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

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## 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. While 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. Borrowers are willing to pay a significant premium for an experimental incentive to avoid future borrowing, implying that they believe they are present focused. We combine these data with a novel sufficient statistic-based identification strategy to estimate a model of partially naive present focus, giving average perceived and actual present focus parameters of $\tilde{\beta} \approx 0.75$ and $\beta \approx 0.72$, respectively. Using our estimated parameters, we carry out a behavioral welfare evaluation of common payday lending regulations. In our model, payday loan bans unambiguously reduce welfare, and limits on repeat borrowing generate at best small welfare gains.

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

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

"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 involves $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 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 proposed to rescind part of its 2017 regulation on the grounds that it would have reduced credit access.

Resolving this debate matters. In 2016, Americans borrowed $35 billion from storefront and online payday lenders, paying $6 billion in interest and fees (Wilson and Wolkowitz 2017).

At the core of this debate is the question of whether borrowers act in their own best interest. If borrowers correctly optimize 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.

This paper presents an experiment with a large payday lender (henceforth, the "Lender") designed to answer two basic questions. First, do people anticipate the extent of their repeat borrowing? Second, are people willing to pay to incentivize themselves to avoid future borrowing? Our

experiment provides descriptive evidence on these questions and allows us to estimate a model of partially naive present focus—one of the first such estimates outside of laboratory experiments. We then use these estimates as inputs to a welfare analysis of three common payday lending regulations—the first such analysis that accounts for the behavioral biases that motivate these regulations.

Our experiment ran in 41 of the Lender's storefronts between January and March 2019. 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 adaptive multiple price list (MPL) in which they chose between the incentive and varying amounts of Money for Sure. We also used a second MPL 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.

This experimental design allows us to estimate a model of partially naive present focus. In our notation, present focused people discount utility in all future periods by $\beta \leq 1$, they predict that their future selves will discount future utility by $\tilde{\beta}$, "sophisticated" people have $\tilde{\beta} = \beta$, and "naive" people have $\tilde{\beta} > \beta$. Extending insights from Acland and Levy (2015) and DellaVigna and Malmendier (2004), we develop formulas that identify $\beta/\tilde{\beta}$ and $\tilde{\beta}$ in intuitive ways based on a set of transparent "sufficient statistics" computed from the survey responses.

Sophistication vs. naivete ($\beta/\tilde{\beta}$) is identified by comparing predicted vs. actual borrowing probabilities: we infer lower $\beta/\tilde{\beta}$ if people are more overoptimistic about staying out of debt. Our analysis is very similar if misprediction of future borrowing is caused by overoptimism about or inattention to future income or consumption needs instead of naivete about present focus. Perceived present focus ($\tilde{\beta}$) is identified by comparing people's valuations of the no-borrowing incentive to the valuations our model predicts they would have if they were time-consistent. People with lower $\tilde{\beta}$ value the incentive more highly because it reduces their future borrowing, aligning future decisions with current preferences.[1] Our formulas allow for risk aversion, many periods, and income or expense shocks that affect the utility cost of repayment.

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

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[1]For example, imagine a borrower who believes she has a 40 percent chance of avoiding borrowing over the next eight weeks without the no-borrowing incentive, and a 60 percent chance of avoiding borrowing with the incentive. If she is risk-neutral and thinks that her future self is time-consistent, she would be indifferent between the $100 no-borrowing incentive and $50 for sure. (This $50 reflects the $60 financial value of the incentive net of a $10 effort cost for avoiding borrowing; see Section 3 for details.) However, if she thinks she is present focused, she would value the incentive at more than $50.

without the incentive, slightly lower than the Control group's actual borrowing probability of 74 percent. This translates to a sophistication estimate of $\beta/\tilde{\beta} \approx 0.96$.

Borrowers appear to learn with experience. 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 exactly correctly on average. This learning could explain why limited naivete in our overall sample contrasts with findings of substantial naivete in lab experiments (Augenblick and Rabin 2019) and exercise (e.g., DellaVigna and Malmendier 2004; Acland and Levy 2015): payday borrowing is a high-stakes decision with clear feedback and repeated opportunities to learn.[2]

We find that borrowers have substantial willingness-to-pay to change their future behavior: they value the no-borrowing incentive 30 percent more than they would if they were time-consistent and risk-neutral. Since their responses on our survey's second MPL reveal that they are in fact risk averse, their valuation of the future behavior change induced by the incentive is even larger than this 30 percent premium suggests. We estimate that the average borrower in our sample has $\tilde{\beta} \approx 0.75$, implying that people believe that they have substantial self-control problems. This estimate is consistent with more qualitative data: 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." If the slight average misprediction we observe is caused entirely by naivete about present focus, then combining our estimate of $\beta/\tilde{\beta}$ with our estimate of $\tilde{\beta}$ implies a present focus estimate of $\beta \approx 0.72$.

Finally, we evaluate payday lending regulations using a structural model of borrowing and repayment with exogenous interest rates, possibly set by government regulation. In our model, borrowers choose a loan amount in period $t = 0$, trading off the benefits of additional liquidity with the perceived future repayment cost. In each subsequent period $t \geq 1$, they can choose to repay the loan (ending the game), default at some cost (also ending the game), or pay only the interest and reborrow the principal (continuing the game to period $t + 1$). In essence, we combine the Heidhues and Koszegi (2010) borrowing model with a stochastic version of the O'Donoghue and Rabin (1999; 2001) optimal stopping models in which people choose whether to complete an unpleasant task (repaying the loan) now or later. We consider three common policies: a payday lending ban (in practice, a low interest rate cap that causes all payday lenders to exit), a "rollover restriction" (in practice, a limit on consecutive borrowing followed by a "cooling off period," which in our model requires borrowers to repay their loan by $t = 3$ at latest), and a tightened loan size cap.

We first provide theoretical propositions that give qualitative intuition for optimal policy. A payday loan ban can only harm time-consistent or sophisticated borrowers, as they correctly predict their future repayment when initally deciding how much to borrow. However, with limited

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[2]Kaur, Kremer, and Mullainathan (2015) and Yaouanq and Schwardmann (2019) also find evidence of learning about self-control in environments with high stakes and repeated feedback.

uncertainty in repayment cost shocks, a ban benefits *persistently* naive borrowers, as they fall into "debt traps" where they continually reborrow because they falsely believe they will repay in the next period. If borrowers are *temporarily* naive and become sophisticated, as in our empirical estimates, the losses from overborrowing are tightly bounded, and a ban is again likely to be harmful. A rollover restriction could benefit both naive and sophisticated present focused borrowers, by inducing faster repayment consistent with long-run preferences. As uncertainty grows, however, we limit to a case where the repayment cost shock fully determines repayment, so present focus no longer distorts behavior and any regulation reduces welfare.

We then carry out numerical simulations that combine our estimates of $\beta$ 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 borrowers with our estimated $\beta$ and $\tilde{\beta}$ enjoy 98 percent as much surplus as a time-consistent borrower. Because borrowers are mostly sophisticated, payday loan bans and tighter loan size caps reduce welfare in our simulations. Rollover restrictions slightly increase welfare in some simulations but reduce welfare in others.

Before we released the paper, we surveyed payday lending practitioners and academic economists who study related issues 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. Although our empirical estimates are consistent with some prior work discussed below, and although our model's policy prescriptions echo arguments by Skiba (2012), Morse (2016), and certain others, 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, contrasting with the actual 4 percentage points. Furthermore, although our experts expressed significant uncertainty in their policy views, more than half believed that payday loan bans are good for borrowers, and rollover restrictions were slightly less popular than bans. Much of current regulation matches these opinions: 18 states ban payday lending, only a small handful of states have effective rollover restrictions.[3] By contrast, in our model, bans markedly reduce welfare, and rollover restrictions are the most promising (or last harmful) form of regulation. While our analyses require many assumptions and should be interpreted cautiously, these contrasts highlight the potential of this type of work to shape expert opinion and improve public policy.

We highlight four 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 consumers as being normatively relevant; this "long-run criterion" is common but controversial (Bernheim and Rangel 2009; Bernheim 2016; Bernheim and Taubinsky 2018). Using some

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[3]Many states have *de jure* rollover restrictions, but most of them have "cooling off periods" of less than two weeks, allowing people to renew borrowing within the same pay cycle.

other 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 people might keep larger buffer stocks in response to payday borrowing restrictions, or that rollover restrictions might result in more (albeit shorter) spells. Fourth, our analyses assume that there are no market failures or behavioral biases other than present focus and misprediction.

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 analyses are difficult to use for welfare evaluation because it is not clear how to trade off effects on different outcomes or include other unmeasured welfare-relevant outcomes. Furthermore, while such evaluations of credit access can be informative about the effects of payday loan bans, they are not very informative about the effects of other regulations such as rollover restrictions or loan size caps: even if access to a product benefits consumers, a well-regulated product might benefit consumers even more (Zinman 2014). This highlights the benefits of welfare analyses that combine revealed preference estimates with explicit measurement of consumer bias. Our paper is the first to do this for payday lending.[4]

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 first-time borrowers, as the information could induce sophistication and reduce borrowing. Their result could also suggest that first-time borrowers underestimate fees, but severe underestimation seems unlikely given that fees are prominently disclosed online and in storefronts.[5] 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

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[4]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), Rees-Jones and Taubinsky (Forthcoming), and see Bernheim and Taubinsky (2018) for a review.

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

focus. Carvalho, Olafsson, and Silverman (2019) show that laboratory measures of decision quality correlate 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 individual behavior, which then allows us to carry out a quantitative behavioral welfare analysis.

Perhaps the most closely related paper on payday lending is Skiba and Tobacman (2018), who use payday lending microdata to estimate a dynamic structural model of borrower behavior. They identify present focus parameters using 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. Recent work by Heidhues and Strack (2019), however, shows that the timing of choices cannot be used to identify either $\beta$ or $\tilde{\beta}$ without strong parametric assumptions, as every distribution of stopping times can be rationalized by a time-consistent model with a different distribution of unobserved shocks.[6] 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.

Finally, our identification strategy for $\beta$ and $\tilde{\beta}$ advances the large literature on present focus in laboratory and field settings. 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.[7] A smaller set of lab experiments and field studies estimate part of a present focus model, for example identifying $\beta$ while assuming that people are fully naive or fully sophisticated.[8] There are only a handful of papers that estimate a full model of partially naive present focus.[9] Our identification strategy is closest to that of parallel work by Carrera et al. (2019), but our application requires a non-separable dynamic programming model that allows for income effects, and our approach delivers point estimates of $\beta$ and $\tilde{\beta}$ rather than only identified sets.

Sections 1 and 2 present the background and experimental design. Sections 3, 4, and 5 present our identification strategy, data, and results. Section 6 presents our behavioral welfare evaluation of payday lending regulations. Section 7 concludes.

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[6]This holds even when the mean and variance of those shocks is known, meaning that matching distributions to only the first two moments is insufficient for identification.

[7]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).

[8]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), Paserman (2008), and Shui and Ausubel (2005).

[9]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).

# 1 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 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 interest and fees at 15 percent of the loan amount for loans up to $250, plus 13 percent on the incremental amount borrowed from $251-$400, plus 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.

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.[10]

If the borrower does not come to the store to repay the loan, the lender attempts to cash the

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[10]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.

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, 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.

## 2  Experimental Design

We designed the experiment to answer two key questions: whether people anticipate repeat borrowing, and whether people are willing to pay to incentivize themselves to avoid future borrowing. In a model of present focus, the first question identifies sophistication $(\beta/\tilde{\beta})$, while the second identifies perceived present focus $(\tilde{\beta})$.

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 the partner lender's borrowing records) and email address (to send them their 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 selected for this reward, we would send them a Visa cash card by 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 for completing the survey, 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 vs. 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.

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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.[11]

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 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 our measure of risk aversion.

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. Two percent of survey respondents (the "MPL group") were randomly assigned to receive the choice they made (or would have made) on a randomly selected row from one of the two MPLs. Thus, it was incentive compatible for participants to answer truthfully on all questions. 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.

**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.**  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 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

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[11]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.

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 matched the borrowing records of participants who had been offered $100 If You Are Debt-Free to the Veritec statewide lending database. By no more than 12 weeks after the survey (in practice, typically at 10 weeks), people 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.

## 3    Identifying Partially Naive Present Focus

### 3.1    Setup

We model a payday loan as a contract in which the borrower receives principal $l$ in period $t$ and must repay $l + p(l)$, the principal plus a fee, in period $t + 1$. We model borrowing using a many-period extension of Heidhues and Koszegi (2010). In the model, people borrow amount $l$ in period $t = 0$. In each subsequent period $t \in \{1, ..., T\}$, with $T$ possibly infinite, borrowers have three options. First, they can *repay* $l + p(l)$ and end the loan cycle. In this case, the game ends. Second, they can pay the fee $p(l)$ and *reborrow* the principal $l$.[12] In this case, the game continues. Third, they can *default*, incurring immediate cost $\chi$. In this case, the game ends.

Since our participants have already gotten their loans when they take the survey, $l$ is exogenous in this section. As documented in Appendix Figure A1, it is realistic to assume away the continuous borrowing decision in $t > 0$. This allows us to model borrowing in a simpler optimal stopping framework. Since the probability of default on any one loan is only 3 percent, we assume that borrowers cannot default on the loan they have just gotten when they take the survey.[13] This allows us to simplify the survey and estimation strategy.

The cost of repaying amount $x$ each period is a convex function $k_t(x, \omega_t)$, where $\omega_t$ is a shock to period $t$ repayment cost that is revealed at the beginning of period $t$. $\omega_t$ captures unexpected expenses such as car repairs and unexpected income shocks such as being scheduled for fewer hours at work.[14] We assume that borrowers have quasi-hyperbolic preferences given by $U^t(u_t, u_{t+1}, \ldots, u_T) = \delta^t u_t + \beta \sum_{\tau=t+1}^{T} \delta^\tau u_\tau$, where $u_t$ is the period $t$ utility flow. Following O'Donoghue and Rabin (2001), we allow people to mispredict their preferences: in period $t$, they

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[12]In Indiana, this more precisely means that they repay the loan in full, paying $l + p(l)$, but then get a new loan with principal $l$.

[13]Notwithstanding this assumption, the possibility of defaulting on future loans can still affect the expected discounted costs of reborrowing.

[14]Like Heidhues and Koszegi (2010), we define a repayment cost function instead of directly modeling consumption, for notational convenience. Of course, the repayment costs correspond to lost consumption.

believe that their period $t+1$ self will have a short-run discount factor $\tilde{\beta} \in [\beta, 1]$.

Imagine that our survey took place in period $t-1$. The no-borrowing incentive can be thought of as additional income of $\gamma = \$100$ to be received in period $t+1$, plus a one-period price increase of $\gamma$ for any borrowing in period $t$. Define $w$ as the borrower's valuation of the $\$100$ no-borrowing incentive. Specifically, $w$ is the amount of Money for Sure in period $t+1$ at which the borrower is indifferent between $w$ and the incentive, as elicited through our MPL.

People's future borrowing is uncertain, as it depends on realizations of the repayment cost shock $\omega_t$. Define $\tilde{\mu}(b, y)$ as the perceived probability of borrowing in period $t$. This is a function of a no-borrowing incentive $b$ for period $t$, where $b = 0$ for the Control group and $b = \gamma$ for the Incentive group, and any additional income $y$ in period $t+1$ from the other experimental rewards (Money for Sure or Flip a Coin for $\$100$). Define $\mu(b, y)$ as the actual probability of borrowing in period $t$. For brevity, we drop the second argument when it is zero, so $\tilde{\mu}(b) := \tilde{\mu}(b, 0)$ and $\mu(b) := \mu(b, 0)$. In the survey, we elicited $\tilde{\mu}(0)$ and $\tilde{\mu}(\gamma)$. In the borrowing data, we observe $\mu(0)$ and $\mu(\gamma)$ for the Control and Incentive groups, respectively.

## 3.2 Graphical Illustration of Identification Strategy

Combining the survey data with actual behavior allows us to identify $\beta$ and $\tilde{\beta}$. For this graphical illustration only, we assume that borrowers are risk-neutral, or more precisely that the period $t+1$ continuation value is linear in debt $x$. Thus, Money for Sure does not affect borrowing, and the $\gamma$ no-borrowing incentive has the same effect as a one-period price increase of $\gamma$. We also assume that borrowing probability is locally linear in the cost of borrowing.

Figure 1 presents demand for loans in period $t$, as a function of the price of borrowing. The x-axis shows the probability of borrowing in period $t$, given uncertainty in the future realization of $\omega_t$. The y-axis shows the period $t+1$ debt that would result from borrowing in period $t$. Without the no-borrowing incentive, this debt is $l + p$; with the one-period price increase embedded in the incentive, this is $l + p + \gamma$.

The figure plots three demand functions. The period $t$ self determines actual demand; that self weights period $t+1$ debt costs by $\beta$. The period $t-1$ self predicts that the period $t$ self will instead weight $t+1$ debt costs by $\tilde{\beta}$, so actual demand is higher than predicted demand if $\tilde{\beta} > \beta$. The period $t-1$ self would prefer that the period $t$ self give full weight to future debt costs, so predicted demand is higher than desired demand if $\tilde{\beta} < 1$. The actual, predicted, and desired weights on period $t+1$ debt amount $x$ are $\beta$, $\tilde{\beta}$, and 1, respectively.

As drawn on the figure, the $t-1$ self predicts that the no-borrowing incentive will decrease borrowing probability from $\tilde{\mu}(0)$ to $\tilde{\mu}(\gamma)$. Actual borrowing probability without the incentive is $\mu(0)$.

### 3.2.1 Identifying Sophistication

Naive borrowers in $t-1$ will underestimate their probability of borrowing in period $t$, driving a wedge between predicted and actual demand.

Define an amount $\gamma^\dagger > 0$ by $\tilde{\mu}(-\gamma^\dagger) = \mu(0)$. A negative argument to $\tilde{\mu}(b)$ implies a one-period repayment *penalty*, i.e. the opposite of our experimental repayment *incentive*. With such a repayment penalty, people would predict a higher borrowing probability. $\gamma^\dagger$ is the repayment penalty at which predicted demand with the penalty would equal actual demand without the penalty.

In Figure 1, $\gamma^\dagger$ is the vertical distance between predicted and actual demand at probability $\mu(0)$: the magnitude of misperception in dollar units. Since the perceived demand slope is $\frac{\tilde{\mu}(\gamma)-\tilde{\mu}(0)}{\gamma}$, we can write $\tilde{\mu}(0) - \gamma^\dagger \frac{\tilde{\mu}(\gamma)-\tilde{\mu}(0)}{\gamma} = \mu(0)$, and thus

$$\gamma^\dagger = \gamma \cdot \frac{\mu(0) - \tilde{\mu}(0)}{\tilde{\mu}(0) - \tilde{\mu}(\gamma)}. \tag{1}$$

We can also write $\gamma^\dagger$ as a function of $\beta$ and $\tilde{\beta}$. For $\gamma^\dagger$ to equate predicted demand at penalty $\gamma^\dagger$ with actual demand at zero penalty, it must also equate the predicted utility cost of borrowing at repayment penalty $\gamma^\dagger$ with the period $t$ self's actual utility cost of borrowing at zero penalty. Mathematically, this is:

$$\underbrace{\beta\,(l+p)}_{\text{period } t \text{ self's borrowing cost}} = \underbrace{\tilde{\beta}\left(l+p-\gamma^\dagger\right)}_{\text{predicted borrowing cost with penalty } \gamma^\dagger}. \tag{2}$$

We can see this equation on Figure 1, as actual demand at debt level $l + p$ and predicted demand at debt level $l + p - \gamma^\dagger$ both generate borrowing probability $\mu(0)$.

Re-arranging gives an intuitive formula for sophistication—the ratio of actual to perceived present focus:

$$\frac{\beta}{\tilde{\beta}} = \frac{l+p-\gamma^\dagger}{l+p}. \tag{3}$$

If people correctly predict borrowing on average, $\gamma^\dagger = 0$ and $\beta/\tilde{\beta} = 1$. Naive borrowers have $\gamma^\dagger > 0$ and $\beta/\tilde{\beta} < 1$. In words, Equation (3) says that if an $X\%$ decrease in borrowing cost increases predicted borrowing to match actual borrowing at the normal price, then $\beta$ is $X\%$ of $\tilde{\beta}$.

### 3.2.2 Identifying Perceived Present Focus

Now consider the identification of $\tilde{\beta}$. Intuitively, people with lower $\tilde{\beta}$ will value the no-borrowing incentive more highly in period $t - 1$, as the incentive can help align period $t$ borrowing with period $t - 1$ preferences. Since the no-borrowing incentive is equivalent to receiving additional income $\gamma$ in $t + 1$ plus a one-period price increase of $\gamma$ for borrowing in $t$, we can write valuation as $w = \gamma - CS_{t-1}$, where $CS_{t-1}$ is the $t - 1$ self's perceived consumer surplus loss from the temporary price increase.

This perceived consumer surplus loss $CS_{t-1}$ has two components, which are shaded on Figure 1. The first is the consumer surplus loss that the $t - 1$ self predicts will accrue to the period $t$ self. Equivalently, this is the standard consumer surplus loss from a price change for borrowers who are

time-consistent. This is just the shaded trapezoid under the predicted demand curve between the borrowing probabilities at the old and new prices: $\gamma \cdot \left(\frac{\tilde{\mu}(0)+\tilde{\mu}(\gamma)}{2}\right)$.

The second component is the "internality reduction" benefit: the additional consumer surplus from the $t-1$ self's perspective that accrues because the incentive brings borrowing more in line with $t-1$ preferences. This gain equals the trapezoid between the predicted and desired demand curves and between $\tilde{\mu}(0)$ and $\tilde{\mu}(\gamma)$. The height of the trapezoid at each point is the difference between self $t$'s and self $t-1$'s perceived borrowing costs, so the average height is $\left(1-\tilde{\beta}\right)\left(l+p+\frac{\gamma}{2}\right)$. The width is the change in borrowing probability $(\tilde{\mu}(0)-\tilde{\mu}(\gamma))$. The area is thus $\left(1-\tilde{\beta}\right)\left(l+p+\frac{\gamma}{2}\right)(\tilde{\mu}(0)-\tilde{\mu}(\gamma))$.

$CS_{t-1}$, the period $t-1$ self's perceived consumer surplus loss from the price increase, is the first trapezoid net of the second. This is analogous to the social welfare change from a Pigouvian tax in the presence of an externality: the period $t-1$ self is like the "social planner," the period $t$ self is like the "consumer," and the internality is like the externality.

The period $t-1$ self's valuation of the no-borrowing incentive is thus

$$w = \underbrace{\gamma}_{\text{income}} - \underbrace{\gamma \cdot \left(\frac{\tilde{\mu}(0)+\tilde{\mu}(\gamma)}{2}\right)}_{\text{period } t \text{ CS loss}} + \underbrace{\underbrace{\left(1-\tilde{\beta}\right)\left(l+p+\frac{\gamma}{2}\right)}_{t-1 \text{ vs. } t \text{ marginal utility difference}} \underbrace{(\tilde{\mu}(0)-\tilde{\mu}(\gamma))}_{\Delta \text{behavior}}}_{\text{internality reduction benefit}}. \tag{4}$$

Define $\tilde{\Delta} := \tilde{\mu}(0) - \tilde{\mu}(\gamma)$ as the predicted reduction in borrowing probability from the incentive and $\bar{\tilde{\mu}} := \frac{\tilde{\mu}(0)+\tilde{\mu}(\gamma)}{2}$ as the average borrowing probability with and without the incentive. Substituting these definitions and solving for $\tilde{\beta}$ gives

$$\tilde{\beta} = 1 - \frac{\overbrace{w}^{\text{valuation}} - \overbrace{\gamma \cdot (1-\bar{\tilde{\mu}})}^{\text{valuation if time-consistent}}}{\left(l+p+\frac{\gamma}{2}\right)\tilde{\Delta}}. \tag{5}$$

In this risk-neutral illustration, borrowers who perceive themselves to be time-consistent value the no-borrowing incentive at $w = \gamma \cdot (1-\bar{\tilde{\mu}})$, and borrowers who perceive themselves to be present focused have higher valuations.

## 3.3    Formal Model

We now formalize the model and allow non-linear continuation value. Let $\tilde{C}_{t+1}(x,\omega_t)$ denote the period $t+1$ continuation cost as perceived in all periods before $t+1$, as a function of period $t+1$ debt $x$ and period $t$ repayment cost shock $\omega_t$. Note that $x$ can be negative in our experiment if the borrower repays in $t$ and is due an incentive payment in $t+1$.

We make three assumptions about repayment costs. First, we assume that for the infinite-horizon case $(T = \infty)$, there is some finite $T'$ after which $k_t(x,\omega)$ does not vary with $t$. Second, we assume that the period $t$ repayment cost shock $\omega_t$ follows a Markov process, so $\omega_{t+1}$ depends only on $\omega_t$. Third, we assume that $\frac{\frac{d}{dx}k_t(x,\omega_t)|_{x=x_1}}{\frac{d}{dx}\tilde{C}_{t+1}(x,\omega_t)|_{x=x_2}}$ and $\frac{d}{dx}\tilde{C}_{t+1}(x,\omega_t)|_{x=x_2}$ are independent (or minimally

dependent) for all $x_1, x_2$. In words, any new period $t$ information that updates the *relative* benefit of repaying in period $t$ is uninformative about the period $t+1$ expected cost. This assumption is satisfied if $\omega_t$ and $\omega_{t+1}$ are independent, or if $\omega_t = (\theta_t, \eta_t)$, where $\theta_t$ is independent over time and $\eta_t$ is a multiplicative repayment cost shock satisfying $E[\eta_{t+1}|\eta_t] = \eta_t$.

Let $\tilde{\mu}'_b$ and $\tilde{\mu}'_y$ denote the derivatives of $\tilde{\mu}$ with respect to $b$ and $y$, respectively. Define $\rho(b, y) := -\frac{\tilde{\mu}'_y}{\tilde{\mu}'_b}$ as the ratio of perceived demand responses to increases in $y$ versus $b$. This is positive because $\tilde{\mu}'_b < 0$ and $\tilde{\mu}'_y > 0$: a lower no-borrowing incentive and higher future liquidity both increase borrowing.

Define $\alpha(b, y) := \frac{\rho(b,y)}{l+b}$. In Appendix E.3, we show that $\alpha$ approximates the coefficient of absolute of risk aversion, from the period $t-1$ perspective. That is, $\alpha$ measures period $t-1$ preferences over gambles to be received in period $t+1$. $\rho$ and $\alpha$ measure income effects and risk preferences; they are increasing in the curvature of utility. For shorthand, we write $\rho := \rho(0,0)$ and $\alpha := \alpha(0,0)$.

Define $c$ as the certainty equivalent of the Flip a Coin for \$100 reward; we use this to measure $\rho$ and $\alpha$.

When $\tilde{\beta} < 1$, borrowers believe that their future selves will have different preferences, and $\tilde{C}$ is the solution to a non-cooperative game played between the different selves. Existence and uniqueness of $\tilde{C}$ is thus not immediate. Theorem 1 in Appendix D shows that under some regularity conditions on $k_t$ and $\omega_t$, there exists a unique equilibrium for finite $T$, and a unique stationary equilibrium for $T = \infty$, with smooth continuation value functions $\tilde{C}_t$.[15] This theorem justifies our sufficient statistics approach, which requires both uniqueness and smoothness. Although uniqueness and smoothness are not guaranteed in dynamic consumption-savings models with sophisticated present focus (Harris and Laibson, 2001; Laibson et al., 2015), our "optimal stopping" framework does allow general existence and uniqueness results.

### 3.3.1 Identifying Sophistication

In Section 3.2, we showed how a $\gamma^\dagger$ repayment penalty equated the perceived and actual utility costs of borrowing. With nonlinear $\tilde{C}_{t+1}$, we must adjust those utility costs for curvature.

**Proposition 1.** *Assume that terms of order $\tilde{\mu}''_y \gamma^2$ and $\tilde{\mu}''_\gamma \gamma^2$ are negligible. Under the quadratic approximation to $\tilde{C}_{t+1}$ that terms of order $(l+\gamma)^3 \tilde{C}'''(x, \omega_t)$ and higher are negligible,*

$$\underbrace{\beta \left(l + p\right) \left(1 + \frac{\rho}{2}\right)}_{period\ t\ self's\ borrowing\ cost} = \underbrace{\tilde{\beta} \left(l + p - \gamma^\dagger\right) \left(1 + \frac{\rho}{2} + \frac{\alpha}{2}\gamma^\dagger\right)}_{predicted\ borrowing\ cost\ with\ penalty\ \gamma^\dagger}. \tag{6}$$

*where $\gamma^\dagger = \gamma \cdot \frac{\mu(0) - \tilde{\mu}(0)}{\tilde{\mu}(0) - \tilde{\mu}(\gamma)}$.*

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[15]If in the infinite horizon case $k_t$ depends on $t$ for $t < T'$, by stationarity we mean that equilibrium behavior is stationary in $t$ for $t \geq T'$. 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 $\theta$ and $\eta$. We use stationarity as an equilibrium refinement.

As in Equation (2), the left-hand side is the utility cost of borrowing with no repayment penalty, while the right-hand side is the predicted utility cost of borrowing with penalty $\gamma^{\dagger}$. In the linear case with $\alpha = \rho = 0$, this formula simplifies to Equation (2).

Since the utility cost of borrowing is now concave in a repayment penalty $\gamma^{\dagger}$, the $\gamma^{\dagger}$ decrease in the effective price of borrowing decreases the utility cost of borrowing by less. Thus, if an $X\%$ debt decrease would increase predicted borrowing to match actual borrowing without the penalty, then naivete causes people to underestimate the perceived utility cost of borrowing by less than $X\%$, and $\beta$ is more than $X\%$ of $\tilde{\beta}$.

