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Staff Working Paper/Document de travail du personnel—2025-6

Last updated: January 30, 2025

High-Cost Consumer Credit: Desperation, Temptation and Default

by Joaquín Saldain

Financial Stability Department
Bank of Canada
Jsaldain@bankofcanada.ca

DOI: https://doi.org/10.34989/sdp-2025-6 | **ISSN** 1701-9397

Acknowledgements

This paper was previously circulated as "A Quantitative Model of High-Cost Consumer Credit." Thanks to Eric Young, Zach Bethune, Anton Korinek, Sheisha Kulkarni, Gajendran Raveendranathan, Leland Farmer and Johannes Stroebel, discussants Jason Somerville and John Mondragon, and seminar participants at the University of Virginia, Western University, Universidad de los Andes, Singapore Management University, Bank of Canada, Richmond Fed-UVA-Duke Research Workshop, Midwest Macro, Central Bank of Uruguay, Central Bank of Paraguay, Universidad ORT, Universidad de Montevideo, Econometric Society European Summer Meeting, 2021 LACEA-LAMES Annual Meeting, Junior Household Finance Seminar, SEA Annual Meeting, NTA Annual Conference. I also gratefully acknowledge the support of the Bankard Fund for Political Economy.

Abstract

I study the welfare consequences of regulations on high-cost consumer credit in the United States. I estimate a heterogeneous-agents model with uninsurable idiosyncratic risk, risk-based pricing of loans, and preference heterogeneity including households with self-control issues. I find that one-third of high-cost borrowers suffer from self-control issues. Noncontingent regulatory borrowing limits have distributional consequences within households with self-control issues. High-income households benefit from restrictions on borrowing because they face loose price schedules from lenders that allow them to overborrow. Low-income households face tight individually targeted loan price schedules that limit households' borrowing capacity so that borrowing restrictions cannot improve welfare over them.

Topics: Credit and credit aggregates; Financial markets; Interest rates
JEL codes: E71, E2, G51

Résumé

J'étudie l'incidence sur le bien-être de la réglementation du crédit à la consommation à taux élevé aux États-Unis. J'estime un modèle à agents hétérogènes intégrant le risque idiosyncrasique non assurable, la tarification des prêts basée sur le risque, et les préférences hétérogènes présentes, notamment, parmi les ménages trop portés à emprunter. Je constate que le tiers des personnes qui contractent des emprunts à taux élevé sont dépensières. Les limites réglementaires s'appliquant universellement aux emprunts ont des effets différenciés sur les ménages dépensiers. Les ménages à haut revenu tirent avantage des restrictions sur les emprunts parce que les prêteurs leur offrent une tarification moins contraignante leur permettant de se surendetter. Les ménages à faible revenu, eux, se voient imposer des taux d'emprunt ciblés et contraignants qui limitent leur capacité d'emprunt, de sorte que les restrictions sur les emprunts ne peuvent améliorer leur bien-être.

Sujets : Crédit et agrégats du crédit; Marchés financiers; Taux d'intérêt
Codes JEL : Code

1 Introduction

High-cost consumer credit—payday loans, pawn loans, and title loans—is highly regulated in the US. From outright bans to borrowing limits and interest rate caps, policymakers frequently debate how to regulate these markets.[1] On the research side, it is very much an open question. This paper studies the welfare consequences of current regulations on high-cost consumer credit markets.

I focus on a specific policy trade-off. Borrowers may be willing to borrow at high interest rates during bad times (e.g., health shocks) or they might be tempted to consume more in the present than what is desirable for them in the long run. In the first case, policy should seek to preserve access to credit as a means of consumption smoothing. In the second case, policy may seek to restrict borrowing from households that lack self-control. The latter may justify the restrictive regulations that we observe in the US. I make two contributions that get at the heart of the matter. First, I measure the extent to which self-control issues are present among high-cost borrowers. Second, I measure the welfare effects of regulations, considering a key interaction between lenders' pricing and households' lack of self-control. The price of debt can either exacerbate or limit overborrowing by households lacking self-control, which affects the efficacy and optimality of regulations.

I quantify this policy trade-off using a quantitative model of unsecured credit in the tradition of Livshits, MacGee, and Tertilt (2007), Chatterjee, Corbae, Nakajima, and Ríos-Rull (2007) and Athreya, Tam, and Young (2012), and most closely with Nakajima (2017). The model features (i) households that face uninsurable idiosyncratic risk in their income and expenditures, (ii) heterogeneity in preferences, with standard patient and impatient agents, and a third group that faces temptation and lacks self-control, and (iii) risk-based pricing by lenders.

I find that noncontingent loan size limits, the most common regulation currently in place, have substantial distributional effects. Within households that suffer from temptation, higher-income households benefit from borrowing limits up to 0.5% of their consumption because lenders offer them loose price schedules for borrowing, which allows for overborrowing. However, lower-income households experience a welfare loss of up to 0.10% from loan size limits as they face tight individually targeted pricing schedules, which already limit the extent to which borrowers can overborrow. Exponential discounters, patient or impatient, experience a welfare loss in response to borrowing limits. This result underscores the importance of studying heterogeneous preferences—in particular temptation and lack of self-control—together with the pricing strategies of lenders.

In the model, income and expenditure shocks capture plausible sources of uncertainty for

[1] For instance, a quarter of the US population lives in states where payday lending is banned. As shown in Figure 15, most regulatory borrowing limits are below \$500. See Barth, Hilliard, Jahera, and Sun (2016) for details on state payday lending regulations.

households, which could drive the demand for high-cost borrowing. In Table 7, I document that households that take out payday loans are more likely to have experienced unusually high expenditures or unemployment of the head of the household than households that did not take out payday loans, after controlling for income, wealth, and age of the head of the household. In modeling expenditure shocks, I depart from the unsecured credit literature and use consumption thresholds from Miranda-Pinto, Murphy, Walsh, and Young (2020). Consumption thresholds are discretionary—households choose how much to adjust their consumption, and eventually their borrowing, in response to the expenditure shock. Consumption thresholds are also persistent and thus more appropriate for high-frequency borrowing than i.i.d. expenditure shocks common in the unsecured credit literature.

The different preferences allow the model to have households that potentially benefit from regulations such as those that are tempted and lack self-control and others that will surely experience welfare reductions because of them, for instance, exponential discounters with high or low discount factors. Previous papers on high-cost lending such as Skiba and Tobacman (2008) and Allcott, Kim, Taubinsky, and Zinman (2022), have considered quasi-hyperbolic discounting as a driver of the demand for payday loans.[2] Also, heterogeneity in preferences is supported by several papers. For instance, liquidity shocks, impatience, and time inconsistency coexist in driving the demand for high-cost loans in Iceland (Carvalho, Olafsson, and Silverman (2024)). In Allcott et al. (2022), the valuations of a no-borrowing incentive of $100 range from $0 to $160. The broad range of valuations suggests that some borrowers may benefit from not being able to borrow (high valuations), e.g., households that face temptation, but others suffer significantly (low valuations).

Finally, there is limited commitment and households can default on their loans, so the prices posted by lenders will reflect that risk at the individual level. This is consistent with payday lenders using subprime credit scores to extend loans.[3] Here I am departing from the literature on models of high-cost credit, namely Skiba and Tobacman (2008) and Allcott et al. (2022), which considered exogenous interest rates for loans and limited risk-based pricing. The importance of modeling the price of credit is that price schedules can either limit overborrowing or exacerbate it, thus affecting the efficacy and optimality of regulations. Interest rates will also be a function of operational costs that make lenders, such as payday lenders, exogenously expensive.[4]

To take the model to the data, I focus on payday lending because of data availability. High-cost consumer loans are used by 7% of US households, particularly by low-wealth and low-income households that lack access to the traditional financial system. Most are payday loans,

[2] Self-control and temptation preferences, in particular the application by Krusell, Kuruşçu, and Smith (2009), generalize quasi-hyperbolic preferences. Quasi-hyperbolic preferences and self-control and temptation coincide when the agent fully succumbs to temptation.

[3] See Bhutta, Skiba, and Tobacman (2015).

[4] See Table 9 for evidence of the importance of operational costs in payday lending rates.

which are small, short-term, high-cost unsecured loans.[5] I estimate the model using a unique dataset of payday loan transactions in Florida between 2003 and 2018, totaling 100 million payday loan transactions. In addition, I use the valuations of a no-borrowing incentive from Allcott et al. (2022). Households with temptation preferences value not being able to borrow in the future, so they have high valuations for the incentive program; exponential discounters have lower valuations since they dislike not being able to borrow. I use the valuations of the no-borrowing incentive to identify the fraction of households that are tempted and lack self-control. I estimate that two-thirds of households that use high-cost loans are exponential discounters (patient or impatient), and the remaining one-third are households that are tempted.

I validate the estimation of the model in two ways. First, the identification of exponential discounters and tempted households is consistent with qualitative survey data on self-control from the National Financial Well-Being Survey, in particular, for high-cost borrowers.[6] The model and survey agree that more than one-third of high-cost borrowers are "not good at resisting temptation" and that 70% "can work diligently toward long-term goals."

Second, the estimated model is also consistent with the effect of real-world regulations on payday lending. Zinman (2010) measures the effect of an interest-rate cap on the probability of re-borrowing in Oregon in 2007. The quantitative model can reproduce the drop of 28 percentage points in the likelihood of re-borrowing found in Zinman (2010) for the Oregon interest-rate cap.

In this model, high-cost borrowing is driven mostly by impatient and temptation households, but there are also loans to patient households. Patient households borrow when income is low, expenditure shocks are binding, and they have run out of savings. The price schedules they face quickly go to zero with the level of debt, so they take out small loans at a high interest rate. Impatient and temptation households borrow at all income levels, which is consistent with data from the Survey of Consumer Finances (SCF, 2016), in which households from all income deciles borrow from payday lenders. However, the model exaggerates high-income borrowing. Depending on their income, they borrow small amounts at high interest rates when they have bad realizations of income or expenditure shocks or large amounts at low rates when they have high-income and low-expenditure shocks. This negative correlation between loan size and interest rate is consistent with the microdata: larger loans are associated with lower interest rates in payday lending.[7]

I evaluate two types of noncontingent regulations: regulatory borrowing limits (cannot borrow more than the regulatory limit) and interest-rate caps (cannot borrow at interest rates higher than the cap). The results show that there are significant distributional effects of noncontingent regulatory borrowing limits within tempted households across the income distribution. Low-

[5] Current Population Survey 2015 and Survey of Consumer Finances 2016.

[6] See Consumer Financial Protection Bureau (2017).

[7] See Bhutta et al. (2015).

income households are hurt by borrowing limits, but high-income households benefit from them. The latter occurs because high-income households face borrowing constraints that are not tight—in other words, they can afford the temptation. On the other hand, low-income households are, to a large extent, constrained by the pricing schedules of lenders and would benefit from more access to credit during bad times. Therefore, the temptation faced by borrowers should be studied jointly with the pricing strategies of lenders to assess the welfare effects of regulations.

Regulatory borrowing limits contingent on income, expenditures, and preferences can generate welfare gains but are unfeasible to implement. Despite the distributional effects, the utilitarian welfare of all types of households, including those that are tempted and lack self-control, is lower with any borrowing limit at all. Tight regulatory borrowing limits reduce welfare the most as it affects small and expensive loans because these are taken out during states of the world with low-income, and high-expenditures—by households of all types.

Non-contingent interest-rate caps are also welfare-reducing for households with self-control. Relatively loose interest-rate caps are welfare-reducing since expensive and small loans correspond to borrowing in states of the world where borrowers need them the most for consumption smoothing.

Related Literature This paper is related to two strands of the literature. The first one is a set of papers that studies consumer credit in models of heterogeneous agents with default and risk pricing, initiated by Chatterjee et al. (2007) and Livshits et al. (2007). I use this class of models to study a segment of the unsecured credit market that is understudied in this literature, such as payday lending. This paper extends the workhorse models in three ways to reproduce the borrowing patterns in the high-cost market. First, I incorporate persistent and discretionary idiosyncratic expenditure shocks as opposed to the traditional i.i.d. and non-discretionary expenditure shocks, which provide a demand for high-cost loans that are more appropriate for high-frequency borrowing. Second, heterogeneity in preferences that includes heterogeneous discount factors together with households that have self-control and temptation preferences. Typically, the literature has considered either heterogeneous discount factors, as in Braxton, Herkenhoff, and M. Phillips (2024) and Chatterjee, Corbae, Dempsey, and Ríos-Rull (2023), or a household that has standard preferences and other households with self-control issues or quasi hyperbolic discounting, as in Nakajima (2017) and Raveendranathan and Stefanidis (2023). Third, I combine borrowing behavior with a field experiment from the payday lending literature to estimate the parameters governing the preferences as opposed to externally calibrating them as has been done in the previous papers. In particular, the contribution is how to distinguish between a patient and impatient household, and a household with temptation issues, which can be observationally equivalent. This strategy is related to the questions posed in Krusell et al. (2009) to calibrate self-control preferences.[8]

A second set of papers studies high-cost lending, in particular payday lending, either empirically or structurally. This paper is closest to the structural papers in this group, namely Skiba and Tobacman (2008), Allcott et al. (2022) and Li and Sun (2021). The first considers quasi-hyperbolic preferences together with income shocks as drivers of payday lending, while the second considers a richer environment with quasi-hyperbolic preferences and partial naivete. Both have exogenous prices for credit. Li and Sun (2021) have endogenous prices that reflect risk but preferences with present bias. My contribution to this literature is to study payday lending regulations in an environment with (i) heterogeneous preferences as opposed to exclusively present bias, (ii) temptation and self-control preferences, a more general model that includes quasi-hyperbolic discounting, where welfare is well defined, and (iii) interest rates that are endogenous and reflect default risk, which interacts with lack of self-control, either limiting or exacerbating it. This specific combination is relevant for the welfare effects of regulations, as it produces winners and losers from borrowing limits, which contrasts with the undesirability of borrowing limits in Allcott et al. (2022). Hence, present bias and pricing on the part of lenders should be studied together to assess the effects of regulations on consumer credit markets.

