Are High-Interest Loans Predatory? Theory and Evidence from Payday Lending

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September 9, 2020

Abstract

It is often argued that consumer lending regulations can increase welfare, because high-interest loans cause "debt traps" where people borrow more than they expect or would like to in the long run. We test this using an experiment with a large payday lender. Although the most inexperienced quartile of borrowers underestimate their likelihood of future borrowing, the more experienced three quartiles predict correctly on average. This finding contrasts sharply with priors we elicited from 103 payday lending and behavioral economics experts, who believed that the average borrower would be highly overoptimistic about getting out of debt. We provide a novel test showing that borrowers are willing to pay a significant premium for an experimental incentive to avoid future borrowing, which implies that they perceive themselves to be time inconsistent. We use the data on forecast accuracy and valuation of the experimental incentive to estimate a structural model of time preferences and beliefs, which we use for a behavioral welfare evaluation of common payday lending regulations. In our model, banning payday loans reduces welfare relative to existing regulation, while limits on repeat borrowing might increase welfare by inducing faster repayment that is more consistent with long-run preferences.

JEL Codes: D14, D15, D18, D61, D90, L69.

Keywords: Payday lending, present focus, naivete, consumer protection, behavioral welfare analysis.

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> "The most hated sort [of wealth-getting], and with the greatest reason, is usury, which makes a gain out of money itself, and not from the natural object of it."
> –Aristotle (Politics)

> "No man of ripe years and of sound mind, acting freely, and with his eyes open, ought to be hindered ... in the way of obtaining money, as he thinks fit."
> –Jeremy Bentham (Defense of Usury, Letter 1, 1787)

People have long questioned the ethics and social consequences of high-interest lending. Indeed, usury laws and other high-interest lending restrictions are among the oldest and most prevalent forms of consumer protection regulation. However, the extent to which such regulation actually benefits or harms consumers is still poorly understood. We study this issue in the context of payday lending in the United States.

Critics argue that payday loans are predatory, trapping consumers in cycles of repeated high-interest borrowing. A typical payday loan incurs $15 interest per $100 borrowed over two weeks, implying an annual percentage rate (APR) of 391 percent, and more than 80 percent of payday loans nationwide in 2011-2012 were reborrowed within 30 days (CFPB 2016). As a result of these concerns, 18 states now effectively ban payday lending (CFA 2019), and in 2017, the Consumer Financial Protection Bureau (CFPB) finalized a set of nationwide regulations. The CFPB's then-director argued that "the CFPB's new rule puts a stop to the payday debt traps that have plagued communities across the country. Too often, borrowers who need quick cash end up trapped in loans they can't afford" (CFPB 2017).

Proponents argue that payday loans serve a critical need: people are willing to pay high interest rates because they very much need credit. For example, Knight (2017) wrote that the CFPB regulation "will significantly reduce consumers' access to credit at the exact moments they need it most." Under new leadership, the CFPB has rescinded part of its 2017 regulation on the grounds that it would reduce credit access.

At the core of this debate is the question of whether borrowers act in their own best interest. If borrowers successfully maximize their utility, then restricting choice reduces welfare. However, if borrowers have self-control problems ("present focus," in the language of Ericson and Laibson 2019), then they may borrow more to finance present consumption than they would like to in the long run. Furthermore, if borrowers are "naive" about their present focus, overoptimistic about their future financial situation, or for some other reason do not anticipate their high likelihood of repeat borrowing, they could underestimate the costs of repaying a loan. In this case, restricting credit access might make borrowers better off.

We designed and implemented an experiment with a large payday lender (henceforth, the "Lender") to answer two basic questions. First, do borrowers anticipate the extent of their repeat borrowing? Second, do borrowers perceive themselves to be time consistent? Our experiment provides model-free evidence on these questions and also identifies a structural model of present focus with partially naive beliefs—one of the first such estimates outside of laboratory experiments.

We then use our structural estimates as inputs to welfare analysis of three common payday lending regulations—the first such analysis that accounts for key potential behavioral biases motivating these regulations.

Our experiment ran from January to March 2019 in 41 of the Lender's storefronts in Indiana, a state with fairly standard lending regulations. Customers taking out payday loans were asked to complete a survey on an iPad. The survey first elicited people's predicted probability of getting another payday loan from any lender over the next eight weeks. We then introduced two different rewards: "$100 If You Are Debt-Free," a no-borrowing incentive that they would receive in about 12 weeks only if they did not borrow from any payday lender over the next eight weeks, and "Money for Sure," a certain cash payment that they would receive in about 12 weeks. We measured participants' valuations of the no-borrowing incentive through an incentive-compatible adaptive multiple price list (MPL) in which they chose between the incentive and varying amounts of Money for Sure. We also used a second incentivized MPL between "Money for Sure" and a lottery to measure risk aversion. The 1,205 borrowers with valid survey responses were randomized to receive either the no-borrowing incentive, their choice on a randomly selected MPL question, or no reward (the Control group). We match each participant's survey responses to borrowing data from the Lender and to the state-wide database of borrowing from all payday lenders.

We first provide model-free results on the two key basic questions above. We find that on average, people almost fully anticipate their high likelihood of repeat borrowing. The average borrower perceives a 70 percent probability of borrowing in the next eight weeks without the incentive, slightly lower than the Control group's actual borrowing probability of 74 percent. Experience seems to matter. People who had taken out three or fewer loans from the Lender in the six months before the survey—approximately the bottom experience quartile in our sample—underestimate their future borrowing probability by 20 percentage points. By contrast, more experienced borrowers predict correctly on average. The fact that payday borrowing is a high-stakes decision with clear feedback and repeated opportunities to learn could explain the contrast with findings of substantial naivete in lab experiments (Augenblick and Rabin 2019) and exercise (e.g., DellaVigna and Malmendier 2004; Acland and Levy 2015; Carrera et al. 2019).

We develop a novel and robust test of perceived time consistency: whether a person's valuation of a future price change differs from the the equivalent variation implied by the Envelope Theorem using her predicted consumption. For example, risk-neutral and time-consistent borrowers who predict that a $100 price increase would reduce their borrowing probability from 70 percent to 50 percent would be willing to pay approximately $\$100 \times (70\% + 50\%)/2 = \$60$ to avoid the price increase. Since the no-borrowing incentive is equivalent to a $100 fixed payment plus a $100 price increase, these example borrowers would value the incentive at $\$100 - \$60 = \$40$. Since the incentive is risky, risk aversion would reduce that valuation. Time-*in*consistent borrowers who believe that their future selves will borrow more than their current preferences would have higher valuations, because the price increase moves future borrowing more in line with current preferences. Thus, if these example borrowers value the incentive at more than $40 and are also risk averse, we can infer that they perceive themselves to be time inconsistent.[1]

On average, borrowers value the no-borrowing incentive 30 percent more than they would if they were time consistent and risk neutral. And since their valuations of our survey lottery reveal that they are in fact risk averse, their valuation of the future borrowing reduction induced by the incentive is even larger than this 30 percent "premium" suggests. Qualitative data support the conclusion that borrowers want to change their behavior: 54 percent of our sample reports that they "very much" would like to give themselves extra motivation to avoid payday loan debt in the future, and only 10 percent report "not at all."

We then use these model-free results to identify a structural model of partially naive present focus. Specifically, we assume that people have quasi-hyperbolic time preferences (e.g., Laibson, 1997; O'Donoghue and Rabin, 1999), meaning that utility in all future periods is discounted by an additional $\beta \leq 1$. We follow O'Donoghue and Rabin (2001) in allowing people to mispredict their present focus, believing that their future selves will discount later periods by $\tilde{\beta}$. "Sophisticated" people have $\tilde{\beta} = \beta$, and "(partially) naive" people have $\tilde{\beta} > \beta$.

Borrowers' predicted versus actual borrowing probabilities identify sophistication versus naivete. The small degree of average misprediction in our data translates to an average value of $\beta/\tilde{\beta}$ that ranges from 0.95 to 0.98, depending on risk aversion assumptions, implying that borrowers are almost fully sophisticated on average. Under the plausible assumption that $\beta \leq \tilde{\beta}$ for all borrowers, this implies that few borrowers are very naive. Borrowers' valuations of the no-borrowing incentive identify average perceived present focus $\tilde{\beta}$. The large observed premium translates to average $\tilde{\beta}$ between 0.76 and 0.87, implying that borrowers believe they have significant self-control problems. Combining our estimates of $\beta/\tilde{\beta}$ and $\tilde{\beta}$ implies an average β between 0.74 and 0.83.

We import these parameter estimates into a model of borrowing and repayment, which we use to evaluate payday lending regulations. The model builds on Heidhues and Koszegi (2010). Borrowers first choose a loan amount in period 0. In each subsequent period, borrowers receive a stochastic repayment cost shock and can choose to repay the loan, reborrow, or default. Prior work in deterministic models has found that even small amounts of naivete can cause discontinuously large effects on behavior and thus large welfare losses (O'Donoghue and Rabin 1999, 2001; Heidhues and Koszegi 2009, 2010). However, we show that stochasticity in cost shocks makes behavior, and thus welfare, continuous in the level of naivete. We further show that losses from naivete can be bounded using observed behavior, and simple calibrations suggest that the losses are small.

Using the model, we carry out numerical simulations that combine our estimates of β and $\tilde{\beta}$ with additional demand and repayment cost uncertainty parameters calibrated to match the observed repayment and default probabilities and the empirical distribution of loan sizes. We find that under a standard \$500 loan size cap, borrowers with our estimated β and $\tilde{\beta}$ enjoy 89 to 96 percent as much surplus as a time-consistent borrower. Because borrowers are close to fully sophisticated about repayment costs, payday loan bans and tighter loan size caps reduce welfare in

[1] In Section 5.1, we show that people overestimate the incentive's effect on borrowing. This does not matter for our test: it requires only that people truthfully report their subjective beliefs on average, not that their subjective beliefs are correct.

our simulations. Limits on repeat borrowing increase welfare in some (but not all) specifications, by inducing faster repayment that is more consistent with long-run preferences. These conclusions are robust to various assumptions about heterogeneity in present focus and naivete.

Before we released the paper, we surveyed academics and non-academics who are knowledgeable about payday lending to elicit their policy views and predictions of our empirical results. We use the 103 responses as a rough measure of "expert" opinion, with the caveat that other experts not in our survey might have different views. Our results contrast sharply with the weight of expert opinion in our survey. Our average expert believed that borrowers would be much more naive than they actually are—specifically, that borrowers would underestimate their future borrowing probability by 30 percentage points, in contrast to the actual 4 percentage points. Furthermore, more than half of our experts believed that payday loan bans are good for borrowers, and repeat borrowing limits were slightly less popular than bans. In contrast, our model suggests that repeat borrowing limits could benefit consumers, while bans do not.[2]

We highlight five important caveats. First, our parameter estimates are local to the 1,205 people in our experiment, although our sample does not differ substantially on observables from typical payday borrowers. Second, our welfare analyses take the long-run preferences of present-focused borrowers as being normatively relevant; this "long-run criterion" is common but somewhat controversial (Bernheim and Rangel 2009; Bernheim 2016; Bernheim and Taubinsky 2018). Using a different welfare criterion would likely strengthen our model's prediction that most regulation reduces welfare. Third, we model borrowing and repayment choices for an exogenous set of potential borrowing spells with exogenous initial liquidity demand, instead of modeling individuals who choose when to borrow over their lifetimes. As a result, we do not capture the possibility that rollover restrictions might result in more (albeit shorter) spells, or that people might keep larger buffer stocks in response to payday borrowing restrictions. However, additional analyses provide no empirical support for those hypotheses: people do not keep significantly more liquid assets in states with payday loan bans or in years after their state imposes a ban. Fourth, our analyses assume that there are no market failures or behavioral biases other than present focus and misprediction. Fifth, our results about the welfare benefits of payday lending consider markets with existing regulations such as moderate loan size caps and truth-in-lending requirements, and thus do not speak to the effects of deregulation.

Section 1 discusses related literature. Sections 2–5 present the background, experimental design, data, and reduced-form empirical results. Section 6 presents the present focus model and estimation, Section 7 presents our behavioral welfare evaluation of payday lending regulations, and Section 8 concludes.

[2]These prescriptions are consistent with arguments by Skiba (2012) and Morse (2016).

1 Related Literature

Our work builds on several existing literatures. One literature uses quasi-experimental variation to evaluate the impacts of payday loan access (Zinman 2010; Melzer 2011, 2018; Morse 2011; Morgan, Strain, and Seblani 2012; Carrell and Zinman 2014; Bhutta, Skiba, and Tobacman 2015; Bhutta, Goldin, and Homonoff 2016; Carter and Skimmyhorn 2017; Gathergood, Guttman-Kenney, and Hunt 2019; Skiba and Tobacman 2019). These papers consider a variety of different outcomes and find a mix of positive and negative effects. Such impact evaluations can be difficult to use for welfare analysis because it is not clear how to trade off effects on different outcomes, how to consider other unmeasured welfare-relevant outcomes, or how to evaluate regulations such as rollover restrictions that change the payday loan product instead of eliminating access. This highlights the need for welfare analyses that include explicit measures of consumer bias. Our paper is the first to do this for payday lending.[3]

We also build on existing papers studying imperfect information and behavioral biases among payday loan borrowers. Bertrand and Morse (2011) show that providing information to first-time borrowers about fees and the likelihood of repeat borrowing reduces borrowing. This result is consistent with our finding of naivete among inexperienced borrowers, as the information could induce sophistication and reduce borrowing.[4] Mann (2013) asks borrowers how long they think it will be before they go an entire pay period without borrowing, finding that 60 percent of borrowers predict correctly within three days. However, Mann (2013) does not present formal statistical tests of whether borrowers are biased on average, and his sample includes only people who have not borrowed in the last 30 days, which may limit the generalizability of his results. Leary and Wang (2016) show that one reason for payday borrowing is failure to plan for predictable income shocks. Carter et al. (2019) find that payday borrowers who are quasi-experimentally granted more time to repay loans do not repay more, and they show that this is consistent with a model of present focus. Carvalho, Olafsson, and Silverman (2019) show that laboratory measures of decision quality are negatively correlated with high-interest borrowing in Iceland. Relative to these papers, a key contribution of our work is a theoretically driven design that allows us to estimate a model of borrowing behavior, which then allows us to carry out a quantitative behavioral welfare analysis.

Skiba and Tobacman (2018) use observational data on payday borrowing to estimate a present focus model. Their identification exploits the timing of default: in their model, naivete is required to explain long borrowing spells ending in default, as sophisticates would default earlier to avoid the interest payments. More recent work by Heidhues and Strack (2019), however, shows that the timing of choices cannot be used to identify either β or $\tilde{\beta}$ without additional parametric assumptions, as

[3] For other examples of this approach to behavioral policy evaluation, see Abaluck and Gruber (2011), Allcott and Taubinsky (2015), Allcott, Lockwood, and Taubinsky (2019), Bronnenberg et al. (2015), Chetty, Looney, and Kroft (2009), Grubb and Osborne (2015), Handel (2013), Handel and Kolstad (2015), Handel, Kolstad, and Spinnewijn (2019), Taubinsky and Rees-Jones (2018), and Rees-Jones and Taubinsky (Forthcoming); see Bernheim and Taubinsky (2018) for a review.

[4] Burke, Leary, and Wang (2016) show that this information provision had material effects when implemented throughout Texas.

every distribution of stopping times can be rationalized by a time-consistent model with a different distribution of unobserved shocks. For example, with a right-skewed distribution of income shocks, one might reborrow repeatedly in hopes of repaying upon a high income draw and then default if that high draw doesn't come.[5]

Finally, our identification strategy for β and $\tilde{\beta}$ advances the large empirical literature on present focus. Many lab and field experiments document preference reversals, demand for commitment, overoptimism, or other evidence of naive or sophisticated present focus without estimating model parameters.[6] Another set of experiments and field studies estimate part of a present focus model, for example identifying β while assuming that people are fully naive or fully sophisticated.[7] There are only a handful of papers that estimate a full model of partially naive present focus.[8] Our identification strategy is closest to that of parallel work by Carrera et al. (2019), which we extend and generalize substantially to applications that involve non-separable dynamic programming models with diminishing marginal utility from money and income effects.

2 Payday Lending Background

Payday loans are small, high-interest, single-payment consumer loans that typically come due on the borrower's next pay date. In the Lender's data, typical loan maturities are about 14 days for people on weekly, biweekly, or semimonthly pay cycles, and about 30 days for people on monthly pay cycles. In 2016, Americans borrowed \$35 billion from storefront and online payday lenders, paying \$6 billion in interest and fees (Wilson and Wolkowitz 2017). In Indiana, the site of our experiment, lenders disbursed 1.2 million payday loans for a total of \$430 million in 2017 (Evans 2019).

Indiana law caps loan sizes at \$605 and caps the marginal interest and fees at 15 percent of the loan amount for loans up to \$250, 13 percent on the incremental amount borrowed from \$251-\$400, and 10 percent on the incremental amount borrowed above \$400. The Lender and its main competitors charge those maximum allowed amounts on all loans. The annual percentage rate (APR) for a 14-day loan with 15 percent interest is 391 percent, meaning that borrowing \$100 over each of the approximately 26.1 two-week periods in a year would incur \$391 in interest. Regulations vary across states (NCSL 2019), although Indiana's price and loan size caps are close to the norm.

[5]The extent to which this matters is unclear: Martinez, Meier, and Sprenger (2020) show that present focus parameter estimates are not very sensitive to distributional assumptions in their tax filing application, while Heidhues and Strack (2019) provide calibrated examples where parameter estimates are highly sensitive.

[6]See, for example, Ashraf, Karlan, and Yin (2006), Beshears et al. (2015), DellaVigna and Malmendier (2006), Duflo, Kremer, and Robinson (2011), Goda et al. (2015), Gine, Karlan, and Zinman (2010), John (forthcoming), Kaur, Kremer, and Mullainathan (2015), Kuchler and Pagel (2018), Read and van Leeuwen (1998), Royer, Stehr, and Sydnor (2015), Sadoff, Samek, and Sprenger (forthcoming), Schilbach (2019), Shapiro (2005), and Toussaert (2018).

[7]See, for example, Acland and Levy (2012), Andreoni and Sprenger (2012a; 2012b), Augenblick (2018), Augenblick, Niederle, and Sprenger (2015), Fang and Silverman (2004), Laibson et al. (2015), Mahajan, Michel, and Tarozzi (2020), Paserman (2008), and Shui and Ausubel (2005). See Imai, Rutter, and Camerer (2020) for a meta-analysis of present focus estimates from the Andreoni and Sprenger (2012a) convex time budget approach.

[8]To our knowledge, these are Augenblick and Rabin (2019), Bai et al. (2018), Carrera et al. (2019), Chaloupka, Levy, and White (2019), and Skiba and Tobacman (2018).

To take out a payday loan, borrowers must present identification, proof of income (e.g. a paycheck stub or direct deposit slip), and a post-dated check for the amount of the loan plus interest. Payday lenders do minimal underwriting, sometimes checking data from a subprime credit bureau. By law, payday lenders in Indiana must report all loans to a database managed by a company called Veritec. Lenders must check that database before disbursing loans to ensure that people do not borrow from more than two lenders at once. We ran our experiment in Indiana because we received regulatory approval to match consenting survey participants to their borrowing records from this database.

When the loan comes due, borrowers can repay (either in person or by allowing the lender to successfully cash the check) or default. After borrowers repay the principal and interest owed on a loan, they can immediately get another loan. In some states, loans can be "rolled over" without paying the full amount due, but Indiana law does not allow this. Per Indiana law, a borrower can get up to five consecutive loans from a given lender. After that, the borrower cannot take out a new loan from any lender for seven days. This rollover restriction has limited impact because it lasts less than one pay cycle, so people can get another loan before they get close to running out of money before their next paycheck arrives.

In 2017, 80 percent of the Lender's loans nationwide were followed by another loan within the next eight weeks. In principle, people can borrow any continuous amount. In practice, most people make a binary decision to either reborrow the same amount or not get a new loan. Appendix Figure A1 shows that of all consecutive loans disbursed nationwide by the Lender in 2017, 68 percent of the subsequent loans were for the exact same amount as the previous loan, while 17 percent were for more and 15 percent were for less. We will use this fact to simplify our model.[9]

If the borrower does not come to the store to repay the loan, the lender attempts to cash the post-dated check, and is allowed by state law to do so up to three times. For bounced checks, the borrower's bank will likely charge a fee of about $30, and lenders in Indiana charge an additional $25 bounced check fee. State law does not permit late fees. If the loan remains unpaid, the Lender's local staff try to work out a repayment plan with the borrower. If that fails, the Lender occasionally refers an account to a third-party collection agency. The Lender does not lend to people who have unpaid balances from past loan cycles.

Default is relatively rare on a per-loan basis: in 2017, only 3 percent of the Lender's loans ended in default. However, about 16 percent of loan *sequences* ended in default in that year.

Payday lending has the hallmarks of a competitive market. Entry requires only modest physical capital, technology, and regulatory compliance relative to many other industries. There are about 300 payday lending stores in Indiana, of which the majority are owned by three national chains (Evans 2019). Despite high interest rates, risk-adjusted profits appear to be low: Ernst & Young (2009) estimated pre-tax profit margins of less than 9 percent on the borrowing fees, with the majority of the costs due to operating costs (62 percent) and defaulted loans (25 percent). Thus,

[9]This fact is notable because depending on the distribution of income shocks, a standard model might predict that borrowers would gradually pay down the principal instead of repeatedly borrowing the same amount and then repaying in full.

market power is unlikely to be an economically meaningful distortion in this industry.

Substitutes for storefront payday loans include online loans, checking account overdrafts, auto title loans, pawn shops, loans from friends and family, and paying bills late. There is some disagreement across datasets about how much liquidity payday borrowers might have available on credit cards, which have much lower interest rates (Agarwal, Skiba, and Tobacman 2009; Bhutta, Skiba, and Tobacman 2015).

The Lender and its main competitors transparently disclose the interest and other fees, in both absolute levels and APRs, both in stores and on their websites. Furthermore, the CFPB's 2017 regulation would limit the number of times that lenders can attempt to cash borrowers' checks, which generates the main fees that could be less salient to borrowers. For this reason, we do not study shrouded fees as a motivation for additional regulation.

3 Experimental Design

We designed the experiment to answer two key questions: whether people anticipate repeat borrowing, and whether people are willing to pay a premium for an incentive to avoid future borrowing.

The experiment ran at 41 of the Lender's stores in Indiana from January 7th through March 29th, 2019, for two weeks in each store. We piloted and refined the survey extensively in fall 2018, including follow-up interviews with store staff and with people who had taken the survey to check their interpretation and understanding of the questions.

We contracted with a research company called EA Consultants to place a recruiter in each center on most days. The recruiter would approach customers either before or after they took out a loan and ask them to take a survey on an iPad. The iPad survey was self-contained, so the recruiters were only needed to recruit and answer questions if they arose. Perhaps as a result of the extensive piloting and refinement, the recruiters reported that they received essentially no questions about the survey.

Survey details. Appendix I presents the full survey instrument. To be eligible, a person must have taken out a payday loan from the Lender in Indiana in the past 30 days. After securing informed consent, the survey asked people's name and date of birth (to match to borrowing records) and email address (to send gift cards as payment for participation).

The first substantive question on the survey was to ask people to report the probability that they would take out another payday loan from any payday lender in the next 8 weeks. The possible answers were 0%, 10%, 20%, ..., 90%, 100%.

The survey then introduced the first reward for completing the survey, "\$100 If You Are Debt-Free." Participants were told that if they were selected for this reward, we would send them a Visa cash card 12 weeks from now if they did not take out another payday loan from *any* lender in the next eight weeks. The survey clarified that "All payday lenders are required to report loans to a database. We will use that database to check your borrowing from all payday lenders." We included a comprehension check question to make sure that participants understood the incentive. We then asked people to report the probability that they would take out another payday loan from any payday lender in the next eight weeks, if they were offered $100 If You Are Debt Free; we call this P in this section only.

Rewards and multiple price lists. After the belief elicitations were complete, the survey introduced the second possible reward: a certain payment that we called "Money for Sure." Just as with the $100 If You Are Debt Free reward, Money for Sure would be paid within 12 weeks on a Visa cash card. The survey then walked participants through an adaptive series of questions to determine their valuations of the no-borrowing incentive. The first question asked whether the person would prefer to receive the no-borrowing incentive or an amount of Money for Sure equal to the incentive's expected value. We helped people to calculate that expected value and highlighted the non-financial reasons why they might prefer a certain payment versus a no-borrowing incentive. The survey read,

> Earlier, you told us that you have a [P]% chance of getting another payday loan before [8 weeks from now] if you are selected for $100 If You Are Debt-Free. In other words, you would have a [$100 - P$]% chance of being debt-free. So on average, $100 If You Are Debt-Free would earn you $[$100 - P$].
>
> Given that, which reward would you prefer?

- $100 If You Are Debt-Free. This gives you extra motivation to stay debt-free.
- $[$100 - P$] For Sure. This gives you certainty and avoids pressure to stay debt-free.

The survey then sequentially offered choices with different amounts of Money For Sure in order to bound the amount at which the borrower was indifferent between the certain payment and $100 If You Are Debt-Free.[10]

The third possible reward for completing the survey was called Flip a Coin for $100. Participants who were selected for this reward would have a 50 percent chance of winning $100 and a 50 percent chance of winning nothing. This would also be paid within 12 weeks on a Visa cash card. The survey led participants through an analogous adaptive question procedure, beginning with a tradeoff between Flip a Coin for $100 and $50 For Sure. People's valuations of Flip a Coin for $100 from this procedure provide a measure of risk aversion.

[10]Because the survey allowed probabilities P to take values 0%, 10%, ..., 90%, 100%, the initial offer of Money For Sure could take values from $0, $10, ..., $90, $100. If the borrower preferred the no-borrowing incentive over $100 - P$ For Sure, the survey would offer another choice with $100 - P + 20$. If the borrower preferred $100 - P + 20$, the survey would offer $100 - P + 40$. If the borrower preferred $100 - P + 40$, the survey would backtrack to $100 - P + 10$ to avoid giving the mistaken impression that this was a bargaining game. Once the borrower preferred x For Sure over the no-borrowing incentive, the survey would offer $x - 10$ for Sure. After that question, the borrower's valuation of incentive would be bounded within a $10 range. The algorithm worked analogously if the borrower initially preferred $100 - P$ For Sure over the no-borrowing incentive.

Attention check and qualitative questions. Immediately after this second MPL, there was an attention check question in which the text asked people to click the "next" button instead of answering. The survey ended with three qualitative questions designed to elicit intuitive measures of desired motivation to avoid future borrowing and of past misprediction of payday borrowing.

Randomization and incentive compatibility. The computer used people's responses on the two adaptive procedures to fill out two multiple price lists (MPLs) with amounts of Money for Sure ranging from $0 to $160 in increments of $10. Although all participants completed the MPLs, only two percent of survey respondents (the "MPL group") were ex-post randomly assigned to receive the choice they made (or would have made) on a randomly selected row from one of the two MPLs. Because all participants had a chance of having their MPL decisions determine their outcomes, it was incentive compatible for participants to answer all questions truthfully. We informed people of this before beginning the questions, saying "Think carefully, because the computer may randomly select one of the following questions and give you what you chose in that question." People could click to a separate page for full implementation details.

We did not incentivize belief elicitations because truthful reporting is not incentive compatible for individuals who perceive themselves to be time inconsistent. A person who thinks that she borrows too much should report a borrowing probability that is lower than her actual belief, to incentivize her future self to borrow less.[11]

The randomization assigned participants to $100 If You Are Debt-Free (the "Incentive group"), no reward (the "Control group"), or the MPL group with 44, 54, and 2 percent probability, respectively. Participants were randomized if they had "valid" survey data under four pre-registered criteria: (i) if they passed both the no-borrowing incentive comprehension check and the attention check, (ii) did not make inconsistent choices on either of the two MPLs, and (iii,iv) had certainty equivalents of less than $160 on both of the two MPLs.

Post-survey. After the survey was complete, the iPad informed participants of whether they had been selected for a reward. Each day, we matched surveys to the Lender's records. Participants whose name and birth date could be matched to a payday loan disbursed by the Lender in the past 30 days were sent an email thanking them for participating and a reminder of any reward that they had received. They also received a separate email from our gift card vendor explaining how to claim their $10 gift card. People who began the survey but failed to complete received an email encouraging them to complete their survey from where they had left off. People who took out payday loans from a store on a day when the survey was available in that store were emailed a link to take the survey online.

After four weeks, all participants received a second email, including a reminder of any reward that they had received. After eight weeks, we received borrowing records from the Veritec statewide database. By no more than 12 weeks after the survey (in practice, typically at 10 weeks), people

[11] Although Augenblick and Rabin (2019) show that this distortion is bounded in deterministic, continuous-effort settings, this does not generalize to our stochastic discrete choice setting.

who had received Money For Sure or had been offered $100 If You Are Debt-Free and had not borrowed were sent an email from our gift card vendor explaining how to claim their cash cards.

4 Data

4.1 Survey and Borrowing Data

13,191 people took out payday loans from one of the Lender's stores on a day when the survey was available in that store. We have the Lender's records for those 13,191 loans, plus all loans from 2012 through February 2018 for a random sample of the Lender's customers nationwide who took out payday loans either online or in storefronts. The Lender's data include income, an internal credit score on a scale from 0–1000, pay cycle length, loan length, and loan amount. For our analyses using the Lender's nationwide data, we use all loans disbursed in 2017, the most recent complete year. From the statewide payday lending database managed by Veritec, we also observe whether each survey participant got another loan from any lender over the next eight weeks after they took the survey. Payday borrowers typically borrow from only one lender, and reborrowing rates are almost exactly the same whether calculated with the Lender's data or with the Veritec data. Appendix Table A1 presents more information on our key variables and their sources. Appendix Table A2 documents that the Incentive and Control groups are balanced on observables.

Of the 13,191 people who took out loans on survey days in survey stores, 2,236 consented and 2,122 completed the survey, of whom 1,205 had valid survey data under the four pre-registered criteria introduced in Section 3. See Appendix Table A3 for details. Unless otherwise noted, figures and tables in the paper are limited to the 1,205 borrowers with valid data, following our pre-registered sample inclusion criteria.[12] Three percent of surveys were completed by borrowers who had not responded in the store and were invited by email. Although our valid sample comprises only a small share of customers who could have taken the survey, Table 1 shows that they are comparable on our observable characteristics to the 13,191 borrowers on survey days and to the Lender's borrowers nationwide in 2017. The average loan length in our survey sample is 16 days, the average loan amount is $373, and borrowers' average annual income is about $34,000.

To cleanly compare predicted and actual borrowing, our survey participants' borrowing after the survey must not be affected by unexpected common shocks. For example, if unemployment suddenly rose in the two months after the survey, this could cause an unpredicted borrowing increase that our framework would attribute to naivete. Appendix Figure A4 shows that in Indiana over the study period, per-capita income growth was steady and unemployment varied by only 0.1 percentage points.

We say that borrowers *reborrowed* if they were issued another loan from any payday lender at any point between the day they took the survey and eight weeks after the survey. We say that borrowers *defaulted* on a loan if they did not pay off all principal and fees owed. We say that borrowers *repaid* if they did not reborrow or default—that is, if they did not owe debt to a payday

[12] The pre-registration is available at www.socialscienceregistry.org/docs/analysisplan/2037.

lender at any point between the day their current loan (at the time of the survey) came due and eight weeks after the survey. We define a *loan sequence* (or *borrowing spell*) as a series of loans with no more than eight weeks between any two loan disbursals.

4.2 Expert Survey

Before releasing our paper, we elicited predictions of our results and opinions about payday lending regulation from a sample of domain experts, following recent work by DellaVigna and Pope (2018) and others. We surveyed both academic and non-academic experts. For academics, our sample frame was behavioral and household finance economists we cited in our April 2019 draft, plus participants before two seminar presentations in April 2019. For non-academic experts, the sample frame was (i) the chief consumer finance regulator in each of the 50 states plus DC, (ii) the lead staff person for each Congressperson and Senator on the federal House and Senate financial services committees, (iii) researchers and regulators working on consumer lending and credit from the CFPB and the Department of Defense, and (iv) leadership and head payday lending experts at five major think tanks (the Pew Center, the Center for Financial Services Innovation, the Consumer Federation of America, the National Consumer Law Foundation, and the Center for Responsible Lending).

The survey began with a detailed description of our study's context and sample, followed by two sets of questions. First, we elicited opinions about whether three common types of payday lending regulation were good or bad for consumers, and the certainty that the expert had in her answer. Second, we elicited predictions of our empirical results. To elicit expert beliefs about borrowers' misprediction, we asked if the experts thought that the average payday loan borrower underestimates, overestimates, or correctly foresees the chance that she will reborrow in the future. We then told experts that borrowers in our data had about a 70 percent chance of reborrowing over the next eight weeks, and asked for their estimate of borrowers' average predicted reborrowing probability.[13] To elicit expert beliefs about borrowers' demand for behavior change, we asked if the experts thought that "the average payday loan borrower would want to give herself extra motivation to avoid re-borrowing." For experts who reported that they had a PhD in economics, we also elicited their estimate of borrowers' average $\tilde{\beta}$ parameter.

We had 103 respondents, of whom 68 percent work at a university and have a PhD in economics. See Appendix Table A4 for descriptive statistics. Appendix J presents the full expert survey instrument.

5 Reduced-Form Empirical Results

This section presents answers to our two empirical research questions using only minimal modeling assumptions.

[13]We said 70 percent because we did not yet know the sample average reborrowing probability when we fielded the expert survey.

Define b as possible amounts of a no-borrowing incentive and $\gamma = \$100$ as the actual incentive offered in our experiment. Define $\mu(b)$ and $\tilde{\mu}(b)$ as the actual and perceived probabilities of reborrowing over the next eight weeks. Define $w(b)$ as a borrower's valuation of a no-borrowing incentive of amount b, i.e. the $w(b)$ such that the borrower would be indifferent between a b dollar no-borrowing incentive and $w(b)$ dollars of Money for Sure. To be concise, we often use w (with no argument) to refer to the $w(\gamma)$ elicited on the survey.

Figure 1 illustrates the framework guiding our analysis. The x-axis is the probability of borrowing in the next eight weeks, and the y-axis is the cost of borrowing. There are three demand curves: actual, predicted, and desired. In a standard model of time-consistent consumers with rational expectations, these three curves coincide. Actual and predicted demand differ if people mispredict future borrowing due to naivete about self-control problems, overoptimism about or inattention to future income or expenditure needs, or any other reason. Predicted and desired demand differ if people perceive themselves to be time inconsistent.

5.1 Do Borrowers Anticipate Repeat Borrowing?

We begin by comparing predicted and actual borrowing in the standard environment without the experimental no-borrowing incentive. Figure 2 shows that the average borrower predicts she has a $\tilde{\mu}(0) \approx 70$ percent chance of borrowing without the incentive, while in reality, $\mu(0) \approx 74$ percent of borrowers in the Control group did borrow. This implies that the average borrower almost fully anticipates repeat borrowing.[14] Although our pre-registered exclusion restrictions could in principle be correlated with sophistication, we find that is not the case: Appendix Figure A10 shows that the results are largely the same when we do not apply the restrictions.

This slightly underestimated borrowing probability is consistent with responses to an additional qualitative survey question. When asked how their past expectations of payday loan usage had lined up with reality, 36, 25, and 39 percent of borrowers reported getting payday loans "more often than I expected," "less often than I expected," and "about as often as I expected," respectively. This response distribution is close to the rational expectations benchmark, under which equal shares of people would report borrowing "more often" and "less often" than expected.

Figure 3 presents misprediction as a function of recent borrowing experience. The four experience groups are approximately quartiles of the experience distribution in our sample. Borrowers who had gotten three or fewer loans in the previous six months underestimate future borrowing by 20 percentage points, whereas borrowers with four or more recent loans predict close to correctly on average.[15] This is consistent with borrowers learning from experience—either about their present

[14] The samples in the left and right spikes of Figure 2 are different in that the left spike includes the full sample while the right spike includes the (randomly assigned) Control group only. This makes little difference for the conclusion because there is only minimal sampling error: the Control group's predicted borrowing probability without the no-borrowing incentive is 69 percent.

[15] Over-optimistic beliefs are sometimes attributed to aspirational reporting, where time-inconsistent people misreport beliefs in order to encourage future behavior change (Augenblick and Rabin, 2019). The fact that experienced borrowers are on average exactly right suggests that this and related reporting biases did not affect their reports, although such factors could in principle affect less experienced borrowers.

focus or about the consequences of borrowing, as we discuss further in Section 6.8. It is also possible that this correlation is due to unobserved factors that positively correlate with both reborrowing and sophistication, although it is unclear what these factors might be, and our model in Section 7 predicts a negative correlation: all else equal, sophisticated types reborrow *less*, which would imply a learning effect even larger than suggested by the correlation in Figure 3.[16]

This evidence that experienced borrowers are sophisticated differs from evidence of substantial naivete in other settings. One potential explanation is that learning is context-specific, and payday borrowing is a high-stakes domain with clear feedback and repeated learning opportunities.[17]

Appendix B further explores borrowers' beliefs, showing that predicted and actual borrowing are positively correlated. This relationship is attenuated relative to a 45-degree line because of survey response noise due to rounding and other cognitive difficulties in articulating probabilities. However, we show in the appendix that this does not bias our estimate of individuals' average forecast, because rounding leads to approximately mean-zero measurement error in people's true subjective beliefs.

The respondents to our expert survey believed that borrowers would be much more naive than they actually are. 78 percent of our respondents thought that the average borrower underestimates reborrowing. Figure 4 presents the distribution of respondents' beliefs about borrowers' average predicted reborrowing probability. The average respondent thought that the average borrower would predict only a 40 percent chance (standard error = 2.1 percent) of reborrowing over the next eight weeks, a 30 percentage point misprediction relative to the 70 percent reborrowing probability we told the experts. This contrasts sharply with the limited misprediction documented in Figure 2.

Misprediction in Incentive condition. A related but different question is whether people correctly predict their borrowing in the Incentive condition. The average borrower predicts that she has only a $\tilde{\mu}(\gamma) \approx 50$ percent chance of borrowing if offered the no-borrowing incentive, while in reality, $\mu(\gamma) \approx 70$ percent of borrowers in the Incentive group did borrow. Putting this together with the averages in Figure 2, this implies that the average borrower predicts that the no-borrowing incentive would reduce borrowing by $\tilde{\Delta} := \tilde{\mu}(0) - \tilde{\mu}(\gamma) \approx 20$ percentage points, whereas in reality, the incentive reduced borrowing by only $\mu(0) - \mu(\gamma) \approx 3.8$ percentage points.

There are several potential explanations. First, even if borrowers correctly predict their status quo borrowing probability, they might overestimate their demand response if liquidity shocks have

[16] Appendix Figure A11 shows qualitatively similar results after defining experience to be the number of previous loans in the current loan cycle. Appendix Figure A12 shows that the decrease in misprediction with experience is driven mostly by higher predicted borrowing probability, not lower actual borrowing probability. Appendix Figure A13 shows that misprediction does not differ statistically by internal credit score or income.

[17] Settings where significant naivete has been documented include real-effort laboratory experiments (Augenblick and Rabin 2019), which are low-stakes one-shot settings, and gym attendance (DellaVigna and Malmendier 2004; Acland and Levy 2015; Carrera et al. 2019), which has repeated learning opportunities but relatively low stakes. Kaur, Kremer, and Mullainathan (2015) and Yaouanq and Schwardmann (2019) find that people become more sophisticated over time in experiments with clear and salient feedback. Theoretical models show that learning is enhanced by stakes in the presence of partial commitment devices (Ali 2011), or by the possibility of many future contracting opportunities (Gagnon-Bartsch, Rabin, and Schwartzstein 2019).

higher variance than they realize. Indeed, because of the lack of price variation in the payday loan market, borrowers have little opportunity to learn their price elasticity. Second, because the experimental incentive is new and unfamiliar, borrowers may have forgotten about it and failed to predict that they would forget. Indeed, although our participants are liquidity constrained and we sent two reminder emails, our gift card vendor reports that only 44 percent of the $100 gift cards were claimed, compared with 76 percent of the $10 gift cards given as participation payments the day after the survey. Third, experimenter demand effects could have caused people to overstate their beliefs about the effect of the incentive.

Appendix Figure A14 shows that there is no relationship between experience and misprediction in the Incentive condition. Because experienced borrowers are more accurate in the Control condition, this means that experienced borrowers are actually worse at predicting the effect of the incentive relative to Control. This suggests that learning is context-specific and bias-specific. Borrowers may be fairly sophisticated about their present focus in normal conditions, but very naive about their propensity to forget in unfamiliar conditions.

Figure 5 presents estimates of the average predicted and actual effects of the incentive separately for people who reported that the incentive would reduce their borrowing and people who reported that it would not. Because of noise in reported beliefs, the latter group includes the five percent of respondents who reported $\tilde{\mu}(\gamma) > \tilde{\mu}(0)$, and splitting on *reported* beliefs may not be the same as splitting on *actual* beliefs. The figure shows that the low predicted response group correctly predicts that the incentive will not affect their borrowing and the high predicted response group correctly predicts that the incentive will reduce their borrowing, but the latter group substantially overestimates the actual effect.

The bulk of the evidence suggests that misprediction in the Incentive condition lacks external validity: it appears to be driven by the unusual nature of the experimental incentive. Thus, we use only the misprediction in the status quo Control condition to identify naivete. Our estimates in Sections 5.2 and 6 rely only on the assumption that people truthfully reported their subjective beliefs (on average) about the effect of the incentive on borrowing; the fact that these subjective beliefs are incorrect does not matter. We explore robustness to this assumption in Section 6.

5.2 Do Borrowers Perceive Themselves to Be Time Consistent?

To identify perceived time inconsistency, we compare valuations of the no-borrowing incentive to the valuation a time-consistent borrower would have. Our strategy exploits the fundamental link between time consistency and the Envelope Theorem for dynamic optimization. A time-consistent person's expected utility is unaffected by marginal changes in her future behavior, since her future behavior maximizes her current utility function (by definition). Thus, a time-consistent borrower's valuation of a marginal no-borrowing incentive equals the mechanical effect of the incentive on cash-on-hand; the induced marginal behavior change has no effect. By contrast, future behavior changes do have first-order effects on the expected utility of time-*in*consistent people because they do not share the preferences of their future selves. Thus, a time-inconsistent borrower's valuation of the no-borrowing incentive will include this additional effect.

Combining valuations of future price changes with predictions of future behavior thus allows tests of whether people perceive themselves to be time inconsistent. To be clear, this is a test of perceived, not actual, time inconsistency, and the test is robust to misprediction of the effects of the no-borrowing incentive.

For intuition, examine Figure 1. For this figure, we assume that borrowers have constant marginal utility from the experimental payments. The no-borrowing incentive of $\gamma = \$100$ is equivalent to giving people \$100 while also increasing the price of borrowing by \$100. Thus, a time-consistent borrower values the incentive at \$100 minus the consumer surplus loss from a \$100 price increase. On the figure, this consumer surplus loss is area ABCD. Thus, borrowers who perceive themselves to be time consistent will value the incentive at $\$100 - ABCD$.

However, borrowers who perceive themselves to be time-inconsistent predict that they will have different preferences in the future than they do when they take the survey. The figure captures this by distinguishing between predicted and desired demand. As drawn, desired demand is shifted inward, meaning that borrowers want their future selves to borrow less. The perceived additional utility gain from a marginal behavior change is the vertical distance between perceived and desired demand, which integrates to the trapezoid ABEF over the behavior change induced by the $\gamma = \$100$ incentive. Thus, borrowers who perceive themselves to be time inconsistent will value the incentive at $\$100 - ABCD + ABEF$.

In Appendix D.1, we formalize this idea using the the general Envelope Theorem results developed by Milgrom and Segal (2002) for arbitrary choice-sets, which encompass almost any time-consistent stochastic dynamic programming model. We summarize the key results here using simplified notation.

Consider a time-consistent borrower determining her change in valuation $w'(b)db$ from a marginal incentive change db. Let $\bar{m}_1$ and $\bar{m}_0$, respectively, denote the expected marginal utilities of money (for the time when the experimental payments are made) across states of the world in which the person does and does not borrow. The borrower predicts that she will avoid borrowing with probability $1 - \tilde{\mu}$, and the expected marginal utility in that state of the world is $\bar{m}_0$, so the Envelope Theorem implies that utility from the change db is $(1 - \tilde{\mu})db\bar{m}_0$. Similarly, the expected utility from $w'(b)db$ Money for Sure is $(\tilde{\mu}\bar{m}_1 + (1 - \tilde{\mu})\bar{m}_0)\, w'(b)db$.

