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SAFE Working Paper No. 273

Leibniz Institute for Financial Research SAFE
Sustainable Architecture for Finance in Europe

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Cultivating Self-Control in FinTech: Evidence from a Field Experiment on Online Consumer Borrowing*

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First version: October 2019
Current version: May 2020

Abstract:

We report the results of a longitudinal intervention with students across five universities in China designed to reduce online consumer debt. Our research design allocates individuals to either a financial literacy treatment, a self-control training program, or a zero-touch control group. The self-control training program features detailed tracking of spending and borrowing, budgeting, and introspection about consumption choices. These sessions reduce future online borrowing and delinquency charges, mainly driven by a reduction in entertainment-related spending and borrowing. In contrast, financial literacy interventions improve test scores but only marginally affect borrowing. Our results suggest that cultivating self-regulation and budgeting skills can largely improve borrowing behavior on e-commerce platforms.

JEL Classifications: G51, G53, D14, D18, G23, G21

Keywords: Self-control, Online borrowing, Consumer credit, FinTech, Financial literacy

* We thank Galina Andreeva, Christine Laudenbach, Benjamin Loos, Yuri Pettinicchi, Jialan Wang and participants at the Third Fintech and Internet Finance Forum, Goethe University Frankfurt, University of Technology Sydney, and WU Vienna for helpful comments and suggestions. Hanspal thanks the Joachim Herz Stiftung for generous support. This project is supported by the Major Philosophy and Social Sciences Research Program of Hubei Province Higher Education Committee (Grant No.:19ZD016).

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1. Introduction

Advances in technology have transformed the way individuals access credit and make purchases. China presents an illustrative example, where only a decade ago deferred payments, installment loans, and personal credit cards were rare or used sparingly. Today consumer credit is commonplace and increasing. Outstanding consumer loans grew by 40% from 2017 to 2018 and online lending is one of the most rapidly growing segments (Hancock and Xueqiao, 2018).[1]

Consumer credit on e-commerce platforms in China has grown rapidly not only because of its ease and convenience, but also because the segment of the population that it often targets has a limited credit history, making other sources of credit difficult to obtain (Xie, 2019).[2] As opposed to traditional sources of credit which require an established credit score, proof of employment, and regular income, e-commerce platforms such as Alibaba and JD.net (the largest online portals in China) determine loan eligibility and create credit-rating profiles using individuals' purchase history and account data within their own network of sites and products (e.g., Alibaba's online retail site and Alipay, Alibaba's mobile payment app). Instant, online credit is often marketed to university students, who contribute to a large and at-risk group for online borrowing.[3] In China, more than 25% of individuals under the age of 30 have an Ant Check Later (Alibaba) microloan account and nearly half of Huabei's clients are under the age of 30 (Ant Financial, 2019; Xie, 2019).[4] A recent study reported that 53% of college students had used loan services for purchasing products such as Apple laptops and iPhones and spent a large fraction of their income to debt repayment (Rong 360, 2019). Indeed, in our setting, almost 50% of students had recently used online lending and more than 20% stated that these loans were a source of constant stress for them.

A large literature has examined the skills associated with financial literacy (i.e., numeracy, understanding inflation, and risk diversification), and how they translate into savings and borrowing decisions (i.e., stock market participation, retirement planning, and credit card usage).[5] Recent contributions examine how *non-cognitive skills* such as self-efficacy and self-control are linked to financial behavior either in the cross-section or by offering the opportunity for the sophisticated

[1] The speed at which the country has transformed payment and credit norms is unparalleled. As an example consider mobile payments, which in 2018 totaled over $41 trillion - 92% of which occurred over two platforms, Alipay and WeChat, which each boast over a *billion* users (Klein, 2019).

[2] Online credit is often targeted towards young-adults and students who are crowded out of the traditional credit card market. Many suggest that these forms of credit and a completely digital (or mobile) purchasing process is more convenient than traditional credit cards or cash (Hancock and Xueqiao, 2018; Nakamura, 2018).

[3] These young adults are technology-savvy and well accustomed to online purchasing. They represent a large market for retailers, and have been shown to be vulnerable to peer-pressure and conspicuous consumption decisions (O'Cass and McEwen, 2004; Podoshen, Li, and Zhang, 2011; Hao et al., 2019). Adverse decisions which can impact credit scores and indebtedness can manifest well into adulthood and have far reaching consequences.

[4] Estimates suggest that Huabei (meaning "just spend") has nearly 500 million clients (Xie, 2019).

[5] For recent reviews of the literature on financial literacy and education see Lusardi and Mitchell (2014), Fernandes, Lynch, and Netemeyer (2014), Kaiser et al., (2020), and Gomes, Haliassos, and Ramadorai (2020).

to benefit from a commitment device.[6] However, there is limited evidence if these skills can be trained or manipulated and their effect on downstream behavior. Furthermore, we know little about how these skills intersect with financial technology and new forms of credit. Examining these channels in a controlled setting are particularly relevant as new technology increases the speed, saliency, and ease at which (potentially) at-risk borrowers may access capital.

In this paper we report the results of a longitudinal intervention study on self-control with university students in Wuhan, China spanning from November 2016 to February 2019. We examine the uptake of online consumer debt before and after subjects receive substantial financial literacy or financial self-control training. We hypothesize that in an era of FinTech, lack of self-control and budgeting skills are important determinants of online consumption and borrowing behavior. If individuals are misinformed about borrowing, improving financial knowledge with education may affect subsequent field behavior. On the other hand, if online borrowing is driven by factors other than information or basic literacy, budgeting and self-control training may be more suited to improve borrowing outcomes.

Our research design randomizes individuals into either a self-control treatment, a placebo treatment on financial literacy, or a control group. The self-control interventions in our study are motivated from a literature in psychology where (financial) self-regulation has three key components: (1) goal setting; (2) engaging in actions that lead to obtaining one's standard or goal; and (3) monitoring progress toward the goal (Baumeister et al., 1994, Carver and Scheier, 1998). We are motivated by Oaten and Chan (2006, 2006b, 2007), where individuals follow the above protocol to improve health behaviors. Students in the treatment use a personal financial management (PFM) tool for expense tracking and in subsequent sessions discuss in detail budgeting plans, specific transactions, and motivations and feelings about purchases with the instructor in attempt to improve on their personal financial goals. While our education treatments attempt to represent a baseline improvement in key areas of financial literacy,[7] the self-control sessions aimed to increase individuals' self-reflection, budgeting, and spending skills.

Online borrowing is prevalent amongst the students in our sample. Prior to our intervention, 47% of students in our sample report having borrowed online at least once in the last 12 months. The majority of our sample consists of female students (66%), more than half of the

[6] For examples for cross-sectional studies see Meier and Sprenger (2010), Lown (2011), Gathergood (2011), Farrell, Tim, and Risse (2016), Kuhnen and Melzer (2018), Parise and Peijnenburg (2018), and Kuchler and Pagel (2020). For interventions: Ashraf, Karlan, and Yin (2006), Beshears et al., (2015), or Beshears et al., (2018) for a comprehensive review.

[7] The courses on finally literacy are small group sessions where students learn about financial topics such as the time value of money and compounding interest, risk diversification, and importantly, information about consumer lending such as associated fees and interest rates.

students are involved in a business-degree program, and many of them report relatively high levels of financial confidence and awareness. While some of the borrowing is reported to be used for university-related expenses, most respondents admit to using the consumer credit for entertainment-related consumption.

We find that individuals in the control group experience a large increase from pre- to post-intervention periods in their rate of online borrowing. This is likely due to the general increasing trend in online payments, borrowing, and financial technology in China over the time period. In contrast, subjects participating in the self-control treatment reduce borrowing by 14 percentage points compared to the control group, more than twice the size of the effect of the literacy treatment. This is an economically significant effect given a pre-treatment rate of borrowing of 47% and corresponds to an average treatment effect of 29.7%. At the same time, they show no improvement in objective measures of financial literacy. This finding is partially consistent with our main hypothesis and suggests online borrowing may be not driven purely by a lack of financial literacy, and skills such as budgeting and planning, and self-control training may be particularly relevant in reducing online-based consumer debt. Students in the financial literacy intervention improve their financial literacy test scores relative to the control (and self-control) groups, by approximately 0.8 points out of 6, relative to a mean pre-period score of 3.35. However, we do not find a significant effect of the financial literacy treatments on reducing online consumer loan take-up. This in part rules out the potential explanation that borrowing behavior is due to a lack of financial literacy (Agarwal et al, 2008; Ru and Schoar, 2016).

One important question which arises is if the self-control interventions affects all individuals, or if the treatment effects are heterogeneous across the sample. Indeed, we find substantial gender effects: the rate of borrowing pre- to post-treatment decreases by approximately 6 percentage points (p.p.) for women and 7 p.p. for men in the literacy treatment, and by approximately 10 p.p. for women, and 20 p.p. for men in the self-control treatment. The men in our sample are just as responsive to the education intervention as women, but twice as likely to respond to the self-control sessions. Conditional on borrowing pre-intervention, individuals in the control group slightly reduce borrowing in the future. This suggests that the increase in the overall borrowing rate is mainly driven by individuals who borrow for the first time. The effect for the financial literacy treatment is small and marginally significant, while subjects in the self-control treatment, conditional on previous borrowing, decrease future borrowing by more than 20 percentage points. Our interventions therefore affect intensive margin borrowing, rather than preventing individuals from borrowing for the first time. Relative to the control sample, the unconditional effect for individuals in our self-control treatment reduces borrowing by

approximately 150 RMB per month (approximately $260 per year). A significant effect, given that the average monthly online borrowing amount is 570 RMB.

One concern about our design and institutional setting is that treatments may induce students to exaggerate or lie about their borrowing behavior in surveys. Additionally, as there is a relatively long time lag between the intervention and the follow up, students may have simply forgotten the details of their spending. To address these sources of potential imprecision in our outcome variable, we match survey respondents to transaction-level data on online borrowing from the third-party personal financial management (PFM) app that is used alongside of the self-control intervention. This allows us to investigate the effect of the sessions on borrowing, aside from measurement error or bias in self-reported borrowing behavior. With this data, we show a decline in borrowing at both the extensive and intensive margins following the second and third classes for those in the self-control treatment, precisely after the sessions where subjects analyze their previous spending behavior. The decline in borrowing decays slightly over time but in our last time period remains statistically lower than initial borrowing rates. Furthermore, this approach allows us to rule out Hawthorne effects, or that our results are simply driven by subjects responding to being monitored, as we observe a decrease in borrowing in the transaction data after the study period.

It may be fully rational to take high-interest loans for short-periods for smoothing fluctuations in income in order to meet payment deadlines and avoid additional costs, or for emergencies or investments which may lead to higher future income (Morse, 2011; Ru and Schoar, 2016). In our setting, subjects report however, that the majority of borrowing is for entertainment-related expenses such as clothing, dining out, or for electronics. Importantly, we find that this is the expense channel where our interventions have the largest effect. If students are able to perfectly smooth consumption, online borrowing presents a source of liquidity for current consumption. However, our analysis of PFM data shows a large and statistically significant reduction in late-fee payments on delinquent online loans after self-control sessions for subjects who are liquidity constrained and those who provide survey responses indicating high levels of 'stress' associated with online debt. This suggests that subjects indeed incur non-negligible financial and non-pecuniary costs associated with online borrowing. On the other hand, our survey responses suggest that those who are the *least* stressed by their borrowing behavior are those who are most able to reduce borrowing at the extensive margin.

The credit product we study is unique from credit cards and other sources of consumer debt as it is linked purchases made online, offered at point of sale, and targeted directly to consumers based on their purchase history. On the other hand, many of these technology-based differences echo existing credit products and we therefore believe that our results extrapolate

broadly to consumer debt behavior. Our findings generally suggest that self-control is an important underlying mechanism relevant to study in consumer financial decision making. Furthermore, we argue that our results are not only externally valid to other parts of the world, but our self-control treatment is simple to administer and is as cost-effective as our standard literacy interventions.

Our study contributes to a three important strands of literature. First, we add to a large and established literature which analyzes the link between financial literacy and household financial decision making. One aspect of this literature initially focused on financial aptitude or cognitive skills in financial decision making (e.g., Grinblatt, Keloharju, and Linnainmaa, 2011; or see Lusardi and Mitchell, 2014 for a recent review of the literature), while another has examined the link between non-cognitive skills and behavior and financial distress, debt-behavior, and poor financial decision making (Thaler and Shefrin, 1981; Heidhues and Kőszegi, 2010; Kuhnen and Melzer, 2018; Parise and Peijnenburg, 2018). The existing literature examining self-control in financial decisions has almost exclusively focused on present-bias and time inconsistent behavior. Much of this work has focused on providing (partially) sophisticated time-inconsistent agents a) the ability to select into a commitment device (Beshears et al., 2015; Ashraf, Karlan, and Yin, 2006; Ambec and Treich, 2007) b) objective information disclosure (Duflo and Saez, 2003; Bertrand and Morse, 2011), or c) payment reminders (Karlan et al., 2016), with the goal of improving downstream borrowing behavior. A recent innovation to this literature is by Laudenbach, Pirchsel, and Siegel (2019) who examine how personal communication from a loan officer in addition to a standard information disclosure affects default rates. Our study examines a different channel: rather than lenders communicating with borrowers, we study the effect of borrowers' self-introspection on their own behavior.

Our intervention differs from this existing literature in a number of ways. Importantly, we do not offer a commitment device to subjects, with the hypothesis that the take up of such an instrument would affect borrowing. Rather, we study how students' engagement with a curriculum that fosters introspection of personal spending affects downstream behavior. This 'self-control' track is simply an alternative or modification to a pure financial literacy classroom setting. The instructor could be the same (which they are in our experiment), and the in fact, the costs are identical. The PFM app used in our program has the sole function of data collection to mitigate measurement error risk. In our study we need not assume that subjects have time inconsistent preferences, nor do we measure individuals' sophistication about potential lack of self-control. While research and policy often highlight the need to integrate financial literacy into training and curriculum across the general population (Lusardi, 2019; OECD, 2019), our results suggest that self-control and budgeting skills may be an important aspect of such education (Shefrin, 2019).

The literature on financial education at large is generally divided into two streams. The first documents the effect heterogeneity in financial literacy has on downstream financial behavior, i.e., "measured financial literacy" (Fernandes, Lynch, and Netemeyer, 2014). For example Lusardi and Tufano (2015) document low levels of debt literacy, with only about one-third of American adults' understandings the basics of compounding interest. These low levels of debt literacy are linked to costly borrowing habits.[8] The second stream of the literature analyzes the effect of financial education interventions on future behavior, i.e., "manipulated financial literacy" (Fernandes, Lynch, and Netemeyer, 2014). This literature spans countries and regions (Cole, Sampson, and Zia, 2011; Xu and Zia, 2012; Cole, Paulson, and Shastry, 2014; Sayinzoga et al, 2016), age groups (e.g., Carlin and Robinson, 2010; Becchetti, Caiazza, and Coviello, 2013; and Lührmann, Serra-Garcia, and Winter, 2015), the type of educational intervention and what is taught (Clark, Morrill, and Allen, 2012), and the type of downstream behavior which is affected. Agarwal et al., (2019) find that low-credit score mortgage borrowers were not significantly affected by mandatory counseling sessions, while higher-credit score borrowers avoided counselling by taking less risky mortgages. In our controlled setting, subjects' access to treatments are exogenously determined aside from product choice or credit score, and our findings rather indicate that counselling has a significantly higher deterrent effect compared to general financial education. Our findings show that interventions aimed at improving consumers' non-cognitive skills, e.g., self-regulation and budgeting skills by increasing awareness of consumption and borrowing decisions can lead to significant changes in field behavior.