Within this second group of papers, there is a large body of literature on payday lending that focuses on estimating the causal link between taking a payday loan and the financial well-being of borrowers (e.g., payday loan use, being late with loan or bill payments, demand for other sources of credit and bankruptcy), as well as the effect of regulations. See Agarwal, Skiba, and Tobacman (2009); Zinman (2010); Morse (2011); Melzer (2011); Bhutta (2014); Bhutta et al. (2015); Bhutta, Goldin, and Homonoff (2016); Gathergood, Guttman-Kenney, and Hunt (2018); Skiba and Tobacman (2019). This paper is consistent with the effect of an interest-rate cap studied in Zinman (2010), the heterogeneous drivers of the demand for high-cost loans as in Carvalho et al. (2024) and the whole distribution of valuations of a no-borrowing incentive given to payday borrowers in Allcott et al. (2022).

The rest of the paper is organized as follows. Section 2 presents a simple two-period model to show the optimality of regulatory borrowing limits when households suffer from temptation and how it depends on the prices offered by lenders. Section 3 presents a quantitative version of the two-period model. In section 4, I discuss the calibration of the parameters of the quantitative model, and section 5 presents the main results for the welfare consequences of regulatory borrowing limits and interest rate caps. Finally, section 6 concludes.

[8] The extent to which these preferences are observationally equivalent is left for future research. See Feigenbaum (2016), who studies this idea when consumption is proportional to wealth.

2 A simple model

The goal of this section is twofold. First, to present temptation and self-control preferences in the context of a model of consumption and savings decisions. Second, to show that regulatory borrowing limits can improve the welfare of households with temptation and self-control issues and that the optimal regulatory borrowing limit depends on the financial frictions in the credit market.

The environment for this section is a simple consumption-saving, two-period model. The risk-free rate is fixed as in a small open economy. The representative household receives an endowment in both periods. Markets are incomplete and the household only has access to a one-period asset. Lenders are risk neutral, have deep pockets, extend unsecured loans, and receive deposits from the household in a competitive environment.

2.1 Self-Control and Temptation Preferences

I use the utility representation of preferences with temptation and self-control of Gul and Pesendorfer (2001), and in particular, the application to consumption-saving problems by Krusell et al. (2009). Households that lack self-control derive utility from their long-run preferences, i.e., commitment utility, but in the short run, they may be tempted to follow their temptation utility. However, resisting temptation by exerting self-control is costly. Households trade off commitment utility with the cost of self-control. The optimization problem of a household with these preferences is shown in (6).

The commitment and temptation utility differ in the discount rates. The commitment utility has a discount rate β, and the temptation utility has a lower discount factor, $\delta\beta$, with $\delta < 1$. Whether the agent follows its commitment or temptation utility depends on the parameter γ, the strength of the temptation. Actual allocations $\{c_1, c_2, a_2\}$ maximize $u(c_1) + \beta u(c_2) + \gamma [u(c_1) + \delta\beta u(c_2)]$, subject to the corresponding budget constraints. Maximal temptation allocations $\{\tilde{c_1}, \tilde{c_2}, \tilde{a_2}\}$ maximize $u(\tilde{c_1}) + \delta\beta u(\tilde{c_2}))$, subject to budget constraints. The flow utility $u(c)$ has standard properties: $u'(c) > 0$, $u''(c) < 0$ and $\lim_{c\to 0} u'(c) = \infty$.

$$\max_{c_1,c_2,a_2} \quad \underbrace{u(c_1)+\beta u(c_2)}_{\text{Commitment utility}} + \underbrace{\gamma\left[u(c_1)+\delta\beta u(c_2)\right]}_{\text{Temptation utility}} - \underbrace{\gamma \max_{\tilde{c_1},\tilde{c_2},\tilde{a_2}} u(\tilde{c_1})+\delta\beta u(\tilde{c_2})}_{\text{Maximal temptation}} \tag{1}$$

$$\text{s.t.} \quad c_1 = y - \frac{1}{R}a_2 \tag{2}$$

$$c_2 = y + a_2 \tag{3}$$

$$\tilde{c_1} = y - \frac{1}{R}\tilde{a_2} \tag{4}$$

$$\tilde{c_2} = y + \tilde{a_2} \tag{5}$$

$$\bar{a} \leq a_2, \tilde{a_2} \tag{6}$$

Since $\delta < 1$, the actual allocation of savings will be greater than that under full temptation. Suppose that a regulator can impose a savings floor, $\bar{a}$. Then the regulator can increase the household's welfare by limiting how much he can save, illustrated in Figure 1: low levels of $\bar{a}$ are binding only for the temptation allocation, so welfare increases as the value of the maximal temptation is lower. At greater levels of $\bar{a}$, when both allocations are constrained, utility is simply the commitment allocation, so there is an optimal $\bar{a}$ at the allocation that maximizes the commitment utility.

2.2 With Financial Frictions

In this section, I introduce a financial friction in the credit markets (when $a_2 < 0$) and study how the optimal $\bar{a}$ changes with these frictions.

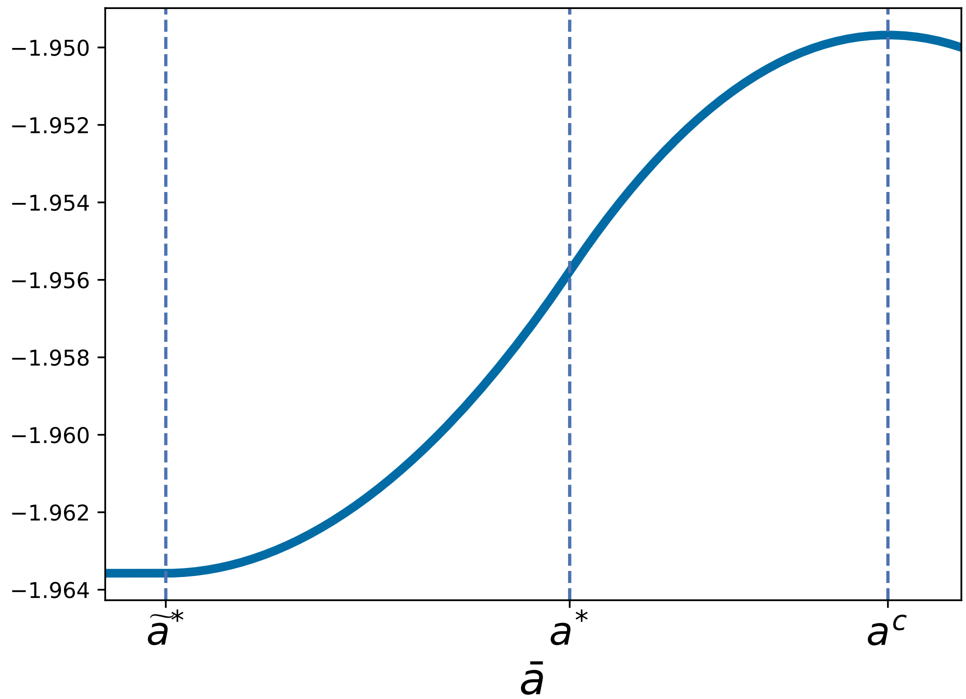
I assume that the endowment in period 2 is stochastic and can take two values, as in Equation 7, and that households can default on their debt in period 2 ($a_2 < 0$). Lenders know this and price their loans accordingly.

$$y_2 = \begin{cases} y_h, & \text{w/ prob. } \pi \\ y_l, & \text{w/ prob. } 1-\pi \end{cases} \tag{7}$$

Households now have to decide how much to consume and save in period one and in period two, and if they will repay their debt or default, as in Equation 8. If they repay, they consume their endowment plus savings. If they default, which only happens when assets are negative, they do not have to pay back their debt, so they consume their endowment but face a utility cost for defaulting λ. In Equation 9, identical decisions are made but under full temptation. Finally, lenders operate in perfect competition and make zero expected profits (Equation 10).

The cost of default is critical for the level of the optimal regulatory borrowing limit. The cost of default affects the default decision by households and, thus, the prices posted by lenders.

Figure 1: Welfare



Note: This figure plots the welfare of a household with self-control preferences as a function of regulatory borrowing limits set by a regulator. $\widetilde{a*}$ represents the optimal asset chosen by the household under full temptation; $a*$ the asset chosen by maximizing commitment and the temptation utility; and, a^c, the optimal asset choice under the commitment utility.

Hence, it affects actual borrowing decisions but also temptation allocations.

$$U = \max_{a_2} (1+\gamma)\, u\left(y_1 - q(a_2)a_2\right) + (1+\gamma\delta)\, \beta\, \mathbb{E}_{y_2} \max_{d\in\{0,1\}} \left\{u\left(y_2 - a_2\right), u\left(y_2\right) - \lambda\right\} - \widetilde{U} \tag{8}$$

$$\widetilde{U} = \gamma \max_{\widetilde{a}_2} u\left(y_1 - q(\widetilde{a}_2)\widetilde{a}_2\right) + \delta\beta\, \mathbb{E}_{y_2} \max_{d\in\{0,1\}} \left\{u\left(y_2 - \widetilde{a}_2\right), u\left(y_2\right) - \lambda\right\} \tag{9}$$

$$q(a_2) = 1 - \mathbb{E}[d(a_2)] \tag{10}$$

To illustrate how the cost of default λ affects the optimal borrowing limit, I show how the cost of default affects allocations and welfare. In Figure 2, for different levels of λ, I plot indifference curves for the household in (q, a_2), together with the price schedule posted by the lender given by (10). There are three indifference curves: the one that governs the actual choice, which is a combination of the commitment and temptation utilities (orange dotted line); the commitment utility (grey dash-dot line); and the temptation utility (blue dashed line). The intersection of any of the indifference curves and the price schedule represents the choice under the utility underlying that indifference curve. In Figure 3, I show lifetime utility as a function of borrowing limits.[9]

High λ In Figure 2a, the cost of default goes to infinity, so households prefer to not default. Here prices are entirely horizontal, and allocations are all relatively low debt levels with the ordering expected for a present-biased temptation. As in the case studied above, the optimal borrowing limit coincides with the commitment allocation.

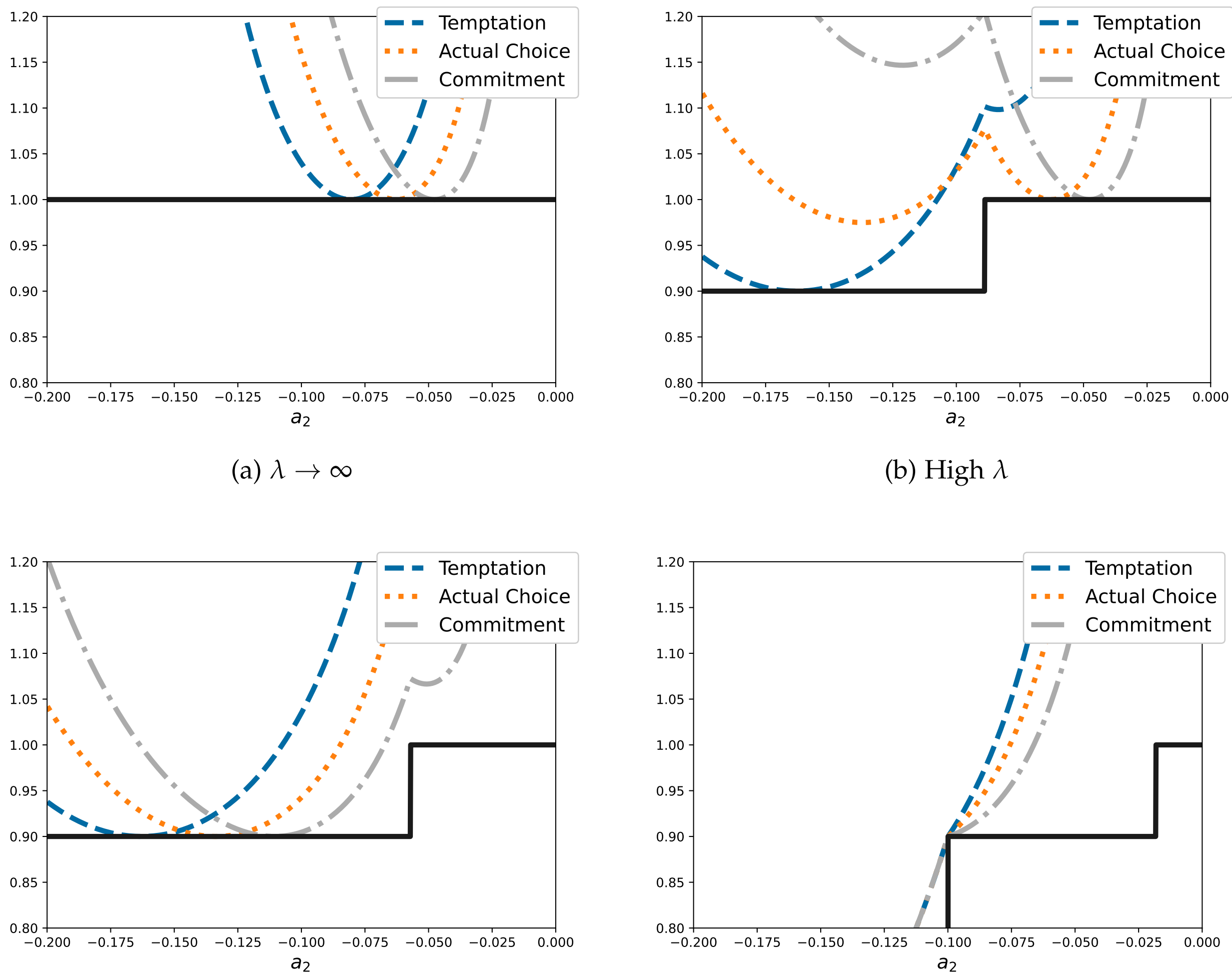
Mid λ Now, I look at cases where λ is low enough to default in some cases. In Figure 2b, λ is high such that commitment and actual allocation remain the same as before. However, for the low discount factor of temptation, the temptation allocation has shifted towards higher debt levels. From Figure 3, we can see that the utility is now double-peaked with respect to the borrowing limit (orange dashed line). Now the optimal one does not coincide with commitment allocation. Instead, the regulator wants to limit borrowing to the point where the price schedule jumps with the default probability. For lower levels of borrowing, utility goes down because now the loss from the maximal temptation increases due to the higher prices.

