on immediate rewards compared to rewards at any point in the future, while impatience implies that rewards matter the lesser the farther away in the future they materialize.

in households' financial health. However, analyzing whether financial decision-making is really driven by present bias has traditionally been impeded by the lack of appropriate data: To credibly assess whether households indeed consume, save, and invest in a present-biased way requires detailed information on the exact timing and the nature of spending as well as the current financial condition in which spending takes place.

Fortunately, technological developments in recent years have accelerated the availability of such data in fully digitized form. In the following we show how such data allows precisely categorizing individual financial decision-making to be present-biased or not by developing diagnostic tools exploiting financial transaction data. Doing so, we strongly build on existing work by Kuchler and Pagel (2017).

II. Methodology

1. Setting and data

Our partner in providing the data is a German FinTech with more than 200,000 registered clients. A key service of the firm is providing adequate credit scores to their clients. To do so they retrieve bank transaction data of their clients' bank accounts. The firm further offers support in managing their personal finances by sorting income and expenditures along different dimensions, e.g. restaurant visits, rent, shopping, and the like.

If a potential client registers and agrees to make her bank transaction data available, this triggers the following process: During registration users must enter personal data (age, marital status etc.) and need to identify themselves appropriately, for instance by validation of their personal ID. Once the registration process is complete the firm requests account transaction data and pre-checks the credit worthiness of the client. The respective client's bank delivers the transaction data once the client approves the transmission. As soon as the firm gathered all customer data, transactions are classified, both in terms of income sources (salary, pension, unemployment benefits, etc.) as well as expenditure types (rent, grocery, restaurants, debt payments, etc.). The firm then provides the client with an overview of her financial situation and regularly proposes financial products to help the client to improve her creditworthiness, e.g. loans with favorable terms.

In our analysis we focus on a sample of 3662 users for which individual transaction data is available in fully anonymized form for 337 days on average. Overall, these users generate 1.77 million transactions in our observation period. The average aggregate income (net of taxes etc.) over the respective sample period is approx. 22,000 € per household.

2. Assess the prevalence of present-bias in financial decision-making

The data provided by our partner firm is well-suited to evaluate a household's degree of present-bias as revealed by its financial decision-making. Present-bias induces uneven spending patterns by systematically shifting consumption upfront: The immediate reward of consuming now is weighted systematically stronger than the reward of consuming at any future point in time. Thus, present-biased financial decision-making corresponds to excessive shares of consumption spending in direct response to the reception of income. Hence, how much immediate consumption reacts to income serves as an appropriate measure of present-bias (see Kuchler and Pagel (2017)).

To measure specific expenditure patterns, we first define individual spending periods by identifying regularly arriving payments (*payment cycles*). Within each of these cycles, we estimate how sensitive expenditures in specific spending categories reflecting immediate consumption³ are to incoming payments. In turn, these individual-specific *paycheck sensitivities* provide the basis upon which we classify households: The more they systematically overspend on immediate consumption when receiving income the higher their degree of present-bias.

3. Evaluating the economic costs of present-bias in financial decision-making

In economic terminology, present-bias represents a specific form of irrationality as it implies time-inconsistency of choices. But does this irrational behavior actually even harm individuals? We investigate the link between present-biased behavior and financial outcomes reflecting actual economic costs. To measure such costs potentially driven by present-biased financial behavior, we make use of overdrafts. As present-biased consumption profiles make individuals more vulnerable to running into liquidity problems, we conjecture that an increase in the frequency, length, and level of overdrafts is a likely consequence.

III. Results

Our results consist of two parts: First, we want to see how strong the prevalence of present-bias in households' actual financial behavior really is. Therefore, we look at the distribution of our empirical measure of present-bias, namely paycheck sensitivities as explained above. Second, we then assess the relevance of present-biased financial decision-making by analyzing the correlation of individual paycheck sensitivities and a series of measures capturing the use of overdrafts, which represents a particularly expensive and arguably suboptimal way of short-term borrowing.

³ We use the categories *shopping, restaurants, and entertainment*.

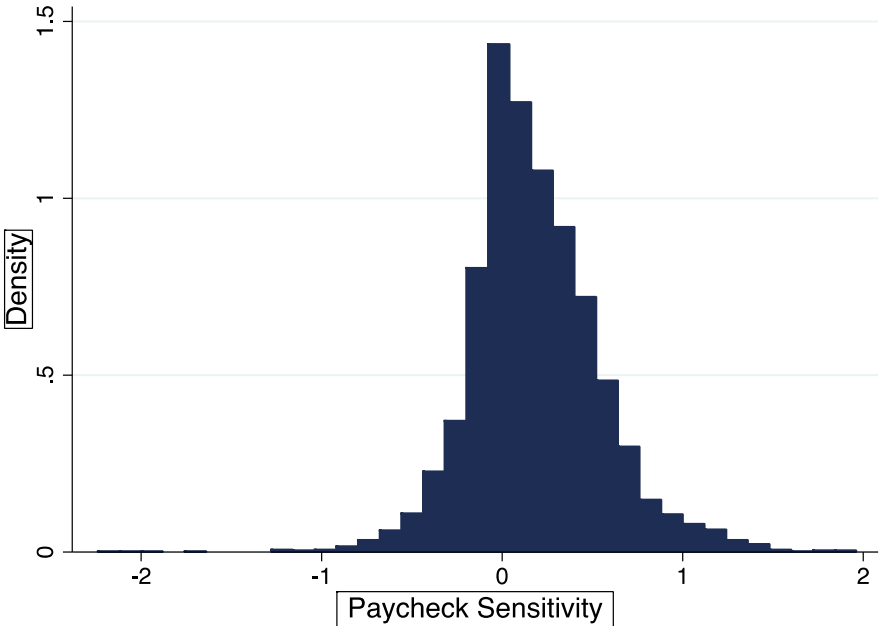
1. The extent of present-bias revealed by individual financial transaction data