Second, we add to a literature on consumer credit, most specifically on studies on payday lending and credit card debt. These studies range from descriptive to experimental or naturally occurring experiments to identify the causal effect of information on field behavior.[9] Bertrand and Morse (2011) increase the information available to payday borrowers and find large reductions in borrowing. Burke et.al., (2016) provide information on the costs and likelihood of renewing payday loans, and suggest these disclosures can significantly reduce the payday loan demand. Other studies have investigated the impact of income timing (Leary and Wang, 2016) and insurance coverage (Allen et al., 2017) on the use of payday loans. Our contribution to this literature is twofold: we first describe a relatively new and prevalent source of consumer credit, which at least in China is gaining mainstream appeal. The similarities between online consumer credit and payday lending and installment credit are numerous, and therefore understanding the underlying determinants and

[8] Similarly Dick and Jaroszek (2019) find low financial literacy and cognitive reflection skills are linked to high overdraft consumer credit in Germany and a large literature has found a link between financial literacy and better financial outcomes such financial risk taking, portfolio diversification, and stock market participation (Guiso and Jappelli, 2008; Bucher-Koenen and Lusardi, 2011; van Rooij et al., 2011; Lührmann, Serra-Garcia, and Winter, 2015; Von Gaudecker, 2015; and Brugiavini et al., 2018).

[9] See Stegman (2007) for a review on payday lending.

consequences are of great importance. Secondly, we provide empirical evidence on how self-regulation and training budgeting skills can affect individuals' credit demand.

Finally, we contribute to a growing literature in the interaction between individuals and households and financial technology. A focus of this literature has recently been on algorithmic lending and changes in access to, or pricing of credit due to technology (Bartlett et al., 2019; Parlour, Rajan, and Zhu, 2019). Berg et al., (2019) show that the digital footprint left by online consumers provides simple and statistically powerful information in predictive default rates. Similarly Agarwal et al., (2020) extend this finding to mobile data, particularly relevant amongst younger consumers. Others studies examine a link between mobile apps and savings and spending behavior (D'Acunto, Rossi, and Weber, 2019; D'Acunto et al., 2020; Gargano and Rossi, 2020). We contribute to this literature by using a controlled setting to investigate how literacy and self-control may be important contributors to participation in new, technology-based forms of credit and consumption.

Our study proceeds as follows: in the following section we briefly describe the intuitional setting in China. In section three we detail our experimental setting, discussing the base and follow-up survey along with information about our financial literacy and self-control treatments. In section five, we present our main findings along with robustness checks and various other empirical results. We discuss the ramifications of our findings and conclude in the final two sections.

2. Institutional background

Chinese shopping habits have changed rapidly. The balance of online consumer loans has grown fivefold between 2015 and 2017, reaching 350 billion RMB ($54.6 billion) (Nakamara, 2018). This increase in online lending comes as Chinese internet companies, including e-commerce giant Alibaba Group Holdings and JD.com, have begun offering new forms of lending. Part of the growth in consumer credit can be attributed to a wave of regulatory changes which eased existing restrictions on smaller scale lending to consumers and fueled a technology-driven marketplace (Nakamara, 2018).

As noted, these online consumer credit products are underwritten by the retailers themselves and loans are made to borrowers based on the company's internal data and credit scoring models. Because these companies already have their customers' historical shopping data, shoppers do not need to provide more information to complete their purchase. Alibaba has its own smartphone payment service called or Ant Financial (formally Alipay). JD.com works with WeChatPay, a smartphone payment service owned and operated by Tencent Holdings. The vast amount of individual data that these retailers hold over their customer base allows them to extend credit at varying principal amounts and interest rates based on purchase history quickly and at

point-of-sale. Customers choose their method of payment as soon as they select a product, paying in a lump sum or in installments.

Online consumer loans vary across major platforms and lenders and there does not appear to be any definitive standard. For example, Huabei is the credit granting arm of Ant Financial (formally known as Alipay) and grants financing on major e-commerce platforms in China (e.g., Taobao and Tmall, Meituan, Sulin, and others). Financing available ranges from 500 RMB ($70) to 50,000 RMB ($7,000). Huabei offers 0% interest from a minimum 10 days to a maximum 41 days, with a 0.05% daily late fee over the unpaid loan balance, which is the same terms for all borrowers. Fixed repayment plans range from 0.83% interest rate for 3-month terms to 0.73% for 12-month periods. Alibaba's main competitor, Jingdong (also known as JD.com), operates its credit arm under the name of Baitio (or JD Finance). JD Finance offers credit exclusively on JD.com for up to 15,000 RMB ($2,000) and offers 30-day 0% interest. After this period, borrowers face a 0.03% daily late fee over the unpaid loan balance which is the same for all borrowers. As opposed to Ant Financial, fixed repayment plans with similar schedules offer 0.5% to 1.2% monthly interest rates which vary between products and borrowers. A major online cash loan product (known as 'Jiebei') owned by Ant Financial is also offered in the market at varying daily interest rates (0.04% to 0.05%) based on the borrowers' credit rating and standing. Weilidai owned by Tencent offers a flat rate 0.05% to all borrowers. Credit card-based installment credit offered by major banks (Bank of China, China Construction Bank, Bank of Communications, and others) provide fixed terms at similar or slightly higher rates with similar late fees. However, students and young-adults need to provide their guardians' consent, and need to be pre-approved to access this type of credit.

The cost of default of online consumer loans is relatively lower than that of formal bank credit. Institutional lenders, based on credit reporting policy by regulation in China, can be classified into reporting lenders (e.g., financial institutions including banks and financial firms) and non-reporting lenders (e.g., FinTech companies). Only reporting lenders are mandated to report borrower repayments and defaults to the credit registry (the public credit registry) under the central bank—the People's Bank of China. Starting from 2005, Chinese regulators have required financial institutions to report repayment/default information on both business and individual loans to the Credit Reference Center at the People's Bank of China (i.e., the public credit registry). Formal credit reports, comprised of such loan performance information, is shared among all financial institutions on a complimentary basis.

The benefits and harms of credit card debt and access to higher-cost credit has been well researched in developed countries, particularly the United States. Aside from popular news media, there is scant academic literature on the topic as it relates to China. This is in part surprising as the size of the Chinese consumer credit market is very large, and quickly evolving. At the same time,

attitudes about debt accumulation, savings, and consumption, have changed from previous to new generations (Hancock and Xueqiao, 2018). Moreover, as opposed to the US context, indebtedness of youth and university students is not caused by credit card or payday lending, but rather driven by the emergence of FinTech companies who provide online financial credit services.

These new forms of credit may indeed by a convenient advancement in technology for many. However for some they may pose a dangerous threat to financial health. Young adults are in the formative years of their financial lifecycle. Students are going through the process of moving from financial dependence to independence. They may have learned basic skills in cash management at home before coming to university but it is in university where they often make experiences with credit (Xiao et al., 2007). University students can borrow online with ease, but they may know little about how to use credit services effectively. Thus, guidance and support seem to be crucial and motivates our study of how financial education, budgeting, and self-control skills affect the usage of such products.

3. Experimental design

a. Baseline survey (wave one)

We conducted a baseline survey consisting of questions on demographic characteristics, spending and consumption information, debt behavior, and financial literacy before the interventions from September to November in 2016. The sample is composed by 1,972 randomly selected second-year university students living in 650 on-campus student dormitories across 5 universities in Wuhan, China.[10] The 1,972 surveyed students span the main educational majors offered in universities in China. We conducted our survey in students' dormitories because of the novel feature that on-campus dorms are mandatory for all students in universities in China. This allows us to mitigate concerns over confounding spillover effects between treatments and from family and friends. In the universities in Wuhan, one dorm room can accommodate 4 to 6 students. Once a student's room is assigned at the time he/she enrolls in the university, it is difficult, and unlikely that the student is able to change their room for the remainder of their term at the university. This means that students normally stay with same roommates for 4 years. To achieve high response rates, we conducted both the baseline survey and follow-up survey in students' dorms between the hours of 7pm to 10:30pm during the time students are most likely (and sometimes required) to stay in their dorms.[11]

[10] Wuhan is the capital of Hubei province and is one of the most populous cities in central China. The city has the 3rd largest education and scientific base in China and the largest number of undergraduate students. In Wuhan there are 84 higher educational institutions including two of the top 10 Universities in China.

[11] In some universities, checks are carried out to ensure students come back to dorms at night by dorm managers.

We first randomly selected 650 student dormitory rooms across the five universities in Wuhan, China. We selected the five universities based on the feasibility of study implementation and chose universities from various positions in standard academic rankings in order to obtain a cross-section of students.[12] We then interviewed all the residents who were available in the selected dorms. The number of residents in each of the selected dorms is between 4 and 6.

We hired 20 volunteer student interviewers from the five universities to help us collect responses from selected participants. The surveys were conducted in-person by the student volunteers in collaboration with dormitory managers. Dormitory managers are building attendants employed as a third-party consultant to oversee the safety and security of living residences. These managers walked volunteers through living quarters and approached student residences but were not involved during interview sessions. Our volunteers made clear that they were not university staff but independent researchers and data that may or may not be provided by subjects would not be shared with any university officials and the responses would purely be for research purposes. Each interview took approximately 10-15 minutes. A total of 31 dorm rooms did not answer the door. Also there were 19 rooms in which none of the students agreed to participate in our study. We continued to randomly select dorms and interview students in the newly selected dorm until we reached our target of 650 dorms. In total, 1,972 students were interviewed in our baseline survey. The average number of students interviewed in each dorm was 2.76.[13]

b. Selection and treatment interventions

After our initial collection of the baseline sample, we randomly allocated the 1,972 students into three groups: a zero-touch control group, a self-control training group, and a financial education group.

This selection was done in the following process: we randomly selected one student from each of the 650 student dorms into the intervention group. When we selected the treated students, we required the selected students to guarantee their time to participate in the intervention. If the initially selected student could not commit to attending all sessions, we asked another one in the same dorm at random. We do not believe that this requirement had a meaningful effect on our selection, as only a handful of students could not commit in the initial selection process. This process guaranteed that there is one student in the treatment group from each dorm. The treatment group is therefore composed of these 650 students and non-selected 1,322 students comprise the control group. We randomly divided the 650 students in the treatment group equally into two

[12] 241 (13.4%) subjects are from a university in the highest relative ranking; 393 (21.9%) in the second; 508 (28.4%) in the third; 423 (23.6%) in the fourth; and 227 (12.6%) in the fifth, or lowest ranking.
[13] Students were incentivized to participate in the survey with a small gift such as package containing toothpaste, hand towel, and soap costing approximately 4 RMB (~$0.55).

groups. 325 students were assigned to the financial education treatment while the other 325 students were assigned to the self-control treatments.[14]

For all of our intervention sessions, we hired ten second-year master's students from the Department of Finance, Wuhan University of Science and Technology (WUST) as instructors. Each instructor was paid a standard amount for each session they taught regardless of the subject matter. In total, we organized 20 treatment-group cohorts (10 financial literacy groups and 10 self-control groups). We then randomly assigned each instructor one financial literacy group and one self-control group, i.e., each instructor was required to supervise a group from the two different interventions. Once groups were assigned to an instructor, that instructor was required to teach the 3 sessions for each group.

As instructors may put different effort into teaching and may have different teaching skills and styles, we took careful effort to try to reduce any potential confounds to our study. First, before the intervention took place, all ten instructors were trained together by our research team. In order to become an instructor, each applicant had to strictly follow our procedures and had to hold and pass a trial class. In addition, instructors were told that our research team would randomly visit their classes throughout the interventions. In total, we visited 10 sessions and found no areas of concern. Finally, instructors were told at length that students' loan take up is voluntary and individual, and therefore they should not push students to specifically cut their loan take-up, or try to sway their decisions. To belabor this point, our setup explicitly features no incentive for instructors tied to students' outcomes or responses. Therefore it is not surprising that our results are largely unaffected when we control for both universities and instructors, as noted in the subsequent results section.

i. Treatment one: Self-control training

For our study on self-control, we rely heavily on the extant literature in psychology. Initial evidence on the benefits of increasing self-regulatory strength was provided by Muraven, Baumeister, and Tice (1999). Baumeister et al. (2006) also argue that self-control that is analogous to a muscle in that it seems to become tired after exertion and can be improved by regular exercise and practice.[15] Further evidence was provided in a series of investigations by Oaten and Cheng (2006, 2006b, 2007). In one project Oaten and Cheng (2006) enrolled participants in a physical exercise programs for two months. They find that people who performed the exercise routines became more

[14] Students in the treatment groups were incentivized to attend the sessions with a 30 RMB (~$4.25) supermarket giftcard upon completion of each session. These incentives were designed to affect only attendance, rather than initial participation.

[15] Also see Eisenberg et al. (2019) for a recent review and meta-analysis of self-regulation studies in psychology.

successful at reducing their cigarette smoking, alcohol use and impulsive spending. Another investigation by Oaten and Cheng (2007) focused on financial behavior, an area where self-control failures are most troublesome and costly, they posit.

Following the three components of self-regulation, (1) setting standards (or goals); (2) engaging in actions that lead to obtaining one's standard or goal; and (3) monitoring progress toward the goal (Baumeister et al., 1994; Carver and Scheier, 1998), Oaten and Cheng (2007) employ a financial monitoring program to improve participants' financial self-control. In the financial monitoring program participants were instructed to bring personal spending and/or banking records (i.e., check stubs, bank statements, credit card statements, receipts, etc.) from the previous month to provide a baseline measure of personal spending. The experimenter discussed with the participant their financial goals, and a personalized financial monitoring program was then prepared.

We closely follow the financial monitoring program proposed by Oaten and Cheng (2007) and designed a similar self-control training intervention. Our main innovation to the design used in Oaten and Cheng (2007) was to migrate the spending data collection process to the use of an online mobile app, which automatically links students' bank accounts, purchases, income, and credit and borrowing behavior. We document this process in detail below. As in the financial literacy treatments, we randomized the 325 students into sessions with about 33 students each. In total 10 parallel training sessions were organized. Each session lasted 90 minutes. Average attendance in the self-control training sessions was 92%.