### 3.3.2   Identifying Perceived Present Focus

In Section 3.2, we derived the valuation of the no-borrowing incentive with linear continuation value. With nonlinear $\tilde{C}_{t+1}$, the valuation of the no-borrowing incentive is the equivalent variation that accrues in period $t + 1$, from the $t - 1$ perspective. To estimate this equivalent variation, we must adjust the borrowing demand curves for income effects, just as we must adjust Marshallian demand curves for income effects in standard consumer problems.

**Proposition 2.** *Under the assumptions of Proposition 1,*

$$
\left(1 - \frac{\alpha w}{2}\right) \left\{ \underbrace{w \cdot \left(1 + \rho\left(\tilde{\mu}(0) + \frac{1}{2}\frac{w\rho}{\gamma}\tilde{\Delta}\right)\right)}_{direct\ utility\ from\ income\ w} - \underbrace{\left(1 - \tilde{\beta}\right)\left(1 + \frac{\rho}{2}\right)(l + p)}_{t-1\ vs.\ t\ marginal\ utility\ difference} \underbrace{\frac{w\rho}{\gamma}\tilde{\Delta}}_{\Delta behavior} \right\} \tag{7}
$$

$$
= \left(1 - \frac{\alpha\gamma}{2}\right) \left\{ \underbrace{\gamma \cdot (1 - \bar{\tilde{\mu}})}_{\gamma - period\ t\ CS\ loss} + \underbrace{\left(1 - \tilde{\beta}\right)\left(1 + \frac{\rho}{2}\right)\left(l + p + \frac{\gamma}{2}\right)}_{t-1\ vs.\ t\ marginal\ utility\ difference} \underbrace{\tilde{\Delta}}_{\Delta behavior} \right\}.
$$

As in Equation (4), the left-hand side is the utility value of $w$ dollars of Money for Sure, and the right-hand side is the utility value of the no borrowing incentive. In the linear case with $\alpha = \rho = 0$, this formula simplifies to Equation (4). Equation (7) differs from Equation (4) for four reasons.

First, additional income and reduced debt have a decreasing marginal effect on utility. Under our quadratic approximation to $\tilde{C}_{t+1}$, the utility of additional income $X$ is $X\left(1 - \frac{\alpha X}{2}\right)$. Since the left-hand side and right-hand side translate payments of $w$ and $\gamma$ to utility, they decrease by proportions $\left(1 - \frac{\alpha w}{2}\right)$ and $\left(1 - \frac{\alpha \gamma}{2}\right)$, respectively.

Second, future income makes it easier to repay debt, which increases the incentive to borrow. Being due income $w$ in period $t+1$ increases the probability of borrowing in period $t$ by $\frac{w\rho}{\gamma}\tilde{\Delta}$. This adds a second term to the left-hand side, as the period $t - 1$ self perceives that $w$ dollars of Money for Sure worsens any internality from over-borrowing in period $t$.

Third, marginal utility of money is higher when people have more debt. In the state of the world where people reborrow in $t$, marginal utility in $t + 1$ is higher by $(1 + \rho)$. Thus, the utility

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from receiving $w$ dollars of Money for Sure in $t + 1$ is increased by $1 + \rho Y$, where $Y$ is the average of the probabilities of reborrowing with and without receiving $w$. Accounting for the second bullet, $Y = \tilde{\mu}(0) + \frac{1}{2} \frac{w\rho}{\gamma} \tilde{\Delta}$, which gives the multiplier $\left(1 + \rho \left(\tilde{\mu}(0) + \frac{1}{2} \frac{w\rho}{\gamma} \tilde{\Delta}\right)\right)$ on $w$.

Fourth, the internality is proportional to the cost of debt, so the internality increases when the debt cost is convex. Under our quadratic approximation, the internality terms increase by proportion $\left(1 + \frac{\rho}{2}\right)$.

## 3.4 Empirical Implementation

In theory, Equations (6) and (7) hold for each individual borrower, and individual survey responses could imply individual-specific $\beta$ and $\tilde{\beta}$. In practice, any survey responses are noisy, so we observe $\tilde{\mu}$, $w$, and $c$ with measurement error. Furthermore, since Equations (6) and (7) 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 (6) and (7): $l_g$, $p_g$, $w_g$, $\tilde{\mu}_g$, and $\mu_g$, and $\gamma_g^\dagger = \gamma \cdot \frac{\mu_g(0) - \tilde{\mu}_g(0)}{\tilde{\mu}_g(0) - \tilde{\mu}_g(\gamma)}$. For our primary estimates, we define the $g$ to be five groups defined by quintiles of loan size $l$.

In Appendix E.3, we show how the coefficient of absolute risk aversion can be backed out from the \$100 coin flip certainty equivalent $c$. Using the group-level average $c_g$, the empirical analogue of this formula is

$$\alpha_g = \frac{\frac{\gamma}{2} - c_g}{\left(\frac{\gamma^2}{2} - c_g^2\right)}. \tag{8}$$

In this equation, we infer higher $\alpha$ (more risk aversion) from lower $c$ (lower valuation of a gamble). We then calculate $\rho_g = (l_g + p_g)\alpha_g$.

In Appendix E.4, we show how we can substitute the group average variables into Equations (6) and (7), take expectations over observations, and re-arrange, giving the following estimating equations:

$$\widehat{\left(\frac{\beta}{\tilde{\beta}}\right)} = \frac{\sum_i \left(l_g + p_g - \gamma_g^\dagger\right) \left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2} \gamma_g^\dagger\right)}{\sum_i (l_g + p_g) \left(1 + \frac{\rho_g}{2}\right)} \tag{9}$$

and

$$\hat{\tilde{\beta}} = 1 - \frac{\sum_i \left\{w_g \cdot \left(1 + \rho_g \left(\tilde{\mu}_g(0) + \frac{1}{2} \frac{w_g \rho_g}{\gamma} \tilde{\Delta}_g\right)\right) \left(1 - \frac{\alpha_g w_g}{2}\right) - \gamma \cdot (1 - \bar{\tilde{\mu}}_g) \left(1 - \frac{\alpha_g \gamma}{2}\right)\right\}}{\sum_i \left(1 + \frac{\rho_g}{2}\right) \tilde{\Delta}_g \left\{(l_g + p_g + \frac{\gamma}{2}) \left(1 - \frac{\alpha_g \gamma}{2}\right) + (l_g + p_g) \frac{w_g \rho_g}{\gamma} \left(1 - \frac{\alpha_g w_g}{2}\right)\right\}}. \tag{10}$$

In the linear case with $\alpha_g = \rho_g = 0$, these two equations simplify to analogues of Equations (3) and (5). Equation (9) shows that we infer lower $\beta/\tilde{\beta}$ (more naivete) when $\gamma^\dagger$ is larger (people more heavily underestimate future borrowing). Equation (10) shows that we infer a lower $\tilde{\beta}$ (more

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perceived present focus) when $w$ is higher (people are willing to pay more for the incentive to avoid future borrowing).[16]

We estimate standard errors by bootstrapping.

Appendix E.4 details the assumptions under which Equations (9) and (10) deliver the sample average $\beta/\tilde{\beta}$ and $\tilde{\beta}$ when those parameters are heterogeneous across borrowers. One key assumption is that terms of order $\mathbb{E}[(1 - \tilde{\beta}_i)^2|g]$ are negligible. This is reasonable because the share of borrowers that plausibly have $\beta_i \ll 1$ is limited by the assumption that $\tilde{\beta}_i \leq 1$ combined with our empirical estimate that the average $\tilde{\beta}_i$ is not far from one. A second key assumption is that $\mathbb{E}[\tilde{\beta}_i|g]$ does not vary across $g$. This is reasonable if we think that $\tilde{\beta}$ is unrelated to loan size. Other papers estimating 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. In Section 5.3, we explore heterogeneity on observables and present estimates with alternative group definitions.

Under the assumption that $\beta_i/\tilde{\beta}_i$ is orthogonal to $\tilde{\beta}_i$ (i.e. that people who think they are more vs. less present focused misperceive their true present focus by the same proportion on average), we can back out an estimate of the sample average $\beta$ by simply multiplying $\widehat{\left(\frac{\beta}{\tilde{\beta}}\right)}$ from Equation (9) by $\hat{\tilde{\beta}}$ from Equation (10). Appendix E.4 shows that this method is also valid if $\beta_i$ is orthogonal to a naivete statistic $\frac{\tilde{\beta}_i - \beta_i}{1 - \beta_i}$, which reflects the degree to which individuals think their present focus is closer to 1 than it actually is.

## 3.5 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 (Karlan et al. 2016; Gabaix 2017). Consider a model in which borrowers perceive that future repayment costs will be $\kappa \leq 1$ as large as they actually are. In such a model, it is straightforward to show that the right-hand-side of Equation (9) delivers an estimate of $\kappa \cdot \beta/\tilde{\beta}$. Intuitively, naivete about present focus causes a borrower to think that the period $t + 1$ self will give immediate costs $\beta/\tilde{\beta}$ less weight than he does in reality, which is mathematically isomorphic to believing that period $t + 1$ costs will be $\kappa$ smaller than they are in reality.

If $\kappa \neq 1$, we cannot immediately back out an estimate of $\beta$. 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 $\beta$ on $\hat{\beta} \in \left[\widehat{\left(\frac{\beta}{\tilde{\beta}}\right)} \cdot \hat{\tilde{\beta}}, \hat{\tilde{\beta}}\right]$. 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 sources of misprediction.

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[16]In addition to the first $w_g$, there are also additional $w_g$ in Equation (10). These matter less for identification because $\alpha$ and $\rho$ are small.

### 3.6 Comparison to Alternative Identification Strategies

As highlighted by our graphical exposition around Figure 1, we identify $\beta$ and $\tilde{\beta}$ in intuitive ways using straightforward survey questions and incentivized choices that map transparently into our model. Our "sufficient statistics" approach to estimating $\tilde{\beta}$ and $\beta$ has additional benefits relative to other approaches. One alternative approach could be to identify time preferences from survey questions about receiving money now vs. later, as in Andreoni and Sprenger (2012a) and other work. However, since our participants by definition have access to payday loans, they can easily borrow against later payments, so time preferences over payments do not identify time preferences over consumption. A second alternative approach could be to use real-effort tasks to measure borrowers' $\beta$ and $\tilde{\beta}$, as in Augenblick and Rabin (2019) and Augenblick, Niederle, and Sprenger (2015). However, our evidence on how experience reduces naivete suggests that naivete may be context-specific, so parameter estimates from real-effort tasks might not be relevant for payday borrowing.

A third alternative approach would be to use observational data in a structural consumption-savings model, as in Skiba and Tobacman (2018). They assume that all repayment cost shocks come from variation in income reported by borrowers to the lender, and they use those reports to calibrate an AR(1) income process. However, repayment cost shocks also depend on unexpected repairs, health emergencies, work scheduling, availability of side jobs, loans and gifts from family, and many other contingencies (Levy and Sledge 2012). Heidhues and Strack (2019) show that in an optimal stopping model, $\beta$ and $\tilde{\beta}$ are not identified without strong functional form assumptions on unobserved shocks. While our approach does use locally quadratic approximations and assumptions on the correlation of unobserved shocks over time, we avoid any stronger assumptions on the distribution of repayment cost shocks.

Of course, our approach has its own limitations. Our survey required the cooperation of a lender, extensive piloting and refinement, and a large grant for implementation. Furthermore, we still need to calibrate repayment cost shock distributions for our counterfactual simulations in Section 6.

## 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 Figures A2-A5 present the full distribution of predicted borrowing probabilities and valuations of the no-borrowing incentive and $100 coin flip.

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 2. See Appendix Table A2 for details. All figures and tables in the paper are limited to the 1,205 borrowers with valid data, following our pre-registered sample inclusion criteria.[17] 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 $34,000. Appendix Table A3 documents that the Incentive and Control groups are balanced on observables.

To cleanly compare predicted and actual borrowing, our survey participants' borrowing after the survey must not be affected by systematic unexpected 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 A6 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 have *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 have *defaulted* on a loan if they do not pay off all principal and fees owed. We say that borrowers have *repaid* if they do not reborrow or default—that is, if they do not owe debt to a payday 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

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

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 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 on borrower decision-making. 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.[18] 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 then 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 Empirical Results

### 5.1 Do People Anticipate Repeat Borrowing?

Figure 2 compares predicted to actual borrowing in the eight weeks after the survey. This and subsequent figures describing borrower beliefs use predicted borrowing from the first survey question (before the no-borrowing incentive was introduced) and actual borrowing in the Control group, mapping to the misprediction statistic $\mu(0) - \tilde{\mu}(0)$ required by the theory. The average borrower predicts that she has a 70 percent chance of borrowing without the no-borrowing incentive, whereas in reality, 74 percent of borrowers in the Control group did borrow. This implies that on average, borrowers are almost fully sophisticated. This is the key moment in Equation (9) that identifies $\beta/\tilde{\beta}$.[19]

Several analyses help validate the elicited beliefs. First, Appendix Figure A7 shows that people

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

[19]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 also 0.70.

who reported a higher probability of borrowing in the next eight weeks were in fact substantially more likely to borrow. Second Appendix Figure A8 shows that 36, 25, and 39 percent of people reported getting payday loans "more often than I expected," "less often than I expected," and "about as often as I expected," respectively. These retrospective reports are consistent with the slight naivete reflected in predicted reborrowing probabilities.[20]

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. This suggests that people learn with experience.[21]

This evidence of learning and eventual sophistication differs from evidence of substantial naivete in other settings. One potential explanation is that payday borrowing is a high-stakes domain with clear feedback and repeated learning opportunities. 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. Yaouanq and Schwardmann (2019) find that people become more sophisticated over time in a laboratory experiment with clear and salient feedback.[22]

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

The average borrower predicted a $\tilde{\mu}(\gamma) \approx 50$ percent chance of reborrowing if offered the no-borrowing incentive. This turned out to be a substantial overestimate of the incentive's actual effect. Because the no-borrowing incentive was an unfamiliar experimental instrument, this misprediction of the incentive's effect is not policy relevant, and we do not use it to identify sophistication versus naivete. Our estimates of $\tilde{\beta}$ are valid as long as borrowers based their valuations of the no-borrowing incentive on the probabilities they reported on the survey. See Appendix C for further discussion.

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[20]Rational expectations are consistent with some borrowers borrowing more or less than expected, as long as those are both equally likely.

[21]Appendix Figure A9 shows qualitatively similar results after defining experience to be the number of previous loans in the current loan cycle. Appendix Figure A10 shows that the decrease in misprediction with experience is driven mostly by higher predicted reborrowing probability, although experienced borrowers also have slightly lower actual borrowing probability. Appendix Figure A11 shows that misprediction does not differ statistically by internal credit score or income.

[22]Hanna, Mullainathan, and Schwartzstein (2014) and Gagnon-Bartsch, Rabin, and Schwartzstein (2019) theoretically explore conditions under which individuals may be more or less likely to learn. Learning is enhanced by stakes in the presence of costly attention (Hanna, Mullainathan, and Schwartzstein 2014), or by the possibility of many future contracting opportunities (Gagnon-Bartsch, Rabin, and Schwartzstein 2019).

## 5.2 Are People Willing to Pay to Incentivize Themselves to Avoid Future Borrowing?

Figure 5 presents the distributions of responses to two qualitative questions we asked borrowers at the end of the survey. Panel (a) 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." This qualitative result foreshadows and corroborates our estimate that $\tilde{\beta} < 1$. Panel (b) shows that even though many people want motivation to avoid payday loan debt, they tend to think that restrictions on repeat borrowing would be bad for them. Individual 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.

Figure 6 presents the key moments that identify $\tilde{\beta}$. The first spike shows that the average borrower in our sample values the \$100 no-borrowing incentive at \$52. The second spike shows the average modeled valuation of the incentive assuming borrowers are risk-neutral and time consistent. As described in Section 3, a risk-neutral borrower with $\tilde{\beta} = 1$ would value the no-borrowing incentive at $\$100 \times (1 - \bar{\tilde{\mu}})$. As presented above, $\tilde{\mu}(0) \approx 70\%$, and $\tilde{\mu}(\gamma) \approx 50\%$. Thus, the average modeled valuation for risk-neutral and time consistent borrowers would be $\$100 \times \left(1 - \frac{70\% + 50\%}{2}\right) \approx \$40$. The \$12 difference between these first two spikes, i.e. the average of $w - \gamma \cdot (1 - \bar{\tilde{\mu}})$, is what we call "willingness-to-pay for motivation."

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 WTP for motivation is a loose lower bound on how much borrowers are willing to pay to incentive themselves to avoid future borrowing.

Compared to the \$40 time-consistent risk-neutral benchmark, the \$12 premium implies that borrowers are willing to pay more than 30 percent more for the incentive than they would if they believed themselves to be time-consistent. Since borrowers expect that the incentive will reduce their borrowing probability by 20 percentage points, the \$12 premium also implies that they are willing to pay more than \$0.60 for every one percentage point reduction in their probability of borrowing over the next eight weeks. These results drive our empirical estimate that $\tilde{\beta} < 1$.

Figure 7 shows that valuations and qualitative responses are correlated in expected ways across borrowers. Panel (a) shows that people who say they want more motivation to avoid payday loan debt indeed have higher WTP for motivation. Panel (b) shows that people who say that a rollover restriction would be good for them also have higher WTP for motivation.

## 5.3 Parameter Estimates

Table 2 presents our parameter estimates. Column 1 presents the estimated $\beta/\tilde{\beta}$, which can also be interpreted as $\kappa$ in a model where borrowers perceive that future repayment costs will be share $\kappa$ as large as they actually are. Column 2 presents the estimated $\tilde{\beta}$. Column 3 presents the implied estimate of $\beta$. As discussed in Section 3.5, this is a lower bound on $\beta$ if some of misprediction is

caused by overoptimism about future repayment costs.

The first row presents our primary estimates, using Equations (9) and (10). Our primary estimate of borrowers' average $\tilde{\beta}$ is 0.75, with a 95 percent confidence interval of $(0.72, 0.78)$. The estimate of average sophistication $\beta/\tilde{\beta}$ is 0.96, reflecting the fact that the sample slightly underestimates borrowing on average; this is statistically distinguishable from one with about 95 percent confidence. The implied lower bound estimate of $\beta$ is 0.72.

The second row presents estimates for the risk-neutral case, inserting $\rho = 0$ into the estimating equations. Imposing risk neutrality understates demand for behavior change by failing to account for the fact that risk aversion reduces valuation of the (risky) no-borrowing incentive. Correspondingly, the estimated $\tilde{\beta}$ rises to 0.87. Sophistication $\beta/\tilde{\beta}$ changes less, as it is primarily driven by the extent of misprediction and the predicted demand slope.

The third row presents estimates for the subsample of borrowers who had taken out three or fewer loans from the Lender in the six months before taking the survey. The fourth row presents 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 $\beta/\tilde{\beta} \approx 0.84$. The point estimates for $\tilde{\beta}$ differ modestly, at 0.74 and 0.78 for more and less experienced borrowers, respectively.

The implied lower bounds on $\beta$ are statistically different for the two groups, at 0.66 for the inexperienced group and 0.74 for the experienced group. There are two possible explanations. First, it could be that the groups' actual $\beta$ parameters are the same, and the reduced misprediction in the experienced group is from learning about repayment costs, 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 $\beta$ 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-$\beta$ types simply select out of borrowing.

As discussed in Section 3.4, we estimate population average parameters under certain orthogonality and homogeneity assumptions. The fifth row of Table 2 presents estimates where we separately estimate the parameters by above vs. 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 first row. Thus, accounting for heterogeneity along this key dimension does not affect our estimates of the sample average.

We explore additional heterogeneity in Appendix B. Appendix Figure A12 presents estimates of $\beta/\tilde{\beta}$ and $\tilde{\beta}$ for splits of internal credit score and income in addition to recent borrowing experience. Below-median income consumers perceive more present focus than above-median income consumers $(\tilde{\beta} \approx 0.70$ versus $\tilde{\beta} \approx 0.78$, respectively).[23] Appendix Figure A13 shows heterogeneity in $\tilde{\beta}$ by

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[23]Lower-income consumers have similar "WTP for motivation" as higher-income consumers in Appendix Figure A11, but they are more risk-averse and take out smaller loans, so their $\tilde{\beta}$ is lower.

responses to the qualitative survey questions on desire for motivation and personal impact of rollover restrictions, paralleling Figure 7. Our $\tilde{\beta}$ point estimates, which adjust "WTP for motivation" for risk aversion and other factors, are similarly correlated with responses to these two qualitative survey questions.[24]

The experts who responded to our survey believed that borrowers would have less demand for behavior change than they actually did. Only 56 percent of experts believed that the average borrower would want motivation to avoid future borrowing. By contrast, Figure 5 documented that 90 percent of borrowers reported qualitatively that they wanted extra motivation to avoid payday loan debt. Quantitatively, Figure 8 shows that most experts overestimated borrowers' average $\tilde{\beta}$. The average expert predicted $\tilde{\beta} \approx 0.86$, which is somewhat larger than the $\tilde{\beta} \approx 0.75$ reported in Table 2.

## 6    Policy Implications

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 borrowing for 30 days after three consecutive loans), and a loan size cap. In Section 6.1, we begin by giving theoretical intuition for how different parameters affect welfare. In Section 6.2, we turn to numerical simulations.

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.

We extend the modeling framework from Section 3. We endogenize the initial decision in period $t = 0$ of whether and how much to borrow. Let $u(l, \nu)$ denote the benefit of borrowing amount $l$, where $\nu$ is a shock. Define $C(l)$ as the actual expected cost (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 cost functions are endogenously determined by equilibrium borrower behavior and the repayment cost functions $k_t(x, \omega_t)$; Theorem 1 in Appendix D shows that they are well-defined and differentiable.

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 $u(l, \nu) - \beta \delta C(l)$ and the welfare

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[24]One result that does not line up well is that people who say that they "not at all" want motivation have estimated $\tilde{\beta} < 1$. Even though Panel (a) of Figure 7 shows that this group has WTP for motivation that is relatively small and statistically indistinguishable from zero, they are sufficiently risk averse that their implied $\tilde{\beta}$ is less than one.

criterion is $\beta\delta\left[u(l,\nu) - \delta C(l)\right]$. The difference between these two cases is that in our alternative analysis, the borrower "over-borrows" relative to the welfare criterion because the benefits are in the present while the repayment costs are in the future. To avoid the mechanical implication that borrowers with lower $\beta$ derive less welfare, we normalize both welfare criteria by $1/\beta$.

We also impose additional structure on the repayment cost function $k_t(x, \omega_t)$. First, we assume that $k_t$ does not vary with $t$. Second, we divide the repayment cost shock $\omega_t$ into two components, $\omega_t = (\theta_t, \eta_t)$. $\theta_t \sim F$ denotes a component that is independent and identically distributed across $t$. $\eta_t$ is a serially correlated component distributed according to $G_0$ in $t = 1$ and $G(\cdot|\eta_{t-1})$ in periods $t \geq 2$. $k$ is increasing in both $\theta$ and $\eta$. We impose some regularity assumptions on these shocks, as detailed in Appendix D.

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.

## 6.1 Theoretical Results

### 6.1.1 Setup

We now present theoretical intuition for the welfare effects of payday borrowing under different assumptions for borrower types and the amount of uncertainty. For borrower types, we consider different assumptions for $\beta$ 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 $t \geq 1$. For uncertainty in repayment cost shocks, we consider families of distributions $F_\lambda$, $G_\lambda^0$, and $G_\lambda$ with variance indexed by $\lambda$ but with common support and means that do not depend on $\lambda$. $\lambda \to 0$ refers to the case of vanishing uncertainty in repayment costs, whereas $\lambda \to \infty$ refers to the case with high uncertainty. See Appendix F.1 for details.

In this sub-section, we assume infinite horizon ($T = \infty$), which allows us to consider stationary equilibria, and we assume that the discount factor is $\delta = 1$, which is a close approximation given that pay cycles are two weeks to one month long.

Starting in $t = 1$ (after the borrower has decided to get a loan), the repayment decision is similar to the optimal stopping problem in O'Donoghue and Rabin (1999; 2001): the borrower faces a one-time unpleasant task (repaying the loan) and decides whether to complete it now or later. Present focused borrowers want to delay the unpleasant task, but this delay is costly, as it requires an additional period of interest payment.

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. With no uncertainty, 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 uncertainty, we can focus on stationary pure-strategy equilibria, which may be more realistic. In

Appendix F.4, we draw a link between our setting and fully deterministic settings by establishing a type of "purification theorem" showing that as uncertainty vanishes ($\lambda \to 0$), behavior converges to a stationary mixed strategy equilibrium of a deterministic game. Notwithstanding these differences, our initial results with vanishing uncertainty parallel theirs: the costs of present focus itself are bounded, whereas the costs of naivete can grow essentially without bound.

### 6.1.2  Repayment Behavior and Costs

When do borrowers repay, and what are the resulting repayment costs $C$, as a function of $\beta$ and $\tilde{\beta}$? Define $C_\lambda^{TC}(l)$, $C_\lambda^N(l)$, and $C_\lambda^S(l)$ as the actual expected repayment cost for time-consistent, naive, and sophisticated borrowers, respectively. We first focus on the vanishing uncertainty case, $\lambda \to 0$. We begin with a formal result, which we then illustrate with several special cases.

**Proposition 3.** *Suppose that* $\mathbb{E}[k(l+p(l), \omega)] < \chi$, *so that it is not optimal to default in period* $t = 1$. *If* $\beta \geq \beta^* := \frac{\mathbb{E}[k(l+p(l), \omega)] - \mathbb{E}[k(p(l), \omega)]}{\mathbb{E}[k(l+p(l), \omega)]}$, *then the behavior of the present-biased borrower approaches that of a time-consistent borrower as* $\lambda \to 0$. *Otherwise:*

*1. If* $\tilde{\beta}_1 > \beta$, *then* $\lim_{\lambda \to 0} \left( C_\lambda(l) - C_\lambda^{TC}(l) \right) = \infty$.

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

Appendix F presents proofs of this and other propositions in this section. For intuition, consider several different borrower types in the limit case of a fully deterministic game. The time-consistent type ($\beta = \tilde{\beta} = 1$) repays immediately in $t = 1$ to avoid paying additional interest. Thus, $C_{\lambda \to 0}^{TC} = k(l + p)$.

Next, consider the fully naive type ($\tilde{\beta}_0 = \tilde{\beta}_1 = 1$, $\beta < 1$). They believe they will have $\beta = 1$ next period, and thus that they will repay in $t + 1$. Thus, they think they are trading off the cost of repaying in period $t$ with the $\beta$-discounted cost of repaying in period $t + 1$. They repay in $t = 1$ if $k(l + p) \leq k(p) + \beta k(l + p)$, i.e. if $\beta \geq \beta^* = \frac{k(l+p) - k(p)}{k(l+p)}$. Naive types with $\beta < \beta^*$ will always reborrow, even as they always expect to repay in the next period. This gives infinite repayment cost $C_{\lambda \to 0}^N = \infty$, as formalized in the first part of the proposition.

The fully sophisticated type ($\tilde{\beta} = \beta < 1$) with $\beta < \beta^*$ plays a stationary mixed strategy in which they (i) are indifferent between repaying and reborrowing and (ii) expect the same future repayment cost $C_{\lambda \to 0}^S$ if they reborrow.[25] This gives $k(l + p) = k(p) + \beta C_{\lambda \to 0}^S$, and thus $C_{\lambda \to 0}^S = \frac{k(l+p) - k(p)}{\beta}$. With limited present focus $\beta \geq \beta^*$, sophisticated borrowers also repay immediately in $t = 1$.[26]

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[25] For sophisticates, the only stationary equilibrium is a mixed-strategy equilibrium, because neither reborrowing forever nor repaying as soon as possible can be supported as equilibria. If sophisticates thought they would always repay as soon as possible, then they would want to deviate from the equilibrium by instead reborrowing in period $t = 1$. If they thought that they would always reborrow, then they would prefer repaying immediately in period $t = 1$ instead of incurring the infinite cost of reborrowing.

[26] This is because the future repayment cost $C_{\lambda \to 0}^S$ must be at least $k(l + p)$, so the cost of the stationary mixed strategy is $k(p) + \beta C_{\lambda \to 0}^S \geq k(p) + \beta k(l + p)$, and this exceeds $k(l + p)$, the cost of repaying immediately, for $\beta \geq \beta^*$.

For $\beta < \beta^*$, sophisticates' present focus increases repayment cost $C_{\lambda \to 0}^S$ by no more than $1/\beta$, as formalized in the second part of the proposition.

Now consider temporarily naive borrowers with perceived present focus $\tilde{\beta}_0 > \beta$ in $t = 0$ and $\tilde{\beta}_1 = \beta$ in $t \geq 1$. For $\beta \geq \beta^*$, borrowers correctly predict that they will repay in $t = 1$. For $\beta < \beta^*$ and $\tilde{\beta}_0 < \beta^*$ (the less naive case), borrowers predict that their repayment cost will be the same as a sophisticate with $\beta = \tilde{\beta}_0$, $C_{\lambda \to 0}^S(\tilde{\beta}_0) = \frac{k(l+p)-k(p)}{\tilde{\beta}_0}$, but their actual repayment cost is $C_{\lambda \to 0}^S(\beta) = \frac{k(l+p)-k(p)}{\beta}$. Their ratio of predicted to actual repayment costs is thus $\frac{C_{\lambda \to 0}^S(\tilde{\beta}_0)}{C_{\lambda \to 0}^S(\beta)} = \frac{\beta}{\tilde{\beta}_0}$. For $\beta < \beta^*$ and $\tilde{\beta}_0 > \beta^*$ (the more naive case), borrowers predict they will repay immediately and thus incur cost $k(l+p)$, but their actual cost is $C_{\lambda \to 0}^S(\beta) = \frac{k(l+p)-k(p)}{\beta}$. The ratio of predicted to actual repayment costs is thus $\beta \frac{k(l+p)}{k(l+p)-k(p)}$. Since $\beta_0 \geq \beta^* = \frac{k(l+p)-k(p)}{k(l+p)}$, this ratio exceeds $\beta/\tilde{\beta}_0$. Thus, temporary naivete causes the ratio of perceived to actual repayment costs to be as low as $\beta/\tilde{\beta}_0$, as formalized in the third part of the proposition.