Thus, the valuation $w'(b)db$ of a marginal incentive change db satisfies

$$\underbrace{(\tilde{\mu}\bar{m}_1 + (1 - \tilde{\mu})\bar{m}_0)\, w'(b)db}_{\text{expected utility from Money for Sure}} = \underbrace{(1 - \tilde{\mu})db\bar{m}_0}_{\text{expected utility from incentive}}. \tag{1}$$

If the borrower is risk neutral over income, then $\bar{m}_0 = \bar{m}_1$, and $w'(b)db = (1-\tilde{\mu})db$. In practice, we expect $\bar{m}_0 \leq \bar{m}_1$, both because the income from a non-marginal incentive reduces marginal utility and because people have higher marginal utility of income in the states of the world where they need to borrow. This implies

$$w'(b)db \leq (1 - \tilde{\mu})db. \tag{2}$$

To determine a borrower's valuation of the non-marginal no-borrowing incentive γ, we integrate over Equation (2) as formalized in Appendix D.1. Assuming that $\tilde{\mu}$ is locally linear in the incentive over this range, we show in Appendix D.2 that borrowers who perceive themselves to be time consistent must have

$$w(\gamma) \leq w^* := \left(1 - \tilde{\mu}(0) + \frac{\tilde{\Delta}}{2}\right)\gamma, \tag{3}$$

where $\tilde{\Delta} := \tilde{\mu}(0) - \tilde{\mu}(\gamma)$.[18] With constant marginal utility, this holds with equality, and the right-hand side is the valuation we derived graphically on Figure 1: \$100 $- ABCD$. Because the bound uses subjective expectations $\tilde{\mu}$, it is valid for borrowers who mispredict borrowing for any reason, including if they unexpectedly forget about the no-borrowing incentive.

Now consider borrowers who perceive themselves to be time *in*consistent. The standard Envelope Theorem logic does not apply: borrowers who perceive themselves to be time inconsistent believe that their future behavior will not optimize current utility, so their valuation of the incentive includes the current utility benefits from behavior change. The perception that one will "overborrow" ("underborrow") in the future relative to current preferences will increase (decrease) valuations of the no-borrowing incentive. Valuations w above the valuation bound w^* from Equation (3) are consistent with perceived overborrowing.[19] Valuations below that bound could be consistent with perceived underborrowing or with $\bar{m}_0 < \bar{m}_1$. Thus, we have a one-sided test of time inconsistency. In Section 6, we impose additional structure to tighten the bound and allow two-sided tests. Even the one-sided test, however, is significantly more powerful in detecting perceived time inconsistency than is the take-up of commitment contracts with no financial upside, since demand for such contracts is easily eroded by the need for flexibility in an uncertain environment (e.g., Heidhues and Kőszegi, 2009; Laibson, 2015; Carrera et al., 2019).

Figure 6 presents the key moments that identify time inconsistency. The first spike shows that the average borrower in our sample values the \$100 no-borrowing incentive at \$52. The second spike is the valuation bound for time-consistent borrowers from the right-hand side of Equation (3): $w^* = \left(1 - 70\% + \frac{70\% - 50\%}{2}\right) \times \$100 \approx \$40$ on average. Since the average valuation exceeds the average valuation bound, we infer that the average borrower perceives herself to be time inconsistent. We refer to the difference between these first two spikes, i.e. the average of $w - w^*$, as the "behavior change premium." This is \$12 on average, or 30 percent more than the average valuation bound.

The third spike on Figure 6 shows that the average borrower is willing to pay \$42 for the \$100 coin flip. This implies material risk aversion, with a risk premium of about \$8 for a 50 percent chance of receiving \$100. Thus, the \$12 behavior change premium could be a loose lower bound on

[18] The bound continues to hold if $\tilde{\mu}$ is concave in b, and increases only slightly under reasonable functional forms when $\tilde{\mu}$ is convex. For example, if $\tilde{\mu}'(\gamma) = \frac{1}{4}\tilde{\mu}'(0)$, constituting an arguably high degree of curvature, Equation (3) becomes $w(\gamma) \leq [(1 - \tilde{\mu}(0)) + 0.6(\tilde{\mu}(\gamma) - \tilde{\mu}(0))]\,\gamma$ under a quadratic approximation to $\tilde{\mu}$. See Appendix D.2 for details.

[19] If people understate their true predicted borrowing probability $\tilde{\mu}(\gamma)$ on the survey, then the valuation bound we calculate is higher than the "correct" valuation bound, which biases against detecting perceived time inconsistency.

borrowers' actual valuation of the behavior change induced by the incentive.

This perceived time inconsistency is consistent with qualitative survey responses. Panel (a) of Figure 7 shows that 54 percent of people report that they would "very much" like to give themselves extra motivation to avoid future payday loan debt, 36 percent report "somewhat," and only 10 percent "not at all." Panel (b) shows that although many people want motivation to avoid payday loan debt, they tend to think that restrictions on repeat borrowing would be bad for them. This is consistent with uncertainty about liquidity shocks creating a need for flexibility. Responses to these two questions are correlated: people who want more motivation are more likely to think that borrowing restrictions would be good for them.

Appendix Figure A2 presents the distribution of valuations of the no-borrowing incentive. Figure 8 shows that the behavior change premium is correlated with other survey responses in expected ways. People who report that they want more motivation to avoid payday loan debt, that a rollover restriction would be good for them, or that the incentive will reduce their probability of borrowing have higher behavior change premia.

6 Partially-Naive Present Focus Model

6.1 Model

The previous section shows that misperceived borrowing and perceived time inconsistency are identified with minimal assumptions. In this section, we use similar identification ideas and additional assumptions to estimate a structural model of borrowers' time preferences and beliefs.

We assume that borrowers have quasi-hyperbolic preferences given by $U_t = u_t + \beta \sum_{\tau=t+1}^{T} \delta^{\tau-t} u_\tau$, where u_t is the period t utility flow. Following O'Donoghue and Rabin (2001), we allow people to mispredict their preferences: in all periods $t < \tau$, they predict that their period τ self will have short-run discount factor $\tilde{\beta}$. We discuss other misprediction models in Section 6.7.

Our model builds on Heidhues and Koszegi (2010). We focus on three periods of a potentially longer or infinite-horizon model. In period 0, the borrower gets a loan of amount l and then takes our survey. The next eight weeks after the survey are period 1. At the beginning of period 1, the borrower receives a smoothly distributed transitory shock θ. This shock captures expenses (such as car repairs) and income shocks (such as being scheduled for fewer hours at work) that are unpredictable as of period 0. In period 1, the borrower chooses to either *repay* or *reborrow*. If she repays, she pays the principal and fee $l + p(l)$ in period 1 and receives no-borrowing incentive b in period 2. If she reborrows, she pays only the fee $p(l)$ in period 1, owes $l + p(l)$ in period 2, and does not receive the no-borrowing incentive.

For notational convenience, we define repayment cost and continuation cost functions, with the understanding that these functions correspond to reduced consumption and reduced continuation values. The cost of paying amount x in period 1 is a smooth function $k(x, \theta)$ that is convex in x and strictly increasing in θ. The expected reduction in period 2 continuation value caused by period 2 debt x is $\tilde{C}(x)$. The x in $\tilde{C}(x)$ can be negative for borrowers who are owed an incentive payment.

For simplicity, the exposition in this section assumes that the borrower has the same expectation $\tilde{C}$ of period 2 continuation costs in both periods 0 and 1. However, the proofs of this section's results in Appendix E allow for certain types of correlated shocks that reveal additional information about $\tilde{C}$ in period 1.

The assumption of a well-behaved continuation cost function $\tilde{C}$ is far from innocuous when $\tilde{\beta} < 1$, because $\tilde{C}$ is the solution to a non-cooperative game played between the different selves (Harris and Laibson 2001; Laibson et al. 2015). In Appendix F.1, we show existence, uniqueness, and smoothness of $\tilde{C}$ in the fully dynamic model presented in Section 7.

Three assumptions of this framework should be made explicit. First, people cannot get a loan of any amount other than l in period 1. As shown in Appendix Figure A1, this is realistic because most people either repay or reborrow the same amount as their previous loan. Second, borrowers cannot default in period 1. This is a reasonable approximation because the probability of default on any one loan is only 3 percent. The microfounded model in Appendix F.1 allows people to default in period 2 or later, so the possibility of default can influence the period 2 continuation value $\tilde{C}$. Third, borrowers have only one borrowing decision in period 1.

To quantify the different marginal utilities $\bar{m}_1$ and $\bar{m}_0$ from Section 5.2, we use a quadratic approximation to $\tilde{C}(x)$. Let $\alpha := \frac{\tilde{C}''(0)}{\tilde{C}'(0)}$ be the coefficient of absolute risk aversion at $x = 0$, and define $\rho := \alpha(l + p)$. Under a quadratic approximation, ρ approximates the percent difference in marginal utilities when people reborrow versus repay: $\rho \approx \tilde{C}'(l + p)/\tilde{C}'(0) - 1$.

6.2 Demand for Payday Loans

This formulation allows us to put structure on the desired, predicted, and actual demand curves from Figure 1. Define θ^*_B as the cutoff value of θ at which the period 1 benefits of reborrowing equal the discounted period 2 costs:

$$\underbrace{k(l+p,\theta^*_B) - k(p,\theta^*_B)}_{\text{period 1 utility benefit of reborrowing}} = \underbrace{B\delta\left(\tilde{C}(l+p) - \tilde{C}(-b)\right)}_{\text{period 2 continuation cost of reborrowing}}. \tag{4}$$

The actual, predicted, and desired cutoffs θ^*_B are derived from setting $B = \beta$, $B = \tilde{\beta}$, and $B = 1$, respectively. The borrower reborrows when $\theta > \theta^*_\beta$. When taking the survey in period 0, the borrower predicts that she will reborrow if $\theta > \theta^*_{\tilde{\beta}}$. To maximize period 0 utility, the borrower would reborrow if $\theta > \theta^*_1$. Actual, predicted, and desired demands are thus the probability that θ exceeds θ^*_β, $\theta^*_{\tilde{\beta}}$, and θ^*_1, respectively.

The constant marginal utility case from Section 5.2 corresponds to linear $\tilde{C}$. Under this assumption, Equation (4) can be written as

$$\frac{k(l+p,\theta^*_B) - k(p,\theta^*_B)}{B\delta\tilde{C}'} = l + p + b. \tag{5}$$

Now the period 1 benefits and period 2 costs of reborrowing are in units of period 2 dollars, consistent with the y-axis of Figure 1. Each borrowing probability on the x-axis corresponds to a unique θ_B^*, and thus a unique numerator on the left-hand side of Equation (5). Since predicted demand uses $B = \tilde{\beta}$ instead of $B = \beta$ in the denominator, predicted demand is shifted down from actual demand by proportion $\beta/\tilde{\beta}$ on Figure 1. Since desired demand uses $B = 1$, desired demand is shifted down from predicted demand by proportion $\tilde{\beta}$.

6.3 Identifying Sophistication versus Naivete

In Section 5.1, we compared predicted and actual demand to identify misprediction in probability units. We now identify the relationship between β and $\tilde{\beta}$ by transforming misprediction into marginal utility units.

Define $\gamma^\dagger$ such that $\tilde{\mu}(\gamma^\dagger) = \mu(0)$. In words, γ is the no-borrowing incentive at which predicted demand with the incentive would equal actual demand without the incentive. Under a linear approximation, the perceived demand slope is $\frac{-\tilde{\Delta}}{\gamma}$ (where $\tilde{\Delta} := \tilde{\mu}(0) - \tilde{\mu}(\gamma)$, as before), the definition of $\gamma^\dagger$ becomes $\tilde{\mu}(0) + \gamma^\dagger \frac{-\tilde{\Delta}}{\gamma} = \mu(0)$, and thus

$$\gamma^\dagger = \frac{\gamma}{-\tilde{\Delta}} \left(\mu(0) - \tilde{\mu}(0) \right). \tag{6}$$

This shows how $\gamma^\dagger$ transforms misprediction $\mu(0) - \tilde{\mu}(0)$ into dollar units using the perceived demand slope $\frac{\gamma}{-\tilde{\Delta}}$. In Figure 1, $\gamma^\dagger$ is the vertical distance between points H and G, the predicted and actual demand curves at probability $\mu(0)$. $\gamma^\dagger > 0$ implies that people overestimate future borrowing, while $\gamma^\dagger < 0$ implies that people underestimate borrowing. From Section 5.1, we know that $\gamma^\dagger < 0$ on average in the data.

We can also write $\gamma^\dagger$ as a function of β and $\tilde{\beta}$ using the right-hand side of Equation (4). For $\gamma^\dagger$ to equate predicted demand at incentive $\gamma^\dagger$ with actual demand at zero incentive, it must also equate the predicted period 2 reborrowing cost at incentive $\gamma^\dagger$ with the actual reborrowing cost at zero incentive:

$$\underbrace{\beta \left[\tilde{C}\left(l+p\right) - \tilde{C}(0) \right]}_{\text{period } t \text{ self's borrowing cost}} = \underbrace{\tilde{\beta} \left[\tilde{C}\left(l+p\right) - \tilde{C}(-\gamma^\dagger) \right]}_{\text{predicted borrowing cost with incentive } \gamma^\dagger}. \tag{7}$$

We can re-write this as a function of α and ρ using a quadratic approximation to $\tilde{C}$.

Proposition 1. *Assume that terms of order $(l+p+b)^3 \tilde{C}'''$ and $\tilde{\mu}''\gamma^2$ are negligible. Then*

$$\underbrace{\beta \left(l+p\right) \left(1 + \frac{\rho}{2}\right)}_{\textit{period } t \textit{ self's borrowing cost}} = \underbrace{\tilde{\beta} \left(l+p+\gamma^\dagger\right) \left(1 + \frac{\rho}{2} - \frac{\alpha}{2}\gamma^\dagger\right)}_{\textit{predicted borrowing cost with incentive } \gamma^\dagger}, \tag{8}$$

where $\gamma^\dagger = \frac{\gamma}{-\tilde{\Delta}} \left(\mu(0) - \tilde{\mu}(0) \right)$.[20]

[20] The quadratic approximation to $\tilde{C}$ is increasing in $\gamma^\dagger$ for all $\gamma^\dagger < 0$. The quadratic function $(l+p+x)(1+\rho/2 - \alpha/2x)$ can be factored as $(l+p+x)(2/\alpha + l + p - x)\alpha/2$, which has its vertex at $1/\alpha$. Thus, $\gamma^\dagger$ uniquely identifies $\beta/\tilde{\beta}$.

If $\tilde{C}$ is linear, then $\rho = \alpha = 0$, and thus

$$\frac{\beta}{\tilde{\beta}} = \frac{l + p + \gamma^{\dagger}}{l + p}. \tag{9}$$

We can see this equation on Figure 1. Both the left-hand side and right-hand side reflect the ratio of the height of H to the height of G, i.e. the ratio of predicted to actual marginal utility at probability $\mu(0)$. We infer lower $\beta/\tilde{\beta}$ (more naivete) when $\gamma^{\dagger}$ is more negative (people more heavily underestimate future borrowing).

In Appendix E.1, we show that Equation (9) provides a lower bound on $\beta/\tilde{\beta}$ under general assumptions allowing any convex $\tilde{C}$ (not just a quadratic approximation) and arbitrarily correlated shocks to k and $\tilde{C}$.

6.4 Identifying Perceived Present Focus

In Section 5.2, we identified perceived time inconsistency by testing for whether people value the no-borrowing incentive more than they would if they perceived themselves to be time consistent. We now identify perceived present focus parameter $\tilde{\beta}$ by putting more structure on that intuition.

For this section, we need to consider how predicted reborrowing $\tilde{\mu}$ depends on both Money for Sure w and on the no-borrowing incentive b, and thus we sometimes write $\tilde{\mu}(w, b)$ in the derivations. When $\tilde{\mu}$ has one argument, we continue to mean $\tilde{\mu}(b)$.

From the perspective of the period 0 self, the change in expected utility from a marginal change in b at $w = 0$ is

$$\frac{dV}{db} = \delta \left[\underbrace{\left[\left(k(l+p, \theta^*_{\tilde{\beta}}) - k(p, \theta^*_{\tilde{\beta}})\right) - \delta\left(\tilde{C}(l+p) - \tilde{C}(-b)\right)\right]}_{\text{utility loss from marginal borrowing probability increase}} \underbrace{\tilde{\mu}'_b(0,b)}_{\Delta \text{ behavior}} + \delta \underbrace{(1 - \tilde{\mu}(0,b))\tilde{C}'(-b)}_{\text{mechanical effect}} \right] \tag{10}$$

The "mechanical effect" is the expected utility gain from the increased incentive, holding behavior constant. From Equation (4), the period 0 self predicts that the period 1 self will set $k(l+p, \theta^*_{\tilde{\beta}}) - k(p, \theta^*_{\tilde{\beta}}) = \tilde{\beta}\delta\left(\tilde{C}(l+p) - \tilde{C}(-b)\right)$. Substituting this into (10) yields

$$\frac{dV}{db} = \delta^2 \left[-\underbrace{\left(1 - \tilde{\beta}\right)\left(\tilde{C}(l+p) - \tilde{C}(-b)\right)}_{\text{perceived internality}} \underbrace{\tilde{\mu}'_b(0,b)}_{\Delta \text{ behavior}} + \underbrace{(1 - \tilde{\mu}(0,b))\tilde{C}'(-b)}_{\text{mechanical effect}} \right]. \tag{11}$$

This follows the Envelope Theorem discussion from Section 5.2. Borrowers with $\tilde{\beta} = 1$ perceive that period 1 behavior maximizes period 0 preferences, so the first term inside the brackets drops out and $\frac{dV}{db}$ is just the mechanical effect of the incentive.

Using similar logic, the period 0 self's change in expected utility from a marginal change dw in Money for Sure at $b = 0$ is

$$\frac{dV}{dw} = \delta^2 \left[-\underbrace{\left(1-\tilde{\beta}\right)\left(\tilde{C}(l+p-w)-\tilde{C}(-w)\right)}_{\text{perceived internality}} \underbrace{\tilde{\mu}'_w(w,0)}_{\Delta \text{ behavior}} + \underbrace{(1-\tilde{\mu}(w,0))\tilde{C}'(-w)+\tilde{\mu}(w,0)\tilde{C}'(l+p-w)}_{\text{mechanical effect}} \right]. \tag{12}$$

To compute the non-marginal effects of w and b, we integrate over the marginal conditions above and set them equal. To obtain simple approximations to these integrals in terms of observables, we continue to assume that $\tilde{\mu}$ is locally linear and take a quadratic approximation to $\tilde{C}$.

Proposition 2. *Assume that terms of order $(l+p)^3\tilde{C}'''/\tilde{C}'$ are negligible and that $\tilde{\mu}$ is locally linear and separable in w and b. Then*

$$\left(1-\frac{\alpha w}{2}\right)\left\{ \underbrace{w \cdot \left(1+\rho\left(\tilde{\mu}(0)+\frac{w\rho}{\gamma}\frac{\tilde{\Delta}}{2}\right)\right)}_{\textit{utility from } w \textit{ if time consistent}} - \underbrace{\left(1-\tilde{\beta}\right)\left(1+\frac{\rho}{2}\right)(l+p)}_{\textit{perceived internality}} \underbrace{\frac{w\rho}{\gamma}\tilde{\Delta}}_{\Delta(w)\ \textit{behavior}} \right\} \tag{13}$$

$$= \left(1-\frac{\alpha\gamma}{2}\right)\left\{ \underbrace{\gamma \cdot \left(1-\tilde{\mu}(0)+\frac{\tilde{\Delta}}{2}\right)}_{\textit{utility from } \gamma \textit{ if time consistent}} + \underbrace{\left(1-\tilde{\beta}\right)\left(1+\frac{\rho}{2}\right)\left(l+p+\frac{\gamma}{2}\right)}_{\textit{perceived internality}} \underbrace{\tilde{\Delta}}_{\Delta(\gamma)\ \textit{behavior}} \right\}.$$

The left-hand side is the expected utility of $w(\gamma)$ dollars of Money for Sure, and the right-hand side is the expected utility of the γ no borrowing incentive.

If $\tilde{C}$ is linear, then $\alpha = \rho = 0$, and this simplifies to

$$w = \underbrace{\left(1-\tilde{\mu}(0)+\frac{\tilde{\Delta}}{2}\right)\gamma}_{\text{utility from } \gamma \text{ if time consistent}} + \underbrace{\underbrace{\left(1-\tilde{\beta}\right)\left(l+p+\frac{\gamma}{2}\right)}_{\text{perceived internality}} \underbrace{\tilde{\Delta}}_{\Delta(\gamma)\text{behavior}}}_{\text{internality reduction benefit}}. \tag{14}$$

We can see this equation on Figure 1. As discussed in Section 5.2, risk-neutral people who perceive they are time consistent value the no-borrowing incentive at $\left(1-\tilde{\mu}(0)+\frac{\tilde{\Delta}}{2}\right)\gamma$. The additional structure in this section allows us to map the behavior change premium trapezoid ABEF to an estimate of $\tilde{\beta}$. The height of the trapezoid is the difference between the weights that the period 0 and period 1 self put on the perceived period 2 continuation cost of reborrowing: $\left(1-\tilde{\beta}\right)\left(l+p+\frac{\gamma}{2}\right)$. The width is the change in borrowing probability $\tilde{\Delta} \coloneqq \tilde{\mu}(0)-\tilde{\mu}(\gamma)$. We infer a lower $\tilde{\beta}$ (more perceived present focus) when w is more positive (people are willing to pay more for the incentive to avoid future borrowing).

6.5 Identifying Curvature

Our formulas can accommodate any curvature parameter α. One approach is to use borrowers' certainty equivalents of the Flip a Coin for \$100 lottery: lower certainty equivalents imply more curvature. In Appendix E.3, we show that this implies a sample average $\alpha \approx 0.0064$.

The benefit of this approach is that α is elicited from our population of payday borrowers. Curvature estimates from other populations may not be relevant: the fact that payday borrowers carry costly debt suggests that their marginal utility may be sensitive to small gains and losses. However, $\alpha \approx 0.0064$ may be too large: under a quadratic approximation, $\alpha \approx 0.0064$ implies that an extra \$100 of debt increases utility from the marginal dollar by 64 percent, and thus borrowers who have \$400 more debt (approximately the average loan size) in period 2 have 256 percent higher marginal utility. One potential confound is that since the \$100 lottery is smaller than most loans, certainty equivalents may be affected by small-stakes risk aversion that is behaviorally distinct from utility function curvature (Rabin 2000). For comparison, our lottery α estimate is 3 to 30 times larger than other estimates using higher-stakes field decisions such as insurance choice and labor supply in less liquidity-constrained populations.[21] In our empirical estimation, we therefore consider multiple curvature values between $\alpha = 0.0064$ and $\alpha = 0$.

6.6 Empirical Implementation

In theory, Equations (8) and (13) hold for each individual borrower, and individual survey responses could imply individual-specific β and $\tilde{\beta}$. In practice, any survey responses are noisy, so we observe $\tilde{\mu}$, w, and risk aversion with measurement error. Furthermore, since Equations (8) and (13) involve squaring some of these survey response variables, we have non-classical measurement error that cannot be addressed by simply taking expectations.

To address this, we define groups of observations indexed by g and calculate group-level averages of the empirical objects in Equations (8) and (13), including $\gamma_g^\dagger = \frac{\gamma}{\tilde{\mu}_g(0)-\tilde{\mu}_g(\gamma)}\left(\mu_g(0) - \tilde{\mu}_g(0)\right)$. For our primary estimates, we use the five groups defined by quintiles of loan size l.

In Appendix E.4, we show how we can substitute the group average variables into Equations (8) and (13), take expectations over observations, and re-arrange, giving the following estimating equations:

$$\widehat{\left(\frac{\beta}{\tilde{\beta}}\right)} = \frac{\sum_i \left(l_g + p_g + \gamma_g^\dagger\right)\left(1 + \frac{\rho_g}{2} - \frac{\alpha_g}{2}\gamma_g^\dagger\right)}{\sum_i \left(l_g + p_g\right)\left(1 + \frac{\rho_g}{2}\right)} \tag{15}$$

and

[21] Using insurance decisions, Cohen and Einav (2007) estimate $\alpha \approx (0.00087, 0.0019)$, Handel (2013) estimates $\alpha \approx (0.00019, 0.000325)$, and Sydnor (2010) estimates $\alpha \approx 0.002$. Chetty (2006) estimates a constant relative risk aversion coefficient of 0.7 from labor supply elasticities, which translates to $\alpha \approx 0.0007$ if payday borrowers have \$1000 monthly "uncommitted" (in the sense of Chetty and Szeidl, 2007) consumption. Using relatively small-stakes gambles, van Gaudecker, van Soest, and Wengstrom (2011) estimate $\alpha \approx 0.03$, and Holt and Laury (2002) estimate $\alpha \approx 0.2$.

$$\hat{\tilde{\beta}} = 1 - \frac{\sum_i \left\{ w_g \cdot \left(1 + \rho_g \left(\tilde{\mu}_g(0) + \frac{w_g \rho_g}{\gamma} \frac{\tilde{\Delta}_g}{2}\right)\right) \left(1 - \frac{\alpha_g w_g}{2}\right) - \gamma \cdot \left(1 - \tilde{\mu}_g(0) + \frac{\tilde{\Delta}_g}{2}\right) \left(1 - \frac{\alpha_g \gamma}{2}\right) \right\}}{\sum_i \left(1 + \frac{\rho_g}{2}\right) \tilde{\Delta}_g \left\{ \left(l_g + p_g + \frac{\gamma}{2}\right) \left(1 - \frac{\alpha_g \gamma}{2}\right) + (l_g + p_g) \frac{w_g \rho_g}{\gamma} \left(1 - \frac{\alpha_g w_g}{2}\right) \right\}}. \quad (16)$$

If $\beta/\tilde{\beta}$ and $\tilde{\beta}$ are homogeneous across borrowers, Equations (15) and (16) deliver unbiased estimates as long as survey response error is mean-zero, so the expectations of w_g, $\tilde{\mu}_g$, μ_g, and $\gamma_g^{\dagger}$ equal the true group means. If $\beta/\tilde{\beta}$ and $\tilde{\beta}$ are heterogeneous, Appendix E.4 lays out a set of assumptions under which Equations (15) and (16) are unbiased. One key assumption is that terms of order $E[(1-\tilde{\beta}_i)^2|g]$ are negligible. This is reasonable because if we think that no borrowers have $\tilde{\beta} > 1$, not many borrowers can plausibly have $\tilde{\beta}_i \ll 1$ given that our empirical estimate is that the average $\tilde{\beta}_i$ is not far from one. A second key assumption is that $E[\tilde{\beta}_i|g]$ does not vary across g. This is reasonable if we think that perceived time inconsistency is unrelated to loan size. Other papers that estimate present focus models (e.g. Laibson et al. 2015; Skiba and Tobacman 2018) assume homogeneity or comparable orthogonality conditions, although Bai et al. (2018) estimate a distribution of unobserved heterogeneity.

If $\beta/\tilde{\beta}$ and $\tilde{\beta}$ are homogeneous or $\beta_i/\tilde{\beta}_i$ is orthogonal to $\tilde{\beta}_i$ (i.e., people who think they are more versus less present focused misperceive their true present focus by the same proportion on average), then the sample average β is simply

$$\hat{\beta} = \widehat{\left(\frac{\beta}{\tilde{\beta}}\right)} \cdot \hat{\tilde{\beta}}. \quad (17)$$

Appendix E.4 shows that this estimator is also unbiased if β_i is orthogonal to a naivete statistic $\frac{1-\tilde{\beta}_i}{1-\beta_i}$ introduced by Augenblick and Rabin (2019), which reflects the degree to which people think their present focus is closer to 1 than it actually is.

We estimate standard errors by bootstrapping.

6.7 Other Sources of Misprediction

This section has interpreted misprediction $\mu(0) - \tilde{\mu}(0)$ through the lens of a present focus model. However, misprediction could also be driven by overoptimism about future income or expenditure needs, or inattention to changes in those variables (Browning and Tobacman 2015; Karlan et al. 2016; Gabaix 2017). Our estimates of $\tilde{\beta}$ do not depend on the magnitude or source of misprediction, but our estimates of β could be affected.

For example, consider a model in which borrowers perceive that period 1 repayment costs k will be factor $\kappa \leq 1$ as large as they actually are. Then the right-hand side of Equation (7) is multiplied by $1/\kappa$, and the right-hand side of Equation (15) delivers an estimate of $\kappa \cdot \beta/\tilde{\beta}$. Intuitively, naivete about present focus causes a borrower to think that the period 1 self will give immediate costs $\beta/\tilde{\beta}$ less weight than she does in reality, which is mathematically isomorphic to believing that period 1 costs will be κ smaller than they are in reality (Browning and Tobacman 2015).

If $\kappa \neq 1$, we cannot estimate β with Equation (17). However, if we assume that $\kappa \leq 1$ and $\beta/\tilde{\beta} \leq 1$—that is, that borrowers are not *under*optimistic and do not perceive themselves to be *future* focused—then we can bound β on $\left[\widehat{\left(\frac{\beta}{\tilde{\beta}}\right)} \cdot \hat{\tilde{\beta}}, \hat{\tilde{\beta}}\right]$ using the estimates from Equations (15) and (16). The lower bound is from the assumption that $\kappa = 1$, so all of misprediction is driven by naivete about present focus, while the upper bound is from the assumption that $\beta/\tilde{\beta} = 1$, so all of misprediction is driven by other factors.

While Section 5 showed that borrowers overestimated the effect the incentive would have on borrowing, this should not affect our parameter estimates. We do not use misprediction in the Incentive condition to identify $\beta/\tilde{\beta}$, and our estimate of $\tilde{\beta}$ and the above bounds on β are valid as long as respondents correctly reported their beliefs on average on the survey. This would be the case under either of two plausible microfoundations for misprediction of the incentive effect: if $\kappa < 1$ and borrowers thus underestimate the *variance* in repayment cost shocks, or if they forget about the incentive with some probability in period 1, but naively fail to foresee this in period 0.

6.8 Parameter Estimates

Table 2 presents our parameter estimates. Column 1 presents the estimated average $\beta/\tilde{\beta}$, which can also be interpreted as κ in a model where borrowers perceive that future repayment costs will be share κ as large as they actually are. Column 2 presents the estimated average $\tilde{\beta}$. Column 3 presents the implied estimate of average β. As discussed in Section 6.7, this is a lower bound on β if $\kappa < 1$.

The first five rows present estimates using the full sample at different values of α. The estimates of $\beta/\tilde{\beta}$, $\tilde{\beta}$, and β are monotonic in α over this range, so the estimates for $\alpha \approx 0.0064$ and $\alpha = 0$ provide bounds. Our point estimates of borrowers' average $\beta/\tilde{\beta}$ range from 0.95 to 0.98, reflecting the fact that the sample slightly underestimates borrowing on average. For each α, $\beta/\tilde{\beta}$ is statistically distinguishable from one with slightly more than 95 percent confidence. Our point estimates of borrowers' average $\tilde{\beta}$ range from 0.76 to 0.87, and the upper end of the confidence intervals never exceeds 0.90. Assuming less risk aversion increases $\tilde{\beta}$ because it increases the modeled valuation that a time-consistent borrower would have for the (risky) incentive, thereby reducing the premium attributed to perceived internality reduction. The point estimates of β range from 0.74 to 0.83.

The next two rows present estimates for the subsample of borrowers who had gotten three or fewer loans from the Lender in the six months before taking the survey, for the bounding high and low values of α. The two rows after that present estimates for the complementary subsample with four or more loans of recent experience. Consistent with Figure 3, more experienced borrowers are fully sophisticated, with estimated $\beta/\tilde{\beta} \approx 1.00$, while less experienced borrowers have $\beta/\tilde{\beta}$ between 0.79 and 0.89. The point estimates for $\tilde{\beta}$ differ modestly. Under the plausible assumption that $\beta \leq \tilde{\beta}$ for all borrowers, this implies that experienced borrowers are all sophisticated, although there is more scope for significant heterogeneity among the inexperienced borrowers.

The implied lower bounds on β are statistically different for the two groups, especially for $\alpha = 0$. There are two possible explanations. First, it could be that the groups' actual β parameters are the same, and the reduced misprediction in the experienced group is from learning about the utility cost of repayment, not learning about present focus. Second, the different estimates could be driven by experiential learning in the sense of Laibson's (2018) "model-free equilibrium": borrowers with particularly low β learn that borrowing is delivering low payoffs, and they thus avoid borrowing. In this model, borrowers do not necessarily learn an exact model of their preferences, and their perceived $\tilde{\beta}$ does not necessarily change—the low-β types simply select out of borrowing.

As discussed in Section 6.6, we estimate population average parameters under certain orthogonality and homogeneity assumptions. The final rows of Table 2 present estimates where we separately estimate the parameters by above- versus below-median experience (our most important moderator) and take the subsample size-weighted average of the two estimates within each bootstrap replication. The resulting parameter estimates are almost identical to the primary estimates in the earlier rows. Thus, accounting for heterogeneity along this key dimension does not affect our estimates of the sample average.

So far, we have assumed that people correctly reported their beliefs (on average) on the survey. If people instead overstated their true beliefs $\tilde{\Delta}$ about the effect of the incentive, our parameter estimates can be interpreted as bounds. $\tilde{\beta}$ would be an upper bound (i.e. people perceive more present focus than we estimate), because if predicted behavior is less responsive to the incentive than people report, their internality reduction per unit of behavior change is higher than we estimate. Sophistication would be an upper bound (i.e. $\beta/\tilde{\beta}$ will be smaller than we estimate), because if predicted demand is less responsive than people report, a given amount of misprediction in the Control condition implies a larger difference in predicted versus actual marginal utility.

To explore possible magnitudes, we estimate $\beta/\tilde{\beta}$ and $\tilde{\beta}$ with alternative equations where we set $\tilde{\Delta}$ to half its reported amount, keeping $\alpha = 0.0064$. That is, we assume that people report that the incentive will reduce their borrowing probability by twice as much as they actually believe. Under this assumption, $\tilde{\beta}$ drops substantially to 0.54, and $\beta/\tilde{\beta}$ decreases to 0.95. Thus, to estimate $\tilde{\beta}$, it is crucial to assume that people reported their beliefs without bias. However, the fact that this alternative assumption delivers a low $\tilde{\beta}$ that is out of line with estimates from other domains provides additional support for the assumption that people did correctly report their beliefs.

The respondents to our expert survey believed that borrowers would have less demand for behavior change than they actually did. Only 56 percent believed that the average borrower would want motivation to avoid future borrowing. By contrast, Figure 7 documented that 90 percent of borrowers reported qualitatively that they wanted extra motivation to avoid payday loan debt. Quantitatively, Figure 9 shows that most respondents overestimated borrowers' average $\tilde{\beta}$. The average respondent predicted $\tilde{\beta} \approx 0.86$ (standard error = 0.03), which is larger than the point estimates in Table 2 except at $\alpha = 0$.

7 Policy Evaluation

In this section, we study the welfare effects of three common payday lending regulations: a payday lending ban (in practice, effectuated by a low interest rate cap that causes all lenders to exit), a rollover restriction (in practice, effectuated by a required "cooling off period" that disallows additional borrowing for 30 days after three consecutive loans), and a loan size cap. In Section 7.1, we set up the model. In Section 7.2, we give theoretical intuition for how different parameters affect welfare. In Section 7.3, we turn to numerical simulations.

7.1 Model

We continue with the model as described in Section 6, except that we endogenize the initial loan amount, explicitly model reborrowing over many periods, and allow default. We also re-number the periods, so periods 0–2 from Section 6 could represent any three periods in this section.

People borrow amount l in period $t = 0$. In each subsequent period $t \in \{1, ..., T\}$, with T possibly infinite, borrowers receive transitory shock θ_t and correlated shock η_t and then have three options. First, they can *repay* $l + p(l)$. In this case, the game ends. Second, they can pay the fee $p(l)$ and *reborrow* the principal l. In this case, the game continues. Third, they can *default*, incurring immediate cost χ. In this case, the game ends.

Let $u(l, \nu)$ denote the benefit of borrowing amount l, where ν is a shock. Analogous to Section 6, the utility cost of paying amount x in period t is $k(x, \theta_t, \eta_t)$. Define $C(l)$ as the actual cost, in expectation using the $t = 0$ information set, of repaying a loan of size l beginning in $t = 1$, and let $\tilde{C}(l)$ denote the $t = 0$ self's perception of that cost. These continuation cost functions are endogenously determined by repayment cost function $k(x, \theta_t, \eta_t)$ and equilibrium borrower behavior. Theorem 1 in Appendix F.1 shows that under some regularity conditions on k and $\{\theta_t, \eta_t\}$, there exists a unique equilibrium for finite T, and a unique stationary equilibrium for $T = \infty$, with smooth continuation cost functions C and $\tilde{C}$.[22]

For welfare analysis, we use the "long-run criterion," taking the preferences of the $t = -1$ self to be normatively relevant. This is common (e.g. O'Donoghue and Rabin 1999, 2006; Carroll et al. 2009) but not uncontroversial (Bernheim and Rangel 2009; Bernheim 2016; Bernheim and Taubinsky 2018). Any welfare criterion that places more weight on the later selves' preferences to borrow would likely strengthen our conclusion that most regulation reduces welfare.

For our primary analysis, we follow Heidhues and Koszegi (2010) in assuming that the loan affects utility only after period $t = 0$, as might be the case for a car repair that the borrower can afford only by taking out a loan. Thus, the borrower chooses l in $t = 0$ to maximize $\beta\delta \left[u(l, \nu) - \tilde{C}(l)\right]$, and the welfare criterion is $\beta\delta^2 \left[u(l, \nu) - C(l)\right]$. We also present alternative analyses in which the benefits of the loan accrue fully in $t = 0$, so the borrower maximizes $u(l, \nu) - \beta\delta\tilde{C}(l)$, and the welfare criterion is $\beta\delta \left[u(l, \nu) - \delta C(l)\right]$. The difference between these two cases is that in our alter-

[22] We are able to establish these results even though the Bellman operator on the continuation value functions is not a contraction. When $T = \infty$, there may also be non-stationary equilibria in environments with minimal variation in θ and η. We use stationarity as an equilibrium refinement.

native analysis, the borrower "overborrows" relative to the welfare criterion even when $C(l) = \tilde{C}(l)$, since the benefits are immediate while the repayment costs are delayed. To avoid the mechanical implication that borrowers with lower β derive less welfare, we normalize both welfare criteria by $1/\beta$.

Our analyses consider only consumer welfare, and we abstract away from the supply side of the market by assuming that the interest rate is exogenous. This is realistic given that interest rates in Indiana and other states equal the regulated cap.

7.2 Theoretical Results

7.2.1 Setup

We now present theoretical intuition for the welfare effects of payday borrowing under different assumptions for borrower types and the amount of volatility in θ and η. For borrower types, we consider different assumptions for β and $\tilde{\beta}$, and we allow borrowers to learn their type, having perceived present focus $\tilde{\beta}_0 \geq \beta$ in period $t = 0$ and $\tilde{\beta}_1 \in [\beta, \tilde{\beta}_0]$ for $t \geq 1$. In this sub-section, we assume infinite horizon ($T = \infty$), which allows us to consider stationary equilibria, and we assume that the long-run discount factor is $\delta = 1$, which is a close approximation given that pay cycles are two weeks to one month long.

7.2.2 Repayment Behavior and Costs

The effect of β and $\tilde{\beta}$ on repayment costs depends on the amount of volatility in repayment cost shocks $\{\theta, \eta\}$. Proposition 5 in Appendix F.4 shows that with high enough volatility, present focus and naivete have *zero* effect on repayment costs: regardless of β and $\tilde{\beta}$, borrowers repay in "good" states and reborrow in "bad" states. Proposition 6 in Appendix F.4 shows that in the limit case of vanishing volatility in θ and η, persistently naive ($\tilde{\beta}_1 > \beta$) borrowers perpetually reborrow because they are over-optimistic about repaying in the next period, which entices them to reborrow in the current period. This generates *infinite* repayment costs C. This result echoes O'Donoghue and Rabin (1999, 2001), who show that naive agents can infinitely delay an unpleasant task (such as repaying a loan) in a deterministic setting.[23]

However, the limit case in Proposition 6 leads to stark and counterfactual predictions. First, because borrowers predict that their future selves will be approximately indifferent between reborrowing and repaying, they will believe that even small temporary incentives to repay next period will ensure repayment that period. However, our belief elicitations reject this. Second, with even

[23] In Appendix F.6, we establish a type of "purification theorem" showing that as repayment cost shock volatility vanishes, behavior converges to a stationary mixed strategy equilibrium of a deterministic game. Our framework differs from O'Donoghue and Rabin (1999, 2001) in three main ways. First, because our borrowers choose their loan amounts in $t = 0$, the welfare effects of present focus and naivete operate on that margin as well. Second, our borrowers have the option to default. Third, we allow uncertainty in repayment costs, which substantially changes the equilibrium and results. In a deterministic environment, O'Donoghue and Rabin show that sophisticated types play pure strategies with cycles, for example completing the task only in periods that are multiples of three. By introducing stochasticity, we can focus on stationary pure-strategy equilibria, which may be more realistic.

small amounts of persistent naivete, borrowers would reborrow in perpetuity. However, this does not happen in the data. In fact, we can use observed reborrowing rates to provide upper bounds on the effects of β and $\tilde{\beta}$ on repayment costs.

Proposition 3. *Suppose that the unconditional distribution of η is time invariant. Let μ be the empirically observed reborrowing rate. Relative to the repayment costs $C^{TC}(l)$ of time-consistent borrowers, the repayment costs $C^S_\beta(l)$ of borrowers with present focus β and $\tilde{\beta}_1 = \beta$ are bounded by*

$$C^S_\beta(l) \leq \frac{C^{TC}(l)}{1-(1-\beta)\mu} \leq \frac{C^{TC}(l)}{\beta}. \tag{18}$$

If $\mu < 1$, the repayment costs $C^{PN}_{\beta,\tilde{\beta}_1}(l)$ of partially naive borrowers with present focus β and long-run beliefs $\tilde{\beta}_1 > \beta$ are bounded by

$$C^S_\beta(l) \leq C^{PN}_{\beta,\tilde{\beta}_1}(l) \leq \frac{C^{TC}(l) - \mu\beta C^S_{\tilde{\beta}_1}(l)}{1-\mu}. \tag{19}$$

The first expression shows that for sophisticates, present focus cannot increase repayment costs by more than proportion $1/\beta$. The second expression shows that for persistently naive types, naivete can generate large repayment costs only in the limit of perpetual reborrowing ($\mu \to 1$).

To illustrate Proposition 3, consider the case of temporary partial naivete ($\tilde{\beta}_0 > \beta$, $\tilde{\beta}_1 = \beta$), as in our empirical results. When the weak inequalities in Proposition 3 hold with equality, perceived costs are $\tilde{C} = \frac{C^{TC}}{1-(1-\tilde{\beta}_0)\mu}$, actual costs are $C = C^S_\beta = \frac{C^{TC}}{1-(1-\beta)\mu}$, and the ratio is $\tilde{C}/C = \frac{1-(1-\beta)\mu}{1-(1-\tilde{\beta}_0)\mu}$. If the reborrowing probability is $\mu = 0.75$ and if $\tilde{\beta}_0 = 0.78$ and $\beta = 0.70$, as shown in the sixth row of Table 2 for $\alpha = 0.0064$, then $\tilde{C} \approx 1.20C^{TC}$, $C \approx 1.29C^{TC}$, and $\tilde{C}/C \approx 0.93$. That is, present focus increases the cost of borrowing by 29 percent, and temporary naivete leads borrowers to underestimate these costs by seven percent in period $t = 0$.

Next, consider the case with persistent partial naivete ($\tilde{\beta}_1 > \beta$). When the weak inequalities in Proposition 3 hold with equality, perceived costs are $\tilde{C} = C^S_{\tilde{\beta}_1} = \frac{C^{TC}(l)}{1-\left(1-\tilde{\beta}_1\right)\mu}$, actual costs are $C = C^{PN}_{\beta,\tilde{\beta}_1} = \frac{C^{TC}(l)-\mu\beta C^S_{\tilde{\beta}_1}(l)}{1-\mu}$, and the ratio is $\tilde{C}/C = \frac{1-\mu}{1-\mu+\left(\tilde{\beta}_1-\beta\right)\mu}$. If the reborrowing probability is $\mu = 0.75$ and if $\tilde{\beta}_1 = 0.76$ and $\beta = 0.74$, as shown in the top row of Table 2 for $\alpha = 0.0064$, then $\tilde{C} = 1.22C^{TC}$, $C = 1.29C^{TC}$, and $\tilde{C}/C \approx 0.94$. That is, the borrower underestimates the costs of re-borrowing in each period by six percent.

This illustrates that theoretical results that minor naivete can have discontinuously large welfare costs (O'Donoghue and Rabin 1999, 2001; Heidhues and Koszegi 2009, 2010) hinge on the assumption of a deterministic environment. Proposition 4 in Appendix F.2 shows that in our model, behavior is continuous in all parameters in the presence of uncertainty.

The proofs in Appendix F also show that these results are similar if borrowers mispredict future borrowing because they mispredict future repayment costs $k(x, \theta, \eta)$ rather than their level of present focus.[24]

[24] The observed overestimation of the effect of the no-borrowing incentive could reflect underestimation of the

7.2.3 Welfare Gains from Payday Borrowing

We now consider the welfare gains from payday borrowing, taking into account the $t = 0$ borrowing decision. Figure 10 illustrates how a borrower with a given loan demand shock ν determines her desired loan size l in period $t = 0$. The downward-sloping line is the marginal utility from borrowing an additional dollar, $u'(l, \nu)$. The two upward-sloping lines are the actual and perceived marginal repayment costs, C' and $\tilde{C}'$. These cost functions are the same if $\tilde{\beta}_0 = \beta$, and they differ if $\tilde{\beta}_0 > \beta$.