The classes followed a similar schedule to our financial literacy classes. Class number one was scheduled for Saturday, March 18th, 2017. During this first class, participants were instructed to install and sign up with a free Personal Financial Management (PFM) mobile app.[16] The app can synchronize students' financial accounts including bank accounts, WeChat Pay account, Alipay account, and students' campus cards.[17] Participants were required to give the app permissions to access all their payment accounts including bank accounts, credit card accounts, Wechat Pay account, Alipay account and students' campus cards so that the app can collect all spending data into one place for the participants. The PFM accurately tracks income and expenses by category much like those used in the recent literature (e.g., Olaffson and Pagel, 2018; Braeuer, Hackethal, and Hanspal, 2019). Categories in the app include utilities, groceries, dining out, cash withdrawals, movies, tuition, books & magazines, electronics & software, gym and fitness, pharmacy, alcohol,

[16] The app used in the treatment is developed by a well-known company (Youdao Inc) listed on the NYSE.

[17] Wechat pay and Alipay are the two most popular third-party mobile payment apps in China. Both Wechat pay and Alipay have become very common in China that paying with cash is rare, even with street performers and taxi drivers. Student campus card can be used as an electronic wallet in the canteen, the supermarket, the school shuttle bus and other personal payment on campus. Students can top up their campus card with their bank account or cash.

travel, shopping, etc. In this first session, our trainers instructed the participants how to use the app. Subjects were then asked to record their spending with the app for the following two months, from March 19th 2017 to May 19th 2017.

Class two took place on Saturday June 10th, 2017. In this session, participants were required to provide their spending tracked by the app from March 19th 2017 to May 19th 2017 along with their total monthly income, totally monthly expenses and total monthly savings or debt for the period. The financial accounting for these two months provided a baseline measure of the participants' personal spending in the third session. Based on the spending records, our trainer asked each participant to detail any non-planned purchases, purchases that costed more than half the subject's monthly income, and spending categories that costed more than budgeted, in last two months. With each of these, subjects were asked to describe how they feel about the purchases ex-post. In addition, counselors helped the participants to set up goals and budgets in each spending category each month for the following four months and required participants to keep tracking their spending for the next period (June 11th, 2017 to October 10th, 2017) with the app. At the end of each month the participants were required to submit their spending records to their counsellor through WeChat and email.

In the final class on Saturday, October 10th, 2017, participants were required to provide their spending tracked by the app since the last session along with income and financial accounting as previously. Participants were asked to compare their true spending to the goals and budgets set in the last session and were again asked about unplanned or unbudgeted purchases, and how they felt about them ex-post. In addition, subjects were asked if they experienced difficulty in complying with the program, and if they felt as they were progressing.

ii. Treatment two: Financial literacy

For each group we held three financial literacy course sessions. We randomized the 325 students into sessions with approximately 33 students in each classroom session. In total 10 parallel training sessions were organized. The students in each session were expected to attend all three of the financial literacy classes over 9 months in 2017. Class number one was scheduled on Saturday March 11th, 2017 and focused on the time value of money and compounding interest. Class two was scheduled on Saturday, June 3rd, 2017 and focused on risk diversification and the trade-offs between risk and returns. Finally, class three was on Saturday, October 28th, 2017 and focused on an introduction to online consumer loans, fees, and interest rates provided by the main lenders in the market. The goal of these sessions was to expose subjects to important, general, concepts in financial literacy as described in the literature (Lusardi and Mitchell, 2014; Lusardi and Tufano, 2015) and improve their knowledge of such topics.

Each training session lasted approximately 90 minutes. In each session, the trainer taught the basic financial topics to students for about 70 minutes, followed by a 20-minute peer discussion. The attendance was marked in every training session by the instructor. Average attendance across the training sessions was 94%. We excluded students from the treatment group if they missed two or more training sessions.

c. Follow-up survey (wave two)

Fifteen months after the interventions, we revisited the students in both the treatment and control groups who participated in the baseline survey. Similar to the baseline survey, our enumerators interviewed the students in their student dorms from 7:30pm to 10:30pm between February 25th, 2019 to April 10th, 2019. In the follow-up survey, we interviewed 1,679 students who participated in the baseline survey, or 94% of the respondents to the baseline survey.

Significant effort was made to decrease attrition.[18] We setup two WeChat groups for the students in the two treatment groups. Our trainer made announcements in the WeChat groups both one week and one day before the session to remind the participants to attend the trainings and submit their assignments. Our trainers also monitored attendance in each training session, if a participant was assigned to take the course but missed a session, the trainer provided a makeup session.

4. Descriptive statistics and cross-sectional determinates of online borrowing

Table 1 presents an overview of the university student subjects in our sample. Approximately 66% of our subjects are female and as noted approximately 47% of all subjects have borrowed online in the past 12 months. We discuss financial literacy test scores in further detail in the subsequent section, but note that our subjects score relatively well, with a median score of 4 of 6 questions. On average, about half of our subjects are business students. In China, women are more likely to study business majors than males, while more male students study science and engineering. Subjects who are not studying business study science, engineering, computer science, medicine, social science (excluding business) and art. Additional survey responses on self-assessed numeric ability and financial behaviors are plotted by gender in Figure 1. In general, we find small and insignificant differences between gender in pre-treatment measures.[19]

[18] The attrition between waves of the survey was very low. Please see Appendix 1 for these tabulations.
[19] Appendix Table 2 presents demographic characteristics by treatment group and provides evidence that the sample is well-balanced.

In Table 2 we begin by examining the cross-sectional determinants of using online borrowing. The dependent variable is an indicator for borrowing online in the previous 12 months. Columns 1-3 sample responses from the first survey in September, 2016, while Columns 4-6 are from the second survey wave in February 2019, Columns 7 pools results from both waves. We note several interesting observations: first, subjects' financial literacy score seems to have little explanatory power in explaining past borrowing decisions; second, while there are less male subjects in our sample, they are more likely to use online borrowing products relative to females. As expected subjects with higher self-assessed monthly expenses are more likely to use online borrowing, and those who state higher levels of confidence in their ability to manage daily finances borrow at lower rates. Surprisingly individuals with higher self-assessed numeracy levels are more likely to borrow, and business students (who also have higher levels of financial literacy) seem to borrow at a lower rate. Hao et al., (2019) similarly examine online consumer credit amongst students in Beijing. Their survey confirms our results that cross-sectional differences amongst education and financial support affect the demand for consumption-based borrowing.

5. Main results

a. The effect of self-control and financial literacy treatments on online borrowing

If individuals are more likely to borrow online because they lack budgeting skills or basic financial literacy skills, our interventions should lead to reduced online borrowing following the two treatments. We first graphically examine this relationship in Figure 2. In Panel A we first note a large increase from pre- to post-intervention periods for the individuals in the hold-out control group. This is likely due to the general increasing trend in online payments, borrowing, and financial technology in China over the time period. The second bar shows, as hypothesized, that financial literacy reduces the growth in online borrowing relative to the control group. That is, these subjects *increase* online borrowing at a slightly *lower* rate compared to the group who received no treatment at all.

The last bar shows that subjects in the self-control treatment on the other hand reduce the rate of online borrowing in the future. We note on the right side graphic that these effect relative to the control group is approximately -15 percentage points. In Panel B we disaggregate this effect by gender and note that it seems to be driven by the men in the sample rather than the females. The rate of borrowing decreases by approximately 6 p.p for women, 7 for men in the literacy treatment, and by approximately 10 for women, and 20 percentage points for men in the self-control treatment.

Table 3 presents this results in a regression framework. Specifically we estimate the following regression:

$$Y_{i,t} = \beta_0 + \beta_1 X_{i,t} + \beta_2 C_j * \varphi_t + \epsilon_{i,j,t,} \quad (1)$$

where $Y_{i,t}$ is an indicator for borrowing online in the last 12 months for subject i, $X_{i,t}$ are a set of time varying and invariant control variables, C_j is the intervention that subject i was allocated to, φ_t captures the post trend for the follow up survey. All regressions control for individual fixed effects and allow for robust standard errors clustered at the individual level.[20] Columns 1-3 relate any treatment experience relative to the control group of subjects, and shows a large, negative, and statistically significant effect on the propensity to borrow online after our interventions. Columns 4-9 disaggregate the effect by financial literacy or self-control treatments. The table states the effect for the financial literacy treatment is only marginally significant (relative to the control or self-control group) while the effect for the self-control is significant at the 1% level.[21] In Appendix Table 4, we jointly estimate both treatments and test for equivalence between financial literacy and self-control on subsequent borrowing. We note that both in OLS and non-linear estimations we largely reject the hypothesis that the treatment effects are equivalent.

Figure 2 and Table 3 suggests that the self-control intervention reduced overall online borrowing, however it may be reasonable to expect that individuals continue to borrow, but at a reduced amount. In Figure 3, we therefore plot the average amount in RMB borrowed online and the average monthly frequency of borrowing by intervention treatment. As noted previously, students in our sample borrow roughly 570 RMB ($83) per month prior to the interventions. As shown in Panel A, the control treatment and the financial literacy intervention have no effect in decreasing the average amount borrowed conditional on borrowing. However, the self-control treatment reduces the amount in RMB substantially. Furthermore, students borrow online rather often, a mean value of 2.75 (3 median) corresponding to bins 1-2 times per month and 3-5 times per month. Again, the self-control treatment is the only intervention that decreases the frequency of borrowing. In Table 4 we present OLS regressions using the mean survey response for the intensive margins of borrowing online while in Appendix Table 5, we present ordered logistic regressions and state the marginal effects for the outcomes associated with our variable of interest, *treat × post*. Both specifications show results consistent with the naïve figures plotting the mean effect.

[20] In unreported regressions we cluster standard errors at varying levels, e.g., treatment cells, which do not have a quantitative affect our results. However, given that the number of groups (11) is small, we present all tables and figures with our preferred individual-level cluster. In general our results are highly robust to alternative choice of clustering.
[21] Appendix Table 3 presents the table with marginal effects after a logistic regression.

As referenced in Section 3, one asset of our experimental design is that treatment intervention instructors were shared across treatment groups, and oversaw both types of financial literacy and self-control sessions. This allows us to measure the within-instructor effect of the courses, and to rule out the concern that the differential effect between interventions is driven by differences in instructor characteristics. In Appendix Table 6 we present OLS and logistic regression results where we jointly estimate treatment and time trends for financial literacy and self-control groups relative to a control group (Columns 1, 2, and 5) and relative to each other (Columns 3, 4, 6, and 7). We include ten instructor fixed effects (11 when relating to a control group with no instructor by design). We note a largely similar trend, the self-control treated subjects decrease borrowing by 14 to 15 percentage points relative to a control, and by 7 to 8 percentage points relative to those in the financial literacy treatment – even when holding constant the class instructor. In Column 7, we additionally control for university fixed effects suggesting that differences across institution are also not driving the variation in our findings.

One important question which arises is which individual are driving the effect? Do the interventions effect all individuals, or is it conditional on their previous experience? In Figure 4 we first plot the mean effect on the rate of online borrowing conditional upon indicating that they borrowed online in the first wave of the survey. We note that conditional on borrowing in the pre-period, individuals in the control group very slightly reduce borrowing in the future. This suggests that the increase in the overall borrowing rate discussed previously is mainly driven by individuals who did not borrow previously. The effect for the financial literacy treatment is small and negative, while subjects in the self-control treatment, conditional on previous borrowing, decrease future borrowing by more than 20 percentage points.

We disaggregate these total effects into who responds to the treatment in Figure 5. Panel A shows that the rate of borrowing amongst individuals sorted into the control group increases significantly (10%) and in the bar with the lightest shade of gray indicates that this is made up of the new entrants. For subjects in the self-control treatment, there is a strong decrease for those who previously borrowed.

In Figure 4 Panel B, we relate these effects to an RMB value. As the survey questionnaire asks participants to choose the bin corresponding to their monthly online borrowing (1 = less than 200, 2 = 200-600, 3=600-1000, and 4 = 1500+), we approximate monthly borrowing by the midpoint of each range. Relative to the control sample, the unconditional effect across the sample amounts to approximately 150 RMB per month decrease in borrowing (approx. $250 per year). A significant effect, given that the average online loan in our setting is approximately 500 RMB, and compared to the effect of less than 50 RMB per month for individuals allocated to the financial literacy group.

b. Online borrowing around self-control treatments: evidence from PFM data

One inherent challenge associated with our baseline and follow-up survey eliciting information about online borrowing behavior is that they are not externally verifiable. A subject may forget about specific borrowing choices or may want to avoid telling the truth about patterns of consumption he or she later regrets. Furthermore, the timing of the follow up survey is well after the third intervention period and does not allow us to investigate the immediate term effects.

To address these two concerns we match subjects from the self-control treatment to their borrowing activity as collected by the third-party personal financial management mobile app. Each subject that participated in the self-control intervention, as part of the protocol, agreed to share their consumption and borrowing data with the researchers. We collect the data in six waves that coincide with two constraints. The first is that the PFM stores historic data for six months at a time, the second constraint is that we are only allowed to monitor PFM data around the preset dates of our interventions.

Our detailed PFM data consists of individuals who gave us additional permission to use it, i.e., those selected for the self-control treatment. Therefore, our analysis of this data is a single-difference estimation. The outcome variable is a measure of borrowing behavior conditional on individual fixed effects, and our variables of interest are different points in time around the different intervention dates (the self-control training sessions). Table 5 presents the results.

The dependent variable in Column 1 is an indicator for borrowing online, in Column 2 it is the average monthly amount borrowed, and in Column 3 it is the average number of times borrowed in a month. For each specification we omit the first treatment time period and denote it as the baseline pre-treatment window. The indicator captures the time span when individuals first began recording their spending data with the PFM, directly at the onset of the first class. In Column 1 for example we note that at the extensive margin the probability of borrowing online decreases marginally in PFM activity following the second course, and then by 6 percentage points following the third and final course. Spending data 5 and 6 are time periods between and during the follow-up survey.

Columns 2 and 3 examine the extensive margin of borrowing. Across columns we note a downward effect in borrowing after the initial courses, and this effect statistically fades over time. These results, and the timing around the interventions are best illustrated graphically. In Figure 6 we plot the marginal effects after the regressions presented in Table 6. Panel A shows the average change in borrowing following the second and third classes at the extensive margin. Panel B and C investigate the change in dollar amount borrowed following the self-control sessions. Panel D and E plot the change in the average number of times borrowed in a month. In Panels B and D

we include all self-control participants while Panels C and E are conditional on borrowing. Across all panels we note a statistically significant and economically meaningful decline in borrowing behavior following the onset of the courses. In general there is a slight uptick in borrowing over time (albeit statistically less than the pre-period) suggesting, unsurprisingly, that our interventions may have more of a short-term compared to a longer time effect. Our results also echo decay effects shown throughout the literature and therefore support the argument that 'just-in-time' financial literacy or counseling, as shown in our effect sizes directly following counselling sessions, may be important for affecting field behavior (Fernandes, Lynch, and Netemeyer, 2014).

At the same time it is unlikely that our main results are driven by Hawthorne effects, or that students are responding to the monitoring effect of the treatment, rather than the treatment itself. One way we can partially rule this out is that we observe the largest decrease in borrowing after the last treatment session when students are no longer expected to discuss their consumption and borrowing patterns in a public forum. Furthermore, the follow up survey is more than one full year later and at this point, students are not aware of the survey itself, its timing, or its content.