Low λ At a low level of λ, eventually all allocations move to higher levels of debt because defaulting is not that costly, even though prices are lower, as in Figure 2c. Now the optimal borrowing limit coincides again with the commitment allocation, but at a high level of debt. The optimal borrowing limit with an extremely high cost of default is now too restrictive as

[9] Parameters used for the numerical example are $\beta = 0.95$, $\delta = 0.60$, $\gamma = 1$, $y_1 = 0.30$, $y_h = 0.50$, $y_l = 0.20$, $\pi = 0.90$.

households want to borrow more. Finally, very low levels of the cost of default make debt prices go to zero very fast with the level of debt. In this case, all allocations are restricted by the pricing schedule. As we can see in the utility plot, welfare never improves with a borrowing limit, since lenders are already constraining the maximal temptation and actual and commitment choices.

Figure 2: Indifference curves and prices



(a) $\lambda \to \infty$

(b) High λ

(c) Mid λ

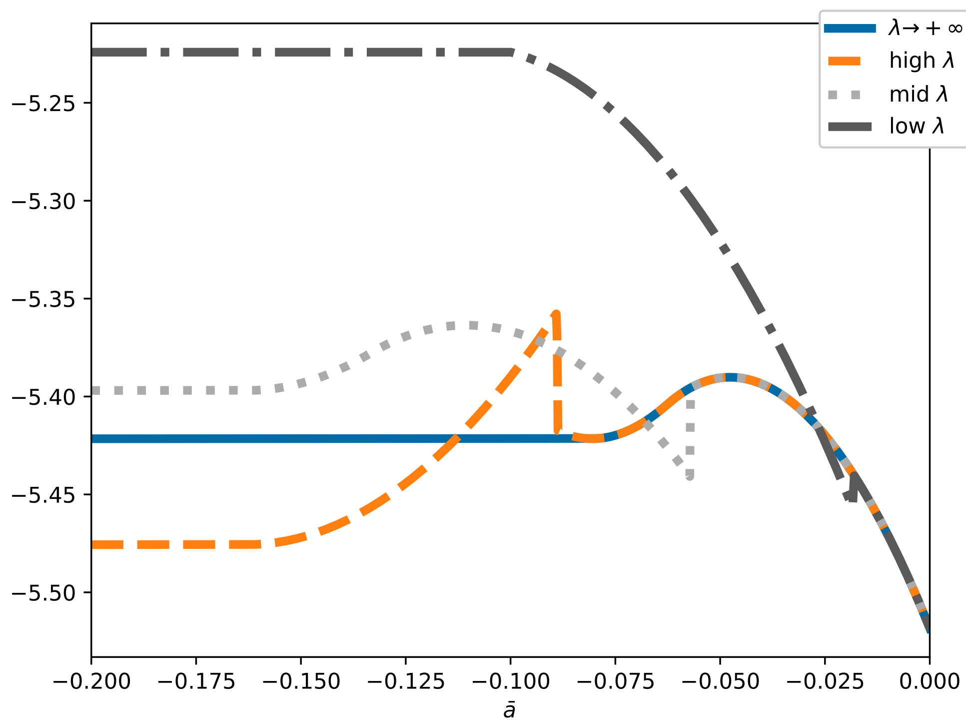
(d) Low λ

Note: Each panel plots three indifference curves: (i) temptation utility, (ii) actual-choice utility, which is a combination of commitment and temptation utilities, and (iii) commitment utility. The cost of default λ changes between panels. The black line represents the price of debt for every level of a_2.

3 Quantitative model

In this section, I extend the simple model from above to capture the empirical features of high-cost consumer credit markets, that is, (i) income and expenditure shocks to realistically reflect the idiosyncratic risk that borrowers face, (ii) heterogeneous preferences: households that have

Figure 3: Welfare, default cost λ and the regulatory borrowing limit $\bar{a}$



Note: This figure plots the welfare of the households with self-control preferences for different values of the cost of default λ, as a function of the regulatory borrowing limit.

self-control issues along with patient and impatient households, and (iii) lenders price their loans according to individual default risk and operational costs.

3.1 Environment

Time is discrete and goes on forever. Overlapping generations of J-period lived households exist. In each period, a measure one of households is born. Households face idiosyncratic endowment and expenditure risk and make decisions about saving, borrowing, and defaulting. Markets are incomplete as households only have access to a one-period bond. There is no aggregate uncertainty.

3.2 Households

Households live during J periods. During ages $j \in [1, W]$, with $W < J$, households receive a stochastic endowment y given by (11); between ages $j \in [W+1, J]$, they receive a deterministic endowment equal to a fraction, Θ, of the last stochastic realization of their endowment in period W. The labor income process is standard in the unsecured credit literature and has two components, a permanent one and a transitory one.

$$
\begin{aligned}
y &= x + z && (11)\\
x' &= \rho_x x + \epsilon'_x && (12)\\
z' &= \rho_z z + \epsilon'_z && (13)\\
& && (14)
\end{aligned}
$$

Households face expenditure shocks at all ages. In the expenditure shocks I deviate from the unsecured credit literature, which uses non-discretionary, i.i.d. expenditure shocks.[10] I use consumption thresholds $\underline{c}$ from Miranda-Pinto et al. (2020). The consumption threshold evolves according to (15) and entails a utility cost $\eta \max(\underline{c} - c, 0)$. The household can decide how much to adjust its consumption to smooth out the expenditure shock by lowering its asset holding—and eventually borrowing—or defaulting, trading off the marginal disutility of the expenditure shock and the marginal cost of increasing consumption. This mechanism is absent in the traditional non-discretionary expenditure shocks where households automatically reduce their assets or default when hit by an expenditure shock. In addition, the expenditure shock used here is persistent, which is more realistic for high-frequency borrowing such as high-cost credit. The presence of consumption thresholds allows consumption to vary as much as income but with

[10] See Chatterjee et al. (2007); Livshits et al. (2007).

a low correlation with it, both features that a standard model with incomplete markets and idiosyncratic risk cannot deliver.[11]

$$\underline{c}' = (1 - \rho_c)\mu_c + \rho_c \underline{c} + \epsilon_c' \tag{15}$$

Households have access to a one-period asset a, with price q, that provides one unit of consumption next period. Households can always save $a > 0$ at the risk-free price $q = \frac{1}{1+r}$, which is exogenous. They can also borrow $a < 0$ exclusively from a high-cost lender, whose pricing is described below. I abstract from credit card borrowing for two reasons: i) approximately half of payday borrowers do not have credit cards (Survey of Consumer Finances (SCF), 2016) and ii) as shown in Bhutta et al. (2015), payday borrowers unsuccessfully look for credit before taking a payday loan, and taking one is associated with the exhaustion of credit limits on credit cards, on average. In Table 8 I provide additional evidence that households take high-cost loans such as payday loans when traditional credit is not available to them. On average, households that took a payday loan are more likely to not have access to credit cards or are looking for credit, and being rejected by lenders during the same period, they took a payday loan, compared to households that did not take one, after controlling for wealth, income, and age (SCF, 2016). Focusing exclusively on high-cost borrowing is also in line with previous papers in the literature, such as Skiba and Tobacman (2008) and Allcott et al. (2022).

Households can default on their debt. If they do default, they are excluded from borrowing in the present, and with probability $1 - \chi$ they will be excluded in future periods. They can regain access to borrowing with probability χ in each period. The state variable d takes the value 1 if they are excluded from borrowing and 0 otherwise.

There are three types of households: patient, impatient, and a behavioral agent. The patient and impatient households differ in their discount factor β, such that the discount factor of the latter is lower than that of the former. The behavioral agent features self-control and temptation issues, as in Gul and Pesendorfer (2001). In particular, I use the specialization to consumption-savings problems by Krusell, Kuruşçu, and Smith (2010). I index a household's type as $i \in \{P, I, T\}$.

Next, I describe the optimization problem of an individual of type $i \in \{P, I, T\}$ with a state vector $(a, y, \underline{c}, d)$. The subindex j represents the age, and the variables with $'$ represent the values of the next period.

No default flag ($d = 0$) When the household is not excluded from borrowing, for any of the types, it has to decide whether to repay or default, as in (16).

[11]See Miranda-Pinto et al. (2020) for further discussion on this point.

$$v_j^i\left(a,x,z,\underline{c},0\right) = \max\left\{v_j^{i,s}\left(a,x,z,\underline{c}\right), v_j^{i,d}\left(a,x,z,\underline{c}\right)\right\}, i = P, I, T \tag{16}$$

For patient and impatient households, $i \in \{P, I\}$, if the household decides to repay, the household chooses its optimal level of assets for the next period and consumption by maximizing lifetime utility subject to the budget constraint, as in (17).

$$\begin{aligned} v_j^{i,s}\left(a,x,z,\underline{c}\right) = &\max_{c,a'}\left\{u(c) - \eta\max(\underline{c}-c,0) + \beta^i \mathop{\mathbb{E}}_{x',z',\underline{c}'|x,z,\underline{c}}\left[v_{j+1}^i\left(a',x',z',\underline{c}',0\right)\right]\right\} \\ &c = a + y - q_j\left(a',x,z,\underline{c}\right)a' \end{aligned} \tag{17}$$

If it decides to default, represented in (18), the household consumes its endowment but faces three costs of defaulting: no borrowing or saving during the period it defaulted; a utility cost λ, known as "stigma" in the literature; and stochastic exclusion from borrowing in the future.

$$v_j^{i,d}\left(a,x,z,\underline{c}\right) = u\left(y\right) - \eta\max(\underline{c}-y,0) - \lambda + \beta^i \mathop{\mathbb{E}}_{x',z',\underline{c}',d'|x,z,\underline{c}}\left[v_{j+1}^i\left(0,x',z',\underline{c}',d'\right)\right] \tag{18}$$

Households with self-control and temptation issues, $i = T$, are presented in equations (19) and (20). These households face the same choices as described above for the exponential discounters. Now, default and consumption/saving decisions are a compromise between their commitment and temptation utilities, governed by discount factors β^T and $\delta\beta^T$, respectively. The degree to which choices are driven by one or the other is determined by the parameter γ, the strength of temptation.

$$\begin{aligned} v_j^{T,s}\left(a,x,z,\underline{c}\right) = &\max_{c,a'}\left\{(1+\gamma)\left[u\left(c\right) - \eta\max(\underline{c}-c,0)\right] + (1+\delta\gamma)\beta^T \mathop{\mathbb{E}}_{x',z',\underline{c}'|x,z,\underline{c}}\left[v_{j+1}^T\left(a',x',z',\underline{c}',0\right)\right]\right\} \\ &- \widetilde{v}_j\left(a,x,z,\underline{c},0\right) \\ &c = a + y - q_j\left(a',x,z,\underline{c}\right)a' \end{aligned} \tag{19}$$

$$\begin{aligned} v_j^{T,d}\left(a,x,z,\underline{c}\right) = &(1+\gamma)\left[u\left(y\right) - \eta\max(\underline{c}-y,0) - \lambda\right] + (1+\delta\gamma)\beta^T \mathop{\mathbb{E}}_{x',z',\underline{c}',d'|x,z,\underline{c}}\left[v_{j+1}^T\left(a',x',z',\underline{c}',d'\right)\right] \\ &- \widetilde{v}_j\left(a,x,z,\underline{c},0\right) \end{aligned} \tag{20}$$

In addition, for each period they will suffer disutility from their maximal temptation $\widetilde{v}_j\left(a,x,z,\underline{c},0\right)$. This is the value function when the choices are consistent with the discount factor $\delta\beta^T$. Their maximal temptation is described by (21), (22) and (23). These decisions are completely analogous to the patient and impatient choices described below but with the temptation discount factor.