Proposition 3 shows that in the limit of vanishing uncertainty, persistent naivete is by far the most costly bias. However, the stark result of infinite repayment cost is linked to a stark prediction about behavior: persistently naive borrowers reborrow in perpetuity. This prediction arises because the deterministic environment causes behavior to be discontinuous in $\tilde{\beta}_1$. In Proposition 7 in Appendix F.2, we show that behavior is continuous in all parameters in the presence of uncertainty. In the proposition below, we allow for uncertainty and establish that moderate levels of present focus or naivete are not very costly unless observed reborrowing rates are close to 100 percent.

**Proposition 4.** *Suppose that $\sum_{\eta'} G(\eta|\eta')G_0(\eta') = G_0(\eta)$ (i.e., the unconditional distribution of $\eta$ is time-invariant). Let $\mu$ be the empirically observed reborrowing rate. Relative to the repayment costs $C^{TC}(l)$ of time-consistent borrowers, the repayment costs $C_\beta^S(l)$ of borrowers with present focus $\beta$ and $\tilde{\beta}_1 = \beta$ are bounded by*

$$C_\beta^S(l) \leq \frac{1}{1-(1-\beta)\mu} C^{TC}(l) \leq \frac{C^{TC}(l)}{\beta}. \tag{11}$$

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

$$C_\beta^S(l) \leq C_{\beta,\tilde{\beta}_1}^{PN}(l) \leq \frac{C^{TC}(l)}{1-\mu} - \frac{\mu}{1-\mu} \beta C_{\tilde{\beta}_1}^S(l). \tag{12}$$

Both bounds in Proposition 4 are loose bounds in the sense that they hold with equality only in the limit of vanishing uncertainty, where time-consistent borrowers repay immediately. The bound on sophisticates' repayment costs shows that present focus cannot increase repayment costs by a factor larger than $1/\beta$. Thus, moderate present focus cannot have large effects on repayment costs. The bound on partial naifs' costs shows that as long as the observed repayment probability is not too close to zero, small changes in naivete will have small effects on repayments costs. It is only in the limit of perpetual reborrowing ($\mu \to 1$) that minor naivete can generate very large repayment costs.

While perpetual reborrowing can arise in fully deterministic models, it does not arise with more uncertainty. If there is at least some chance of a "good" shock under which even present focused consumers want to repay, then $\mu < 1$, and the results of Proposition 4 apply. Adding more variation in $\theta$ dampens the impact that $\beta$ and $\tilde{\beta}$ have on repayment, because more variation in repayment cost shocks reduces the chance of realizing a state of the world in which present focus or naivete affect repayment. Proposition 5 shows that in the limit case of maximal variation in $\theta$—i.e., distributions that have only "very good" or "very bad" shocks—the cost of present focus is zero because borrowers behave identically regardless of $\beta$ and $\tilde{\beta}$.

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

In Appendix F we show that Propositions 3-5 are analogous if borrowers mispredict future borrowing because they mispredict future repayment costs $k(x, \theta, \eta)$ rather than their level of present focus. In particular, suppose that borrowers are sophisticated about their present focus, but they think at $t = 0$ that future costs are $\kappa_0$ as high as they actually are, and they think at $t \geq 1$ that costs are $\kappa_1$ as high as they actually are. Our repayment cost results hold verbatim when $\tilde{\beta}_0$ is replaced by $\beta/\kappa_0$ and $\tilde{\beta}_1$ is replaced by $\beta/\kappa_1$.

### 6.1.3 Welfare Gains from Payday Borrowing

We now consider the welfare gains from payday borrowing, taking into account the $t = 0$ borrowing decision. Figure 9 illustrates how a borrower with a given loan demand shock $\nu$ 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 uncertainty, then $C = \infty$, $l^* > l^\dagger = 0$, $L = \infty$, and payday borrowing decreases welfare. For intermediate cases, $L = O\left((1 - \kappa)^2\right)$, where $\kappa := \tilde{C}'/C'$, the ratio of perceived to actual marginal repayment costs. Intuitively, since Proposition 4 shows that the costs of borrowing are bounded by smooth functions of present focus and naivete, small amounts of bias generate only second-order

welfare losses.[27]

To illustrate, suppose that $u'$ and $C'$ are approximately linear. Then the welfare gain triangle has width $l^\dagger$ and height $(C'' - u'') l^\dagger$, so its area is $G = \frac{1}{2}(C'' - u'') \cdot (l^\dagger)^2$. Analogously, the overborrowing welfare loss triangle has width $l^* - l^\dagger$ and height $(C'' - u'')(l^* - l^\dagger)$, so its area is $L = \frac{1}{2}(C'' - u'') \cdot (l^* - l^\dagger)^2$. The more people misperceive costs, the more they overborrow, so we can write overborrowing $l^* - l^\dagger$ as a function of $1 - \kappa$: $(l^* - l^\dagger) = (1 - \kappa)\frac{C'(l^\dagger)}{\kappa C'' - u''}$.[28] The ratio of the areas of these triangles is thus $L/G = (1 - \kappa)^2 \left(\frac{C'(l^\dagger)}{l^\dagger \cdot (\kappa C'' - u'')}\right)^2$. In Appendix F.7, we show that this typically implies that on average, $L/G < (1 - \kappa)^2$.

For example, consider the case of temporary partial naivete ($\tilde{\beta}_0 > \beta$, $\tilde{\beta}_1 = \beta$). When the weak inequalities in Proposition 4 hold with equality, we have $\kappa = \frac{1 - \mu + \beta\mu}{1 - \mu + \tilde{\beta}_0\mu}$.[29] If the reborrowing probability is $\mu \approx 0.75$, and if $\tilde{\beta}_0 \approx 0.78$ and $\beta \approx 0.66$, as in the third row of Table 2, then $\kappa \approx 0.89$. The welfare loss from overborrowing is then $L/G < (1 - \kappa)^2 \approx 0.012$, i.e. about one percent of the surplus for sophisticated borrowers.

Now consider the case with persistent partial naivete ($\tilde{\beta}_1 > \beta$). When the weak inequalities in Proposition 4 hold with equality, we have $\kappa = \frac{1 - \mu}{1 - \mu + (\tilde{\beta}_1 - \beta)\mu}$.[30] If the reborrowing probability is $\mu \approx 0.75$ and $\tilde{\beta}_1 - \beta \approx 0.03$, as in our primary estimates from Table 2, then $\kappa \approx 0.92$. The welfare loss from overborrowing is then $L/G < (1 - \kappa)^2 \approx 0.007$, i.e. less than one percent of the surplus for sophisticated borrowers.

Finally, assume that borrowers are fully sophisticated, so $C' = \tilde{C}'$, but consider our alternative assumption that borrowing is for consumption in period $t = 0$. The borrower thus sets $l^*$ such that $u'(l^*) = \beta C'(l)$, borrowing more than the $t - 1$ self would prefer. The above welfare calculation is analogous if we define $\tilde{C}' = \beta C'$ as the marginal repayment costs from the $t = 0$ perspective, so $\kappa = \beta$. Using our primary estimate of $\beta \approx 0.72$ from the first row of Table 2, the welfare loss from overborrowing in $t = 0$ is no more than $(1 - 0.72)^2 \approx 0.08$ of the surplus that would result from maximizing $t = -1$ preferences.

**Implications for regulation.** Given our empirical estimates of present focus and sophistication, these calculations suggest that $G \gg L$. Thus, a payday loan ban that eliminates $G$ and $L$ probably decreases welfare.

We can also use Figure 9 to informally discuss the welfare effects of rollover restrictions and loan

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[27]Formally, set $W(\kappa) = u(l^*(\kappa)) - C(l^*(\kappa))$, omitting $\nu$ 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 $W''(\kappa) = ((u''(l^*) - C''(l^*))\frac{dl^*}{d\kappa} + (u'(l^*) - C'(l^*))\frac{d^2l^*}{d\kappa^2}$. 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 $L = ((u''(l^*) - C''(l^*))\frac{dl^*}{d\kappa}(1 - \kappa)^2 + O((1 - \kappa)^3)$.

[28]The borrower chooses $l^*$ such that $u'(l^*) = \tilde{C}'(l^*)$, so $C'(l^\dagger) + (l^* - l^\dagger) u'' = \kappa \cdot [C'(l^\dagger) + (l^* - l^\dagger) C'']$. Rearranging gives $(l^* - l^\dagger) = (1 - \kappa)\frac{C'(l^\dagger)}{\kappa C'' - u''}$.

[29]In the notation of Proposition 4, perceived costs are $\tilde{C} = \frac{1}{1 - (1 - \tilde{\beta}_0)\mu}C^{TC}$, and actual costs are $C = C^S_\beta = \frac{1}{1 - (1 - \beta)\mu}C^{TC}$. The ratio is $\tilde{C}/C = \frac{1 - \mu + \beta\mu}{1 - \mu + \tilde{\beta}_0\mu}$, and $\tilde{C}/C = \tilde{C}'/C' = \kappa$.

[30]Perceived costs are $\tilde{C} = C^S_{\tilde{\beta}_1} = \frac{C^{TC}(l)}{1 - (1 - \tilde{\beta}_1)\mu}$, and actual costs are $C = C^{PN}_{\beta, \tilde{\beta}_1} = \frac{C^{TC}(l) - \mu\beta C^S_{\tilde{\beta}_1}(l)}{1 - \mu}$. The ratio is $\tilde{C}/C = \frac{1 - \mu}{1 - \mu + (\tilde{\beta}_1 - \beta)\mu}$.

size caps. We model a rollover restriction as a requirement that the loan be repaid no later than $t = 3$. Consider first the case with vanishing uncertainty, $\lambda \to 0$. Since present focused borrowers delay repayment beyond $t = 1$, the rollover restriction reduces actual repayment costs $C_{\lambda \to 0}$. On Figure 9, this cost reduction grows the welfare gain triangle for all present focused borrowers and shrinks the over-borrowing loss triangle for naive types. However, at the other extreme of $\lambda \to \infty$, a rollover restriction can only harm borrowers, as it might force them to repay even when they draw high repayment costs in $t = 3$.

An omniscient social planner could in theory set a loan size cap at each borrower's $l^\dagger$, eliminating overborrowing. In practice, policymakers can only set one loan size cap. An optimally set uniform cap could increase welfare if borrowers are fairly homogeneous—that is, if the variation in $l^\dagger$ is small relative to the amount of overborrowing $l^* - l^\dagger$. However, there is substantial variation in loan size, and our calculations above suggest that overborrowing is relatively small.

## 6.2 Numerical simulations

### 6.2.1 Functional Forms

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

The utility cost of repaying $x$ in period $t$ is $k(x, \theta_t, \eta_t) = (\theta_t + \eta_t)(e^{\alpha x} - 1)$, where $\theta \sim Beta(a_\theta, b_\theta)$. 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 $\theta$, and thus to consider "best case" and "worst case" scenarios for regulation. 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 $\chi = \chi_0 \left(e^{\alpha(l+p)} - 1\right)$. 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 counter 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 and because lenders have more incentive to work to collect larger loans.

### 6.2.2 Calibration Procedure

We assume a 15 percent borrowing fee, so $p(l)/l = 0.15$. Since $\alpha$ is close to a coefficient of absolute risk aversion, we use the $\alpha = 0.0024$ estimated from Equation (8) in Section 3. We set $\delta = 0.998$, as this implies a five percent annual discount rate for two week periods, corresponding to bi-weekly

pay cycles. We set $\beta = 0.72$ and $\tilde{\beta} = 0.75$, as estimated in Section 5.

We calibrate the additional 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 the remaining parameters in two steps. In the first step, we calibrate $\bar{\eta}$, $\chi_0$, $q$, $a_\theta$, and $b_\theta$. We set $\chi = 1.1$ to guarantee that borrowers never choose to default when $\eta = 0$ for any distribution of $\theta$. We set $\bar{\eta}$ high enough such that borrowers always choose to default when $\eta = \bar{\eta}$ for any distribution of $\theta$. 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 $\theta$ to match the empirical reborrowing probability. Since the beta distribution has two parameters, there are many parameter pairs that can do so. We thus calibrate the parameters for two scenarios that allow low and high uncertainty in repayment cost shocks. First, we set $\theta \sim Beta(a_\theta, 1)$, where $a_\theta$ 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 $\theta$ ($a_\theta = 0$), which matches the limit case of vanishing uncertainty considered in Proposition 3.[31] Since the variance of $\theta$ is bounded by that of a uniform distribution, this first scenario does not allow the limit case of high uncertainty considered in Proposition 5. We thus consider a second scenario with $\theta \sim Beta(a_\theta, 0.02)$. This allows a highly bimodal distribution with close to the maximum possible variance of $\theta$. In both scenarios, reborrowing probabilities are monotone in $a_\theta$, and it is straightforward to find the $a_\theta$ that matches the empirical reborrowing probability.

With these parameters in hand, we 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 $\nu$. To do so, we simulate a set of potential borrowing spells, each with a draw of $\nu$, and find the perceived optimal loan size $l^* \in [0, \$500]$ for each spell as a function of $\nu$ 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 $(\mu_\nu, \sigma_\nu^2)$ 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 $\nu$ is held fixed across counterfactuals, our simulations do not capture the possibility that people might keep larger buffer stocks in response to payday borrowing

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[31]In Appendix H, we also consider families of distributions $Beta(a_\theta, b_\theta)$ for $b_\theta \in \{0.5, 2, 3, 4, 5\}$. It is possible to find an $\alpha_\theta$ that matches the empirical reborrowing probability for each value of $b_\theta$; the welfare effects of regulation are very similar to when we set $b_\theta = 1$.

restrictions, or that rollover restrictions might result in more potential borrowing spells by breaking up single long spells into multiple short spells. Appendix G provides more details on the calibration and counterfactuals.

Panel (b) of Table 3 presents the simulation parameters. Column 1 presents the calibration when $\theta \sim Beta(a_\theta, 1)$, and column 2 presents the calibration when $\theta \sim Beta(a_\theta, 0.02)$.

### 6.2.3  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 $\theta \sim Beta(a_\theta, 1)$ and $\theta \sim Beta(a_\theta, 0.02)$, respectively. Each row presents behavior under different assumptions for $\beta$, $\tilde{\beta}$, and whether the benefits of the loan accrue in $t = 0$ or $t = 1$. Since the simulation parameters other than $\beta$ and $\tilde{\beta}$ were calibrated using our primary $\left(\hat{\beta}, \hat{\tilde{\beta}}\right)$ and then held constant across rows, the loan size and reborrowing probabilities match the empirical moments in row 2 and vary across the other rows.

In Panel (a), present focus parameters materially affect borrower behavior. Comparing rows 1 and 2 shows that borrowers with our primary estimates of $\beta$ 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 borrow more 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 the empirical estimates in Figure 3. This has little effect relative to row 2.

In rows 9 and 10, we set $\beta$ and $\tilde{\beta}$ match expert forecasts. We use the $\tilde{\beta} = 0.86$ forecasted by the average expert, and we calculate sophistication $\beta/\tilde{\beta}$ by inserting experts' average forecast of borrower misprediction into Equation (9). 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 $\beta$ 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 amd 8 consider extreme parameterizations of heterogeneity, where half the population is time-consistent and the other half has $\beta$ 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.

In Panel (b), present focus parameters have almost no effect on behavior, consistent with Proposition 5. The most significant deviations from the time-consistent benchmark occur when the benefits of the loan accrue fully in $t = 0$; this increases average loan size but does not affect reborrowing probability.

Table 5 presents welfare estimates under alternative payday lending regulations, using the same

set of assumptions for $\beta$, $\tilde{\beta}$, and whether the benefits of the loan accrue in $t = 0$ or $t = 1$. Panels (a) and (b) again present results for $\theta \sim Beta(a_\theta, 1)$ and $\theta \sim Beta(a_\theta, 0.02)$, respectively.

In each panel, column 1 presents welfare effects under the existing policy in our sample, a \$500 loan size cap. Column 2 considers a \$400 loan size cap. Column 3 considers 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 25 percent fee. 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.

In each cell, 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). 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.

In Panel (a), Column 1 of row 2 shows that the welfare losses from our estimated levels of present focus are only about 2.4 percent of the surplus experienced by time-consistent types. Welfare is lower in most other rows, particularly when we assume heterogeneity, temporary naivete, more severe present bias in line with expert forecasts, and/or that the benefits of the loan accrue in $t = 0$. 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 think of 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 other than row 1, as the regulation induces faster repayment in line with the $t = -1$ self's preferences.[32]

In these panel (a) parameterizations with $\theta \sim Beta(a_\theta, 1)$, there are two reasons why present focus and naivete have such small effects on welfare despite having large effects on interest payments in column 3 of Table 4. First, although present focus and naivete can prolong borrowing spells and thus increase the *monetary* costs of borrowing, a countervailing force is that longer borrowing spells allow borrowers to repay when it is less costly to *utility* to do so. Second, people in our model derive substantial surplus from payday borrowing, so even large fee increases have small effects as a proportion of total surplus. Column 4 of Table 5, panel (a) shows that large fee increases (from 15 to 25 percent per loan) reduce welfare by only 4 to 20 percent.[33] The welfare effects of different parameter assumptions and regulations in panel (a) are larger in comparison to the effects of the fee increase.

Panel (b) presents results for the highly bimodal beta distribution, reporting the range of results

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[32]Like all rows other than row 2, using the expert present focus parameters generates counterfactual reborrowing rates and loan sizes. In Appendix H, we present results where we re-calibrate the distributions of $\theta$ and $\nu$ to match the empirical moments using experts' $\beta$ and $\tilde{\beta}$ instead of our primary estimates. All payday lending regulations reduce welfare in that calibration, although the rollover restriction is the least harmful.

[33]This also accords well with the fact that loan amounts bunch at the \$450-\$550 loan size caps in our data, implying that borrowers have significant additional liquidity demand.

over the various values of $\beta$ and $\tilde{\beta}$ that we assume in panel (a). The second row presents the range of results across all scenarios in which the loan affects utility only after $t = 0$. Comparing rows 1 and 2 shows that present focus has little impact on welfare in these high-uncertainty cases, consistent with the results of Proposition 3. Row 3 presents the range of results across all scenarios in which the benefits of the loan accrue in $t = 0$. Results are again quite similar to row 1, although welfare is slightly lower due to the overborrowing relative to $t = -1$ preferences.

Readers should not over-interpret 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 6.1 and 6.2 paint a clear picture: it is unlikely that banning payday lending would increase borrower welfare at realistic levels of present focus and parameter assumptions that match empirically observed moments.

## 6.3   Existing Policies and Expert Policy Views

Through the lens of our theoretical results and numerical calibrations, some existing payday lending regulations are welfare reducing. 18 states have banned payday lending, which in our model causes substantial welfare losses. Nearly all states that allow payday lending have loan size caps, whereas the tightened loan size cap in our model reduces welfare.

In our model, the only policy that increases borrower welfare in some calibrations is a rollover restriction. This encourages 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 lending 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 10 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. 33 percent of IGM experts agreed that a payday loan ban would make consumers better off, while 25 percent disagreed, and 37 percent were uncertain.[34]

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[34]See here for the IGM survey results.

# 7 Conclusion

This paper contributes new empirical facts and theoretically grounded policy analysis to the contentious debate about payday lending regulation. We find that borrowers learn from experience: inexperienced borrowers underestimate their likelihood of borrowing, while more experienced borrowers predict correctly. This learning and eventual sophistication might arise because 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 to incentivize themselves to avoid future borrowing, which implies that they perceive themselves to be present focused. Our novel approach to estimating $\beta$ 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 people to develop larger buffer stocks might increase welfare.

In the context of our structural model of borrowing and repayment, our finding of present focus with temporary naivete implies that payday loan bans and tightened loan size caps are likely to harm borrowers. Rollover restrictions could slightly increase welfare by inducing faster repayment in line with long-run preferences, although they reduce welfare under alternative parameterizations. 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.

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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 | 5.37 |  | 6.03 |
|  | (2.93) |  | (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**

|  | (1) Estimated $\beta/\tilde{\beta}$ | (2) Estimated $\tilde{\beta}$ | (3) Estimated $\beta$ |
|---|---|---|---|
| Primary estimate | 0.96 | 0.75 | 0.72 |
|  | (0.93, 1.00) | (0.72, 0.78) | (0.69, 0.75) |
| Assuming risk neutral ($\rho = 0$) | 0.95 | 0.87 | 0.83 |
|  | (0.90, 1.00) | (0.85, 0.90) | (0.78, 0.87) |
| $0 - 3$ loans in past six months | 0.84 | 0.78 | 0.66 |
|  | (0.68, 0.91) | (0.73, 0.82) | (0.51, 0.73) |
| 4+ loans in past six months | 1.00 | 0.74 | 0.74 |
|  | (0.96, 1.03) | (0.71, 0.77) | (0.70, 0.78) |
| Group observations by loans in past six months | 0.95 | 0.75 | 0.71 |
|  | (0.88, 0.98) | (0.72, 0.77) | (0.65, 0.74) |

Notes: Column 1 presents estimates of sophistication $\beta/\tilde{\beta}$ estimated using Equation (9). Column 2 presents estimates of perceived present bias $\tilde{\beta}$ using Equation (10). Column 3 presents estimates of $\beta$; this is a lower bound if some of misprediction is from factors other than naivete about present focus. The bottom row defines 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) $\theta \sim Beta(a_\theta, 1)$ | (2) $\theta \sim Beta(a_\theta, 0.02)$ |
|---|---|---|
| $\alpha$ | 0.0024 | 0.0024 |
| $\delta$ | 0.998 | 0.998 |
| $\beta$ | 0.72 | 0.72 |
| $\tilde{\beta}$ | 0.75 | 0.75 |
| $q$ | 0.97 | 0.97 |
| $\chi_0$ | 1.10 | 1.10 |
| $E[\theta]$ | 0.80 | 0.82 |
| $Var[\theta]$ | 0.028 | 0.134 |
| $E[\nu]$ | 2.28 | 1.52 |
| $Var[\nu]$ | 1.43 | 1.04 |

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. Columns 1 and 2 assume $\theta \sim Beta(a_\theta, 1)$ and $\theta \sim Beta(a_\theta, 0.02)$, respectively.

Table 4: **Simulated Borrower Behavior**

(a) **Assuming** $\theta \sim Beta(a_\theta, 1)$

| Row | Scenario | (1) Average loan size | (2) Probability of reborrowing | (3) Average amount repaid |
|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 400 | 0.53 | 504 |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 393 | 0.80 | 626 |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 421 | 0.80 | 675 |
| 4 | Heterogeneous | 384 | 0.72 | 669 |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 400 | 0.84 | 709 |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 391 | 0.78 | 611 |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 398 | 0.81 | 647 |
| 8 | Primary, heterogeneous, learning, consume in $t = 0$ | 417 | 0.72 | 744 |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 398 | 0.89 | 841 |
| 10 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 436 | 0.90 | 933 |

(b) **Assuming** $\theta \sim Beta(a_\theta, 0.02)$

| Row | Scenario | (1) Average loan size | (2) Probability of reborrowing | (3) Average amount repaid |
|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 393 | 0.79 | 617 |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 393 | 0.80 | 624 |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 423 | 0.80 | 672 |
| 4 | Heterogeneous | 392 | 0.80 | 626 |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 393 | 0.80 | 624 |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 392 | 0.80 | 626 |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 393 | 0.80 | 625 |
| 8 | Primary, heterogeneous, learning, consume in $t = 0$ | 429 | 0.80 | 688 |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 393 | 0.81 | 632 |
| 10 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 435 | 0.81 | 696 |

Notes: Panels (a) and (b) assume $\theta \sim Beta(a_\theta, 1)$ and $\theta \sim Beta(a_\theta, 0.02)$, respectively. 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 $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.72$, $\tilde{\beta}_0 = 0.86$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

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

### (a) **Assuming $\theta \sim Beta(a_\theta, 1)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 91.9% | 99.6% | 96.0% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 97.6% | 90.0% | 98.1% | 93.3% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 97.2% | 89.8% | 97.8% | 92.7% |
| 4 | Heterogeneous | 94.3% | 87.4% | 97.8% | 89.2% |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 95.3% | 88.3% | 98.0% | 90.5% |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 97.9% | 90.3% | 98.2% | 93.7% |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 97.2% | 89.7% | 98.1% | 92.6% |
| 8 | Primary, heterogeneous, learning, consume in $t = 0$ | 93.8% | 87.3% | 97.0% | 88.3% |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 90.9% | 84.7% | 97.2% | 85.0% |
| 10 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 89.1% | 83.7% | 96.3% | 82.4% |

### (b) **Assuming $\theta \sim Beta(a_\theta, 0.02)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | Time consistent | 100.0% | 92.6% | 87.3% | 85.6% |
| 2 | Consume in $t > 0$ | 98.3-99.8% | 91.1-92.5% | 84.1-88.6% | 82.1-87.1% |
| 3 | Consume in $t = 0$ | 96.5-99.4% | 90.1-92.1% | 81.1-87.8% | 78.4-86.2% |

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) assume $\theta \sim Beta(a_\theta, 1)$ and $\theta \sim Beta(a_\theta, 0.02)$, respectively. "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. In panel (a), 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 $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in rows 2 and 7, respectively. Row 7 models learning, assuming $\beta = 0.72, \tilde{\beta}_0 = 0.86$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 9 and 10 set $\beta$ and $\tilde{\beta}$ to match expert forecasts. In panel (b), row 2 presents the range of welfare across all scenarios where the loan does not affect current consumption, and row 3 presents the range of welfare across all scenarios where the loan is for present consumption in $t = 0$.

# Figures

Figure 1: **Identification of Partially Naive Present Focus**
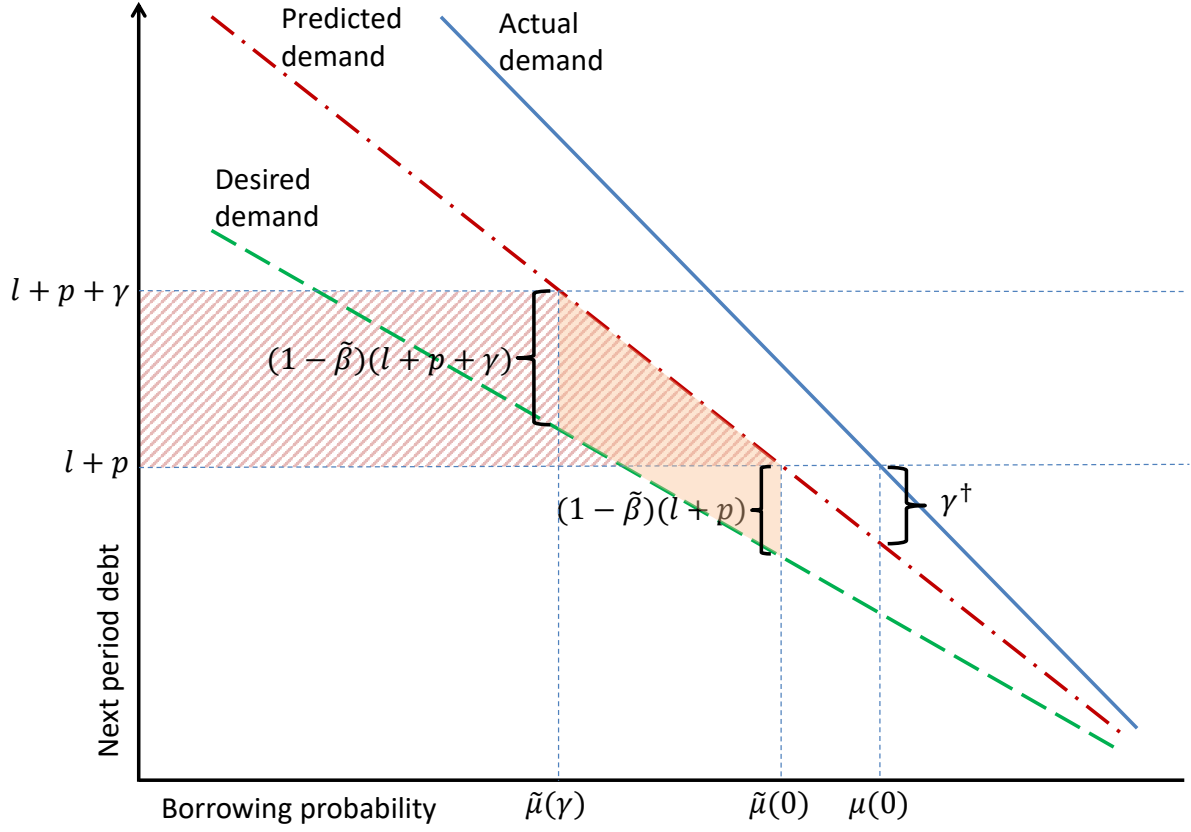


Notes: This figure illustrates identification of the partially naive present focus model assuming that the perceived continuation value for period $t+1$ is linear in debt owed. The y-axis plots the debt owed in period $t+1$ from borrowing principal $l$ in period $t$. The x-axis plots the probability of borrowing in period $t$ conditional on the $t-1$ information set. Predicted and desired demand are for period $t$ from the perspective of the period $t-1$ self.