6. What drives the effectiveness of self-control treatment on online borrowing?

a. The effect of the interventions on financial knowledge

Having established that the self-control treatment significantly improves online borrowing behaviors, we next test whether the positive outcomes are due to improved financial knowledge of the participants. One of our main hypothesis motivating this study was that improving literacy on general financial topics would be important for affecting the decision to borrow online since we believed that many students did not fully understand the details of the loan products. An important aspect of our study is therefore to investigate how our educational treatment affects subsequent financial literacy scores. First, we show the mean effect of our interventions on financial literacy test scores in Figure 7. The figure plots the average financial literacy score before and after treatment interventions by the randomly assigned groups: a control group, a self-control treatment, and a financial literacy treatment. The dark color bars represent the mean financial literacy score before the intervention in wave one while the light color bars is the average score in wave two.

The figure shows rather clearly that individuals in the financial literacy education treatment show improved financial literacy test scores in the second wave of the questionnaire. Table 6 presents these results in a linear regression framework. The financial literacy score ranges from 0-6.[22] In each column we present indicator variables for receiving a *treatment* and participating in an

[22] The questions and answers to the financial literacy segment of the survey can be found in Appendix 2.

intervention, the wave of the survey (*post*), and the interaction of the two, *treatment* × *post*, is our variable of interest. In Columns 1-3 the treatment variable indicates any treatment, either financial literacy or self-control. We note in Column 1 that a treatment of any type increases participants' financial literacy test scores by approximately 0.4 points (out of total a 6) relative to the control sample. This effect remains approximately the same size when we control for individual fixed effects and control variables to account for changes in expenses, confidences, and numeric ability. This last specification, which we estimate across various outcomes, has the benefit for controlling for important covariates suggested to be correlated with both financial literacy and downstream behavior, and are often omitted from existing studies (Fernandes, Lynch, and Netemeyer, 2014).

In Columns 4-6 and 7-9 we distinguish between the two types of treatments that individuals could have received and relate the effects to the control group. First, in Columns 4-6 the treatment variable indicates the financial literacy treatment. We note that compared to the *treat* × *post* variable in Columns 7-9 the financial literacy treatment has a strong effect on test scores while the self-control individuals actually do slightly worse following the treatment, relative to the control group. For subjects in the financial literacy treatment, the effect is 0.78 points out of 6, and relative to a mean pre-period score of 3.35, a treatment effect of approximately 23%.

Overall, our results reveal that the financial literacy treatment significantly improves participants' financial literacy test scores, while self-control treatment does not. Therefore, the effectiveness of self-control treatment on borrowing behaviors is not due to participants' improved financial knowledge.

b. The effect of the interventions on entertainment-related consumption

Individuals may borrow online not because they lack knowledge on online financial products, but because of consumption choices. In Table 7, we investigate the reasons individuals borrow pre- and after our interventions and examine if our interventions can effect individuals' purchasing behavior.

The dependent variable in Columns 1-3 is an indicator for using online borrowing for entertainment-related expenses such as dining out or purchasing items such as phones, games, and clothing. In Columns 4-6 it indicates using the credit for medical, education-related, or other expenses. Columns 1 and 4 are the full sample, 2 and 5 are conditional on borrowing in the first period, and Columns 3 and 6 are conditional on borrowing for entertainment, or other reasons, in the first period respectively. The variables of interest, *Treated SC* and *Treated FL* indicate the self-control and financial literacy interventions.

We note across columns that individuals in the self-control interventions reduce borrowing related to entertainment considerably, and more so than those in the financial literacy treatment.

We further test for significant differences between the two treated groups. *F*-statistic from a test of differences between Treated SC *x* Post and Treated FL *x* Post and the test's *p*-values are presented at the bottom of the table. We largely reject the coefficients' equivalence. Finally, we note across Columns 4-6 that the effect on other-related borrowing is negative, but of much less economic significance relative to entertainment related consumption. Taken together, we provide evidence that lower rates of online borrowing after our self-control intervention are mainly driven by a reduction in entertainment-related spending.

7. Additional discussion

a. Do the interventions target the right subjects?

If individuals are able to perfectly smooth consumption, conveniently borrowing online may not be a threat to welfare and may not be an area that interventions are best suited for. While the news media has conveyed the harms associated with over consumption and the debt burden from online platforms, it is important that we investigate overall welfare in our setting.

In Table 8 we make use of survey responses to investigate liquidity constraints and self-assessed levels of stress associated with individuals' debt levels. When we investigate the treatment response of financial literacy and self-control interventions by monthly income relative to expenditure, we find a larger effect of self-control training (and financial education) on borrowing among more liquidity constrained students. Specifically we define liquidity constrained subjects as those who respond to a survey question on monthly balances with either 'my expenditure occasionally exceeds expenditure' or 'my expenditure always exceed my income.' Similarly, unconstrained students are defined with the responses of 'most of the time, my income is excess expenditure' or 'I usually break even.' We note that after the self-control treatment subjects reduce borrowing by 16 percentage points if they are liquidity constrained pre-treatment, compared to 11 percentage points for unconstrained subjects. The financial education treatments also decreases future borrowing for liquidity constrained individuals. In Columns 4-6 we relate future borrowing to how 'stressful' subjects assess their previous online borrowing behavior. We note the main reduction in future online borrowing appears to be driven by subjects who are the *least* stressed about borrowing. These results together suggest that individuals who are liquidity constrained are able to reduce borrowing in the future, and these subjects appear to be borrowing at a level that they feel comfortable with, i.e., they have enough flexibility in their debt based consumption that they can potentially act on the self-control trainings.

In Table 9, we further examine the potential harm associated with online borrowing by investigating the fees incurred by delinquency status with online lenders. The dependent variable is an indicator which takes the value of one if a subject accumulated a late fee payment in month *m* around self-control treatments. The sample consists of individuals in the self-control treatment and the underlying data comes directly from the third-party app used in the program. The variable of interest, *After self-control treatments*, takes the value of one in months following the third treatment and conclusion of the self-control program. We note first in Column 2 that liquidity constrained subjects reduce the probability of incurring late-fees by approximately 7 percentage points from pre- to post-treatment periods. Investigating in Columns 4-6 levels of perceived stress caused by online borrowing, we note that the effect is driven exclusively by those who state that they are have high levels of stress associated with their borrowing. These individuals reduce the probability of incurring late charges by almost 30 percentage points. We present the unconditional results from this analysis graphically in Figure 8. In sum, we note that for some of the subjects in the sample online borrowing can indeed cause high levels of stress and can be linked to additional delinquency costs. Our findings suggest that the treatments may be able to help reduce them.

b. External validity and cost-efficiency

An important question arising from our study is if our results are externally valid and if there are attributes about our setting which may cast doubt on replicability. In this section we focus our discussion around two main questions; 1) if subjects and consumers in China may differentially adhere to our interventions, and 2) if financial literacy and self-control interventions could be done at scale.

While online borrowing and consumer credit are important areas of debt financing and household consumption globally, it may be the case that subjects in China react differentially to our treatments with regards to their borrowing and spending behavior. Specifically, it could be that subjects are more likely to conform to authority or would be more swayed by instructors, researchers, or by the use and collection of data. We believe our study has several important aspects which allow us to sidestep such concerns. Firstly, both financial literacy and self-control treatments featured a discussion on online consumer lending products and potential harms caused by over-borrowing. If the effect we find from self-control training is solely driven by subjects conforming to authority, participants in the financial literacy treatment should react similarly to such content, which we do not find evidence of. Secondly, all instructors were volunteers from WUST and their basic contact information was disclosed to participants. In the aforementioned Appendix Table 6, we show that university-level variation does not affect our general results and in unreported results

we note a strong and uniform treatment effect from each university estimated individually, when we compare WUST to all other universities in the sample. If the treatment effect is caused by students' beliefs about authority, the effect from instructors on WUST students would likely be much stronger than that of non-WUST students.

In China, each year governments and universities invest a significant amount of money and effort on financial literacy, especially for young adults and university students. Normally this type of education includes basic financial literacy terms and topics, and a focus on borrowing and debt. However, it is unclear if an alternative approach may be more beneficial. Our study aimed to expand on these traditional programs of financial literacy with a self-control training program. Importantly, at least in our experiment, the cost of running the three financial literacy training sessions were equivalent to running the three self-control training sessions and used the same personnel. Specific and heterogeneous instructor training may prove valuable but in our setting is not required. Furthermore, as mentioned previously, the app used in the self-control training is also not a requirement. While a mobile app is easily scalable (e.g., Gargano and Rossi, 2020) and may be a way to deliver the training in itself, self-reported consumption should also work. We do not believe that data collection with the app had a meaningful effect on our subject's behavior as it was a minor detail of the sessions rather than the focus. Participants who were required to use the app, had previously acknowledged that data would be used for research purposes at onset, and there were no complaints or questions related to the use of data. Additionally, participants did not necessarily expect that their debt behavior following the classes would be the focus of research. Finally, it seems at odds that subjects would behave differentially with the self-control treatment's app given that they are already comfortable with online spending and borrowing with apps that use their data to offer personalized credit.

8. Conclusions

In this study we present the short and medium-term effects of financial literacy and self-control training interventions on young-adults' online borrowing behavior. Online consumer credit is offered by the financial arms of large e-commerce retailers in China and are extended to potential borrowers based on their purchase behavior and histories across products and services offered by the retailer conglomerates. While this business model and product offering is currently unique to the Chinese landscape, it seems likely that elements of it could, and will be used in other regions of the world. The use of customer data or digital footprints for credit scoring already occurs in both the US and in Germany (Bartlet et al, 2019; Berg et al., 2018), and the shift of large technology companies to create non-bank financial products is also a worldwide trend (i.e., cryptocurrencies, Facebook's Libra, etc.).

We find that while financial literacy interventions improve literacy test scores, they have only a marginal effect on changing field behavior related to borrowing on e-commerce platforms. The self-control training, on the other hand, seems to be more strongly linked to improved outcomes with online consumer credit, potentially because the training sessions hone soft-skills focused on budgeting and consumption. Perhaps it is not entirely surprising that our intervention on financial literacy did not result in dramatic improvements in field behavior. Indeed, Fernandes, Lynch, and Netemeyer (2014) find very small effects of financial education on downstream financial behavior in a meta-analysis of more than 200 prior studies. In fact, they find smaller effects when they look at a subset of papers which use the 'gold-standard for causal inference'- randomized control experiments, also consistent with other reviews of the literature in consumer finance (Collins and O'Rourke, 2010). The ideal experiment would have tested a third treatment which combined aspects of both financial literacy and self-control, to see if the two channels can incrementally effect borrowing behavior, however we leave this avenue of research for future work. Indeed, Shefrin (2019) argues that existing financial literacy focuses more on knowledge while self-control, budgets, and heuristics are more focused on action. And knowledge must be combined with action oriented behavior in order to be beneficial in household financial decisions. This also echoes Fernandes, Lynch, and Netemeyer (2014) and others who have touted the 'just-in-time' financial education approach, but of course comes with the challenge often associated with self-improvement, that those who would benefit most, may not chose to do so.

There are several key takeaways from our work which motivate future research, policy, and potential product design as it comes to online consumer credit. The first is that university students and young-adults are users of potentially costly credit, often used for entertainment and conspicuous-consumption, and offered based on purchase patterns directly at point of sale. These products are designed to be easy to use, instantaneous, and likely catered to those with somewhat impulsive spending habits. Individuals who lack financial sophistication or the budgeting skills associated with good financial practices, may become easily indebted. On the bright side, the second key takeaway our study finds is that this may be remediable through individualized - and relative to financial literacy– cost effective training. We find that, to some extent, basic quantitative skills developed by educational training, but most importantly soft-skills such as budgeting can be trained by focusing on goal planning and spending decisions.

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Figure 1: Subjects' financial literacy and financial aptitude prior to treatment

In the following figures we plot subjects' financial literacy from wave one of the questionnaire (top to bottom, left to right) by gender (Panel A), their self-assessed numeracy (Panel B), ability to deal with daily finances (Panel C), and financial literacy by educational major (Panel D), monthly expenses (Panel E), and how often they read the financial news (Panel F).

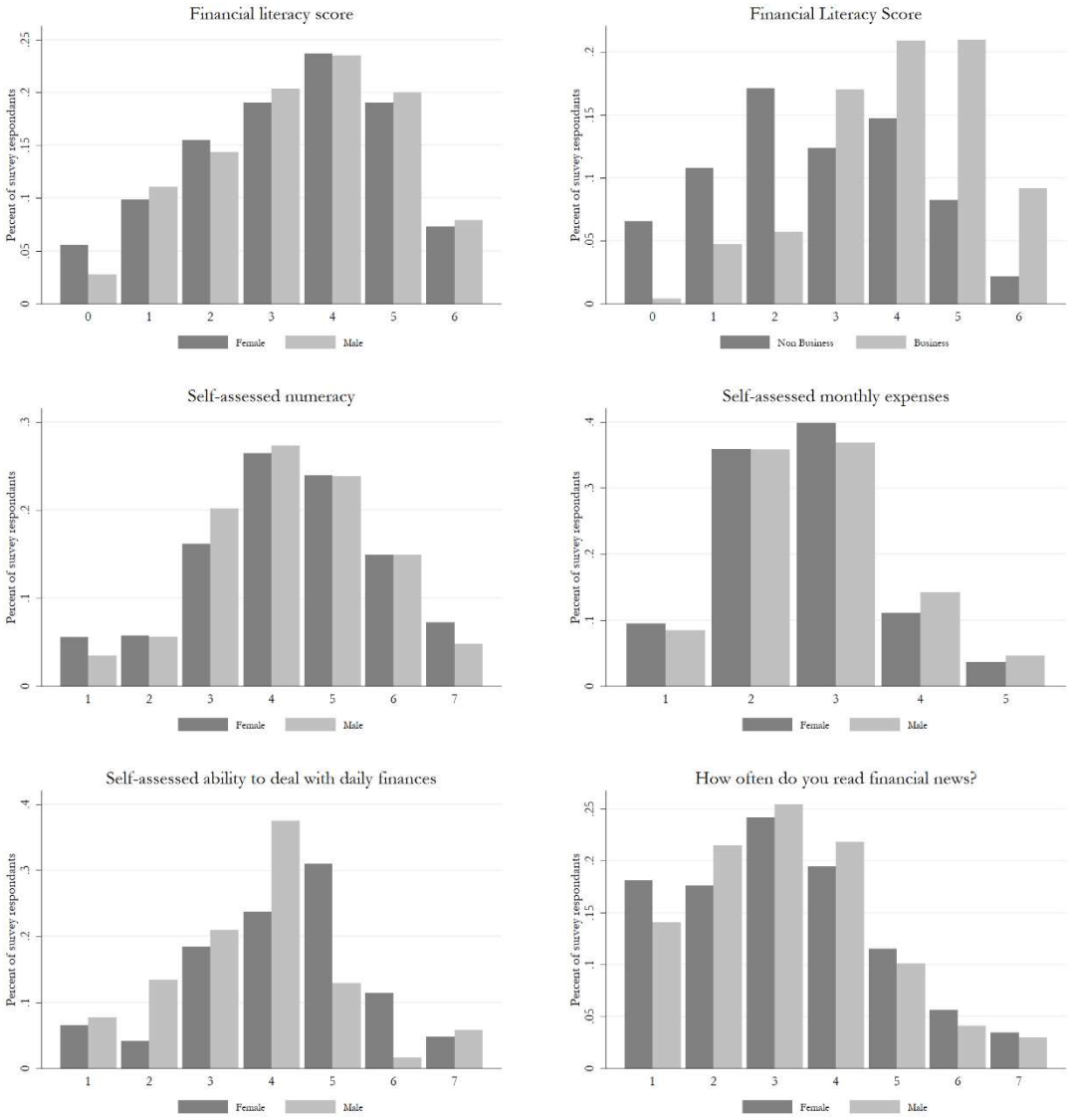
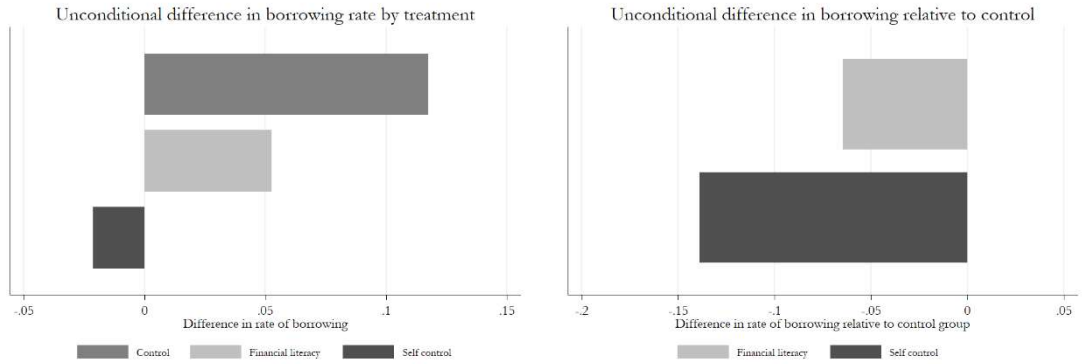


Figure 2: The effect of intervention treatments on online borrowing

The below figures plots the average difference in online borrowing rate from pre- to post- intervention by the three randomly assigned groups: a control group, a financial literacy treatment, and a self-control treatment. In Panel B, we disaggregate the difference from the control group by gender.