It is worth noting that the prices of debt matter for the maximal temptation allocations, a feature not present in patient/impatient households. Financial frictions in the credit market and financial regulations from the government matter not only for the actual choices of the households, but also the maximal temptation allocations, thus affecting welfare differently with respect to patient/impatient households and across income and wealth within temptation households.

$$\widetilde{v}_j\left(a,x,z,\underline{c},0\right) = \max\left\{\widetilde{v}^s_j\left(a,x,z,\underline{c}\right), \widetilde{v}^d_j\left(a,x,z,\underline{c}\right)\right\} \tag{21}$$

$$\begin{aligned}\widetilde{v}^s_j\left(a,x,z,\underline{c}\right) =& \gamma \max_{\widetilde{c},\widetilde{a}'}\left\{u\left(\widetilde{c}\right) - \eta\max(\underline{c}-\widetilde{c},0) + \delta\beta^T \mathop{\mathbb{E}}_{x',z',\underline{c}'|x,z,\underline{c}}\left[v^i_{j+1}\left(\widetilde{a}',x',z',\underline{c}',0\right)\right]\right\} \\ \widetilde{c} =& a + y - q_j\left(\widetilde{a}',x,z,\underline{c}\right)\widetilde{a}'\end{aligned} \tag{22}$$

$$\widetilde{v}^d_j\left(a,x,z,\underline{c}\right) = \gamma\left\{u\left(y\right) - \eta\max(\underline{c}-y,0) - \lambda + \delta\beta^T \mathop{\mathbb{E}}_{x',z',\underline{c}',d'|x,z,\underline{c}}\left[v^i_{j+1}\left(0,x',z',\underline{c}',d'\right)\right]\right\} \tag{23}$$

With a default flag ($d = 1$) When the household is excluded from borrowing, its consumption and savings decisions are such that it cannot borrow $a' \geq 0$, and with a probability χ it may be able to borrow again next period. Equations for this state are presented in equations (27), (28) and (29) in the appendix.

3.3 High-cost lenders

Lenders have access to unlimited funds at an exogenous risk-free interest rate r. There is perfect information, so they observe all relevant states and types of households when pricing their loans. It is common for payday lenders to use a subprime credit bureau such as the Teletrack score, which tracks features such as late bills payment and other payday lenders, to make their lending decisions, as described in Bhutta et al. (2015). In addition, in payday lending, interest rates are positively correlated with the probability of default even though the loan amounts are generally lower than \$500 due to regulatory limits. The fact that regulatory limits are so tight, modeling interest rates as opposed to assuming that they are exogenously fixed is a crucial feature for studying the welfare consequences of alternative regulations.[12]

[12] The case of asymmetric information, especially across types or expenditure shocks, is an interesting extension that can be relevant for the welfare effects of the regulations studies in this paper. I leave this extension for future work.

In addition, the lender has operational costs κ. As shown in the appendix and in Flannery and Samolyk (2005), a substantial part of payday loan interest rates can be explained by operational costs (wages, advertising, and occupational costs). Operational costs generate a wedge between the savings and borrowing rates. Households can save at the risk-free interest rate, but to borrow, they have to pay substantially higher interest rates, independently of their default risk.

Finally, there is free entry. The break-even condition for payday lenders is shown in (24). The price of the loan reflects the expected default decision, d_{j+1}, and the operational costs.

$$q_j^i\left(a', x, z, \underline{c}\right) = \frac{1 - E_{x',z',\underline{c}'|x,z,\underline{c}}\left[d_{j+1}^i\left(a', x', z', \underline{c}'\right)\right]}{1+r} - \kappa \tag{24}$$

4 Calibration

In this section I take the quantitative model to the data. First, I calibrate the parameters of the model in two steps: (i) I calibrate a subgroup of parameters with standard values taken from the literature and (ii) I estimate a second group of ten parameters with eleven moments from the payday loan borrowing behavior. Then, I discuss the identification between impatient and temptation households and validate the estimation using independent survey data and by replicating a real world policy change.

4.1 External parameters

The parameters that are calibrated externally are shown in Table 1. The monthly risk-free interest rate is set to $r = \frac{0.03}{12}$ and the coefficient of risk aversion $\sigma = 2$, as is common in the literature. With respect to the parameters that govern the income and expenditure processes, the estimates from Miranda-Pinto et al. (2020) are used for the mean, persistence, and variance of the shocks of income and expenditure. Their estimates are quarterly, so I find monthly approximations, as explained in D.3. The parameter for the disutility of the expenditure shock is calibrated in the second step, since the model in Miranda-Pinto et al. (2020) is an infinite-horizon model, which means the value they estimate cannot be used in this paper.

The parameter κ that represents the cost of operating the payday lending business is calibrated to match the lowest monthly interest rate observed in the data, which is 10%. This yields $\kappa = 0.09$.

In the estimation of the model, I include the current regulation in Florida: there is an exogenous debt limit, $\bar{a} \geq -\$500$, and a maximum interest rate, $\bar{r} = \frac{0.1a+5}{a}$ that depends on the loan amount.

Table 1: External parameters

Parameter	Value
σ	2
r	0.0025
μ_x	-0.12
ρ_x	0.79
σ_x	0.66
ρ_z	0.99
σ_z	0.10
μ_c	0.003
ρ_c	0.81
σ_c	1.25
κ	0.09

4.2 Jointly estimated parameters

A second group of parameters is jointly estimated: discount factors $(\beta_P, \beta_I, \beta_T)$, default costs (λ, χ), cost of expenditure shocks (η), weights for household types (ω_P, ω_I) and the parameters that govern temptation (γ, δ).

I use two sets of moments in the estimation: payday loan borrowing behavior data—how much households borrow, for how long and how frequently they default—and valuations of a no-borrowing incentive from Allcott et al. (2022). The combination of both data moments is critical for the identification of the three types of households. Without the valuations data, a model with patient and impatient or temptation preferences can be estimated, but the model would not be able to differentiate between impatient and temptation preferences.

4.2.1 Borrowing patterns

I use a database that contains more than 100 million payday loan transactions between 2003 and 2018 by payday lenders in Florida. The statewide database is administered by a private firm, Veritec LLC, and the data can be requested from the Florida Office of Financial Regulation.

All payday lenders in Florida have access to the database. State regulation requires lenders to check that a loan to a client satisfies the financial regulations of the state before issuing a new one. For example, an individual cannot have more than one payday loan at a time, the amount of a loan must be less than $500, the financial fees have to be less than 10% of the principal amount plus a maximum verification fee of $5, and clients cannot renew a loan before 24 hours after repaying a loan. Once the lender confirms that the new loan satisfies the state regulations, they can issue the new loan and report it to the state database.[13]

[13]These statewide payday lending databases are common in states that regulate this sector. Databases have to be kept to enforce regulations. However, each state has different agreements with Veritec LLC on what information can

For every transaction, the dataset includes the date the loan was originated, the principal of the loan, the fees charged, the due date, whether there was a payment from the client and when, and the zip code of the lender. At the client level, the data includes the date of birth and the residential zip code.

One limitation of the data is that a specific client cannot be followed in time. To get around this limitation, I approximate a consumer across time using combinations of date of birth and zip code. If for a zip code and date of birth, there are two or more loans overlapping in at least one day, the observation is dropped. This is because the regulation prohibits having more than one payday loan at a time. After doing this, 70% of the transactions remain in the database. I use this identification of a consumer to measure borrowing sequences. Loan sequences are defined as consecutive loans that are separated by less than 30 days to be consistent with the frequency of the quantitative model. Below, I verify that the strategy for identifying a consumer in time is effective by checking that the borrowing sequences are consistent with those documented in CFPB (2013) for payday lending.

Table 2 summarizes the characteristics of payday loan transactions. On average, a payday loan is $404, with a maturity of 17 days and a monthly interest rate of 22.4% (equivalent to an APR of 268%). Thus, they are small, expensive, and short-term. The average borrowing sequence lasts four months, and approximately 2% of transactions are paid back late, which is my measure of default.

Table 2: Summary Statistics and Regulation

Summary statistics		
	Mean	SD
Loan size ($)	404.1	129.0
Monthly rate	22.4	9.1
Term (days)	17.3	7.0
Default (late > 30 days, %)	1.9	13.7
Sequence length (months)	4.1	8.5
Regulation		
Loan size limit ($)	500	
Interest rate ceiling	10% of principal + $5	
Cooling-off period (days)	1	

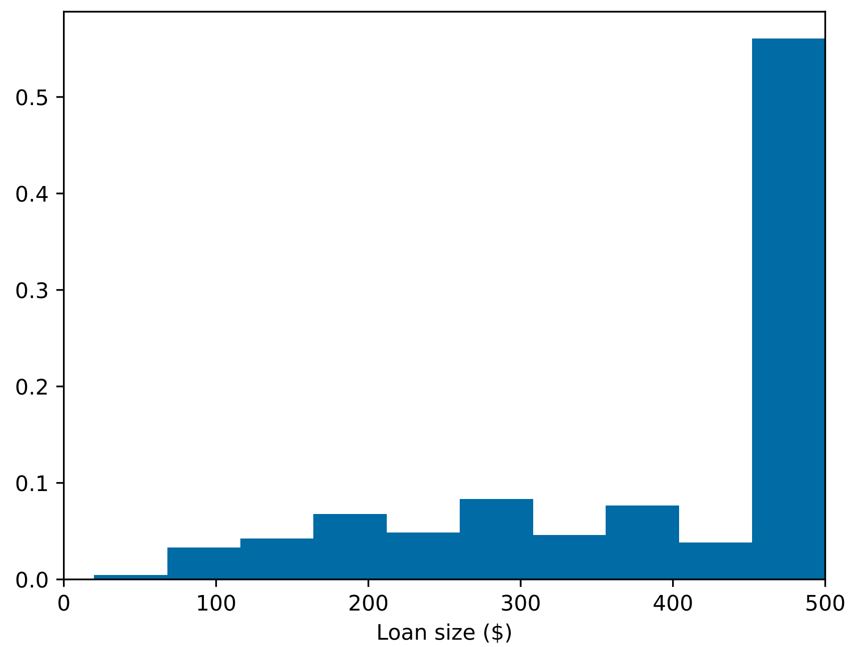
A model of payday lending that is useful to understand the effects of regulations should be able to reproduce at least the borrowing behavior that is directly regulated through loan size limits, interest rate caps, and rollover restrictions, that is, how much is borrowed, the length of borrowing sequences, and the cost of loans—reflected here in how frequently they default and

be accessed by the public.

operational costs.

With respect to the amount borrowed, I approximate the loan size distribution shown in Figure 4 by targeting the proportion of loans at the maximum loan size, the proportion of loans between \$100 and \$450, and the average loan.

Figure 4: Fraction of loans by loan size (in dollars)



With respect to default rates, I consider a loan to be in default when the loan was late for more than 30 days. I target the default rate of short and long sequences, as shown in Figure 5. Longer sequences end up in default more than twice as often as shorter sequences.

The distribution of sequences by length is presented in Figure 6. The distribution of sequences is captured with the fraction of sequences that last less than one month, the fraction that is more than twelve months, and the average sequence length. The loan sequences that I observe for Florida are quantitatively comparable to the ones in CFPB (2013) for a large payday lender. For example, 41% of loan sequences last up to one month in Florida, while in the CFPB data they account for 54%. Similarly, longer sequences that last more than 5 months account for up to 22% and 17%, respectively. The CFPB defines sequences as loans separated by less than 14 days. In the Florida data, sequences are defined as consecutive loans separated by less than 30 days. That explains why there are more short sequences in the CFPB data and longer sequences in the Florida data.