Figure 1 depicts the distribution of households’ individual paycheck sensitivities. The qualitative interpretation of this metric is as follows: A value of 0 implies that a household’s spending on immediate consumption goods is not systematically different in weeks immediately after receiving a paycheck as compared to other weeks. This means that the household’s immediate consumption spending is quite smoothly distributed over its payment cycle. In contrast, positive values imply that households spend systematically more on immediate consumption in weeks after receiving paychecks than in other weeks. Accordingly, negative values imply the opposite.

To further assess the strength of these effects, one can interpret the numerical value of the paycheck sensitivity as the difference in units of 100 percent by which immediate consumption in weeks after receiving a paycheck exceeds such spending in other weeks. A value of 1 then implies that immediate consumption spending is 100% higher in weeks after receiving a paycheck than in other weeks.

Figure 1 clearly shows that a substantial fraction of households in our sample are present-biased as they display a significantly positive paycheck sensitivity: For 20% of the 3662 households we consider in the analysis the estimated paycheck sensitivity is significantly larger than 0. However, we also see that the majority of households appear not to be prone to present-bias as their paycheck sensitivity is close to zero which implies equal spending over the payment cycle. To be precise, the individual paycheck sensitivity of 2831 out of 3662 households does not significantly differ from 0, neither positively nor negatively. Overall, the average paycheck sensitivity of all households in our sample is 0.18. This means that the average household spends 18 percent more on immediate consumption in weeks after receiving paychecks than in other weeks.

Figure 1 Paycheck Sensitivity



2. The consequences of present-bias

The substantial extent of present-bias in our sample naturally leads to the question whether this kind of behavior also has real economic consequences for households prone to it. Recent research has shown that people likely to be present-biased procrastinate more (e.g. Madrian and Shea (2001), Kuchler and Pagdel (2017)), accumulate more credit card debt (Meier and Sprenger (2010)), and have worse loan terms (Gathergood and Weber (2015)). In this spirit, we assess whether present-biased individuals in our sample are more likely to commit financial mistakes. As credit cards are not as widely used in Germany and additionally do not require bills to be paid automatically each month, the main source of short-term credit are credit lines in the form of bank account overdrafts. Since banks charge high interest rates on overdrafts, the corresponding costs can be substantial.

Indeed we find that present-biased households, i.e. households whose immediate consumption spending is more paycheck sensitive, also use overdrafts more often, for a longer time (conditional on being in overdraft), and with higher amounts: An increase in the paycheck sensitivity by one percent is associated with a 0.47 percent increase in the number of days in which the household's account is in overdraft, an increase of the number of periods in which accounts are in overdraft by 0.22 percent and an increase of the length of such overdraft periods by 0.14 percent.

3. Discussion

Building on the collaboration with a German FinTech our project exploits a unique data set featuring individual financial transaction data. This allows verifying whether apparently suboptimal financial decision-making like the use of overdrafts can actually be traced back to underlying biases in general intertemporal preferences, namely present-bias, as revealed by individual consumption expenditure patterns. Our results can thus serve as an empirical basis for assessing the necessity and effectiveness of (different forms of) financial education: If suboptimal financial decision-making can indeed be explained by present-bias, this makes a strong case for potential interventions to overcome these biases and might guide their concrete design. For example, interventions targeting financial illiteracy are rather unlikely to reduce mistakes in financial decision-making stemming from present bias. In turn, different forms of commitment devices and tools and services providing incentives to increase savings appear more promising (Thaler and Benartzi (2004)).

From a firm perspective, the availability of high-quality data as accruing in the context of digital FinTech services allows identifying and classifying individual behavioral types much more precisely. Based on such classifications, firms can design and automatically offer individualized products explicitly targeting the particular needs and preferences of individual clients. The case of present biased financial decision-making serves as an intriguing example where specifically tailored services could create mutual benefits for clients and firms alike. In this regard, our study investigates the potential of combining

(behavioral) economic theory with *Big Data* to gain new insights into the consistency and robustness of individual heterogeneity and thereby the potential for customization in digital financial services.

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