Panel A:



Panel B:

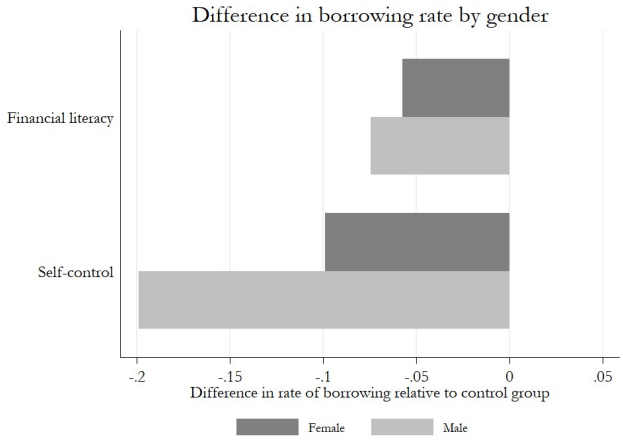
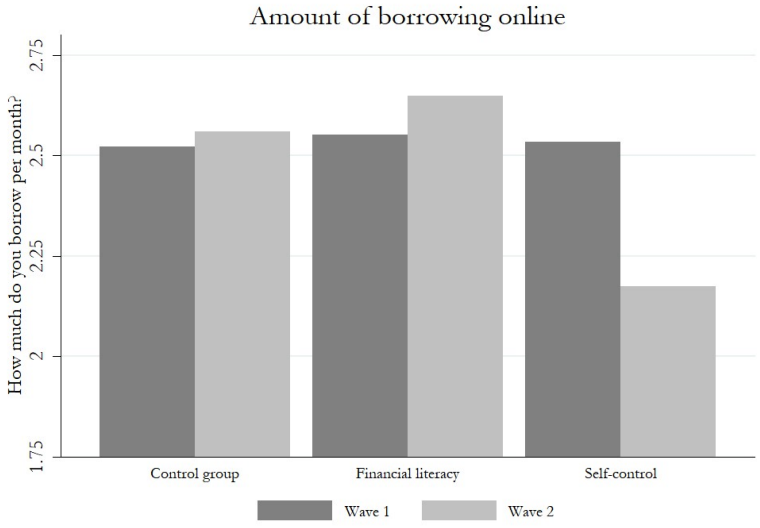


Figure 3: The effect of intervention treatments on the intensive margin of online borrowing

The below figures plots the average amount and frequency of online borrowing in the last 12 months before and after treatment interventions by the three randomly assigned groups: a control group, a financial literacy treatment, and a self-control treatment. The variable that measures the amount of borrowing in Panel A is the response to a survey question about on average how much in RMB per month the subject borrows online (where 1 = less than 200, 2 = 200-600, 3=600-1000, and 4 = 1500+), in Panel B it is the response to a survey question about on average how many times per month the subject borrows online (where 1 = less than 1, 2 = 1-2, 3=3-5, and 4 = 5+). The dark color bars represent the mean financial literacy score before the intervention in wave one while the light score is wave two. Panel B presents the results by gender.

Panel A:



Panel B:

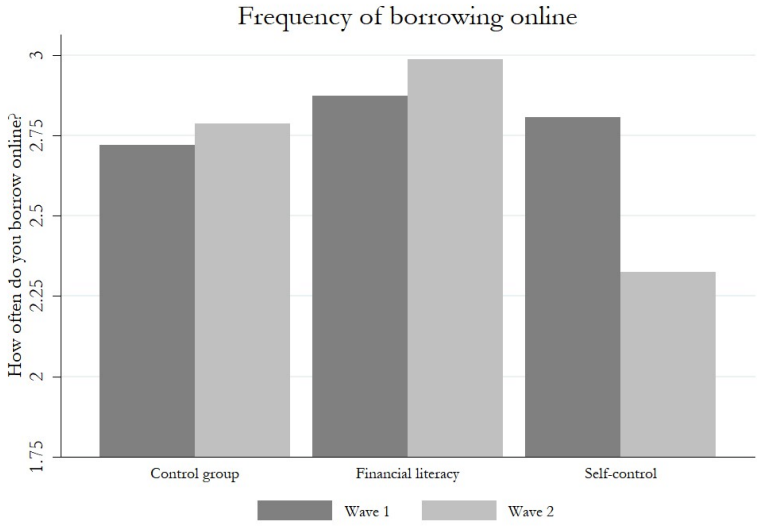
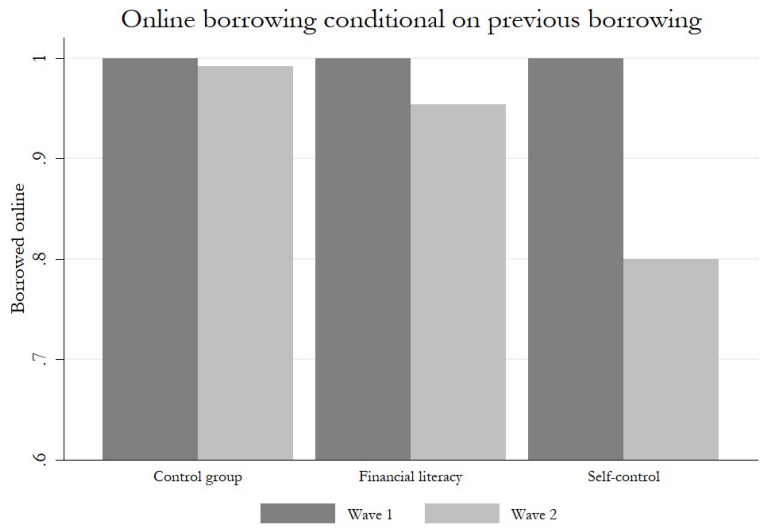


Figure 4: The effect of intervention treatments on online borrowing conditional on pervious borrowing behavior

The figure in Panel A plots the average rate of online borrowing used for discretionary purposes in the last 12 months before and after treatment interventions by the three randomly assigned groups: a control group, a financial literacy treatment, and a self-control treatment conditional on borrowing in the 12 months before the first survey wave. In Panel B, we measure the average monthly difference in RMB borrowed online for the financial literacy and self-control groups relative to the control group, from wave one to wave two. The three colored bars represent the unconditional amount (dark gray), the amount conditional on borrowing in the first wave (mid gray), and the amount conditional on borrowing in both periods (light gray).

Panel A:



Panel B:

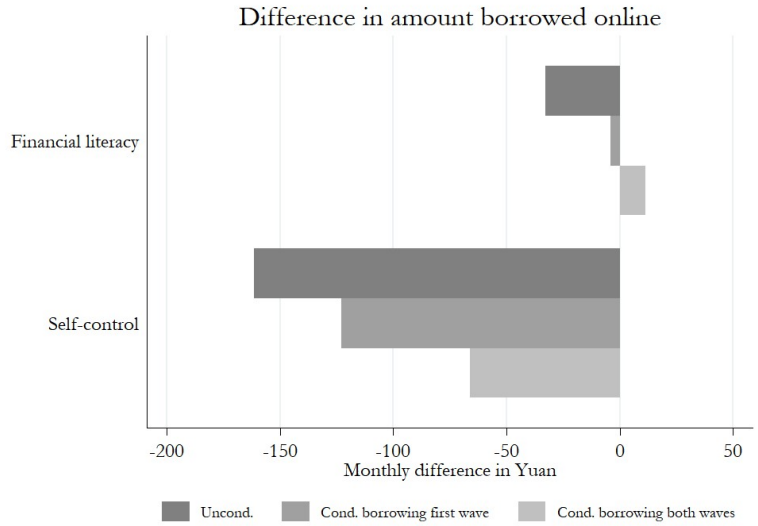


Figure 5: The effect of treatment interventions by borrowing experience

The figure below plots the change in the rate of online borrowing before and after treatment interventions by the three randomly assigned groups: a control group, a financial literacy treatment, and a self-control treatment. We plot the change in the percent of subjects. We present (in dark gray) the total (net) effect, in middle-gray the change conditional on borrowing pre-intervention, and in light gray net-new borrowers, i.e., those that did not borrow pre-intervention.

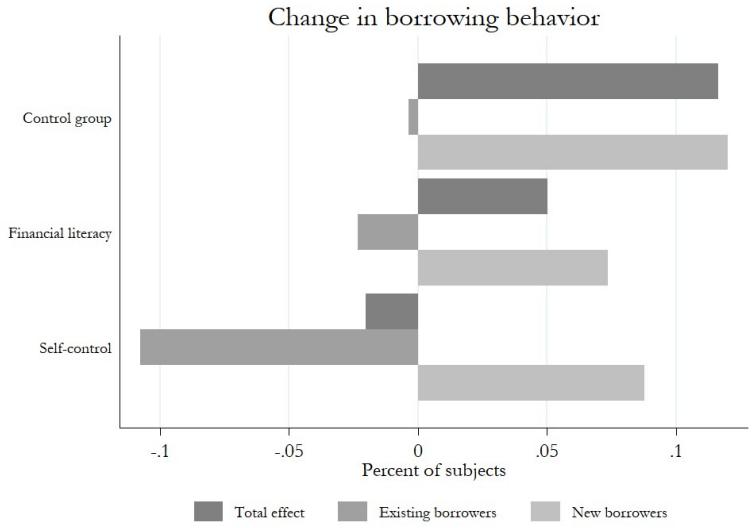
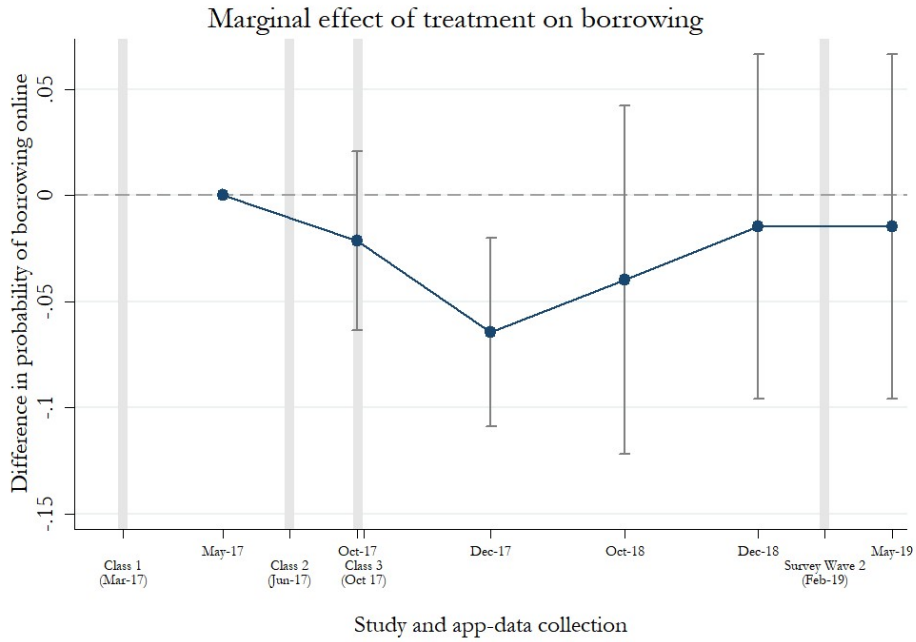


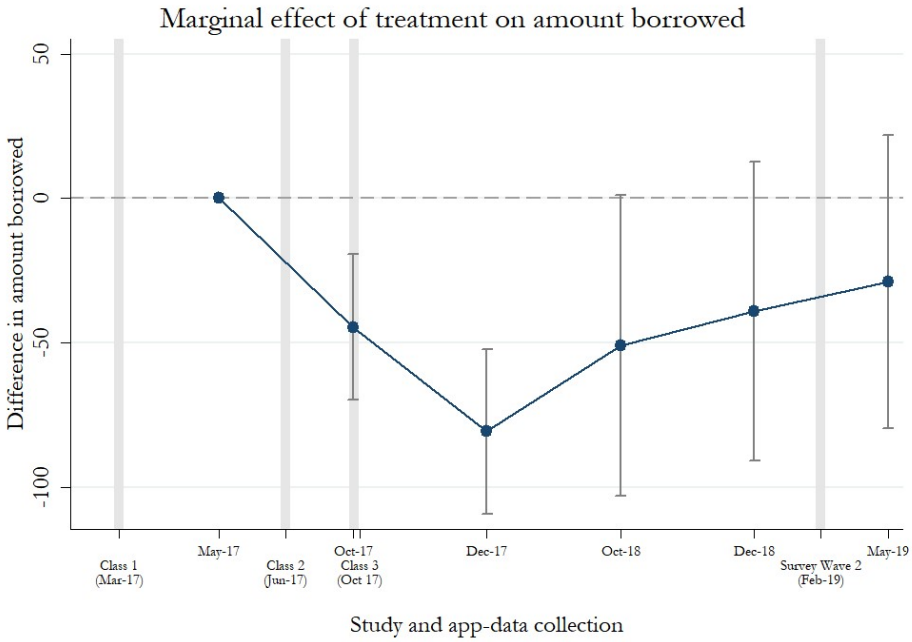
Figure 6: The effect of intervention treatments on online borrowing using third-party mobile app data

The below figures plots the average change in borrowing behavior for subjects in our self-control treatment using third-part PFM data from a mobile app. In Panel A the dependent variable is an indicator for borrowing online, in Panels B and C it is the average monthly amount borrowed, in Panels D and E it is the average number of times borrowed in a month. Panels C and E are conditional on borrowing while Panels B and D are unconditional. The plotted points and 95% confidence intervals are the marginal effects from the specifications in Table 6 with individual fixed effects and robust standard errors clustered at the individual level.