In addition, I also include the fraction of households that borrow from a payday lender to discipline the model in the sense that only a small fraction of households actually take up payday

Figure 5: Fraction of sequences defaulted by sequence length (in months)

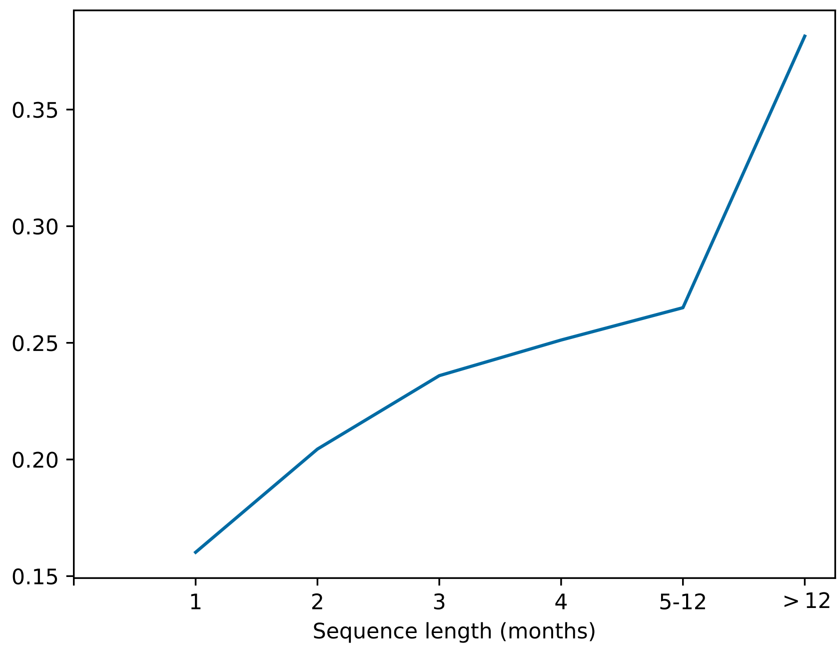
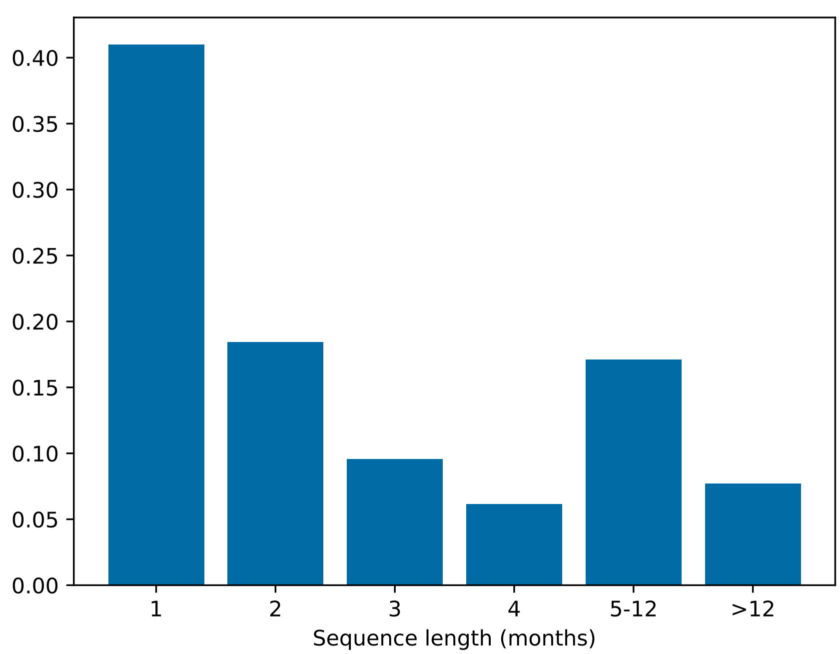


Figure 6: Fraction of sequences by sequence length (in months)



loans. I use the Survey of Consumer Finances (SCF) to measure payday take-up rates. The SCF asks respondents if they took a payday loan during the previous 12 months. In the SCF 2016, 3.6% of the total households borrowed from a payday lender. I adjust this number to 4.8% of households to take into account the fact that 25% of the population lives in states that completely ban payday lending.

4.2.2 No-borrowing incentive

Finally, I use valuation data from a no-borrowing incentive (NBI) offered to payday customers in Indiana, in Allcott et al. (2022). The NBI consists of offering $100 to payday customers in three months if they do not borrow from a payday lender in the next two months. As shown in Figure 16, there is a distribution of the valuations of the incentive, that is, the amount of money-for-sure in three months that would make borrowers indifferent with respect to the incentive. Two facts from this figure are interesting for the purpose of this paper: (i) a quarter of the borrowers have valuations close to zero for the incentive, indicating that there is no value to them of not being able to borrow from a payday lender, and (ii) there are valuations above $100, which is an indication that there are customers who benefit from not being able to borrow. Valuations data are critical for identifying temptation households from exponential discounters. Households with a low discount factor—who are likely to borrow in the future—will be hurt by the NBI and have a low valuation. Households with temptation have a demand for commitment; they value not being able to borrow in the future as it limits their temptation, so they have higher valuations.

To distinguish between patient or impatient households and temptation households, the estimation targets the average valuation of the NBI and the fraction of valuations between $100 and $160. Allcott et al. (2022) use the average valuation and argue that the average borrower is time inconsistent. In this model, valuations above $100 can only be achieved by a household with temptation issues because it indicates a benefit from restricting the choice set, which can be desired by those types of households. Using the valuations above $100 places a lower bound on the mass of households with temptation.[14]

4.3 Model fit

The model is able to capture the main features of payday loan borrowing to a large extent. It captures the fraction of borrowers taking very short high-cost loan sequences, but long sequences as well. The same goes for the distribution of loan sizes: a fraction of borrowers bunching at the maximum loan size allowed by regulation, but also smaller loans. The largest deviation is related

[14] Allcott et al. (2022) find that future borrowing beliefs are affected by the incentive, as households report a lower probability of borrowing than the actual one. This is another reason why using the valuations above $100 is a lower bound to the mass of temptation households. With a higher probability of borrowing in the future, temptation households would likely have a higher valuation.

to the loan size distribution. The model delivers too many small loans (less than \$50) that in the data practically do not exist. This is due to two reasons. On the one hand, the price schedules for households with binding consumption thresholds are very tight and go to zero very quickly before a debt level of \$100.[15] Thus, where income is low and consumption thresholds are binding, loans are relatively small and explain the excessive fraction of small loans provided by the model with respect to the data.

Table 3: Joint estimation: Data vs. model

	Data	Model	Source
Average sequence (months)	4.2	5.1	Florida (2003–2018)
Sequences $>$ 12 months	7.7	8.0	Florida (2003–2018)
Sequences = 1 months	41.0	26.7	Florida (2003–2018)
Average loan (\$)	404	260	Florida (2016)
Fraction loans = \$500	55.8	37.4	Florida (2016)
Fraction loans \$100–\$450	43.68	21.5	Florida (2016)
Default rate long seq.	38.0	29.0	Florida (2003–2018)
Default rate short seq.	16.0	17.9	Florida (2003–2018)
Take-up rate	4.8	5.0	SCF (2016)
Average valuation NBI	52.0	58.8	Zinman et al. (2021)
Fraction of valuations between \$100 and \$160	16.0	13.1	Zinman et al. (2021)

The parameters that produce this fit for the model are presented in Table 4. First, 94% of the households have a discount factor of 0.99; the remaining households are impatient or have temptation and self-control preferences, almost in equal measure. The impatient agent has a very low discount factor of $\beta_2 = 0.15$. The temptation agents combine a discount factor of $\beta_3 = 0.55$ and the temptation discount factor given by $\delta\beta_3 = 0.17 * 0.55$. The borrowing is dominated by the impatient and temptation agents as 95% of the loans are demanded by them, and the remaining by the patient households.

Exclusion is substantial—the probability of regaining access to the credit market after defaulting is only 0.05%. This is consistent with the average time to borrow again after defaulting, which is 24 months in Florida.

4.4 Identification of ω_2

The identification of ω_2 deserves a brief discussion since it is a new parameter in the literature. If the model is estimated with data from the borrowing behavior of consumers, the estimation cannot separate between a consumer that is patient and a consumer that has temptation issues, as shown in Figure 7. There I plot the sum of squared residuals between the moments generated by

[15] This is a combination of high default risk for these households and binding interest rate ceilings from the current Florida regulation.

Table 4: Estimated parameters

	Parameters	Description
β_1	0.99	Discount factor 1
β_2	0.15	Discount factor 2
β_3	0.55	Discount factor temptation
δ	0.17	Nature of temptation
γ	105.2	Strength of temptation
ω_1	0.94	Weight β_1
ω_2	0.034	Weight β_2
λ	0.15	Default utility cost
η	314	Exp shock utility cost
χ	0.05	Re-access probability

the model and the data as a function of ω_2. The blue line includes all moments in the estimation, while the orange line does not include the moments from the NBI. If I ignore the NBI data, having more (less) impatient consumers in detriment (favor) of temptation consumers does not make a difference for the fit of the model. ω_2 can be identified when considering the NBI valuations data.

4.5 Validation

4.5.1 Self-control and temptation preferences

First, I validate the estimate of how many households that borrow in high-cost markets have self-control issues. For this, I use independent data from the National Financial Well-Being Survey, a nationally representative survey asking households about their self-control issues and their use of high-cost credit, among other things.[16] The survey asks respondents three questions about their self-control, as shown in Table 5. For each question, I show the fraction of households that report having self-control issues. I also aggregated the responses according to in how many of the three questions the respondent indicated self-control issues. In the survey, I consider high-cost borrowers to be those households that used payday loans, pawn shops, or check cashing services outside of banks or credit unions in the previous twelve months.[17]

The quantitative model shows that one third of high-cost borrowers have self-control and temptation problems. This estimate is largely consistent with the measurements from the survey data. First, each question of self-control points to a third of high-cost borrowers having self-control issues. Second, when aggregating the questions, the model is within the lower- and upper-bound measures of self-control. Almost 10% of the households reported having self-control issues in all three questions. Households reporting self-control issues in at least one

[16]See Consumer Financial Protection Bureau (2017) for details of the survey.

[17]Considering payday loans and pawn shops exclusively yields the same answers but with half of the observations.

Figure 7: Sum of squared errors of the model

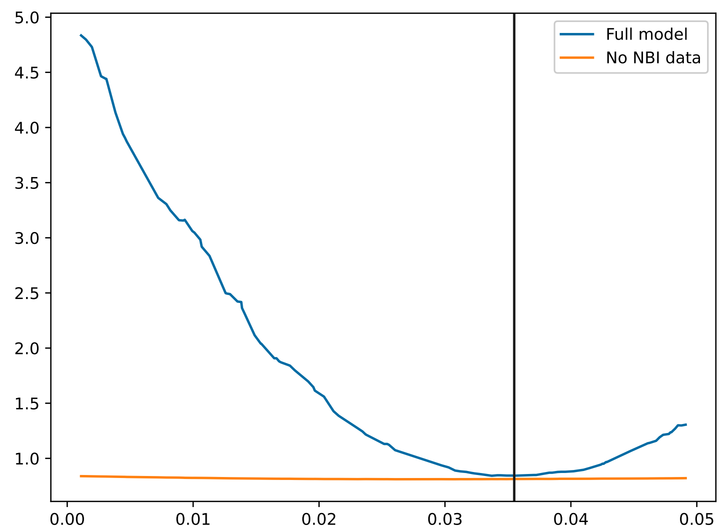


Table 5: Measure of households with self-control issues among high-cost borrowers

		Self-control issues
Survey questions	I am able to work diligently toward long-term goals	31.0
	I am good at resisting temptation	36.8
	I often act without thinking through all the alternatives	37.7
Aggregation	At least one	64.7
	At least two	31.1
	All three	9.7

Note: The table shows the fraction of high-cost borrowers who have self-control issues in the 2017 National Survey of Financial Well-Being. I classify individuals as having self-control issues if they answer "Not very well" or "Not at all" to the question "I am able to work diligently toward long-term goals" or "I am good at resisting temptation" and "Very well" or "Completely well" to the question "I often act without thinking through all the alternatives." When aggregating the answers, I consider the "at least one" scenario where individuals have answered they have self-control issues in at least one of the questions, the "at least two" scenario where individuals have responded to having self-control issues in at least two of the questions, and the "all three" scenario where individuals have been consistent across all three questions about their self-control issues. High-cost borrowers are individuals who have said that they have used a payday loan, a pawn shop, or check cashing services with institutions other than banks or credit unions. The sample of high-cost borrowers is 642 individuals.

question made up almost 65% of households. An intermediate measure where households reported self-control issues in at least two questions account for almost a third, as in the model.

This is qualitative evidence complementary to that provided in Zinman (2010). In their survey, they ask borrowers, "Would you like to give yourself extra motivation to avoid payday loan debt?" to which more than half of respondents answer that they would very much like to.

4.5.2 The effect of the Oregon interest-rate cap

A second validation of the model replicates the effect of a real-world policy change, the interest-rate cap in Oregon studied in Zinman (2010). There is a large body of empirical literature on high-cost lending that estimates the causal effect of regulations or the causal effect of using these credit products. In the model I replicate the findings of Zinman (2010) because it is the paper in which one of the outcome variables can be measured in the quantitative model. That paper evaluates the effect of an interest-rate cap for payday lending in Oregon, using a difference-in-difference approach with the state of Washington, which did not set an interest-rate cap. The new policy consisted of limiting the cost of payday loans to a maximum APR of 150% on loans under $50,000, while the state of Washington did not impose an interest-rate cap on loans up to $500. The paper uses data from the payday loan survey panel before the policy change and five months after the policy change. It measures the effect of the interest-rate cap on the likelihood that households that were borrowing before the change continued to do so five months after the policy change. I run the same exercise in my model.