In $t = 0$, the borrower chooses l to equate the marginal benefit u' and perceived marginal repayment cost $\tilde{C}'$, giving $l = l^*$. The borrower's welfare, however, is determined by actual repayment cost C'. The loan size that maximizes the $t = -1$ self's welfare is $l^\dagger$, where $u' = C'$. The welfare gain from a loan of size $l^\dagger$, denoted G, is the shaded triangle at left. The welfare loss from "overborrowing," denoted L, is the shaded triangle at right. The net welfare gain from a loan of size l^* is $G - L$.

We can use the above logic about repayment behavior to characterize the distance between C' and $\tilde{C}'$, and thus the welfare gain $G - L$. On one extreme, if borrowers are time consistent or fully sophisticated ($\beta = \tilde{\beta}$), then $C' = \tilde{C}'$, $l^* = l^\dagger$, $L = 0$, and payday borrowing increases welfare. On the other extreme, if borrowers are persistently naive ($\tilde{\beta}_1 > \beta$) in the limit case of vanishing volatility, then $C = \infty$, $l^* > l^\dagger = 0$, $L = \infty$, and payday borrowing decreases welfare. For intermediate cases, $L = O\left((1 - \tilde{C}'/C')^2\right)$, i.e. losses from overborrowing are the same order as the square of the share of repayment costs that are misperceived.[25] This implies that for $\tilde{C}'/C'$ close to 1, as in the empirical estimates from Section 7.2.2, L cannot be large in *absolute* terms, even if it is larger than G for some borrowers.

Given our empirical estimates, how likely is it that $L > G$? Following the above calculations, we conservatively assume $\tilde{C}'/C' \approx 0.9$, so borrowers underestimate repayment costs by 10 percent. In general, when demand for a product is only slightly distorted relative to the social optimum, the only way the product can reduce welfare is if consumers don't perceive much surplus from the product. In the context of Figure 10, when $\tilde{C}'/C' \approx 0.9$, this means that the only way to make L larger than G for a given loan size l^* is to make both u' and $\tilde{C}'$ very flat, so that G becomes very short and L becomes very wide.

However, two additional arguments discipline how flat u' and $\tilde{C}'$ can be. First, we show in Appendix F.8 that assuming linear u' and $\tilde{C}'$ and $\tilde{C}'/C' \approx 0.9$, $L > G$ requires $u'(0)/\tilde{C}'(0) \leq 1.25$: the marginal benefit of the first dollar borrowed must not exceed the perceived marginal cost of the first dollar borrowed by more than 25 percent. This requires that demand be implausibly elastic: all payday loan demand would disappear if lenders charged even modestly higher fees. Recall that borrowers in our survey predicted that a \$100 no-borrowing incentive would reduce

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volatility in repayment cost shocks. This would cause borrowers to *overestimate* repayment costs, since higher volatility increases the option value of reborrowing and thus generally reduces the costs of longer borrowing spells.

[25] Formally, let $\kappa := \tilde{C}'/C'$, and set $W(\kappa) = u(l^*(\kappa)) - C(l^*(\kappa))$, omitting ν as an argument for shorthand and defining l^* to satisfy $u'(l^*) - \kappa C'(l^*) = 0$. Then $W'(\kappa) = (u'(l^*) - C'(l^*))\frac{dl^*}{d\kappa}$ and $W''(\kappa) = ((u''(l^*) - C''(l^*))\frac{dl^*}{d\kappa} + (u'(l^*) - C'(l^*))\frac{d^2 l^*}{d\kappa^2}$. Now $L = W(1) - W(\kappa) = W'(1)(1-\kappa) + W''(1)(1-\kappa)^2 + O((1-\kappa)^3)$. Since $W'(1) = 0$ and $W''(1) = ((u''(l^*) - C''(l^*))\frac{dl^*}{d\kappa}$, it follows that $L = ((u''(l^*) - C''(l^*))\frac{dl^*}{d\kappa}(1-\kappa)^2 + O((1-\kappa)^3)$.

their reborrowing probability by only 20 percentage points, which suggests that demand is not that elastic, at least on the reborrowing margin.

Second, an estimate of curvature disciplines how flat $\tilde{C}'$ can be. In Appendix F.8 we show that even when $\tilde{C}''/\tilde{C}'$ is more than ten times smaller than our lottery-based survey estimate of α, $G > L$ for any loan larger than about \$200, which is the majority of payday loans in our data.

7.3 Numerical simulations

7.3.1 Setup

To quantify the welfare effects of payday lending regulations, we now calibrate a parametric version of our borrowing and repayment model. We assume that the benefit from borrowing is $u(l, \nu) = \nu\left(1 - e^{-\alpha_0 l}\right)$, where α_0 is a curvature parameter and $\nu \sim Lognormal(\mu_\nu, \sigma_\nu^2)$. Higher ν implies higher absolute and marginal utility from borrowing. We truncate ν at the 95th percentile of its distribution so that high ν draws do not drive the welfare estimates.

The utility cost of repaying x in period t is $k(x, \theta_t, \eta_t) = (\theta_t + \eta_t)\left(e^{\alpha_1 x} - 1\right)$, where α_1 is a curvature parameter and $\theta \sim Beta(a_\theta, b_\theta)$. We use the beta distribution for two reasons. First, the distribution needs to have bounded support; thick-tailed distributions such as the lognormal generate reborrowing rates that are too low. Second, the flexibility of the beta distribution allows us to match reborrowing rates with different amounts of variance in θ, and thus to consider scenarios where bias has small or large effects on repayment costs. Less flexible distributions would create a false sense of certainty about welfare results. We assume that $\eta \in \{0, \bar{\eta}\}$, with $\eta = 0$ in period $t = 1$ with probability q, and with the probability of transitioning to a different state given by $1 - q$.

The default cost is $\chi = \chi_0\left(e^{\alpha_1(l+p)} - 1\right)$. This parameterization makes it more costly to default on a larger loan. Constant default costs across loan sizes would generate much higher default rates on larger loans, which would run counter to the cross-sectional pattern in our data and the quasi-experimental results in Dobbie and Skiba (2013). Default costs might be higher for larger loans because the "guilt" costs are higher, because lenders have more incentive to work to collect larger loans, and because the costs from losing access to credit may be larger for people who borrow more.

7.3.2 Calibration Procedure

We assume a 15 percent borrowing fee, so $p(l)/l = 0.15$. We set $\delta = 0.998$, as this implies a five percent annual discount rate for two week periods, corresponding to bi-weekly pay cycles.

As discussed in Section 7.2.3, the welfare gains from borrowing are increasing in the slopes of u' and C', or equivalently the curvature of u and C. We thus choose α_0 and α_1 to be conservatively lower than our empirical estimate of $\alpha \approx 0.0064$. We set $\alpha_1 = 0.002$ and use the estimates of $(\beta, \tilde{\beta}) = (0.74, 0.77)$ from the second row of Table 2. We numerically verify that this produces $\tilde{C}$ with a coefficient of absolute risk aversion of almost exactly $\alpha = 0.002$, so these assumptions are internally consistent. We allow α_0 to range between the four non-zero curvature values considered in Table 2.

We calibrate the remaining parameters to match four moments from a random sample of borrowers who took out a loan from the Lender in 2017: the probability of reborrowing, the probability of defaulting, and the mean and variance of loan size. Panel (a) of Table 3 presents those four moments. Ideally, we would match the loan size distribution that would exist without a loan size cap, but only three states (Texas, Wyoming, and Utah) do not have loan size caps. To ensure a more representative sample of states while keeping the calibration simple, we use data from the 11 states where the Lender operates that have loan size caps between \$450 and \$550.

We calibrate these remaining parameters in two steps. In the first step, we calibrate $\bar{\eta}$, χ_0, q, a_θ, and b_θ. We set $\chi = 1.1$ to guarantee that borrowers never choose to default when $\eta = 0$ for any distribution of θ. We set $\bar{\eta}$ high enough such that borrowers always choose to default when $\eta = \bar{\eta}$ for any distribution of θ. This approach simplifies estimation by assuming that all borrowers default if and only if they draw a bad state $\bar{\eta}$. We then set $1 - q$ to match the empirical default rate of 0.028.

We then set the distribution of θ to match the empirical reborrowing probability. We set $\theta \sim Beta(a_\theta, 1)$, where a_θ is the only free parameter. This allows a family of distributions that spans everything between a uniform distribution ($a_\theta = 1$) and a degenerate distribution with no variance in θ ($a_\theta \to \infty$), which matches the limit case of vanishing volatility considered in Proposition 6.[26] In Appendix H we also consider a second scenario with $\theta \sim Beta(a_\theta, 0.02)$, which allows a highly bimodal distribution of θ, as in the limit case of high volatility considered in Proposition 5. In both scenarios, reborrowing probabilities are monotone in a_θ, and it is straightforward to find the a_θ that matches the empirical reborrowing probability.

With these parameters in hand, we numerically calculate perceived and actual expected loan repayment cost $\tilde{C}(l)$ and $C(l)$ for all l.

The second step of the calibration procedure is to calibrate the distribution of ν. To do so, we simulate a set of potential borrowing spells, each with a draw of ν, and find the perceived optimal loan size $l^* \in [0, \$500]$ for each spell as a function of ν and $\tilde{C}(l)$. We cap loan sizes at \$500 to match the fact that our empirical data are drawn from states with loan size caps around \$500. We find the mean and variance (μ_ν, σ_ν^2) such that the distribution of simulated l^* (conditional on $l^* > 0$) matches the empirical mean and variance of loan sizes.

We simulate welfare under counterfactual policies for an exogenous set of potential borrowing spells. Because the distribution of ν is held fixed across counterfactuals, our simulations do not capture the possibility that rollover restrictions might result in more potential borrowing spells by breaking up single long spells into multiple short spells, or that people might keep larger buffer stocks in response to payday borrowing restrictions. This may be realistic: Appendix Table A5 shows that in the Panel Survey of Income Dynamics, households do not hold more liquid assets in states with payday loan bans or in years after their state imposes a ban.

Panel (b) of Table 3 presents the simulation parameters. Column 1 presents the calibration

[26] Changing the second scale parameter b_θ from 1 to values of 2, 3, 4, or 5 does not have a meaningful effect on the results.

when $\alpha_0 = 0.002$, and column 2 presents the calibration when $\alpha_0 = 0.0002$.

Appendix G provides more details on the calibration procedure.

7.3.3 Results

Table 4 presents simulated borrower behavior under the baseline policy in our sample, a $500 loan size cap. Panels (a) and (b) present results for $\alpha_0 = 0.002$ and $\alpha_0 = 0.0002$, respectively. We present results with other values of α_0 in Appendix H. Each row presents behavior under different assumptions for β, $\tilde{\beta}$, and whether the benefits of the loan accrue in $t = 0$ or $t = 1$. Since the simulation parameters other than β and $\tilde{\beta}$ were calibrated using our estimated $\left(\hat{\beta}, \hat{\tilde{\beta}}\right)$ and then held constant across rows, the loan size and reborrowing probabilities in row 2 approximately match the empirical moments from Table 3, and they vary across the other rows.[27]

In both panels, present focus parameters affect borrower behavior. Comparing rows 1 and 2 shows that borrowers with our primary estimates of β and $\tilde{\beta}$ reborrow more and pay more back to the lender than they would if they were time consistent. Comparing rows 2 and 3 shows that people take out larger loans under the alternative assumption that the benefits of the loan accrue fully in $t = 0$. Comparing row 5 to row 2 or row 6 shows that naivete increases reborrowing and amount repaid.

Row 7 considers borrowers who are partially naive in $t \leq 3$ but become sophisticated beginning in $t = 4$, matching our empirical evidence. We estimate that $\beta/\tilde{\beta} \approx 0.84$ at $\alpha = 0.002$ for borrowers with 0–3 loans in the past six months. For this row, we maintain $\beta = 0.74$ and set $\tilde{\beta}_0 = \beta/(\beta/\tilde{\beta}) \approx 0.88$. This has little effect relative to row 2.

In rows 9 and 10, we set β and $\tilde{\beta}$ to match expert forecasts. We use the $\tilde{\beta} = 0.86$ forecasted by the average expert, and we calculate $\beta/\tilde{\beta}$ by inserting experts' average forecast of borrower misprediction into Equation (15) using $\alpha = 0.002$. Multiplying these gives $\beta = 0.63$. These assumptions generate much more reborrowing and much higher fees paid than the time-consistent case or our primary estimates.

In the previous sub-section, we showed that the losses from overborrowing L/G are proportional to $(1-\kappa)^2$. Jensen's Inequality implies that assuming homogeneous β and $\tilde{\beta}$ causes us to understate L/G relative to a heterogeneous case with the same population average parameters. To address this, rows 4 and 8 consider extreme parameterizations of heterogeneity, where half the population is time consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 8 also imposes the alternative assumption that the benefits of the loan accrue fully in $t = 0$, making this row a "worst-case scenario" for borrower welfare, and thus a "best-case scenario" for regulation.

Table 5 presents welfare estimates under alternative payday lending regulations, using the same assumptions in each row as in Table 4. Panels (a) and (b) again present results for $\alpha_0 = 0.002$ and

[27] The small discrepancy in reborrowing probability is because we calibrate the distribution of θ to match reborrowing rates for the empirical loan size distribution instead of the simulated distribution, which assumes a lognormal distribution.

$\alpha_0 = 0.0002$, respectively. In each cell of both panels, we present welfare as a percent of the welfare that time-consistent borrowers derive from the availability of payday loans with a \$500 loan size cap. Thus, we report 100% in column 1 (\$500 cap) of row 1 (time-consistent borrowers). Cells with positive values below 100% imply that borrowers still derive positive surplus from payday loans, but not as much as time-consistent consumers under a \$500 cap. Negative numbers would imply that borrowers are harmed by access to payday loans.

In each panel, column 1 presents welfare effects under the baseline policy, a \$500 loan size cap. Column 2 considers a \$400 loan size cap. On top of the baseline \$500 cap, column 3 adds a rollover restriction, which we model as a requirement that the loan be repaid no later than $t = 3$. Modeling a payday loan ban requires some assumption about what alternative products borrowers can substitute to. Column 4 considers the effects of a payday loan ban under the assumption that borrowers can only substitute to higher-cost loans with a \$500 loan size cap and a 25 percent fee instead of 15 percent. Alternatively, a ban on all short-term high-cost borrowing would eliminate the surplus reported in column 1; this reduces welfare as long as the surplus in column 1 is positive. Of course, time-consistent borrowers are harmed by any regulation imposed in columns 2–4, although the rollover restriction does not affect them much because they repay quickly.

Comparing the different rows in column 1 of each panel, we can see the effects of different parameter assumptions on welfare under status quo regulation. Row 2 shows that the welfare losses from our estimated levels of present focus are only 4.1 percent with less elastic demand (Panel (a)) and 11.2 percent with more elastic demand (Panel (b)). In both panels, welfare is higher in row 2 than most subsequent rows, particularly when we assume heterogeneity, temporary naivete, and that the benefits of the loan accrue in $t = 0$. The larger welfare losses from present focus in Panel (b) are consistent with the discussion in Section 7.2.3 about how more elastic demand decreases the gains from borrowing relative to the costs of overborrowing.

The most significant welfare loss occurs when using experts' forecasts of β and $\tilde{\beta}$. However, Table 4 shows that these scenarios generate counterfactually high reborrowing probabilities. When we instead re-calibrate the distributions of θ and ν to match the empirical reborrowing rate at experts' β and $\tilde{\beta}$, borrower welfare is much higher; see Tables A15–A18 in Appendix H.

Across all rows of both panels other than the expert forecasts, the welfare losses relative to the time-consistent case in row 1 are less than 30 percent, and the net benefits are always positive. Present focus and naivete have smaller effects on welfare (in this table) than they do on interest payments (in Table 4) for two reasons. First, while present focus and naivete can prolong borrowing spells and thus increase the *monetary* costs of borrowing, longer borrowing spells allow borrowers to repay when it is less costly to *utility* to do so. Second, borrowers in our model derive substantial surplus from payday loans: column 4 of Table 5 shows that the gains from borrowing are large even if fees increase substantially to 25 percent.

Comparing the different columns in each row, we can see the effects of regulation under the different parameter assumptions. Given that welfare is so close to the time-consistent benchmark, it is not surprising that loan size caps and payday loan bans reduce welfare, regardless of whether we model a payday loan ban as a fee increase to 25 percent or a ban on all high-cost borrowing. However, rollover restrictions at least slightly improve borrower welfare in all rows with time-inconsistent borrowers, as the regulation induces faster repayment in line with the $t = -1$ self's preferences.

As discussed in Section 7.2, present focus and naivete have smaller effects on borrowing behavior and welfare—and thus the welfare gains from regulation are smaller—when there is more volatility in repayment cost shocks. Tables A11–A14 in Appendix H confirm this numerically, presenting results with the highly bimodal beta distribution generated by the assumption that $\theta \sim Beta(a_\theta, 0.02)$. In these simulations, present focus and naivete have almost no effect on behavior, and all regulations including rollover restrictions reduce welfare.

We advise against relying on the exact magnitudes presented in Table 5, especially because there are many other plausible ways of calibrating a parametric model of borrower behavior. Notwithstanding, the combination of theoretical and numerical results in Sections 7.2 and 7.3 paint a clear picture: it is unlikely that banning payday lending would increase borrower welfare at parameter assumptions that match the empirical data.

7.4 Existing Policies and Expert Policy Views

Through the lens of our theoretical results and numerical calibrations, some existing payday lending regulations are welfare reducing. Eighteen states have banned payday lending, which in our model causes substantial welfare losses relative to the baseline $500 loan size cap. Some states have particularly stringent loan size caps, such as the $300 limit in California, but our model suggests such tightened caps reduce welfare.

In our model, the only additional regulation that appears to benefit borrowers is a rollover restriction. This encourages faster repayment, consistent with our survey participants' qualitative and quantitative desires to motivate themselves to avoid reborrowing. Contrasting with our model's prescriptions, rollover restrictions are *de facto* much less common than bans and loan size caps. While many states have *de jure* rollover restrictions, in most states these rules are in practice ineffective because they are not combined with sufficiently long "cooling off periods" that prohibit new loans within the same pay cycle. Our results suggest that strengthening these policies might be the most promising type of additional regulation. Our results are consistent with the views in Skiba (2012), and the 2017 CFPB rule includes a rollover restriction combined with a mandatory 30-day cooling off period after the third consecutive loan.

Before our paper was released, the experts who responded to our survey were sharply divided about whether regulation would benefit consumers. Figure 11 shows that 56 percent of experts believed that prohibiting payday lending would benefit consumers. In our expert survey, a rollover restriction was less popular than prohibiting payday lending: only 50 percent of our experts thought that a rollover restriction would benefit consumers. However, our experts were very uncertain: their average certainty was 0.44 on a scale from 0 (not at all certain) to 1 (extremely certain).

We also suggested a similar question about payday loan bans for the IGM Economic Experts

Panel, a survey used to gauge opinion among leading economists. Of the IGM experts, 33 percent agreed that a payday loan ban would make consumers better off, while 25 percent disagreed, and 37 percent were uncertain.[28]

8 Conclusion

This paper contributes new empirical facts and theoretically grounded policy analysis to the contentious debate about payday lending regulation. We find that experience matters: inexperienced borrowers underestimate their likelihood of borrowing, while more experienced borrowers predict correctly. One natural explanation is that payday lending is a high-stakes setting with regular and repeated opportunities to observe one's behavior. We also find that borrowers are willing to pay a premium for an incentive to avoid future borrowing, which implies that they perceive themselves to be time inconsistent. Our novel approach to estimating β and $\tilde{\beta}$ in a dynamic stochastic setting could be useful in other applications.

Our analysis does not address important questions around whether other financial products or government regulations might benefit payday borrowers. While our results suggest that borrowers' decisions are close to optimal *given their liquidity needs*, these initial liquidity needs that drive people to demand payday loans may be due to suboptimal consumption and savings decisions (e.g., Leary and Wang 2016). Policies and financial products that encourage more precautionary saving might increase welfare.

In the context of our structural model of borrowing and repayment, our finding of present focus with limited naivete implies that payday loan bans and tightened loan size caps are likely to harm borrowers. Rollover restrictions could increase welfare by inducing faster repayment in line with long-run preferences. The policy prescriptions of our model contrast with the opinions of experts who responded to our survey, as well as with the types of payday lending regulation most popular among U.S. states. The disagreement and uncertainty among experts and regulators highlights the potential value of papers like ours that carry out behavioral welfare analyses grounded in theory and data.

[28]See here for the IGM survey results.

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Tables

Table 1: **Descriptive Statistics and External Validity**

	(1) Valid sample	(2) Customers on survey days	(3) 2017 loans nationwide
Loans in past six months	5.35		6.03
	(2.94)		(4.22)
Annual income ($000s)	34.0	31.8	28.9
	(21.1)	(21.3)	(38.0)
Internal credit score	862	870	861
	(122)	(193)	(125)
Pay cycle length (days)	16.0	18.1	17.3
	(7.7)	(9.1)	(8.2)
Loan length (days)	17.3	18.7	17.5
	(5.9)	(6.8)	(8.4)
Loan amount ($)	373	359	366
	(161)	(165)	(166)
N	1,205	13,191	33,194

Notes: This table presents the means (with standard deviations in parentheses) of key variables in data from the Lender. "Customers on survey days" means all customers who got a loan from a Lender's store on a day when the survey was available in that store. "2017 loans nationwide" is a random sample of people who took out a payday loan from the Lender in 2017.

Table 2: **Partially Naive Present Focus Parameters**

	α	(1) Estimated $\beta/\tilde{\beta}$	(2) Estimated $\tilde{\beta}$	(3) Estimated β
Full sample	0.0064	0.98	0.76	0.74
		(0.95, 0.99)	(0.73, 0.78)	(0.71, 0.77)
Full sample	0.002	0.96	0.77	0.74
		(0.93, 0.99)	(0.74, 0.79)	(0.70, 0.77)
Full sample	0.0005	0.95	0.83	0.79
		(0.91, 1.00)	(0.80, 0.85)	(0.75, 0.83)
Full sample	0.0002	0.95	0.85	0.81
		(0.90, 0.99)	(0.83, 0.88)	(0.77, 0.85)
Full sample	0	0.95	0.87	0.83
		(0.90, 0.99)	(0.85, 0.90)	(0.78, 0.87)
$0-3$ loans in past six months	0.0064	0.89	0.78	0.70
		(0.71, 0.94)	(0.74, 0.82)	(0.52, 0.75)
$0-3$ loans in past six months	0	0.79	0.92	0.73
		(0.59, 0.91)	(0.87, 0.97)	(0.54, 0.85)
4+ loans in past six months	0.0064	1.00	0.75	0.75
		(0.97, 1.01)	(0.72, 0.78)	(0.71, 0.77)
4+ loans in past six months	0	1.00	0.86	0.86
		(0.95, 1.05)	(0.83, 0.89)	(0.80, 0.90)
Group by loans in past six months	0.0064	0.96	0.76	0.73
		(0.90, 0.98)	(0.73, 0.78)	(0.68, 0.75)
Group by loans in past six months	0	0.94	0.87	0.82
		(0.86, 0.98)	(0.85, 0.90)	(0.75, 0.86)

Notes: Column 1 presents estimates of sophistication $\beta/\tilde{\beta}$ estimated using Equation (15). Column 2 presents estimates of perceived present bias $\tilde{\beta}$ using Equation (16). Column 3 presents estimates of β; this is a lower bound if some of misprediction is from factors other than naivete about present focus. The bottom two rows define groups of observations for estimation using both loan size and above/below median loans in past six months. 95 percent confidence intervals calculated using the bias-corrected percentile bootstrap are in parentheses.

Table 3: **Empirical Moments and Calibrated Parameters**

(a) **Empirical Moments**

Moment	Value
Probability of reborrowing	0.80
Probability of default	0.03
Mean loan amount	393
Standard deviation of loan amount	132

(b) **Simulation Parameters**

Parameter	(1) Higher demand elasticity	(2) Lower demand elasticity
α_0	0.0020	0.0002
α_1	0.002	0.002
δ	0.998	0.998
β	0.74	0.74
$\tilde{\beta}$	0.77	0.77
q	0.97	0.97
χ_0	1.10	1.10
$E[\theta]$	0.83	0.83
$Var[\theta]$	0.020	0.020
$E[\nu]$	1.99	3.46
$Var[\nu]$	0.92	0.31

Notes: Panel (a) presents the empirical moments that we match in our calibrated simulations. These moments are from all loans taken out in 2017 by a random sample of the Lender's customers in the 11 states where they operate that have loan size caps between \$450 and \$550. Panel (b) presents the simulation parameters we use. Column 1 is calibrated assuming $\alpha_0 = 0.002$. Column 2 is calibrated assuming $\alpha_0 = 0.0002$.

Table 4: **Simulated Borrower Behavior**

(a) **Higher Demand Elasticity**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	403	0.42	488
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	394	0.78	610
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	426	0.79	666
4	Heterogeneous	386	0.66	665
5	$\beta = 0.74, \tilde{\beta} = 1$	403	0.85	724
6	$\beta = 0.74, \tilde{\beta} = 0.74$	391	0.76	592
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	400	0.83	686
8	Primary, heterogeneous, learning, consume in $t = 0$	423	0.68	944
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	400	0.91	908
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	445	0.91	1017

(b) **Lower Demand Elasticity**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	410	0.43	496
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	393	0.78	610
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	445	0.79	700
4	Heterogeneous	379	0.67	644
5	$\beta = 0.74, \tilde{\beta} = 1$	410	0.85	737
6	$\beta = 0.74, \tilde{\beta} = 0.74$	389	0.76	589
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	405	0.83	694
8	Primary, heterogeneous, learning, consume in $t = 0$	438	0.69	990
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	403	0.91	917
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	470	0.91	1079

Notes: Panels (a) and (b) are calibrated assuming borrowers have higher and lower demand elasticities, respectively. Panel (a) assumes that $\alpha_0 = 0.002$. Panel (b) assumes that $\alpha_0 = 0.0002$. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table 5: **Borrower Welfare Under Payday Lending Regulations**

(a) **Higher Demand Elasticity**

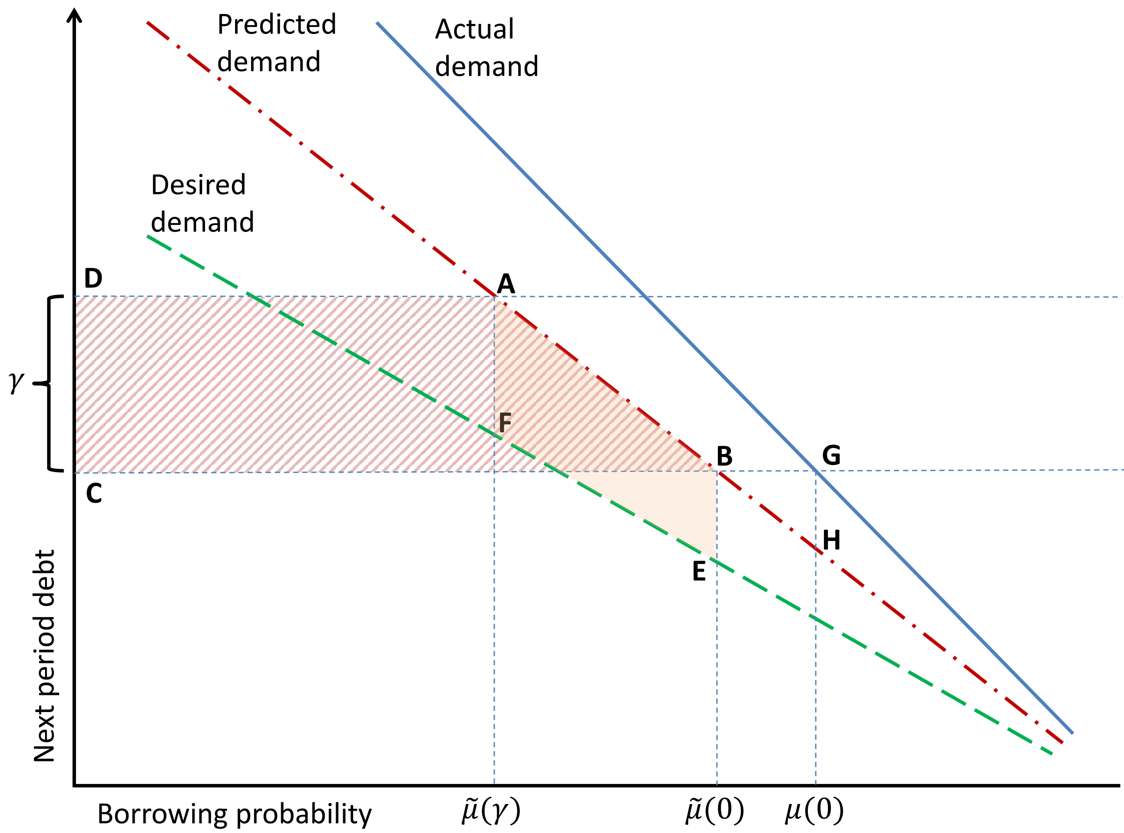
Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	92.0%	99.8%	94.9%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	95.9%	88.7%	97.4%	90.3%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	95.2%	88.3%	96.8%	89.4%
4	Heterogeneous	90.8%	84.4%	97.3%	84.4%
5	$\beta = 0.74, \tilde{\beta} = 1$	91.1%	84.8%	97.1%	84.5%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	96.7%	89.3%	97.4%	91.2%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	95.1%	88.0%	97.2%	88.8%
8	Primary, heterogeneous, learning, consume in $t = 0$	90.2%	84.5%	96.0%	82.8%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	80.8%	76.4%	95.8%	71.8%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	77.0%	74.3%	94.3%	66.2%

(b) **Lower Demand Elasticity**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	89.3%	99.5%	86.1%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	88.8%	80.4%	92.8%	74.6%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	86.0%	78.9%	90.5%	70.4%
4	Heterogeneous	76.3%	69.7%	92.5%	61.7%
5	$\beta = 0.74, \tilde{\beta} = 1$	75.2%	69.6%	91.9%	59.0%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	90.8%	82.0%	92.9%	76.7%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	86.4%	78.3%	92.3%	70.3%
8	Primary, heterogeneous, learning, consume in $t = 0$	70.9%	68.1%	88.0%	50.1%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	47.0%	46.6%	88.3%	26.4%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	32.2%	38.8%	82.8%	1.7%

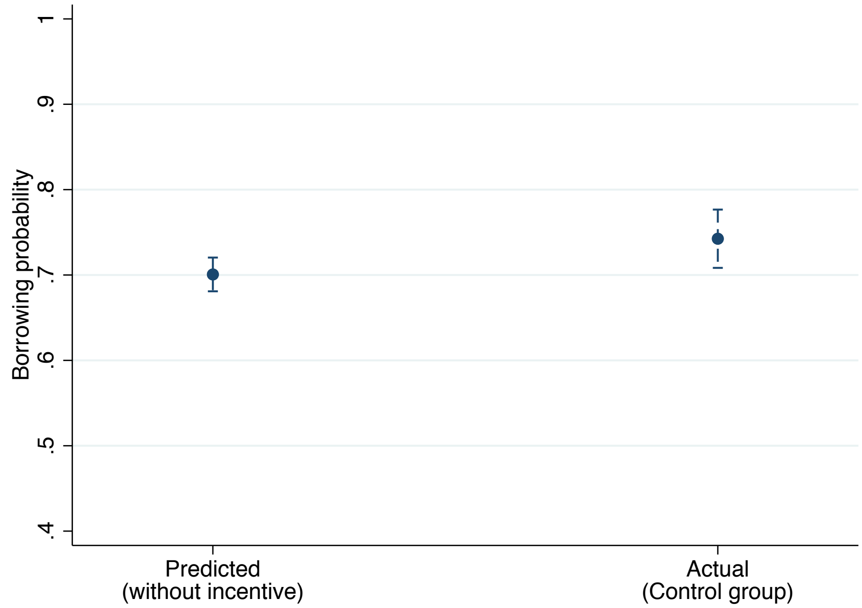
Notes: In each cell, we present welfare as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Panels (a) and (b) are calibrated assuming borrowers have higher and lower demand elasticities, respectively. Panel (a) assumes that $\alpha_0 = 0.002$. Panel (b) assumes that $\alpha_0 = 0.0002$. "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Figure 1: **Identification of Misprediction and Perceived Time Inconsistency**



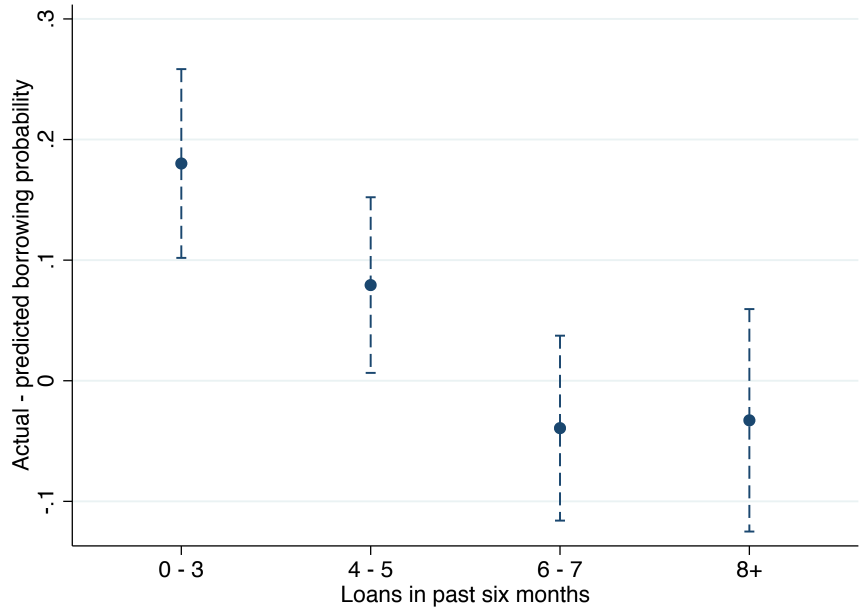
Notes: This figure illustrates identification of the partially naive present focus model assuming that the perceived continuation value is linear in debt owed. The y-axis plots the next period debt that results from borrowing. The x-axis plots the probability of borrowing given the distribution of unpredictable shocks. Predicted and desired demand are from the perspective of the previous period self.

Figure 2: **Predicted and Actual Borrowing**



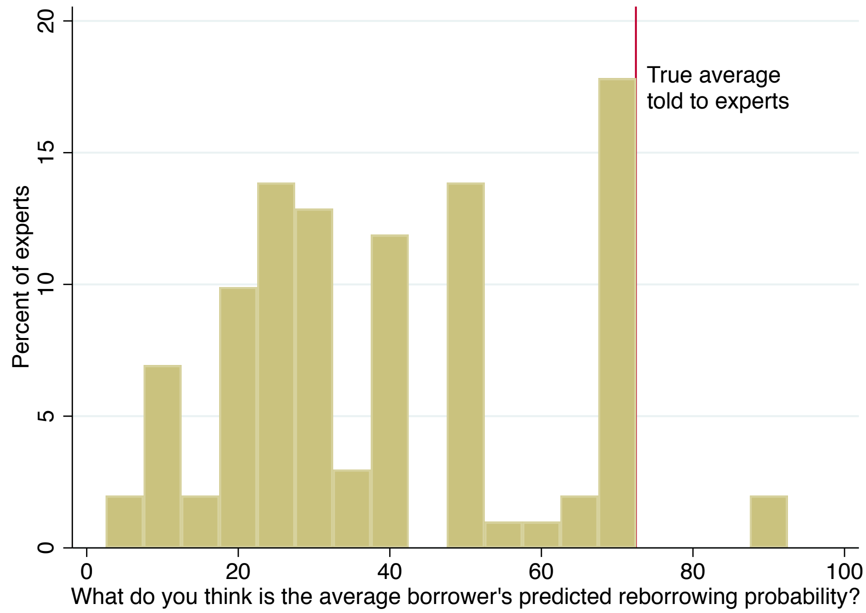
Notes: The left spike presents the average predicted probability of getting another payday loan in the next eight weeks without the no-borrowing incentive. The right spike presents the actual probability of getting another payday loan in the next eight weeks for the Control group, which did not receive the no-borrowing incentive. Error bars represent 95 percent confidence intervals.

Figure 3: **Misprediction by Experience**



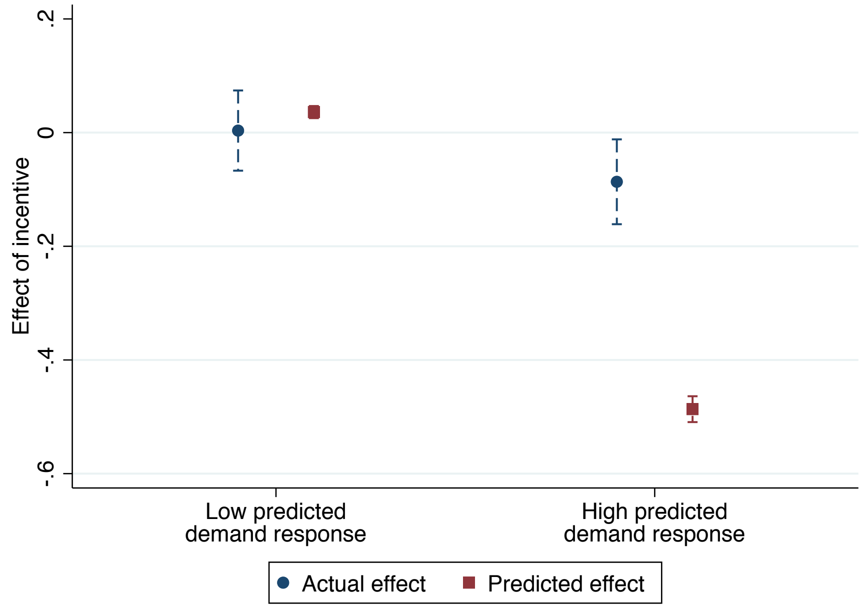
Notes: This figure presents the actual borrowing probability minus the average predicted borrowing probability for subgroups defined by the number of loans taken out from the Lender in the six months before taking the survey. This figure includes only the Control group. Error bars represent 95 percent confidence intervals.

Figure 4: **Experts' Beliefs about Borrowers' Predicted Borrowing Probability**



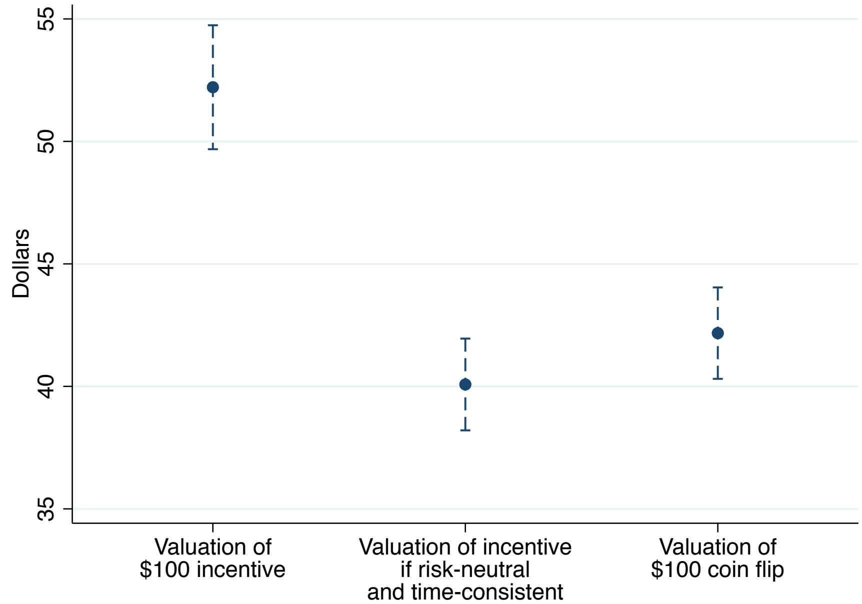
Notes: This is a histogram of experts' beliefs about the average borrower's predicted probability of borrowing again over the next eight weeks. Data are from our survey of expert opinion, which was administered before our paper was released. As a benchmark, we told experts that the true reborrowing probability was 70 percent, which was slightly lower than the Control group's actual average of 74 percent.

Figure 5: **Predicted and Actual Effects of No-Borrowing Incentive**



Notes: This figure presents the predicted and actual effects of the no-borrowing incentive on the probability of getting another loan in the next eight weeks after the survey. “High predicted demand response” includes people who reported that they would have a lower borrowing probability with the incentive compared to without. “Low predicted demand response” includes people who reported that they would have the same or higher borrowing probability with the incentive. About five percent of people reported that they would have a higher borrowing probability with the incentive; this is to be expected due to noise in survey responses. Error bars represent 95 percent confidence intervals.

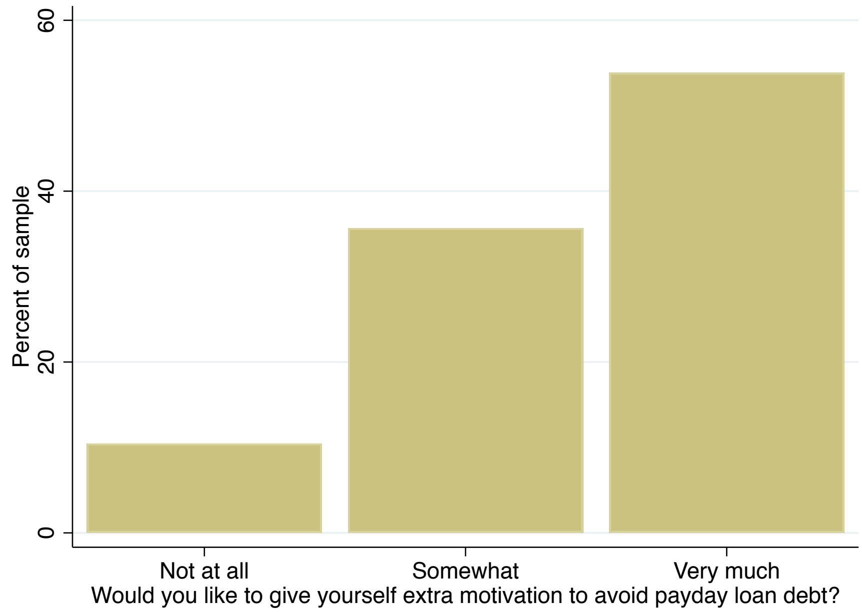
Figure 6: **Behavior Change Premium and Risk Aversion**



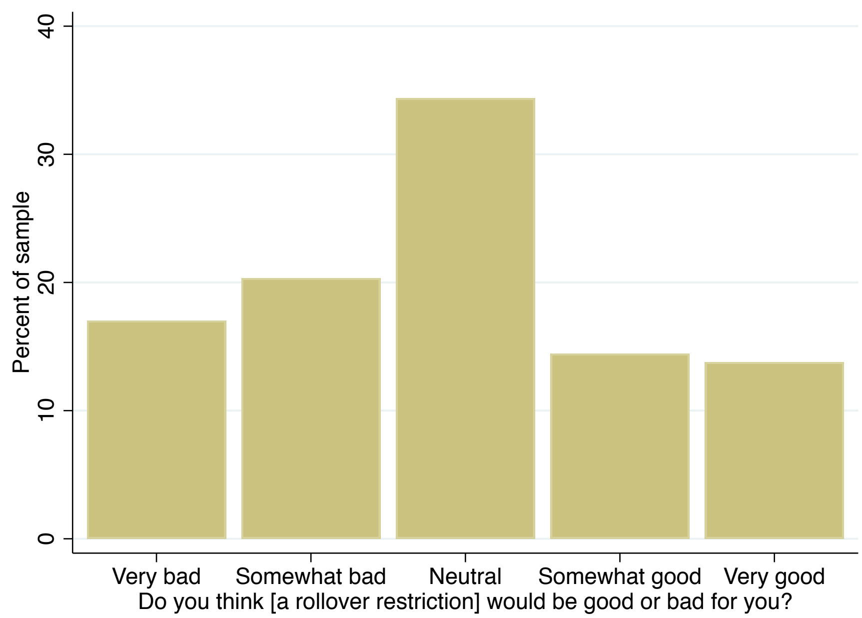
Notes: The first and third spikes are the average valuation of the $100 no-borrowing incentive and the $100 coin flip, respectively. The second spike is the average valuation of the $100 no-borrowing incentive for a risk-neutral borrower who believes she is time consistent, which is $w^* = (1 - \tilde{u}(0) + \tilde{\Delta}/2) \times \$100$. Error bars represent 95 percent confidence intervals.