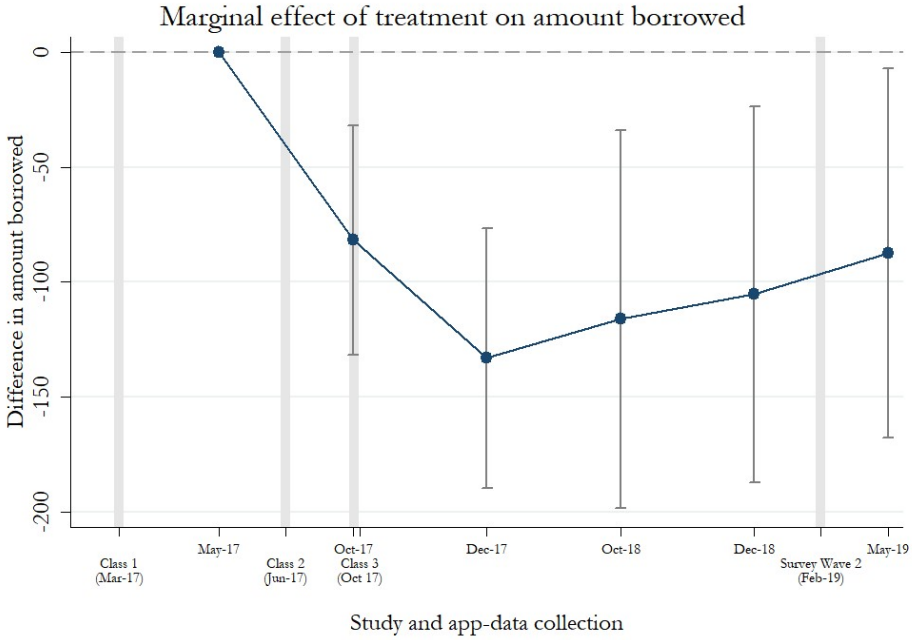
Panel A: Borrowing



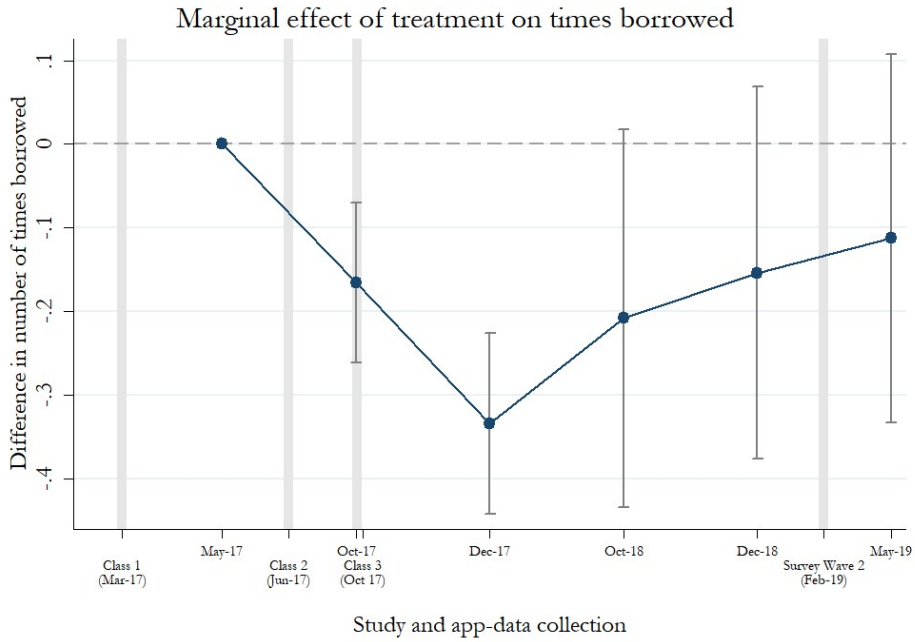
Panel B: Unconditional effect on amount in RMB



Panel C: Conditional on borrowing



Panel D: Unconditional effect on average number of times borrowed



Panel E: Conditional on borrowing

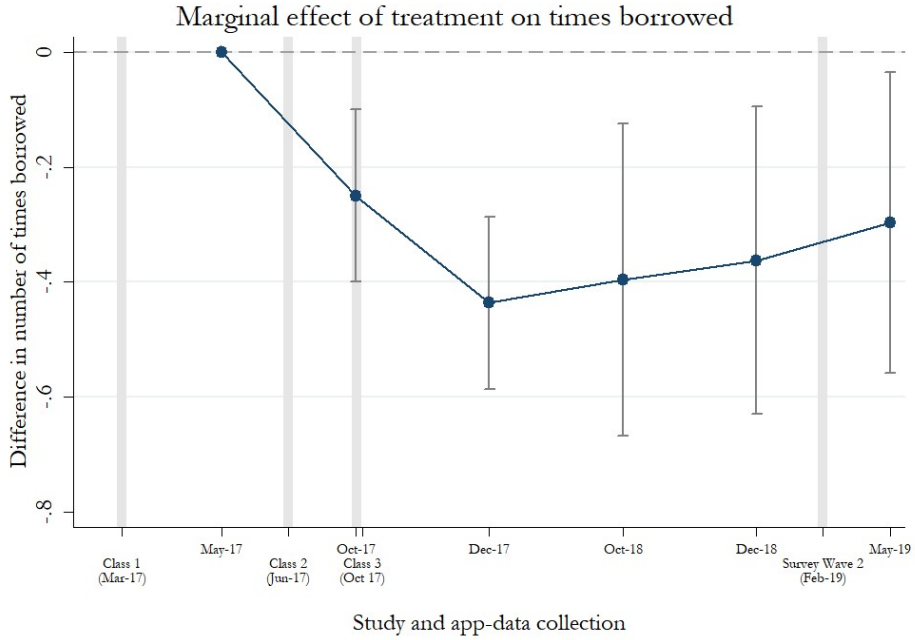


Figure 7: The effect of treatment interventions on financial literacy test scores

The below figure plots the average financial literacy score before and after treatment interventions by the three randomly assigned groups: a control group, a financial literacy treatment, and a self-control treatment. The dark color bars represent the mean financial literacy score before the intervention in wave one while the light score is wave two.

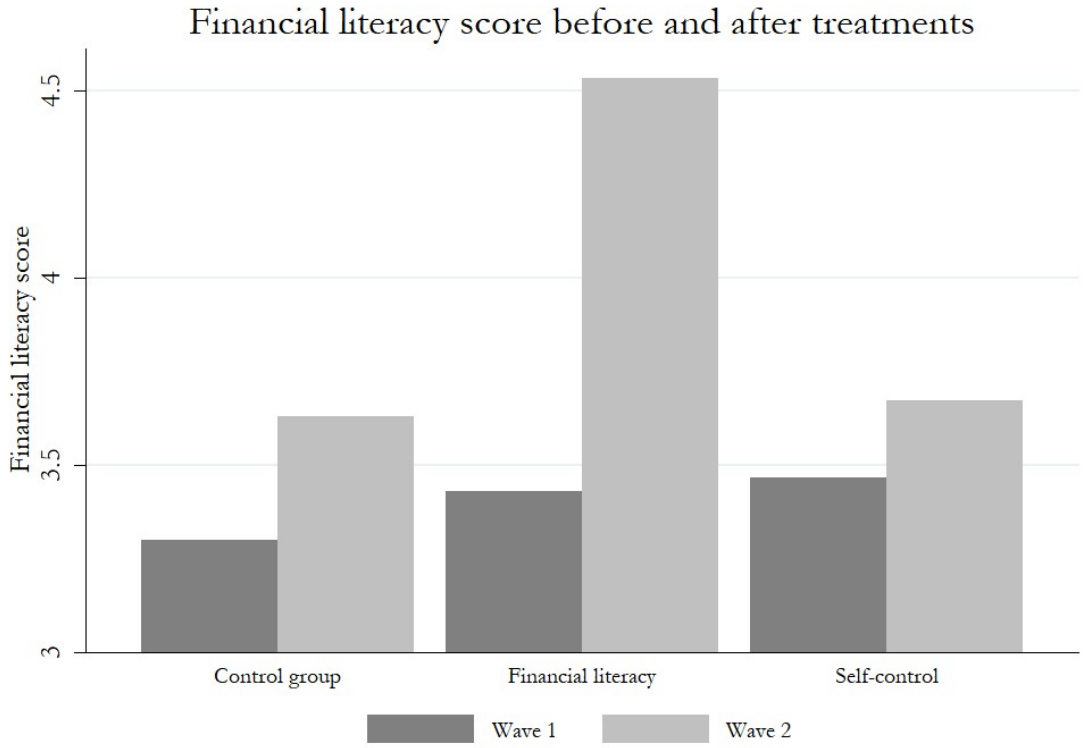
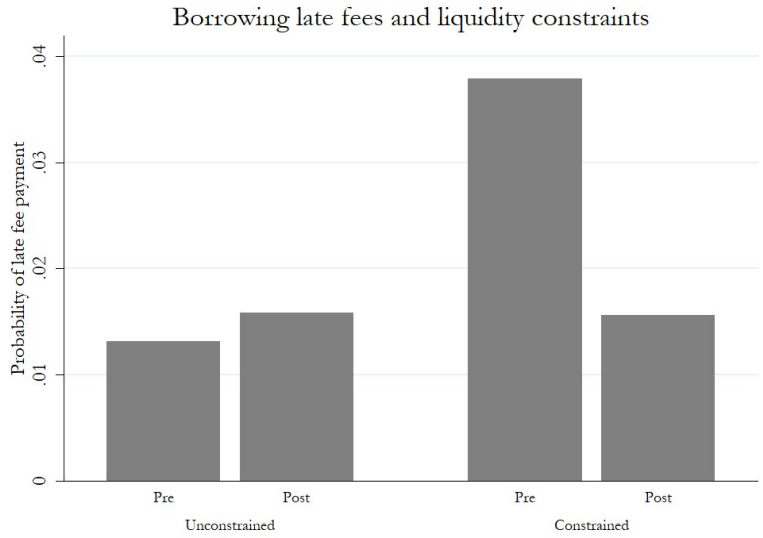


Figure 8: Borrowing late fees, liquidity constraints, and self-perceived stress from debt

The below figures plots the unconditional probability of having a late fee associated with delinquent online borrowing. The sample consists of subjects in the self-control treatment and data is collected using a third-party PFM mobile app. In Panel A we disaggregate the sample into pre- and post- self-control treatment months and by liquidity constrained and unconstrained subjects. In Panel B we disaggregate the sample by pre- and post-treatment and the self-perceived level of stress caused by previous online borrowing.



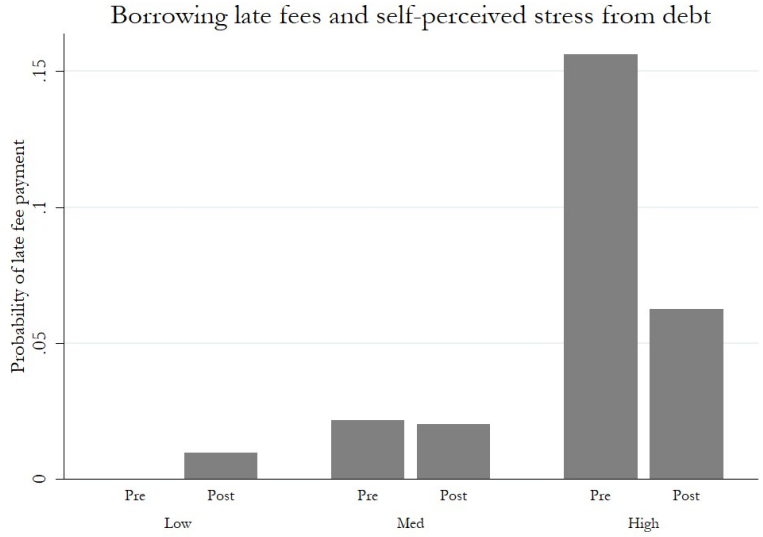


Table 1: Summary statistics

We report descriptive statistics: mean, median, min, and max for all subjects in wave one of the survey questionnaire and subsequent treatment interventions. For each individual, we observe the self-assessed financial and demographic characteristics detailed below from September 2016.

	Mean	Median	Min	Max
	(1)	(2)	(3)	(4)
Male	0.34	0.0	0.0	1.0
Borrowed online in last 12 mo.	0.47	0.0	0.0	1.0
Financial literacy score	3.35	4.0	0.0	6.0
Parents college education	0.14	0.0	0.0	1.0
Monthly expenses	2.66	3.0	1.0	5.0
Business major	0.52	1.0	0.0	1.0
Confidence in daily finances	4.02	4.0	1.0	7.0
Read financial news	3.19	3.0	1.0	7.0
Numeracy	4.29	4.0	1.0	7.0
Financial literacy treatment	0.18	0.0	0.0	1.0
Self-control treatment	0.18	0.0	0.0	1.0
Control treatment	0.64	1.0	0.0	1.0
Observations	1,792			

Table 2: Determinants of past online borrowing

The table below analyzes the determinants of online borrowing. The dependent variable is an indicator for borrowing online in the previous 12 months. Columns 1-3 sample response from the first survey in September, 2016, Columns 4-6 are from survey wave two in February 2019, and Columns 7 pools results from both waves. The variable *financial literacy score* is the score the subject received on a survey based quiz with 6 standard literacy questions. *Monthly expenses* is a survey question where the subject can provide one of five bins for their estimated living expenses per month, *parents college education* indicates if at least one parent has at least a college education, *business major* indicates that the subject studies business at the university. *Confidence in daily finances* and *numeracy* are self-assessed survey questions on how well the subject can manage their daily finances and how good their numeric thinking is. Post takes the value of one if the response is from wave two of the survey. Across select specifications we control for three regions across China where the student is from (East, West, Central), and for student dorm-fixed effects. Robust standard errors clustered at the student-dorm level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Survey wave one			Survey wave two			Pooled
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Financial literacy score	-0.01	0.00	-0.00	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Male	0.29***	0.22***		0.22***	0.18***		
	(0.02)	(0.03)		(0.03)	(0.03)		
Monthly expenses	0.02	0.01	0.03*	0.02*	0.02**	0.03**	0.04***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Parents college education		-0.03	-0.04		-0.04	-0.05	-0.04
		(0.03)	(0.04)		(0.03)	(0.05)	(0.04)
Business major		-0.07***	-0.07*		-0.08***	-0.10**	-0.08***
		(0.02)	(0.04)		(0.02)	(0.04)	(0.03)
Confidence in daily finances		-0.12***	-0.13***		-0.07***	-0.06***	-0.09***
		(0.01)	(0.01)		(0.01)	(0.01)	(0.01)
Numeracy		0.04***	0.04***		0.04***	0.05***	0.05***
		(0.01)	(0.01)		(0.01)	(0.01)	(0.01)
Post							0.08***
							(0.01)
Region fixed effects	No	Yes	Yes	No	Yes	Yes	Yes
Dorm fixed effects	No	No	Yes	No	No	Yes	Yes
R2	0.08	0.23	0.54	0.05	0.11	0.47	0.45
Observations	1,792	1,792	1,792	1,679	1,679	1,679	3,471