Table 6: Effect of the Oregon interest-rate cap on payday loan use

	Zinman (2010)			Model		
	Oregon	Washington	Effect	Oregon	Washington	Effect
Likelihood of payday borrowing after cap	0.51	0.79	-0.28	0.18	0.49	-0.31

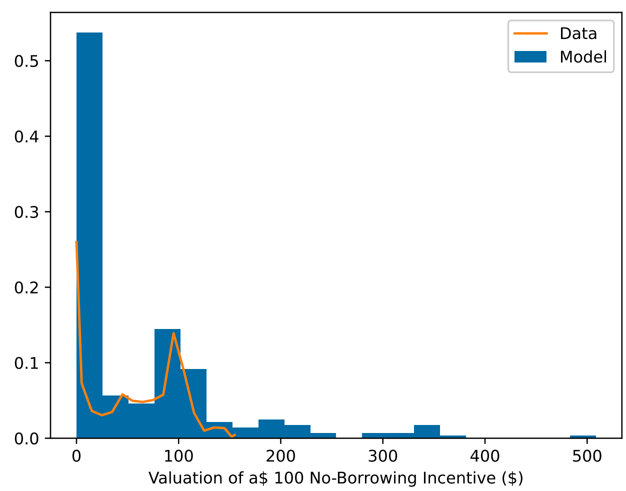
Note: This table shows the probability of a borrower pre-interest-rate cap in Oregon continuing to borrow after the regulatory change, in Oregon and Washington, for the empirical analysis in Zinman (2010) and in the quantitative model. The effect of the policy is the difference between Oregon and Washington.

The results of the model and the data are reported in Table 6. The effect of the interest-rate cap on the likelihood of payday borrowing after the cap in the model is very close to the one in Zinman (2010). There are level differences in the likelihood of continued borrowing, but that could be, for example, due to the fact that the sample they use is not representative of payday borrowers. Also, the policy is completely unanticipated in my model but likely to be anticipated to some extent in the real world.

4.5.3 The distribution of NBI valuations

The last piece of validation of the model comes from Allcott et al. (2022). I used two moments from the valuations reported by payday borrowers in their NBI—the average valuation and the fraction of high valuations. The distribution of the model's valuations is largely consistent with the empirical distribution of the valuations as a whole, as shown in Figure 8. In particular, it captures the low valuations driven by impatient households that dislike the incentive because they want to be able to borrow in the future, the moderate valuations close to $100 driven by patient households, and high valuations driven by temptation households with high income. The model does, however, produce an excess of very low and very high valuations.

Figure 8: Distribution of NBI valuations from Allcott et al. (2022) and model



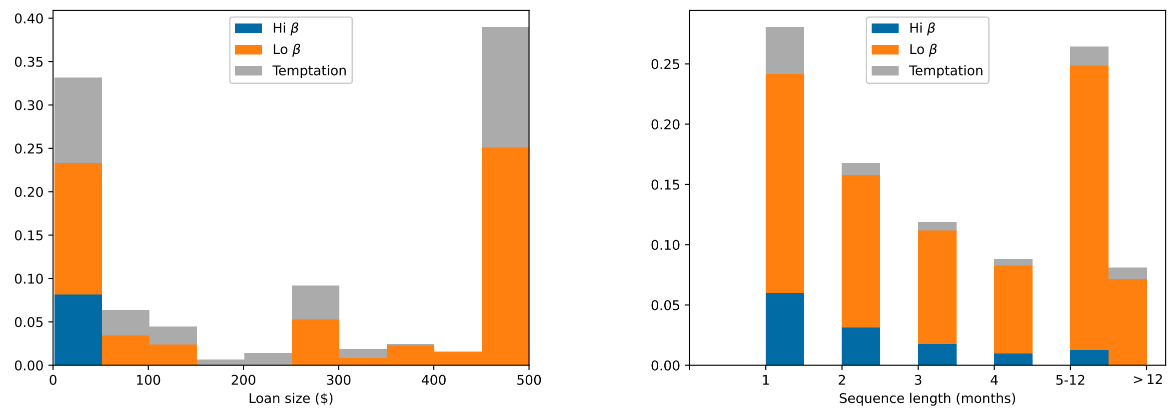
4.6 The drivers of high-cost borrowing

Finally, I provide a look at the drivers of borrowing in the model by types of households, before getting into the effects of regulations.

Patient households borrow small amounts and mostly short sequences of loans, as shown in Figure 9. This is due to the fact that patient households borrow when they have low income and binding expenditure shocks. Otherwise, they save to insure against negative shocks. In these states, price schedules are particularly tight, as shown in Figure 10, due to a high probability of default, which leads to small loans for these households. Due to their saving behavior, they are able to insure against negative income shocks and only need short borrowing sequences to make it through the binding expenditure shocks.

An average 1-month sequence for patient households looks like the one presented in Figure 18. Before borrowing at time 0, they face binding expenditure shocks, thus reducing their assets to keep consumption high. When they run out of assets they borrow from high-cost lenders to reduce the utility loss from the expenditure shock. Borrowing sequences that end with repayment (left panel) last as long as the consumption threshold binds; they end up in default when the consumption thresholds bind even further. In the latter case, the level of assets takes longer to accumulate again because households are saving-constrained, as in Miranda-Pinto et al. (2020).

Figure 9: Distribution of loans and sequences, model and data



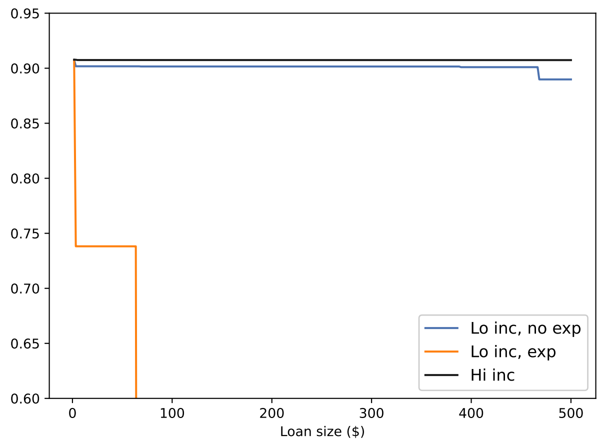
(a) Fraction of loans

(b) Fraction of sequences

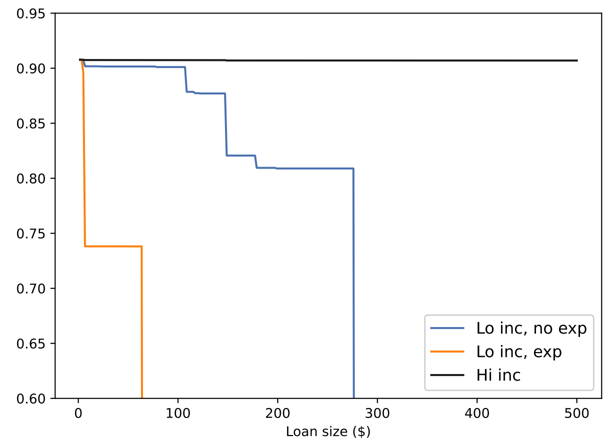
Temptation and impatient households, on the other hand, borrow both small and large loans, as well as they take short and long borrowing sequences. This is because households with different income levels and expenditure shocks face different price schedules. An interesting feature is that the price schedules are tighter than the ones for the patient agents. This is due to the default costs associated with future exclusion from borrowing are heavily discounted compared to patient agents. This can be seen by comparing the price schedules for low income, non-binding expenditure shocks, (blue line) in Figure 10, of patient and temptation households.

In Figure 19 and Figure 20, I show average 4-month sequences for impatient households of low- and high-income. Low discount factors prevent households from accumulating savings to insure against negative expenditure shocks, so their level of assets is low. Borrowing sequences for impatient households start with good news, as opposed to patient households. Sequences on average start with low expenditure shocks, which increases the price of debt through a decrease in the probability of default. The borrowing sequence ends when consumption thresholds return to their relatively high value for these households, decreasing the price of debt. Thus, high-cost borrowing happens when households obtain access to credit or a better access to it in terms of pricing to satisfy their desire for present consumption, as opposed to patient households, who borrow when they experience binding expenditure shocks, and they borrow even at very high interest rates due to their high marginal utility from consumption.

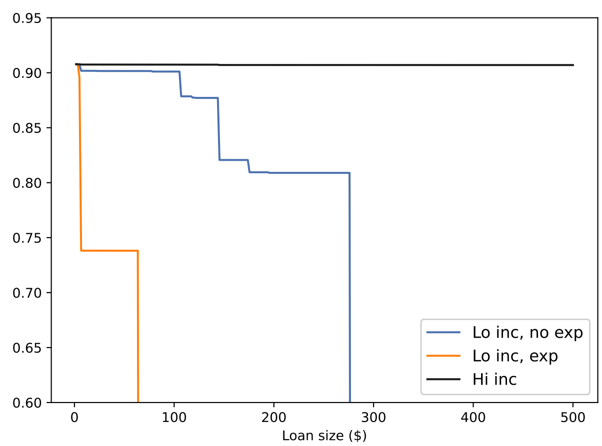
Figure 10: Price schedules by agent type



(a) Patient household



(b) Impatient household



(c) Temptation household

5 The welfare effects of regulations

I perform two types of policy experiments that replicate current payday regulations: regulatory borrowing limits and interest rate ceilings. Both policies are non-contingent, meaning they are the same across the board regardless of financial circumstances. The regulatory borrowing limit $\bar{a}$ imposes a constraint on debt holdings such that $a'(a, y, \underline{c}) \geq \bar{a}$. The interest-rate cap $\bar{q}$ limits how much lenders can charge for any given level of debt such that $q_j^i(a', y, \underline{c}) \geq \bar{q}$.

5.1 Regulatory borrowing limits

The current calibration yields non-contingent regulatory borrowing limits undesirable from a utilitarian perspective, as shown in Figure 11. All types of households have lower welfare with tighter borrowing limits. This was expected for patient and impatient households, but it also occurs for temptation households, although to a smaller extent. The welfare costs of banning high-cost lending are high for the fraction of impatient households (2.5% of consumption).

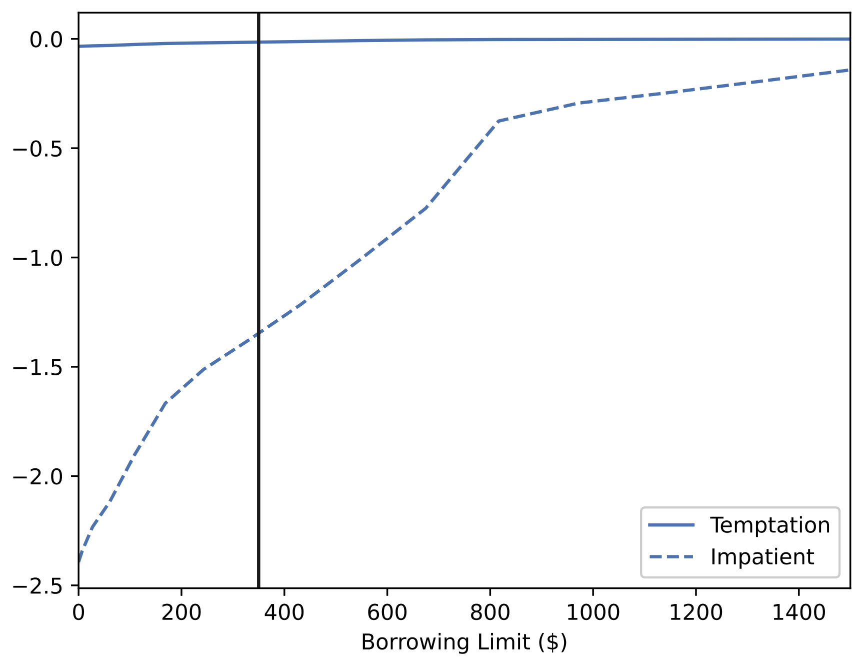
However, there are distributional consequences of borrowing limits within temptation households, as shown in Figure 12. Households of different income face different welfare gains from this policy even for the extreme limit of banning high-cost credit. Low-income households face a welfare cost due to the banning of high-cost credit of almost 0.1% while households with higher income gain more than 0.5% of their consumption.

In Figure 13 I present alternative parameter values for default, temptation, and expenditure shocks. Turning the temptation household into an exponential discounter increases the losses from the regulatory borrowing limits, indicating there is overborrowing but not enough to justify the non-contingent limit for the newborns with temptation. Increasing the default cost $\lambda \to \infty$ also increases the welfare costs of borrowing limits, as households now face horizontal prices of debt and are less constrained, in particular those that face bad income and expenditure shocks. Finally, removing expenditure shocks barely increases the welfare losses.