Figure 7: **Responses to Qualitative Time Consistency Questions**

(a) **Desire for Motivation**



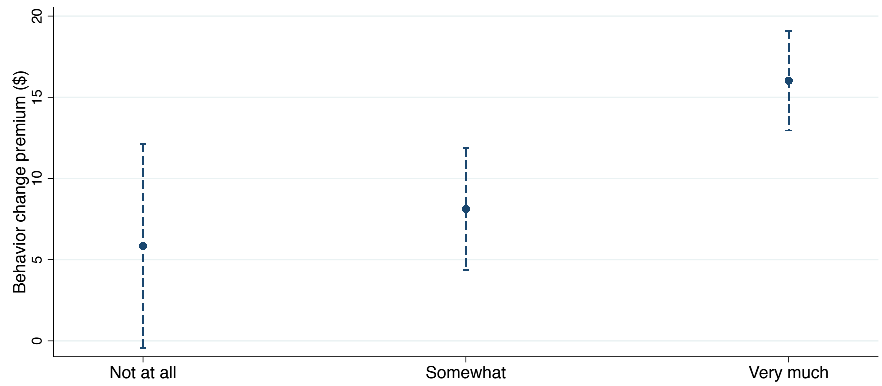
(b) **Personal Impact of Rollover Restrictions**



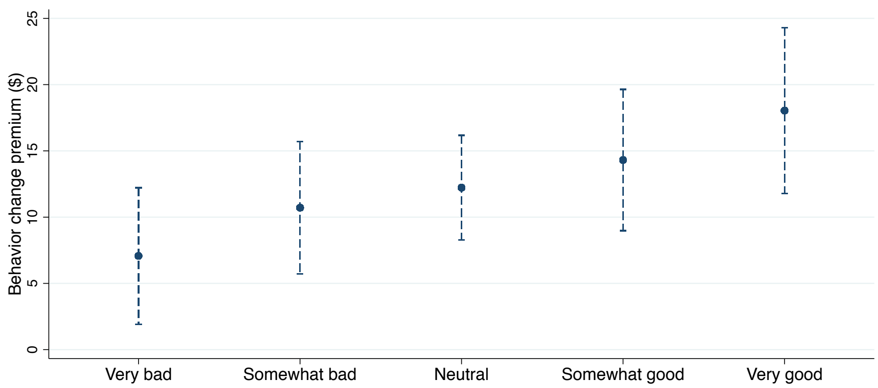
Notes: These are histograms of borrowers' responses to qualitative questions relatived to time consistency asked at the end of the survey. Panel (a) presents responses to the question, "To what extent would you like to give yourself extra motivation to avoid payday loan debt in the future?" Panel (b) presents responss to the question, "Some states have laws that prohibit people from taking out payday loans more than three paydays in a row. Do you think such a law would be good or bad for you?"

Figure 8: **Heterogeneity in Behavior Change Premium**

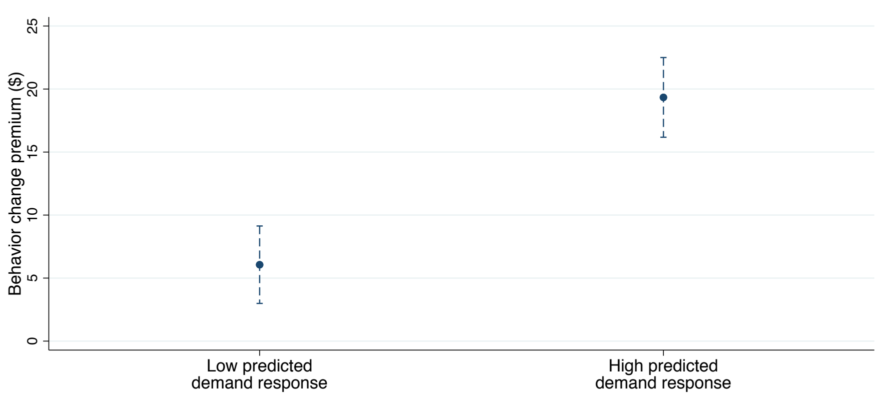
(a) **Heterogeneity by Desire for Motivation**



(b) **Heterogeneity by Personal Impact of Rollover Restrictions**

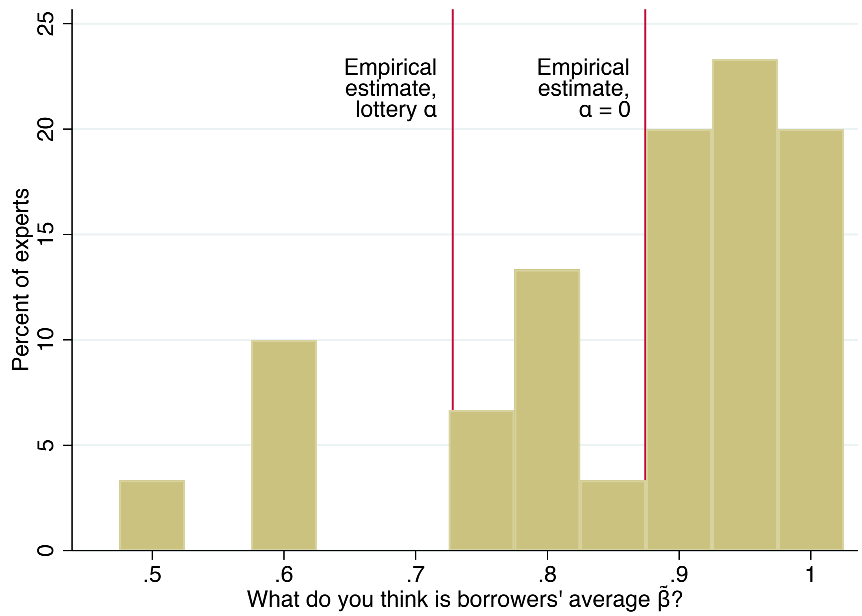


(c) **Heterogeneity by Predicted Demand Response**



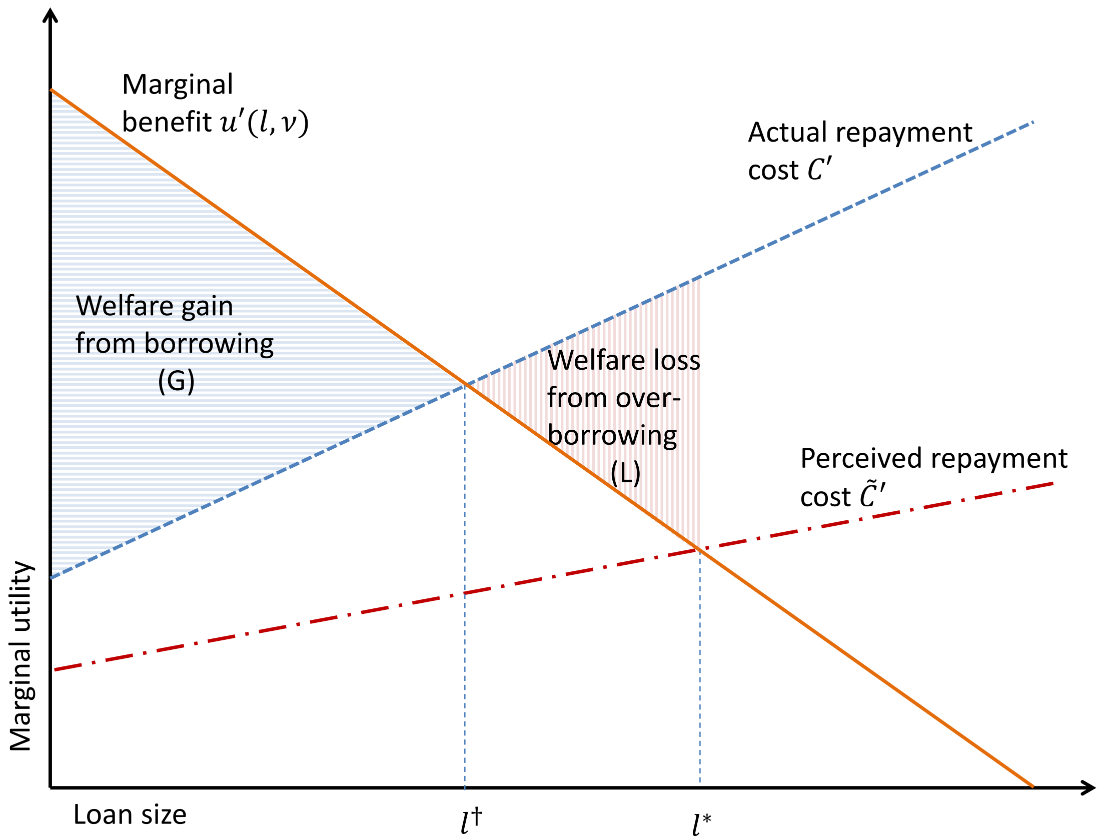
Notes: The behavior change premium equals $w - w^*$, the valuation of the no-borrowing incentive minus the valuation that a risk-neutral and time-consistent borrower would have. Panel (a) presents heterogeneity by response to the question, "To what extent would you like to give yourself extra motivation to avoid payday loan debt in the future?" Panel (b) presents heterogeneity by response to the question, "Some states have laws that prohibit people from taking out payday loans more than three paydays in a row. Do you think such a law would be good or bad for you?" In Panel (c), "High predicted demand response" includes people who reported that they would have a lower borrowing probability with the incentive compared to without, and "Low predicted demand response" includes people who reported that they would have the same or higher borrowing probability with the incentive. Error bars represent 95 percent confidence intervals.

Figure 9: **Experts' Beliefs about Borrowers' Perceived Present Focus**



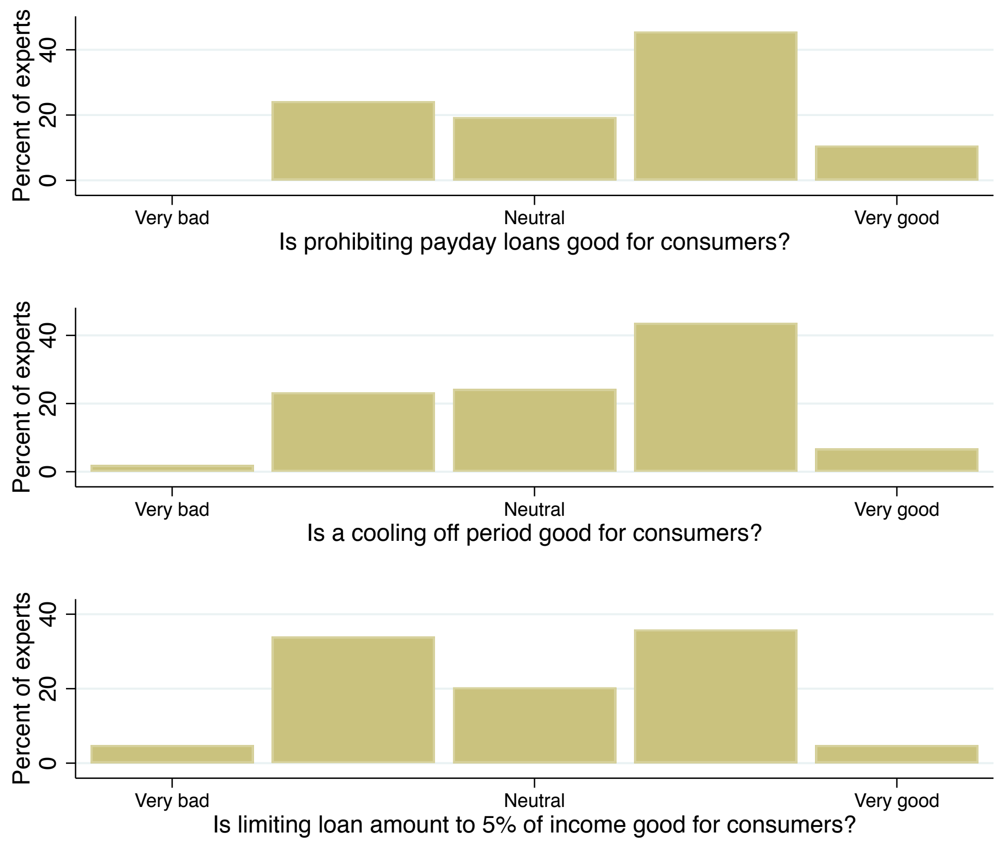
Notes: This is a histogram of experts' predictions of the average borrower's perceived present focus parameter $\tilde{\beta}$; this question was only asked of experts who said they had a PhD in economics. Data are from our survey of expert opinion, which was administered before our paper was released.

Figure 10: **Welfare Effects of Payday Loan Regulation**



Notes: This figure shows how a borrower with a given loan demand shock ν determines her desired loan size l in period $t = 0$. The downward sloping line is the marginal utility from borrowing an additional dollar, $u'(l, \nu)$. The two upward-sloping lines are the actual and perceived discounted expected values (as of $t = 0$, over the distribution of repayment cost shocks ω_t) of the marginal cost of repaying a loan of amount l beginning in $t = 1$. In $t = 0$, the borrower chooses l to equate the marginal benefit u' and perceived marginal repayment cost $\delta\tilde{C}'$, giving $l = l^*$. The loan size that maximizes welfare is $l^\dagger$, where $u' = \delta C'$. The welfare gain from a loan of size $l^\dagger$ is the shaded triangle at left. The welfare loss from setting l too high is the shaded triangle at right.

Figure 11: **Experts' Beliefs about Payday Loan Regulation**



Notes: These are histograms of experts' beliefs about whether specific payday loan regulations are good or bad for consumers overall. Data are from our survey of expert opinion, which was administered before our paper was released.

Online Appendix

Are High-Interest Loans Predatory?
Theory and Evidence from Payday Lending

Hunt Allcott, Joshua Kim, Dmitry Taubinsky, and Jonathan Zinman

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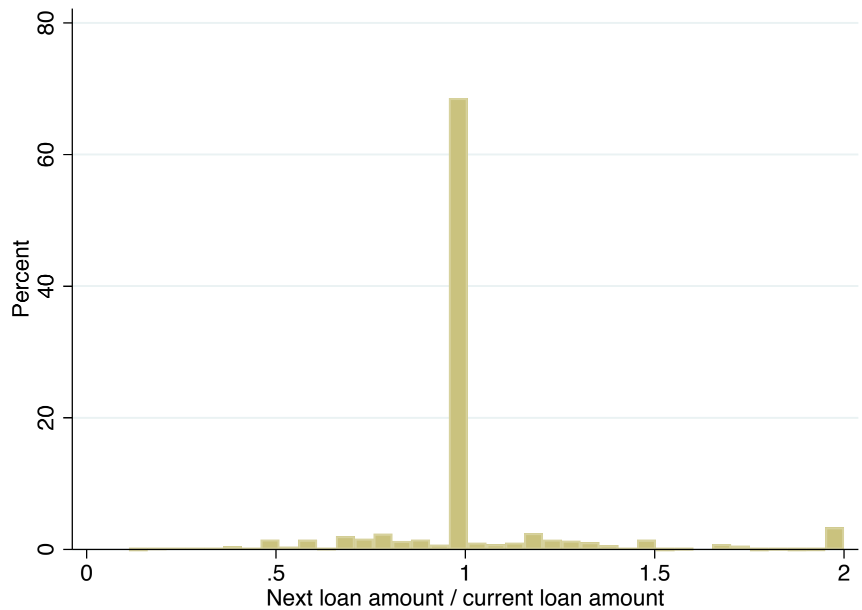
A Data Appendix

Figure A1: **Ratio of Next Loan Size to Current Loan Size**



Notes: For a random sample of payday loans disbursed by the Lender nationwide in 2017, this figure presents the ratio of the borrower's next loan size to the current loan size, for loans taken out within eight weeks of each other.

Table A1: **Descriptive Statistics**

	(1) Data source	(2) Mean	(3) Standard deviation	(4) Minimum value	(5) Maximum value
Loans in past six months	Lender	5.35	2.94	0	15
Annual income ($000s)	Lender	34.0	21.1	1	212
Internal credit score	Lender	862	122	0	997
Pay cycle length (days)	Lender	16.0	7.7	7	30
Loan length (days)	Lender	17.3	5.9	14	35
Loan amount ($)	Lender	373	161	50	600
Took survey in store	Lender	0.97	0.16	0	1
Predicted borrowing probability	Survey	0.70	0.35	0	1
Predicted borrowing probability with incentive	Survey	0.50	0.39	0	1
Valuation of incentive	Survey	52.2	44.8	0	155
Valuation of coin flip	Survey	42.2	33.0	0	155
"Very much" want motivation	Survey	0.54	0.50	0	1
Took out loans "more often than expected"	Survey	0.36	0.48	0	1
Borrowing restrictions "good" for me	Survey	0.28	0.45	0	1
Reborrowed over next eight weeks	Veritec	0.73	0.45	0	1
Reborrowed from Lender over next eight weeks	Lender	0.73	0.44	0	1

Notes: This table presents descriptive statistics for the sample of borrowers with valid survey responses. Sample size is 784 for internal credit score, 1,205 for loans in past six months and reborrowed from Lender over next eight weeks, and 1,205 for all other variables.

Table A2: **Balance**

	(1) Control (SE)	(2) Incentive (SE)	(3) Difference (SE)
Loans in past six months	5.30	5.44	-0.14
	(0.11)	(0.13)	(0.17)
Annual income ($000s)	33.7	34.0	-0.35
	(0.8)	(0.9)	(1.23)
Internal credit score	865	858	7.14
	(4)	(5)	(5.76)
Pay cycle length (days)	15.8	16.3	-0.52
	(0.3)	(0.3)	(0.45)
Loan length (days)	17.26	17.48	-0.22
	(0.24)	(0.25)	(0.35)
Loan amount ($)	373	370	3.69
	(6)	(7)	(9.39)
Took survey in store	0.97	0.98	-0.01
	(0.01)	(0.01)	(0.01)
Predicted borrowing probability	0.69	0.71	-0.02
	(0.01)	(0.01)	(0.02)
Predicted borrowing probability with incentive	0.48	0.51	-0.03
	(0.02)	(0.02)	(0.02)
Valuation of incentive	54.6	50.1	4.51
	(1.8)	(1.9)	(2.61)
Valuation of coin flip	42.0	42.8	-0.80
	(1.3)	(1.4)	(1.93)
"Very much" want motivation	0.56	0.52	0.04
	(0.02)	(0.02)	(0.03)
Took out loans "more often than expected"	0.33	0.40	-0.07
	(0.02)	(0.02)	(0.03)
Borrowing restrictions "good" for me	0.30	0.27	0.03
	(0.02)	(0.02)	(0.03)
N	633	544	
F-test of joint significance (p-value)			0.20
F-test, number of observations			1,177

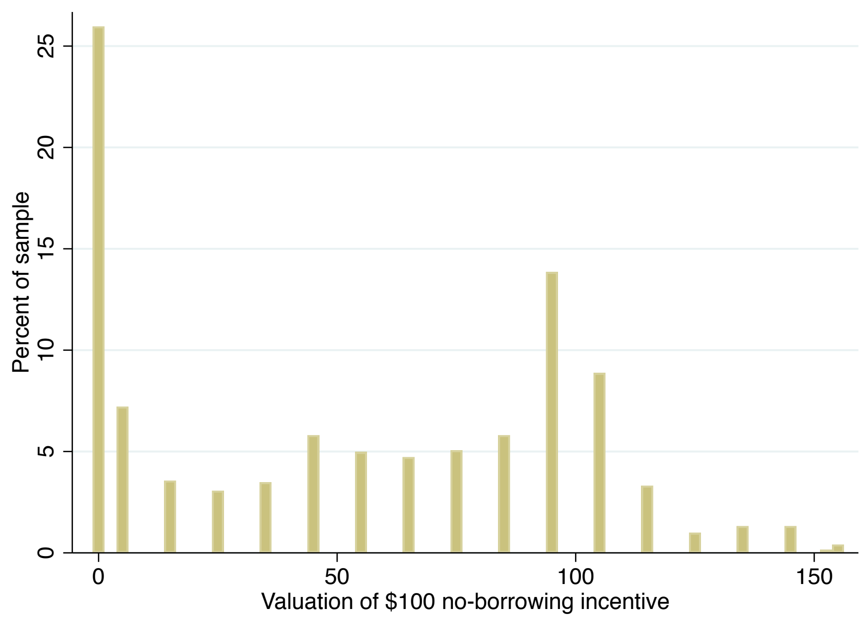
Notes: This table presents means and differences in means of baseline and survey variables for the Control and Incentive groups, with standard errors in parentheses. The data exclude 28 observations that were not assigned to the Control or Incentive groups.

Table A3: **Refusal and Sample Restrictions**

Sample restriction	N
Customers on survey days	13,191
Consented or declined	2,243
Consented	2,236
Completed survey	2,122
Matched to Lender data	1,943
Understood no-borrowing incentive	1,628
Passed attention check	1,428
Consistent MPL choices	1,392
Valuation of incentive < $160	1,205

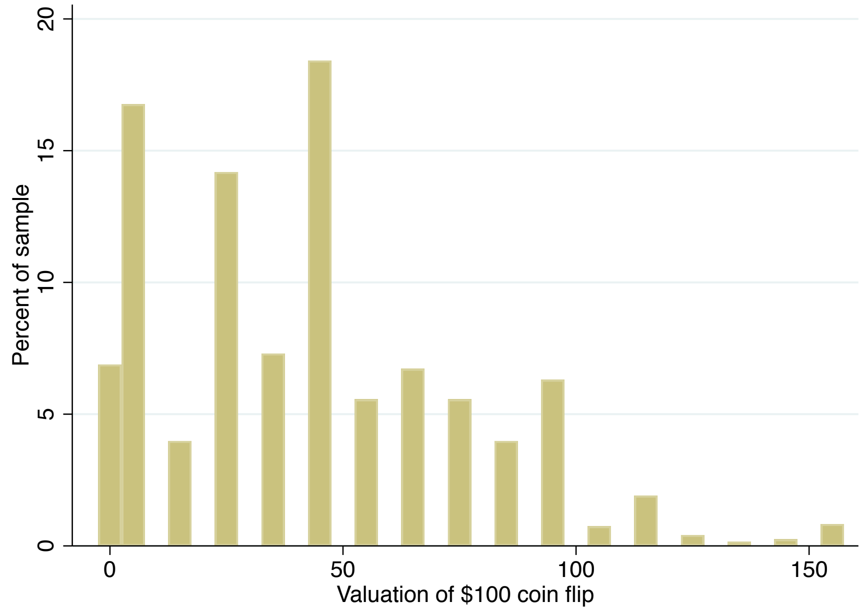
Notes: This table presents sample sizes after refusals and sample restrictions. "Customers on survey days" means all customers who got a loan from a Lender's store on a day when the survey was available in that store.

Figure A2: **Distribution of Valuations of the No-Borrowing Incentive**



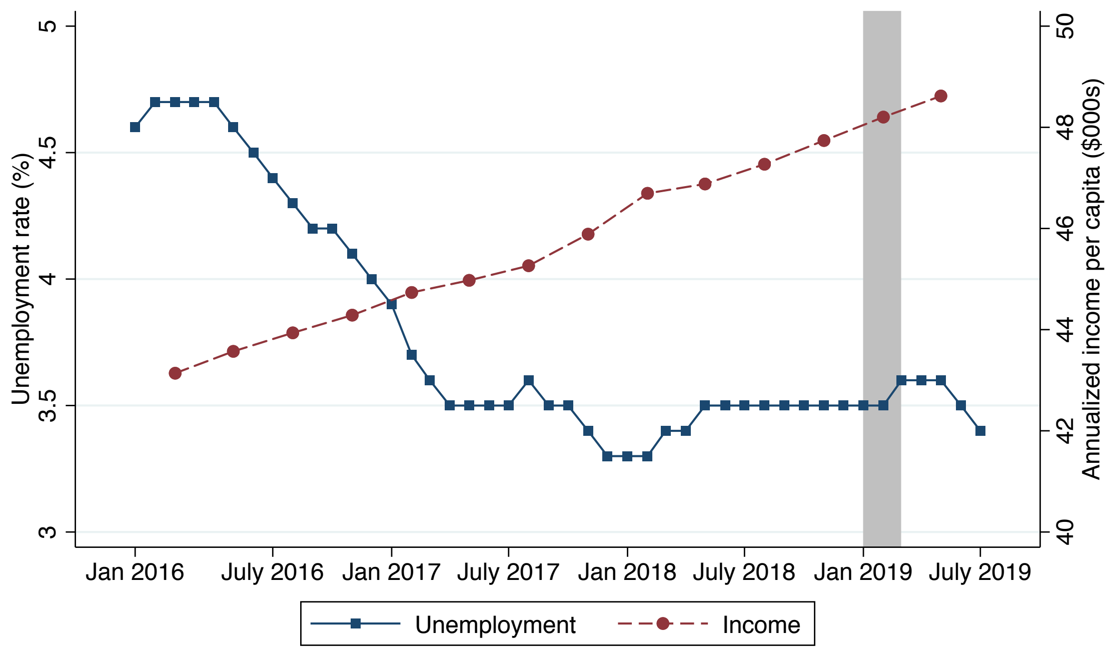
Notes: This figure presents the distribution of valuations of the $100 no-borrowing incentive, as revealed on a multiple price list.

Figure A3: **Distribution of Valuations of the $100 Coin Flip**



Notes: This figure presents the distribution of valuations of the Flip a Coin for $100 reward, as revealed on a multiple price list.

Figure A4: **Indiana Macroeconomic Trends Before and After Survey**



Notes: This figure presents the unemployment rate and average annualized income in Indiana during the study period and for the three years before. Unemployment rate is from the Federal Reserve Bank of St. Louis (2019). Income is in nominal dollars and is from BEA (2019). The grey shaded area illustrates that all surveys were taken between January and March 2019.

Table A4: **Descriptive Statistics for Expert Survey**

Number of respondents	103
Percent academic economists	68%
Opinions about borrower decision making	
Think the average borrower underestimates reborrowing	78%
Average belief about borrowers' predicted reborrowing probability	40%
Think that the average borrower wants extra motivation to avoid borrowing	56%
Average belief about borrowers' perceived present bias parameter $\widetilde{\beta}$	0.86
Average certainty of opinion about borrower decision-making $(0 = \text{not at all}, 1 = \text{extremely})$	0.50
Opinions about effects of payday lending regulation on consumers	
Think prohibiting payday lending is good	56%
Think a rollover restriction with "cooling off period" is good	50%
Think limiting loan size to 5% of income is good	41%
Average certainty about effects of regulation $(0 = \text{not at all}, 1 = \text{extremely})$	0.44

Notes: This table presents descriptive statistics from a survey in which we asked academic and non-academic payday lending experts to predict the results of our study before it was released.

B Predicted Borrowing Data

B.1 Rounding

Figure A5 plots the distribution of predicted reborrowing probabilities without the no-borrowing incentive. Figure A6 plots the distribution of predicted reborrowing probabilities with the incentive. Both figures demonstrate excess mass at 0 percent, 50 percent, and 100 percent, suggesting that survey respondents may gravitate towards round numbers. Since all of our results on predicted reborrowing use averages across respondents, rounding affects our results if and only if it affects the average.

To examine how rounding may affect our results, we conduct an illustrative exercise where we estimate what the counterfactual distribution of predicted reborrowing probabilities may look like in the absence of rounding. We suppose that survey respondents who would answer 0.1 or 0.2 in the absence of rounding, may instead round to 0. Similarly, respondents who would answer 0.8 or 0.9 would round to 1, and respondents who would answer 0.3, 0.4, 0.6, or 0.7 would round to 0.5. Let μ denote the probability that a respondent chooses to round their answer.

We estimate μ by assuming that in the absence of rounding, the number of respondents who would choose to answer a focal number would equal the average number of respondents who chose to answer a non-focal number in the same rounding bin. For example, we assume that the number of respondents who would answer 0 would equal the average number of respondents who chose 0.1 or 0.2. We can then calculate the number of "excess" respondents who chose the focal number, and divide by the number of total respondents in a rounding bin to estimate μ, which we estimate to be $\hat{\mu} = 0.51$. For each rounding bin, we can then estimate the number of respondents who chose to round to the focal number, and redistribute them to recover the counterfactual distribution without rounding.

We plot the distribution of predicted reborrowing probabilities, correcting for rounding, in A7. The new average probability of reborrowing after correcting for rounding is 68 percent, compared to the 70 percent we found without correcting for rounding. Thus, rounding does not seem to substantially affect our results.

B.2 Survey Response Noise

Figure A8 presents a binned scatterplot of participants' predicted probability of reborrowing versus the actual proportion of customers assigned to our Control group who took out an additional loan. We see that borrowers who reported a higher probability of reborrowing were substantially more likely to actually borrow.

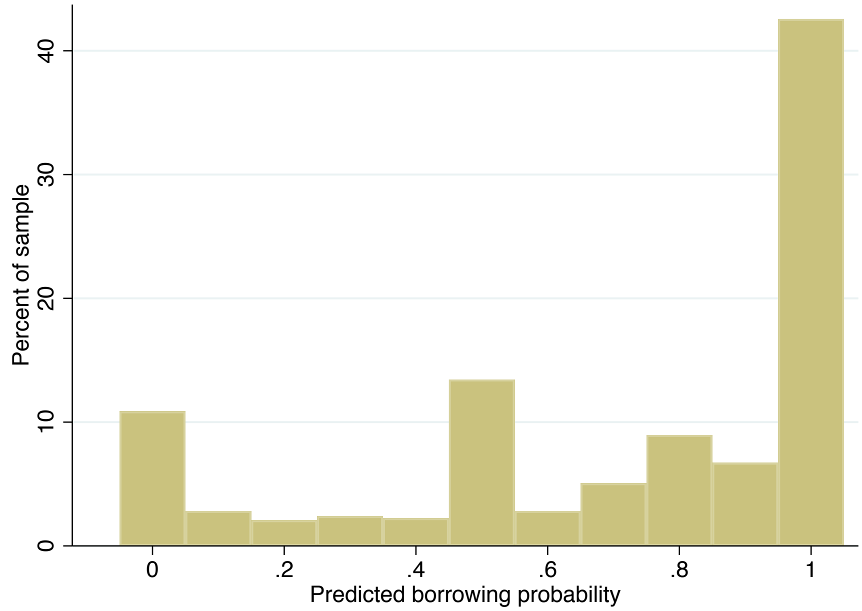
The relationship between predicted and actual borrowing probability is attenuated relative to a 45-degree line, consistent with the expected effects of measurement error due to noisy survey responses. Such noise could be driven by accidentally clicking the wrong numbers or cognitive difficulties in articulating probabilities. To illustrate how measurement error can attenuate the relationship between predicted and actual probabilities, we run a simple simulation where individuals report a predicted probability with noise.

We first draw 10,000 true borrowing probabilities p from a $Beta(2.9, 1)$ distribution. The average of simulated probabilities p thus equals the actual probability of reborrowing we observe in our sample: 74 percent. To simulate measurement error, we follow the procedure used in Mueller, Spinnewijn, and Topa (2019): given a true probability p and a noise parameter d, individuals report a predicted probability $\hat{p} = p + \epsilon$, where $\epsilon \sim U(-d, d)$ if $p - d \geq 0$ and $p + d \leq 1$. If $p - d < 0$, then $\epsilon \sim U(-p, d)$, with a mass-point at $-p$ such that $E[\epsilon] = 0$. Similarly, if $p + d > 1$, then $\epsilon \sim U(-d, 1 - p)$, with a mass-point at $1 - p$ such that $E[\epsilon] = 0$. Panel (a) of Figure A9 presents the results of our simulations with $d = 0.5$.

We also account for rounding bias when individuals report $\hat{p}$. If $\hat{p} \in [0, 0.25)$, then with 50 percent probability, they report $\hat{p} = 0$. Similarly, if $\hat{p} \in [0.25, 0.75)$ or $\hat{p} \in [0.75, 1]$, they report $\hat{p} = 0.5$ or $\hat{p} = 1$ with 50 percent probability, respectively. Panel (b) plots a simulated binscatter plot with both measurement error where $d = 0.5$ and rounding bias.

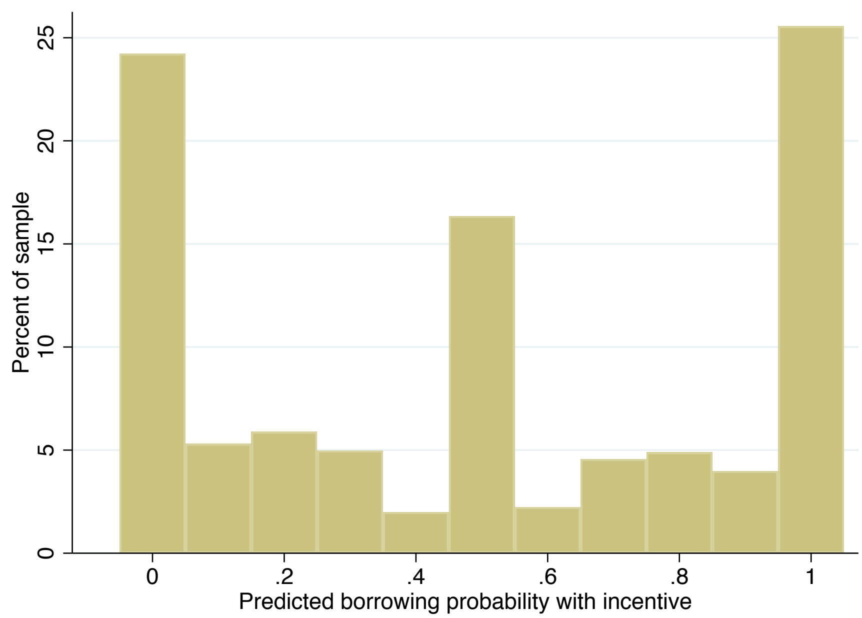
Neither mean-zero measurement error or rounding bias substantially affect our results: the actual average of simulated probabilities is 74 percent and the average of simulated probabilities with measurement error and rounding is 74.3 percent.

Figure A5: **Distribution of Predicted Borrowing Probability**



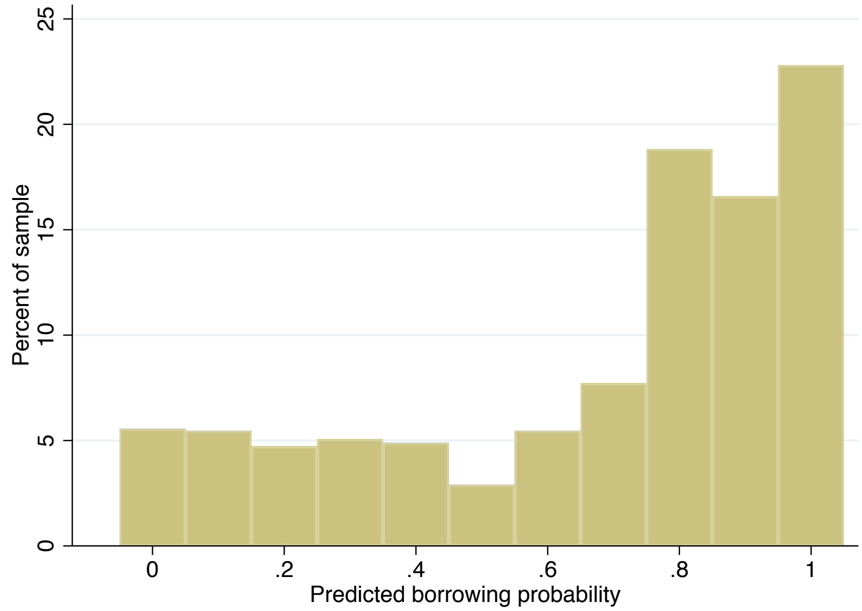
Notes: This figure presents the distribution of answers to the following question: "What do you think is the chance that you will get another payday loan from any lender before [eight weeks from now]?"

Figure A6: **Distribution of Predicted Borrowing Probability with No-Borrowing Incentive**



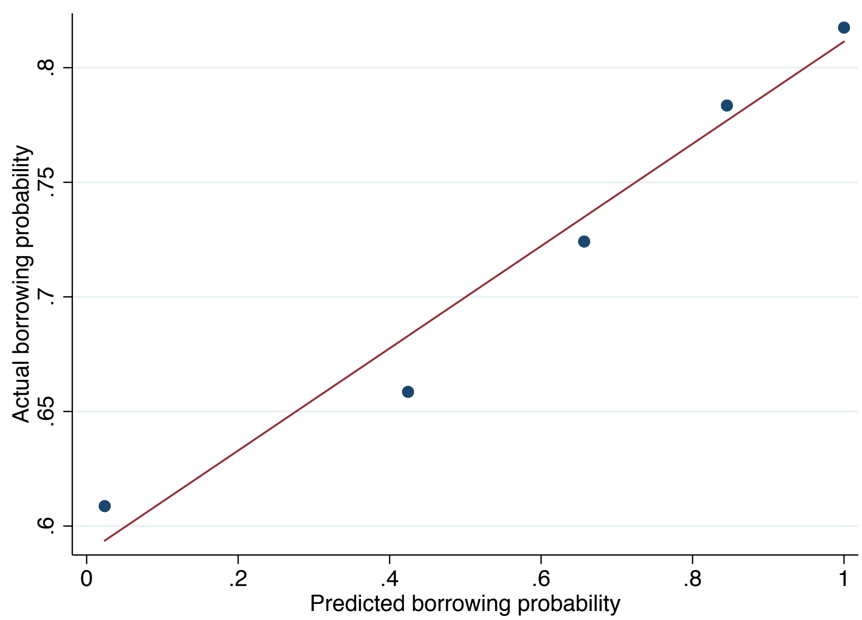
Notes: This figure presents the distribution of answers to the following question: **"If you are selected for $100 If You Are Debt-Free**, what is the chance that you would get another payday loan from any lender before [eight weeks from now]?"

Figure A7: **Distribution of Debiased Predicted Borrowing Probability**



Notes: This figure presents the counterfactual (without rounding) distribution of responses to the following question: "What do you think is the chance that you will get another payday loan from any lender before [eight weeks from now]?"

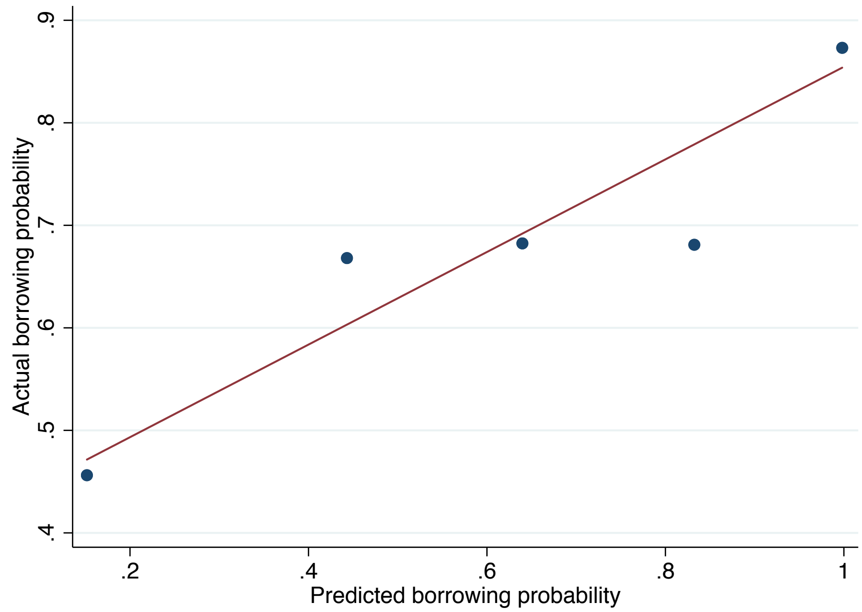
Figure A8: **Predicted versus Actual Borrowing**



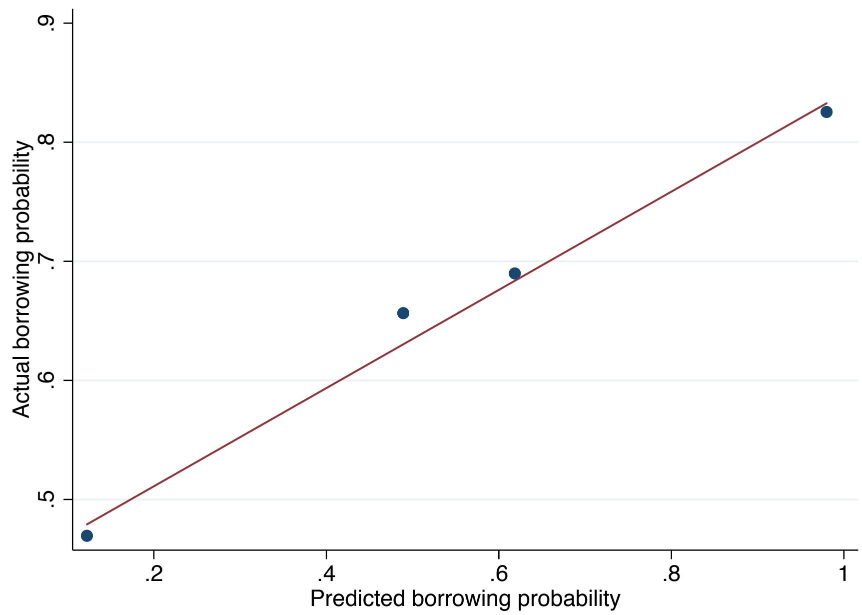
Notes: This figure presents a binned scatterplot of actual versus predicted probability of getting another payday loan in the next eight weeks after the survey, for the Control group.

Figure A9: **Predicted versus Actual Borrowing (Simulations)**

(a) **Simulations with Measurement Error**



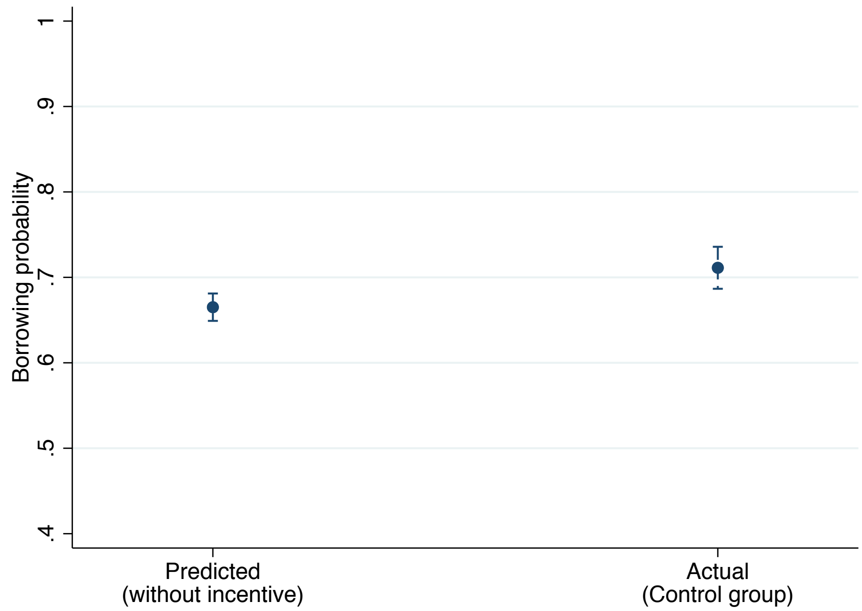
(b) **Simulations with Measurement Error and Rounding Bias**



Notes: These figures present the effects of measurement error and rounding bias on predicted versus actual borrowing probabilities. Panel (a) plots a binned scatterplot of predicted versus actual borrowing probability with mean zero measurement error. Panel (b) includes mean zero measurement error and rounding bias.

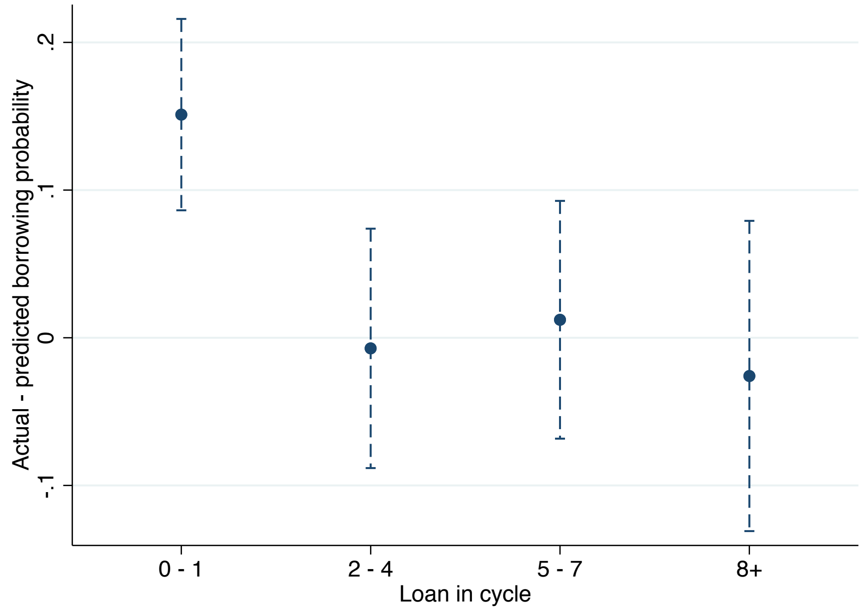
C Empirical Results Appendix

Figure A10: **Predicted and Actual Borrowing Without Pre-Registered Exclusion Restrictions**



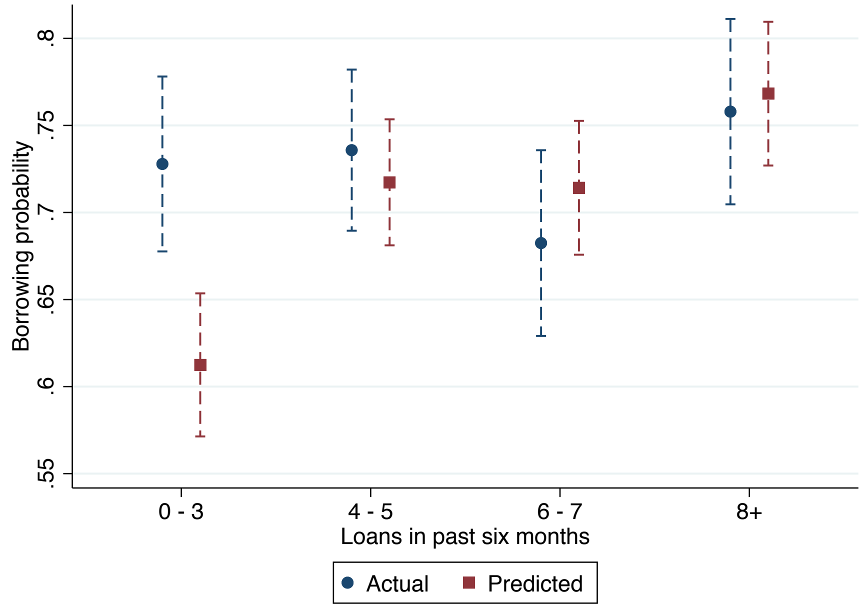
Notes: The data includes all participants, including those whom we pre-registered to exclude. The left spike presents the average predicted probability of getting another payday loan in the next eight weeks without the no-borrowing incentive. The right spike presents the actual probability of getting another payday loan in the next eight weeks for the Control group, which did not receive the no-borrowing incentive. Error bars represent 95 percent condence intervals.