Figure 2: **Predicted and Actual Borrowing**
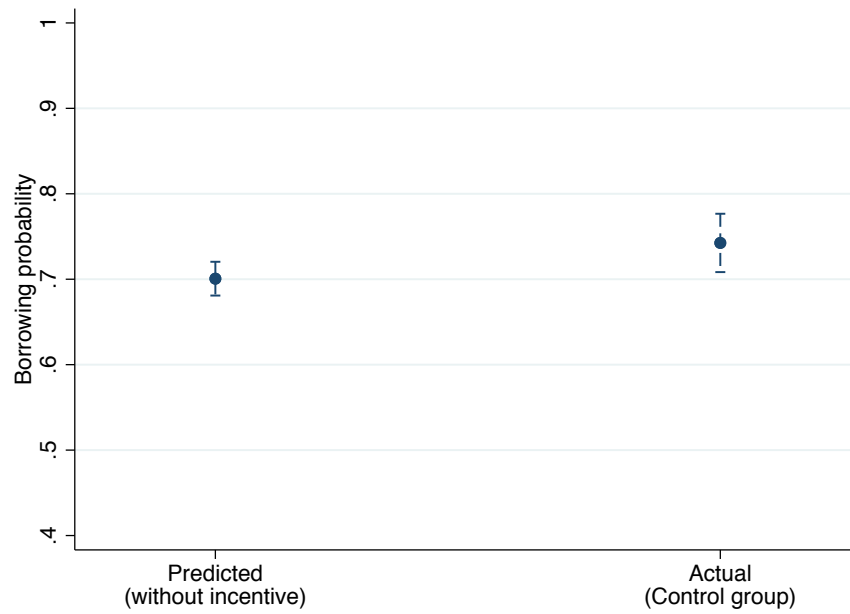


Notes: The left spike presents the average predicted probability of getting another payday loan in the next eight weeks without the no-borrowing incentive. The right spike presents the actual probability of getting another payday loan in the next eight weeks for the Control group, which did not receive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

Figure 3: **Misprediction by Experience**
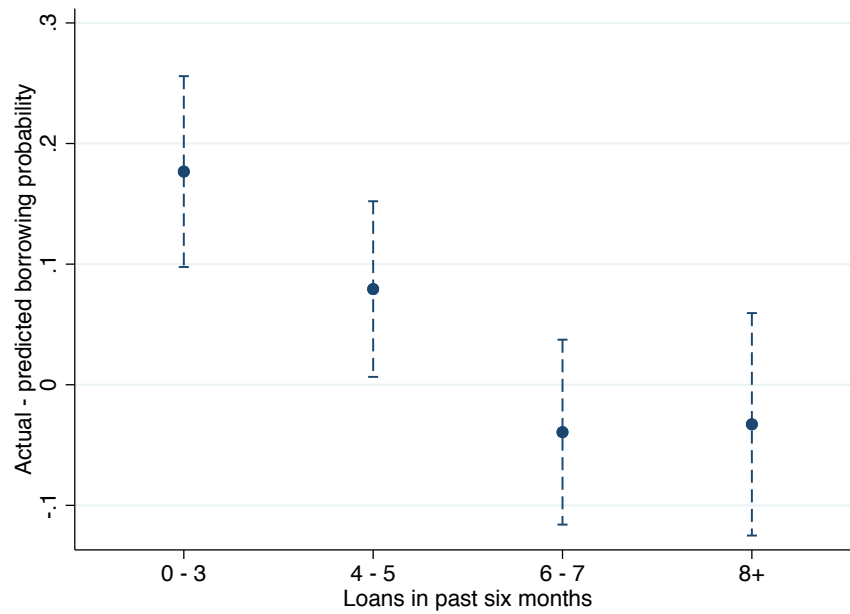


Notes: This figure presents the actual borrowing probability minus the average predicted borrowing probability for subgroups defined by the number of loans taken out from the Lender in the six months before taking the survey. This figure includes only the Control group.

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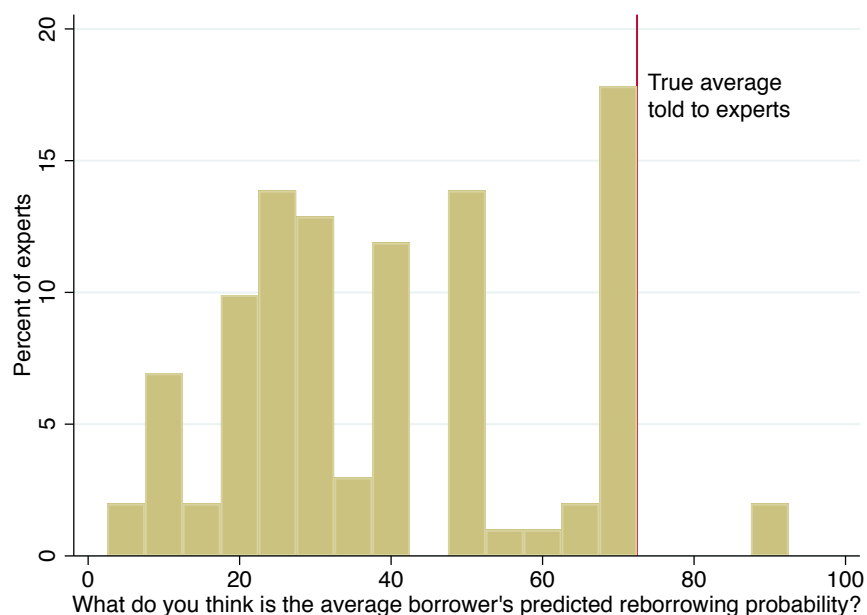


Notes: This is a histogram of experts' beliefs about the average borrower's predicted probability of borrowing again over the next eight weeks. Data are from our survey of expert opinion, which was administered before our paper was released. As a benchmark, we told experts that the true reborrowing probability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

Figure 5: **Responses to Qualitative Questions**

(a) **Desire for Motivation**



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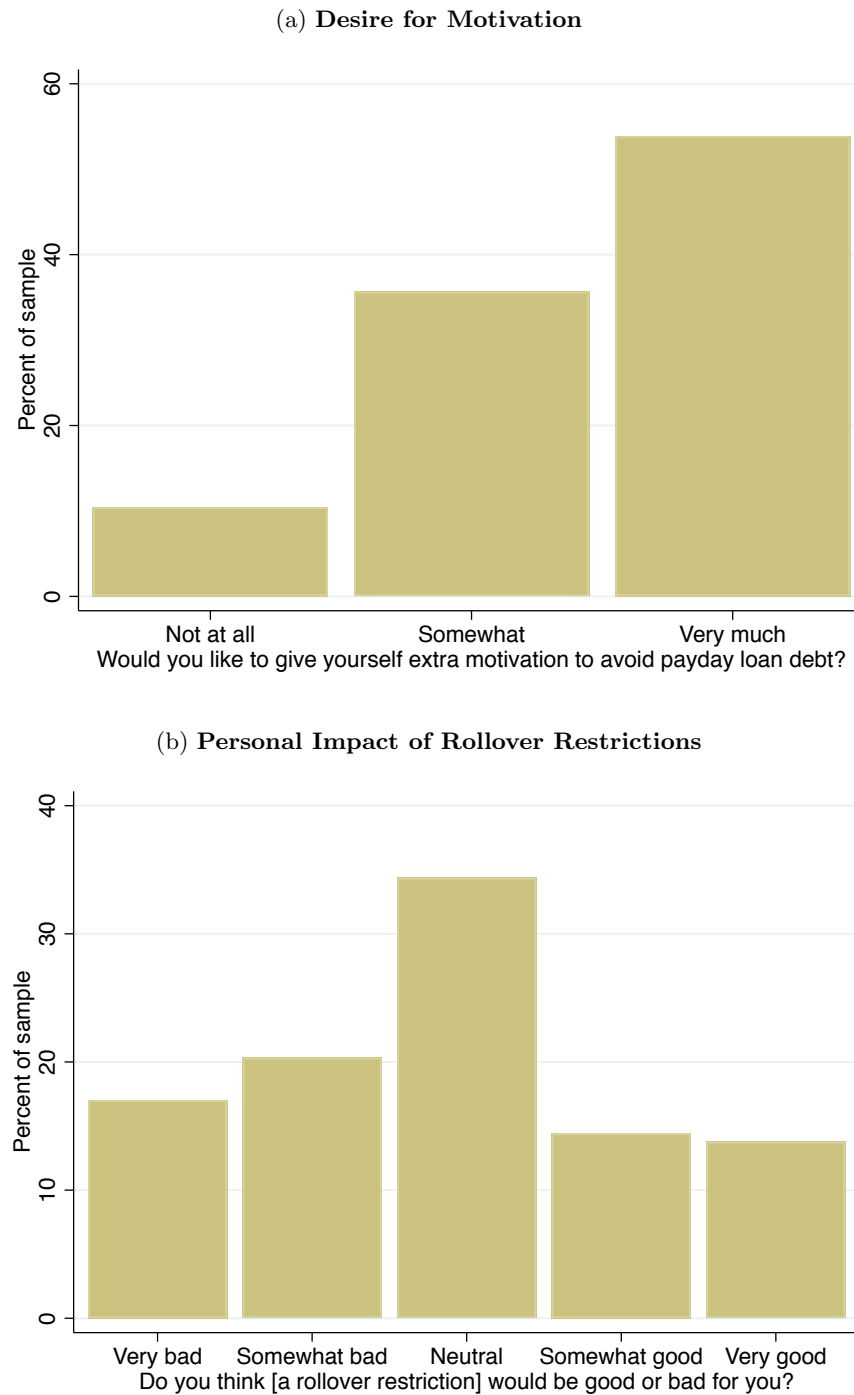


Notes: These are histograms of borrowers' responses to qualitative questions asked at the end of the survey. Panel (a) presents responses to the question, "To what extent would you like to give yourself extra motivation to avoid payday loan debt in the future?" Panel (b) presents responss to the question, "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 6: **Valuation of No-Borrowing Incentive and $100 Coin Flip**
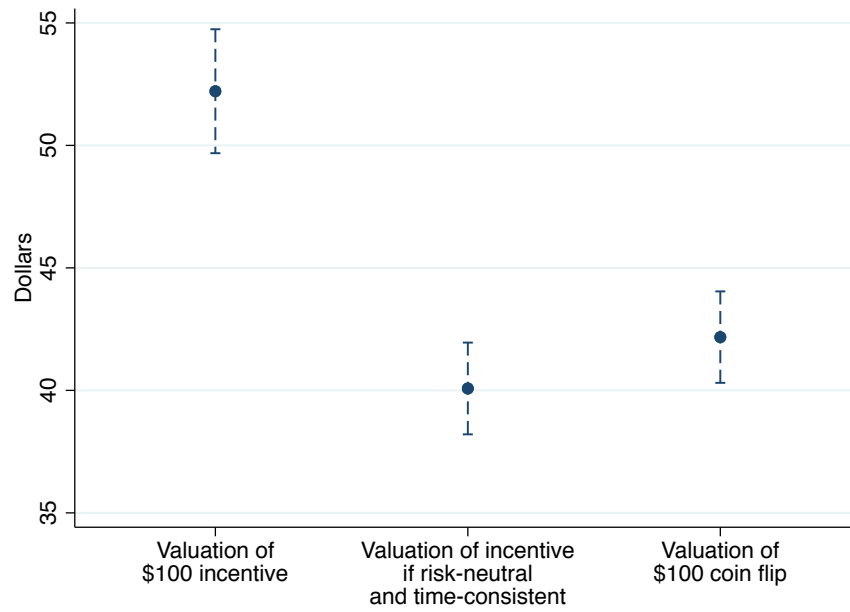


Notes: The first and third spikes are the average valuation of the $100 no-borrowing incentive and the $100 coin flip, respectively. The second spike is the average modeled valuation of the $100 no-borrowing incentive for a risk-neutral borrower who believes she is time consistent, which is $100 \times (1 - \bar{\bar{\mu}})$. Error bars represent 95 percent confidence intervals.

Figure 7: **Heterogeneity in Willingness-to-Pay for Motivation**

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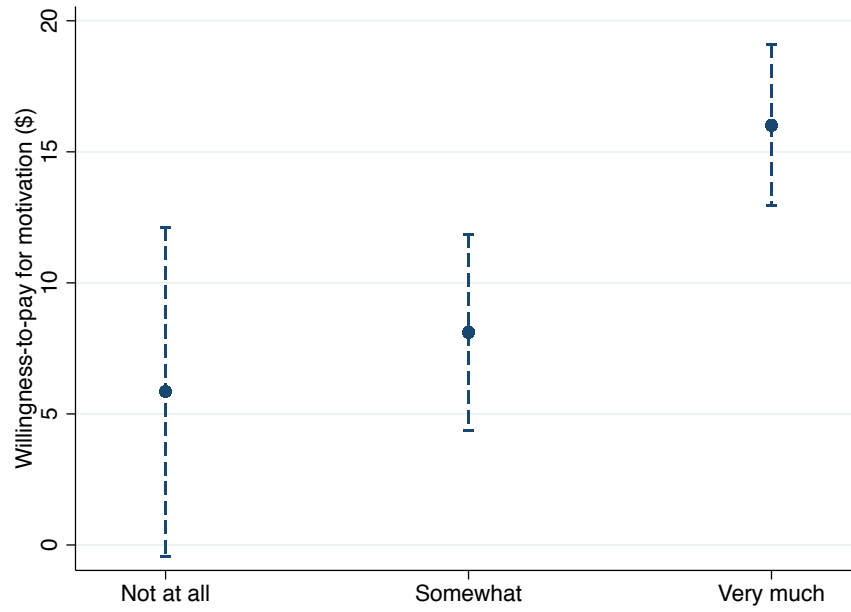


(b) **Heterogeneity by Personal Impact of Rollover Restrictions**
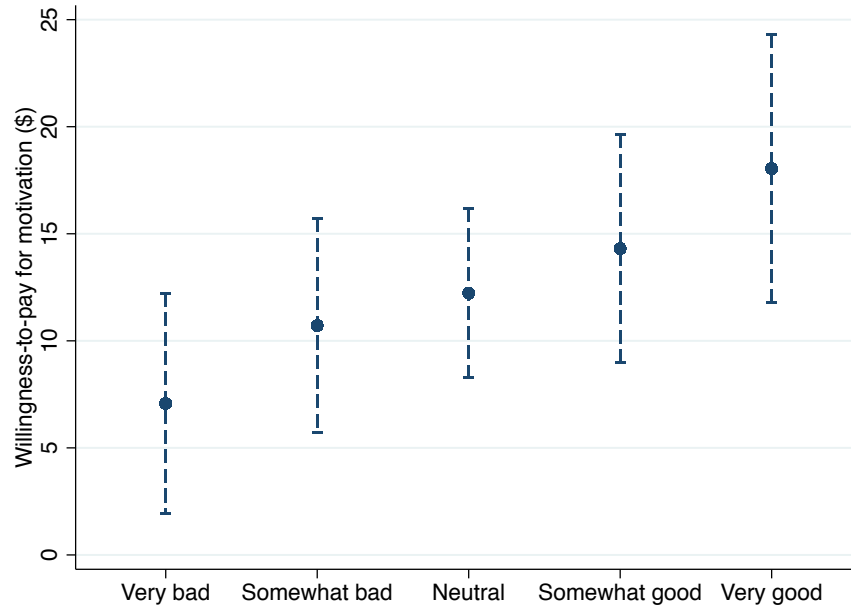


Notes: Willingness-to-pay for motivation equals $w - \$100 \times (1 - \bar{\bar{\mu}})$, the WTP for the no-borrowing incentive minus the WTP that a risk-neutral and time consistent borrower would have. Panel (a) presents heterogeneity by response to the question, "To what extent would you like to give 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?" Error bars represent 95 percent confidence intervals.

Figure 8: **Experts' Beliefs about Borrowers' Perceived Present Focus $\tilde{\beta}$**
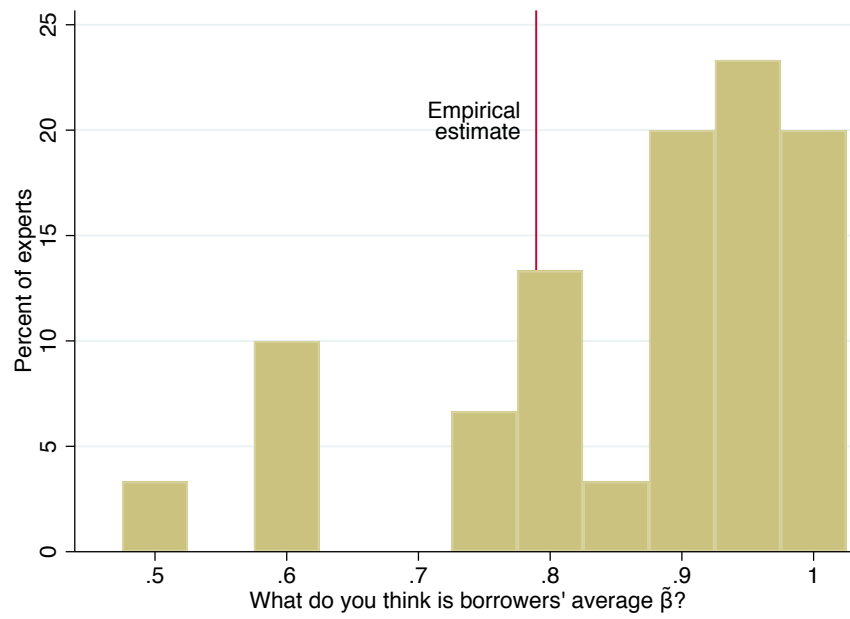


Notes: This is a histogram of experts' predictions of the average borrower's perceived present focus parameter $\tilde{\beta}$; this question was only asked of experts who said they had a PhD in economics. Data are from our survey of expert opinion, which was administered before our paper was released.

Figure 9: **Welfare Effects of Payday Loan Regulation**
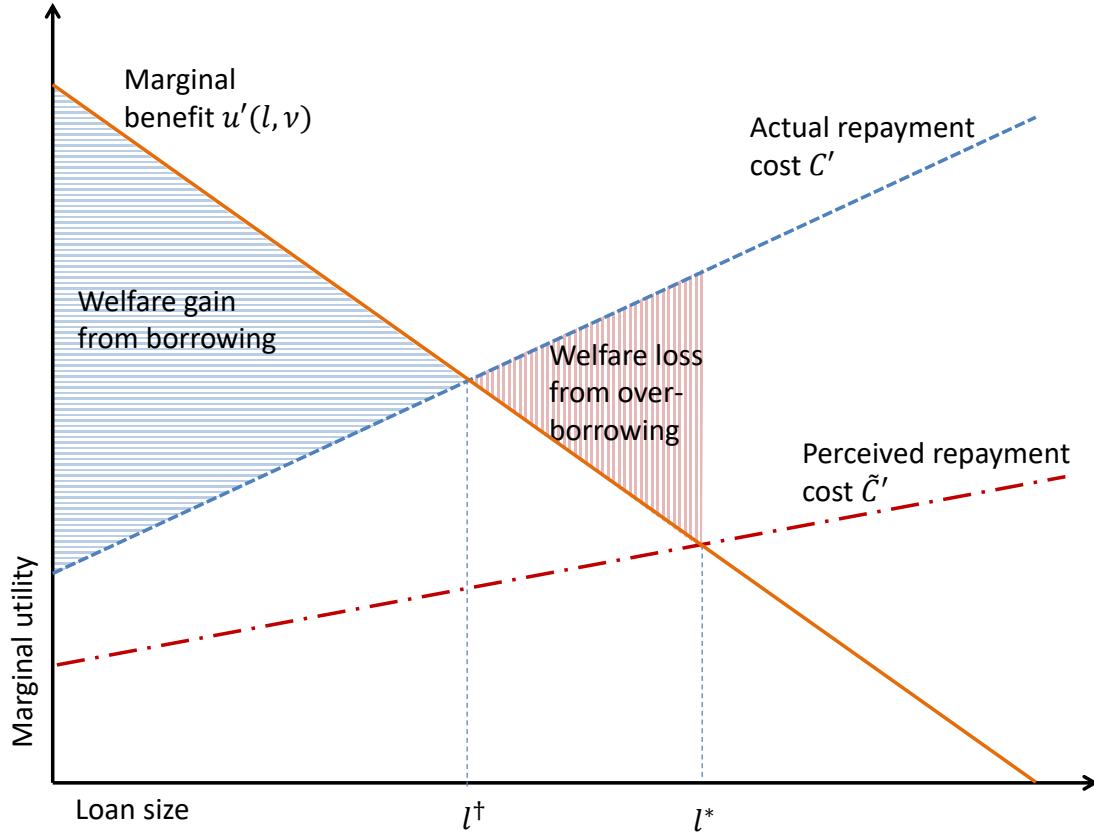


Notes: This figure shows how a borrower with a given loan demand shock $\nu$ determines her desired loan size $l$ in period $t = 0$. The downward sloping line is the marginal utility from borrowing an additional dollar, $u'(l, \nu)$. The two upward-sloping lines are the actual and perceived discounted expected values (as of $t = 0$, over the distribution of repayment cost shocks $\omega_t$) 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 10: **Experts Beliefs about Payday Loan Regulation**
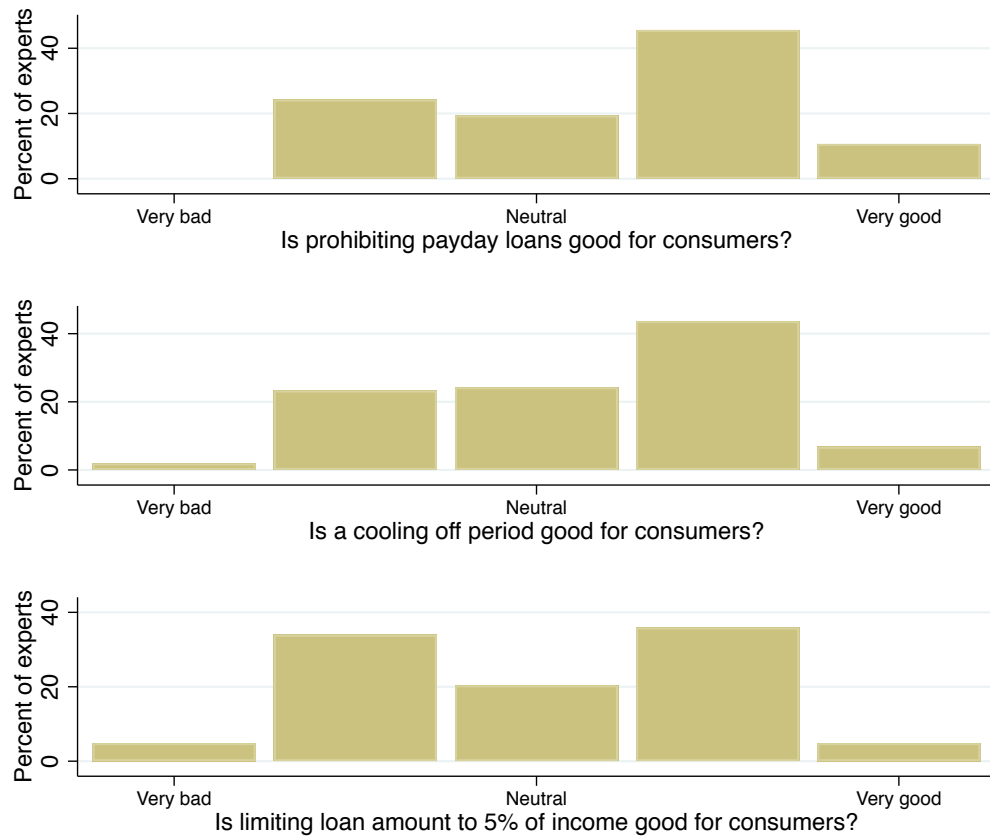


Notes: These are histograms of experts' beliefs about whether specific payday loan regulations are good or bad for consumers overall. Data are from our survey of expert opinion, which was administered before our paper was released.
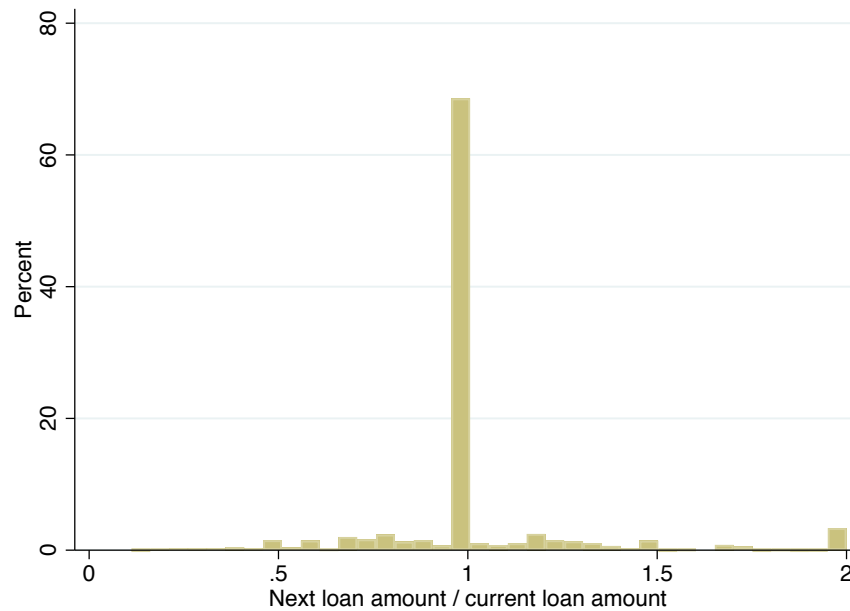
**Online Appendix: Not for Publication**

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

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

# 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 | 5.37 | 2.93 | 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, 1,202 for loans in past six months and reborrowed from Lender over next eight weeks, and 1,205 for all other variables.

Figure A2: **Distribution of Predicted Borrowing Probability**
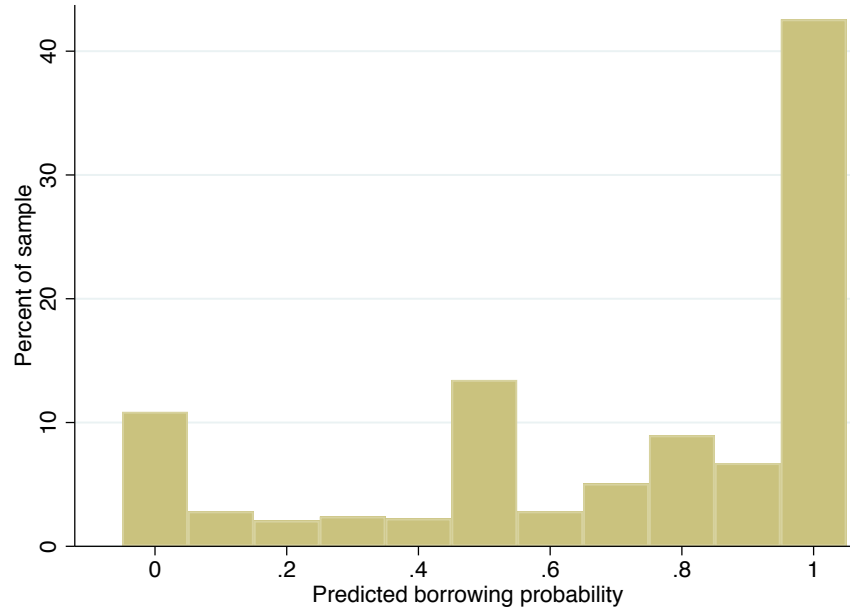


Notes: This figure presents the distribution of answers to the following question: "What do you think is the chance that you will get another payday loan from any lender before [eight weeks from now]?"

Figure A3: **Distribution of Predicted Borrowing Probability with No-Borrowing Incentive**
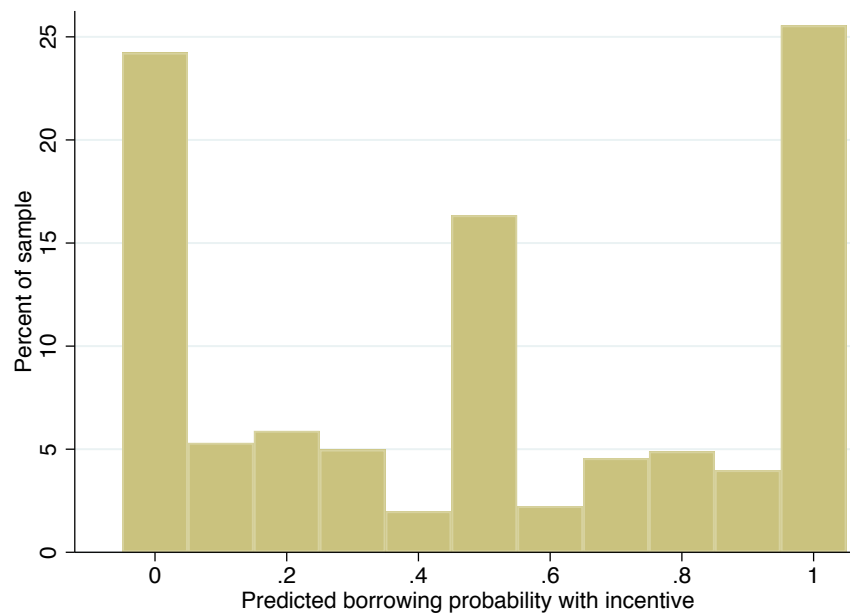


Notes: This figure presents the distribution of answers to the following question: **"If you are selected for $100 If You Are Debt-Free**, what is the chance that you would get another payday loan from any lender before [eight weeks from now]?"