5.2 Interest rate ceilings

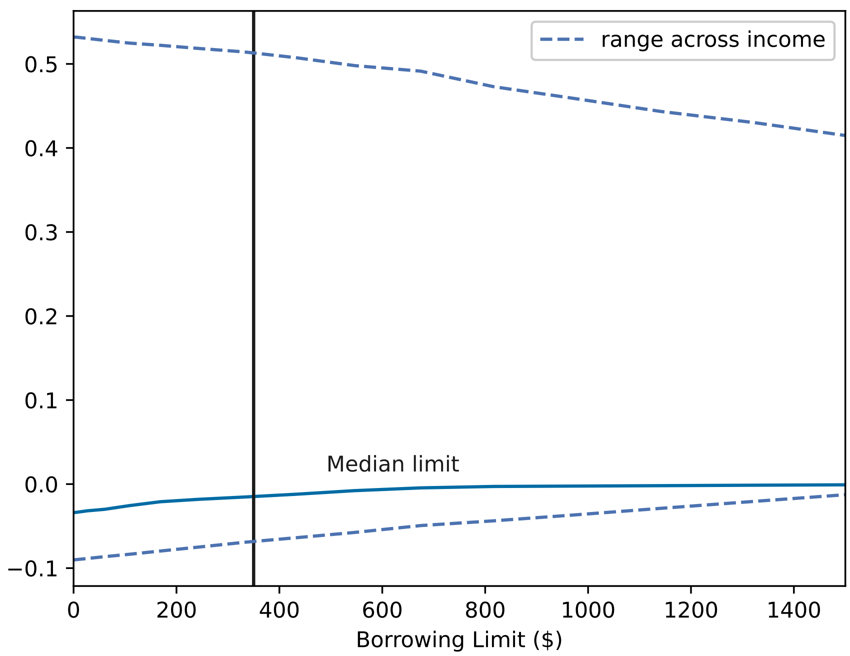
The case for interest rate ceilings as a tool for improving the welfare of temptation households is also not supported by the model for the temptation households. In Figure 14, I plot the welfare gains from varying interest rate ceilings. These turn out to decrease the welfare of households that suffer from temptation. What is interesting is that as you impose tighter interest rate ceilings, the welfare costs occur at interest rate ceilings that are not tight at all. This is a result of the selection in this market by loan size and interest rate. Households that face low income shocks and binding consumption thresholds have a higher probability of default, so the price schedules that they face drop very quickly as debt increases. As a result, they borrow small loans at high interest rates. So, even high interest rate ceilings reduce the welfare of households that suffer from temptation. Very tight ceilings actually increase the welfare to the extent that they limit overborrowing by high-income households at low interest rates, but not enough to revert the initial losses.

Figure 11: Welfare gains (%, consumption equivalent), patient and impatient



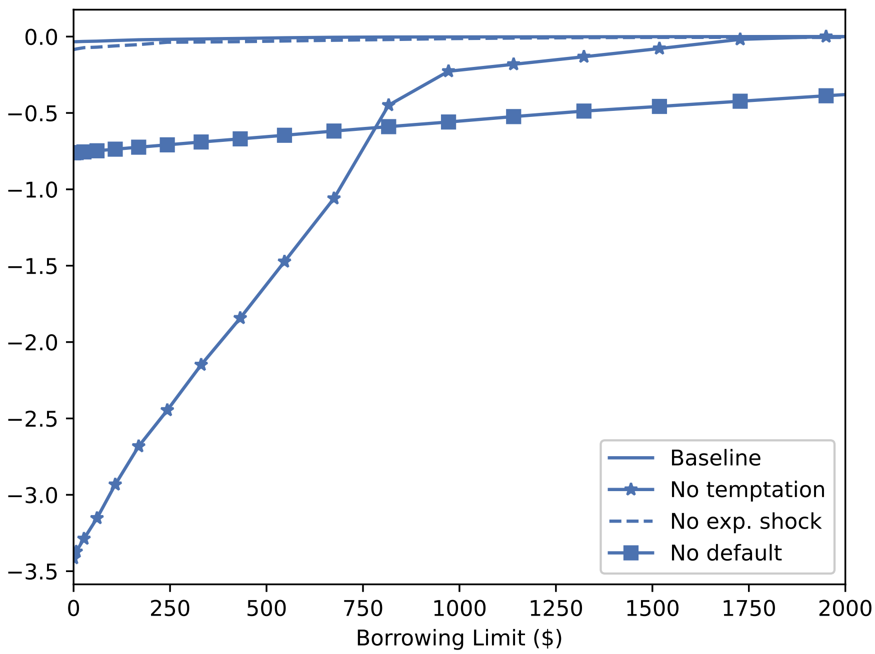
Note: This figure show the consumption equivalent (in %) in an unregulated economy such that newborns are indifferent with respect to an economy with a regulatory borrowing limit. The vertical black line represents the median borrowing limit from actual regulations across states.

Figure 12: Welfare gains (%, consumption equivalent), temptation households



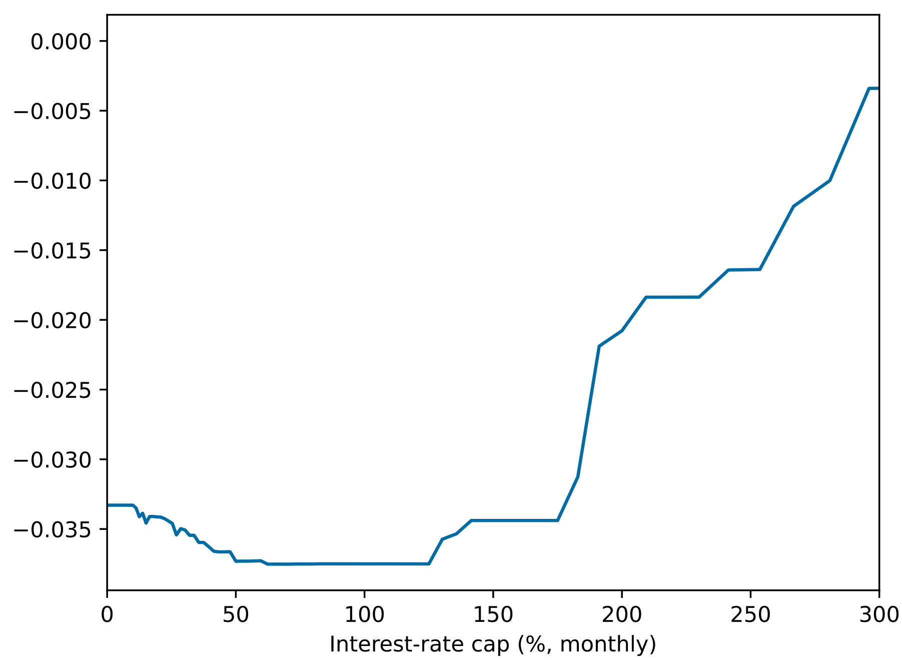
Note: This figure shows the consumption equivalent (in %) in an unregulated economy such that newborns are indifferent with respect to an economy with a regulatory borrowing limit (solid blue line). The dashed lines are the range of welfare gains across the income distribution of the initial draw. The vertical black line represents the median borrowing limit from actual regulations across US states.

Figure 13: Welfare gains (%, consumption equivalent), temptation households



Note: This figure shows the consumption equivalent (in %) in an unregulated economy such that newborns are indifferent with respect to an economy with a regulatory borrowing limit. Different lines represent different modifications of the baseline calibration.

Figure 14: Welfare gains (%, consumption equivalent), temptation households



Note: This figure shows the consumption equivalent (in %) in an unregulated economy such that newborns are indifferent with respect to an economy with a regulatory interest-rate cap.

6 Conclusion

This paper studies the welfare consequences of regulations in high-cost credit markets such as payday lending. I develop and estimate a quantitative unsecured credit model that can reproduce the key features of borrowing in these markets. In particular, I separate the role of households that are patient or impatient and those that suffer from lack of self-control and temptation, which is critical for the welfare evaluation of policies. I find that borrowing limits and interest-rate caps reduce the welfare of all households, even those with temptation, which are the ones that could potentially benefit from them. However, for households that deal with self-control issues, there is significant disagreement about the desirability of borrowing limits across the income distribution.

The paper makes two important contributions to the literature. First, the distinction of households with self-control issues from patient and impatient households. Second, the importance of considering self-control issues together with pricing behavior from lenders, which has implications for the welfare consequences of regulations.

Two directions for future research on the effects of regulations on high-cost consumer credit emerge. First, the case of asymmetric information between lenders and borrowers. The assumption that payday lenders know all the relevant information to predict the expected default probability of borrowers, including their preferences, may not be realistic. In the case where lenders cannot observe the preferences of households, for example, regulations could have effects on all types of households through the pricing of credit. Second, the role of market power in these markets. Accounting in a model how costs, market power, and default rates explain the spread in interest rates between credit cards and payday lenders could yield lessons on interest-rate caps, for instance.

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A Tables

Table 7: Income, expenses and savings

	Coefficient	SE	p-value
Saving habits: spending>income	0.097	0.023	0.000
Saving habits: spending=income	0.118	0.026	0.000
Saving habits: some saving	-0.213	0.026	0.000
Spending>income (prev. 12m)	0.190	0.036	0.000
Spending=income (prev. 12m)	-0.003	0.034	0.926
Spending<income (prev. 12m)	-0.186	0.020	0.000
Expenses unusually high (prev. 12m)	0.076	0.025	0.002
Income unusually low (previous year)	0.000	0.019	0.982
Head: unemployed prev. 12m?	0.067	0.027	0.012
Spouse: unemployed prev. 12m?	0.044	0.035	0.209

Notes: Coefficient is β from the regression $y_i = \alpha + \beta Payday_i + Controls_i + \epsilon_i$. $Controls_i$ include networth deciles, normal income per capita (square root scale) deciles and age groups. SE is standard error of β. Standard errors are calculated taking into consideration the imputation uncertainty of the SCF.

Table 8: Credit attitudes

	Coefficient	SE	p-value
Apply credit card (prev. 12m)	0.111	0.026	0.000
Request increase limit in card (prev. 12m)	0.064	0.015	0.000
Apply auto loan (prev. 12m)	0.101	0.024	0.000
Apply other consumer credit (prev. 12m)	0.127	0.020	0.000
Request increase limit other loans (prev. 12m)	0.076	0.018	0.000
Turned down/less credit wrt applied, prev. 12m	0.288	0.025	0.000

Notes: Coefficient is β from the regression $y_i = \alpha + \beta Payday_i + Controls_i + \epsilon_i$. $Controls_i$ include networth deciles, normal income per capita (square root scale) deciles and age groups. SE is standard error of β. Standard errors are calculated taking into consideration the imputation uncertainty of the SCF.

B Additional Figures

Figure 15: Distribution of borrowing limits in the US (Barth et al. (2016))

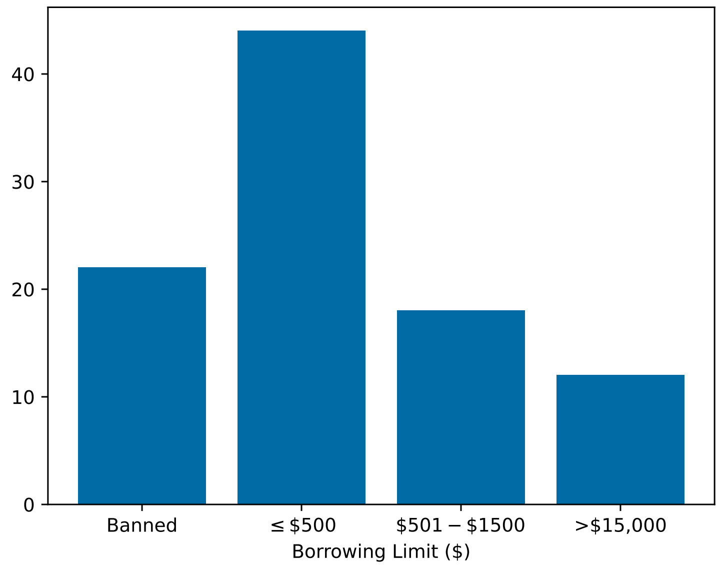
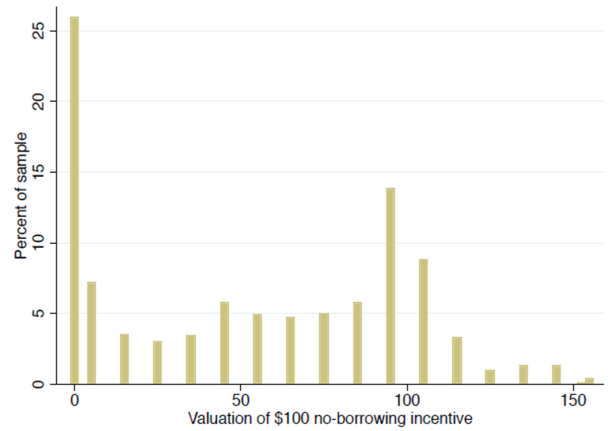


Figure 16: Histogram valuations no-borrowing incentive (Allcott et al. (2022))

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



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

Figure 17: Sum of squared errors between target and model moments (in logs)