Figure A11: **Heterogeneity in Misprediction by Loan in Cycle**



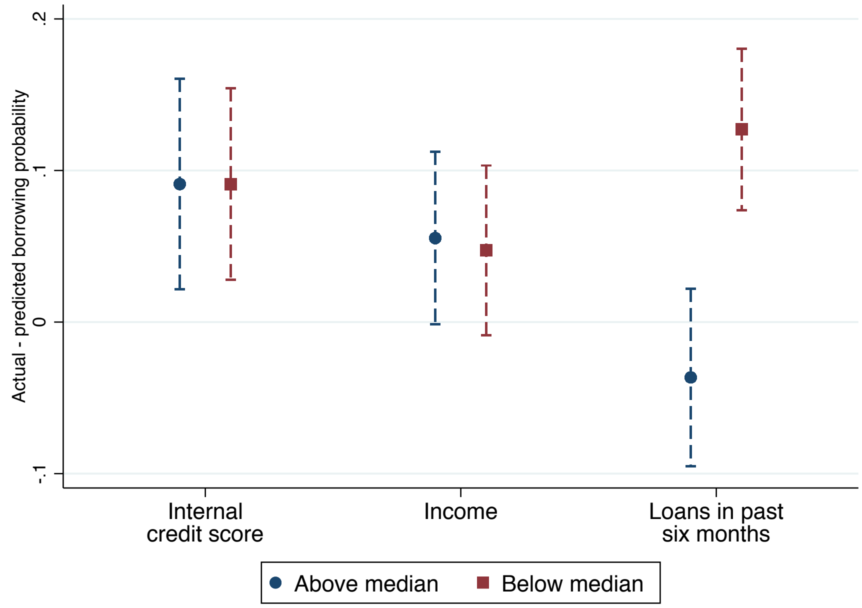
Notes: This figure presents the actual borrowing probability minus the average predicted borrowing probability for subgroups defined by the number of consecutive loans taken out from the Lender before the survey date. "Consecutive loans" are loans taken out within eight weeks of each other. The figure includes only the Control group. Error bars represent 95 percent confidence intervals.

Figure A12: **Heterogeneity in Misprediction by Experience**



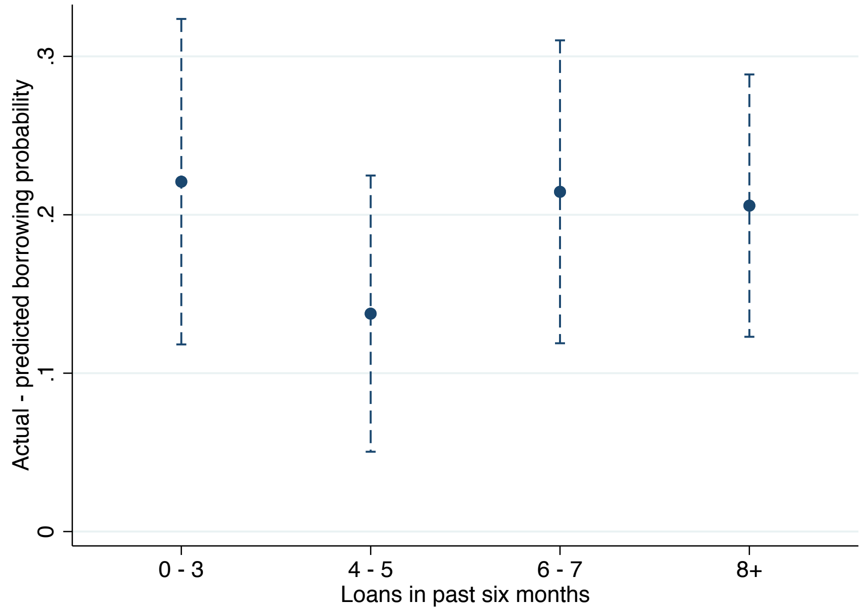
Notes: This figure presents the actual borrowing probability and the average predicted borrowing probability for subgroups defined by the number of loans taken out from the Lender in the six months before taking the survey. The figure includes only the Control group. Error bars represent 95 percent confidence intervals.

Figure A13: **Heterogeneity in Misprediction**



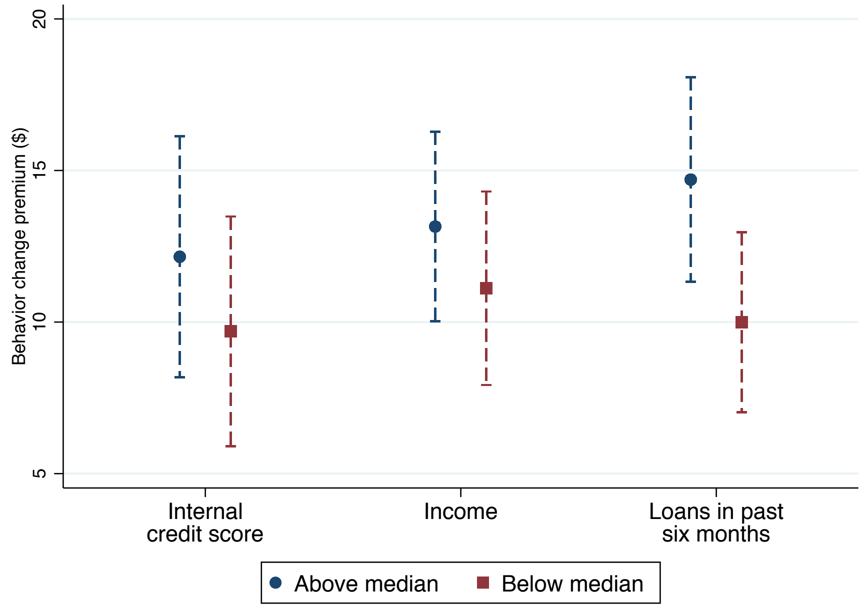
Notes: This figure presents the actual borrowing probability minus the average predicted borrowing probability for borrowers with above- versus below-median internal credit score, income, and number of loans taken out from the Lender in the six months before taking the survey. The figure includes only the Control group. Error bars represent 95 percent confidence intervals.

Figure A14: **Misprediction by Experience in Incentive Group**



Notes: This figure presents the actual borrowing probability minus the average predicted borrowing probability for subgroups defined by the number of loans taken out from the Lender in the six months before taking the survey. This figure includes only the Incentive group. Error bars represent 95 percent confidence intervals.

Figure A15: **Heterogeneity in Behavior Change Premium**



Notes: This figure presents the behavior change premium for borrowers with above- versus below-median internal credit score, income, and number of loans taken out from the Lender in the six months before taking the survey. The behavior change premium equals $w - w^{*}$, the valuation of the no-borrowing incentive minus the valuation that a risk-neutral and time-consistent borrower would have. Error bars represent 95 percent confidence intervals.

Table A5: **Do People Keep More Liquid Assets when Payday Lending is Banned?**

	(1) $ln(1+ assets)$	(2) $ln(1+ assets)$	(3) $1(assets \geq \$400)$	(4) $1(assets \geq \$400)$	(5) $1(assets \geq \$1000)$	(6) $1(assets \geq \$1000)$
Payday loan ban	-0.02	0.02	-0.00	-0.01	-0.00	0.00
	(0.22)	(0.12)	(0.03)	(0.02)	(0.03)	(0.02)
Observations	43,416	40,007	43,416	40,007	43,416	40,007
Dependent variable mean	4.22	4.16	0.51	0.50	0.43	0.42
Household fixed effects	No	Yes	No	Yes	No	Yes

Notes: This table presents a regression of liquid assets on a state payday loan ban indicator and household controls using Panel Survey of Income Dynamics data from 2003–2017. Liquid assets is total amount in checking or savings accounts, money market funds, certificates of deposit, government bonds, or treasury bills, for the respondent and members of his or her household. Household controls are ln(income), ln(education years), ln(household size), and ln(age). Standard errors are clustered by state.

D Formal Statement of Section 5.2 Envelope Theorem Arguments

D.1 Envelope Theorem with General Choice Sets

Formally, we conceptualize the time consistent borrower's problem as follows. There is a space Ω of states of the world equipped with a sigma algebra Σ_Ω. A state of the world can constitute a sequence of liquidity, income, and other types of shocks, as well as signals about future liquidity, income, and other consequential outcomes. There is also a set of possible actions A, equipped with a sigma algebra Σ_A, which can constitute sequences of borrowing, repaying, and any other consumption and savings decisions. A feasible plan is a measurable function $\mathbf{a} : (\Omega, \Sigma_\Omega) \to (A, \Sigma_A)$ that prescribes a sequence of behavior for a realized state of the world, and we let $\mathcal{A}$ denote the set of all feasible plans. Let the experimental incentives be $(w, b) \in [0, \bar{b}] \times [0, \bar{w}]$.

To be clear, this formulation allows for arbitrarily dynamic decisions. For example, let $t = 0$ denote the period in which the borrower takes the study, and let T denote the end of the game. A state of the world $\omega \in \Omega$ can constitute a sequence of realizations $\omega = (\omega_{1,} \dots, \omega_T)$. An action $a = (a_1, \dots a_T)$ constitutes a sequences of choices in each period. At each time period t, the choice-set A_t may be a function of the history $h_t = (\omega_{1,} \dots, \omega_{t-1}, a_1, \dots, a_{t-1})$. Then $\mathbf{a} \in \mathcal{A}$ is a plan for a choice of a_t after each realized history h_t. The utility function u can corresponded to the discounted sum $\sum_{t=1}^{T} \delta^t F_t(a_t, h_t, \omega_t, b, w)$ of flow utility functions F_t that can depend arbitrarily on the states of the world and the decisions made by the borrower. In this formulation we can also remain agnostic about which time period corresponds to the 8-week mark after the start of the study, and which time period corresponds to the 12-week mark at which the experimental incentives are delivered. A time period could be an hour, a day, a week, or anything else. Because borrowers are time-consistent and thus do not wish to revise their state-contingent plans, the dynamic decisions can be represented by a single static choice of a state-contingent plan.

For a plan $\mathbf{a}$, let $\Omega_R(\mathbf{a})$ denote the subset of states for which the borrow is "debt-free" for 8 weeks after the start of the experiment. Let $\mathbf{1}(\omega \in \Omega_D(\mathbf{a})) \in \{0, 1\}$ be an indicator for whether a state belongs $\Omega_R(\mathbf{a})$. Expected utility given a plan $\mathbf{a}$ and experimental incentives (w, b) is

$$U(\mathbf{a}, w, b) = \int_\Omega u(\mathbf{a}(\omega), y; \omega) d\nu(\omega)$$

where $y = w + b\mathbf{1}(\omega \in \Omega_R(\mathbf{a}))$, ν is the measure on (Ω, Σ_Ω), and u is realized utility for each plan and sequence of actions. Our main assumption is that $u(a, y; \omega)$ is continuously differentiable in y for all a and ω, and that the derivative with respect to y is bounded: $\sup_{a,y,\omega} |\frac{\partial}{\partial w} u(a, y; \omega)| < \infty$. This ensures that U is equidifferentiable in w and b on compact set $[0, \bar{b}] \times [0, \bar{w}]$.[29] Theorem 3 of Milgrom and Segal (2002) then ensures that $V(w, b) = \sup_{\mathbf{a} \in \mathcal{A}} U(\mathbf{a}, w, b)$ is continuously differentiable in w, b.

For incentives (w, b), let $\mathbf{a}^*_{w,b}$ be the optimal plan chosen by the borrower, satisfying $U(\mathbf{a}^*_{w,b}, w, b) = V(w, b)$. Note that optimal plans need not be unique, and we use $\mathbf{a}^*$ to denote the borrower's selection.

[29] See Milgrom and Segal (2002), p 587 for the definition of equidifferentiability.

Set $\tilde{\mu}(w,b) := \nu\left(\Omega_R(\mathbf{a}^*_{w,b})\right)$. Define $\bar{m}_0(w,b) := E\left[\frac{\partial}{\partial y}u(\mathbf{a}^*_{w,b}(\omega),y;\omega)|_{y=w+b}|\omega\in\Omega_R(\mathbf{a}^*_{w,b})\right]$ to be the average marginal utility from income in states of the world in which the borrower does not reborrow in the 8-week period. Define $\bar{m}_1(w,b)$ analogously to be the average marginal utility from income in states of the world in which the borrower does reborrow in the 8-week period.

Theorem 1 of Milgrom and Segal (2002) then gives the following:

$$\begin{aligned}
\frac{\partial}{\partial b}V(w,b) &= \frac{\partial}{\partial b}U(\mathbf{a},w,b)\\
&= \int_{\Omega_R(\mathbf{a}^*_{w,b})}\frac{\partial}{\partial y}u(\mathbf{a}^*_{w,b}(\omega),y;\omega)|_{y=w+b}d\nu(\omega)\\
&= \bar{m}_0(w,b)(1-\tilde{\mu}(w,b)) && (20)\\
\frac{\partial}{\partial w}V(w,b) &= \frac{\partial}{\partial w}U(\mathbf{a},w,b)\\
&= \int_{\Omega_R(\mathbf{a}^*_{w,b})}\frac{\partial}{\partial y}u(\mathbf{a}^*_{w,b}(\omega),y;\omega)|_{y=w+b}d\nu(\omega)+\int_{\Omega_R(\mathbf{a}^*_{w,b})^c}\frac{\partial}{\partial y}u(\mathbf{a}^*_{w,b}(\omega),y;\omega)|_{y=w}d\nu(\omega)\\
&= \bar{m}_0(w,b)(1-\tilde{\mu}(w,b))+\bar{m}_1(w,b)\tilde{\mu}(w,b) && (21)
\end{aligned}$$

Now define $w(b)$ to satisfy $V(w(b),0)=V(0,b)$, which is differentiable by the Implicit Function Theorem. From (20) and (21) above, we have

$$w'(b)=\frac{\frac{\partial}{db}V(w(b),b)}{\frac{\partial}{dw}V(w(b),b)}=\frac{\bar{m}_0(w(b),b)(1-\tilde{\mu}(w(b),b))}{\bar{m}_0(w(b),b)(1-\tilde{\mu}(w(b),b))+\bar{m}_1(w(b),b)\tilde{\mu}(w(b),b)}$$

Under the assumption that $\bar{m}_0\leq\bar{m}_1$, which holds in our microfounded structural model, we then have that $w'(b)\leq(1-\tilde{\mu}(w(b),b))$. Note that there are two general economic reasons for $\bar{m}_0\leq\bar{m}_1$. First, y is mechanically higher when the borrower does not reborrow. Second, carrying debt increases marginal utility from money.

Moreover, under the assumption that guaranteed future income in 12 weeks encourages borrowers to continue reborrowing over the first 8 weeks, we have that $\tilde{\mu}(w(b),b)\geq\tilde{\mu}(0,b)$, and thus that

$$w'(b)\leq(1-\tilde{\mu}(0,b))$$

from which it follows that

$$w(b)\leq\int_{x=0}^{b}(1-\tilde{\mu}(0,x))dx. \tag{22}$$

D.2 Approximations to $w(b)$

For the sake of concision, we now write $\tilde{\mu}$ as a function of b only, assuming that it is evaluated at $w=0$. If $\tilde{\mu}$ is (weakly) concave in b, then

$$\begin{aligned}\int_{b=0}^{\gamma}\tilde{\mu}(b)db &= \gamma\int_{t=0}^{1}\tilde{\mu}(t\gamma)dt\\ &\geq \gamma\int_{t=0}^{1}\left[(1-t)\tilde{\mu}(0)+t\tilde{\mu}(\gamma)\right]dt\\ &= \gamma\tilde{\mu}(0)+\gamma\int_{t=0}^{1}t(\tilde{\mu}(\gamma)-\tilde{\mu}(0))dt\\ &= \gamma\left[\tilde{\mu}(0)+\frac{1}{2}(\tilde{\mu}(\gamma)-\tilde{\mu}(0))\right]\end{aligned}$$

with equality holding when $\tilde{\mu}$ is linear in b on $[0,\bar{\gamma}]$, since in that case $\tilde{\mu}(t\gamma)=(1-t)\tilde{\mu}(0)+t\tilde{\mu}(\gamma)$. Thus, when w is (weakly) concave,

$$w(\gamma)\leq\int_{b=0}^{\gamma}(1-\tilde{\mu}(0,b))db\leq\gamma\left[1-\tilde{\mu}(0)+\frac{1}{2}(\tilde{\mu}(0)-\tilde{\mu}(\gamma))\right].$$

Next, suppose that $\tilde{\mu}$ is convex, with $\tilde{\mu}'(\gamma)=k\tilde{\mu}'(0)$ for $k\in(0,1)$. Make the quadratic approximation that terms of order $\tilde{\mu}'''$ and higher are negligible. Then $\tilde{\mu}'(\gamma)=\tilde{\mu}'(0)+\gamma\tilde{\mu}''$, and thus $\tilde{\mu}''=\frac{\tilde{\mu}'(\gamma)-\tilde{\mu}'(0)}{\gamma}=\frac{k-1}{\gamma}\tilde{\mu}'(0)$. Moreover,

$$\begin{aligned}\tilde{\mu}(\gamma)-\tilde{\mu}(0) &= \tilde{\mu}'(0)\gamma+\tilde{\mu}''(0)\gamma^2/2\\ &= \tilde{\mu}'(0)\gamma\left(1+\frac{k-1}{2}\right)\\ &= \tilde{\mu}'(0)\gamma(k+1)/2\end{aligned}$$

and thus $\tilde{\mu}'(0)=2\frac{\tilde{\mu}(\gamma)-\tilde{\mu}(0)}{\gamma(k+1)}$

Then the bound on surplus is given by

$$\begin{aligned}\int_{b=0}^{\gamma}(1-\tilde{\mu}(b))db &= (1-\tilde{\mu}(0))\gamma-\tilde{\mu}'(0)\frac{\gamma^2}{2}-\tilde{\mu}''\frac{\gamma^3}{6}\\ &= (1-\tilde{\mu}(0))\gamma-\tilde{\mu}'(0)\frac{\gamma^2}{2}+\tilde{\mu}'(0)\frac{1-k}{6}\gamma^2\\ &= (1-\tilde{\mu}(0))\gamma-2\frac{\tilde{\mu}(\gamma)-\tilde{\mu}(0)}{\gamma(k+1)}\left(\frac{\gamma^2}{2}-\frac{1-k}{6}\gamma^2\right)\\ &= (1-\tilde{\mu}(0))\gamma-(\tilde{\mu}(\gamma)-\tilde{\mu}(0))\gamma\left(\frac{1}{k+1}-\frac{1-k}{3}\right)\\ &= (1-\tilde{\mu}(0))\gamma+(\tilde{\mu}(0)-\tilde{\mu}(\gamma))\gamma\left(\frac{2+k}{3+3k}\right)\end{aligned}$$

When $k=1/2$, we have $\frac{2+k}{3+3k}=0.56$. When $k=0.25$, we have $\frac{2+k}{3+3k}=0.6$.

E Proofs for Section 6

More generally, we now suppose that the cost functions are now given by $k(x, \theta, \eta)$ and $\tilde{C}(x, \eta)$, where η is the correlated shock distributed according to G. We define $\alpha = E[\tilde{C}''(0, \eta)/\tilde{C}'(0, \eta)]$, and $\rho = \alpha(l + p)$.

To establish the results in the body of the paper, we assume that $\frac{k(l+p,\theta,\eta)-k(p,\theta,\eta)}{\tilde{C}(x_1,\eta)-\tilde{C}(x_2,\eta)} \perp \tilde{C}'(x, \eta) \forall \eta, x_1, x_2$. This stronger assumption guarantees that period 1 decisions relate to period 2 marginal utility from money only through how they affect period 2 debt.

E.1 Proof of Proposition 1

We prove the following more general result:

Proposition (generalization of Prop 1) *Suppose that $\tilde{C}(x, \eta)$ is convex in x for all η. Then $\frac{\beta}{\tilde{\beta}} \geq \frac{l+p+\gamma^\dagger}{l+p}$. Under the assumptions that (i) $\frac{k(l+p,\theta,\eta)-k(p,\theta,\eta)}{\tilde{C}(x_1,\eta)-\tilde{C}(x_2,\eta)} \perp \tilde{C}'(x, \eta) \forall \eta, x_1, x_2$, (ii) terms of order $(l + p)^3 E[\tilde{C}'''(x, \eta)/\tilde{C}'(x, \eta)]$ are negligible and (iii) $\tilde{\mu}$ is locally linear in b, we have the statement of Proposition 1.*

Proof. Define

$$G(b) := \beta E[\tilde{C}(l + p, \eta) - \tilde{C}(0, \eta)] - \tilde{\beta} E[\tilde{C}(l + p, \eta) - \tilde{C}(-b, \eta)]. \tag{23}$$

and note that $G(\gamma^\dagger) = 0$ by definition. The convexity of $\tilde{C}$ implies that $\tilde{C}(0, \eta) \geq \frac{\gamma^\dagger}{l+p+\gamma^\dagger}\tilde{C}(l + p, \eta) + \frac{l+p}{l+p+\gamma^\dagger}\tilde{C}(-\gamma^\dagger, \eta)$ and thus

$$\begin{aligned}
\frac{\beta}{\tilde{\beta}} &= \frac{E[\tilde{C}(l + p, \eta) - \tilde{C}(-\gamma^\dagger, \eta)]}{E[\tilde{C}(l + p, \eta) - \tilde{C}(0, \eta)]} \\
&\geq \frac{E[\tilde{C}(l + p, \eta) - \tilde{C}(-\gamma^\dagger, \eta)]}{\frac{l+p}{l+p+\gamma^\dagger}E[\tilde{C}(l + p, \eta) - \tilde{C}(-\gamma^\dagger, \eta)]} \\
&= \frac{l + p + \gamma^\dagger}{l + p}
\end{aligned}$$

Under the stronger assumptions, we have that up to negligible high-order terms,

$$\begin{aligned}
G(b) &\approx \beta E\left[\tilde{C}'(0, \eta)(l + p) + \frac{\tilde{C}''(0, \eta)}{2}(l + p)^2\right] \\
&\quad - \tilde{\beta} E\left[(l + p + b)\tilde{C}'(0, \eta) + \frac{\tilde{C}''(0, \eta)}{2}(l + p - b)(l + p + b)\right] \\
&= \beta E\tilde{C}' \cdot (l + p)(1 + \alpha/2 \cdot (l + p)) - \tilde{\beta}(l + p + b)E\tilde{C}' \cdot [1 + \alpha/2(l + p - b)] \\
&= \beta E\tilde{C}' \cdot (l + p)(1 + \rho/2) - \tilde{\beta}(l + p + b)E_{G(\cdot|\eta_{t-1})}\tilde{C}' \cdot (1 + \rho/2 - \alpha b/2).
\end{aligned} \tag{24}$$

Setting $G(\gamma^\dagger) = 0$ and dividing through by $E\tilde{C}'$, we have

$$\beta(l+p)(1+\rho/2) = \tilde{\beta}(l+p+\gamma^\dagger) \cdot (1+\rho/2 - \alpha\gamma^\dagger/2), \tag{25}$$

and thus

$$\frac{\beta}{\tilde{\beta}} \approx \frac{1+\rho/2-\alpha\gamma^\dagger/2}{1+\rho/2} \frac{l+p+\gamma^\dagger}{l+p}. \tag{26}$$

Finally, note that $\gamma^\dagger$ is also the solution to $\tilde{\mu}(0,\gamma^\dagger) = \mu(0,0)$. Thus $\tilde{\mu}(0,0) + \gamma^\dagger \tilde{\mu}_b'(0,0) = \mu(0,0) + O((\gamma^\dagger)^2 \tilde{\mu}_b'')$, and so

$$\gamma^\dagger \approx \frac{\mu(0,0) - \tilde{\mu}(0,0)}{-\tilde{\mu}_b'(0,0)} \tag{27}$$

$$\approx \frac{-\gamma}{\tilde{\Delta}} \left(\mu(0,0) - \tilde{\mu}(0,0)\right) \tag{28}$$

□

E.2 Proof of Proposition 2

We assume, in the more general case with η, that $\frac{k(l+p,\theta,\eta)-k(p,\theta,\eta)}{\tilde{C}(x_1,\eta)-\tilde{C}(x_2,\eta)} \perp \tilde{C}'(x,\eta) \forall \eta, x_1, x_2$.

Proof. In period $t-1$, the borrower believes that she will repay if

$$k(l+p,\theta,\eta) - k(p,\theta,\eta) \leq \tilde{\beta}[\tilde{C}(l+p-w,\eta) - \tilde{C}(-w-b,\eta)], \tag{29}$$

where w is money for sure and b is the size of the no-borrowing incentive. The assumption that $\frac{k(l+p,\theta,\eta)-k(p,\theta,\eta)}{\tilde{C}(x_1,\eta)-\tilde{C}(x_2,\eta)} \perp \tilde{C}'(x,\eta) \forall \eta, x_1, x_2$ implies that $\tilde{\mu}$ is not a function of η. If $\tilde{C}'$ is a function of η then the condition implies that $\frac{k(l+p,\theta,\eta)-k(p,\theta,\eta)}{\tilde{C}(x_1,\eta)-\tilde{C}(x_2,\eta)}$ must be constant in η for the assumption to be satisfied, and thus that the perceived probability of reborrowing is constant in η. If $\tilde{C}'$ is constant in η then η only affects k. In this case, η is an idiosyncratic liquidity shock like θ, and there is no loss in generality in simply allowing k be a function of θ only.

Thus, perceived reborrowing probability is a function of θ only, and we can thus define a cutoff $\theta^\dagger$, invariant in η, such that Equation (29) holds with equality at $\theta = \theta^\dagger$. This cutoff satisfies

$$\frac{d\theta^\dagger}{db} = \tilde{\beta} \frac{\tilde{C}'(x-b,\eta)}{k_\theta'(l+p,\theta^\dagger,\eta) - k_\theta'(p,\theta^\dagger,\eta)} \tag{30}$$

$$\frac{d\theta^\dagger}{dw} = -\tilde{\beta} \frac{\tilde{C}'(l+p-w,\eta) - \tilde{C}'(-w-b,\eta)}{k_\theta'(l+p,\theta^\dagger,\eta) - k_\theta'(p,\theta^\dagger,\eta)}. \tag{31}$$

Now

$$-\frac{\tilde{\mu}_w'}{\tilde{\mu}_b'} = \frac{-\frac{d\theta^\dagger}{dw}}{\frac{d\theta^\dagger}{db}} = \frac{\tilde{C}'(l+p-w,\eta)}{\tilde{C}'(-w-b,\eta)} - 1. \tag{32}$$

and

$$\frac{\tilde{C}'(l+p-w,\eta)}{\tilde{C}'(-w-b),\eta)} - 1 = \frac{\tilde{C}'(l+p-w,\eta) - \tilde{C}'(-w-b,\eta)}{\tilde{C}'(-w-b)}$$
$$= \frac{(l+p+b)\tilde{C}''(-w-b,\eta)}{\tilde{C}'(-w-b,\eta)} + O((l+p+b)^2\frac{\tilde{C}'''(-w-b,\eta))}{\tilde{C}'(-w-b,\eta)}$$
$$= (l+p+b)\alpha(w,b,\eta) + O((l+p+b)^2\tilde{C}'''(-w-b,\eta)/\tilde{C}'(-w-b,\eta)). \quad (33)$$

Thus $\rho(w,b,\eta) = -\frac{\tilde{\mu}'_w}{\tilde{\mu}'_b} + O((l+p+b)^2\tilde{C}'''/\tilde{C}')$, and thus does not vary with η up to negligible higher order terms. Similarly, $\alpha = -(l+p+b)\frac{\tilde{\mu}'_w}{\tilde{\mu}'_b} + O((l+p+b)^2\tilde{C}'''/\tilde{C}')$ and thus also does not vary with η. We thus write $\rho(w,b)$ and $\alpha(w,b)$. Moreover,

$$\frac{d}{dw}\frac{\tilde{\mu}'_w}{\tilde{\mu}'_b} = \frac{\tilde{\mu}''_{ww}\tilde{\mu}'_b - \tilde{\mu}''_{wb}\tilde{\mu}'_w}{(\tilde{\mu}'_b)^2}, \quad (34)$$

and thus terms of order $\frac{d}{dw}\frac{\tilde{\mu}'_w}{\tilde{\mu}'_b}$ are negligible, which by equation (33) implies that $\frac{d}{dw}\alpha$ and $\frac{d}{dw}\rho$ are negligible.

Now let

$$V(w,b) := -E\left[\int [k(l+p,\theta,\eta) + \tilde{C}(-w-b)]dF + \int_{\theta>\theta^\dagger} [k(p,\theta) + \tilde{C}(l+p-w)]dF\right]$$

denote the self $t-1$'s expected utility costs as a function of w and b. Our strategy is to characterize V as a function of w and b using second-order approximations of $\tilde{C}$, and to use those to quantify what value of w has the same impact on V as a change in b of size γ.

Ignoring higher-order negligible terms, we have

$$\frac{dV(0,b)}{db}(0,b,\eta_{t-1}) = E\left[(1-\tilde{\mu})\tilde{C}'(-b,\eta) - (1-\tilde{\beta})(\tilde{C}(l+p,\eta) - \tilde{C}(-b,\eta))\tilde{\mu}'_b\right]$$
$$= E\tilde{C}'(a-b,\eta)\left[1-\tilde{\mu} - (1-\tilde{\beta})\frac{\tilde{C}(l+p,\eta) - \tilde{C}(-b,\eta)}{\tilde{C}'(a-b,\eta)}\tilde{\mu}'_b\right]$$
$$= E\tilde{C}'(-b,\eta)\left[1-\tilde{\mu} - (1-\tilde{\beta})\frac{(l+p+b)\tilde{C}' + (l+p+b)^2/2\tilde{C}''}{\tilde{C}'}\tilde{\mu}'_b\right]$$
$$= E\tilde{C}'(-b,\eta)\left[1-\tilde{\mu} - (1-\tilde{\beta})(l+p+b)\tilde{\mu}'_b - (1-\tilde{\beta})(l+p+b)^2\alpha(0,b)/2\tilde{\mu}'_b\right]$$
$$= E\tilde{C}'(-b,\eta)\times$$
$$\left[1-\tilde{\mu} - (1-\tilde{\beta})(l+p+b)\tilde{\mu}'_b + (1-\tilde{\beta})\frac{l+p+b}{2}\tilde{\mu}'_w\right]. \quad (35)$$

Differentiating again, and ignoring negligible terms, yields

$$\begin{aligned}\frac{d^2V(0,b)}{db^2} &= E\tilde{C}'(-b,\eta)\left[-\tilde{\mu}'_b - (1-\tilde{\beta})\tilde{\mu}'_b + (1-\tilde{\beta})\frac{1}{2}\tilde{\mu}'_w\right] \\ &- E\tilde{C}''(-b,\eta)\left[1-\tilde{\mu}-(1-\tilde{\beta})(l+p+b)\tilde{\mu}'_b + (1-\tilde{\beta})\frac{l+p+b}{2}\tilde{\mu}'_w\right], \end{aligned} \tag{36}$$

which also implies that

$$\frac{d^3V(0,b)}{db^3} = -2E\tilde{C}''(-b,\eta)\left[-\tilde{\mu}'_b - (1-\tilde{\beta})\tilde{\mu}'_b + (1-\tilde{\beta})/2\tilde{\mu}'_w\right] \tag{37}$$

and that fourth and higher derivatives of V are negligible. Thus, $V(0,\gamma,\eta) - V(0,0,\eta)$ is given by

$$\begin{aligned}&V'_b|_{(0,0)}\gamma + V''_b|_{(0,0)}\gamma^2/2 + V'''_b|_{(0,0)}\gamma^3/6 \\ &= E\gamma\tilde{C}'\left[1-\tilde{\mu}-(1-\tilde{\beta})(l+p+\gamma)\tilde{\mu}'_b + (1-\tilde{\beta})\frac{l+p+\gamma}{2}\tilde{\mu}'_w\right] \\ &+ E\frac{\gamma^2}{2}\tilde{C}'\left[-\tilde{\mu}'_\gamma - (1-\tilde{\beta})\tilde{\mu}'_b + (1-\tilde{\beta})/2\tilde{\mu}'_a\right] \\ &- E\frac{\gamma^2}{2}\tilde{C}''\left[1-\tilde{\mu}-(1-\tilde{\beta})(l+p+\gamma)\tilde{\mu}'_b + (1-\tilde{\beta})\frac{l+p+\gamma}{2}\tilde{\mu}'_a\right] \\ &- E\frac{\gamma^3}{3}\tilde{C}''\left[-\tilde{\mu}'_\gamma - (1-\tilde{\beta})\tilde{\mu}'_b + (1-\tilde{\beta})/2\tilde{\mu}'_a\right] \\ &= E\tilde{C}'\cdot(1-\alpha\gamma/2)\left[\gamma(1-\tilde{\mu}(0)+\tilde{\Delta}) + (1-\tilde{\beta})\tilde{\Delta}(l+p+\frac{\gamma}{2})(1+\rho/2)\right]. \end{aligned} \tag{38}$$

Similarly, we compute how V changes with respect to w.

$$\begin{aligned}\frac{dV(w,0)}{dw} &= E\left[\tilde{\mu}\tilde{C}'(l+p-w,\eta) + (1-\tilde{\mu})\tilde{C}'(-w,\eta) - (1-\tilde{\beta})(\tilde{C}(l+p-w,\eta)+\tilde{C}(-w,\eta))\tilde{\mu}'_w\right] \\ &= E\left[\tilde{\mu}\tilde{C}'(-w,\eta) + (1-\tilde{\mu})\tilde{C}'(-w,\eta) + \tilde{\mu}(l+p)\tilde{C}''(-w,\eta)\right] \\ &- E\left[(1-\tilde{\beta})(\tilde{C}(l+p-w,\eta) - \tilde{C}(-w,\eta))\tilde{\mu}'_w\right] \\ &= E\tilde{C}'(-w,\eta)\left[1+\tilde{\mu}(l+p) - (1-\tilde{\beta})\frac{\tilde{C}(l+p-w,\eta)-\tilde{C}(-w,\eta)}{\tilde{C}'(-w,\eta)}\tilde{\mu}'_w\right] \\ &= E\tilde{C}'(-w,\eta)\left[1+\tilde{\mu}(l+p)\alpha - (1-\tilde{\beta})\frac{(l+p)\tilde{C}' + (l+p)^2/2\tilde{C}''}{\tilde{C}'(l+p-w)}\tilde{\mu}'_w\right] \\ &= E\tilde{C}'(-w,\eta)\left[1+\tilde{\mu}(l+p+b)\alpha - (1-\tilde{\beta})(l+p)\tilde{\mu}'_a + (1-\tilde{\beta})(l+b)^2\alpha/2\tilde{\mu}'_w\right] \\ &= E\tilde{C}'(-w,\eta)\left[1+\tilde{\mu}(l+p+b)\alpha - (1-\tilde{\beta})(l+p)\left(1+\frac{l+p}{2}\alpha\right)\tilde{\mu}'_w\right]. \end{aligned} \tag{39}$$

Differentiating again yields

$$\frac{d^2V}{dw^2} = E\tilde{C}' \cdot \tilde{\mu}'_w(l+p)\alpha$$
$$+ E\tilde{C}'' \cdot \left[1 + \tilde{\mu}(l+p)\alpha - (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}'_w\right] \tag{40}$$

and

$$\frac{d^3V}{dw^3} = 2E\tilde{C}'' \cdot \tilde{\mu}'_w(l+p)\alpha, \tag{41}$$

with fourth and higher derivatives of V negligible. Thus the impact of sure money w is equal to

$$V_w|_{(0,0)}w + V''_w|_{(0,0)}w^2/2 + V'''_w|_{(0,0)}w^3/6$$
$$= wE\tilde{C}' \cdot \left[1 + \tilde{\mu}(l+p)\alpha - (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}'_w\right]$$
$$+ \frac{w^2}{2}E\tilde{C}' \cdot \tilde{\mu}'_a(l+p)\alpha$$
$$+ \frac{w^2}{2}E\tilde{C}'' \cdot \left[1 + \tilde{\mu}(l+p)\alpha - (1-\tilde{\beta})(l)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}'_w\right]$$
$$+ \frac{w^3}{3}E\tilde{C}'' \cdot \tilde{\mu}'_w(l+p)\alpha$$
$$\approx wE\tilde{C}' \cdot \left[1 + (\tilde{\mu} + (w/2)\tilde{\mu}'_w)(l+p)\alpha - (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}'_w\right]$$
$$+ \frac{w^2}{2}E\tilde{C}'' \left[1 + (\tilde{\mu} + w/2\tilde{\mu}'_w)(l+p)\alpha - (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}'_w\right]$$
$$= -E\tilde{C}'w(1-\alpha w/2)\left[1 + (\tilde{\mu} + w/2\tilde{\mu}'_w)\rho - (1-\tilde{\beta})(l+p)(1+\rho/2)\tilde{\mu}'_w\right]$$
$$= -E\tilde{C}'w(1-\alpha w/2)\left[1 + \rho(\tilde{\mu} - w\rho/2\tilde{\mu}'_b) + (1-\tilde{\beta})(l+p)(1+\rho/2)\rho\tilde{\mu}'_b\right]$$
$$= -E\tilde{C}'(1-\alpha w/2)\times$$
$$\left[w\left((1 + \rho\tilde{\mu} + \rho^2\frac{w}{2\gamma}\tilde{\Delta}\right) + (1-\tilde{\beta})(l+p)(1+\rho/2)\rho\frac{w}{\gamma}\tilde{\Delta}(\gamma)\right] \tag{42}$$

This implies that for non-marginal changes,

$$1-\tilde{\beta} = \frac{w(1-\alpha w/2)\left((1 + \rho\tilde{\mu} + \rho^2\frac{w}{2\gamma}\tilde{\Delta}(\gamma)\right) - \gamma(1-\alpha\gamma/2)(1-\bar{\tilde{\mu}}(\gamma))}{(1-\alpha\gamma/2)\tilde{\Delta}(\gamma)(l+p+\frac{\gamma}{2})(1+\rho/2) + (1-\alpha w/2)(l+p)(1+\rho/2)\rho\frac{w}{\gamma}\tilde{\Delta}(\gamma)}. \tag{43}$$

□

E.3 Deriving Curvature from the Flip-a-Coin MPL

We have already shown that $\tilde{C}''(x,\eta)/\tilde{C}'(x,\eta)$ does not vary with η under the assumption that $k(l+p,\eta)/k(p,\eta) \perp \tilde{C}'(x,\eta)$ for all η. We now make the further assumption that $\alpha(x)$ is approximately constant in x. Thus, $\tilde{C}(x,\eta)$ can be approximated by $\lambda(\eta)\exp(\alpha \cdot x) + \lambda_0(\eta)$, for some functions λ and λ_0 of η, where $\eta \perp \theta$. This assumption is necessary to ensure that if c is the certainty equivalent for a Flip-a-Coin of size b, then c has the same effect on repayment behavior as does the Flip-a-Coin. Without an approximately constant level of absolute risk aversion, the certainty equivalent and the gamble can have different effects on period 1 behavior. Note that for low values of α, $\tilde{C}(x,\eta) = \alpha\tilde{C}'(0,\eta) + \frac{\alpha^2}{2}\tilde{C}''(0,\eta) + O(\alpha^3)$, and thus the quadratic approximation assumed in the body of the paper holds.

Formally, consider a period $t = 1$ certainty equivalent $c_1(\theta)$ for a Flip-a-Coin of size γ, as a function of θ. When θ is below the repayment threshold $\theta^\dagger$, we have

$$\exp(-\alpha c_1(\theta)) = \frac{1}{2}\exp(-\alpha b) + \frac{1}{2}\exp(0). \tag{44}$$

When θ is above the repayment threshold $\theta^\dagger$, we have

$$\exp(\alpha(l + p - c_1(\theta))) = \frac{1}{2}\exp(\alpha(l + p - b)) + \frac{1}{2}\exp(0),$$

which reduces to (44). Thus c^1 is independent of θ, and thus the period-0 certainty equivalent c simply satisfies

$$\exp(-\alpha c) = \frac{1}{2}\exp(-\alpha b) + \frac{1}{2}\exp(0). \tag{45}$$

In our empirical implementation, we estimate α assuming homogeneous risk preferences, and thus that variation in certainty equivalents c_i reflects mean-zero noise. This implies that the estimate $\hat{\alpha}$ satisfies

$$\exp(-\hat{\alpha}E[c_i]) = \frac{1}{2}\exp(-\hat{\alpha}b) + \frac{1}{2}\exp(0). \tag{46}$$

Inserting the empirical values, we have

$$\exp(-\hat{\alpha}42) = \frac{1}{2}\exp(-\hat{\alpha}100) + \frac{1}{2}\exp(0), \tag{47}$$

which is satisfied at $\hat{\alpha} \approx 0.0064$.

E.4 Derivation of Estimating Equations

In this appendix, we show how our estimating equations can be derived from the formulas in Propositions 1 and 2, delivering the mean $\tilde{\beta}$ and β across heterogeneous borrowers. Define x_g as $E[x|g]$, the expectation of variable x in subsample g. We impose the following assumptions.

Assumption 1. *Any measurement error in l_i, p_i, w_i, $\tilde{\mu}_i$, μ_i, α_i, and ρ_i is mean-zero.*

Assumption 2. *l_i, p_i, α_i (and thus ρ_i) are homogeneous within a subsample g.*

Assumption 3. *Terms of order $E[(1-\tilde{\beta}_i)^2|g]$ and $E[(1-\beta_i/\tilde{\beta}_i)^2|g]$ are negligible.*

Assumption 4. $Cov\left[E\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right], (l_g+p_g)\left(1+\frac{\rho_g}{2}\right)\right] = 0.$

Assumption 5. *$\gamma_i^\dagger \perp \mu_i(b)$ for all b.*

Assumption 6. *$\tilde{\mu}_i$ is locally linear in b.*

Assumption 7. *$E\left[\tilde{\beta}_i|g\right]$ does not vary with g.*

Assumption 8. *Either $\beta_i/\tilde{\beta}_i \perp \tilde{\beta}_i$ or $\beta_i \perp \frac{\tilde{\beta}_i-\beta_i}{1-\beta_i}$.*

Assumption 3 is increasingly violated at lower values of $\tilde{\beta}$. However, if $\tilde{\beta}=1$ is an upper bound, our estimate of average $\tilde{\beta}\approx 0.76$ at $\alpha = 0.0064$ limits how small $\tilde{\beta}$ might plausibly be. For example, for a population with fairly extreme heterogeneity, with $\tilde{\beta}=1$ and $\tilde{\beta}=0.6$ each with probability 0.5, then $E[(1-\tilde{\beta}_i)^2] = 0.5\cdot(0.4)^2 = 0.08$.

Assumption 8 is that naivete is independent of perceived present focus. That is, we expect that people who perceive high $\tilde{\beta}$ misperceive β by the same proportion as people who perceive lower $\tilde{\beta}$.