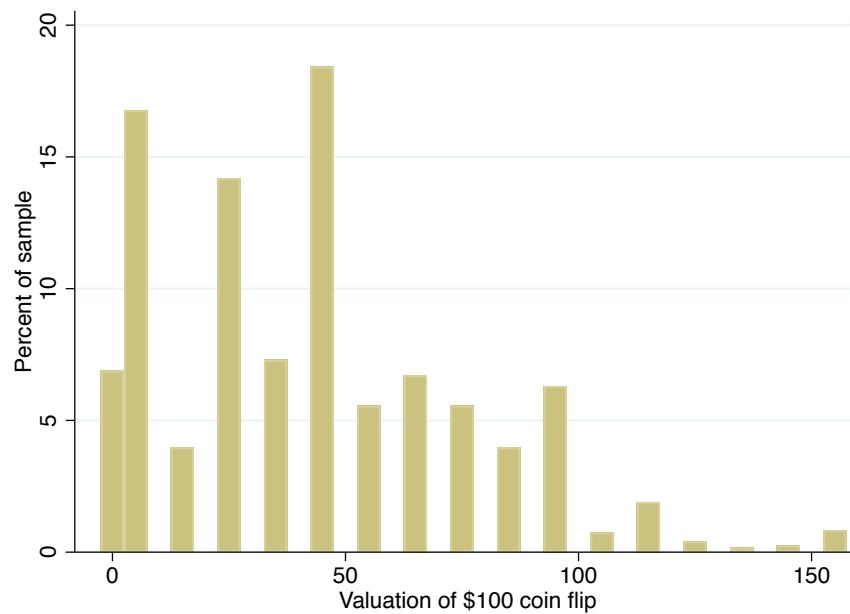Figure A4: **Distribution of Valuations of the No-Borrowing Incentive**
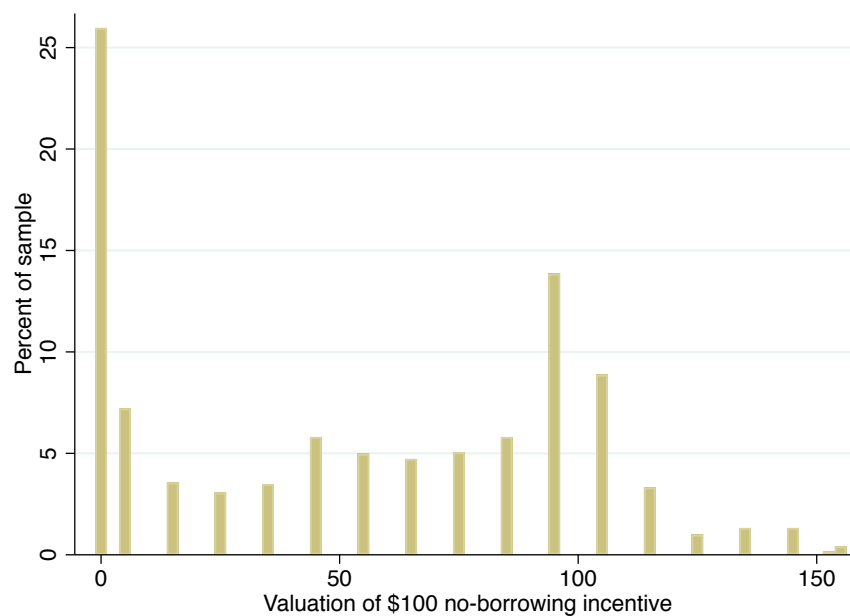


Notes: This figure presents the distribution of valuations of the $100 no-borrowing incentive, as revealed on a multiple price list.

Figure A5: **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.

Table A2: **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.

Table A3: **Balance**

| | (1) Control (SE) | (2) Incentive (SE) | (3) Difference (SE) |
|---|---|---|---|
| Loans in past six months | 5.32 | 5.45 | -0.13 |
| | (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) | | | 0.17 |
| F-test, number of observations | | | 1,174 |

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.

Figure A6: **Indiana Macroeconomic Trends Before and After Survey**
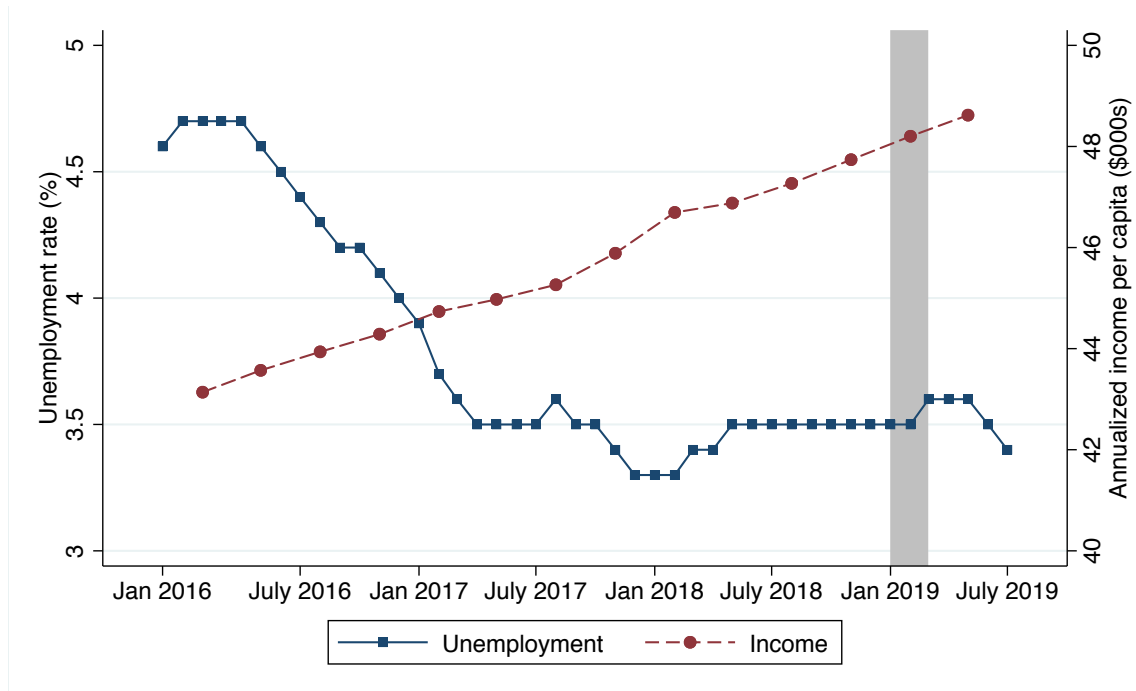


Notes: This figure presents the unemployment rate and average annualized income in Indiana during the study period and for the three years before. Unemployment rate is from the Federal Reserve Bank of St. Louis (2019). Income is in nominal dollars and is from BEA (2019). The grey shaded area illustrates 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    Empirical Results Appendix

Figure A7: **Predicted versus Actual Borrowing**
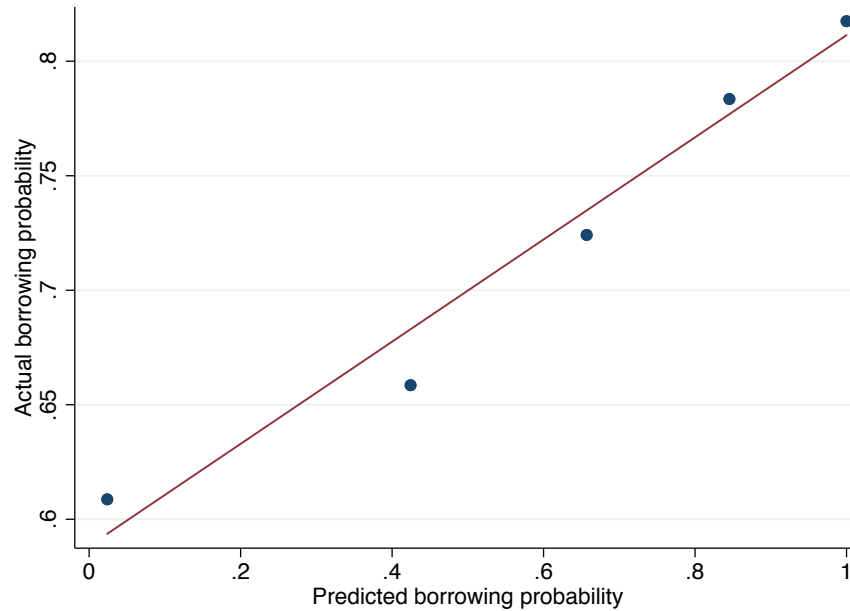


Notes: This figure presents a binned scatterplot of actual versus predicted probability of getting another payday loan in the next eight weeks after the survey, for the Control group. As is standard in belief elicitation surveys, the relationship is attenuated relative to the 45-degree line, due to factors such as noise in survey responses driven by gravitating toward focal numbers, accidentally clicking the wrong numbers, and cognitive difficulties in articulating probabilities. Our empirical strategy described in Section 3.4 allows for mean-zero survey response noise.

Figure A8: **Self-Reports about Actual vs. Expected Payday Borrowing in the Past**
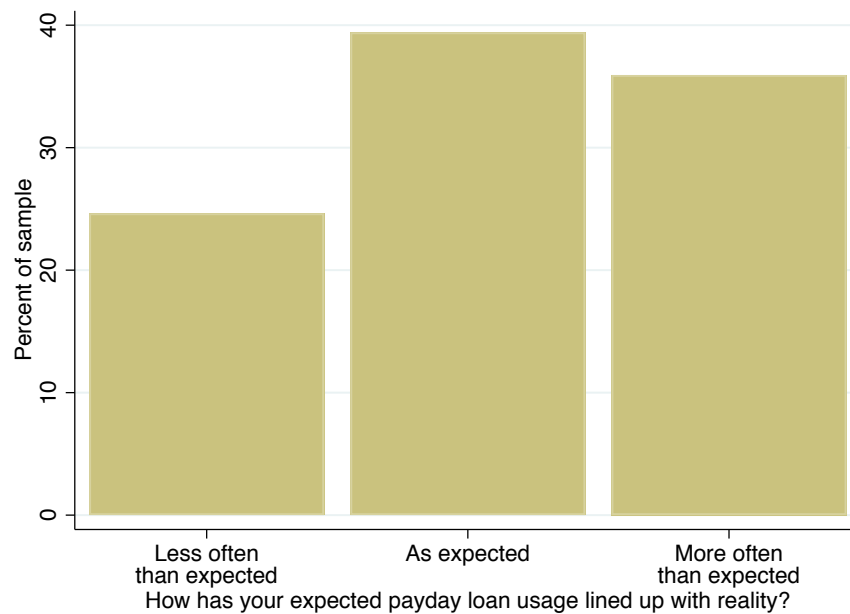


Notes: This figure presents a histogram of borrowers' responses to the following qualitative question asked at the end of the survey: "In the past, how has your expected payday loan usage lined up with reality?"

Figure A9: **Heterogeneity in Misprediction by Loan in Cycle**
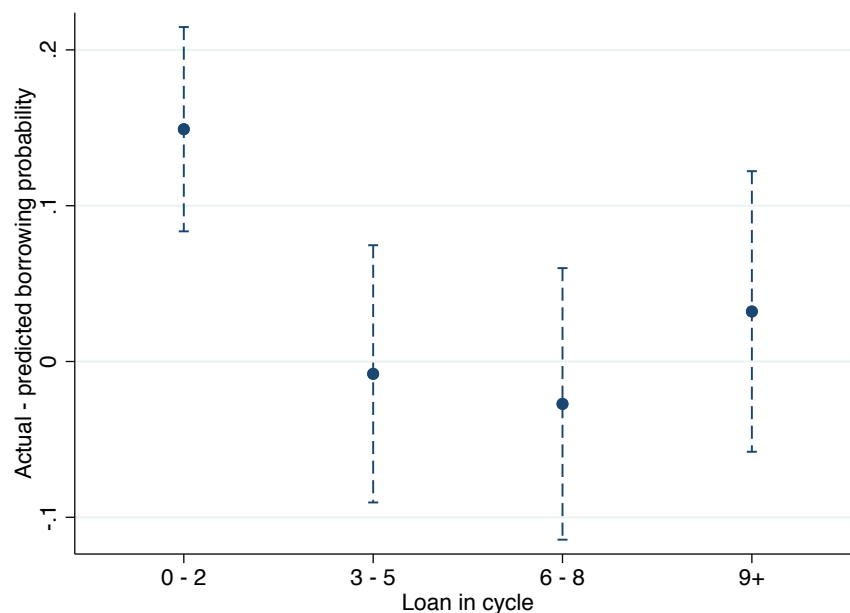


Notes: This figure presents the actual borrowing probability minus the average predicted borrowing probability for subgroups defined by the number of consecutive loans taken out from the Lender before the survey date. "Consecutive loans" are loans taken out within eight weeks of each other. The figure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

Figure A10: **Heterogeneity in Misprediction and Willingness-to-Pay for Motivation**
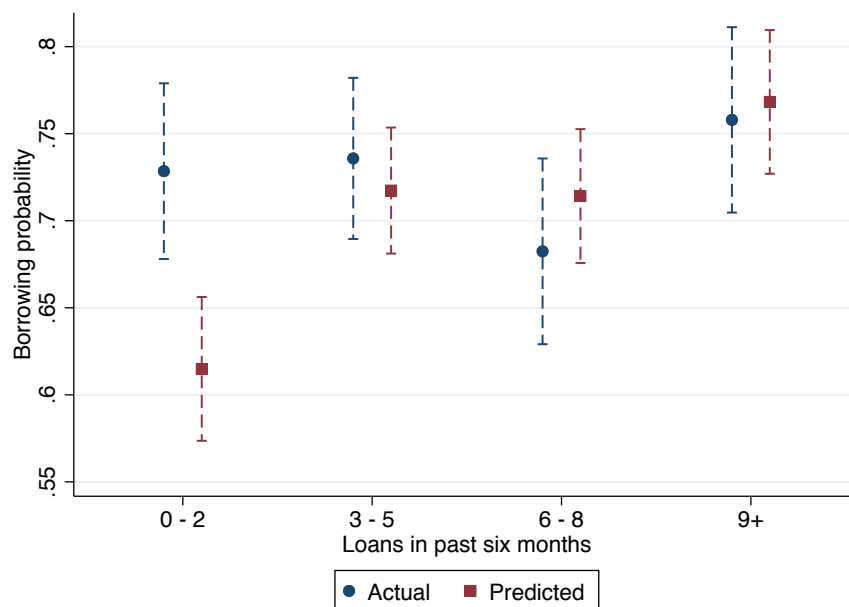


Notes: This figure presents the actual borrowing probability and the average predicted borrowing probability for subgroups defined by the number of loans taken out from the Lender in the six months before taking the survey. The figure includes only the Control group. Error bars represent 95 percent confidence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

Figure A11: **Heterogeneity in Misprediction and Willingness-to-Pay for Motivation**

(a) **Misprediction of Future Borrowing**



(b) **Willingness-to-Pay for Motivation**
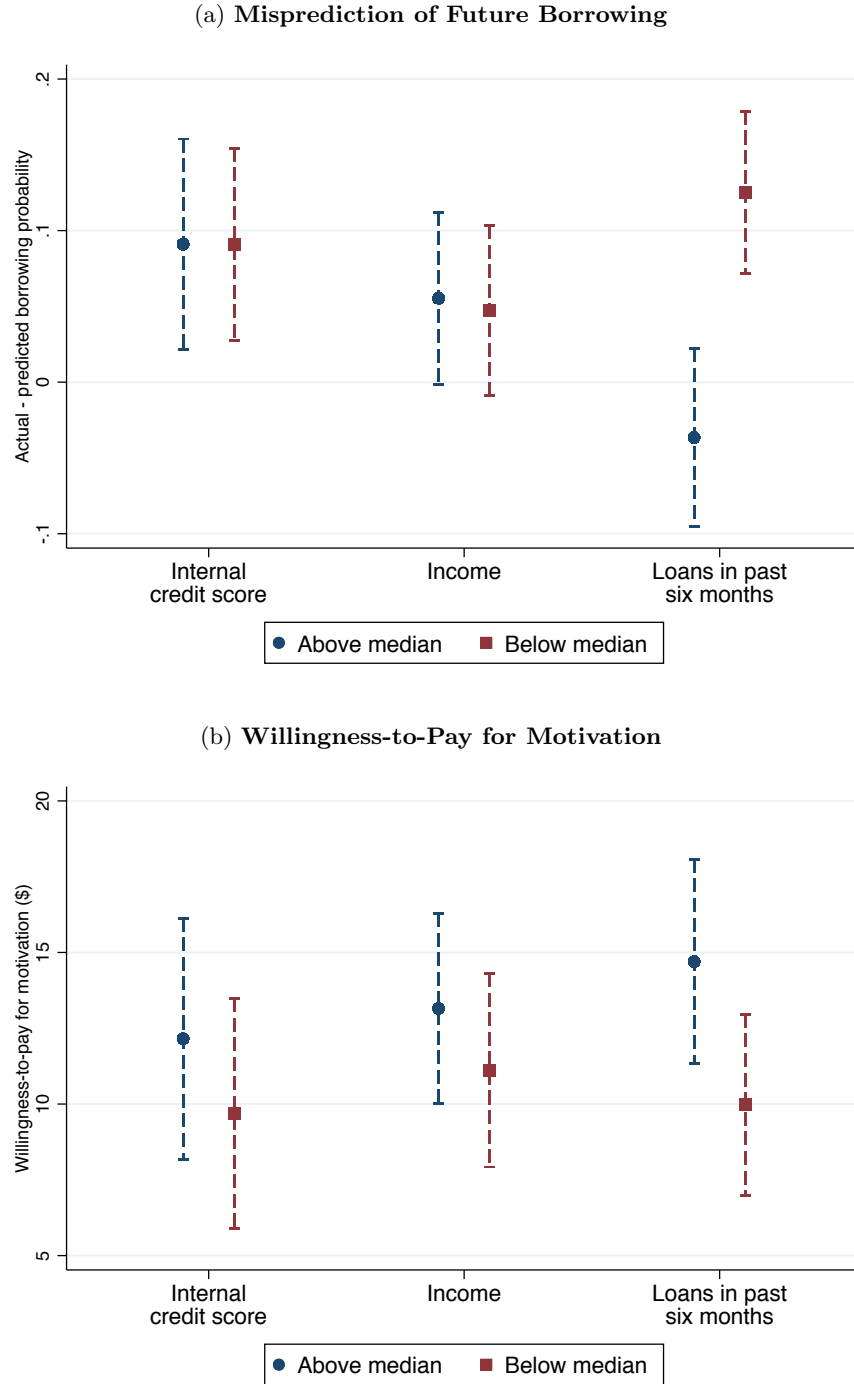


Notes: These figures present separate estimates after splitting the sample into above- vs. below-median internal credit score, income, and number of loans taken out between July 2018 and the day the borrower took the survey. Panel (a) includes only the Control group. Willingness-to-pay for motivation equals $w - \$100 \times (1 - \bar{\mu})$, the WTP for the no-borrowing incentive minus the WTP that a risk-neutral and time consistent borrower would have. Internal credit score is missing for approximately 1/3 of observations, so the average for that pair is different than the averages for the other two pairs. Error bars represent 95 percent confidence intervals.

Figure A12: **Heterogeneity in Partially Naive Present Focus Parameters**

(a) **Sophistication** $\beta/\tilde{\beta}$



(b) **Perceived Present Focus** $\tilde{\beta}$
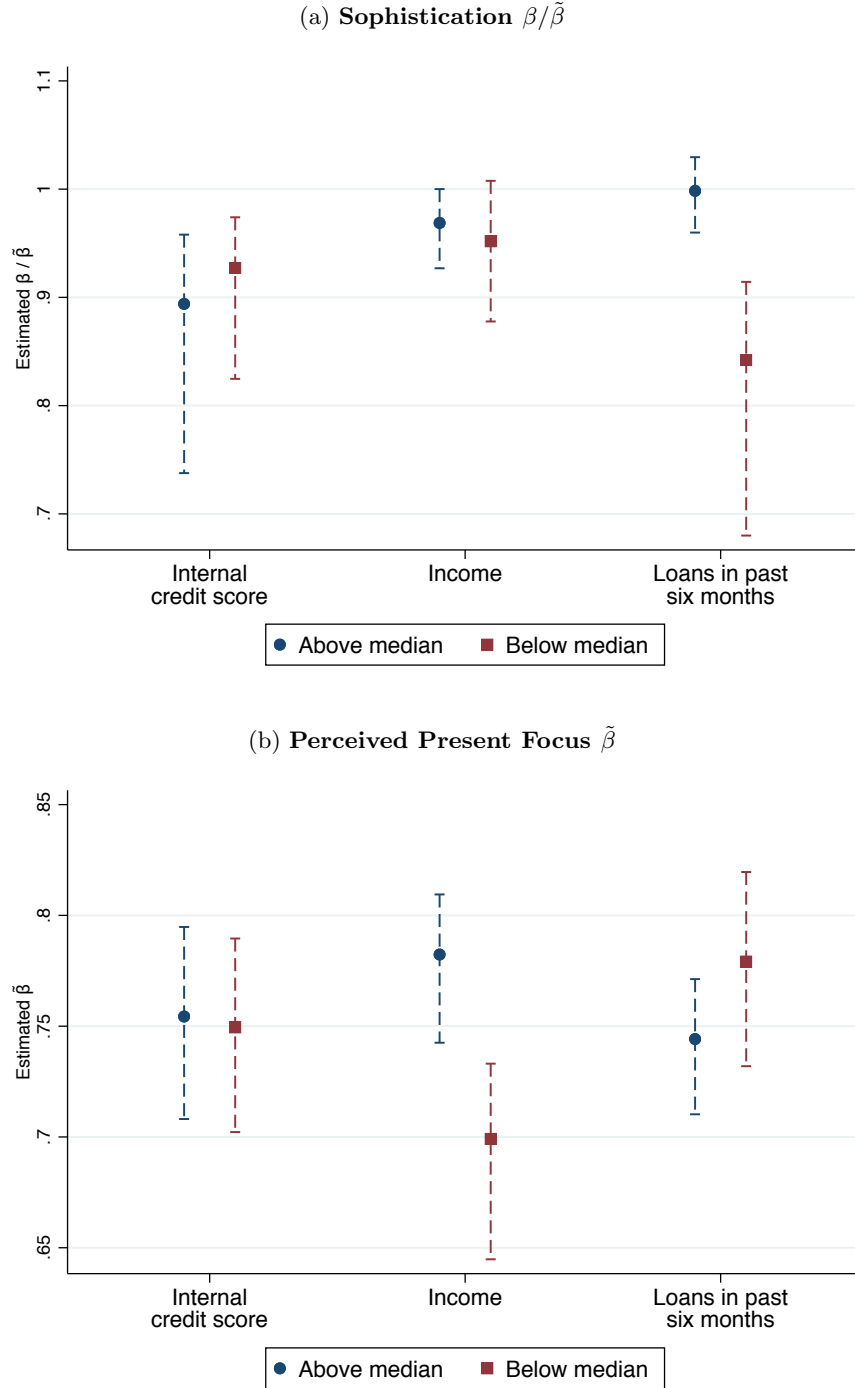


Notes: The figures present separate estimates after splitting the sample into above- vs. below-median internal credit score, income, and number of loans taken out between July 2018 and the day the borrower took the survey. Panel (a) presents estimates of sophistication $\beta/\tilde{\beta}$ estimated using Equation (9). Panel (b) presents estimates of perceived present focus $\tilde{\beta}$ using Equation (10). Internal credit score is missing for approximately 1/3 of observations, so the average for that pair is different than the averages for the other two pairs. Error bars represent 95 percent confidence intervals calculated using the bias-corrected percentile bootstrap.

Figure A13: **Heterogeneity in $\tilde{\beta}$**

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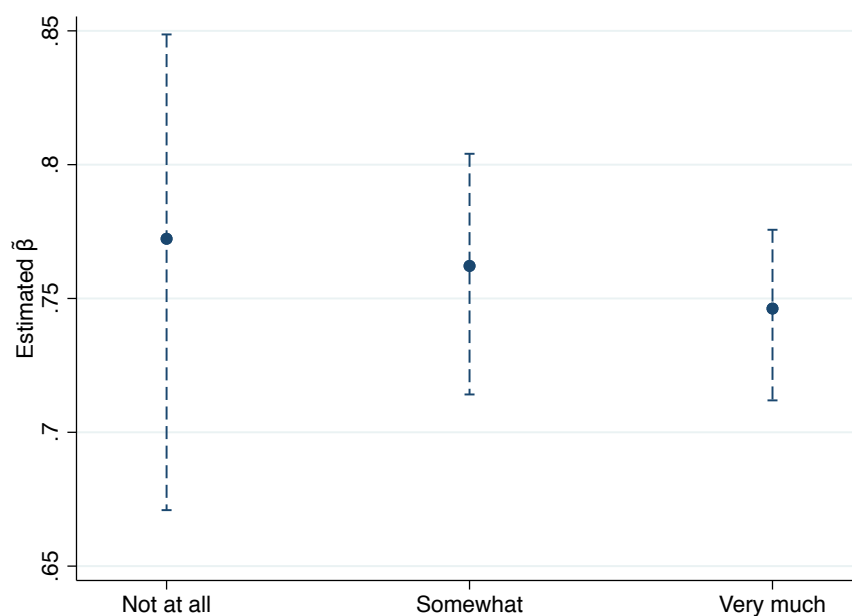


(b) **Heterogeneity in $\tilde{\beta}$ by Personal Impact of Rollover Restrictions**
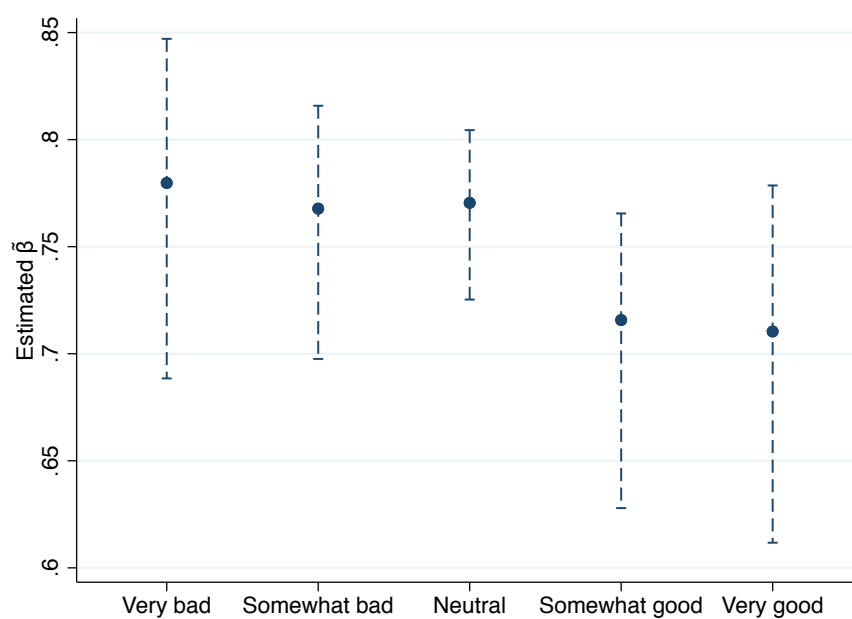


Notes: $\tilde{\beta}$ is estimated using Equation (10). Panel (a) presents heterogeneity by response to the question, "To what extent would you like to give yourself extra motivation to avoid payday loan debt in the future?" Panel (b) presents heterogeneity by response to the question, "Some states 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?" Error bars represent 95 percent confidence intervals calculated using the bias-corrected percentile bootstrap.

## C    Borrower Beliefs in Incentive Condition

The average borrower predicts that she has only a 50 percent chance of borrowing if offered the no-borrowing incentive, whereas in reality, 70 percent of borrowers in the Incentive group did borrow. There are at least three explanations for why predicted and actual behavior differ so much with the incentive. First, whereas repeat borrowers have had multiple opportunities to learn about their behavior in the status-quo Control condition, the no-borrowing incentive is new and unfamiliar, so forecasting behavior is more difficult. Second, people may have forgotten about the incentive offer, even though they are liquidity constrained and we sent two reminder emails. Indeed, 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.[35] These first two explanations might reinforce each other: the novelty of the incentive could lead borrowers to forget about it and also to fail to predict this forgetting. Third, our survey might have generated an experimenter demand effect that caused people to overstate the effect that the no-borrowing incentive would have on their borrowing.

While both of Equations (9) and (10), the estimating equations for $\tilde{\beta}$ and $\beta/\tilde{\beta}$, use predicted borrowing probability with the incentive $\tilde{\mu}(\gamma)$, neither uses actual borrowing probability with the incentive. Thus, as long as people correctly reported their beliefs $\tilde{\mu}(\gamma)$, as would be the case in the first two explanations, our parameter estimates are valid.

For example, consider a model with full naivete about imperfect prospective memory, so borrowers believe they will remember the no-borrowing incentive, whereas in reality they remember with probability $\psi \leq 1$ . In this case, the formulas for $\beta/\tilde{\beta}$ and $\tilde{\beta}$ are unaffected, and actual borrowing probability will be $\mu_\psi(\gamma) = (1 - \psi)\mu_{\psi=1}(0) + \psi\mu_{\psi=1}(\gamma)$, where $\mu_{\psi=1}(0)$ and $\mu_{\psi=1}(\gamma)$ are borrowing probabilities for the perfect memory case. Note that $\psi$ represents whether people remembered the no-borrowing incentive when deciding whether or not to reborrow over the next eight weeks, not whether people eventually claimed the no-borrowing incentive. Since people who did not borrow received an additional email instructing them to claim the no-borrowing incentive, the 44 percent claim rate is an upper bound on $\psi$.

If people under-reported their true $\tilde{\mu}(\gamma)$ on the survey, as would be the case in the third explanation, 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 demand is more inelastic to the incentive than people report, their WTP per expected 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 more inelastic than people report, a given amount of misprediction in the Control condition implies a larger difference in marginal utility.

To explore possible magnitudes, we estimate naivete and $\tilde{\beta}$ with alternative equations where we set $\Delta\tilde{\mu}$ to half its reported amount. That is, we assume that people report that the no-borrowing

---

[35]In follow-up surveys and email communications, some people who did not claim their $100 gift cards reported that they had trouble with the gift card vendor's processes. In these cases, we worked with the borrower and the gift card vendor to facilitate delivery.

incentive will reduce their borrowing probability by twice as much as they actually believe. Under this assumption, $\tilde{\beta}$ drops substantially to 0.47, and $\beta/\tilde{\beta}$ decreases to 0.93. Thus, it important to our interpretations that on average, people faithfully reported their perceived borrowing probability under the no-borrowing incentive, and did not expect that the no-borrowing incentive would have such small effect.