Table 3: The effect of treatment interventions on future online borrowing

The table below analyzes the effect of various treatment interventions on subjects' propensity to borrow online before and after participating in the treatment interventions. The dependent variable is an indicator for borrowing online in the previous 12 months. In each column we present indicator variables for receiving a *treatment* and participating in an intervention, the wave of the survey (*post*), and the interaction of the two, *treatment x post* our variable of interest. In Columns 1-3 the treatment variable indicates any treatment, either financial literacy or self-confidence. In Columns 4-6 the treatment variable indicates the financial literacy treatment and Columns 7-9 the treatment variable indicates the self-control treatment. The sample includes data from both survey waves. We first present results without any control variables then add individual-fixed effects and control variables to account for changes in expenses, confidences, and numeric ability. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Any treatment			Financial literacy			Self-control		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated	0.08***			0.04			0.08***		
	(0.02)			(0.03)			(0.03)		
Post	0.12***	0.12***	0.12***	0.09***	0.09***	0.09***	0.10***	0.10***	0.11***
	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)
Treated *x* Post	-0.10***	-0.10***	-0.11***	-0.03	-0.04	-0.05*	-0.12***	-0.12***	-0.11***
	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Financial literacy score			0.00			0.00			-0.00
			(0.01)			(0.01)			(0.01)
Monthly expenses			-0.01			-0.01			-0.01
			(0.02)			(0.02)			(0.02)
Confidence in daily finances			-0.02**			-0.02**			-0.02*
			(0.01)			(0.01)			(0.01)
Numeracy			0.01			0.01			0.00
			(0.01)			(0.01)			(0.01)
Individual fixed effects	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
R2	0.01	0.88	0.88	0.01	0.88	0.88	0.01	0.88	0.88
Observations	3,471	3,471	3,471	3,471	3,471	3,471	3,471	3,471	3,471

Table 4: The effect of treatment interventions on the intensive margin of online borrowing

The table below analyzes the effect of various treatment interventions on subjects' online borrowing before and after participating in the treatment interventions. The dependent variable in Panel A the dependent variable is the response to a survey question about on average how much in RMB per month the subject borrows online (where 1 = less than 200, 2 = 200-600, 3=600-1000, and 4 = 1500+), in Panel B it is the response to a survey question about on average how many times per month the subject borrows online (where 1 = less than 1, 2 = 1-2, 3=3-5, and 4 = 5+). In each column we present indicator variables for receiving a *treatment* and participating in an intervention, the wave of the survey (*post*), and the interaction of the two, *treatment x post* our variable of interest. In Columns 1-3 the treatment variable indicates any treatment, either financial literacy or self-confidence. In Columns 4-6 the treatment variable indicates the financial literacy treatment and Columns 7-9 the treatment variable indicates the self-control treatment. The sample includes data from both survey waves. We first present results without any control variables then add individual-fixed effects and control variables to account for changes in expenses, confidences, and numeric ability. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: How much do you borrow online?

	Any treatment			Financial literacy			Self-control		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated	0.02			0.03			0.01		
	(0.08)			(0.09)			(0.09)		
Post	0.04	0.06	0.03	-0.04	-0.03	-0.06	0.05	0.08	0.05
	(0.04)	(0.07)	(0.07)	(0.04)	(0.06)	(0.06)	(0.04)	(0.05)	(0.06)
Treated *x* Post	-0.16**	-0.15	-0.17*	0.14*	0.18	0.18	-0.41***	-0.44***	-0.43***
	(0.07)	(0.10)	(0.10)	(0.07)	(0.11)	(0.12)	(0.08)	(0.12)	(0.12)
Financial literacy score			0.05			0.04			0.04
			(0.03)			(0.03)			(0.03)
Monthly expenses			0.01			0.01			0.00
			(0.10)			(0.10)			(0.10)
Confidence in daily finances			0.01			0.02			0.02
			(0.03)			(0.03)			(0.03)
Numeracy			0.02			-0.01			-0.00
			(0.04)			(0.04)			(0.03)
Individual fixed effects	No	No	No	No	No	No	No	No	No
R2	0.00	0.86	0.86	0.00	0.86	0.86	0.01	0.87	0.87
Observations	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786

Panel B: How often do you borrow online?

	Any treatment			Financial literacy			Self-control		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated	0.12*			0.13			0.05		
	(0.07)			(0.09)			(0.08)		
Post	0.07	0.10	0.08	-0.05	-0.04	-0.07	0.07**	0.11**	0.09
	(0.04)	(0.07)	(0.08)	(0.04)	(0.06)	(0.07)	(0.04)	(0.05)	(0.06)
Treated *x* Post	-0.23***	-0.29***	-0.32***	0.16**	0.19**	0.20*	-0.55***	-0.68***	-0.68***
	(0.07)	(0.10)	(0.11)	(0.07)	(0.09)	(0.11)	(0.09)	(0.13)	(0.13)
Financial literacy score			0.05*			0.04			0.04
			(0.03)			(0.03)			(0.03)
Monthly expenses			-0.01			-0.01			-0.02
			(0.11)			(0.11)			(0.10)
Confidence in daily finances			0.00			0.02			0.02
			(0.04)			(0.04)			(0.04)
Numeracy			0.03			-0.02			-0.02
			(0.04)			(0.04)			(0.03)
Individual fixed effects	No	No	No	No	No	No	No	No	No
R2	0.00	0.84	0.84	0.01	0.83	0.83	0.02	0.85	0.85
Observations	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786	1,786

Table 5: The effect of treatment interventions on third-party app borrowing data

The table below analyzes the effect of the self-control treatment intervention on subjects' borrowing behavior over time. The dependent variable in Column 1 is an indicator for borrowing online, in Column 2 it is the average monthly amount borrowed, and in Column 3 it is the average number of times borrowed in a month. The sample consists of individuals in the self-control treatment and the underlying data comes directly from the third-party app used in the program. The explanatory variables are indicators taking the value of one for the different time periods that we can access data from the app. The first three time-period variables coincide with the timing of the self-control treatment classes. We present the coefficients a linear regression including individual fixed effects. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Borrowed online	Average amount borrowed	Average number of times borrowed
	(1)	(2)	(3)
Spending data 1: 3/17-5/17	-	-	-
	-	-	-
Spending data 2: 6/17-10/17	-0.02	-44.62***	-0.17***
	(0.02)	(12.85)	(0.05)
Spending data 3: 11/17-12/17	-0.06***	-80.75***	-0.33***
	(0.02)	(14.52)	(0.05)
Spending data 4: 6/18-10/18	-0.04	-50.98*	-0.21*
	(0.04)	(26.51)	(0.12)
Spending data 5: 11/18-12/18	-0.01	-39.10	-0.15
	(0.04)	(26.41)	(0.11)
Spending data 6: 1/19-5/19	-0.01	-28.99	-0.11
	(0.04)	(25.85)	(0.11)
Constant	0.53***	297.02***	1.46***
	(0.02)	(14.24)	(0.06)
Individual fixed effects	Yes	Yes	Yes
R2	0.65	0.73	0.73
Observations	1,698	1,698	1,698

Table 6: The effect of treatment interventions on financial literacy test scores

The table below analyzes the effect of various treatment interventions on subjects' responses to financial literacy questions. The dependent variable is the score individuals received on a financial literacy quiz included in the questionnaire. The score ranges from 0-6. In each column we present indicator variables for receiving a *treatment* and participating in an intervention, the wave of the survey (*post*), and the interaction of the two, *treatment x post* our variable of interest. In Columns 1-3 the treatment variable indicates any treatment, either financial literacy or self-confidence. In Columns 4-6 the treatment variable indicates the financial literacy treatment and includes subjects from the control and financial literacy treatments. In Columns 7-9 the treatment variable indicates the self-control treatment and includes subjects from the control and self-control treatments. The sample includes data from both survey waves. We first present results without any control variables then add individual-fixed effects and control variables to account for changes in expenses, confidences, and numeric ability. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Any treatment			Financial literacy			Self-control		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Treated	0.20**			0.13			0.17		
	(0.08)			(0.10)			(0.10)		
Post	0.25***	0.25***	0.25***	0.33***	0.33***	0.32***	0.33***	0.33***	0.33***
	(0.05)	(0.07)	(0.08)	(0.05)	(0.07)	(0.08)	(0.05)	(0.07)	(0.08)
Treated *x* Post	0.41***	0.41***	0.38***	0.77***	0.78***	0.78***	-0.12*	-0.12	-0.12
	(0.07)	(0.10)	(0.10)	(0.10)	(0.14)	(0.15)	(0.07)	(0.09)	(0.09)
Monthly expenses			-0.01			0.04			-0.01
			(0.11)			(0.12)			(0.11)
Confidence in daily finances			0.01			0.02			0.02
			(0.04)			(0.04)			(0.04)
Numeracy			0.05			-0.01			-0.02
			(0.05)			(0.05)			(0.05)
Individual fixed effects	No	Yes	Yes	No	No	No	No	No	No
R2	0.03	0.79	0.79	0.05	0.75	0.75	0.01	0.80	0.80
Observations	3,471	3,471	3,471	2,848	2,848	2,848	2,848	2,848	2,848

Table 7: The effect of treatment interventions on entertainment based borrowing

The table below analyzes the effect of the financial literacy and self-control treatment interventions on subjects' entertainment-related borrowing behavior. The dependent variable in Columns 1-3 is an indicator for using online borrowing for entertainment-related expenses such as dining out or purchasing items such as phones, games, and clothing. In Columns 4-6 it indicates using the credit for medical, education-related, or other expenses. Columns 1 and 4 are the full sample, 2 and 5 are conditional on borrowing in the first period, and Columns 3 and 6 are conditional on borrowing for entertainment or other reasons in the first period, respectively. *Treated SC* and *Treated FL* indicate the self-control and financial literacy interventions respectively. We present the coefficients a linear regression including individual fixed effects. F-statistics from a test of differences between Treated SC *x* Post and Treated FL *x* Post and the test's *p*-value are presented at bottom. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Entertainment reasons			Other reasons		
	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.09***	-0.00	-0.00	0.03***	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)
Treated SC *x* Post	-0.10***	-0.14***	-0.20***	-0.04*	-0.05**	-0.17**
	(0.03)	(0.04)	(0.06)	(0.02)	(0.02)	(0.08)
Treated FL *x* Post	-0.07***	-0.04	-0.05	-0.01	-0.00	-0.01
	(0.03)	(0.03)	(0.03)	(0.02)	(0.00)	(0.02)
Financial literacy score	-0.00	-0.00	-0.00	0.00	0.00	0.01
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Monthly expenses	-0.00	0.01	0.01	-0.00	-0.01	-0.03
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.05)
Confidence in daily finances	-0.01	-0.01	-0.01	-0.01	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.02)
Numeracy	0.01	-0.00	-0.00	-0.00	-0.00	-0.00
	(0.01)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
F-stat	0.43	4.69	6.17	1.29	4.01	4.11
p-value	0.51	0.03	0.01	0.26	0.05	0.04
R2	0.90	0.95	0.57	0.92	0.99	0.58
Observations	3,471	1,641	1,290	3,471	1,641	351

Table 8: The effect of treatment interventions, liquidity constraints, and self-perceived stress from debt

The table below analyzes the effect of the financial literacy and self-control treatment interventions on subjects' rate of online borrowing by heterogeneity in liquidity constraints and self-perceived levels of stress related to borrowing online. The dependent variable is an indicator for borrowing online in the previous 12 months. Column 1 presents our baseline result while Columns 2 and 3 divide the sample by constrained vs unconstrained subjects based on their survey responses in the initial wave. Columns 4-6 divide the sample by a survey question in Wave 1 regarding the amount of stress that the subject feels from their online borrowing. *Treated SC* and *Treated FL* indicate the self-control and financial literacy interventions respectively. We present the coefficients a linear regression including individual fixed effects. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

		Monthly income to expenses		Stress from loans		
	Baseline	Cons.	Uncons.	Low	Med	High
	(1)	(2)	(3)	(4)	(5)	(6)
Post	0.12***	0.16***	0.10***	0.01	-0.03	0.02
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Treated SC *x* Post	-0.13***	-0.16**	-0.11**	-0.27***	-0.16***	-0.13
	(0.04)	(0.06)	(0.05)	(0.09)	(0.06)	(0.09)
Treated FL *x* Post	-0.08**	-0.13**	-0.05	-0.02	-0.03	-0.10
	(0.03)	(0.06)	(0.04)	(0.03)	(0.03)	(0.08)
Financial literacy score	-0.00	0.00	-0.00	-0.01	0.01**	-0.01
	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)
Monthly expenses	-0.01	0.03	-0.03	-0.03	0.03	-0.01
	(0.02)	(0.05)	(0.03)	(0.05)	(0.03)	(0.05)
Confidence in daily finances	-0.02*	-0.01	-0.03***	0.01	-0.00	-0.03
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)
Numeracy	0.01	0.02	0.01	-0.01	-0.00	0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.88	0.84	0.88	0.61	0.56	0.58
Observations	3,471	1,167	2,304	412	917	312

Table 9: Borrowing late fees, liquidity constraints, and self-perceived stress from debt

The table below analyzes the effect of the financial literacy and self-control treatment interventions on subjects' late fees linked to their online debt. The dependent variable is an indicator which takes the value of one if a subject accumulated a late fee payment in month *m* around self-control treatments. The sample consists of individuals in the self-control treatment and the underlying data comes directly from the third-party app used in the program. The variable *After self-control* treatments takes the value of one in months following the third treatment and conclusion of the self-control program. We present the coefficients a linear regression including individual fixed effects. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

		Monthly income to expenses		Stress from loans		
	Baseline	Cons.	Uncons.	Low	Med	High
	(1)	(2)	(3)	(4)	(5)	(6)
After self-control treatments	-0.01	-0.07**	0.01	0.05	0.02	-0.28***
	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.09)
Financial literacy score	-0.00	-0.02	0.00	0.01	-0.04	0.08***
	(0.01)	(0.03)	(0.01)	(0.01)	(0.03)	(0.02)
Monthly expenses	0.01	0.03*	0.00	-0.02	0.00	0.12*
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.06)
Confidence in daily finances	-0.00	0.01	-0.01	-0.01	-0.02	0.02
	(0.00)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Numeracy	-0.00	0.01	-0.01	-0.00	0.00	0.00
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Individual fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R2	0.24	0.25	0.25	0.15	0.22	0.30
Observations	6,114	2,074	4,040	984	1,700	612

Online Appendix for

"Cultivating Self-Control in FinTech: Evidence from a Field Experiment on Online Consumer Borrowing"

Appendix Figure 1: Financial literacy and self-control intervention sessions

The figures below show a financial literacy lecture and a small group sessions in self-control training. The photos were taken during real intervention treatments during 2017.