Estimating naivete. To derive the estimating equation for naivete, we begin with Equation (8). Imposing Assumptions 1 and 2 and re-arranging gives

$$\frac{\beta_i}{\tilde{\beta}_i} = \frac{\left(l_g+p_g+\gamma_i^\dagger\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}\gamma_i^\dagger\right)}{(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)}. \tag{48}$$

Now note that from the proof of Proposition 1, we have that

$$0 \geq -\gamma_i^\dagger \geq (l+p)(1-\beta_i/\tilde{\beta}_i) \tag{49}$$

This implies that $O(Var[\gamma_i^\dagger|g])$ is $O(E[(1-\beta_i/\tilde{\beta}_i)^2|g])$ and thus negligible under Assumption 3. Taking expectations over borrowers within a group g gives

$$\begin{aligned} E\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right] &= \frac{E\left[\left(l_g+p_g+\gamma_i^\dagger\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}\gamma_i^\dagger\right)|g\right]}{(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)} \\ &= \frac{\left(l_g+p_g+E[\gamma_i^\dagger|g]\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}E[\gamma_i^\dagger|g]\right)-\frac{\alpha_g}{2}Var[\gamma_i^\dagger|g]}{(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)} \\ &= \frac{\left(l_g+p_g+E[\gamma_i^\dagger|g]\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}E[\gamma_i^\dagger|g]\right)}{(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)} + O(E[(1-\beta_i/\tilde{\beta}_i)^2|g]). \end{aligned} \tag{50}$$

Rearranging, we have

$$\begin{aligned}
E\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right](l_g+p_g)\left(1+\frac{\rho_g}{2}\right) &= \left(l_g+p_g+E[\gamma_i^\dagger|g]\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}E[\gamma_i^\dagger|g]\right)\\
\Leftrightarrow E\left[E\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right](l_g+p_g)\left(1+\frac{\rho_g}{2}\right)\right] &= E\left[\left(l_g+p_g+E[\gamma_i^\dagger|g]\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}E[\gamma_i^\dagger|g]\right)\right]\\
\Leftrightarrow E\left[\frac{\beta_i}{\tilde{\beta}_i}\right]E\left[(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)\right] &= E\left[\left(l_g+p_g+E[\gamma_i^\dagger|g]\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}E[\gamma_i^\dagger|g]\right)\right]\\
\Leftrightarrow E\left[\frac{\beta_i}{\tilde{\beta}_i}\right] &= \frac{E\left[\left(l_g+p_g+E[\gamma_i^\dagger|g]\right)\left(1+\frac{\rho_g}{2}-\frac{\alpha_g}{2}E[\gamma_i^\dagger|g]\right)\right]}{E\left[(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)\right]}, \qquad (51)
\end{aligned}$$

where the third line follows from Assumption 4.

Finally, note that $\gamma(\mu_i(0)-\tilde{\mu}_i(0)) = -\gamma_i^\dagger(\tilde{\mu}_i(0)-\tilde{\mu}_i(\gamma))$. To a first-order approximation, $\mu_i(0)-\tilde{\mu}_i(0) = -\frac{(\tilde{\beta}_i-\beta_i)}{\tilde{\beta}_i}\tilde{\mu}_i'(0)$ and $\tilde{\mu}_i(0)-\tilde{\mu}_i(\gamma) = -\gamma\mu_i'(0)\frac{\tilde{\beta}_i}{\beta_i}$, and thus by Assumption 5,

$$\begin{aligned}
E\left[\frac{\gamma(\mu_i(0)-\tilde{\mu}_i(0))}{(\tilde{\mu}_i(0)-\tilde{\mu}_i(\gamma))}|g\right]-\frac{E[\mu_i(0)-\tilde{\mu}_i(0))|g]}{E[(\tilde{\mu}_i(0)-\tilde{\mu}_i(\gamma))|g]} &= E\left[\frac{(\tilde{\beta}_i-\beta_i)}{\tilde{\beta}_i}\right]-\frac{E\left[\frac{(\tilde{\beta}_i-\beta_i)}{\beta_i}\mu_i'(0)\right]}{E\left[\frac{\tilde{\beta}_i}{\beta_i}\mu_i'(0)\right]}\\
&= E\left[-\frac{\beta_i}{\tilde{\beta}_i}|g\right]+\frac{1}{E\left[\frac{\tilde{\beta}_i}{\beta_i}|g\right]}\\
&= E\left[-\frac{\beta_i}{\tilde{\beta}_i}|g\right]+E\left[-\frac{\beta_i}{\tilde{\beta}_i}|g\right]+O(E[(1-\beta_i/\tilde{\beta}_i)^2|g])
\end{aligned}$$

which implies that $E[\gamma_i^\dagger|g] = -\gamma\frac{E[\mu_i(0)-\tilde{\mu}_i(0))|g]}{E[(\tilde{\mu}_i(0)-\tilde{\mu}_i(\gamma))|g]} = \gamma_g^\dagger$ up to negligible higher-order terms. Substituting that in gives

$$E\left[\frac{\beta_i}{\tilde{\beta}_i}\right] = \frac{E\left[\left(l_g+p_g-\gamma_g^\dagger\right)\left(1+\frac{\rho_g}{2}+\frac{\alpha_g}{2}\gamma_g^\dagger\right)\right]}{E\left[(l_g+p_g)\left(1+\frac{\rho_g}{2}\right)\right]}. \qquad (52)$$

The empirical analogue is the estimating equation, Equation (15).

Estimating $\tilde{\beta}$. To derive the estimating equation for $\tilde{\beta}$, we begin with Equation (13). Imposing Assumptions 1 and 2, re-arranging, and taking expectations over borrowers within a group g gives

$$\begin{aligned}
&E\left[\left(1-\tilde{\beta}_i\right)\left(1+\frac{\rho_g}{2}\right)\tilde{\Delta}_i\left\{\left(l_g+p_g+\frac{\gamma}{2}\right)\left(1-\frac{\alpha_g\gamma}{2}\right)+(l_g+p_g)\frac{w_i\rho_g}{\gamma}\left(1-\frac{\alpha_g w_i}{2}\right)\right\}|g\right]\\
&= E\left[\left\{w_i\cdot\left(1+\rho_g\left(\tilde{\mu}_g(0)+\frac{w_i\rho_g}{\gamma}\frac{\tilde{\Delta}_i}{2}\right)\right)\left(1-\frac{\alpha_g w_i}{2}\right)-\gamma\cdot\left(1-\tilde{\mu}_i(0)+\frac{\tilde{\Delta}_i}{2}\right)\left(1-\frac{\alpha_g\gamma}{2}\right)\right\}|g\right]. \qquad (53)
\end{aligned}$$

Now note that $Var[w_i|g]$, $Cov[\tilde{\Delta}_i, w_i|g]$, $Cov[w_i, \tilde{\beta}_i|g]$, $Cov[\tilde{\beta}_i, \tilde{\Delta}_i|g]$, $Cov[\tilde{\beta}_i, \tilde{\mu}_i(0)|g]$ are $O(E(1-\tilde{\beta}_i)^2)$ because Assumptions 1, 2, and 5 imply that conditional on g, the only variation in w_i and $\tilde{\Delta}_i$ is through $\tilde{\beta}_i$. They are then negligible under Assumption 3. The above equation thus reduces to

$$E\left[1-\tilde{\beta}_i|g\right]\left(1+\frac{\rho_g}{2}\right)\tilde{\Delta}_g\left\{\left(l_g+p_g+\frac{\gamma}{2}\right)\left(1-\frac{\alpha_g\gamma}{2}\right)+(l_g+p_g)\frac{w_g\rho_g}{\gamma}\left(1-\frac{\alpha_g w_g}{2}\right)\right\}$$
$$= w_g\cdot\left(1+\rho_g\left(\tilde{\mu}_g(0)+\frac{w_g\rho_g}{\gamma}\frac{\tilde{\Delta}_g}{2}\right)\right)\left(1-\frac{\alpha_g w_g}{2}\right)-\gamma\cdot\left(1-\tilde{\mu}_g(0)+\frac{\tilde{\Delta}_g}{2}\right)\left(1-\frac{\alpha_g\gamma}{2}\right). \quad (54)$$

Taking the expectation over groups g and applying Assumption 7 then implies that

$$E\left[\tilde{\beta}_i\right]=1-\frac{E\left[\left\{w_g\cdot\left(1+\rho_g\left(\tilde{\mu}_g(0)+\frac{w_g\rho_g}{\gamma}\frac{\tilde{\Delta}_g}{2}\right)\right)\left(1-\frac{\alpha_g w_g}{2}\right)-\gamma\cdot\left(1-\tilde{\mu}_g(0)+\frac{\tilde{\Delta}_g}{2}\right)\left(1-\frac{\alpha_g\gamma}{2}\right)\right\}\right]}{E\left[\left(1+\frac{\rho_g}{2}\right)\tilde{\Delta}_g\left\{\left(l_g+p_g+\frac{\gamma}{2}\right)\left(1-\frac{\alpha_g\gamma}{2}\right)+(l_g+p_g)\frac{w_g\rho_g}{\gamma}\left(1-\frac{\alpha_g w_g}{2}\right)\right\}\right]}. \quad (55)$$

The empirical analogue is the estimating equation, Equation (16).

Backing out β. Taking a Taylor expansion, we have

$$E\left[\frac{\beta_i}{\tilde{\beta}_i}\right]=\frac{E[\beta_i]}{E[\tilde{\beta}_i]}+O(Cov[\beta_i,\tilde{\beta}_i])+O(E[(1-\tilde{\beta}_i)^2])$$

Since assumption 3 guarantees that $O(E[(1-\tilde{\beta}_i)^2])$ is negligible, we need only show that $O(Cov[\beta_i, \tilde{\beta}_i])$ is negligible. Now if the first condition of assumption 8 holds, then $O(Cov[\beta_i, \tilde{\beta}_i]) = O(E[(1-\tilde{\beta}_i)^2])$. Consider then the second condition, and set $\nu_i \equiv \frac{\tilde{\beta}_i-\beta_i}{1-\beta_i}$. Then $\beta_i = \frac{\tilde{\beta}_i-\nu_i}{1-\nu_i}$, and since $\beta_i \perp \nu_i$, this implies that $O(Cov[\beta_i, \tilde{\beta}_i]) = O(E[(1-\tilde{\beta}_i)^2])$. Thus $E\left[\frac{\beta_i}{\tilde{\beta}_i}\right] = \frac{E[\beta_i]}{E[\tilde{\beta}_i]}$ up to negligible higher-order terms.

F Additional Results and Proofs for Section 7

F.1 Existence and Uniqueness of Equilibrium

We suppose that the period t cost of repaying an amount x is $k_t(x, \theta, \eta)$. As before, we assume that in each period $t \geq 1$, the borrower can either choose to repay p, $l+p$, or default. We also assume that for the infinite-horizon case ($T=\infty$), there is some finite T' after which $k_t(x, \theta, \eta)$ does not vary with t.

We divide the shocks to costs of repayment into two components: an i.i.d. component and a serially correlated component. We set $\omega_t = (\theta_t, \eta_t)$, where $\theta_t \sim F$ denotes the i.i.d. component and $\eta_t \sim G(\cdot|\eta_{t-1})$ denotes the serially correlated component. We let G_0 denote the distribution of η in period 1.

We make several regularity assumptions on the distribution θ and the cost of repayment k.

Assumption 9. *The distribution of θ has a smooth density function f with convex and compact support.*

Assumption 10. *$k(x, \theta, \eta)$ is twice differentiable in all three arguments.*

Assumption 11. *For all $x_2 > x_1$ and η, $k(x_2, \theta, \eta) - k(x_1, \theta, \eta)$ is increasing in θ, with $\lim_{\theta\to\infty} k(x_2, \theta, \eta) - k(x_1, \theta, \eta) = \infty$.*

Assumption 12. *For all finite $x \geq 0$ and $\eta, \int_\theta k(x, \theta, \eta)dF(\theta) < \infty$.*

Assumption 13. *The distributions $G(\cdot|\eta)$ have common finite support, and $G(\eta|\eta) > 1/2$, $G(\eta'|\eta) > 0$ for $\eta' \in$ supp G.*

Let $\tilde{r}(l, \eta_t)$ denote the period $\tau < t$ perceived continuation value of starting off in period t with a loan of size l after experiencing a shock η_t in period t. This is different from $\tilde{C}(l, \eta_t)$, which is the period t self's perceived continuation value of starting period $t + 1$ in with debt l. The two are linked by the relationship $\tilde{C}(l, \eta_t) = \sum_{\eta'} \tilde{r}(l, \eta')G(\eta'|\eta_t)$. For the proofs in the appendix, however, it will be convenient to utilize $\tilde{r}$.

For our purposes, it is also useful to consider the fee p as fixed and independent of l, and the repayment rule to be that the borrower must pay either pay $\min(l, p)$ or repay in full or default. To economize on notation we assume that $p < l$, as otherwise the game ends immediately.

In period $t - 1$ the individual defaults if

$$\min\left(k_t(l + p, \theta_{t-1}, \eta_{t-1}), \beta\delta E[\tilde{r}(l, \theta, \eta)|\eta_{t-1}] + k_t(p, \theta_{t-1}, \eta_{t-1})\right) \geq \chi. \quad (56)$$

Conditional on not defaulting, the individual chooses to repay if

$$k_t(l + p, \theta_{t-1}, \eta_{t-1}) \leq \beta\delta E[\tilde{r}(l, \theta, \eta)|\eta_{t-1}] + k_t(p, \theta_{t-1}, \eta_{t-1}). \quad (57)$$

In periods $\tau < t - 1$ the individual thinks he will choose to default if

$$\min\left(k_t(l + p, \theta_{t-1}, \eta_{t-1}), \tilde{\beta}\delta E[\tilde{r}(lp, \theta, \eta)|\eta_{t-1}] + k_t(p, \theta_{t-1}, \eta_{t-1})\right) \geq \chi, \quad (58)$$

and if he does not default then he will repay in period t if

$$k_t(l + p, \theta_{t-1}, \eta_{t-1}) \leq \tilde{\beta}\delta E[\tilde{r}(p, \theta, \eta)|\eta_{t-1}] + k_t(p, \theta_{t-1}, \eta_{t-1}). \quad (59)$$

We begin considering the case with infinite horizon and time-invariant cost-of-repayment functions ($k_t \equiv k$ for all t)

Theorem 1. *Suppose that $T = \infty$ and $k_t \equiv k$ for all t. For each l, there exists a unique stationary equilibrium with a continuation value function $\tilde{C}(\eta)$ that is twice differentiable in l.*

Proof. Say there are J elements in the union of the supports of $g(\cdot|\eta)$, enumerated $\eta_1, \ldots, \eta_J$. Then $\tilde{r}(\eta)$ is a vector in $\mathbb{R}^J$, and we adopt the convention that $\tilde{r}(\eta_i)$ corresponds to the ith component of the vector.

For any function $h : \mathbb{R}^J \to \mathbb{R}^J$, define $\bar{h}(\eta) = \sum h(\eta')G(\eta'|\eta)$. By definition, the continuation value $\tilde{r}(\eta)$ must be a fixed point of the map $B(h) = (B_1(h), \ldots, B_M(h))$ defined as

$$\begin{aligned} B_i(h) &= \delta Pr(D(h,\eta_i))\chi \\ &+ \int_{\theta \le c(h,\eta_i)} \mathbf{1}_{\theta \notin D(h,\eta_i)} k(l+p,\theta,\eta_i)dF + \int_{\theta \ge c(h,\eta_i)} \mathbf{1}_{\theta \notin D(h,\eta_i)} \left(\delta\bar{h}(\eta_i) + k(p,\theta,\eta_i)\right) dF, \end{aligned} \quad (60)$$

where $c(h,\eta)$ is the solution to

$$k(l+p,c,\eta) = \tilde{\beta}\delta\bar{h}(\eta) + k(p,c,\eta), \quad (61)$$

which is unique by Assumption 11, and

$$D(h,\eta_i) := \{\theta | \min\left(k(l+p,\theta,\eta_i), \tilde{\beta}\delta\bar{h}(\eta_i) + k(p,\theta,\eta_i)\right) \ge \chi\}. \quad (62)$$

Since $k(l+p,\theta,\eta_i), \tilde{\beta}\delta\bar{h}(\eta_i)+k(p,\theta,\eta_i)$ are both increasing in θ, $\min\left(k(l+p,\theta,\eta_i), \tilde{\beta}\delta\bar{h}(\eta_i) + k(p,\theta,\eta_i)\right)$ is increasing in θ, and thus there is a unique cutoff $d(h,\eta_i)$ such that $\theta \in D(h,\eta_i)$ iff $\theta \ge d(h,\eta_i)$.

Now observe that $B_i(h) > 0$ and that $B_i(h) < \chi/\tilde{\beta}$. Consequently, $B(h) \in [0,\chi/\tilde{\beta}]^J$ for all h. By Brouwer's fixed point theorem, continuity of B is thus sufficient to establish that B has a fixed point inside $[0,\chi/\tilde{\beta}]^J$.

Set $m^+(h,\eta_i) = \max(c(h,\eta_i), d(h,\eta_i))$ and $m^-(h,\eta_i) = \min(c(h,\eta_i), d(h,\eta_i))$. Clearly, c and d are both differentiable in h, and thus m^+ and m^- are continuous and almost everywhere differentiable in h. Now if $c > d$ then the borrower repays in full when $\theta < d$ and defaults when $\theta > d$. When $c < d$ the borrower repays in full when $\theta < c$, rolls over the loan when $\theta \in (c,d)$, and defaults when $\theta > d$. Therefore,

$$B_i(h) = \int_{\theta \ge m^+(h,\eta_i)} \chi f(\theta)d\theta + \int_{\theta \le m^-(h,\eta_i)} k(l+p,\theta,\eta_i)f(\theta)d\theta \quad (63)$$

$$+ \int_{c(h,\eta_i) \le \theta \le m_i^+(h,\eta_i)} \left(\delta\bar{h}(\eta_i) + k(p,\theta,\eta_i)\right) f(\theta)d\theta, \quad (64)$$

where the integral in Equation (64) is equal to zero if $c(h,\eta_i) = d_i^+(h,\eta_i)$. Each integral above is continuous in h. Consequently, B is continuous in h, which establishes that it has a fixed point.

We now move on to consider uniqueness. First, note that c and d can be expressed as functions of $\bar{h}(\eta_i)$ only, and do not depend separately on $h(\eta_i)$ conditional on that mean. Consequently, $B_i(h)$ is a function of $\bar{h}(\eta_i)$ only. Our strategy is to show that $\frac{d}{d\bar{h}(\eta_i)}B_i(h) < 1$ at all points of differentiability. This will imply the result because if h and h' are both fixed points of B, so that $B_i(h) = h(\eta_i)$ and $B_i(h') = h'(\eta_i)$ $\forall i$, then we reach a contradiction as follows: Assume, without loss of generality, that $h(\eta_i) - h'(\eta_i) = \max_j |h(\eta_j) - h'(\eta_j)| > 0$ for some i. By assumption 13, this implies that $\bar{h}(\eta_i) \ge \bar{h}'(\eta_i)$. Since $\bar{h}(\eta_i) - \bar{h}'(\eta_i) \le h(\eta_i) - h'(\eta_i)$ by construction, we obtain the contradiction that

$$\begin{aligned}h(\eta_i) - h'(\eta_i) &= B_i(h) - B_i(h') \\ &< \bar{h}(\eta_i) - \bar{h}'(\eta_i) \\ &\leq h(\eta_i) - h'(\eta_i). \end{aligned} \tag{65}$$

To show that $\frac{d}{d\bar{h}(\eta_i)} B_i(h) < 1$, we consider three cases in turn. First, $d < c$, second, $d > c$, and third d higher than the maximum of the support of θ (consumers never default at η_i). In all cases we use the fact that c is increasing in $\bar{h}(\eta_i)$ while d is decreasing in $\bar{h}(\eta_i)$, which follows from Assumption 11.

In the first case, $k(l + p, d), \eta_i) = \chi$, and thus

$$B_i(h) = \int_{\theta \leq d(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta + \int_{d(h,\eta_i) \leq \theta} \chi f(\theta) d\theta \tag{66}$$

$$\begin{aligned}\frac{\partial}{\partial \bar{h}(\eta_i)} B_i &= (k(l + p, d, \eta_i) - \chi) \frac{\partial d}{d\bar{h}(\eta_i)} f(d) \\ &= 0.\end{aligned} \tag{67}$$

In the second case, $\tilde{\beta}\delta\bar{h}(\eta_i) + k(p, d, \eta) = \chi$, and thus

$$\begin{aligned}B_i(h) = &\int_{\theta \leq c(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta \\ &+ \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \left(\delta\bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) f(\theta) d\theta + \int_{\theta > d(h,\eta_i)} \chi f(\theta) d\theta,\end{aligned} \tag{68}$$

$$\begin{aligned}\frac{\partial}{\partial \bar{h}(\eta_i)} B_i = &\left(k(l + p, c, \eta_i) - \delta\bar{h}(\eta_i) - k(lp, \theta, \eta_i)\right) f(c) \frac{\partial c}{\partial \bar{h}(\eta_i)} \\ &+ \left(\delta\bar{h}(\eta_i) + k(p, d, \eta_i) - \chi\right) f(d) \frac{\partial d}{\partial \bar{h}(\eta_i)} + \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \delta f(\theta) d\theta \\ &= -(1 - \tilde{\beta})\delta\bar{h}(\eta_i) f(c) \frac{\partial c}{\partial \bar{h}(\eta_i)} + (1 - \tilde{\beta})\delta\bar{h}(\eta_i) f(d) \frac{\partial d}{\partial \bar{h}(\eta_i)} + \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \delta f(\theta) d\theta \\ &< \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \delta f(\theta) d\theta \leq \delta.\end{aligned} \tag{69}$$

Note that in the limit of $d \to c$ in this second case, $\tilde{\beta}\delta\bar{h}(\eta) + k(p, c, \eta) = k(l + p, c, \eta) \to \chi$, and thus $\frac{\partial d}{\partial \bar{h}(\eta_i)} = \frac{\partial c}{\partial \bar{h}(\eta_i)}$. Thus $\frac{\partial}{\partial \bar{h}(\eta_i)} B_i \to 0$ in the limit of this second case. Thus B_i is differentiable in h at $c = d$.

In the third case,

$$B_i(h) = \int_{\theta \le c(h,\eta_i)} k(l+p,\theta,\eta_i) f(\theta) d\theta + \int_{c(h,\eta_i)\le\theta)} \left(\delta \bar{h}(\eta_i) + k(p,\theta,\eta_i)\right) f(\theta) d\theta \tag{70}$$

$$\frac{\partial}{\partial \bar{h}(\eta_i)} B_i = \left(k(l+p,c,\eta_i) - \delta\bar{h}(\eta_i) - k(p,\theta,\eta_i)\right) f(c) \frac{\partial c}{\partial \bar{h}(\eta_i)} + \int_{c(h,\eta_i)\le\theta} \delta f(\theta) d\theta$$

$$= \left(\tilde{\beta}\delta\bar{h}(\eta_i) - \delta\bar{h}(\eta_i)\right) f(c) \frac{\partial c}{\partial \bar{h}(\eta_i)} + \int_{c(h,\eta_i)\le\theta} \delta f(\theta) d\theta$$

$$< \int_{c(h,\eta_i)\le\theta} \delta f(\theta) d\theta \le \delta \tag{71}$$

It is clear that the derivative in the third case is the limit case in which d approaches the supremum of the support of θ. Thus B_i is differentiable in h when d is at the maximum of the support. Consequently, the steps above also show that B_i is everywhere differentiable in h. Finally, similar reasoning shows that B is also twice differentiable in h as well as twice differentiable in l. The implicit function theorem then implies that the unique fixed point of B must be twice differentiable in l. □

Extension to finite horizon and partial time-invariance

The result holds immediately for the case of finite horizon. Plainly, in period $t = T$ the continuation-value function is unique, and is twice differentiable because the density function is smooth. The continuation-value functions in periods $t < T$ are obtained by repeated application of the bellman operator B_i defined above. Because we have already shown that it is twice differentiable, the result follows immediately for finite horizon. Similarly, if the $T = \infty$ and the cost functions are time-invariant starting at $t = T'$, then $\tilde{r}_{T'}$ are unique and twice-differentiable (once we apply the stationarity requirement that the equilibrium is stationary when the cost functions are stationary), and $\tilde{r}_t$ for $t < T'$ can be obtained from $\tilde{r}_{T'}$ by repeated application of the bellman operator.

F.2 Continuity and Monotonicity

We first prove basic regularity and comparative static conditions on $\beta, \tilde{\beta}_0, \tilde{\beta}_1$.

Proposition 4. *A borrower's period 0 expected utility is continuous in $\beta, \tilde{\beta}_0, \tilde{\beta}_1$, is increasing in β, and is decreasing in $\tilde{\beta}_0$ and $\tilde{\beta}_1$ when there is no variation in η_i.*

Proposition 4 states that borrower's expected utility is continuously decreasing in present focus and naivete. We prove the result about naivete under the special case of no variation in η_i because theoretically there are technical exceptions to the general statement that welfare falls in naivete; however, we do not think of these technical exceptions as empirically relevant.

F.3 Proof of Proposition 4

Preliminaries

We begin with a lemma, and then continue on to proof of the main proposition.

Lemma 1. *B_i is decreasing in $\tilde{\beta}$.*

Proof. By Assumption 11, both c is increasing in β and d is decreasing in $\tilde{\beta}$. We consider three cases in turn. First, $d < c$, second, $d > c$, and third $d = \infty$ (consumers never default at η_i). In the first case, $k(l + p, d), \eta_i) = \chi$, and thus

$$B_i(h) = \int_{\theta \leq d(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta + \int_{d(h,\eta_i) \leq \theta} \chi f(\theta) d\theta \tag{72}$$

$$\frac{\partial}{\partial \tilde{\beta}} B_i = (k(l + p, d, \eta_i) - \chi) \frac{\partial d}{d\tilde{\beta}} f(d) \tag{73}$$

$$= 0.$$

In the second case, $\tilde{\beta}\delta\bar{h}(\eta_i) + k(p, d, \eta) = \chi$, and thus

$$\begin{aligned} B_i(h) = & \int_{\theta \leq c(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta + \\ & + \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \left(\delta\bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) f(\theta) d\theta + \int_{\theta > d(h,\eta_i)} \chi f(\theta) d\theta \end{aligned} \tag{74}$$

$$\begin{aligned} \frac{\partial}{\partial \tilde{\beta}} B_i = & \left(k(l + p, c, \eta_i) - \delta\bar{h}(\eta_i) - k(lp, \theta, \eta_i)\right) f(c) \frac{\partial c}{\partial \tilde{\beta}} \\ & + \left(\delta\bar{h}(\eta_i) + k(p, d, \eta_i) - \delta\chi\right) f(d) \frac{\partial d}{\partial \tilde{\beta}} \\ = & \left(\tilde{\beta}\delta\bar{h}(\eta_i) - \delta\bar{h}(\eta_i)\right) f(c) \frac{\partial c}{\partial \tilde{\beta}} + (1 - \tilde{\beta})\delta\bar{h}(\eta_i) f(d) \frac{\partial d}{\partial \tilde{\beta}} \\ < & \ 0. \end{aligned} \tag{75}$$

In the third case,

$$B_i(h) = \int_{\theta \leq c(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta + \int_{c(h,\eta_i) \leq \theta)} \left(\delta\bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) f(\theta) d\theta \tag{76}$$

$$\begin{aligned} \frac{\partial}{\partial \tilde{\beta})} B_i = & \left(k(l + p, c, \eta_i) - \delta\bar{h}(\eta_i) - k(p, \theta, \eta_i)\right) f(c) \frac{\partial c}{\partial \tilde{\beta}} \\ = & \left(\tilde{\beta}\delta\bar{h}(\eta_i) - \delta\bar{h}(\eta_i)\right) f(c) \frac{\partial c}{\partial \tilde{\beta}} \\ < & \ 0. \end{aligned} \tag{77}$$

□

Lemma 2. *$\tilde{r}$ is decreasing in $\tilde{\beta}$ when there is no variation in η_i*

Proof. Index the recursion operator and the fixed points by $\tilde{\beta}$. Assume, for the sake of contradiction, that for $\tilde{\beta} < \tilde{\beta}'$, $\tilde{r}_{\tilde{\beta}'} > \tilde{r}_{\tilde{\beta}}$. We now generate the following contradiction:

$$\begin{aligned}
\tilde{r}_{\tilde{\beta}'} - \tilde{r}_{\tilde{\beta}} &= B_{\tilde{\beta}'}(\tilde{r}_{\tilde{\beta}'}) - \tilde{r}_{\tilde{\beta}}(\tilde{r}_{\tilde{\beta}}) \\
&< B_{\tilde{\beta}}(\tilde{r}_{\tilde{\beta}'}) - \tilde{r}_{\tilde{\beta}}(\tilde{r}_{\tilde{\beta}}) \\
&< \bar{\tilde{r}}_{\tilde{\beta}'} - \bar{\tilde{r}}_{\tilde{\beta}} \\
&= \tilde{r}_{\tilde{\beta}'} - \tilde{r}_{\tilde{\beta}}.
\end{aligned} \tag{78}$$

□

Proof of the main result

Proof. Paralleling the perceived continuation value definition in the proof of Theorem 1, we define $r(l, \eta_i)$ to be the period $\tau < t$ objectively expected continuation value of starting out period t with loan l if η_i is realized.

Let $c^*(\eta)$ be the value of c satisfying

$$k(l + p, c, \eta) = \beta\delta\bar{\tilde{r}}(\eta) + k(l, c, \eta), \tag{79}$$

which is unique by Assumption 11, and set $d^*(\eta_i)$ to be the unique value of d that satisfies

$$\min\left(k(l + p, d, \eta_i), \beta\delta\bar{\tilde{r}}(\eta_i) + k(p, d, \eta_i)\right) = \chi. \tag{80}$$

Set $m^{*+}(h, \eta_i) = \max(c^*(\eta_i), d^*(\eta_i))$ and $m^{*-}(h, \eta_i) = \min(c^*(\eta_i), d^*(\eta_i))$. Then the objective expectation of continuation value is the fixed point of $B^* = (B_1^*, \ldots B_M^*)$ given by

$$\begin{aligned}
B_i^*(h) = &\int_{\theta \geq m^{*+}(\eta_i)} \chi f(\theta) d\theta + \int_{\theta \leq m^{*-}(\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta \\
&+ \int_{c^*(\eta_i) \leq \theta \leq m_i^{*+}(\eta_i)} \left(\delta\bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) f(\theta) d\theta.
\end{aligned} \tag{81}$$

Because $\bar{\tilde{r}}$ is uniquely determined, are $c^*(\eta_i)$ and $d^*(\eta_i)$. Thus, the above is simply a system of M linear equations in M unknowns, which has a unique solution.

Plainly, d^* and c^* are continuous in β and $\bar{\tilde{r}}$. And since $\bar{\tilde{r}}$ is continuous in $\tilde{\beta}$, this implies that both are continuous in $\tilde{\beta}$ as well. Finally, $B_i^*(h)$ is clearly continuous in d^* and c^*, which implies the continuity result of the proposition.

We now consider comparative statics on d^* and c^*. By Assumption 11, Equations (79) and (80) imply that both c^* is increasing β and $\tilde{r}$, and d^* is decreasing in β and $\tilde{r}$. By Lemma 2, this implies that c^* is decreasing in $\tilde{\beta}$ and d^* is increasing in $\tilde{\beta}$ when there is no variation in η_i.

Consequently, comparative statics on d^* and c^* translate directly to comparative statics on β and $\tilde{\beta}$. In particular, to complete the proof we need to show that the objective expectation of period 0 utility is increasing in c^* and decreasing in d^*. For that, it is enough to show that B^* is increasing in c^* and decreasing in d^*.

□

F.4 Results with vanishing and maximal uncertainty

To parametrize the degree of uncertainty, we consider a family of distributions F_l and G_l, with G^0_λ and $G(\cdot|\eta_j)$ all having a common support for all λ, and with $\theta \in [0, \bar{\theta}]$ and $\eta_j \in [0, \bar{\eta}]$. We suppose that the means $E_{F_\lambda}[\theta]$, $E_{G^0_\lambda}[\eta]$, and $E_{G_\lambda}[\eta|\eta_j]$ do not depend on λ. Defining $\sigma^2_F, \sigma^2_{G^0}, \sigma^2_{G(\cdot|\eta_j)}$ to be the maximum variance of distributions with respective means $E_{F_\lambda}[\theta]$, $E_{G^0_\lambda}[\eta]$, and $E_{G_\lambda}[\eta|\eta_j]$ and supports within $[0, \bar{\theta}]$, $[0, \bar{\eta}]$, $[0, \bar{\eta}]$,[30] we assume that

1. $\lim_{\lambda\to 0} Var_{F_\lambda}[\theta] = 0, \lim_{\lambda\to 0} \max_{ij}(\eta_i - \eta_j) = 0$
2. $\lim_{\lambda\to\infty} Var_{F_\lambda}[\theta] = \sigma^\infty(\mu)$, $\lim_{\lambda\to\infty} Var_{G^0_\lambda}[\eta] = \sigma^2_{G^0}$, $\lim_{\lambda\to\infty} Var_{G_\lambda}[\eta|\eta_j] = \sigma^2_{G(\cdot|\eta_j)}$

We also make the normalization assumption that for all x, $k(x, \theta, \eta) = 0$ when $\theta = 0$. We consider the welfare and policy implications of bias under two extreme cases: (i) minimal uncertainty, represented by $\lambda \to 0$ and (ii) high uncertainty, represented by $\lambda \to \infty$. When studying (i), we focus on the interesting case in which $E[k(l + p(l), \theta)] < \chi$, so that it is not optimal to default immediately. In the statements below, we use $E[k(x), \omega)]$ to denote the expectation with respect to the period 1 distribution of $\omega = (\eta, \eta)$.

Proposition 5. *Define $\bar{\theta}$ as the upper bound of the support of $F(\theta)$. For $\bar{\theta}$ high enough,* $\lim_{\lambda\to\infty} \left(C_\lambda(l) - C^{TC}_\lambda\right) = 0$ *and* $\lim_{\lambda\to\infty} \left(\tilde{C}_\lambda(l) - C^{TC}_\lambda\right) = 0$.

Proposition 6. *Suppose that $E[k(l + p(l), \omega)] < \chi$, so that it is not optimal to default in period $t = 1$. If $\beta \geq \beta^* := \frac{E[k(l+p(l),\omega)]-E[k(p(l),\omega)]}{E[k(l+p(l),\omega)]}$, then the behavior of the present focused borrower approaches that of a time-consistent borrower as $\lambda \to 0$. Otherwise:*

1. *If $\tilde{\beta}_1 > \beta$, then* $\lim_{\lambda\to 0} \left(C_\lambda(l) - C^{TC}_\lambda(l)\right) = \infty$.
2. *If $\tilde{\beta}_1 = \beta$, then* $\lim_{\lambda\to 0} C_\lambda(l) = \frac{C^{TC}(l)-E[k(p(l),\omega)]}{\beta}$.
3. *If $\tilde{\beta}_1 = \beta$, then* $\lim_{\lambda\to 0} \frac{\tilde{C}_\lambda(l)}{C_\lambda(l)} = \beta\frac{\max\left(\left(C^{TC}(l)-E[k(p(l),\omega)]\right)/\tilde{\beta}_0, C^{TC}(l)\right)}{C^{TC}(l)-E[k(p(l),\omega)]} \in [\beta/\tilde{\beta}_0, 1]$. *If $\tilde{\beta}_1 > \beta$, then* $\lim_{\lambda\to 0} \frac{\tilde{C}_\lambda(l)}{C_\lambda(l)} = 0$.

F.5 Proof of Proposition 5

We begin with a series of lemmas.

[30] By the Bhatia and Davis (2000) inequality, $\sigma^\infty(\mu)$ and $(\sigma^\infty(\mu_j))$ exist.

Lemma 3. *The distributions F_λ and G_λ converge in distribution to distributions F_* and G_* such that F_* is Bernoulli on $[0, \bar{\theta}]$ and $G_*^0, G_*(\cdot|\eta_i)$ are Bernoulli on $[0, \bar{\eta}]$.*

Proof. The Bhatia-Davis inequality implies that given a constraint on the man and the support, the maximum variance is obtained by a Bernoulli distribution with all mass on the lower and upper bound of the support. For F_λ, this implies a variance equal to $\mu(\bar{\theta} - \mu)$, where $\mu = E_{F_\lambda}[\theta]$.

Now suppose, for the sake of contradiction, that the Lemma were not true for F_λ. Then there are some $\alpha > 0$ and $\epsilon > 0$ such that F_λ puts weight at least α on the probability that $\theta \in [\epsilon, \bar{\theta} - \epsilon]$ for all λ. Then

$$\begin{aligned} Var_{F_\lambda}[\theta] &= \int \theta^2 dF - \mu^2 \\ &\leq (1-\alpha) \int \bar{\theta}\theta dF_\lambda + \alpha \int (\bar{\theta} - \epsilon)\theta dF - \mu^2 \\ &= \bar{\theta}\mu - \mu^2 - \alpha\epsilon\mu. \end{aligned} \tag{82}$$

Consequently, the variance of F_λ is bounded away from the maximal possible variance, which contradicts the assumption that the variance of F_λ converges to the maximal possible variance.

By the same logic, G_λ^0 and $G_\lambda(\cdot|\eta_i)$ converge to Bernoulli distributions as well. □

Lemma 4. *Let F^* and G^* be the distributions to which F_λ and G_λ converge. For $\bar{\theta}$ large enough, there is a unique stationary pure-strategy equilibrium under F^* and G^*that does not depend on β and $\tilde{\beta}$.*

Proof. We show that the for $\bar{\theta}$ large enough, the unique equilibrium is to repay when $\theta = 0$, and to delay or default when $\theta = \bar{\theta}$. Since the costs of repayment are zero for $\theta = 0$, it is clear that it is optimal to repay when $\theta = 0$. Set $k_{max} = \max_i k(p, \bar{\theta}, \eta_i)$, and $\alpha = Pr(\theta = 0)$. Now fixing $\bar{\eta}$, by Assumption 11 there is a $\bar{\theta}^\dagger$ high enough such that $k(l + p, \bar{\theta}, \eta) - k(p, \bar{\theta}, \eta) > \chi$ for all $\eta \in [0, \bar{\eta}]$ and all $\bar{\theta} \geq \bar{\theta}^\dagger$. Thus for all such $\bar{\theta}$, the consumer either pays the fee only and continues to the next period, or just defaults. □

Lemma 5. *For $\bar{\theta}$ large enough, the expected period 0 utility under F_λ, G_λ converges to expected period 0 utility under F_*, G_*.*

Proof. Let the common support of G_λ be $\eta_1 < \cdots < \eta_J$. Let $\tilde{r}_\lambda = (\tilde{r}_\lambda(\eta_i), \ldots \tilde{r}_\lambda(\eta_J))$ be the vector of perceived equilibrium continuation strategies for each F_λ, G_λ, and let r_* be the vector of continuation strategies corresponding to F_*, G_*. Note that by the assumption that G_λ have common support, Lemma 3 implies that $\eta_1 = 0$ and $\eta_J = \bar{\eta}$ and that $G_\lambda^0(\eta), G_\lambda(\eta|\eta_i) \to 0$ for $0 < \eta < \bar{\eta}$.

Now consider the best response correspondences B^λ, B^* with respect to F_λ,G_λ and F_*, G_*, respectively, defined in Equations (63,64). By the above, it is enough to show that $\tilde{r}_\lambda(0) \to r_*(0)$ and $\tilde{r}_\lambda(\bar{\eta}) \to r_*(\bar{\eta})$. To that end, note Lemma 3 implies that $G_\lambda(\cdot|\eta)$ converges to a Bernoulli distribution with support 0 and $\bar{\eta}$ and probability $\frac{\bar{\eta}}{E_{G_*}[\eta'|\eta]}$ of $\eta = \bar{\eta}$. Thus for any $h : \mathbb{R}^J \to \mathbb{R}^J$ and η

$$\sum_{\eta'} h(\eta')G_\lambda(\eta'|\eta) \to \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta'|\eta]}\right) h(0) + \frac{\bar{\eta}}{E_{G_*}[\eta'|\eta]} h(\bar{\eta}). \tag{83}$$

Consequently, if $k(l+p,\bar{\theta},\eta) - k(p,\bar{\theta},\eta) > \chi$ for all $\eta \in [0,\bar{\eta}]$, then by the reasoning of Lemma 4 and the fact that F_λ converges to a Bernoulli distribution with support $\{0,\bar{\theta}\}$,

$$B_j^\lambda(h) \to Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p,\bar{\theta},\eta) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|\eta_j]}\right) h(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|\eta_j]} h(\bar{\eta})\right) \tag{84}$$

for all j and $h : \mathbb{R}^J \to \mathbb{R}^J$. Moreover, since $\tilde{r}_\lambda(\eta_i) \in [0,\chi/\tilde{\beta}]$ for all λ and η_i, we can restrict attention to $h \in [0,\chi/\tilde{\beta}]^J$, which allows us to strengthen the convergence in Equation (84) above to uniform convergence. This implies that $\lim_{\lambda\to 0}\tilde{r}_\lambda(0)$ and $\lim_{\lambda\to 0}\tilde{r}_\lambda(\bar{\eta})$ solve the system of linear equations

$$\lim_{\lambda\to 0}\tilde{r}_\lambda(0) = Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p,\bar{\theta},0) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|0]}\right) \lim_{\lambda\to 0}\tilde{r}_\lambda(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|0]} \lim_{\lambda\to 0}\tilde{r}_\lambda(\bar{\eta})\right) \tag{85}$$

$$\lim_{\lambda\to 0}\tilde{r}_\lambda(\bar{\eta}) = Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p,\bar{\theta},\bar{\eta}) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|\bar{\eta}]}\right) \lim_{\lambda\to 0}\tilde{r}_\lambda(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|\bar{\eta}]} \lim_{\lambda\to 0}\tilde{r}_\lambda(\bar{\eta})\right) \tag{86}$$

but the system of equations above is precisely the system of equations that characterizes $r_*(0)$ and $r_*(\bar{\eta})$. □

Proof of the main result

Proof. The result follows immediately from the three lemmas above. We have that (i)$\lim_{\lambda\to 0}\tilde{r}_\lambda(0) = r_*(0)$, $\lim_{\lambda\to 0}\tilde{r}_\lambda(\bar{\eta}) = r_*(\bar{\eta})$; (ii) G_λ^0 and $G_\lambda(\cdot|\eta_j)$ converge to G_*^0 and $G_*(\cdot|\eta_j)$ and (iii) the uniform convergence condition of Equation (84), together with Lemma 5, imply that

$$\tilde{r}_\lambda(\eta) \to Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p,\bar{\theta},\eta) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|\eta]}\right) r_*(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|\eta]} r_*(\bar{\eta})\right). \tag{87}$$

and thus that $\tilde{r}_\lambda(\eta)$ are all bounded away from zero. Now fixing $\bar{\eta}$, by Assumption 11 there is a $\bar{\theta}^\dagger$ high enough such that $k(l+p,\bar{\theta},\eta) - k(p,\bar{\theta},\eta) > \chi$ for all $\eta \in [0,\bar{\eta}]$ and all $\bar{\theta} \geq \bar{\theta}^\dagger$. Under this condition, the individual does indeed repay for small enough θ, and does not repay for θ sufficiently close to $\bar{\theta}$. □

Extension to misprediction of costs

The arguments above extend verbatim to the case in which borrowers are sophisticated about their present focus but think that future costs are κ as high as they are.

F.6 Proof of Proposition 6

Proof. or shorthand, let $\bar{k}(x)$ denote the expectation of the period 1 costs of repayment, and let $\bar{k}(x, \eta_i)$ denote the expectation conditional on η_i. Let $\tilde{r}_\lambda(\eta_i)$ denote the expected cost, given a realization of η_i, with respect to the distributions F_l and G_l. Construct $\bar{\tilde{r}}_\lambda(\eta_i) := \sum_j \tilde{r}_\lambda(\eta_j)G(\eta_j|\eta_i)$. □

Lemma 6. $\lim_{\lambda\to 0} \max_{ij} |\bar{r}(\eta_i) - \bar{r}(\eta_j)| = 0$.

Proof. Note that as $\lambda \to 0$, there is no option value of delaying, and thus the time-consistent individual repays immediately. Any delays are suboptimal. Consequently, $\lim_{\lambda\to 0} \tilde{r}_i(l) \geq \bar{k}(l + p)$ and $\lim_{\lambda\to 0} \bar{\tilde{r}}_i(l) \geq \bar{k}(l + p)$ for all i.

Now consider first the case in which $\tilde{\beta}_1 \geq \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$. In this case

$$\lim_{\lambda\to 0}\left(k(p) + \tilde{\beta}_1\,\bar{\tilde{r}}_i(l)\right) \geq k(p) + \tilde{\beta}_1\bar{k}(l+p)$$
$$\geq \bar{k}(l+p), \tag{88}$$

and thus the borrower repays immediately. Consequently, $\lim_{\lambda\to 0} \bar{\tilde{r}}_i(l) = \bar{k}(l + p)$ for all i.

Next, consider the case in which $\tilde{\beta}_1 < \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$. We break up the proof into three cases.