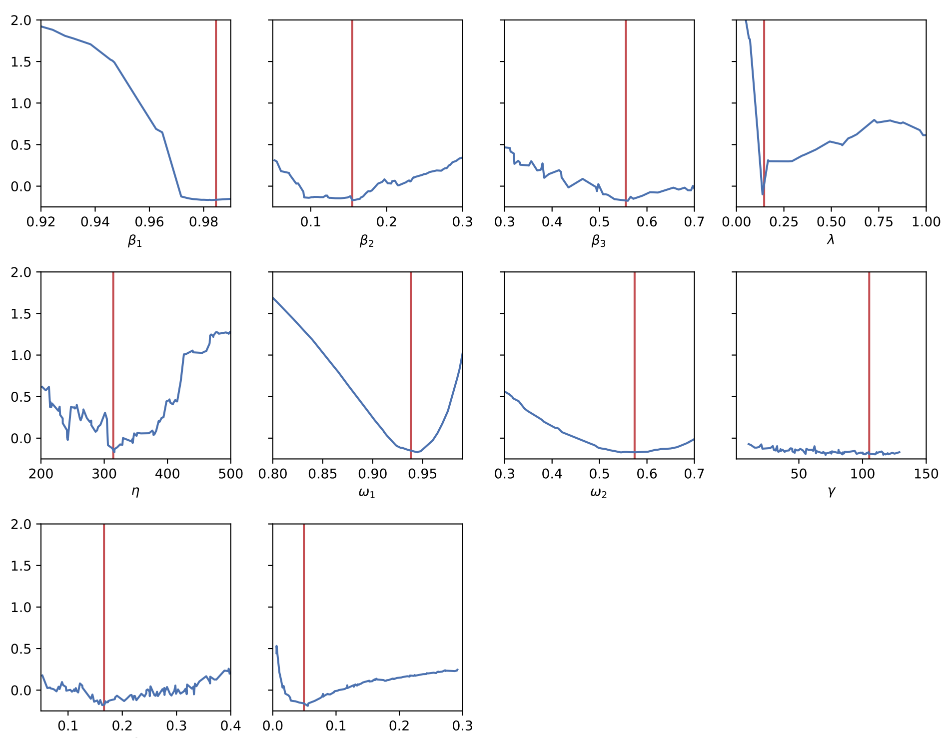
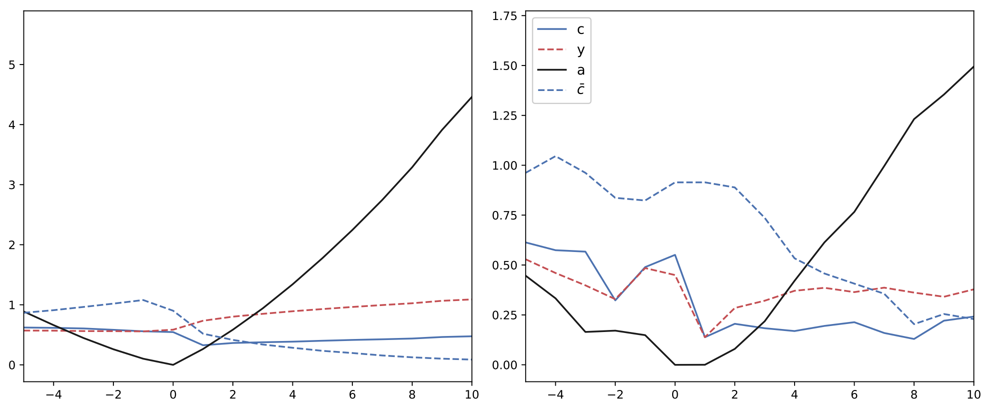
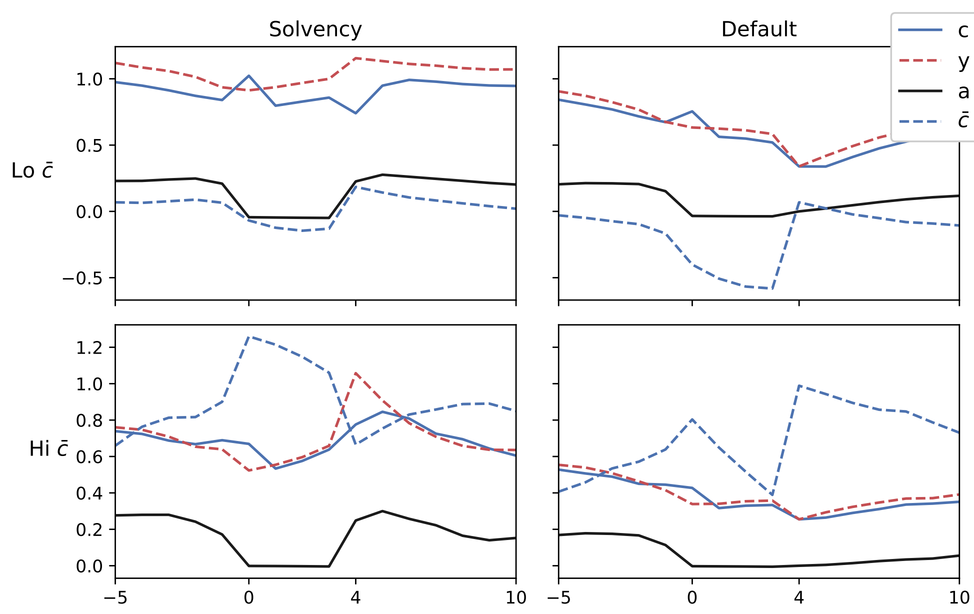


Figure 18: Average patient household's 1-month borrowing sequence



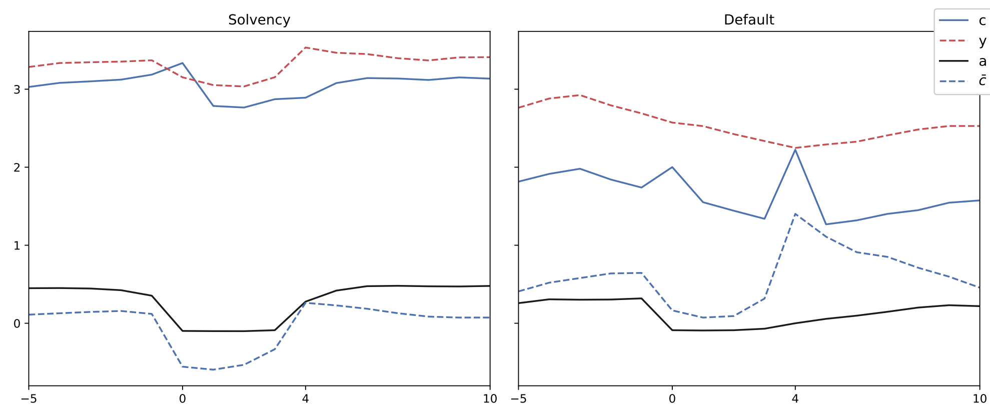
Notes: This figure shows an average 1-month borrowing sequence for patient households. The x-axis shows the time periods before and after the borrowing sequence starts (at time equal to 0). The y-axis shows consumption, endowment, assets and consumption thresholds.

Figure 19: Average 4-month borrowing sequence for low income, impatient households



Notes: This figure shows an average 4-month borrowing sequence for low-income, impatient households. The x-axis shows the time periods before and after the borrowing sequence starts (at time equal to 0). The y-axis shows consumption, endowment, assets and consumption thresholds.

Figure 20: Average 4-month borrowing sequence for high income, impatient households



Notes: This figure shows an average 4-month borrowing sequence for high-income, impatient households. The x-axis shows the time periods before and after the borrowing sequence starts (at time equal to 0). The y-axis shows consumption, endowment, assets and consumption thresholds.

C Why are interest rates so high?

Building on the work done by Flannery and Samolyk (2005), I provide additional data on payday lenders to explain the high interest rates that we observe. Specifically, how much of the observed interest rates are explained by operating costs and default?

In Equation 26 I write an expression for the zero-profit interest rate for payday lenders, $\bar{R^P}$:

$$\Pi = \rho \bar{R^P} L - \kappa - RL = 0 \tag{25}$$

$$\Rightarrow \bar{R^P} = \frac{1}{\rho}\left[R + \frac{\kappa}{L}\right] \tag{26}$$

where ρ is the probability of repayment, κ is fixed costs of the payday lender (wages, occupancy costs, advertising, corporate expenses), L is the total amount loaned, and R is the rate at which the lender borrows the funds that it lends. I use the store level data from Flannery and Samolyk (2005) and K-10 forms for two public payday lenders, between 2009 and 2011, Advance America, Cash Advance Centers Inc. and QC Holdings, Inc., to calibrate these parameters. Results are shown in Table 9. Comparing the zero profit interest rate and the effective interest rate that these lenders charge, surprisingly, the former explains most of the fees charged by lenders, which indicates that payday lending is a very costly activity.

Table 9: Calibration of zero-profit payday lending interest rate

	Flannery and Samolyk	AEA	QCCO
$\frac{\kappa}{L}$	0.12	0.10	0.093
R	1.015	1.002	1.002
ρ	0.98	0.97	0.96
$\bar{R^P}$	1.156	1.140	1.145
R^P	1.176	$\leq$ 1.22	1.15-1.20

Notes: The first column uses data from Flannery and Samolyk (2005); the remaining columns use data from K-10 forms for Advance America, Cash Advance Centers Inc. and QC Holdings, Inc., between 2009 and 2011.

D Analytical Appendix

D.1 Model

With default flag ($d = 1$) When households are type $i = P, I$, they solve

$$v_j^i\left(a, x, z, \underline{c}, 1\right) = \max_{c, a' \geq 0} \left\{ u\left(c\right) - \eta \max(\underline{c} - c, 0) + \beta^i \mathop{\mathbb{E}}_{x', z', \underline{c}', d' | x, z, \underline{c}} \left[v_{j+1}^i \left(a', x', z', \underline{c}', d'\right) \right] \right\} \tag{27}$$

$$c = a + y - \frac{1}{1+r} a'$$

When they have self-control and temptation preferences

$$\begin{aligned} v_j^T\left(a, x, z, \underline{c}, 1\right) = \max_{c, a' \geq 0} & \left\{ (1+\gamma) \left[u\left(\widetilde{c}\right) - \eta \max(\underline{c} - c, 0) \right] + (1 + \gamma\delta) \beta^T \mathop{\mathbb{E}}_{x', z', \underline{c}', d' | x, z, \underline{c}} \left[v_{j+1}^T \left(a', x', z', \underline{c}', d'\right) \right] \right\} \\ & - \widetilde{v}_j \left(a, y, \underline{c}, 1\right) \\ \widetilde{c} = & \, a + y - \frac{1}{1+r} \widetilde{a}' \end{aligned} \tag{28}$$

$$\widetilde{v}_j\left(a, x, z, \underline{c}, 1\right) = \gamma \max_{\widetilde{c}, \widetilde{a}' \geq 0} \left\{ u \left(\widetilde{c} \right) - \eta \max(\underline{c} - \widetilde{c}, 0) + \delta \beta^T \mathop{\mathbb{E}}_{x', z', \underline{c}', d' | x, z, \underline{c}} \left[v_{j+1}^T \left(\widetilde{a}', x', z', \underline{c}', d'\right) \right] \right\} \tag{29}$$

$$\widetilde{c} = a + y - \frac{1}{1+r} \widetilde{a}'$$

D.2 Valuations no-borrowing incentive

Among payday borrowers, I randomly choose N borrowers. For each borrower of type $i \in \{P, I, T\}$, states $(a, y, \underline{c}, d)$ and age j, I:

- compute the expected value of the no-borrowing incentive (NBI) of \$100 in 3 months, $v_j^{i,*}\left(a, y, \underline{c}\right)$;
- find the money-for-sure (MFR) value, p in $j + 2$ that makes the borrower indifferent between the NBI and the MFR, $v_j^i\left(a, y, \underline{c}, 1, p\right) = v_j^{i,*}\left(a, y, \underline{c}\right)$;

D.2.1 No-borrowing incentive

Households get a_0 in 3 months if they do not borrow in the next 2 months. The value of the incentive for a household of type i and state $(a, y, \underline{c}, d)$ in period j is:

$$v^{i,*}_{j+2}\left(a,y,\underline{c}\right) = v^{i,s}_{j+2}\left(a+a_0,y,\underline{c}\right) \tag{30}$$

$$\begin{aligned} v^{i,*}_{j+1}\left(a,y,\underline{c}\right) &= \max_{c,a'\geq 0}\left\{u\left(c\right)-\eta\max(\underline{c}-c,0)+\beta \mathop{\mathbb{E}}_{y',\underline{c}'|y,\underline{c}}\left[v^{i,*}_{j+2}\left(a',y',\underline{c}'\right)\right]\right\}, i=P,I \\ c &= a+y-\frac{1}{1+r}a' \end{aligned} \tag{31}$$

$$\begin{aligned} v^{i,*}_{j}\left(a,y,\underline{c}\right) &= \max_{c,a'\geq 0}\left\{u\left(c\right)-\eta\max(\underline{c}-c,0)+\beta \mathop{\mathbb{E}}_{y',\underline{c}'|y,\underline{c}}\left[v^{i,*}_{j+1}\left(a',y',\underline{c}'\right)\right]\right\}, i=P,I \\ c &= a+y-\frac{1}{1+r}a' \end{aligned} \tag{32}$$

D.3 Income and Expenditure Shocks

I use the estimated quarterly income and expenditure shocks in Miranda-Pinto et al. (2020) to obtain monthly processes for the quantitative model.

I find $x_{i,t}, z_{i,t}$ such that $y_t = \log \sum_{i=1}^{3} \exp\left(\mu + x_{i,t} + z_{i,t}\right)$, with $t =$ quarter, $i =$ month. y_t is the quarterly income (in logs) process from Miranda-Pinto et al. (2020).

$$x_{i,t} = \rho_x x_{i,t-1} + \sigma_x \epsilon^x_{i,t-1} \tag{33}$$

$$z_{i,t} = \rho_z z_{i,t-1} + \sigma_z \epsilon^z_{i,t-1} \tag{34}$$

For expenditures, I find $\bar{c}_{i,t}$ such that $\bar{c}_t = \frac{1}{3}\sum_{i=1}^{3} \bar{c}_{i,t}$, with $t =$ quarter, $i =$ month. $\bar{c}_t$ is the quarterly consumption threshold process from Miranda-Pinto et al. (2020).

$$\bar{c}_{i,t} = \rho_c \bar{c}_{i,t-1} + \sigma_{\bar{c}} \epsilon^{\bar{c}}_{i,t-1} \tag{35}$$