# D    Existence and Uniqueness of Equilibrium

We begin by considering the case in which $k_t$ 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 make several regularity assumptions on the distribution $\theta$ and the cost of repayment $k$.

**Assumption 1.** *The distribution of $\theta$ has a smooth density function $f$ with convex and compact support.*

**Assumption 2.** *$k(x, \theta, \eta)$ is twice differentiable in all three arguments.*

**Assumption 3.** *For all $x_2 > x_1$ and $\eta$, $k(x_2, \theta, \eta) - k(x_1, \theta, \eta)$ is increasing in $\theta$, with $\lim_{\theta \to \infty} k(x_2, \theta, \eta) - k(x_1, \theta, \eta) = \infty$.*

**Assumption 4.** *For all finite $x \geq 0$ and $\eta, \int_\theta k(x, \theta, \eta) dF(\theta) < \infty$.*

**Assumption 5.** *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 $\eta_t$ 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

$$\min\left(k(l + p, \theta_{t-1}, \eta_{t-1}), \beta\delta E[\tilde{r}(l, \theta, \eta)|\eta_{t-1}] + k(p, \theta_{t-1}, \eta_{t-1})\right) \geq \chi. \tag{13}$$

Conditional on not defaulting, the individual chooses to repay if

$$k(l + p, \theta_{t-1}, \eta_{t-1}) \leq \beta\delta E[\tilde{r}(l, \theta, \eta)|\eta_{t-1}] + k(p, \theta_{t-1}, \eta_{t-1}). \tag{14}$$

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

$$\min\left(k(l + p, \theta_{t-1}, \eta_{t-1}), \tilde{\beta}\delta E[\tilde{r}(lp, \theta, \eta)|\eta_{t-1}] + k(p, \theta_{t-1}, \eta_{t-1})\right) \geq \chi, \tag{15}$$

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

$$k(l + p, \theta_{t-1}, \eta_{t-1}) \leq \tilde{\beta}\delta E[\tilde{r}(p, \theta, \eta)|\eta_{t-1}] + k(p, \theta_{t-1}, \eta_{t-1}). \tag{16}$$

We begin considering the case with infinite horizon, and with 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 $i$th 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

$$B_i(h) = \delta Pr(D(h, \eta_i))\chi$$
$$+ \int_{\theta \leq c(h, \eta_i)} \mathbf{1}_{\theta \notin D(h, \eta_i)} k(l + p, \theta, \eta_i) dF + \int_{\theta \geq c(h, \eta_i)} \mathbf{1}_{\theta \notin D(h, \eta_i)} \left(\delta\bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) dF, \tag{17}$$

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

$$k(l + p, c, \eta) = \tilde{\beta}\delta\bar{h}(\eta) + k(p, c, \eta), \tag{18}$$

which is unique by Assumption 3, and

$$D(h, \eta_i) := \{\theta| \min\left(k(l + p, \theta, \eta_i), \tilde{\beta}\delta\bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) \geq \chi\}. \tag{19}$$

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

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,

$$B_i(h) = \int_{\theta \geq m^+(h,\eta_i)} \chi f(\theta) d\theta + \int_{\theta \leq m^-(h,\eta_i)} k(l+p,\theta,\eta_i) f(\theta) d\theta \tag{20}$$

$$+ \int_{c(h,\eta_i) \leq \theta \leq m_i^+(h,\eta_i)} \left( \delta \bar{h}(\eta_i) + k(p,\theta,\eta_i) \right) f(\theta) d\theta, \tag{21}$$

where the integral in Equation (21) 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 5, this implies that $\bar{h}(\eta_i) \geq \bar{h}'(\eta_i)$. Since $\bar{h}(\eta_i) - \bar{h}'(\eta_i) \leq h(\eta_i) - h'(\eta_i)$ by construction, we obtain the contradiction that

$$\begin{aligned} h(\eta_i) - h'(\eta_i) &= B_i(h) - B_i(h') \\ &< \bar{h}(\eta_i) - \bar{h}'(\eta_i) \\ &\leq h(\eta_i) - h'(\eta_i). \end{aligned} \tag{22}$$

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 $\theta$ (consumers never default at $\eta_i$). 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 3.

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

$$B_i(h) = \int_{\theta \leq d(h,\eta_i)} k(l+p,\theta,\eta_i) f(\theta) d\theta + \int_{d(h,\eta_i) \leq \theta} \chi f(\theta) d\theta \tag{23}$$

$$\frac{\partial}{\partial \bar{h}(\eta_i)} B_i = (k(l+p,d,\eta_i) - \chi) \frac{\partial d}{d\bar{h}(\eta_i)} f(d) \tag{24}$$

$$= 0.$$

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

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

$$+ \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \left( \delta \bar{h}(\eta_i) + k(p, \theta, \eta_i) \right) f(\theta) d\theta + \int_{\theta > d(h,\eta_i)} \chi f(\theta) d\theta, \tag{25}$$

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

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

$$= -(1 - \tilde{\beta}) \delta \bar{h}(\eta_i) f(c) \frac{\partial c}{\partial \bar{h}(\eta_i)} + (1 - \tilde{\beta}) \delta \bar{h}(\eta_i) f(d) \frac{\partial d}{\partial \bar{h}(\eta_i)} + \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \delta f(\theta) d\theta$$

$$< \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \delta f(\theta) d\theta \leq \delta. \tag{26}$$

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,

$$B_i(h) = \int_{\theta \leq c(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta + \int_{c(h,\eta_i) \leq \theta} \left( \delta \bar{h}(\eta_i) + k(p, \theta, \eta_i) \right) f(\theta) d\theta \tag{27}$$

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

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

$$< \int_{c(h,\eta_i) \leq \theta} \delta f(\theta) d\theta \leq \delta \tag{28}$$

It is clear that the derivative in the third case is the limit case in which $d$ approaches the supremum of the support of $\theta$. 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.

# E    Proofs for Section 3

## E.1    Proof of Proposition 1

*Proof.* Define

$$G(b) := \beta E_{G(\cdot|\eta_{t-1})}[\tilde{C}_{t+1}(l+p,\eta) - \tilde{C}_{t+1}(0,\eta)] - \tilde{\beta}E_{G(\cdot|\eta_{t-1})}[\tilde{C}_{t+1}(l+p,\eta) - \tilde{C}_{t+1}(b,\eta)]. \quad (29)$$

We then have that up to negligible high-order terms,

$$G(b) \approx \beta E_{G(\cdot|\eta_{t-1})}\left[\tilde{C}'(0,\eta)(l+p) + \frac{\tilde{C}''_{t+1}(0,\eta)}{2}(l+p)^2\right]$$

$$- \tilde{\beta}E_{G(\cdot|\eta_{t-1})}\left[(l+p-b)\tilde{C}'_{t+1}(0,\eta) + \frac{\tilde{C}''_{t+1}(0,\eta)}{2}(l+p-b)(l+p+b)\right]$$

$$= \beta E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1} \cdot (l+p)(1 + \alpha/2 \cdot (l+p)) - \tilde{\beta}(l+p-b)E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1} \cdot [1 + \alpha/2(l+p+b)]$$

$$= \beta E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1} \cdot (l+p)(1 + \rho/2) - \tilde{\beta}(l+p-b)E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1} \cdot (1 + \rho/2 + \alpha b/2). \quad (30)$$

Setting $G(\gamma^\dagger) = 0$ and dividing through by $E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1}$, we have

$$\beta(l+p)(1 + \rho/2) = \tilde{\beta}(l+p-\gamma^\dagger) \cdot (1 + \rho/2 + \alpha\gamma^\dagger/2), \quad (31)$$

and thus

$$\frac{\beta}{\tilde{\beta}} \approx \frac{1 + \rho/2 + \alpha\gamma/2}{1 + \rho/2}\frac{l+p-\gamma^\dagger}{l+p}. \quad (32)$$

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

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

$$\approx \gamma\frac{\mu(0,0) - \tilde{\mu}(0,0)}{\tilde{\mu}(0,0) - \tilde{\mu}(\gamma,0)}. \quad (33)$$

$\square$

## E.2    Proof of Proposition 2

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

$$k_t(l+p, \theta_t, \eta_t) - k_t(p, \theta_t, \eta_t) \leq \tilde{\beta}[\tilde{C}_{t+1}(l+p+a, \eta_t) - \tilde{C}_{t+1}(a-b, \eta_t)], \qquad (34)$$

where $a$ is the additional amount of debt and $b$ is the size of the no-borrowing incentive. The assumption that $\frac{\frac{d}{dx}k_t(x,\omega_t)|_{x=x_1}}{\frac{d}{dx}\tilde{C}_{t+1}(x,\omega_t)|_{x=x_2}}$ and $\frac{d}{dx}\tilde{C}_{t+1}(x,\omega_t)|_{x=x_2}$ are independent implies that $\frac{k_t(l+p,\omega_t)-k_t(p,\omega_t)}{\tilde{C}_{t+1}(l+a+b,\omega_t)-\tilde{C}_{t+1}(a,\omega_t)}$ is independent of $\tilde{C}'_{t+1}(x,\eta_t)$. Now if $\tilde{C}'_{t+1}$ is a function of $\eta$ then the condition implies that $\frac{k_t(l+p,\omega_t)-k_t(p,\omega_t)}{\tilde{C}_{t+1}(l+p+a,\omega_t)-\tilde{C}_{t+1}(a-b,\omega_t)}$ must be constant in $\eta$ for the assumption to be satisfied, and thus that the perceived probability of reborrowing is constant in $\eta$. For $\tilde{C}'_{t+1}$ to always be constant in $\eta$ it must be that $k_t$ is always constant in $\eta$, which again implies that $\tilde{\mu}$ is not a function of $\eta$.

We can thus define a cutoff $\theta^\dagger$ such that Equation (34) holds with equality at $\theta = \theta^\dagger(\eta)$. Then

$$\frac{d\theta^\dagger}{db} = \tilde{\beta}\frac{\tilde{C}'_{t+1}(x-b)}{k'_\theta(l+p, \theta^\dagger, \eta) - k'_\theta(p, \theta^\dagger, \eta)} \qquad (35)$$

$$\frac{d\theta^\dagger}{da} = \tilde{\beta}\frac{\tilde{C}'_{t+1}(l+p+a, \eta) - \tilde{C}'_{t+1}(a-b, \eta)}{k'_\theta(l+p, \theta^\dagger, \eta) - k'_\theta(p, \theta^\dagger, \eta)}. \qquad (36)$$

Thus

$$\rho := \frac{\tilde{\mu}'_a}{\tilde{\mu}'_b} = \frac{\frac{d\theta^\dagger}{da}}{\frac{d\theta^\dagger}{db}} = \frac{\tilde{C}'_{t+1}(l+p+a, \eta)}{\tilde{C}'_{t+1}(a-b, \eta)} - 1. \qquad (37)$$

Now

$$\frac{\tilde{C}'_{t+1}(l+p+a, \eta)}{\tilde{C}'_{t+1}(a-b))} - 1 = \frac{\tilde{C}'_{t+1}(l+p+a, \eta) - \tilde{C}'_{t+1}(a-b, \eta)}{\tilde{C}'_{t+1}(a-b)}$$

$$= \frac{(l+p+b)\tilde{C}''_{t+1}(a-b, \eta)}{\tilde{C}'_{t+1}(a-b, \eta)} + O((l+p+b)\tilde{C}'''_{t+1}(a-b, \eta))$$

$$= (l+p+b)\alpha(a, b, \eta) + O((l+p+b)^2\tilde{C}'''_{t+1}(a-b, \eta)). \qquad (38)$$

Thus $\alpha(a, b, \eta) = \frac{\rho}{l+p+b} + O((l+p+b)\tilde{C}'''_{t+1}(l+a+b))$, and thus does not vary with $\eta$ up to negligible higher order terms. Moreover,

$$\frac{d}{da}\frac{\tilde{\mu}'_a}{\tilde{\mu}'_b} = \frac{\tilde{\mu}''_{aa}\tilde{\mu}'_b - \tilde{\mu}''_{ab}\tilde{\mu}'_a}{(\tilde{\mu}'_b)^2}, \qquad (39)$$

and thus terms of order $\gamma^2\frac{d}{da}\frac{\tilde{\mu}'_a}{\tilde{\mu}'_b}$ are negligible, which also means that terms of order $a^2\alpha'_a(a, b)$ are negligible.

Now let

$$V(a, b, \eta_{t-1}) := E_{G(\cdot|\eta_{t-1})} \times$$

$$\left[ \int [k(l+p, \theta, \eta_t) + \tilde{C}_{t+1}(a-b)]dF + \int_{\theta > \theta^\dagger} [k(p, \theta) + \tilde{C}_{t+1}(l+p+a)]dF \right] \qquad (40)$$

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

Ignoring higher-order negligible terms, we have

$$-\frac{dV}{db}(a, b, \eta_{t-1}) = E_{G(\cdot|\eta_{t-1})} \left[ (1-\tilde{\mu})\tilde{C}'_{t+1}(a-b, \eta) - (1-\tilde{\beta})(\tilde{C}_{t+1}(l+p+a, \eta) - \tilde{C}_{t+1}(a-b, \eta))\tilde{\mu}'_b \right]$$

$$= E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1}(a-b, \eta) \left[ 1 - \tilde{\mu} - (1-\tilde{\beta})\frac{\tilde{C}_{t+1}(l+p+a, \eta) - \tilde{C}_{t+1}(a-b, \eta)}{\tilde{C}'_{t+1}(a-b, \eta)}\tilde{\mu}'_b \right]$$

$$= E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1}(a-b, \eta) \left[ 1 - \tilde{\mu} - (1-\tilde{\beta})\frac{(l+p+b)\tilde{C}'_{t+1} + (l+p+b)^2/2\tilde{C}''_{t+1}}{\tilde{C}'_{t+1}}\tilde{\mu}'_b \right]$$

$$= E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1}(a-b, \eta) \left[ 1 - \tilde{\mu} - (1-\tilde{\beta})(l+p+b)\tilde{\mu}'_b - (1-\tilde{\beta})(l+p+b)^2\alpha(a,b)/2\tilde{\mu}'_b \right]$$

$$= E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1}(a-b, \eta) \times$$

$$\left[ 1 - \tilde{\mu} - (1-\tilde{\beta})(l+p+b)\tilde{\mu}'_b - (1-\tilde{\beta})\frac{l+p+b}{2}\tilde{\mu}'_a \right]. \qquad (41)$$

Differentiating again, and ignoring negligible terms, yields

$$-\frac{d^2V}{db^2} = E_{G(\cdot|\eta_{t-1})}\tilde{C}'_{t+1}(a-b, \eta) \left[ -\tilde{\mu}'_b - (1-\tilde{\beta})\tilde{\mu}'_b - (1-\tilde{\beta})\frac{1}{2}\tilde{\mu}'_a \right]$$

$$- E_{G(\cdot|\eta_{t-1})}\tilde{C}''_{t+1}(a-b, \eta) \left[ 1 - \tilde{\mu} - (1-\tilde{\beta})(l+p+b)\tilde{\mu}'_b - (1-\tilde{\beta})\frac{l+p+b}{2}\tilde{\mu}'_a \right], \qquad (42)$$

which also implies that

$$-\frac{d^3V}{db^3} = -2E_{G(\cdot|\eta_{t-1})}\tilde{C}''_{t+1}(a-b, \eta) \left[ -\tilde{\mu}'_b - (1-\tilde{\beta})\tilde{\mu}'_b - (1-\tilde{\beta})/2\tilde{\mu}'_a \right] \qquad (43)$$

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

$$
\begin{aligned}
& - V_b|_{(0,0)}\gamma - V_b''|_{(0,0)}\gamma^2/2 - V_b'''|_{(0,0)}\gamma^3/6 \\
&= E_{G(\cdot|\eta_{t-1})}\gamma\tilde{C}_{t+1}'\left[1 - \tilde{\mu} - (1-\tilde{\beta})(l+p+\gamma)\tilde{\mu}_b' - (1-\tilde{\beta})\frac{l+p+\gamma}{2}\tilde{\mu}_a'\right] \\
&\quad + E_{G(\cdot|\eta_{t-1})}\frac{\gamma^2}{2}\tilde{C}_{t+1}'\left[-\tilde{\mu}_\gamma' - (1-\tilde{\beta})\tilde{\mu}_b' - (1-\tilde{\beta})/2\tilde{\mu}_a'\right] \\
&\quad - E_{G(\cdot|\eta_{t-1})}\frac{\gamma^2}{2}\tilde{C}_{t+1}''\left[1 - \tilde{\mu} - (1-\tilde{\beta})(l+p+\gamma)\tilde{\mu}_b' - (1-\tilde{\beta})\frac{l+p+\gamma}{2}\tilde{\mu}_a'\right] \\
&\quad - E_{G(\cdot|\eta_{t-1})}\frac{\gamma^3}{3}\tilde{C}_{t+1}''\left[-\tilde{\mu}_\gamma' - (1-\tilde{\beta})\tilde{\mu}_b' - (1-\tilde{\beta})/2\tilde{\mu}_a'\right] \\
&= E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}' \cdot (1 - \alpha\gamma/2)\left[\gamma(1 - \bar{\tilde{\mu}}(\gamma)) - (1-\tilde{\beta})\tilde{\Delta}(\gamma)(l+p+\frac{\gamma}{2})(1+\rho/2)\right]. \quad (44)
\end{aligned}
$$

Similarly, we compute how $V$ changes with respect to $a$.

$$
\begin{aligned}
\frac{dV}{da} &= E_{G(\cdot|\eta_{t-1})}\left[\tilde{\mu}\tilde{C}_{t+1}'(l+p+a, \eta) + (1-\tilde{\mu})\tilde{C}_{t+1}'(a-b, \eta) + (1-\tilde{\beta})(\tilde{C}_{t+1}(l+p+a, \eta) - \tilde{C}_{t+1}(a-b, \eta))\tilde{\mu}_a'\right] \\
&= E_{G(\cdot|\eta_{t-1})}\left[\tilde{\mu}\tilde{C}_{t+1}'(a-b, \eta) + (1-\tilde{\mu})\tilde{C}_{t+1}'(a-b, \eta) + \tilde{\mu}(l+p+b)\tilde{C}_{t+1}''(a-b, \eta)\right] \\
&\quad - E_{G(\cdot|\eta_{t-1})}\left[(1-\tilde{\beta})(\tilde{C}_{t+1}(l+p+a, \eta) - \tilde{C}_{t+1}(a-b, \eta))\tilde{\mu}_a'\right] \\
&= E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'(a-b, \eta)\left[1 + \tilde{\mu}(l+p+b)\alpha + (1-\tilde{\beta})\frac{\tilde{C}_{t+1}(l+p+a, \eta) - \tilde{C}_{t+1}(a-b, \eta)}{\tilde{C}_{t+1}'(a-b, \eta)}\tilde{\mu}_a'\right] \\
&= E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'(a-b, \eta)\left[1 + \tilde{\mu}(l+p+b)\alpha + (1-\tilde{\beta})\frac{(l+p+b)\tilde{C}_{t+1}' + (l+p+b)^2/2\tilde{C}_{t+1}''}{\tilde{C}_{t+1}'(l+p+a+b)}\tilde{\mu}_a'\right] \\
&= E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'(a-b, \eta)\left[1 + \tilde{\mu}(l+p+b)\alpha + (1-\tilde{\beta})(l+p+b)\tilde{\mu}_a' + (1-\tilde{\beta})(l+b)^2\alpha(a,b)/2\tilde{\mu}_a'\right] \\
&= E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'(a-b, \eta)\left[1 + \tilde{\mu}(l+p+b)\alpha + (1-\tilde{\beta})(l+p+b)\left(1 + \frac{l+p+b}{2}\alpha\right)\tilde{\mu}_a'\right]. \quad (45)
\end{aligned}
$$

Differentiating again yields

$$
\begin{aligned}
\frac{d^2V}{da^2} &= E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}' \cdot \tilde{\mu}_a'(l+p+b)\alpha \\
&\quad + E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'' \cdot \left[1 + \tilde{\mu}(l+p+b)\alpha + (1-\tilde{\beta})(l+p+b)\left(1 + \frac{l+p+b}{2}\alpha\right)\tilde{\mu}_a'\right] \quad (46)
\end{aligned}
$$

and

$$
\frac{d^3V}{da^3} = 2E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'' \cdot \tilde{\mu}_a'(l+p+b)\alpha, \quad (47)
$$

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

$$V_a|_{(0,0)}(-w) + V_a''|_{(0,0)}w^2/2 - V_a'''|_{(0,0)}w^3/6$$

$$= -wE_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}' \cdot \left[1 + \tilde{\mu}(l+p)\alpha + (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}_a'\right]$$

$$+ \frac{w^2}{2}E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}' \cdot \tilde{\mu}_a'(l+p)\alpha$$

$$+ \frac{w^2}{2}E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'' \cdot \left[1 + \tilde{\mu}(l+p)\alpha + (1-\tilde{\beta})(l)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}_a'\right]$$

$$- \frac{w^3}{3}E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'' \cdot \tilde{\mu}_a'(l+p)\alpha$$

$$\approx -wE_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}' \cdot \left[1 + (\tilde{\mu} - w/2\tilde{\mu}_a')(l+p)\alpha + (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}_a'\right]$$

$$+ \frac{w^2}{2}E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}''\left[1 + (\tilde{\mu} - w/2\tilde{\mu}_a')(l+p)\alpha + (1-\tilde{\beta})(l+p)\left(1 + \frac{l+p}{2}\alpha\right)\tilde{\mu}_a'\right]$$

$$= -E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'w(1-\alpha w/2)\left[1 + (\tilde{\mu} - w/2\tilde{\mu}_a')\rho + (1-\tilde{\beta})(l+p)\left(1 + \rho/2\right)\tilde{\mu}_a'\right]$$

$$= -E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'w(1-\alpha w/2)\left[1 + \rho(\tilde{\mu} - w\rho/2\tilde{\mu}_b') + (1-\tilde{\beta})(l+p)\left(1 + \rho/2\right)\rho\tilde{\mu}_b'\right]$$

$$= -E_{G(\cdot|\eta_{t-1})}\tilde{C}_{t+1}'(1-\alpha w/2)\times$$

$$\left[w\left((1 + \rho\tilde{\mu} + \rho^2\frac{w}{2\gamma}\tilde{\Delta}(\gamma)\right) + (1-\tilde{\beta})(l+p)\left(1 + \rho/2\right)\rho\frac{w}{\gamma}\tilde{\Delta}(\gamma)\right] \tag{48}$$

This implies that for non-marginal changes,

$$1 - \tilde{\beta} = \frac{-w(1-\alpha w/2)\left((1 + \rho\tilde{\mu} + \rho\frac{\rho a}{2\gamma}\tilde{\Delta}(\gamma)\right) + \gamma(1-\alpha\gamma/2)(1-\bar{\tilde{\mu}}(\gamma))}{(1-\alpha\gamma/2)\tilde{\Delta}(\gamma)(l+p+\frac{\gamma}{2})(1+\rho/2) + (1-\alpha w/2)(l+p)(1+\rho/2)\rho\frac{w}{\gamma}\tilde{\Delta}(\gamma)}. \tag{49}$$

$\square$

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

**Proposition 6.** *Assume that $\tilde{\mu}_w''b^2$, $\tilde{\mu}_b''b^2$, $\tilde{\mu}_{wb}''b^2$, and terms of order $(l+\gamma)^3\tilde{C}_{t+1}'''(x,\omega_t)$ and higher are negligible. If c is the period 2 certainty equivalent of a 50% chance of receiving an amount b in period 2 then*

$$\alpha \approx \frac{b/2 - c}{\left(\frac{b^2}{2} - c^2\right)} \tag{50}$$

*and $\rho \approx (l+p)\alpha$.*

*Proof.* From the flip-a-coin certain equivalent $c$, we have that when the debt owed in period $t+1$ is known to be $x$ and, the certainty equivalent in that state is the value $c$ that satisfies

$$0 = E\left[\frac{\tilde{C}(x(\eta_t) - b, \eta_t) + \tilde{C}(x(\eta_t), \eta_t)}{2}\right] - E\tilde{C}(x - c, \eta_t)$$

$$= E\left[(-b/2 + c)\tilde{C}'(x(\eta_t), \eta_t) + \left(b^2/2 - c^2\right)\tilde{C}''(x(\eta_t), \eta_t) + O(b^3\tilde{C}''')\right]$$

$$= E\tilde{C}'(x(\eta_t), \eta_t)\left[\left(c - b/2 + (b^2/2 - c^2)\alpha(x)\right)\right] + O(b^3\tilde{C}'''). \tag{51}$$

Because our assumptions imply that terms of order $\alpha'(x)(l + p + b)^3$ are negligible, (see proof of Proposition 2), we have that

$$0 = c - b/2 + (b^2/2 - c^2)\alpha(0) + O\left(\alpha'(x)(l + p + b)^3\right), \tag{52}$$

which generates the desired result. $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\square$

## 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 $\beta$ across heterogeneous borrowers. Define $x_g$ as $\mathbb{E}[x|g]$, the expectation of variable $x$ in subsample $g$. We impose the following assumptions.

**Assumption 6.** *Any measurement error in $l_i$, $p_i$, $w_i$, $\tilde{\mu}_i$, $\mu_i$, $\alpha_i$, and $\rho_i$ is mean-zero.*

**Assumption 7.** *$l_i$, $p_i$, $\alpha_i$, and $\rho_i$ are homogeneous within a subsample $g$.*

**Assumption 8.** *Terms of order $\mathbb{E}[(1 - \tilde{\beta}_i)^2|g]$ and $\mathbb{E}[(1 - \beta_i/\tilde{\beta}_i)^2|g]$ are negligible.*

**Assumption 9.** *$Cov\left[\mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right], (l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)\right] = 0.$*

**Assumption 10.** *$Cov\left[\gamma_i^\dagger, \tilde{\mu}_i(0) - \tilde{\mu}_i(\gamma)\right] = 0.$*

**Assumption 11.** *$\mathbb{E}\left[\tilde{\beta}_i|g\right]$ does not vary with $g$.*

**Assumption 12.** *Either $\beta_i/\tilde{\beta}_i \perp \tilde{\beta}_i$ or $\beta_i \perp \frac{\tilde{\beta}_i - \beta_i}{1 - \tilde{\beta}_i}$.*

Assumption 8 is increasingly violated at lower values of $\tilde{\beta}$. However, if $\tilde{\beta} = 1$ is an upper bound, our estimate of average $\tilde{\beta} \approx 0.75$ 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 $\mathbb{E}[(1 - \tilde{\beta}_i)^2] = 0.5 \cdot (0.4)^2 = 0.08$.

Assumption 12 is that naivete is independent of perceived present focus. That is, we expect that people who perceive high $\tilde{\beta}$ misperceive $\beta$ by the same proportion as people who perceive lower $\tilde{\beta}$.

**Estimating naivete**

To derive the estimating equation for naivete, we begin with Equation (6). Imposing Assumptions 6 and 7 and re-arranging gives

$$\frac{\beta_i}{\tilde{\beta}_i} = \frac{\left(l_g + p_g - \gamma_i^\dagger\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\gamma_i^\dagger\right)}{(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)}. \tag{53}$$

Taking expectations over borrowers within a group $g$ gives

$$\begin{aligned}
\mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right] &= \frac{\mathbb{E}\left[\left(l_g + p_g - \gamma_i^\dagger\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\gamma_i^\dagger\right)|g\right]}{(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)} \\
&= \frac{\left(l_g + p_g - \mathbb{E}[\gamma_i^\dagger|g]\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\mathbb{E}[\gamma_i^\dagger|g]\right) - \frac{\alpha_g}{2}Var[\gamma_i^\dagger|g]}{(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)} \\
&\approx \frac{\left(l_g + p_g - \mathbb{E}[\gamma_i^\dagger|g]\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\mathbb{E}[\gamma_i^\dagger|g]\right)}{(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)}. 
\end{aligned} \tag{54}$$

The third line follows from the second line because variance in $\gamma_i^\dagger$ is determined by variance in $(1 - \tilde{\beta}_i)$, and hence terms of order $\frac{\alpha_g/2}{l_g+p_g}Var[\gamma_i^\dagger|g]$ are $O(\mathbb{E}[(1 - \tilde{\beta}_i)^2|g])$ and thus negligible under Assumption 8.

Now rearranging, we have

$$\begin{aligned}
\mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right](l_g + p_g)\left(1 + \frac{\rho_g}{2}\right) &= \left(l_g + p_g - \mathbb{E}[\gamma_i^\dagger|g]\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\mathbb{E}[\gamma_i^\dagger|g]\right) \\
\Leftrightarrow \mathbb{E}\left[\mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}|g\right](l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)\right] &= \mathbb{E}\left[\left(l_g + p_g - \mathbb{E}[\gamma_i^\dagger|g]\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\mathbb{E}[\gamma_i^\dagger|g]\right)\right] \\
\Leftrightarrow \mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}\right]\mathbb{E}\left[(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)\right] &= \mathbb{E}\left[\left(l_g + p_g - \mathbb{E}[\gamma_i^\dagger|g]\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\mathbb{E}[\gamma_i^\dagger|g]\right)\right] \\
\Leftrightarrow \mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}\right] &= \frac{\mathbb{E}\left[\left(l_g + p_g - \mathbb{E}[\gamma_i^\dagger|g]\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\mathbb{E}[\gamma_i^\dagger|g]\right)\right]}{\mathbb{E}\left[(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)\right]},
\end{aligned} \tag{55}$$

where the third line follows from Assumption 9.