Case 1. Suppose, toward a contradiction, that there exist $\epsilon_1 > 0$ and $\epsilon_2 > 0$ such that $\max_i\left(\bar{k}(p) + \tilde{\beta}_1\bar{\tilde{r}}_\lambda(\eta_i)\right) > \bar{k}(l+p)+\epsilon_1$ and $\min_i\left(\bar{k}(p) + \tilde{\beta}_1\bar{\tilde{r}}(\eta_i)\right) < \bar{k}(l+p)-\epsilon_1$for all λ. Then there exists $\bar{\lambda} > 0$ such that $\max_i\left(\bar{k}(p, \eta_i) + \tilde{\beta}_1\bar{\tilde{r}}_\lambda(\eta_i)\right) > \bar{k}(l+p, \eta_i)+\epsilon_1$ and $\min_i\left(\bar{k}(p, \eta_i) + \tilde{\beta}_1\bar{\tilde{r}}_\lambda(\eta_i)\right) < \bar{k}(l+p, \eta_i)-\epsilon_1$ for all $\lambda \leq \bar{\lambda}$. Consequently, $Pr\left(\max_i\left(k(p, \theta, \eta_i) + \tilde{\beta}_1\bar{\tilde{r}}_\lambda(\eta_i)\right) > \bar{k}(l + p, \theta, \eta_i) + \epsilon_1\right) \to 1$, meaning that the probability that the borrower thinks he chooses to repay that period approaches 1. Thus if $\bar{i}(\lambda)$ is the index that maximizes $\bar{\tilde{r}}_\lambda(\eta_i)$, then $\tilde{r}_\lambda(\eta_{\bar{i}}) \to \bar{k}(l + p)$. Similarly, if $\underline{i}(\lambda)$ is the index that minimizes $\bar{\tilde{r}}_i(\eta_i)$ then in this case the probability that the borrower thinks he chooses to repay approaches 0, and $\tilde{r}_\lambda(\eta_{\underline{i}}) \to \bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) + \bar{k}(p)$.

Now since by assumption $G(\eta_i|\eta_i) > 1/2$ for all i, and since $\lim_{\lambda\to 0} \tilde{r}_i(l) \geq \bar{k}(l+p)\forall i$, we have that

$$\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\bar{i}}) \leq \frac{1}{2}\bar{k}(l + p) + \frac{1}{2}\lim_{\lambda\to 0}\max_i \tilde{r}_\lambda(i)$$
$$\leq \frac{1}{2}\bar{k}(l + p) + \frac{1}{2}\lim_{\lambda\to 0}\left(k(p) + \bar{\tilde{r}}_{\bar{i}}\right)$$
$$\Leftrightarrow \lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\bar{i}}) \leq \bar{k}(p) + \bar{k}(l + p), \tag{89}$$

and

$$\begin{aligned}\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) &\geq \frac{1}{2}\bar{k}(l+p)+\frac{1}{2}\lim_{\lambda\to 0}\tilde{r}(\eta_{\underline{i}})\\ &= \frac{1}{2}\bar{k}(l+p)+\frac{1}{2}\lim_{\lambda\to 0}\left(\bar{\tilde{r}}_\lambda(\eta_{\underline{i}})+\bar{k}(p)\right)\\ \Leftrightarrow \lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) &\geq \bar{k}(p)+\bar{k}(l+p), \end{aligned} \tag{90}$$

which implies that $\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) \geq \lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}})$—a contradiction.

Case 2. Suppose that there exists $\epsilon > 0$ such that $\max_i\left(\bar{k}(p)+\tilde{\beta}_1\bar{\tilde{r}}_\lambda(\eta_i)\right) > \bar{k}(l+p)+\epsilon$ for all λ. Now if there exists ϵ such that $\bar{k}(p)+\tilde{\beta}_1\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_i) > \bar{k}(l+p)+\epsilon$ for all i, then by the reasoning in Case 1, the borrower never delays repayment in the limit, and thus $\bar{\tilde{r}}_\lambda(\eta_i)\to\bar{k}(l+p)$ for all i, which is impossible when $\tilde{\beta}_1 < \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$. Thus by Case 1,

$$\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) = \frac{\bar{k}(l+p)-\bar{k}(p)}{\tilde{\beta}_1} > \bar{k}(l+p) = \lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}), \tag{91}$$

which again generates a contradiction.

Case 3. Suppose, toward a contradiction, that there exists $\epsilon > 0$ such that $\min_i\left(\bar{k}(p)+\tilde{\beta}_1\bar{\tilde{r}}_\lambda(\eta_i)\right)$ $< \bar{k}(l+p)-\epsilon$ for all λ. Now if there exists ϵ such that $\bar{k}(p)+\tilde{\beta}_1\bar{\tilde{r}}(\eta_i) < \bar{k}(l+p)-\epsilon$ for all i, then by the reasoning in Case 1, the borrower always delays repayment in the limit, and thus $\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_i)=\infty$ for all i. Thus by Case 1, $\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\bar{i}}) = \frac{\bar{k}(l+p)-\bar{k}(p)}{\tilde{\beta}_1}$, and therefore for μ denoting the probability of transition from$\underline{i}$ to a state in which the agent does not delay with probability 1:

$$\begin{aligned}\lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) &\geq \mu\frac{\bar{k}(l+p)-\bar{k}(p)}{\tilde{\beta}_1}+(1-\mu)\lim_{\lambda\to 0}\tilde{r}(\eta_{\underline{i}})\\ &= \mu\frac{\bar{k}(l+p)-\bar{k}(p)}{\tilde{\beta}_1}+(1-\mu)\lim_{\lambda\to 0}\left(\bar{\tilde{r}}_\lambda(\eta_{\underline{i}})+\bar{k}(p)\right)\\ \Leftrightarrow \lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) &\geq \frac{\bar{k}(l+p)-\bar{k}(p)}{\tilde{\beta}_1}+\frac{(1-\mu)}{\mu}\bar{k}(p)\\ &> \frac{\bar{k}(l+p)-\bar{k}(p)}{\tilde{\beta}_1}\\ &= \lim_{\lambda\to 0}\bar{\tilde{r}}_\lambda(\eta_{\bar{i}}), \end{aligned} \tag{92}$$

which generates a contradiction. □

The above lemma implies that the pure strategies and payoffs of the setting with diminishing uncertainty converge to the stationary mixed strategy equilibrium of a game with no uncertainty, in which the cost of delay is $\bar{k}(p)$ and the cost of paying immediately is $\bar{k}(l+p)$. For the proof of the proposition, we therefore consider the stationary mixed strategy equilibria of the game with no uncertainty.

Proof of the main result

Proof. We first characterize the perceived equilibrium in terms of $\tilde{\beta}$. As before, if $\tilde{\beta} \geq \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$ then the agent perceives himself to repay immediately.

Assume now that $\tilde{\beta} < \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$ and let $\tilde{\mu}$ be the perceived probability of repaying next period. For the mixed strategy to be feasible, the agent must be indifferent between continuing or not in the next period, and thus the continuation cost $\tilde{r}$ must satisfy $\bar{k}(p) + \tilde{\beta}\tilde{r} = \bar{k}(l+p)$, or

$$\tilde{r} = \frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}}. \tag{93}$$

To solve for $\tilde{\mu}$, observe also that

$$\tilde{r} = \tilde{\mu}\bar{k}(l+p) + (1-\tilde{\mu})(\bar{k}(p) + \tilde{r}). \tag{94}$$

Solving Equations (93) and (94) yields

$$\tilde{\mu} = \frac{\tilde{\beta}}{1-\tilde{\beta}} \frac{\bar{k}(p)}{\bar{k}(l+p) - \bar{k}(p)}. \tag{95}$$

Now if $\beta \geq \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$ then the agent does indeed repay immediately.

If $\beta < \tilde{\beta}_1$ then the agent never repays since the perceived continuation cost $\tilde{r}_1$ in periods $t \geq 1$ satisfies Equation (93) with $\tilde{\beta}_1$ in place of $\tilde{\beta}$, and thus $\bar{k}(p) + \beta\tilde{r}_1 < \bar{k}(l+p)$. Consequently, the agent simply accumulates infinite costs from continually paying the fee p.

If $\beta = \tilde{\beta}_1$ then the continuation cost is given by $r = \frac{\bar{k}(l+p)-\bar{k}(p)}{\beta}$

Parts 2 and 3 of the proposition follows simply from Equations (93) and (95), noting that $r^{TC} \to \bar{k}(l+p)$. □

Extension to misprediction of costs

Suppose instead that borrowers perceive future costs to be $\kappa \leq 1$ as high as they are. Lemma 6 holds verbatim. Moreover, $\lim_{\lambda\to 0} \bar{\tilde{r}}_i(l) \geq \kappa\bar{k}(l+p)$ for all i so if $\beta/\kappa \geq \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$ then

$$\begin{aligned} \lim_{\lambda\to 0} \left(k(p) + \tilde{\beta}_1\bar{\tilde{r}}(l)\right) &\geq k(p) + \tilde{\beta}_1\bar{k}(l+p) \\ &\geq \bar{k}(l+p), \end{aligned} \tag{96}$$

and the borrower perceives himself to repay immediately.

Assume now that $\beta/\kappa < \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$ and let $\tilde{\mu}$ be the perceived probability of repaying next period. For the mixed strategy to be feasible, the agent must be indifferent between continuing or not in the next period, and thus the continuation cost $\tilde{r}$ must satisfy $\kappa\bar{k}(p) + \beta\tilde{r} = \kappa\bar{k}(l + p)$, or

$$\tilde{r} = \frac{\bar{k}(l + p) - \bar{k}(p)}{\beta/\kappa}. \tag{97}$$

Now if $\beta \geq \frac{\bar{k}(l+p)-\bar{k}(p)}{\bar{k}(l+p)}$ then the agent does indeed repay immediately.

If $\kappa < 1$ then the agent never repays since the perceived continuation cost $\tilde{r}_1$ in periods $t \geq 1$ satisfies Equation (97) with $\tilde{\beta}_1$ in place of $\tilde{\beta}$, and thus $\bar{k}(p) + \beta\tilde{r}_1 < \bar{k}(l + p)$. Consequently, the agent simply accumulates infinite costs from continually paying the fee p.

If $\kappa = 1$ then the continuation cost is given by $r = \frac{\bar{k}(l+p)-\bar{k}(p)}{\beta}$. Parts 2 and 3 of the proposition follows simply from Equation (97), noting that $r^{TC} \to \bar{k}(l + p)$.

F.7 Proof of Proposition 3

Proof. We first solve for $C^S_\beta(\eta)$: the continuation value function when a state η is realized in period $t \geq 1$. We suppress the loan size l as an argument for simplicity. The key fact is that $\min(k(l + p, \theta, \eta), \chi) \leq k(l + p, \theta, \eta) + (1 - \beta)C^S_\beta(\eta)$. Partition the set Θ into the sets D, RB, and RP where D is the set of all θ for which the borrower defaults, RB is the set for which the borrower re-borrows, RP is the set of all θ for which the borrower repays in full. Define

$$\begin{aligned} r^*(\eta_i) := \min_{D,RP,RB} \int_{\theta\in D} \chi f(\theta)d\theta + \int_{\theta\in RB} \left(\delta C^S_\beta(\eta_i) + k(p, \theta, \eta_i)\right) f(\theta)d\theta \\ + \int_{\theta\leq RP} k(l + p, \theta, \eta_i)f(\theta)d\theta \end{aligned} \tag{98}$$

That is, r^* is the minimum expected cost to a time-consistent borrower from the period 1 perspective, given a realization η_i at the beginning of period 1, but given the continuation value function $C^S_\beta(\eta_i)$ that corresponds to a present-focused borrower. Let $D^*_\eta, RP^*_\eta, RB^*_\eta$ denote this cost minimizing strategy.

Let D_η, RB_η, and RP_η be the sets corresponding to the actual strategy of the present-focused borrower. Note that for $\theta \in RB_\eta$, $k(p, \theta, \eta) + \beta C^S_\beta(\eta) \leq \min(k(l + p, \theta, \eta), \chi)$, and thus

$$k(p, \theta, \eta) + C^S_\beta(\eta) \leq \min(k(l + p, \theta, \eta), \chi) + (1 - \beta)C^S_\beta(\eta). \tag{99}$$

If the borrower does not reborrow, then her choice of whether to default or repay in full corresponds to that of a time-consistent borrower, since both are immediate costs. Because both are immediate costs, the present-focused borrower is less likely to do both relatively to a time-consistent borrower. Thus $D_\eta \subset D^*_\eta$ and $RP_\eta \subset RP^*_\eta$. Thus, relative to a time-consistent borrower with the same continuation value function, the present focused borrower can only make a mistake when he reborrows, and in this case the size of the mistake cannot be more than $(1 - \beta)C^S_\beta(\eta_i)$, the amount by which he underweights future costs. Thus

$$r(\eta_i) \leq r^*(\eta_i) + \mu(1-\beta)C^S_\beta(\eta_i), \tag{100}$$

where μ is the probability of reborrowing. To bound the period 0 expected cost function C^S_β, we sum the above equation over all realizations of η_i, weighted by prior G_0:

$$C^S_\beta \leq \sum r^*(\eta)G_0(\eta) + \mu(1-\beta)C^S_\beta. \tag{101}$$

To obtain Equation (101) from Equation (100), we use the fact that $C^S_\beta(\eta_i) = \sum_\eta r(\eta)G(\eta|\eta_i)$, and that the unconditional distribution of η is time invariant. This implies that $\sum_{\eta_i}\sum_\eta r(\eta)G(\eta|\eta_i)G_0(\eta_i)$ $= \sum_\eta r(\eta)G_0(\eta) = C^S_\beta$.

To complete the proof for sophisticates, note that $\sum r^*(\eta)G_0(\eta)$ cannot be lower than C^{TC}; else, the time-consistent borrower could choose a better strategy. Thus,

$$C^S_\beta \leq C^{TC} + \mu(1-\beta)C^S_\beta. \tag{102}$$

Rearranging gives the first result.

For partial naifs we again have $D_\eta \subset D^*_\eta$ and $RP_\eta \subset RP^*_\eta$. It also continues to hold that if the borrower does not reborrow, then her choice of whether to default or repay in full corresponds to that of a time-consistent borrower. However, Equation (99) is modified to

$$k(p,\theta,\eta) + C^S_{\tilde\beta}(\eta) \leq \min(k(l+p,\theta,\eta),\chi) + (1-\beta)C^S_{\tilde\beta}(\eta). \tag{103}$$

Adding $C^{PN}_{\beta,\tilde\beta}(\eta) - C^S_{\tilde\beta}(\eta)$ to both sides yields

$$k(p,\theta,\eta) + C^{PN}_{\beta,\tilde\beta}(\eta) \leq \min(k(l+p,\theta,\eta),\chi) + C^{PN}_{\beta,\tilde\beta}(\eta) - \beta C^S_{\tilde\beta}(\eta). \tag{104}$$

Proceeding as before, define

$$\begin{aligned} r^*(\eta_i) := \min_{D,RP,RB} & \int_{\theta\in D} \chi f(\theta)d\theta + \int_{\theta\in RB}\left(\delta C^{PN}_{\beta,\tilde\beta}(\eta_i) + k(p,\theta,\eta_i)\right) f(\theta)d\theta \\ & + \int_{\theta\leq RP} k(l+p,\theta,\eta_i)f(\theta)d\theta \end{aligned} \tag{105}$$

from which it follows that for partial naifs',

$$r(\eta_i) \leq r^*(\eta_i) + \mu\left(C^{PN}_{\beta,\tilde\beta}(\eta_i) - \beta C^S_{\tilde\beta}(\eta_i)\right), \tag{106}$$

As before, summing over the realizations of η_i and using the time-invariance of the unconditional distribution of η produces implies that

$$C^{PN}_{\beta,\tilde\beta} \leq C^{TC} + \mu C^{PN}_{\beta,\tilde\beta} - \mu\beta C^S_{\tilde\beta}. \tag{107}$$

Rearranging Equation (107) gives the second result in the proposition. □

Extension to misprediction of costs

By identical logic, let $C^{PN}_{\beta,\kappa}$ denote the continuation value function of an agent who perceive future costs to be only κ as high as they are, and let $C^{S}_{\beta,\kappa}(\eta)$ denote the the continuation value function that would result if the borrower was in fact right. Then

$$C^{PN}_{\beta,\kappa} \le C^{TC} + \mu C^{PN}_{\beta,\kappa}(\eta) - \mu\beta C^{S}_{\beta,\kappa}, \tag{108}$$

and thus

$$C^{PN}_{\beta,\kappa} \le \frac{C^{TC}}{1-\mu} - \frac{\mu}{1-\mu}\beta C^{S}_{\beta,\kappa}. \tag{109}$$

F.8 Additional Calibration Results

F.8.1 Conditions on Marginal Benefits and Costs of First Dollar Borrowed

The surplus from borrowing will be positive when $l^* < 2l^\dagger$. To see this, first note that $C'(l^\dagger) = C'(0) + l^\dagger C''$ and $u'(l^\dagger) = u'(0) + l^\dagger u'' u'(0) = u'(l^\dagger) - l^\dagger u''(l^\dagger)$ and thus

$$\begin{aligned} u'(0) &= u'(l^\dagger) - l^\dagger u'' \\ &= C'(l^\dagger) - l^\dagger u'' \\ &= l^\dagger(C'' - u'') + C'(0) \end{aligned} \tag{110}$$

Borrower welfare at the optimal $l^\dagger$ is then given by

$$G := \frac{(u'(0) - C'(0))l^\dagger}{2} = \frac{C'' - u''}{2}(l^\dagger)^2. \tag{111}$$

If borrowers instead choose l^* to solve $u'(l) = \kappa C'(l)$—where either $\kappa = \beta/\tilde{\beta}_0$ or $k = \beta$, as in the body of the paper—then

$$L = \frac{1}{2}\Delta^2(C'' - u'').$$

Consequently, borrower welfare is positive if $l^\dagger > \Delta = l^* - l^\dagger$.

Now

$$l^\dagger = \frac{u'(0) - C'(0)}{(C'' - u'')} \tag{112}$$

and

$$l^* = \frac{u'(0) - \kappa C'(0)}{(\kappa C'' - u'')}. \tag{113}$$

Now $2l^\dagger > l^*$ if and only if

$$
\begin{aligned}
&2\frac{u'(0)-C'(0)}{(C''-u'')} > \frac{u'(0)-\kappa C'(0)}{(\kappa C''-u'')}\\
\Leftrightarrow &(u'(0)-\kappa C'(0))(C''-u'') < 2(\kappa C''-u'')(u'(0)-C'(0))\\
\Leftrightarrow &\kappa C'(0)C''-(2-\kappa)u''C'(0) < (2\kappa-1)C''u'(0)-u'(0)u''\\
\Leftrightarrow &C'(0)\left[kC''-(2-\kappa)u''(0)\right] < u'(0)\left[(2\kappa-1)C''-u''\right]\\
\Leftrightarrow &\frac{u'(0)}{C'(0)} > \frac{\kappa C''-(2-\kappa)u''}{(2\kappa-1)C''-u''} \qquad (114)
\end{aligned}
$$

Now since C'' and $-u''$ are both positive, the term $\frac{kC''-(2-\kappa)u''}{(2\kappa-1)C''-u''}$ is increasing in C''/u'' when $\frac{\kappa}{2\kappa-1} > (2-\kappa)$ and $(2\kappa-1) > 0$. This inequality holds for $\kappa \in (1/2, 1]$, as it is equivalent to

$$
\begin{aligned}
&\kappa > (2\kappa-1)(2-\kappa)\\
\Leftrightarrow &0 > -2\kappa^2+4\kappa-2\\
\Leftrightarrow &0 > -2(\kappa-1)^2 \qquad (115)
\end{aligned}
$$

Inequality (114) thus holds if it holds in the limit case $C''/u'' \to \infty$, which reduces to $u'(0)/C'(0) > \kappa/(2\kappa-1)$ or, equivalently,

$$u'(0)/\tilde{C}'(0) > 1/(2\kappa-1). \qquad (116)$$

For example, at $\kappa = 0.9$, $G > L$ if $u'(0)/\tilde{C}'(0) > 1/(1.8-1) = 1.25$. This is a worst-case bound that applies to cases in which $u''/C'' \approx 0$ (marginal costs increase much faster than marginal benefits), which is tightened to $u'(0) > C'(0)/\kappa$ when $u'' = C''$, and to $u'(0) > C'(0)(2-\kappa)$ when $C'' = 0$.

F.8.2 Calibrations with Linear Demand and Marginal Cost

To further explore how likely condition (114) is to hold, consider a population of potential borrowers with linear marginal benefits and costs given by $\theta_B u'(l)$ and $\theta_C C'(l)$, where (θ_B, θ_C) follow an arbitrary joint distribution. Suppose that $-u'(0)/u''(0) = C'(0)/C''(0) \equiv \alpha$. In reality, u' likely declines faster than C', as borrowers have a particular liquidity shock that they need to address, and the marginal benefits of borrowing an amount greater than the liquidity need are relatively small. Thus, the illustrative assumption that $-u'(0)/u''(0) = C'(0)/C''(0)$ is likely conservative, as the bounds for guaranteeing that $G > L$ become less demanding with more curvature in either u' or C'.

Then for $\theta := \theta_B/\theta_C \cdot u'(0)/C'(0)$,

$$l^*(\theta) = \frac{\theta_B u'(0) - \kappa\theta_C C'(0)}{(\kappa\theta_C C'' - \theta_B u'')} = \frac{1}{\alpha}\frac{\theta-\kappa}{\theta+\kappa} \tag{117}$$

The condition that $2l^\dagger > l^*$ is equivalent to

$$2\frac{\theta_B u'(0) - \theta_C C'(0)}{(\theta_C C'' - \theta_B u'')} > \frac{\theta_B u'(0) - \kappa\theta_C C'(0)}{(\kappa\theta_C C'' - \theta_B u'')} \Leftrightarrow \frac{2}{\alpha}\frac{\theta-1}{\theta+1} > \frac{1}{\alpha}\frac{\theta-\kappa}{\theta+\kappa}. \tag{118}$$

For $\kappa = 0.9$, equation (118) holds when $\theta > 1.1$. What does this translate to for $l^*(\theta)$? Setting $\alpha = 0.002$, which is more three times smaller than our empirical estimate, this translates to $l^*(\theta) > \$50$ by equation (1). In other words, all individuals who take out loans of size \$50 or greater must have $G > L$. Setting $\alpha = 0.0005$, which is more than ten times smaller than our empirical estimates, implies that $l^*(\theta) > \$200$.

G Details on Simulations

G.1 Solving the model for $T = \infty$

Let F be the CDF of θ_t. Let $r_t(\eta)$ be the actual expected utility of starting out in debt in period t given a realization of η. Let $\tilde{r}_t$ be the perceived utility cost, from the period $\tau < t$ perspective, of starting out in debt in period t. Define $\theta^\dagger(\eta)$ as the cutoff value such that a borrower repays in period t if and only if $\theta_t \leq \theta^\dagger$ (conditional on not defaulting). Define $\tilde{\theta}^\dagger$ to be the perceived cutoff in period $\tau < t$. Define $d(\eta)$ as the cutoff value such that a borrower defaults in period t if and only if $\theta_t > d(\eta)$. Define $\tilde{d}(\eta)$ to be the perceived cutoff in period $\tau < t$.

G.1.1 Perceived equilibrium

We look for a solution in which when things are good ($\eta = \underline{\eta}$), the borrower does not default (at baseline $\beta, \tilde{\beta}$ parameters) but when things are bad ($\eta = \bar{\eta}$) the person always defaults.

When $\eta = \underline{\eta}$ and the borrower is debating whether to repay in full or reborrow, she compares the repayment cost of paying in full, $(\theta_t + \underline{\eta})(e^{\alpha(l+p(l))} - 1)$, and the perceived repayment cost of reborrowing, $(\theta_t + \underline{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))$. The θ_t where these two perceived repayment costs are equal defines $\tilde{\theta}^\dagger(\underline{\eta})$. When $\eta = \bar{\eta}$, $\tilde{\theta}^\dagger(\bar{\eta})$ is obtained similarly.

Thus, we have that the reborrowing cutoffs (conditional on not defaulting) are

$$\tilde{\theta}^{\dagger}(\underline{\eta}) = \frac{\tilde{\beta}\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \tag{119}$$

$$\tilde{\theta}^{\dagger}(\bar{\eta}) = \frac{\tilde{\beta}\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} - \bar{\eta}. \tag{120}$$

Derivation of $\tilde{\theta}^{\dagger}(\underline{\eta})$:

$$(\theta + \underline{\eta})(e^{\alpha(l+p(l))} - 1) = (\theta + \underline{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))$$

$$(\theta + \underline{\eta})(e^{\alpha(l+p(l))} - e^{\alpha p(l)}) = \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))$$

$$\theta + \underline{\eta} = \frac{\tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}$$

$$\theta = \frac{\tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}, \tag{121}$$

where the last line follows by the assumption that $\underline{\eta} = 0$.

Derivation of $\tilde{\theta}^{\dagger}(\bar{\eta})$:

$$(\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1) = (\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))$$

$$(\theta + \bar{\eta})(e^{\alpha(l+p(l))} - e^{\alpha p(l)}) = \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))$$

$$\theta + \bar{\eta} = \frac{\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}$$

$$\theta = \frac{\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} - \bar{\eta}. \tag{122}$$

When $\eta = \underline{\eta}$ there are two cases to consider. In the first case, χ is "large enough" so that $\tilde{\theta}^{\dagger}(\underline{\eta}) < \tilde{d}(\underline{\eta})$ (i.e. χ is large enough to fit with the solution we are looking for). In this case, when the borrower debates between reborrowing and defaulting, she compares the perceived repayment cost of reborrowing, $(\theta_t + \underline{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))$, and the cost of defaulting, χ. The θ_t where these two perceived costs are equal defines $\tilde{d}(\underline{\eta})$ in this case. In the second case, χ is "small enough" so that $\tilde{\theta}^{\dagger}(\underline{\eta}) > \tilde{d}(\underline{\eta})$ (which does not align with the solution we are looking for, but is needed for completeness). In this case, the borrower debates between repaying and defaulting. She compares the repayment cost of paying in full, $(\theta_t + \underline{\eta})(e^{\alpha(l+p(l))} - 1)$, and the cost of defaulting,

χ. The θ_t where these two costs are equal defines $\tilde{d}(\underline{\eta})$ in this case. Define $\tilde{\chi}^\dagger(\underline{\eta})$ as the boundary between these two cases. At $\tilde{\chi}^\dagger(\underline{\eta})$, we have that $\tilde{\theta}^\dagger(\underline{\eta}) = \tilde{d}(\underline{\eta})$ (Note that when $\theta_t = \tilde{\theta}^\dagger(\underline{\eta}) = \tilde{d}(\underline{\eta})$, the borrower is indifferent between repaying, reborrowing, and defaulting). Setting $\tilde{\theta}^\dagger(\underline{\eta}) = \tilde{d}(\underline{\eta})$ and solving for χ defines $\tilde{\chi}^\dagger(\underline{\eta})$.

Similarly, when $\eta = \bar{\eta}$ there are two cases to consider. In the first case, χ is "small enough" so that $\tilde{\theta}^\dagger(\bar{\eta}) > \tilde{d}(\bar{\eta})$ (i.e. χ is small enough to fit with the solution we are looking for). In this case, the borrower debates between repaying and defaulting. She compares the repayment cost of paying in full, $(\theta_t + \bar{\eta})(e^{\alpha(l+p(l))} - 1)$, and the cost of defaulting, χ. The θ_t where these two costs are equal defines $\tilde{d}(\bar{\eta})$ in this case. In the second case, χ is "large enough" so that $\tilde{\theta}^\dagger(\bar{\eta}) < \tilde{d}(\bar{\eta})$ (which does not align with the solution we are looking for, but is needed for completeness). In this case, when the borrower debates between reborrowing and defaulting, she compares the perceived repayment cost of reborrowing, $(\theta_t + \bar{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))$, and the cost of defaulting, χ. The θ_t where these two perceived costs are equal defines $\tilde{d}(\bar{\eta})$ in this case. Define $\tilde{\chi}^\dagger(\bar{\eta})$ as the boundary between these two cases. At $\tilde{\chi}^\dagger(\bar{\eta})$, we have that $\tilde{\theta}^\dagger(\bar{\eta}) = \tilde{d}(\bar{\eta})$ (Note that when $\theta_t = \tilde{\theta}^\dagger(\bar{\eta}) = \tilde{d}(\bar{\eta})$, the borrower is indifferent between repaying, reborrowing, and defaulting). Setting $\tilde{\theta}^\dagger(\bar{\eta}) = \tilde{d}(\bar{\eta})$ and solving for χ defines $\tilde{\chi}^\dagger(\bar{\eta})$.

Thus, we have that the defaulting cutoffs are:

$$\tilde{d}(\underline{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} & \text{if } \chi \leq \tilde{\chi}^\dagger(\underline{\eta}) \\ \frac{\chi - \tilde{\beta}\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha p(l)}-1} & \text{if } \chi > \tilde{\chi}^\dagger(\underline{\eta}) \end{cases} \tag{123}$$

$$\tilde{d}(\bar{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} - \bar{\eta} & \text{if } \chi \leq \tilde{\chi}^\dagger(\bar{\eta}) \\ \frac{\chi - \tilde{\beta}\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha p(l)}-1} - \bar{\eta} & \text{if } \chi > \tilde{\chi}^\dagger(\bar{\eta}) \end{cases}, \tag{124}$$

where

$$\tilde{\chi}^\dagger(\underline{\eta}) = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \tilde{\beta}\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right) \tag{125}$$

$$\tilde{\chi}^\dagger(\bar{\eta}) = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \tilde{\beta}\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right). \tag{126}$$

Derivation of $\tilde{d}(\underline{\eta})$, $\chi \leq \tilde{\chi}^\dagger(\underline{\eta})$ case:

$$(\theta + \underline{\eta})(e^{\alpha(l+p(l))} - 1) = \chi$$

$$\theta + \underline{\eta} = \frac{\chi}{e^{\alpha(l+p(l))} - 1}$$

$$\theta = \frac{\chi}{e^{\alpha(l+p(l))} - 1} \tag{127}$$

Derivation of $\tilde{d}(\underline{\eta})$, $\chi > \tilde{\chi}^{\dagger}(\underline{\eta})$ case:

$$(\theta + \underline{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})) = \chi$$

$$(\theta + \underline{\eta})(e^{\alpha p(l)} - 1) = \chi - \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))$$

$$\theta + \underline{\eta} = \frac{\chi - \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))}{e^{\alpha p(l)} - 1}$$

$$\theta = \frac{\chi - \tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))}{e^{\alpha p(l)} - 1} \tag{128}$$

Derivation of $\tilde{d}(\bar{\eta})$, $\chi \leq \tilde{\chi}^{\dagger}(\bar{\eta})$ case:

$$(\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1) = \chi$$

$$\theta + \bar{\eta} = \frac{\chi}{e^{\alpha(l+p(l))} - 1}$$

$$\theta = \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \bar{\eta} \tag{129}$$

Derivation of $\tilde{d}(\bar{\eta})$, $\chi > \tilde{\chi}^{\dagger}(\bar{\eta})$ case:

$$(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})) = \chi$$

$$(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) = \chi - \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))$$

$$\theta + \bar{\eta} = \frac{\chi - \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha p(l)} - 1}$$

$$\theta = \frac{\chi - \tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha p(l)} - 1} - \bar{\eta} \tag{130}$$

Derivation of $\tilde{\chi}^{\dagger}(\underline{\eta})$:

$$\tilde{\theta}^{\dagger}(\underline{\eta}) = \frac{\tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} = \frac{\chi}{e^{\alpha(l+p(l))} - 1} = \tilde{d}(\underline{\eta})$$

$$\chi = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}\tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})) \tag{131}$$

Derivation of $\tilde{\chi}^{\dagger}(\bar{\eta})$:

$$\tilde{\theta}^{\dagger}(\bar{\eta}) = \frac{\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} - \bar{\eta} = \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \bar{\eta} = \tilde{d}(\bar{\eta})$$

$$\frac{\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} = \frac{\chi}{e^{\alpha(l+p(l))} - 1}$$

$$\chi = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})) \tag{132}$$

The Bellman operator on the continuation value functions is

$$B_1(\tilde{r}(\underline{\eta}), \tilde{r}(\bar{\eta})) \begin{cases} \int_{\underbrace{\theta \leq \tilde{d}(\underline{\eta})}_{Repay}} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi\overbrace{(1 - F(\tilde{d}(\underline{\eta})))}^{Pr(Default)} & \text{if } \chi \leq \tilde{\chi}^{\dagger}(\underline{\eta}) \\ \overbrace{(1 - F(\tilde{d}(\underline{\eta})))}^{Pr(Default)}\chi + \int_{\underbrace{\theta \leq \tilde{\theta}^{\dagger}(\underline{\eta})}_{Repay}} \theta(e^{\alpha(l+p(l))} - 1)dF & \\ + \int_{\underbrace{\tilde{\theta}^{\dagger}(\underline{\eta}) \leq \theta \leq \tilde{d}(\underline{\eta})}_{Reborrow}} [\theta(e^{\alpha p(l)} - 1) + \delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))]dF & \text{if } \chi > \tilde{\chi}^{\dagger}(\underline{\eta}) \end{cases} \tag{133}$$

$$B_2(\tilde{r}(\underline{\eta}), \tilde{r}(\bar{\eta})) = \begin{cases} \int_{\underbrace{\theta \leq \tilde{d}(\bar{\eta})}_{Repay}} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi\overbrace{(1 - F(\tilde{d}(\bar{\eta})))}^{Pr(Default)} & \text{if } \chi \leq \tilde{\chi}^{\dagger}(\bar{\eta}) \\ \overbrace{(1 - F(\tilde{d}(\bar{\eta})))}^{Pr(Default)}\chi + \int_{\underbrace{\theta \leq \tilde{\theta}^{\dagger}(\bar{\eta})}_{Repay}} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF & \\ + \int_{\underbrace{\tilde{\theta}^{\dagger}(\bar{\eta}) \leq \theta \leq \tilde{d}(\bar{\eta})}_{Reborrow}} [(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))]dF & \text{if } \chi > \tilde{\chi}^{\dagger}(\bar{\eta}) \end{cases} \tag{134}$$

The solution is a fixed point of $B = (B_1, B_2)$: $B_1(\tilde{r}) = \tilde{r}(\underline{\eta})$, $B_2(\tilde{r}) = \tilde{r}(\bar{\eta})$. For a given set of parameters χ, q, a, and b and $\bar{\eta}$, we can solve Equations (133) and (134) by plugging in Equations (119), (120), (123), and (124) into Equations (133) and (134), which gives a set of two equations in two unknowns for each of the three cases (i) $\tilde{d}(\underline{\eta}) < \tilde{\theta}^{\dagger}(\underline{\eta})$, $\tilde{d}(\bar{\eta}) < \tilde{\theta}^{\dagger}(\bar{\eta})$, or (ii) $\tilde{d}(\underline{\eta}) > \tilde{\theta}^{\dagger}(\underline{\eta})$, $\tilde{d}(\bar{\eta}) < \tilde{\theta}^{\dagger}(\bar{\eta})$, or (iii) $\tilde{d}(\underline{\eta}) > \tilde{\theta}^{\dagger}(\underline{\eta})$, $\tilde{d}(\bar{\eta}) > \tilde{\theta}^{\dagger}(\bar{\eta})$. We solve for the parameters in each case, and then check whether the solution satisfies the condition of that case. As shown in Theorem 1, the solution is unique.

Once $\tilde{r}(\underline{\eta})$ and $\tilde{r}(\bar{\eta})$ are computed, we can immediately back out $\tilde{\theta}^{\dagger}(\underline{\eta}), \tilde{\theta}^{\dagger}(\bar{\eta}), \tilde{d}(\underline{\eta}), \tilde{d}(\bar{\eta})$ from Equations (119), (120), (123), and (124).

G.1.2 Actual Loan Repayment Behavior

Now actual behavior can be obtained by replacing $\tilde{\beta}$ with β in the preceding equations and is given as follows:

1. When $\eta_t = \underline{\eta}$: (a) if $\chi > \chi^{\dagger}(\underline{\eta})$, the person defaults if $\theta_t > d(\underline{\eta})$, repays that period if $\theta_t \leq \theta^{\dagger}(\underline{\eta})$, and otherwise just continues on to period t after only paying the fee $p(l)$. (b) if $\chi \leq \chi^{\dagger}(\underline{\eta})$, the person defaults if $\theta_t > d(\underline{\eta})$ and repays that period if $\theta_t \leq d(\underline{\eta})$.
2. When $\eta_t = \bar{\eta}$: (a) if $\chi \leq \chi^{\dagger}(\bar{\eta})$, the person defaults if $\theta_t > d(\bar{\eta})$ and repays that period if $\theta_t \leq d(\bar{\eta})$. (a) if $\chi > \chi^{\dagger}(\bar{\eta})$, the person defaults if $\theta_t > d(\bar{\eta})$, repays that period if $\theta_t \leq \theta^{\dagger}(\bar{\eta})$, and otherwise just continues on to period t after only paying the fee $p(l)$.

Where (all derivations are the same as before, but with β replacing $\tilde{\beta}$):

$$\theta^{\dagger}(\underline{\eta}) = \frac{\beta\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \tag{135}$$

$$\theta^{\dagger}(\bar{\eta}) = \frac{\beta\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} - \bar{\eta} \tag{136}$$

$$d(\underline{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} & \text{if } \chi \leq \chi^{\dagger}(\underline{\eta}) \\ \frac{\chi - \beta\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha p(l)}-1} & \text{if } \chi > \chi^{\dagger}(\underline{\eta}) \end{cases} \tag{137}$$

$$d(\bar{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} - \bar{\eta} & \text{if } \chi \leq \chi^{\dagger}(\bar{\eta}) \\ \frac{\chi - \beta\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha p(l)}-1} - \bar{\eta} & \text{if } \chi > \chi^{\dagger}(\bar{\eta}) \end{cases} \tag{138}$$

$$\chi^{\dagger}(\underline{\eta}) = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \beta\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right) \tag{139}$$

$$\chi^{\dagger}(\bar{\eta}) = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \beta\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right) \tag{140}$$

G.1.3 Objective Function for Taking Out a Loan

In period 0, the person's perceived cost of taking out the loan is $\tilde{r}(l, \eta)$, and thus the person chooses l to maximize one of the following two objective functions

$$\max_{l \in [0,\bar{l}]} \beta\left[1 - \nu e^{-\alpha l} - \tilde{C}(l)\right] \tag{141}$$

$$\max_{l \in [0,\bar{l}]} 1 - \nu e^{-\alpha l} - \beta\tilde{C}(l), \tag{142}$$

where $\tilde{C}(l) = q\tilde{r}(l, \underline{\eta}) + (1-q)\tilde{r}(l, \bar{\eta})$. The first objective function corresponds to the benefits of the loan being realized in the future (e.g., car repair), while the second objective function corresponds to the loan being used for immediate consumption.

G.1.4 Borrower Welfare

We adopt the time $t = 0$ criterion to compute borrower welfare. The decision rule in sub-section G.1.2 leads to the following equations for the continuation value function, where $d(\eta)$ and $\theta^\dagger(\eta)$ are as defined in that sub-section:

$$r(\underline{\eta}) = \begin{cases} \int_{\theta \le d(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\underline{\eta}))) & \text{if } \chi \le \chi^\dagger(\underline{\eta}) \\ (1 - F(d(\underline{\eta})))\chi + \int_{\theta \le \theta^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF & \\ + \int_{\theta^\dagger(\underline{\eta}) \le \theta \le d(\underline{\eta})} [\theta(e^{\alpha p(l)} - 1) + \delta(qr(\underline{\eta}) + (1-q)r(\bar{\eta}))]dF & \text{if } \chi > \chi^\dagger(\underline{\eta}) \end{cases} \tag{143}$$

$$r(\bar{\eta}) = \begin{cases} \int_{\theta \le d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\bar{\eta}))) & \text{if } \chi \le \chi^\dagger(\bar{\eta}) \\ (1 - F(d(\bar{\eta})))\chi + \int_{\theta \le \theta^\dagger(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF & \\ + \int_{\theta^\dagger(\bar{\eta}) \le \theta \le d(\bar{\eta})} [(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \delta(qr(\bar{\eta}) + (1-q)r(\underline{\eta}))]dF & \text{if } \chi > \chi^\dagger(\bar{\eta}) \end{cases} \tag{144}$$

So once we know $d(\eta)$ and $\theta^\dagger(\eta)$, we just have two linear equations in two unknowns that we can immediately use to solve for $r(\underline{\eta})$ and $r(\bar{\eta})$. Note that $\chi^\dagger(\underline{\eta}) \le \chi^\dagger(\bar{\eta})$, because $\tilde{r}(\underline{\eta}) \le \tilde{r}(\bar{\eta})$. To see how to solve this linear system of equations, define constants

$$A \equiv \int_{\theta \le d(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\underline{\eta}))), \tag{145}$$

$$B \equiv (1 - F(d(\underline{\eta})))\chi + \int_{\theta \le \theta^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^\dagger(\underline{\eta}) \le \theta \le d(\underline{\eta})} \theta(e^{\alpha p(l)} - 1)dF, \tag{146}$$

$$C \equiv \delta q[F(d(\underline{\eta})) - F(\theta^\dagger(\underline{\eta}))], \tag{147}$$

$$D \equiv \delta(1-q)[F(d(\underline{\eta})) - F(\theta^\dagger(\underline{\eta}))]. \tag{148}$$

Then, if $\chi \le \chi^\dagger(\underline{\eta})$, note that:

$$r(\underline{\eta}) = \int_{\theta \le d(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\underline{\eta}))) = A. \tag{149}$$

If $\chi > \chi^{\dagger}(\underline{\eta})$, note that:

$$\begin{aligned} r(\underline{\eta}) &= (1 - F(d(\underline{\eta})))\chi + \int_{\theta \leq \theta^{\dagger}(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^{\dagger}(\underline{\eta}) \leq \theta \leq d(\underline{\eta})} \theta(e^{\alpha p(l)} - 1)dF \\ &+ \delta q[F(d(\underline{\eta})) - F(\theta^{\dagger}(\underline{\eta}))]r(\underline{\eta}) + \delta(1-q)[F(d(\underline{\eta})) - F(\theta^{\dagger}(\underline{\eta}))]r(\bar{\eta}) \\ &= B + Cr(\underline{\eta}) + Dr(\bar{\eta}). \end{aligned} \tag{150}$$

Define constants

$$G \equiv \int_{\theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\bar{\eta}))) \tag{151}$$

$$H \equiv (1 - F(d(\bar{\eta})))\chi + \int_{\theta \leq \theta^{\dagger}(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^{\dagger}(\bar{\eta}) \leq \theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha p(l)} - 1)dF \tag{152}$$

$$I \equiv \delta q[F(d(\bar{\eta})) - F(\theta^{\dagger}(\bar{\eta}))] \tag{153}$$

$$J \equiv \delta(1-q)[F(d(\bar{\eta})) - F(\theta^{\dagger}(\bar{\eta}))]. \tag{154}$$

Then, if $\chi \leq \chi^{\dagger}(\bar{\eta})$, note that:

$$r(\bar{\eta}) = \int_{\theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\bar{\eta}))) = G. \tag{155}$$

If $\chi > \chi^{\dagger}(\bar{\eta})$, note that:

$$\begin{aligned} r(\bar{\eta}) &= (1 - F(d(\bar{\eta})))\chi + \int_{\theta \leq \theta^{\dagger}(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^{\dagger}(\bar{\eta}) \leq \theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha p(l)} - 1)dF \\ &+ \delta q[F(d(\bar{\eta})) - F(\theta^{\dagger}(\bar{\eta}))]r(\bar{\eta}) + \delta(1-q)[F(d(\bar{\eta})) - F(\theta^{\dagger}(\bar{\eta}))]r(\underline{\eta}) \\ &= H + Ir(\bar{\eta}) + Jr(\underline{\eta}). \end{aligned} \tag{156}$$

So, if $\chi \leq \chi^{\dagger}(\underline{\eta}) \leq \chi^{\dagger}(\bar{\eta})$, we get the system:

$$r(\underline{\eta}) = A$$

$$r(\bar{\eta}) = G$$

If $\chi^{\dagger}(\underline{\eta}) < \chi \leq \chi^{\dagger}(\bar{\eta})$, we get the system:

$$(1 - C)r(\underline{\eta}) - Dr(\bar{\eta}) = B$$

$$r(\bar{\eta}) = G$$

And, if $\chi^{\dagger}(\underline{\eta}) \leq \chi^{\dagger}(\bar{\eta}) < \chi$, we get the system:

$$(1 - C)r(\underline{\eta}) - Dr(\bar{\eta}) = B$$

$$-Jr(\underline{\eta}) + (1 - I)r(\bar{\eta}) = H$$

Each system is easily solved.

Once we have $r(\underline{\eta})$ and $r(\bar{\eta})$, actual borrower welfare is going to be

$$E_{\nu}\left[1 - \nu e^{-\alpha l^{*}(\nu)} - C(l)\right] \tag{157}$$

where $C(l) = qr(l, \underline{\eta}) + (1 - q)r(l, \bar{\eta})$ and $l^{*}(\nu)$ is the loan size given a realization of ν, and where we just set $r \equiv 0$ when $l^{*}(\nu) = 0$.

G.2 $T < \infty$

We use backwards induction to solve the finite-horizon model.