Appendix Figure 2: Third-party mobile PFM app

The figures below show example screens from third-party mobile personal financial management apps used alongside the self-control interventions to track spending, income, and borrowing behavior.

Appendix 1: Intervention treatments and description of activities

1. Sample and treatments

The total sample (1,972 students) was randomly divided into three groups:

- Group 1 (financial education)
  325 students were randomly assigned to take the financial literacy trainings.
- Group 2 (self-control training)
  325 students were randomly assigned to take the self-control trainings.
- Control group
  1,322 were allocated to a zero-touch control group. No offer of financial education program and/or self-control program was made to this group.

2. Schedule and plan for each financial literacy class:

Class One: 11 March 2017 (Saturday)

- Time value of money
- Compounding of interest

Class Two: 3 June 2017 (Saturday)

- Risk diversification
- Trade-offs between risk and return

Class Three: 28 October 2017 (Saturday)

- Introduction to online consumer loans, fees, and interest rates provided by the main lenders in the market.

3. Schedule and plan for each self-control training class:

Class one: 18 March 2017 (Saturday)

- Participants were instructed to install and sign up a free Personal Financial Management (PFM) mobile app. The app can sync to students' financial accounts including bank accounts, WeChat Pay account, Alipay account, and students' campus cards. Participants were required to give the app permissions to access all their payment accounts including bank accounts, credit card accounts, Wechat Pay account, Alipay account and students' campus cards so that the app can collect all spending data into one place for the participants. The app can automatically put each transaction into different categories for example utilities, groceries, eating out, cash, movies, tuition, books & magazines, Electronics & Software, Gym, Pharmacy, Alcohol, travel, shopping. The PFM accurately tracks income and expenses by category much like those used in the recent literature (e.g., Olaffson and Pagel, 2018; Braeuer, Hackethal, and Hanspal, 2019). In this session, our trainers instructed the participants how to use the app.
- Participants were then asked to record their spending with the app for the following two months, from March 19th 2017 to May 19th 2017.

Class two: 10 June 2017 (Saturday)

- In this session, participants were required to provide their spending tracked by the app from March 19th 2017 to May 19th 2017 along with their total monthly income, totally monthly expenses and total monthly savings/deficits for the period. The financial accounting for these two months provided a baseline measure of the participants' personal spending. Based on the spending records, our trainer asked the following questions to each participant:
  - ✓ Detail any non-planned purchases, if any, in last two months
  - ✓ How do you feel about those purchases now?
  - ✓ Detail any purchases that costed more than half your monthly income
  - ✓ How do you feel about those purchases now?
  - ✓ Detail any spending categories that costed more than your budget, if any, in last two months.
  - ✓ How do you feel about the spending that costed more than your budget now?

- Our trainers helped the participants to set up goals/budgets in each spending categories each month for the following four months.
- Required participants to keep tracking their spending during the period from 11 June 2017 to 10 October 2017 with the app. At the end of each month the participants were required to submit their spending records to their trainer through WeChat and email.
- The app has a goal-tracking function to help users measure their true spending against a budget.

Class three: 10 October 2017 (Saturday)

- In the last session, participants were required to provide their spending tracked by the app from 11 June 2017 to 10 October 2017 along with their total monthly income, totally monthly expenses and total monthly savings/deficits to their trainers.
- Participants were asked to compare their true spending to the goal/targets the participated set in the last session. The following questions were asked:
  - ✓ Detail any non-planned purchases, if any, in last two months
  - ✓ How do you feel about those purchases now?
  - ✓ Detail any purchases that costed more than half your monthly income
  - ✓ How do you feel about those purchases now?
  - ✓ Detail and explain any spending categories that costed more than your goal/budget, if any.
  - ✓ How do you feel about the spending that costed more than you goal/budget now?
- After this session, students were required to complete three questions and submitted their answers to the trainers two days after the training session.
  - ✓ What level of difficulty, if any, have you experienced complying with the program?
  - ✓ Do you feel you are progressing with the program?
  - ✓ Do you wish to comment on the program generally?

4. Attrition between first and second survey waves:

114 initial participants were unavailable for the follow-up survey:

- 59 participants were from control group
- 26 participants were from the FL training group
- 29 participants were from the self-control graining group

Reasons:

- 17 initial participants left their university before the follow-up survey.
- 23 initial participants were on sick leave during our visit
- 78 initial participants were not available during our visit for other reasons.

Appendix 2: Financial literacy questions

1. In terms of a deposit amounting to 1,000 Yuan, what is the sum of principal and interest at the annual rate of 2% after 5 years?
   A. more than 1,100 Yuan
   B.1,100 Yuan
   C. less than 1,100 Yuan
   D. uncertain

2. If the interest rate of your savings account is 1% and the inflation rate is 2%, what is the total change in the amount of stuff you can purchase with the same amount of money in one year?
   A. more than previous year
   B. less than previous year
   C. same as previous year
   D. uncertain

3. If the bank interest rate rises, what is the general change in the price of a bond?
   A. rise
   B. fall
   C. no association between bank interest rate and bond price
   D. no idea

4. True or false: compared to a mortgage loan of 30 years, a 15 year mortgage loan features a higher monthly payment while the sum of the interest is less than that of 30 years mortgage loan.
   A. true
   B. false
   C. no idea
   D. refuse to answer

5. True or false: compared to the purchase of one share of a mutual fund, purchasing a share of one company generally offers a higher guaranteed return.
   A. true
   B. false
   C. no idea
   D. refuse to answer

6. Does repayment of credit card on time at minimum amount count as negative information?
   A. yes
   B. no
   C. counts for 30 days later
   D. count after the grace period

Appendix Table 2: Summary statistics by treatment

We report mean values for all subjects in wave one of the survey questionnaire by treatment intervention. For each individual, we observe the self-assessed financial and demographic characteristics detailed below from September 2016.

Treatment group:	Financial literacy	Self-control	Control
	(1)	(2)	(3)
Male	0.31	0.38	0.33
Financial literacy score	3.43	3.47	3.30
Parents college education	0.15	0.11	0.14
Monthly expenses	2.39	2.39	2.81
Business major	0.53	0.53	0.52
Confidence in daily finances	3.97	3.82	4.09
Read financial news	3.31	3.16	3.16
Numeracy	4.34	4.33	4.27
N	324	326	1,142

Appendix Table 3: The effect of treatment interventions on future online borrowing

The table below analyzes the effect of various treatment interventions on subjects' propensity to borrow online before and after participating in the treatment interventions. The dependent variable is an indicator for borrowing online in the previous 12 months. We present marginal effects after a logistic regression. In each column we present indicator variables for receiving a *treatment* and participating in an intervention, the wave of the survey (*post*), and the interaction of the two, *treatment x post* our variable of interest. In Columns 1-3 the treatment variable indicates any treatment, either financial literacy or self-confidence. In Columns 4-6 the treatment variable indicates the financial literacy treatment and Columns 7-9 the treatment variable indicates the self-control treatment. The sample includes data from both survey waves. We first present results without any control variables then add control variables. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	Any treatment		Financial literacy		Self-control	
	(1)	(2)	(3)	(4)	(5)	(6)
Treated	0.08***	0.08***	0.04	0.06*	0.08***	0.07**
	(0.02)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Post	0.12***	0.14***	0.09***	0.12***	0.10***	0.12***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Treated *x* Post	-0.10***	-0.13***	-0.03	-0.11***	-0.12***	-0.09**
	(0.02)	(0.02)	(0.02)	(0.03)	(0.03)	(0.03)
Financial literacy score		-0.00		-0.00		-0.00
		(0.01)		(0.01)		(0.01)
Male		0.23***		0.23***		0.23***
		(0.03)		(0.03)		(0.03)
Monthly expenses		0.03**		0.03**		0.03**
		(0.01)		(0.01)		(0.01)
Parents college education		-0.05		-0.05		-0.05
		(0.04)		(0.04)		(0.04)
Business major		-0.09***		-0.09***		-0.09***
		(0.03)		(0.03)		(0.03)
Confidence in daily finances		-0.11***		-0.12***		-0.11***
		(0.01)		(0.01)		(0.01)
Numeracy		0.05***		0.05***		0.05***
		(0.01)		(0.01)		(0.01)
Region fixed effects	No	Yes	No	Yes	No	Yes
Observations	3,471	3,471	3,471	3,471	3,471	3,471

Appendix Table 4: The effect of treatment interventions on future online borrowing

The table below analyzes the effect of the financial literacy and self-control treatment interventions on subjects' future borrowing behavior. The dependent variable in Columns 1-3 is an indicator for using borrowing online. Columns 1 and 2 are estimated with OLS while 3-4 present marginal effects after a probit model. *Treated SC* and *Treated FL* indicate the self-control and financial literacy interventions respectively. F-statistics from a test of differences between Treated SC *x* Post and Treated FL *x* Post and the test's *p*-value are presented at bottom. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	OLS		Probit	
	(1)	(2)	(3)	(4)
Treated SC	0.10***		0.10***	0.08**
	(0.03)		(0.03)	(0.03)
Treated FL	0.07**		0.07**	0.08**
	(0.03)		(0.03)	(0.03)
Post	0.12***	0.12***	0.12***	0.14***
	(0.01)	(0.01)	(0.01)	(0.01)
Treated FL *x* Post	-0.06***	-0.08***	-0.06***	-0.13***
	(0.02)	(0.02)	(0.02)	(0.03)
Treated SC *x* Post	-0.14***	-0.13***	-0.14***	-0.11***
	(0.03)	(0.02)	(0.03)	(0.03)
Financial literacy score		-0.00		-0.00
		(0.01)		(0.01)
Monthly expenses		-0.01		0.03**
		(0.02)		(0.01)
Confidence in daily finances		-0.02***		-0.11***
		(0.01)		(0.01)
Numeracy		0.01		0.05***
		(0.01)		(0.01)
Male				0.22***
				(0.02)
Parents college education				-0.04
				(0.03)
Business major				-0.09***
				(0.02)
Individual fixed effects	No	Yes	No	No
Region fixed effects	No	No	No	Yes
F-stat/Chi^2	5.31	2.91	5.32	0.35
p-value	0.02	0.09	0.02	0.55
R2	0.01	0.88	0.01	0.14
Observations	3,471	3,471	3,471	3,471

Appendix Table 5: The effect of treatment interventions on the intensive margin of online borrowing

The table below analyzes the effect of various treatment interventions on subjects' online borrowing before and after participating in the treatment interventions. The dependent variable in Panel A the dependent variable is the response to a survey question about on average how much in RMB per month the subject borrows online (where 1 = less than 200, 2 = 200-600, 3=600-1000, and 4 = 1500+), in Panel B it is the response to a survey question about on average how many times per month the subject borrows online (where 1 = less than 1, 2 = 1-2, 3=3-5, and 4 = 5+). We provide ordered-logit regressions and present the marginal effects for the coefficients of interest. In each column we present indicator variables for receiving a *treatment* and participating in an intervention, the wave of the survey (*post*), and the interaction of the two, *treatment x post* our variable of interest. In Columns 1-3 the treatment variable indicates any treatment, either financial literacy or self-confidence. In Columns 4-6 the treatment variable indicates the financial literacy treatment and Columns 7-9 the treatment variable indicates the self-control treatment. The sample includes data from both survey waves. We first present results without any control variables then add control variables. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

Panel A: How much do you borrow online?

	Any treatment		Financial literacy		Self-control	
	(1)	(2)	(3)	(4)	(5)	(6)
Treat x Post						
...Less than 200	0.04**	0.06***	-0.04*	-0.01	0.11***	0.10***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
...Between 200-600	0.02**	0.04***	-0.02*	-0.01	0.07***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
...Between 600-1000	-0.03**	-0.04***	0.03*	0.01	-0.08***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
...Between 1000-1500	-0.02**	-0.03***	0.02*	0.01	-0.06***	-0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
...More than 1500	-0.01**	-0.02***	0.01*	0.00	-0.04***	-0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Control variables	No	Yes	No	Yes	No	Yes
Region fixed effects	No	Yes	No	Yes	No	Yes
Observations	1,786	1,786	1,786	1,786	1,786	1,786

Panel B: How often do you borrow online?

	Any treatment		Financial literacy		Self-control	
	(1)	(2)	(3)	(4)	(5)	(6)
Treat x Post						
...Less than once	0.04***	0.06***	-0.03**	-0.01	0.09***	0.09***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
...Between 1-2	0.06***	0.08***	-0.04**	-0.01	0.13***	0.13***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
...Between 3-5	-0.01***	-0.02***	0.01**	0.00	-0.03***	-0.03***
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
...More than 5 times	-0.09***	-0.12***	0.06**	0.02	-0.19***	-0.19***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Control variables	No	Yes	No	Yes	No	Yes
Region fixed effects	No	Yes	No	Yes	No	Yes
Observations	1,786	1,786	1,786	1,786	1,786	1,786

Appendix Table 6: The effect of treatment interventions on future online borrowing: Within instructor specification

The table below analyzes the effect of the financial literacy and self-control treatment interventions on subjects' future borrowing behavior. The dependent variable in Columns 1-7 is an indicator for using borrowing online. Columns 1-4 are estimated with OLS while 5-7 present marginal effects after a probit model. *Treated SC* and *Treated FL* indicate the self-control and financial literacy interventions respectively. Columns 1, 2, and 5 include the full sample, while Columns 3, 4, 6, and 7 include subjects from financial literacy and self-control treatments. Instructor fixed effects indicate a dummy variable for the 10 instructors used in both financial literacy and self-control treatments, or in indicator for no-instructor (Columns 1, 2, and 5). University fixed effects are a dummy variable for 5 universities. Robust standard errors clustered at the individual level are in parentheses. ***, **, * denote significance at the 1%, 5%, and 10% levels, respectively.

	OLS				Logit		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Treated-FL	0.54***	0.32***			0.81***		
	(0.04)	(0.04)			(0.01)		
Treated-SC	0.57***	0.34***	0.03	0.01	0.81***	0.01	0.02
	(0.02)	(0.03)	(0.04)	(0.04)	(0.01)	(0.04)	(0.04)
Post	0.12***	0.11***	0.05***	0.04	0.12***	0.04	0.04
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)
Treated-FL *x* Post	-0.06***	-0.06***			-0.06***		
	(0.02)	(0.02)			(0.02)		
Treated-SC *x* Post	-0.14***	-0.14***	-0.07**	-0.07**	-0.15***	-0.08**	-0.09**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)
Control variables	No	Yes	No	Yes	Yes	Yes	Yes
Region fixed effects	No	No	No	No	Yes	Yes	Yes
Instructor fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
University fixed effects	No	No	No	No	No	No	Yes
R2	0.01	0.08	0.01	0.09	0.06	0.07	0.08
Observations	3,471	3,471	1,246	1,246	3,471	1,244	1,244

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