Finally, note that $\gamma(\mu_i(0) - \tilde{\mu}_i(0)) = \gamma_i^\dagger(\tilde{\mu}_i(0) - \tilde{\mu}_i(\gamma))$ and thus

$$\mathbb{E}[\gamma_i^\dagger(\tilde{\mu}_i(0) - \tilde{\mu}_i(\gamma))|g] = \gamma\mathbb{E}[\mu_i(0) - \tilde{\mu}_i(0))|g], \tag{56}$$

which implies that $\mathbb{E}[\gamma_i^\dagger|g] = \gamma\frac{\mathbb{E}[\mu_i(0)-\tilde{\mu}_i(0))|g]}{\mathbb{E}[(\tilde{\mu}_i(0)-\tilde{\mu}_i(\gamma))|g]} = \gamma_g^\dagger$ by Assumption 10. Substituting that in gives

$$\mathbb{E}\left[\frac{\beta_i}{\tilde{\beta}_i}\right] = \frac{\mathbb{E}\left[\left(l_g + p_g - \gamma_g^\dagger\right)\left(1 + \frac{\rho_g}{2} + \frac{\alpha_g}{2}\gamma_g^\dagger\right)\right]}{\mathbb{E}\left[(l_g + p_g)\left(1 + \frac{\rho_g}{2}\right)\right]}. \tag{57}$$

The empirical analogue is the estimating equation, Equation (9).

**Estimating $\tilde{\beta}$**

To derive the estimating equation for $\tilde{\beta}$, we begin with Equation (7). Imposing Assumptions 6 and 7, re-arranging, and taking expectations over borrowers within a group $g$ gives

$$\mathbb{E}\left[\left(1 - \tilde{\beta}_i\right)\left(1 + \frac{\rho_g}{2}\right)\tilde{\Delta}_i\left\{\left(l_g + p_g + \frac{\gamma}{2}\right)\left(1 - \frac{\alpha_g\gamma}{2}\right) + (l_g + p_g)\frac{w_i\rho_g}{\gamma}\left(1 - \frac{\alpha_g w_i}{2}\right)\right\}|g\right]$$
$$= \mathbb{E}\left[\left\{w_i \cdot \left(1 + \rho_g\left(\tilde{\mu}_g(0) + \frac{1}{2}\frac{w_i\rho_g}{\gamma}\tilde{\Delta}_i\right)\right)\left(1 - \frac{\alpha_g w_i}{2}\right) - \gamma \cdot (1 - \bar{\bar{\mu}}_i)\left(1 - \frac{\alpha_g\gamma}{2}\right)\right\}|g\right]. \quad (58)$$

Now note that $Var[w_i|g]$, $Cov[\tilde{\Delta}_i, w_i|g]$, $Cov[w_i, \tilde{\Delta}_i|g]$, $Cov[\tilde{\beta}_i, \tilde{\Delta}_i|g]$ are $O(\mathbb{E}(1 - \tilde{\beta}_i)^2)$ because Assumptions 6 and 7 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 8. The above equation thus reduces to

$$\mathbb{E}\left[1 - \tilde{\beta}_i|g\right]\left(1 + \frac{\rho_g}{2}\right)\tilde{\Delta}_g\left\{\left(l_g + p_g + \frac{\gamma}{2}\right)\left(1 - \frac{\alpha_g\gamma}{2}\right) + (l_g + p_g)\frac{w_g\rho_g}{\gamma}\left(1 - \frac{\alpha_g w_g}{2}\right)\right\}$$
$$= w_g \cdot \left(1 + \rho_g\left(\tilde{\mu}_g(0) + \frac{1}{2}\frac{w_g\rho_g}{\gamma}\tilde{\Delta}_g\right)\right)\left(1 - \frac{\alpha_g w_g}{2}\right) - \gamma \cdot (1 - \bar{\bar{\mu}}_g)\left(1 - \frac{\alpha_g\gamma}{2}\right). \quad (59)$$

Taking the expectation over groups $g$ and applying Assumption 11 then implies that

$$\mathbb{E}\left[\tilde{\beta}_i\right] = 1 - \frac{\mathbb{E}\left[\left\{w_g \cdot \left(1 + \rho_g\left(\tilde{\mu}_g(0) + \frac{1}{2}\frac{w_g\rho_g}{\gamma}\tilde{\Delta}_g\right)\right)\left(1 - \frac{\alpha_g w_g}{2}\right) - \gamma \cdot (1 - \bar{\bar{\mu}}_g)\left(1 - \frac{\alpha_g\gamma}{2}\right)\right\}\right]}{\mathbb{E}\left[\left(1 + \frac{\rho_g}{2}\right)\tilde{\Delta}_g\left\{\left(l_g + p_g + \frac{\gamma}{2}\right)\left(1 - \frac{\alpha_g\gamma}{2}\right) + (l_g + p_g)\frac{w_g\rho_g}{\gamma}\left(1 - \frac{\alpha_g w_g}{2}\right)\right\}\right]}. \quad (60)$$

The empirical analogue is the estimating equation, Equation (10).

**Backing out $\beta$**

Finally, we can back out $\mathbb{E}[\beta_i]$ from $\mathbb{E}[\beta_i/\tilde{\beta}_i]$ and $\mathbb{E}[\tilde{\beta}_i]$. Under Assumption 12, we have that $\mathbb{E}[\beta_i] = \mathbb{E}[(\beta_i/\tilde{\beta}_i)\tilde{\beta}_i] = \mathbb{E}[\beta_i/\tilde{\beta}_i]\mathbb{E}[\tilde{\beta}_i]$.

Alternatively, suppose that $\beta_i$ is independent of $\nu_i \equiv \frac{\tilde{\beta}_i - \beta_i}{1 - \beta_i}$. The statistic $\nu_i$ measures the percent by which individuals exaggerate that their present focus is closer to 1 than to its true level. In other words, $\tilde{\beta}_i = (1 - \nu_i)\beta_i + \nu_i$. Under this assumption

$$\mathbb{E}[\beta_i/\tilde{\beta}_i] = \mathbb{E}\left[\frac{\beta_i}{(1 - \nu_i)\beta_i + \nu_i}\right]$$
$$= \mathbb{E}[\beta_i]\frac{1}{E[(1 - \nu_i)\beta_i + \nu_i]} + O(\mathbb{E}[\nu_i^2])$$
$$= \frac{\mathbb{E}[\beta_i]}{\mathbb{E}[\tilde{\beta}_i]} + O(\mathbb{E}[\nu_i^2]). \quad (61)$$

Thus,

$$\mathbb{E}[\beta_i/\tilde{\beta}_i]\mathbb{E}[\tilde{\beta}_i] = \mathbb{E}[\beta_i] + O(\mathbb{E}[\nu_i^2]). \quad (62)$$

Now

$$\mathbb{E}[\nu_i^2] = \mathbb{E}\left[\tilde{\beta}_i^2\left(\frac{1-\beta_i/\tilde{\beta}_i}{1-\beta_i}\right)\right]$$
$$= O\left(\mathbb{E}[(1-\beta_i/\tilde{\beta}_i)^2|g]\right), \tag{63}$$

and is thus negligible.

# F    Proofs for Section 6

## F.1    Setup

To parametrize the degree of uncertainty, we consider a family of distributions $F_l$ and $G_l$, with $G_\lambda^0$ and $G(\cdot|\eta_j)$ all having a common support for all $\lambda$, and with $\theta \in [0, \bar{\theta}]$ and $\eta_j \in [0, \bar{\eta}]$. We suppose that the means $E_{F_\lambda}[\theta]$, $E_{G_\lambda^0}[\eta]$, and $E_{G_\lambda}[\eta|\eta_j]$ do not depend on $\lambda$. Defining $\sigma_F^2, \sigma_{G^0}^2, \sigma_{G(\cdot|\eta_j)}^2$ to be the maximum variance of distributions with respective means $E_{F_\lambda}[\theta]$, $E_{G_\lambda^0}[\eta]$, and $E_{G_\lambda}[\eta|\eta_j]$ and supports within $[0, \bar{\theta}]$, $[0, \bar{\eta}]$, $[0, \bar{\eta}]$,[36] 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. $\lim_{\lambda \to \infty} Var_{F_\lambda}[\theta] = \sigma^\infty(\mu), \lim_{\lambda \to \infty} Var_{G_\lambda^0}[\eta] = \sigma_{G^0}^2, \lim_{\lambda \to \infty} Var_{G_\lambda}[\eta|\eta_j] = \sigma_{G(\cdot|\eta_j)}^2$

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 $\omega$.

## F.2    Continuity and Monotonicity

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

**Proposition 7.** *A borrower's period 0 expected utility is continuous in $\beta, \tilde{\beta}_0, \tilde{\beta}_1$, is increasing in $\beta$, and is decreasing in $\tilde{\beta}_0$ and $\tilde{\beta}_1$ when there is no variation in $\eta_i$.*

Proposition 7 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 $\eta_i$ 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.

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

## F.3  Proof of Proposition 7

**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 3, both $c$ is increasing in $\beta$ 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 $\eta_i$). In the first case, $k(l + p, d), \eta_i) = \chi$, and thus

$$B_i(h) = \int_{\theta \leq d(h,\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta + \int_{d(h,\eta_i) \leq \theta} \chi f(\theta) d\theta \tag{64}$$

$$\frac{\partial}{\partial \tilde{\beta}} B_i = (k(l + p, d, \eta_i) - \chi) \frac{\partial d}{d \tilde{\beta}} f(d) \tag{65}$$

$$= 0.$$

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

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

$$+ \int_{c(h,\eta_i) \leq \theta \leq d(h,\eta_i)} \left( \delta \bar{h}(\eta_i) + k(p, \theta, \eta_i) \right) f(\theta) d\theta + \int_{\theta > d(h,\eta_i)} \chi f(\theta) d\theta \tag{66}$$

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

$$+ \left( \delta \bar{h}(\eta_i) + k(p, d, \eta_i) - \delta \chi \right) f(d) \frac{\partial d}{\partial \tilde{\beta}}$$

$$= \left( \tilde{\beta} \delta \bar{h}(\eta_i) - \delta \bar{h}(\eta_i) \right) f(c) \frac{\partial c}{\partial \tilde{\beta}} + (1 - \tilde{\beta}) \delta \bar{h}(\eta_i) f(d) \frac{\partial d}{\partial \tilde{\beta}} \tag{67}$$

$$< 0.$$

In the third case,

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

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

$$= \left( \tilde{\beta} \delta \bar{h}(\eta_i) - \delta \bar{h}(\eta_i) \right) f(c) \frac{\partial c}{\partial \tilde{\beta}} \tag{69}$$

$$< 0.$$

$\square$

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

*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:

$$
\begin{aligned}
\tilde{r}_{\tilde{\beta}'} - \tilde{r}_{\tilde{\beta}} &= B_{\tilde{\beta}'}(\tilde{r}_{\tilde{\beta}'}) - \tilde{r}_{\tilde{\beta}}(\tilde{r}_{\tilde{\beta}}) \\
&< B_{\tilde{\beta}}(\tilde{r}_{\tilde{\beta}'}) - \tilde{r}_{\tilde{\beta}}(\tilde{r}_{\tilde{\beta}}) \\
&< \bar{\tilde{r}}_{\tilde{\beta}'} - \bar{\tilde{r}}_{\tilde{\beta}} \\
&= \tilde{r}_{\tilde{\beta}'} - \tilde{r}_{\tilde{\beta}}.
\end{aligned}
\tag{70}
$$

$\square$

**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 $\eta_i$ is realized.

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

$$
k(l + p, c, \eta) = \beta \delta \bar{\tilde{r}}(\eta) + k(l, c, \eta),
\tag{71}
$$

which is unique by Assumption 3, and set $d^*(\eta_i)$ to be the unique value of $d$ that satisfies

$$
\min\left(k(l + p, d, \eta_i), \beta \delta \bar{\tilde{r}}(\eta_i) + k(p, d, \eta_i)\right) = \chi.
\tag{72}
$$

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

$$
\begin{aligned}
B_i^*(h) &= \int_{\theta \geq m^{*+}(\eta_i)} \chi f(\theta) d\theta + \int_{\theta \leq m^{*-}(\eta_i)} k(l + p, \theta, \eta_i) f(\theta) d\theta \\
&+ \int_{c^*(\eta_i) \leq \theta \leq m_i^{*+}(\eta_i)} \left(\delta \bar{h}(\eta_i) + k(p, \theta, \eta_i)\right) f(\theta) d\theta.
\end{aligned}
\tag{73}
$$

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 $\beta$ 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 3, Equations (71) and (72) imply that both $c^*$ is increasing $\beta$ and $\tilde{r}$, and $d^*$ is decreasing in $\beta$ 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 $\eta_i$.

Consequently, comparative statics on $d^*$ and $c^*$ translate directly to comparative statics on $\beta$ 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 $d^*$.

$\square$

## F.4    Proof of Proposition 3

*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 $\eta_i$. Let $\tilde{r}_\lambda(\eta_i)$ denote the expected cost, given a realization of $\eta_i$, with respect to the distributions $F_l$ and $G_l$. Construct $\bar{\tilde{r}}_\lambda(\eta_i) := \sum_j \tilde{r}_\lambda(\eta_j) G(\eta_j | \eta_i)$.

$\square$

**Lemma 3.** $\lim_{\lambda \to 0} \max_{ij} |\bar{r}(\eta_i) - \bar{r}(\eta_j)| = 0$.

*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

$$\lim_{\lambda \to 0} \left( k(p) + \tilde{\beta}_1 \, \bar{\tilde{r}}_i(l) \right) \geq k(p) + \tilde{\beta}_1 \bar{k}(l + p)$$
$$\geq \bar{k}(l + p), \tag{74}$$

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 $\lambda$. 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

$$\lim_{\lambda \to 0} \bar{\tilde{r}}_\lambda(\eta_{\bar{i}}) \leq \frac{1}{2} \bar{k}(l + p) + \frac{1}{2} \lim_{\lambda \to 0} \max_i \tilde{r}_\lambda(i)$$
$$\leq \frac{1}{2} \bar{k}(l + p) + \frac{1}{2} \lim_{\lambda \to 0} \left( k(p) + \bar{\tilde{r}}_{\bar{i}} \right)$$
$$\Leftrightarrow \lim_{\lambda \to 0} \bar{\tilde{r}}_\lambda(\eta_{\bar{i}}) \leq \bar{k}(p) + \bar{k}(l + p), \tag{75}$$

and

$$\lim_{\lambda \to 0} \bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) \geq \frac{1}{2}\bar{k}(l+p) + \frac{1}{2}\lim_{\lambda \to 0}\tilde{r}(\eta_{\underline{i}})$$

$$= \frac{1}{2}\bar{k}(l+p) + \frac{1}{2}\lim_{\lambda \to 0}\left(\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) + \bar{k}(p)\right)$$

$$\Leftrightarrow \lim_{\lambda \to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) \geq \bar{k}(p) + \bar{k}(l+p), \tag{76}$$

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, toward a contradiction, 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 $\lambda$. Now if there exists $\epsilon$ 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,

$$\lim_{\lambda \to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) = \frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}_1} > \bar{k}(l+p) = \lim_{\lambda \to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}), \tag{77}$$

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 $\lambda$. Now if there exists $\epsilon$ 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 $\mu$ denoting the probability of transition from $\underline{i}$ to a state in which the agent does not delay with probability 1:

$$\lim_{\lambda \to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) \geq \mu\frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}_1} + (1-\mu)\lim_{\lambda \to 0}\tilde{r}(\eta_{\underline{i}})$$

$$= \mu\frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}_1} + (1-\mu)\lim_{\lambda \to 0}\left(\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) + \bar{k}(p)\right)$$

$$\Leftrightarrow \lim_{\lambda \to 0}\bar{\tilde{r}}_\lambda(\eta_{\underline{i}}) \geq \frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}_1} + \frac{(1-\mu)}{\mu}\bar{k}(p)$$

$$> \frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}_1}$$

$$= \lim_{\lambda \to 0}\bar{\tilde{r}}_\lambda(\eta_{\bar{i}}), \tag{78}$$

which generates a contradiction. $\qquad\square$

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

$$\tilde{r} = \frac{\bar{k}(l+p) - \bar{k}(p)}{\tilde{\beta}}. \tag{79}$$

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

$$\tilde{r} = \tilde{\mu}\bar{k}(l+p) + (1-\tilde{\mu})(\bar{k}(p) + \tilde{r}). \tag{80}$$

Solving Equations (79) and (80) yields

$$\tilde{\mu} = \frac{\tilde{\beta}}{1-\tilde{\beta}}\frac{\bar{k}(p)}{\bar{k}(l+p) - \bar{k}(p)}. \tag{81}$$

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 (79) 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 (79) and (81), noting that $r^{TC} \to \bar{k}(l+p)$. $\qquad\square$

## Extension to misprediction of costs

Suppose instead that borrowers perceive future costs to be $\kappa \leq 1$ as high as they are. Lemma 3 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

$$\lim_{\lambda\to 0}\left(k(p) + \tilde{\beta}_1\bar{\tilde{r}}(l)\right) \geq k(p) + \tilde{\beta}_1\bar{k}(l+p)$$
$$\geq \bar{k}(l+p), \tag{82}$$

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

$$\tilde{r} = \frac{\bar{k}(l+p) - \bar{k}(p)}{\beta/\kappa}. \tag{83}$$

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 (83) 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 (83), noting that $r^{TC} \to \bar{k}(l+p)$.

## F.5   Proof of Proposition 4

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

$$r^*(\eta_i) := \min_{D,RP,RB} \left\{ \int_{\theta \in D} \chi f(\theta)d\theta + \int_{\theta \in RB} \left( \delta C_\beta^S(\eta_i) + k(p,\theta,\eta_i) \right) f(\theta)d\theta + \int_{\theta \leq RP} k(l+p,\theta,\eta_i)f(\theta)d\theta \right\} \tag{84}$$

That is, $r^*$ is the minimum expected cost to a time-consistent borrower from the period 1 perspective, given a realization $\eta_i$ at the beginning of period 1, but given the continuation value function $C_\beta^S(\eta_i)$ that corresponds to a present-focused borrower. Let $D_\eta^*, RP_\eta^*, RB_\eta^*$ denote this cost minimizing strategy.

Let $D_\eta$, $RB_\eta$, and $RP_\eta$ be the sets representing the actual strategy of the present-focused borrower. Note that for $\theta \in RB_\eta$, $k(p,\theta,\eta) + \beta C_\beta^S(\eta) \leq \min(k(l+p,\theta,\eta),\chi)$, and thus

$$k(p,\theta,\eta) + C_\beta^S(\eta) \leq \min(k(l+p,\theta,\eta),\chi) + (1-\beta)C_\beta^S(\eta). \tag{85}$$

Moreover, $D_\eta \subset D_\eta^*$ and $RP_\eta \subset RP_\eta^*$. Finally, note that the 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. Thus, relative to a time-consistent borrower with the same continuation value function, the present-biased borrower can only make a mistake when he reborrows, and in this case the size of the mistake cannot be more than $(1-\beta)C_\beta^S(\eta_i)$, the amount by which he underweights future costs. Thus

$$r(\eta_i) \leq r^*(\eta_i) + \mu(1-\beta)C_\beta^S(\eta_i), \tag{86}$$

where $\mu$ is the probability of reborrowing. To bound the period 0 expected cost function $C_\beta^S$, we

sum the above equation over all realizations of $\eta_i$, weighted by prior $g_0(\eta)$:

$$C_\beta^S \leq \sum r^*(\eta)g_0(\eta) + \mu(1-\beta)C_\beta^S. \tag{87}$$

To obtain Equation (87) from Equation (86), we use the fact that $C_\beta^S(\eta_i) = \sum_\eta r(\eta)g(\eta|\eta_i)$, and that the unconditional distribution of $\eta$ is time invariant. This implies that $\sum_{\eta_i} \sum_\eta r(\eta)g(\eta|\eta_i)g_0(\eta_i) = \sum_\eta r(\eta)g_0(\eta) = C_\beta^S$.

To complete the proof for sophisticates, note that $\sum r^* g_0(\eta)$ cannot be lower than $C^{TC}$, and thus

$$C_\beta^S \leq C^{TC} + \mu(1-\beta)C_\beta^S. \tag{88}$$

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 (85) is modified to

$$k(p,\theta,\eta) + C_{\tilde\beta}^S(\eta) \leq \min(k(l+p,\theta,\eta),\chi) + (1-\beta)C_{\tilde\beta}^S(\eta). \tag{89}$$

Adding $C_{\beta,\tilde\beta}^{PN}(\eta) - C_{\tilde\beta}^S(\eta)$ to both sides yields

$$k(p,\theta,\eta) + C_{\beta,\tilde\beta}^{PN}(\eta) \leq \min(k(l+p,\theta,\eta),\chi) + C_{\beta,\tilde\beta}^{PN}(\eta) - \beta C_{\tilde\beta}^S(\eta), \tag{90}$$

And proceeding as before shows that

$$C_{\beta,\tilde\beta}^{PN} \leq C^{TC} + \mu C_{\beta,\tilde\beta}^{PN} - \mu\beta C_{\tilde\beta}^S. \tag{91}$$

Rearranging Equation (91) gives the second result in the proposition. ☐

### Extension to misprediction of costs

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

$$C_{\beta,\kappa}^{PN} \leq C^{TC} + \mu C_{\beta,\kappa}^{PN}(\eta) - \mu\beta C_{\beta,\kappa}^S, \tag{92}$$

and thus

$$C_{\beta,\kappa}^{PN} \leq \frac{C^{TC}}{1-\mu} - \frac{\mu}{1-\mu}\beta C_{\beta,\kappa}^S. \tag{93}$$

## F.6    Proof of Proposition 5

We begin with a series of lemmas.

**Lemma 4.** *The distributions $F_\lambda$ and $G_\lambda$ 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 $F_\lambda$, 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 $F_\lambda$. Then there are some $\alpha > 0$ and $\epsilon > 0$ such that $F_\lambda$ puts weight at least $\alpha$ on the probability that $\theta \in [\epsilon, \bar\theta - \epsilon]$ for all $\lambda$. Then

$$
\begin{aligned}
Var_{F_\lambda}[\theta] = \int \theta^2 dF - \mu^2 \\
\leq (1-\alpha) \int \bar\theta \theta dF_\lambda + \alpha \int (\bar\theta - \epsilon)\theta dF - \mu^2 \\
= \bar\theta\mu - \mu^2 - \alpha\epsilon\mu.
\end{aligned}
\tag{94}
$$

Consequently, the variance of $F_\lambda$ is bounded away from the maximal possible variance, which contradicts the assumption that the variance of $F_\lambda$ converges to the maximal possible variance.

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

**Lemma 5.** *Let $F^*$ and $G^*$ be the distributions to which $F_\lambda$ and $G_\lambda$ converge. For $\bar\theta$ large enough, there is a unique stationary pure-strategy equilibrium under $F^*$ and $G^*$ that does not depend on $\beta$ 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 3 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 6.** *For $\bar\theta$ large enough, the expected period 0 utility under $F_\lambda, G_\lambda$ converges to expected period 0 utility under $F_*, G_*$.*

*Proof.* Let the common support of $G_\lambda$ 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 $F_\lambda, G_\lambda$, and let $r_*$ be the vector of continuation strategies corresponding to $F_*, G_*$. Note that by the assumption that $G_\lambda$ have common support, Lemma 4 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 $B^\lambda, B^*$ with respect to $F_\lambda, G_\lambda$ and $F_*, G_*$, respectively, defined in Equations (20,21). 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 4 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 $\eta$

$$\sum_{\eta'} h(\eta')G_\lambda(\eta'|\eta) \to \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta'|\eta]}\right) h(0) + \frac{\bar{\eta}}{E_{G_*}[\eta'|\eta]} h(\bar{\eta}). \tag{95}$$

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 5 and the fact that $F_\lambda$ converges to a Bernoulli distribution with support $\{0, \bar{\theta}\}$,

$$B_j^\lambda(h) \to Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p, \bar{\theta}, \eta) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|\eta_j]}\right) h(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|\eta_j]} h(\bar{\eta})\right) \tag{96}$$

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 $\lambda$ and $\eta_i$, we can restrict attention to $h \in [0, \chi/\tilde{\beta}]^J$, which allows us to strengthen the convergence in Equation (96) 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

$$\lim_{\lambda \to 0} \tilde{r}_\lambda(0) = Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p, \bar{\theta}, 0) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|0]}\right) \lim_{\lambda \to 0} \tilde{r}_\lambda(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|0]} \lim_{\lambda \to 0} \tilde{r}_\lambda(\bar{\eta})\right) \tag{97}$$

$$\lim_{\lambda \to 0} \tilde{r}_\lambda(\bar{\eta}) = Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p, \bar{\theta}, \bar{\eta}) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|\bar{\eta}]}\right) \lim_{\lambda \to 0} \tilde{r}_\lambda(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|\bar{\eta}]} \lim_{\lambda \to 0} \tilde{r}_\lambda(\bar{\eta})\right) \tag{98}$$

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

**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) $G_\lambda^0$ and $G_\lambda(\cdot|\eta_j)$ converge to $G_*^0$ and $G_*(\cdot|\eta_j)$ and (iii) the uniform convergence condition of Equation (96), together with Lemma 6, imply that

$$\tilde{r}_\lambda(\eta) \to Pr_{F_*}(\theta = \bar{\theta})\frac{1}{\tilde{\beta}} \min\left(\tilde{\beta}\chi, \tilde{\beta}k(p, \bar{\theta}, \eta) + \left(1 - \frac{\bar{\eta}}{E_{G_*}[\eta|\eta]}\right) r_*(0) + \frac{\bar{\eta}}{E_{G_*}[\eta|\eta]} r_*(\bar{\eta})\right). \tag{99}$$

and thus that $\tilde{r}_\lambda(\eta)$ are all bounded away from zero. Now fixing $\bar{\eta}$, by Assumption 3 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 $\theta$, and does not repay for $\theta$ sufficiently close to $\bar{\theta}$. $\square$

**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 $\kappa$ as high as they are.

## F.7  Additional Calibration Results

For the illustrative calibrations in the body of the paper, suppose that $u''(l)$ and $C''(l)$ are constant. Then $C'(l^\dagger) = C'(0) + l^\dagger C''$ and $u'(l^\dagger) = u'(0) + l^\dagger u'' u'(0) = u'(l^\dagger) - l^\dagger u''(l^\dagger)$ and thus

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

$$
u'(0) = u'(l^\dagger) - l^\dagger u'' = l^\dagger(C'' - u'') \tag{100}
$$

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

$$
G := \frac{(u'(0) - C'(0))l^\dagger}{2} = \frac{C'' - u''}{2}(l^\dagger)^2. \tag{101}
$$

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 $\Delta := l^* - l^\dagger$ satisfies

$$
\begin{aligned}
u'(l^\dagger) + \Delta u'' &= \kappa(C'(l^\dagger) + \Delta C'') \\
\Leftrightarrow C'(l^\dagger) + \Delta u'' &= \kappa(C'(l^\dagger) + \Delta C'') \\
\Leftrightarrow \Delta &= (1 - \kappa)\frac{C'(l^\dagger)}{\kappa C'' - u''}. \tag{102}
\end{aligned}
$$

The size of the deadweight triangle is therefore

$$
\begin{aligned}
L = \frac{1}{2}\Delta^2(C'' - u'') &= \frac{1}{2}(1 - \kappa)^2\left(\frac{C'(l^\dagger)}{\kappa C'' - u''}\right)^2 \cdot (C'' - u'') \\
&= (1 - \kappa)^2\left(\frac{C'(l^\dagger)}{l^\dagger(\kappa C'' - u'')}\right)^2 G. \tag{103}
\end{aligned}
$$

When $C'(0) = 0$, $C'(l^\dagger) = l^\dagger C''$, and thus $L < (1 - \kappa)^2 G$ as long as $\kappa$ is large enough that $C'' < \kappa C'' - u''$. Since $u'' < 0$, this is not a stringent inequality.

In general, $L < (1 - \kappa)^2 G$ when $C'(l^\dagger) < l^\dagger(\kappa C'' - u'')$. This is satisfied whenever, for example, $u'(0) \geq 2C'(0)$, as in that case

$$
-l^\dagger u'' = -l^\dagger \frac{C'(l^\dagger) - u'(0)}{l^\dagger} = u'(0) - C'(l^\dagger) \geq u'(0) - C'(0). \tag{104}
$$

In words, this condition simply states that the benefits the marginal benefits of the first dollar borrowed are substantially larger than the costs.

The deadweight loss triangle may be relatively large when the marginal benefits of the first dollar borrowed are not much larger than marginal costs. However, this condition is unlikely to hold for most borrowers, and in particular those who borrow large amounts. Consequently, the borrowers who derive the most surplus from borrowing are also the borrowers who lose the smallest portion of that surplus. This property suggests that average deadweight loss is likely to be small relative to average possible surplus whenever there are borrowers who derive significant utility from borrowing.

To illustrate, suppose that, with some abuse of notation, the benefits from borrowing are given by $\theta u'(l)$ and that we are in the extreme case where the first dollar borrowed is as costly as the last dollar borrowed: $C'' = 0$. In this case, the amount borrowed satisfies

$$\theta(u'(0) + l^*(\theta)u'') = \kappa C' \tag{105}$$

or

$$l^*(\theta) = \frac{\kappa}{\theta}\frac{C'}{u''} - \frac{u'(0)}{u''}. \tag{106}$$

By similar logic, the optimal borrowing amount is

$$l^\dagger(\theta) = \frac{1}{\theta}\frac{C'}{u''} - \frac{u'(0)}{u''}. \tag{107}$$

Then the deadweight loss triangle for all $l^\dagger(\theta) > 0$ is given by

$$\begin{aligned}
D(\theta) &= -(1-\kappa)^2 \left(\frac{C'}{\theta u''}\right)^2 \frac{\theta u''}{2} \\
&= -(1-\kappa)^2 \left(-\frac{u'(0)}{u''} - l^\dagger(\theta)\right)^2 \frac{\theta u''}{2} \\
&= -(1-\kappa)^2 \left(\bar{l} - l^\dagger(\theta)\right)^2 \frac{\theta u''}{2},
\end{aligned} \tag{108}$$

where $\bar{l}$ is the highest loan. Maximal surplus is given by

$$W(\theta) = \frac{-\theta u''}{2}(l^\dagger(\theta))^2. \tag{109}$$

Now

$$\begin{aligned}
\frac{E[D(\theta)]}{E[W(\theta)]} &\leq \frac{(1-\kappa)^2 E\left[\left(\bar{l} - l^\dagger(\theta)\right)^2\right] E[\theta]}{E[(l^\dagger(\theta)^2]E[\theta]} \\
&\leq (1-\kappa)^2 \frac{E\left[\left(\bar{l} - l^\dagger(\theta)\right)\right]^2 + Var[l^\dagger(\theta)]}{E[(l^\dagger(\theta)]^2 + Var[l^\dagger(\theta)]}.
\end{aligned} \tag{110}$$

Thus $\frac{E[D(\theta)]}{E[W(\theta)]} \leq (1-\kappa)^2$ as long as $E[l^{\dagger}(\theta)] > \bar{l}/2$—i.e., when the average loan size is higher than half of the largest loan amount, as in our data.