In period T, the agent must either repay or default. The cost of repaying is $(\theta_T + \eta)(e^{\alpha(l+p(l))} - 1)$ and the cost of defaulting is χ. Thus, the agent repays if

$$(\theta_T + \eta)(e^{\alpha(l+p(l))} - 1) \leq \chi$$

$$\theta_T \leq \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \eta. \tag{158}$$

This gives us the cutoffs

$$d_T(\underline{\eta}) = \tilde{d}_T(\underline{\eta}) = \frac{\chi}{e^{\alpha(l+p(l))} - 1} \tag{159}$$

$$d_T(\bar{\eta}) = \tilde{d}_T(\bar{\eta}) = \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \bar{\eta}. \tag{160}$$

Which gives us the expected costs

$$r_T(\underline{\eta}) = \tilde{r}_T(\underline{\eta}) = (1 - F(d_T(\underline{\eta})))\chi + \int_{\theta \leq d_T(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF \tag{161}$$

$$r_T(\bar{\eta}) = \tilde{r}_T(\bar{\eta}) = (1 - F(d_T(\bar{\eta})))\chi + \int_{\theta \leq d_T(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF. \tag{162}$$

Note that we can calculate these directly once we have the calibrated parameters of the model (which we'll get from calibrating the infinite-time model).

In period $T - 1$, the agent has the option to repay, reborrow, or default, as in the infinite-horizon model. The recursive formulas in section G.1 for the perceived and actual cutoffs and expected costs hold here, as well. We plug in $r_T(\underline{\eta})$ and $r_T(\bar{\eta})$ into the right-hand side of Equations (119),(120),(123),(124) to derive the perceived cutoffs in $T-1$, which we then use to calculate $\tilde{r}_{T-1}$ using Equations (133) and (134) and $\tilde{r}_T$. From this we obtain the actual period $T-1$ cutoffs using Equations (135),(136),(137), and (138), which then give us r_{T-1} through the recursion

$$r_{t-1}(\underline{\eta}) = \begin{cases} \int_{\theta \le d_t(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d_t(\underline{\eta}))) & \text{if } \chi \le \chi^\dagger(\underline{\eta}) \\ (1 - F(d(_t\underline{\eta})))\chi + \int_{\theta \le \theta_t^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF & \\ + \int_{\theta_t^\dagger(\underline{\eta}) \le \theta \le d_t(\underline{\eta})} [\theta(e^{\alpha p(l)} - 1) + \delta(q r_t(\underline{\eta}) + (1-q) r_t(\bar{\eta}))]dF & \text{if } \chi > \chi^\dagger(\underline{\eta}) \end{cases} \tag{163}$$

$$r_{t-1}(\bar{\eta}) = \begin{cases} \int_{\theta \le d_t(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d_t(\bar{\eta}))) & \text{if } \chi \le \chi^\dagger(\bar{\eta}) \\ (1 - F(d_t(\bar{\eta})))\chi + \int_{\theta \le \theta_t^\dagger(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF & \\ + \int_{\theta_t^\dagger(\bar{\eta}) \le \theta \le d_t(\bar{\eta})} [(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \delta(q r_t(\bar{\eta}) + (1-q) r_t(\underline{\eta}))]dF & \text{if } \chi > \chi^\dagger(\bar{\eta}) \end{cases} \tag{164}$$

We then use $\tilde{r}_{T-1}(\underline{\eta})$, $r_{T-1}(\underline{\eta})$, $\tilde{r}_{T-1}(\bar{\eta})$, and $r_{T-1}(\bar{\eta})$ to calculate $\tilde{r}_{T-2}(\underline{\eta})$, $r_{T-2}(\underline{\eta})$, $\tilde{r}_{T-2}(\bar{\eta})$, and $r_{T-2}(\bar{\eta})$. We continue this recursion until we have calculated $\tilde{r}_1(\underline{\eta})$, $r_1(\underline{\eta})$, $\tilde{r}_1(\bar{\eta})$, and $r_1(\bar{\eta})$.

If $\tilde{C}(l) = q\tilde{r}_1(l, \underline{\eta}) + (1-q)\tilde{r}_1(l, \bar{\eta})$ and $C(l) = q r_1(l, \underline{\eta}) + (1-q) r_1(l, \bar{\eta})$, then the agent solves either Equation (141) or Equation (142) and we can calculate welfare as $E_\nu \left[1 - \nu e^{-\alpha l^*(\nu)} - C(l)\right]$, where $l^*(\nu)$ is the loan size given a realization of ν, and where we just set $r \equiv 0$ when $l^*(\nu) = 0$.

G.3 Learning

In period 0, the agent thinks they'll act with $\tilde{\beta} = \tilde{\beta}_0$ in all future periods. Thus, we can calculate $\tilde{C}(l)$ as in section G.1.1, but with $\tilde{\beta} = \tilde{\beta}_0$. In period $t = 4$, the agent has $\tilde{\beta} = \beta$. By setting $\tilde{\beta} = \beta$, we can calculate $r(\underline{\eta})$ and $r(\bar{\eta})$ as in section G.1. Call these $r_4(\underline{\eta})$ and $r_4(\bar{\eta})$.

Now consider period $t = 3$. In this period, the agent thinks that they'll have $\tilde{\beta} = \tilde{\beta}_0$ in period 4 and onwards. Thus, we can use our fixed-point solutions for $\tilde{r}(\underline{\eta})$ and $\tilde{r}(\bar{\eta})$ to calculate the actual cutoffs (using the formulas in section G.1.2). Then, we can use these actual cutoffs, $r_4(\underline{\eta})$, and $r_4(\bar{\eta})$ to calculate $r_3(\underline{\eta})$ and $r_3(\bar{\eta})$ (using the formulas in section G.1.2).

We can continue in this way to calculate $r_2(\underline{\eta})$ and $r_2(\bar{\eta})$ and then again to calculate $r_1(\underline{\eta})$ and $r_1(\bar{\eta})$. With those in hand, we have $C(l)$ for welfare purposes.

G.4 Details on Numerical Procedures

As described in Section 7.3, we calibrate our parametric model of borrowing and repayment in two steps. In the first step, we calibrate the scale parameters of the beta distribution and the transition probability $1 - q$ to match the empirical rate of reborrowing (0.8) and the empirical default rate (0.028) respectively. In the second step, we calibrate the distribution of $\nu \sim lognormal(\mu_\nu, \sigma_\nu^2)$ to match the empirical mean (393) and standard deviation (132) of loan sizes.

Our first step calibration procedure is as follows: first, given a choice of scale parameters of the beta distribution, the coefficient of absolute risk aversion α_1, the transition probability, and the free variables χ and $\bar{\eta}$, we can solve the continuation values $\tilde{r}(\underline{\eta})$ and $\tilde{r}(\bar{\eta})$ for any loan amount l by substituting Equations (119) - (126) into Equations (133) and (134), producing a system of two equations with two unknowns. We then solve this system via fixed point iteration. Given a simulated borrower's loan amount and the corresponding perceived continuation values, we next simulate actual reborrowing behavior as described in Section G.1.2: in the initial period, borrowers have probability $1-q$ of being in state $\bar{\eta}$. After receiving a θ_t draw, borrowers can either repay, reborrow, or default, with the associated cutoff values coming from plugging the perceived continuation values into Equations (135) - (138). If borrowers do not repay or default, they switch states with probability $1-q$ and receive a new θ_t draw. This process repeats until the borrower repays or defaults, thus simulating an entire borrowing history given an initial choice of l.

To draw the loan amounts we use for the first-stage calibration, we sample 10,000 empirical loans from data provided by the Lender. We restrict our sample to the 11 states which have a loan cap between \$450 and \$550 and to loans that were originated in 2017, resulting in approximately $104,000$ loans that we sample from.[31] For each of the 10,000 loan amounts, we then simulate the entire borrowing history to estimate the simulated reborrowing and default rate.

To calibrate the parameters of the beta distribution, we first fix a given choice of the second scale parameter of the beta distribution and then successively refine a grid search over the first scale parameter of the beta distribution until our simulated reborrowing and default rates match their empirical counterparts. The grid search procedure is as follows: we start by searching over the first scale parameter in a grid of steps of size 0.5, ranging from 0 to 30. We then pick the interval that is closest to the empirical reborrowing probability and search in that interval in steps of size 0.1. As discussed in Section 7.3, when simulating reborrowing decisions, we assume that borrowers have an $\alpha_1 = 0.002$. We calibrate θ making three different assumptions: (1) for our primary estimates, we assume that $(\tilde{\beta}, \beta) = (0.77, 0.74)$ (corresponding to the $(\tilde{\beta}, \beta)$ we estimate when assuming $\alpha = 0.002$) and $\theta \sim Beta(a_\theta, 1)$, (2) for our bimodal estimates, we assume that $(\tilde{\beta}, \beta) = (0.77, 0.74)$ and $\theta \sim Beta(a_\theta, 0.02)$, and (3) for our expert forecasts, we assume that $(\tilde{\beta}, \beta) = (0.86, 0.63)$ (corresponding to the $(\tilde{\beta}, \beta)$ implied by our expert survey) and $\theta \sim Beta(a_\theta, 1)$.

Our second step calibration procedure is as follows: we calibrate the distribution of $\nu \sim Lognormal(\mu_\nu, \sigma_\nu^2)$ to match the empirical mean and standard deviation of loan sizes. Given a draw ν and a value of α_0, we find each simulated borrower's optimal loan size l^*, with a maximum loan size of \$500 to match the fact that our empirical data is drawn from states with loan size caps around \$500. We make four different assumptions about the value of α_0: $0.0002, 0.0005, 0.002$, or 0.0064. We then solve for (μ_ν, σ_ν^2) using the Nelder-Mead algorithm.

To estimate welfare under different policy counterfactuals and different values of α_0, we first

[31] There are 16 states which have a loan cap between \$450 and \$550: Alabama, Alaska, Colorado, Florida, Hawaii, Indiana, Iowa, Kansas, Kentucky, Mississippi, Missouri, North Dakota, Oklahoma, Rhode Island, South Carolina, and Virginia. However, our Lender does not have lending data in Alaska, Colorado, Hawaii, North Dakota, or Rhode Island, leading to our sample of 11 states.

draw 50,000 values of ν using the calibrated parameters above. For our baseline infinite horizon, no learning model, we back out the perceived continuation values again by substituting Equations (119) - (126) into Equations (133) and (134) and solving via fixed point iteration. To solve for the actual costs $C(l)$, we follow Section G.1.4. Each of the 50,000 simulated borrowers then choose an $l^* \in [0, \bar{l}]$ that solves Equation (141). With each borrower's choice of of l^* and associated cost $C(l^*)$, we estimate average borrower welfare using Equation (157).

When estimating welfare under a rollover restriction, we instead solve for $\tilde{C}(l)$ and $C(l)$ by backwards induction as described in Section G.2. This allows us to solve each borrower's choice of l^* using Equation (141) and calculate welfare as in Equation (157).

When estimating welfare assuming learning, we assume that borrowers have a constant $\beta = 0.74$. In periods 1 - 3, borrowers are partially naive and have a $\tilde{\beta} = \tilde{\beta}_0$. We compute $\tilde{\beta}_0$ by using the estimate of naivete among the subset of new borrowers who participated in our field experiment, where a new borrower is defined as a borrower who took out less than 4 payday loans from the Lender in the 6 months prior to the start date of our experiment. $\tilde{\beta}_0$ is then calculated as β divided by the estimated naivete of new borrowers, which in our primary estimates results in $\tilde{\beta}_0 = 0.88$. After period $t = 4$, borrowers become perfectly sophisticated. Using these parameters, we then compute the perceived and actual costs of borrowing. The process of computing $\tilde{C}(l)$ is the same as in the infinite-horizon case. To calculate $C(l)$, we follow the procedure described in Section G.3. In the fourth-period, since borrowers are sophisticated, the actual continuation values are equal to the perceived continuation values. Substituting the perceived continuation values into Equations (135) - (138) yields the actual cutoffs, which we can plug into the recursion in Equations (163)-(164) to yield the third period actual continuation values. Recursively repeating this process yields $C(l)$. Once we compute $\tilde{C}(l)$ and $C(l)$ for every l, we again solve each borrower's choice of l^* using Equation (141) and calculate welfare as in Equation (157).

When estimating welfare assuming heterogeneous borrowers using our primary estimates of $(\tilde{\beta}, \beta)$, we assume that 50% of borrowers are perfectly time consistent and that 50% of borrowers have $(\tilde{\beta}, \beta) = (0.53, 0.48)$ such that the average $(\tilde{\beta}, \beta)$ equals $(0.77, 0.74)$. Aggregate welfare in the heterogeneous case is thus the average of welfare for time-consistent borrowers and partially-naive borrowers. When estimating welfare assuming heterogeneous borrowers using experts' forecasts of $(\tilde{\beta}, \beta)$, we again assume that 50% of borrowers are perfectly time consistent and that 50% of borrowers have $(\tilde{\beta}, \beta) = (0.73, 0.26)$ such that the average $(\tilde{\beta}, \beta)$ equals experts' forecasts $(0.86, 0.63)$.

H Additional Simulation Results

Table A6 presents the results of our calibrations at our empirical estimates of β and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 1)$. Table A7 presents the results of our calibrations at our empirical estimates of β and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 0.02)$. Table A8 presents the results of our calibrations using experts' forecasts of β and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 1)$. For our expert opinion calibration, we use the $\tilde{\beta} = 0.86$ forecasted by the average expert. We also estimate $\beta/\tilde{\beta} = 0.73$ by inserting experts' average forecast of borrower misprediction into Equation (15). We then back out the implied expert opinion of $\beta = 0.63$.

Tables A9 and A10 present the welfare estimates for $\alpha_0 = 0.0064$ and $\alpha_0 = 0.0005$, respectively, using our empirical estimates of β and $\tilde{\beta}$ and assuming $\theta \sim Beta(a_\theta, 1)$. Tables A11 - A14 present the welfare estimates for different values of α_0, using our empirical estimates of β and $\tilde{\beta}$ and assuming $\theta \sim Beta(a_\theta, 0.02)$. Lastly, Tables A15 - A18 present the welfare estimates for different values of α_0, using experts' forecasts of β and $\tilde{\beta}$ and assuming $\theta \sim Beta(a_\theta, 1)$.

Examining how the welfare costs of present focus change when we calibrate the model using experts' forecasts of β and $\tilde{\beta}$, column 1 of row 4 in Panel (b) of Table A16 shows that the welfare costs of present focus at experts' forecasted parameters are only 6 percent of time-consistent borrowers' surplus. Furthermore, the basic pattern of policy impacts is very similar to Panel (a) of Table 5: bans and loan size caps significantly reduce welfare, and in this case even a rollover restriction has a slightly negative effect.

Table A6: **Calibrated Parameters: Empirical Estimates,** $\theta \sim Beta(a_\theta, 1)$

Parameter	(1) $\alpha_0 = 0.0064$	(2) $\alpha_0 = 0.002$	(3) $\alpha_0 = 0.0005$	(4) $\alpha_0 = 0.0002$
$E[\theta]$	0.83	0.83	0.83	0.83
$Var[\theta]$	0.020	0.020	0.020	0.020
$E[\nu]$	2.86	1.99	2.69	3.46
$Var[\nu]$	3.91	0.92	0.41	0.31

Notes: This table presents the calibrated parameters for additional simulations using our empirical estimates of β and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 1)$.

Table A7: **Calibrated Parameters: Empirical Estimates,** $\theta \sim Beta(a_\theta, 0.02)$

Parameter	(1) $\alpha_0 = 0.0064$	(2) $\alpha_0 = 0.002$	(3) $\alpha_0 = 0.0005$	(4) $\alpha_0 = 0.0002$
$E[\theta]$	0.82	0.82	0.82	0.82
$Var[\theta]$	0.134	0.134	0.134	0.134
$E[\nu]$	2.11	1.21	1.90	2.50
$Var[\nu]$	3.23	0.53	0.16	0.86

Notes: This table presents the calibrated parameters for additional simulations using our empirical estimates of β and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 0.02)$.

Table A8: **Calibrated Parameters: Expert Forecasts,** $\theta \sim Beta(a_\theta, 1)$

Parameter	(1) $\alpha_0 = 0.0064$	(2) $\alpha_0 = 0.002$	(3) $\alpha_0 = 0.0005$	(4) $\alpha_0 = 0.0002$
$E[\theta]$	0.64	0.64	0.64	0.64
$Var[\theta]$	0.060	0.060	0.060	0.060
$E[\nu]$	2.30	1.43	2.16	2.62
$Var[\nu]$	3.63	0.85	1.08	2.39

Notes: This table presents the calibrated parameters for additional simulations using experts' beliefs about β and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 1)$.

Table A9: **Calibrated Using Empirical Estimates of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0064$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	398	0.42	481
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	393	0.78	610
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	410	0.79	640
4	Heterogeneous	390	0.66	678
5	$\beta = 0.74, \tilde{\beta} = 1$	398	0.85	714
6	$\beta = 0.74, \tilde{\beta} = 0.74$	392	0.76	593
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	397	0.83	679
8	Primary, heterogeneous, learning, consume in $t = 0$	409	0.68	899
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	396	0.91	899
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	420	0.91	955

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	96.9%	100.0%	99.5%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	99.6%	96.6%	99.8%	99.1%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	99.6%	96.5%	99.7%	99.0%
4	Heterogeneous	99.1%	96.1%	99.7%	98.4%
5	$\beta = 0.74, \tilde{\beta} = 1$	99.2%	96.2%	99.7%	98.5%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	99.7%	96.6%	99.8%	99.1%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	99.5%	96.5%	99.7%	98.9%
8	Primary, heterogeneous, learning, consume in $t = 0$	99.1%	96.2%	99.7%	98.4%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	98.2%	95.4%	99.6%	97.2%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	98.0%	95.3%	99.5%	97.0%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0064$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table A10: **Calibrated Using Empirical Estimates of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0005$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	409	0.43	495
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	394	0.78	611
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	440	0.79	692
4	Heterogeneous	382	0.67	653
5	$\beta = 0.74, \tilde{\beta} = 1$	409	0.85	735
6	$\beta = 0.74, \tilde{\beta} = 0.74$	391	0.76	591
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	404	0.83	693
8	Primary, heterogeneous, learning, consume in $t = 0$	435	0.69	979
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	403	0.91	917
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	464	0.91	1064

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	89.6%	99.6%	88.7%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	91.0%	82.4%	94.2%	79.2%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	88.9%	81.2%	92.5%	76.2%
4	Heterogeneous	80.5%	73.5%	94.0%	67.9%
5	$\beta = 0.74, \tilde{\beta} = 1$	80.0%	73.7%	93.5%	66.5%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	92.6%	83.7%	94.3%	80.9%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	89.0%	80.7%	93.8%	75.7%
8	Primary, heterogeneous, learning, consume in $t = 0$	76.9%	72.6%	90.5%	60.3%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	57.3%	55.1%	90.6%	39.6%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	46.2%	49.2%	86.5%	21.8%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0005$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table A11: **Calibrated Using Empirical Estimates of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.0064$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	393	0.79	612
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	393	0.80	621
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	411	0.80	658
4	Heterogeneous	393	0.80	627
5	$\beta = 0.74, \tilde{\beta} = 1$	393	0.79	617
6	$\beta = 0.74, \tilde{\beta} = 0.74$	393	0.80	623
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	393	0.80	626
8	Primary, heterogeneous, learning, consume in $t = 0$	392	0.80	630
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	393	0.81	632
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	421	0.80	672

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	97.0%	98.4%	97.9%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	100.0%	97.0%	98.3%	97.9%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	99.9%	97.0%	98.3%	97.8%
4	Heterogeneous	99.9%	97.0%	98.3%	97.8%
5	$\beta = 0.74, \tilde{\beta} = 1$	100.0%	97.0%	98.3%	97.9%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	100.0%	97.0%	98.3%	97.9%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	100.0%	97.0%	98.3%	97.9%
8	Primary, heterogeneous, learning, consume in $t = 0$	99.7%	96.8%	98.1%	97.6%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	99.9%	97.0%	98.3%	97.8%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	99.9%	96.9%	98.2%	97.7%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.0064$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table A12: **Calibrated Using Empirical Estimates of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.002$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	393	0.79	612
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	393	0.80	620
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	434	0.80	696
4	Heterogeneous	392	0.80	625
5	$\beta = 0.74, \tilde{\beta} = 1$	393	0.80	617
6	$\beta = 0.74, \tilde{\beta} = 0.74$	393	0.80	622
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	393	0.80	625
8	Primary, heterogeneous, learning, consume in $t = 0$	377	0.80	606
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	393	0.81	631
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	452	0.80	721

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	93.3%	82.1%	76.6%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	99.7%	93.0%	81.9%	76.0%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	98.7%	92.4%	80.0%	74.0%
4	Heterogeneous	99.3%	92.7%	81.7%	75.6%
5	$\beta = 0.74, \tilde{\beta} = 1$	99.7%	93.0%	81.9%	76.0%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	99.7%	93.0%	81.9%	76.0%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	99.7%	93.0%	81.9%	76.0%
8	Primary, heterogeneous, learning, consume in $t = 0$	93.5%	89.3%	77.0%	69.5%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	99.4%	92.8%	81.6%	75.5%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	97.3%	91.6%	77.6%	71.1%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.002$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table A13: **Calibrated Using Empirical Estimates of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.0005$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	393	0.79	612
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	392	0.80	619
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	460	0.80	733
4	Heterogeneous	392	0.80	625
5	$\beta = 0.74, \tilde{\beta} = 1$	393	0.80	617
6	$\beta = 0.74, \tilde{\beta} = 0.74$	392	0.80	620
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	393	0.80	628
8	Primary, heterogeneous, learning, consume in $t = 0$	345	0.80	558
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	393	0.81	631
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	480	0.80	765

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	91.7%	58.9%	45.4%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	99.2%	91.0%	58.4%	44.1%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	94.9%	88.6%	49.3%	33.2%
4	Heterogeneous	98.2%	90.1%	58.0%	43.3%
5	$\beta = 0.74, \tilde{\beta} = 1$	99.2%	90.9%	58.4%	43.9%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	99.2%	91.0%	58.4%	44.1%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	99.2%	91.0%	58.4%	44.0%
8	Primary, heterogeneous, learning, consume in $t = 0$	77.7%	76.6%	37.3%	18.7%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	98.3%	90.2%	57.9%	43.0%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	90.6%	86.1%	38.3%	19.8%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.0005$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table A14: **Calibrated Using Empirical Estimates of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.0002$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	396	0.79	620
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	397	0.80	633
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	422	0.81	676
4	Heterogeneous	396	0.80	630
5	$\beta = 0.74, \tilde{\beta} = 1$	396	0.80	637
6	$\beta = 0.74, \tilde{\beta} = 0.74$	397	0.79	614
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	396	0.80	627
8	Primary, heterogeneous, learning, consume in $t = 0$	351	0.80	562
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	396	0.80	631
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	433	0.81	703

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	85.6%	71.7%	65.0%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	99.5%	85.2%	71.3%	64.2%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	96.5%	83.0%	66.9%	59.4%
4	Heterogeneous	99.0%	84.7%	71.1%	63.6%
5	$\beta = 0.74, \tilde{\beta} = 1$	99.5%	85.2%	71.3%	64.1%
6	$\beta = 0.74, \tilde{\beta} = 0.74$	99.5%	85.2%	71.3%	64.2%
7	$\beta = 0.74, \tilde{\beta}_0 = 0.88, \tilde{\beta}_1 = 0.74$ (learning)	99.5%	85.2%	71.3%	64.2%
8	Primary, heterogeneous, learning, consume in $t = 0$	84.7%	75.1%	59.0%	48.6%
9	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	99.0%	84.8%	71.0%	63.5%
10	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	92.3%	79.9%	61.0%	52.4%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 0.02)$ and $\alpha_0 = 0.0002$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 8 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Rows 4 and 8 model heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.74$, $\tilde{\beta}_0 = 0.88$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set β and $\tilde{\beta}$ to match expert forecasts.

Table A15: **Calibrated Using Experts' Forecasts of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0064$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	396	0.61	516
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	394	0.75	581
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	411	0.75	605
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	395	0.81	647
5	$\beta = 0.63, \tilde{\beta} = 1$	396	0.81	648
6	$\beta = 0.63, \tilde{\beta} = 0.63$	390	0.78	602
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	421	0.81	683
8	Heterogeneous expert β	394	0.77	815

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	97.0%	99.7%	99.2%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	99.8%	96.8%	99.6%	98.9%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	99.8%	96.8%	99.5%	98.9%
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	99.4%	96.5%	99.4%	98.4%
5	$\beta = 0.63, \tilde{\beta} = 1$	99.3%	96.4%	99.4%	98.4%
6	$\beta = 0.63, \tilde{\beta} = 0.63$	99.6%	96.7%	99.4%	98.7%
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	99.3%	96.4%	99.3%	98.3%
8	Expert heterogeneous β	97.4%	94.9%	99.2%	95.8%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0064$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 7 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 8 models heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 4. Rows 4 and 7 set β and $\tilde{\beta}$ to match expert forecasts.

Table A16: **Calibrated Using Experts' Forecasts of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.002$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	397	0.61	516
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	391	0.75	577
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	426	0.75	628
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	395	0.81	646
5	$\beta = 0.63, \tilde{\beta} = 1$	397	0.82	650
6	$\beta = 0.63, \tilde{\beta} = 0.63$	384	0.78	593
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	444	0.81	722
8	Heterogeneous expert β	393	0.77	810

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline ($500 cap)	(2) $400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	92.4%	97.2%	91.6%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	97.9%	90.8%	95.6%	89.3%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	97.2%	90.4%	94.9%	88.3%
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	93.7%	87.4%	93.9%	84.4%
5	$\beta = 0.63, \tilde{\beta} = 1$	93.2%	87.0%	93.8%	83.9%
6	$\beta = 0.63, \tilde{\beta} = 0.63$	96.1%	89.3%	94.2%	87.3%
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	91.5%	86.2%	91.9%	81.1%
8	Expert heterogeneous β	74.0%	71.0%	91.9%	59.8%

Notes: Panel (a) presents simulated borrowing behavior under a $500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a $500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.002$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 7 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 8 models heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 4. Rows 4 and 7 set β and $\tilde{\beta}$ to match expert forecasts.

Table A17: **Calibrated Using Experts' Forecasts of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0005$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	397	0.61	517
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	393	0.75	582
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	420	0.75	621
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	396	0.81	648
5	$\beta = 0.63, \tilde{\beta} = 1$	397	0.82	658
6	$\beta = 0.63, \tilde{\beta} = 0.63$	387	0.78	594
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	436	0.81	716
8	Heterogeneous expert β	394	0.77	808

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline (\$500 cap)	(2) \$400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	86.6%	96.4%	89.2%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	97.3%	84.5%	94.3%	86.2%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	96.2%	83.8%	93.1%	84.7%
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	91.9%	80.2%	92.0%	80.1%
5	$\beta = 0.63, \tilde{\beta} = 1$	91.3%	79.8%	92.0%	79.3%
6	$\beta = 0.63, \tilde{\beta} = 0.63$	95.0%	82.7%	92.5%	83.7%
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	88.3%	77.9%	88.9%	74.8%
8	Expert heterogeneous β	66.6%	59.9%	89.6%	49.2%

Notes: Panel (a) presents simulated borrowing behavior under a \$500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a \$500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0005$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 7 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 8 models heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 4. Rows 4 and 7 set β and $\tilde{\beta}$ to match expert forecasts.

Table A18: **Calibrated Using Experts' Forecasts of β and $\tilde{\beta}$:** $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0002$

(a) **Simulated Borrowing Behavior**

Row	Scenario	(1) Average loan size	(2) Probability of reborrowing	(3) Average amount repaid
1	$\beta = 1, \tilde{\beta} = 1$	395	0.61	516
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	392	0.74	576
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	412	0.75	608
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	394	0.81	646
5	$\beta = 0.63, \tilde{\beta} = 1$	395	0.81	651
6	$\beta = 0.63, \tilde{\beta} = 0.63$	389	0.78	602
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	421	0.81	695
8	Heterogeneous expert β	393	0.77	801

(b) **Borrower Welfare Under Payday Lending Regulation**

Row	Scenario	(1) Baseline (\$500 cap)	(2) \$400 cap	(3) Rollover restriction	(4) 25% fee
1	$\beta = 1, \tilde{\beta} = 1$	100.0%	83.9%	97.3%	91.9%
2	$\beta = 0.74, \tilde{\beta} = 0.77$ (primary estimates)	98.0%	82.3%	95.8%	89.7%
3	$\beta = 0.74, \tilde{\beta} = 0.77$, consume in $t = 0$	97.2%	81.7%	94.9%	88.6%
4	$\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast)	94.0%	79.2%	94.1%	85.2%
5	$\beta = 0.63, \tilde{\beta} = 1$	93.6%	78.8%	94.0%	84.6%
6	$\beta = 0.63, \tilde{\beta} = 0.63$	96.3%	81.0%	94.4%	87.8%
7	$\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$	91.0%	77.1%	91.6%	81.3%
8	Expert heterogeneous β	75.4%	64.4%	92.3%	62.1%

Notes: Panel (a) presents simulated borrowing behavior under a \$500 loan size cap. Panel (b) presents welfare estimates as a percent of the surplus that time-consistent borrowers derive from the availability of payday loans under a \$500 loan size cap. Both panels assume that $\theta \sim Beta(a_\theta, 1)$ and $\alpha_0 = 0.0002$. In Panel (b), "Rollover restriction" in column 3 refers to the requirement that borrowers repay by period $t = 3$ at the latest. "25% fee" in column 4 refers to an increase in the borrowing fee from 15% to 25%, which might be caused by substitution to higher-cost credit after a payday loan ban. Rows 3 and 7 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 8 models heterogeneity, where half the population is time-consistent and the other half has β and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 4. Rows 4 and 7 set β and $\tilde{\beta}$ to match expert forecasts.

I Survey Screenshots

Figure A16: **Introduction and Consent**

Introduction

This survey is part of a research collaboration between [Lender] and researchers at a group of universities: Stanford, Berkeley, NYU, and Dartmouth. Our goal is to learn more about payday loan customers.

The survey should take about 5-10 minutes. To thank you for your time, you will receive a $10 cash card after you finish all of the questions. You will also have the opportunity to earn an additional cash reward up to $160. About 40% of participants will be offered an additional reward. *Note that if you took the survey in 2018, you are eligible to take the survey again. You can only take the survey once in 2019. To participate, you must have taken out a payday loan from [Lender] in Indiana in the past 30 days. You will only be paid once for completing the survey.*

If you participate in this survey, the researchers will analyze data regarding your borrowing history provided by [Lender] and third-party data sources such as Veritec Solutions, LLC and/or Clarity Services. By participating in this survey, you permit Veritec Solutions and/or Clarity Services to share data, including data obtained from lenders, with the parties and third parties involved in this research project, including the company issuing payments for the research awards.

If you participate in the survey, your data will be confidential and will be used for research purposes only. Your individual answers will not be given to [Lender] and will not impact your ability to borrow from [Lender] or other lenders. De-identified data from this research project may be made publicly available for replication studies. All identifying information will be removed and we will maintain your privacy in all published and written data resulting from this study.

If you have any questions, you can contact the research team at mhorste@poverty-action.org or at PaydayResearch_Kim@stanford.edu. If you have any concerns or complaints about the research, please contact the Stanford Institutional Review Board at (650) 723-2480 or via email at IRB2-Manager@lists.stanford.edu. You can also write to the Innovations for Poverty Action Institutional Review Board at humansubjects@poverty-action.org.

Given the above information, do you wish to participate in the survey?

○ I want to participate! I hereby certify that by clicking this box and participating in the research survey, I have read and understood the information described above. Furthermore, I consent to and authorize the researchers to obtain information and data about me from the data sources listed above.

Figure A17: **Personal Information**

INTRODUCTION

Before we begin, we'd like to get a bit of background information. **Please answer carefully. If we can't match your information to your [Lender] borrowing records, we won't be able to process your survey rewards.**

First Name

Last Name

Date of birth (mm/dd/yyyy)

Email address

Figure A18: **Predictions about Future Borrowing**

FUTURE BORROWING

First, we'd like to ask your opinion about how likely you are to get another payday loan from any lender before **[8 weeks from now].**

We'd like you to give us a number from 0 to 100, where 0 means there is absolutely no chance and 100 means it's absolutely sure to happen.

For example, no one can ever be sure about tomorrow's weather, but if you think that rain is very unlikely tomorrow, you might say that there is 10% chance of rain. If you think that there is a very good chance that it will rain tomorrow, you might say that there is 80% chance of rain.

What do you think is the chance that you will get another payday loan from any lender before **[8 weeks from now]?**

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Choose one	○	○	○	○	○	○	○	○	○	○	○

Figure A19: **"$100 If You Are Debt-Free" Description**

FUTURE BORROWING

Imagine the computer selects you for the **$100 If You Are Debt-Free** reward. This would give you an incentive to avoid getting another payday loan. We would like to learn how much you think it would reduce your chance of getting another payday loan.

If you are selected for $100 If You Are Debt-Free, what is the chance that you would get another payday loan from any lender before [8 weeks from now]?

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Choose one	○	○	○	○	○	○	○	○	○	○	○

Reminders:

- Earlier, you told us that your chance of getting a payday loan before [8 weeks from now] WITHOUT **$100 If You Are Debt-Free** was 80%.
- If the computer selects you for **$100 If You Are Debt-Free**, we will send you $100 if you **do not** get another payday loan from [Lender] or *any other payday lender* before [8 weeks from now]. We would send you the money by [12 weeks from now] on a Visa cash card.
- Your answer to this question won't affect your chance of being selected for **$100 If You Are Debt-Free**, and we won't give this or your other answers to [Lender].

Figure A20: **Predictions about Future Borrowing with Incentive**

$100 IF YOU ARE DEBT-FREE

If you complete this survey, the computer may select you for an additional reward. The first possible reward is **$100 If You Are Debt-Free**.

If the computer selects you for **$100 If You Are Debt-Free**, we will send you $100 if you **do not** get another payday loan from [Lender] *or any other payday lender* before *[8 weeks from now].** We would send you the money by **[12 weeks from now]** on a Visa cash card.

Note: All payday lenders are required to report loans to a database. We will use that database to check your borrowing from all payday lenders.

We want to make sure we explained this clearly. Which of the following is true?

If the computer selects me for **$100 If You Are Debt-Free,** then:

- ○ If I don't get another payday loan from any lender before [8 weeks from now], I will receive a $100 Visa cash card by [12 weeks from now]
- ○ If I get another payday loan before [8 weeks from now] from Advance America, I will NOT receive the $100 Visa cash card.
- ○ If the database shows that I got another payday loan before [8 weeks from now] from another payday lender, I will NOT receive the $100 Visa cash card
- ○ All of the above

Figure A21: **"Money for Sure" Description**

WHICH REWARD DO YOU PREFER?

The second possible reward for completing this survey is simply **Money for Sure.** It is paid the same way as the **$100 If You Are Debt-Free**: we would send you the money by [12 weeks from now] on a Visa cash card.

Money For Sure is exactly what it sounds like: You get it for sure, REGARDLESS of whether or not you get another payday loan.

Figure A22: **Introduction to the Multiple Price List**

WHICH REWARD DO YOU PREFER?

Now you get to tell us how you would choose between **Money For Sure** and **$100 If You Are Debt-Free.**

Think carefully, because the computer may randomly select one of the following questions and give you what you chose in that question. Click here if you want more information on how the computer randomly selects questions.

Figure A23: **MPL Example 1**

How might you decide?

Earlier, you told us that you have a **40%** chance of getting another payday loan before [8 weeks from now] if you are selected for **$100 If You Are Debt-Free**. In other words, you would have a **60%** chance of being debt-free. So on average, **$100 If You Are Debt-Free** would earn you $60**.**

Given that, which reward would you prefer?

- ◯ **$60 For Sure**. This gives you certainty and avoids pressure to stay debt-free.
- ◯ **$100 If You Are Debt-Free**. This gives you extra motivation to stay debt-free.

Figure A24: **MPL Example 2**

WHICH REWARD DO YOU PREFER?

Now we are going to ask you a similar question, but for a different amount of **Money For Sure** that the computer has selected.

Which reward would you prefer?

- ◯ **$100 if You Are Debt-Free**. Given your chance of getting another payday loan, on average this earns you $20 less in rewards. This also gives you extra motivation to stay debt-free.
- ◯ **$80 For Sure**. Given your chance of getting another payday loan, on average this earns you $20 more in rewards. This also gives you certainty and avoids pressure to stay debt-free.

Figure A25: **MPL Example 3**

WHICH REWARD DO YOU PREFER?

Now we are going to ask you a similar question, but for a different amount of **Money For Sure** that the computer has selected.

Which reward would you prefer?

- ◯ **$100 if You Are Debt-Free**. Given your chance of getting another payday loan, on average this earns you $20 more in rewards. This also gives you extra motivation to stay debt-free.
- ◯ **$40 For Sure**. Given your chance of getting another payday loan, on average this earns you $20 less in rewards. This also gives you certainty and avoids pressure to stay debt-free.

Figure A26: **"Flip a Coin for $100" Description**

FLIP A COIN FOR $100

The third and final possible reward for completing this survey is **Flip a Coin for $100**. It is paid the same way as the other two rewards: we would send you the money by [12 weeks from now] on a Visa cash card.

If you're selected for **Flip a Coin for $100**, the computer will flip a (computerized) coin. You'll have a 50% chance of winning $100 and a 50% chance of winning nothing. So on average, **Flip a Coin for $100** would earn you $50.

Figure A27: **Introduction to Flip a Coin MPL**

FLIP A COIN FOR $100

Now you get to tell us how you would choose between **Money For Sure** and **Flip a Coin for $100.**

Think carefully, because the computer may randomly select one of the following questions and give you what you chose in that question. Click here if you want more information on how the computer randomly selects questions.

Figure A28: **Flip a Coin MPL Example 1**

FLIP A COIN FOR $100

Which reward would you prefer?

- ◯ **$50 For Sure**
- ◯ **Flip a Coin for $100**

Figure A29: **Flip a Coin MPL Example 2**

WHICH REWARD DO YOU PREFER?

Now we are going to ask you a similar question, but for a different amount of **Money For Sure**.

Which reward would you prefer?

- **$70 For Sure**
- **Flip a Coin for $100**

Figure A30: **Flip a Coin MPL Example 3**

WHICH REWARD DO YOU PREFER?

Now we are going to ask you a similar question, but for a different amount of **Money For Sure**.

Which reward would you prefer?

- **Flip a Coin for $100**
- **$30 For Sure**

Figure A31: **Final Questions**

FINAL QUESTIONS

We have three final questions.

To what extent would you like to give yourself extra motivation to avoid payday loan debt in the future?

- ○ Very much
- ○ Somewhat
- ○ Not at all

In the past, how has your expected payday loan usage lined up with reality?

- ○ I usually ended up getting payday loans less often than I expected
- ○ I usually ended up getting payday loans about as often as I expected
- ○ I usually ended up getting payday loans more often than I expected

Some states have laws that prohibit people from taking out payday loans more than three paydays in a row. Do you think such a law would be good or bad for you?

- ○ Very good
- ○ Somewhat good
- ○ Neutral
- ○ Somewhat bad
- ○ Very bad

J Expert Survey Screenshots

Figure A32: **Introduction**

Consent Form

This survey is a part of a study by Hunt Allcott (NYU), Joshua Kim (Stanford), Dmitry Taubinsky (UC Berkeley), and Jonathan Zinman (Dartmouth). The goal of the survey is to get a sense of what academics' prior beliefs are about whether payday loan regulation may be welfare enhancing, and the degree to which borrowers may or may not be making mistakes. The survey should take about 3 minutes. Participation is voluntary and your data will be used for research purposes only.

We will be happy to email you the results of this survey and a copy of our completed manuscript.

This survey is part of a study by Hunt Allcott (NYU), Josh Kim (Stanford), Dmitry Taubinsky (UC Berkeley) and Jonathan Zinman (Dartmouth). Feel free to email Dmitry with any questions or concerns (dmitry.taubinsky@berkeley.edu). If you have any concerns of complaints about the research, please contact the Stanford Institutional Review Board at (650) 723-2480 or via email at IRB2-Manager@lists.stanford.edu

Given the above information, do you wish to participate in the survey?

○ Yes, I wish to participate
○ No, I do not wish to participate

Figure A33: **Background Information**

Do you have a PhD in economics?

- ○ Yes
- ○ No

Which best describes your primary employer?

- ○ US Congress
- ○ State regulatory agency
- ○ State legislature
- ○ Federal agency (CFPB, Federal Reserve, FCA, etc.)
- ○ Payday lender or other financial services company
- ○ Think tank or advocacy organization
- ○ University
- ○ [ ] Other (please explain)

Figure A34: **Market Background**

Market background

As you are probably well aware, payday loans are short-term loans designed to be fully repaid on or soon after the borrower's next payday. In data we are studying, the average loan size is $373, the modal loan maturity is 14 days, the interest rate is $10-$15 per $100 borrowed (depending on loan amount), and full repayment (principal + interest) is due in a single payment at maturity.

Borrowers often "re-borrow", either by paying late (incurring additional interest and fees) or by fully repaying but then taking out a new loan soon after. (Renewals/refinancing/rollovers are prohibited by law in our study setting.)

Figure A35: **Opinions about Payday Loan Bans**

Some states have laws that effectively prohibit payday lending, for example by imposing a low interest rate cap. Do you think such a law is good or bad for consumers overall?

- ○ Very good
- ○ Somewhat good
- ○ Neutral
- ○ Somewhat bad
- ○ Very bad

How certain are you of your answer?

	Not certain at all	Slightly certain	Moderately certain	Very certain	Extremely certain
Choose one	○	○	○	○	○

Figure A36: **Opinions about Rollover Restrictions**

Imagine a law that successfully enforces a one-month "cooling off period" for any individual who takes out payday loans more than three paydays in a row or for an individual who takes out but does not repay a payday loan. During the cooling off period, the individual could not borrow from any payday lender. Do you think such a law is good or bad for consumers overall?

- ○ Very good
- ○ Somewhat good
- ○ Neutral
- ○ Somewhat bad
- ○ Very bad

How certain are you of your answer?

	Not certain at all	Slightly certain	Moderately certain	Very certain	Extremely certain
Choose one	○	○	○	○	○

Figure A37: **Opinions about Loan Size Caps**

Pew Charitable Trusts has proposed a law that effectively limits payday loan amounts to no more than 5% of the borrower's expected gross income over the loan repayment period. Do you think such a law is good or bad for consumers overall?

- ○ Very good
- ○ Somewhat good
- ○ Neutral
- ○ Somewhat bad
- ○ Very bad

How certain are you of your answer?

	Not certain at all	Slightly certain	Moderately certain	Very certain	Extremely certain
Choose one	○	○	○	○	○

Figure A38: **Opinions about Borrower Decision-Making**

Opinions about borrower decision-making

Finally, we'd like to ask for your predictions about key aspects of borrower behavior in our study. From January 7th to March 29th, 2019, we surveyed 1,205 payday borrowers from one of the USA's largest payday lenders in several of the lender's stores in Indiana. Indiana state law prohibits renewals/refinancing/rollovers but has only mild restrictions on re-borrowing consecutively or from multiple lenders. We then tracked subsequent borrower behavior with data from our partner lender and the Veritec small-dollar loan database used to track compliance with state regulations.*

Do you think that the average payday loan borrower in our sample correctly foresees the chance that she will re-borrow in the next 60 days?

Remember: *re-borrowing* is defined as (a) paying late (incurring additional fees) or (b) fully repaying but then taking out a new loan soon after from our lender or any other lender that reports into the Indiana Veritec database.

- ○ Yes
- ○ No, I think the average borrower overestimates the chance she will re-borrow in the next 60 days.
- ○ No, I think the average borrower underestimates the chance she will re-borrow in the next 60 days.

How certain are you of your answer?

	Not certain at all	Slightly certain	Moderately certain	Very certain	Extremely certain
Choose one	○	○	○	○	○

Figure A39: **Beliefs about Borrowers' Predicted Reborrowing Probability**

Opinions about borrower decision-making

In data we've been analyzing, the average payday loan borrower has about a 70% chance of re-borrowing within the next 60 days. Above, you answered that you think the average person underestimates that probability. What do you think the average borrower in our data *believes* is that probability? (*Please answer in percentage points, from 0 to 100.*)

Figure A40: **Beliefs about Borrowers' Demand for Motivation**

Do you think that the average payday loan borrower would want to give herself extra motivation to avoid re-borrowing in the future? (In technical terms, do you think that the average borrower is present-biased / time inconsistent / has costly self-control and is at least partially sophisticated about it?)

- Yes
- No

How certain are you of your answer?

	Not certain at all	Slightly certain	Moderately certain	Very certain	Extremely certain
Choose one	○	○	○	○	○

Figure A41: **Beliefs about $\tilde{\beta}$**

What do you think is the average beta-hat (perceived present bias parameter in a beta-delta-beta-hat model) of payday borrowers? If you are not familiar with the model, please write N/A.

Figure A42: **Beliefs about Whether Borrows Say They Want Motivation**

We also asked borrowers, “Would you like to give yourself extra motivation to avoid payday loan debt?” The possible answers were “not at all,” “somewhat,” and “very much.”

What percent of borrowers do you think answered “very much”? *(Please give an answer from 0 to 100.)*

How certain are you of your answer?

	Not certain at all	Slightly certain	Moderately certain	Very certain	Extremely certain
Choose one	○	○	○	○	○