# G    Details on Simulations

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

Let $F$ be the CDF of $\theta_t$. Let $r_t(\eta)$ be the actual expected utility of starting out in debt in period $t$ given a realization of $\eta$. 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 $\theta_t$ 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

$$\tilde{\theta}^{\dagger}(\underline{\eta}) = \frac{\tilde{\beta}\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \tag{111}$$

$$\tilde{\theta}^{\dagger}(\bar{\eta}) = \frac{\tilde{\beta}\delta\left(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} - \bar{\eta}. \tag{112}$$

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

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

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

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

$$\theta = \frac{\tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}, \tag{113}$$

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

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

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

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

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

$$\theta = \frac{\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta}))}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} - \bar{\eta}. \tag{114}$$

When $\eta = \underline{\eta}$ there are two cases to consider. In the first case, $\chi$ is "large enough" so that $\tilde{\theta}^\dagger(\underline{\eta}) < \tilde{d}(\underline{\eta})$ (i.e. $\chi$ 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, $\chi$. The $\theta_t$ where these two perceived costs are equal defines $\tilde{d}(\underline{\eta})$ in this case. In the second case, $\chi$ 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, $\chi$. The $\theta_t$ 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 $\chi$ defines $\tilde{\chi}^\dagger(\underline{\eta})$.

Similarly, when $\eta = \bar{\eta}$ there are two cases to consider. In the first case, $\chi$ is "small enough" so that $\tilde{\theta}^\dagger(\bar{\eta}) > \tilde{d}(\bar{\eta})$ (i.e. $\chi$ 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, $\chi$. The $\theta_t$ where these two costs are equal defines $\tilde{d}(\bar{\eta})$ in this case. In the second case, $\chi$ 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, $\chi$. The $\theta_t$ 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 $\chi$ defines $\tilde{\chi}^\dagger(\bar{\eta})$.

Thus, we have that the defaulting cutoffs are:

$$
\tilde{d}(\underline{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} & \text{if } \chi \le \tilde{\chi}^{\dagger}(\underline{\eta}) \\ \frac{\chi - \tilde{\beta}\delta\left(q\tilde{r}(\underline{\eta})+(1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha p(l)}-1} & \text{if } \chi > \tilde{\chi}^{\dagger}(\underline{\eta}) \end{cases} \tag{115}
$$

$$
\tilde{d}(\bar{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} - \bar{\eta} & \text{if } \chi \le \tilde{\chi}^{\dagger}(\bar{\eta}) \\ \frac{\chi - \tilde{\beta}\delta\left(q\tilde{r}(\bar{\eta})+(1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha p(l)}-1} - \bar{\eta} & \text{if } \chi > \tilde{\chi}^{\dagger}(\bar{\eta}) \end{cases}, \tag{116}
$$

where

$$
\tilde{\chi}^{\dagger}(\underline{\eta}) = \frac{e^{\alpha(l+p(l))}-1}{e^{\alpha(l+p(l))}-e^{\alpha p(l)}}\tilde{\beta}\delta\left(q\tilde{r}(\underline{\eta})+(1-q)\tilde{r}(\bar{\eta})\right) \tag{117}
$$

$$
\tilde{\chi}^{\dagger}(\bar{\eta}) = \frac{e^{\alpha(l+p(l))}-1}{e^{\alpha(l+p(l))}-e^{\alpha p(l)}}\tilde{\beta}\delta\left(q\tilde{r}(\bar{\eta})+(1-q)\tilde{r}(\underline{\eta})\right). \tag{118}
$$

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

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

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

$$
\theta = \frac{\chi}{e^{\alpha(l+p(l))} - 1} \tag{119}
$$

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

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

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

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

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

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

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

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

$$\theta = \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \bar{\eta} \tag{121}$$

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

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

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

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

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

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

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

$$\chi = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}\tilde{\beta}\delta(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})) \tag{123}$$

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

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

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

$$\chi = \frac{e^{\alpha(l+p(l))} - 1}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}}\tilde{\beta}\delta(q\tilde{r}(\bar{\eta}) + (1-q)\tilde{r}(\underline{\eta})) \tag{124}$$

The Bellman operator on the continuation value functions is

$$B_1(\tilde{r}(\underline{\eta}), \tilde{r}(\bar{\eta})) \begin{cases} \underbrace{\int_{\theta \le \tilde{d}(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF}_{Repay} + \chi \overbrace{(1 - F(\tilde{d}(\underline{\eta})))}^{Pr(Default)} & \text{if } \chi \le \tilde{\chi}^\dagger(\underline{\eta}) \\[2em] \overbrace{(1 - F(\tilde{d}(\underline{\eta})))}^{Pr(Default)} \chi + \underbrace{\int_{\theta \le \tilde{\theta}^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF}_{Repay} & \text{if } \chi > \tilde{\chi}^\dagger(\underline{\eta}) \\[1em] + \underbrace{\int_{\tilde{\theta}^\dagger(\underline{\eta}) \le \theta \le \tilde{d}(\underline{\eta})}[\theta(e^{\alpha p(l)} - 1) + \delta(q\tilde{r}(\underline{\eta}) + (1 - q)\tilde{r}(\bar{\eta}))]dF}_{Reborrow} \end{cases}$$

$$\text{(125)}$$

$$B_2(\tilde{r}(\underline{\eta}), \tilde{r}(\bar{\eta})) = \begin{cases} \underbrace{\int_{\theta \le \tilde{d}(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF}_{Repay} + \chi \overbrace{(1 - F(\tilde{d}(\bar{\eta})))}^{Pr(Default)} & \text{if } \chi \le \tilde{\chi}^\dagger(\bar{\eta}) \\[2em] \overbrace{(1 - F(\tilde{d}(\bar{\eta})))}^{Pr(Default)} \chi + \underbrace{\int_{\theta \le \tilde{\theta}^\dagger(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF}_{Repay} & \text{if } \chi > \tilde{\chi}^\dagger(\bar{\eta}) \\[1em] + \underbrace{\int_{\tilde{\theta}^\dagger(\bar{\eta}) \le \theta \le \tilde{d}(\bar{\eta})}[(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \delta(q\tilde{r}(\bar{\eta}) + (1 - q)\tilde{r}(\underline{\eta}))]dF}_{Reborrow} \end{cases}$$

$$\text{(126)}$$

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 $\chi$, $q$, $a$, and $b$ and $\bar{\eta}$, we can solve Equations (125) and (126) by plugging in Equations (111), (112), (115), and (116) into Equations (125) and (126), 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 (111), (112), (115), and (116).

### G.1.2   Actual Loan Repayment Behavior

Now actual behavior can be obtained by replacing $\tilde{\beta}$ with $\beta$ 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 $\theta_t \le \theta^\dagger(\underline{\eta})$, and otherwise just continues on to period $t$ after only paying the fee $p(l)$. (b) if $\chi \le \chi^\dagger(\underline{\eta})$, the person defaults if $\theta_t > d(\underline{\eta})$ and repays that period if $\theta_t \le d(\underline{\eta})$.

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 $\beta$ replacing $\tilde{\beta}$):

$$\theta^\dagger(\underline{\eta}) = \frac{\beta\delta\left(q\tilde{r}(\underline{\eta}) + (1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha(l+p(l))} - e^{\alpha p(l)}} \tag{127}$$

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

$$d(\underline{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} & \text{if } \chi \leq \chi^\dagger(\underline{\eta}) \\ \frac{\chi - \beta\delta\left(q\tilde{r}(\underline{\eta})+(1-q)\tilde{r}(\bar{\eta})\right)}{e^{\alpha p(l)}-1} & \text{if } \chi > \chi^\dagger(\underline{\eta}) \end{cases} \tag{129}$$

$$d(\bar{\eta}) = \begin{cases} \frac{\chi}{e^{\alpha(l+p(l))}-1} - \bar{\eta} & \text{if } \chi \leq \chi^\dagger(\bar{\eta}) \\ \frac{\chi - \beta\delta\left(q\tilde{r}(\bar{\eta})+(1-q)\tilde{r}(\underline{\eta})\right)}{e^{\alpha p(l)}-1} - \bar{\eta} & \text{if } \chi > \chi^\dagger(\bar{\eta}) \end{cases} \tag{130}$$

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

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

### 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

$$\max_{l\in[0,\bar{l}]} \beta\left[1 - \nu e^{-\alpha l} - \tilde{C}(l)\right] \tag{133}$$

$$\max_{l\in[0,\bar{l}]} 1 - \nu e^{-\alpha l} - \beta\tilde{C}(l), \tag{134}$$

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:

$$r(\underline{\eta}) = \begin{cases} \int_{\theta \leq d(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\underline{\eta}))) & \text{if } \chi \leq \chi^\dagger(\underline{\eta}) \\ (1 - F(d(\underline{\eta})))\chi + \int_{\theta \leq \theta^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF \\ + \int_{\theta^\dagger(\underline{\eta}) \leq \theta \leq d(\underline{\eta})} [\theta(e^{\alpha p(l)} - 1) + \delta(qr(\underline{\eta}) + (1-q)r(\bar{\eta}))]dF & \text{if } \chi > \chi^\dagger(\underline{\eta}) \end{cases} \quad (135)$$

$$r(\bar{\eta}) = \begin{cases} \int_{\theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\bar{\eta}))) & \text{if } \chi \leq \chi^\dagger(\bar{\eta}) \\ (1 - F(d(\bar{\eta})))\chi + \int_{\theta \leq \theta^\dagger(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF \\ + \int_{\theta^\dagger(\bar{\eta}) \leq \theta \leq d(\bar{\eta})} [(\theta + \bar{\eta})(e^{\alpha p(l)} - 1) + \delta(qr(\bar{\eta}) + (1-q)r(\underline{\eta}))]dF & \text{if } \chi > \chi^\dagger(\bar{\eta}) \end{cases} \quad (136)$$

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 $\chi^\dagger(\underline{\eta}) \leq \chi^\dagger(\bar{\eta})$, because $\tilde{r}(\underline{\eta}) \leq \tilde{r}(\bar{\eta})$. To see how to solve this linear system of equations, define constants

$$A \equiv \int_{\theta \leq d(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\underline{\eta}))), \quad (137)$$

$$B \equiv (1 - F(d(\underline{\eta})))\chi + \int_{\theta \leq \theta^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^\dagger(\underline{\eta}) \leq \theta \leq d(\underline{\eta})} \theta(e^{\alpha p(l)} - 1)dF, \quad (138)$$

$$C \equiv \delta q[F(d(\underline{\eta})) - F(\theta^\dagger(\underline{\eta}))], \quad (139)$$

$$D \equiv \delta(1 - q)[F(d(\underline{\eta})) - F(\theta^\dagger(\underline{\eta}))]. \quad (140)$$

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

$$r(\underline{\eta}) = \int_{\theta \leq d(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\underline{\eta}))) = A. \quad (141)$$

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

$$r(\underline{\eta}) = (1 - F(d(\underline{\eta})))\chi + \int_{\theta \leq \theta^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^\dagger(\underline{\eta}) \leq \theta \leq d(\underline{\eta})} \theta(e^{\alpha p(l)} - 1)dF$$
$$+ \delta q[F(d(\underline{\eta})) - F(\theta^\dagger(\underline{\eta}))]r(\underline{\eta}) + \delta(1 - q)[F(d(\underline{\eta})) - F(\theta^\dagger(\underline{\eta}))]r(\bar{\eta})$$
$$= B + Cr(\underline{\eta}) + Dr(\bar{\eta}). \quad (142)$$

Define constants

$$G \equiv \int_{\theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\bar{\eta}))) \quad (143)$$

$$H \equiv (1 - F(d(\bar{\eta})))\chi + \int_{\theta \leq \theta^\dagger(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^\dagger(\bar{\eta}) \leq \theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha p(l)} - 1)dF \quad (144)$$

$$I \equiv \delta q[F(d(\bar{\eta})) - F(\theta^\dagger(\bar{\eta}))] \quad (145)$$

$$J \equiv \delta(1 - q)[F(d(\bar{\eta})) - F(\theta^\dagger(\bar{\eta}))]. \quad (146)$$

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

$$r(\bar{\eta}) = \int_{\theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d(\bar{\eta}))) = G. \quad (147)$$

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

$$r(\bar{\eta}) = (1 - F(d(\bar{\eta})))\chi + \int_{\theta \leq \theta^\dagger(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF + \int_{\theta^\dagger(\bar{\eta}) \leq \theta \leq d(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha p(l)} - 1)dF$$
$$+ \delta q[F(d(\bar{\eta})) - F(\theta^\dagger(\bar{\eta}))]r(\bar{\eta}) + \delta(1 - q)[F(d(\bar{\eta})) - F(\theta^\dagger(\bar{\eta}))]r(\underline{\eta})$$
$$= H + Ir(\bar{\eta}) + Jr(\underline{\eta}). \quad (148)$$

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

$$\mathbb{E}_\nu \left[ 1 - \nu e^{-\alpha l^*(\nu)} - C(l) \right] \tag{149}$$

where $C(l) = qr(l, \underline{\eta}) + (1-q)r(l, \bar{\eta})$ and $l^*(\nu)$ is the loan size given a realization of $\nu$, 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 $\chi$. Thus, the agent repays if

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

$$\theta_T \leq \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \eta. \tag{150}$$

This gives us the cutoffs

$$d_T(\underline{\eta}) = \tilde{d}_T(\underline{\eta}) = \frac{\chi}{e^{\alpha(l+p(l))} - 1} \tag{151}$$

$$d_T(\bar{\eta}) = \tilde{d}_T(\bar{\eta}) = \frac{\chi}{e^{\alpha(l+p(l))} - 1} - \bar{\eta}. \tag{152}$$

Which gives us the expected costs

$$r_T(\underline{\eta}) = \tilde{r}_T(\underline{\eta}) = (1 - F(d_T(\underline{\eta})))\chi + \int_{\theta \leq d_T(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF \tag{153}$$

$$r_T(\bar{\eta}) = \tilde{r}_T(\bar{\eta}) = (1 - F(d_T(\bar{\eta})))\chi + \int_{\theta \leq d_T(\bar{\eta})} (\theta + \bar{\eta})(e^{\alpha(l+p(l))} - 1)dF. \tag{154}$$

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 (111),(112),(115),(116) to derive the perceived cutoffs in $T-1$, which we then use to calculate $\tilde{r}_{T-1}$ using Equations (125) and (126) and $\tilde{r}_T$. From this we obtain the actual period $T-1$ cutoffs using Equations (127),(128),(129), and (130), which then give us $r_{T-1}$ through the recursion

$$r_{t-1}(\underline{\eta}) = \begin{cases} \int_{\theta \leq d_t(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF + \chi(1 - F(d_t(\underline{\eta}))) & \text{if } \chi \leq \chi^\dagger(\underline{\eta}) \\ (1 - F(d(_t\underline{\eta})))\chi + \int_{\theta \leq \theta_t^\dagger(\underline{\eta})} \theta(e^{\alpha(l+p(l))} - 1)dF \\ + \int_{\theta_t^\dagger(\underline{\eta}) \leq \theta \leq d_t(\underline{\eta})} [\theta(e^{\alpha p(l)} - 1) + \delta(qr_t(\underline{\eta}) + (1-q)r_t(\bar{\eta}))]dF & \text{if } \chi > \chi^\dagger(\underline{\eta}) \end{cases} \tag{155}$$

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

$$\tag{156}$$

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 $C(l) = qr_1(l, \underline{\eta}) + (1-q)r_1(l, \bar{\eta})$, then the agent solves either Equation (133) or Equation (134) and we can calculate welfare as $\mathbb{E}_\nu \left[1 - \nu e^{-\alpha l^*(\nu)} - C(l)\right]$, where $l^*(\nu)$ is the loan size given a realization of $\nu$, 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 6.2, 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.

Our first step calibration procedure is as follows: first, given a choice of scale parameters of the beta distribution, the transition probability, and the free variables $\chi$ 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 (111) - (118) into Equations (125) and (126), 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 $\theta_t$ draw, borrowers can either repay, reborrow, or default, with the associated cutoff values coming from plugging the perceived continuation values into Equations (127) - (130). If borrowers do not repay or default, they switch states with probability $1 - q$ and receive a new $\theta_t$ 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.[37] 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. We do this for 7 seven choices of the second scale parameter: 0.02 (corresponding to the approximate Bernoulli case), 0.5, 1, 2, 3, 4, and 5.

The second step of the calibration procedure is to 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. In doing so, we find each simulated borrower's optimal loan size $l^*$ as a function of her draw $\nu$, allowing only loan sizes up to \$500 to match the fact that our empirical data is drawn from states with loan size caps around \$500. We then solve for $(\mu_\nu, \sigma_\nu^2)$ using the Nelder-Mead algorithm.

To estimate welfare under different policy counterfactuals, we first draw 1,000 values of $\nu$ using the calibrated parameters above. We use the same values of $\nu$ for all counterfactuals to ensure random sampling does not affect our welfare estimates under different policies. For our baseline infinite horizon, no learning model, we back out the perceived continuation values again by substituting Equations (111) - (118) into Equations (125) and (126) and solving via fixed point iteration. To solve for the actual costs $C(l)$, we follow Section G.1.4. Each of the 1,000 simulated borrowers then choose an $l^* \in [0, \bar{l}]$ that solves Equation (133). With each borrower's choice of of $l^*$ and associated cost $C(l^*)$, we estimate average borrower welfare using Equation (149).

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 (133) and calculate welfare as in Equation (149).

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[37]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.

When estimating welfare assuming learning, we assume that borrowers have a constant $\beta$, which in our primary estimates corresponds to $\beta = 0.72$. 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 $\beta$ divided by the estimated naivete of new borrowers, which in our primary estimates results in $\tilde{\beta}_0 = 0.86$. 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 (127) - (130) yields the actual cutoffs, which we can plug into the recursion in Equations (155)-(156) 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 (133) and calculate welfare as in Equation (149).

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 $(\tilde{\beta}, \beta) = (0.45, 0.5)$ such that the average $(\tilde{\beta}, \beta)$ equals our primary estimates of $(0.75, 0.72)$. 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 $(\tilde{\beta}, \beta) = (0.25, 0.73)$ such that the average $(\tilde{\beta}, \beta)$ equals experts' forecasts $(0.54, 0.86)$.

# H    Additional Simulation Results

Table A5 presents the results of our calibrations at our empirical estimates of $\beta$ and $\tilde{\beta}$.

For our expert opinion calibration, we use the $\tilde{\beta} = 0.86$ forecasted by the average expert, and we calculate naivete $\beta/\tilde{\beta} = 0.73$ by inserting experts' average forecast of borrower misprediction into Equation (9). We then back out our expert opinion $\beta = 0.63$.

Table A6 presents calibrations where we set $(\beta, \tilde{\beta})$ to match expert forecasts but also calibrate the other parameters to the levels shown in column 2 of panel (b) of Table 3, which match empirically observed reborrowing rates and other moments. Column 1 of row 4 shows that the welfare costs of present focus at experts' forecasted parameters are only 4 percent of time consistent borrowers' surplus. Furthermore, the basic pattern of policy impacts is very similar to Panel (a): bans and loan size caps significantly reduce welfare, and in this case even a rollover restriction has a slightly negative effect.

Tables A7-A12 present the welfare estimates.

Table A5: **Calibrated Parameters (Primary)**

| Parameter | (1) $\theta \sim$ $Beta(a_\theta, 0.5)$ | (2) $\theta \sim$ $Beta(a_\theta, 1)$ | (3) $\theta \sim$ $Beta(a_\theta, 2)$ | (4) $\theta \sim$ $Beta(a_\theta, 3)$ | (5) $\theta \sim$ $Beta(a_\theta, 4)$ | (6) $\theta \sim$ $Beta(a_\theta, 5)$ |
|---|---|---|---|---|---|---|
| $E[\theta]$ | 0.80 | 0.80 | 0.76 | 0.76 | 0.76 | 0.72 |
| $Var[\theta]$ | 0.046 | 0.028 | 0.019 | 0.014 | 0.010 | 0.011 |
| $E[\nu]$ | 2.21 | 2.28 | 2.27 | 2.33 | 2.34 | 2.29 |
| $Var[\nu]$ | 1.48 | 1.43 | 1.43 | 1.61 | 1.45 | 1.47 |

Notes: This table presents the calibrated parameters for additional simulations using our empirical estimates of $\beta$ and $\tilde{\beta}$.

Table A6: **Calibrated Parameters (Expert)**

| Parameter | (1) $\theta \sim$ $Beta(a_\theta, 0.5)$ | (2) $\theta \sim$ $Beta(a_\theta, 1)$ | (3) $\theta \sim$ $Beta(a_\theta, 2)$ | (4) $\theta \sim$ $Beta(a_\theta, 3)$ | (5) $\theta \sim$ $Beta(a_\theta, 4)$ | (6) $\theta \sim$ $Beta(a_\theta, 5)$ |
|---|---|---|---|---|---|---|
| $E[\theta]$ | 0.69 | 0.60 | 0.52 | 0.47 | 0.43 | 0.40 |
| $Var[\theta]$ | 0.083 | 0.069 | 0.048 | 0.037 | 0.031 | 0.026 |
| $E[\nu]$ | 1.74 | 1.62 | 1.61 | 1.54 | 1.49 | 1.32 |
| $Var[\nu]$ | 1.30 | 1.23 | 1.09 | 1.25 | 1.35 | 0.88 |

Notes: This table presents the calibrated parameters for additional simulations using experts' beliefs about $\beta$ and $\tilde{\beta}$.

Table A7: **Calibrated Using Empirical Estimates of $\beta$ and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 0.5)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 92.0% | 98.9% | 95.1% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 98.2% | 90.6% | 97.8% | 92.9% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 97.8% | 90.4% | 97.4% | 92.3% |
| 4 | Heterogeneous | 96.2% | 88.8% | 97.4% | 90.7% |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 97.3% | 89.9% | 97.7% | 91.6% |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 98.4% | 90.8% | 97.8% | 93.1% |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 98.1% | 90.5% | 97.7% | 92.6% |
| 8 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 94.9% | 87.9% | 97.0% | 88.6% |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 93.5% | 87.1% | 96.0% | 86.6% |

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. We assume that $\theta \sim Beta(a_\theta, 0.5)$. "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 9 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 4 models heterogeneity, where half the population is time-consistent and the other half has $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 2. Row 7 models learning, assuming $\beta = 0.72$, $\tilde{\beta}_0 = 0.86$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 8 and 9 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

Table A8: **Calibrated Using Experts' Forecasts of $\beta$ and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 1)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 92.6% | 97.2% | 93.6% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 98.6% | 91.5% | 96.1% | 92.0% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 98.1% | 91.2% | 95.5% | 91.3% |
| 4 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 96.3% | 89.7% | 95.0% | 89.3% |
| 5 | $\beta = 0.63, \tilde{\beta} = 1$ | 96.1% | 89.5% | 94.9% | 89.0% |
| 6 | $\beta = 0.63, \tilde{\beta} = 0.63$ | 97.6% | 90.6% | 95.2% | 90.8% |
| 7 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 95.0% | 88.9% | 93.6% | 87.3% |
| 8 | Expert heterogeneous $\beta$ | 84.2% | 79.8% | 93.1% | 74.2% |

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. We assume that $\theta \sim Beta(a_\theta, 1)$. "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 $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 4. Rows 4 and 7 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

Table A9: **Calibrated Using Empirical Estimates of $\beta$ and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 2)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 92.0% | 99.8% | 96.3% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 97.1% | 89.7% | 98.0% | 93.2% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 96.6% | 89.4% | 97.7% | 92.6% |
| 4 | Heterogeneous | 92.6% | 86.1% | 97.9% | 87.8% |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 93.0% | 86.5% | 97.8% | 88.7% |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 97.6% | 90.1% | 98.1% | 93.8% |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 96.5% | 89.2% | 97.9% | 92.1% |
| 8 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 85.8% | 80.8% | 97.0% | 79.8% |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 83.3% | 79.4% | 96.1% | 76.2% |

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. We assume that $\theta \sim Beta(a_\theta, 2)$. "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 9 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 4 models heterogeneity, where half the population is time-consistent and the other half has $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 2. Row 7 models learning, assuming $\beta = 0.72, \tilde{\beta}_0 = 0.86$ in periods $0 \le t \le 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \ge 4$. Rows 8 and 9 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

Table A10: **Calibrated Using Empirical Estimates of $\beta$ and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 3)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 91.6% | 99.9% | 96.9% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 96.9% | 89.2% | 98.1% | 93.6% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 96.5% | 89.0% | 97.8% | 93.1% |
| 4 | Heterogeneous | 91.8% | 85.1% | 98.3% | 87.4% |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 90.9% | 84.6% | 97.8% | 87.3% |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 97.6% | 89.8% | 98.1% | 94.4% |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 96.2% | 88.6% | 97.9% | 92.4% |
| 8 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 81.5% | 77.0% | 97.2% | 75.1% |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 78.6% | 75.4% | 96.4% | 70.9% |

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. We assume that $\theta \sim Beta(a_\theta, 3)$. "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 9 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 4 models heterogeneity, where half the population is time-consistent and the other half has $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 2. Row 7 models learning, assuming $\beta = 0.72$, $\tilde{\beta}_0 = 0.86$ in periods $0 \leq t \leq 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \geq 4$. Rows 8 and 9 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

Table A11: **Calibrated Using Empirical Estimates of $\beta$ and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 4)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|-----|----------|--------------|--------------|--------------------------|-------------|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 91.8% | 100.0% | 96.8% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 96.3% | 89.0% | 97.8% | 92.9% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 95.8% | 88.7% | 97.5% | 92.3% |
| 4 | Heterogeneous | 90.0% | 83.8% | 98.3% | 85.1% |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 87.1% | 82.0% | 97.5% | 83.5% |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 97.3% | 89.7% | 97.9% | 94.0% |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 95.4% | 88.2% | 97.7% | 91.3% |
| 8 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 74.4% | 71.4% | 96.9% | 65.8% |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 70.5% | 69.2% | 96.1% | 60.0% |

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. We assume that $\theta \sim Beta(a_\theta, 4)$. "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 9 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 4 models heterogeneity, where half the population is time-consistent and the other half has $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 2. Row 7 models learning, assuming $\beta = 0.72, \tilde{\beta}_0 = 0.86$ in periods $0 \le t \le 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \ge 4$. Rows 8 and 9 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

Table A12: **Calibrated Using Empirical Estimates of $\beta$ and $\tilde{\beta}$, assuming $\theta \sim Beta(a_\theta, 5)$**

| Row | Scenario | (1) $500 cap | (2) $400 cap | (3) Rollover restriction | (4) 25% fee |
|---|---|---|---|---|---|
| 1 | $\beta = 1, \tilde{\beta} = 1$ | 100.0% | 91.8% | 99.9% | 96.8% |
| 2 | $\beta = 0.72, \tilde{\beta} = 0.75$ (primary estimates) | 96.5% | 89.1% | 97.9% | 93.2% |
| 3 | $\beta = 0.72, \tilde{\beta} = 0.75$, consume in $t = 0$ | 96.0% | 88.8% | 97.5% | 92.6% |
| 4 | Heterogeneous | 90.3% | 84.0% | 98.2% | 85.6% |
| 5 | $\beta = 0.72, \tilde{\beta} = 1$ | 88.2% | 82.8% | 97.5% | 84.9% |
| 6 | $\beta = 0.72, \tilde{\beta} = 0.72$ | 97.4% | 89.8% | 97.9% | 94.1% |
| 7 | $\beta = 0.72, \tilde{\beta}_0 = 0.86, \tilde{\beta}_1 = 0.72$ (learning) | 95.6% | 88.3% | 97.7% | 91.6% |
| 8 | $\beta = 0.63, \tilde{\beta} = 0.86$ (expert forecast) | 75.7% | 72.5% | 96.9% | 68.1% |
| 9 | $\beta = 0.63, \tilde{\beta} = 0.86$, consume in $t = 0$ | 71.9% | 70.5% | 96.1% | 62.7% |

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. We assume that $\theta \sim Beta(a_\theta, 5)$. "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 9 present alternative analyses where the benefits of the loan accrue fully in $t = 0$, so borrowers overborrow relative to the welfare criterion. Row 4 models heterogeneity, where half the population is time-consistent and the other half has $\beta$ and $\tilde{\beta}$ such that the population averages correspond to the assumptions in row 2. Row 7 models learning, assuming $\beta = 0.72, \tilde{\beta}_0 = 0.86$ in periods $0 \le t \le 3$, and $\tilde{\beta}_1 = \beta$ in periods $t \ge 4$. Rows 8 and 9 set $\beta$ and $\tilde{\beta}$ to match expert forecasts.

# I   Survey Screenshots

Figure A14: **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 Advance America 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.

◯ I do not want to participate.

Figure A15: **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 A16: **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 A17: **"$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 A18: **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 A19: **"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 A20: **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 A21: **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 A22: **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 A23: **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 A24: **"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 A25: **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 A26: **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 A27: **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 A28: **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 A29: **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 A30: **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 A31: **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 A32: **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 A33: **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 A34: **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 A35: **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 A36: **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 A37: **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 A38: **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 A39: **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 A40: **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 | ○ | ○ | ○ | ○ | ○ |