The Payday Loan Puzzle: A Credit Scoring Explanation

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Introduction

Motivation

- Payday loans: Unsecured, small amount ($300), short-term (2 weeks), and high-cost (400%)
- 12 million user and $50 billion (Stagman, 2007; PEW, 2016)
- Hotly debated regulatory topic

- **Payday loan puzzle** in U.S. (Agarwal et al, 2009):
  - **2/3** of payday loan borrowers have liquidity left on credit cards ($< 20\%$)
  - Significant extra monetary costs about **$200** over a year

Credit Scoring Explanation

"Why are people taking out [payday] loans instead of using their cards?" Ranney told me, "This guy was implying that these people weren't smart enough to make the 'right' decision. I laughed in his face. ***'They're protecting the card!'*** *I told him. [...]"* ***Whereas failure to repay a payday loan won't affect a consumer's credit score, failure to repay a credit card will.***

— Lisa Servon (2017): *The Unbanking of America*

What We Do

- Reputation protection: **“Using payday loans to protect credit scores!”**
  - Credit scores very important in U.S. Credit Scores
  - Payday lenders do not report to credit bureaus in U.S. (CFPB, 2017)
- Build a Huggett-type model of two assets, two default options, both hidden information (type scores) and hidden actions
  - Rationalize the puzzling behavior via type score protection
- Use calibrated model to understand payday loan puzzle
- Policy experiments: Quantity caps, full ban

Intuition — Type Score Protection via Payday Loans

- HHs' types (discount factors) β are unobservable
- Types score: Probability of being patient (good type)
- Types score updated with observable bank loan choice and default
- Credit terms thus condition on type scores
- Income $\downarrow \implies$ Borrowing bank loans $\implies$ Type score $\downarrow$ (today)
  $\implies$ Fail to repay bank loans $\implies$ Type score $\downarrow$ (tomorrow)
- Payday loans and payday default are unobservable "to banks"
- HHs might use more expensive payday loans to protect type scores

Key Findings

- Endogenously generate the payday loan puzzle
  - Account for 40% of the puzzle occurrence
  - Match the magnitude of monetary losses
- Restricting the size of or banning payday loans are welfare-reducing
  - Heterogeneity across types

Literature / Contribution

- **Consumer finance and default**: Chatterjee et al. (2007), Livshits et al. (2007), **Chatterjee et al. (2020)**, Exler (2020), Saldain (2021)

  First to model defaultable bank and payday loans with hidden information and actions
- **Pecuniary mistakes**: Agarwal et al. (2009), Cartel et al. (2011)

  First to endogenously generate and rationalize the payday loan puzzle
- **Payday loan policy debate**: Zinman (2010), Morgan et al. (2012), Skiba and Tobacman (2019), Melzer (2011)

  First to analyze welfare implications of policies in a richer framework

Model

Model Environment

- Time is discrete
- Endowment economy with idiosyncratic shocks
- Incomplete market: Bank assets, payday loans
- Banks, payday lenders, and households
- Households' hidden types (discount factors) $\Longrightarrow$ Type scores
- Banks cannot see payday loans

Households

- Infinitely-lived with survival rate ρ
- Risk-averse, derive utility from consumption c
- Two types of HHs: $\boldsymbol{\beta_L}$ and $\boldsymbol{\beta_H}$ (stochastic persistent)
- Receive stochastic earnings $\boldsymbol{z}$ (transitory) and $\boldsymbol{e}$ (persistent)
- Have bank assets $\boldsymbol{b}$, payday debts $\boldsymbol{p}$, type score $\boldsymbol{s}$ (Prob. of β_H)
- Repay or default $\boldsymbol{d}$
  - Formal default (both), payday default (payday loan only)
  - Filing costs, stigma costs, exclusion in the filing period
- Can borrow/save $\boldsymbol{b'}$ in banking sector
- Can borrow $\boldsymbol{p'}$ in payday lending sector (if $b' \leq 0$)
- Subject to action-specific utility shocks $\boldsymbol{\epsilon} \implies \boldsymbol{\sigma^{(d,b',p')}(\beta,z,e,b,s,p)}$

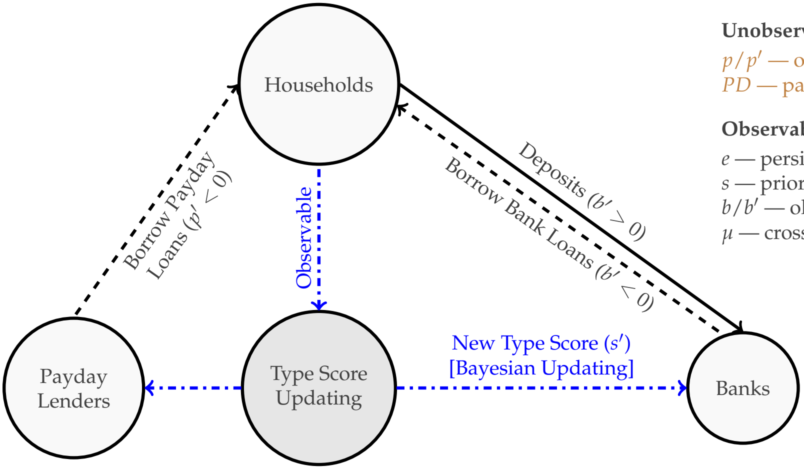
▸ Budget Constraint ▸ Value Function ▸ Choice Probability

Banks and Payday Lenders

- Risk-neutral
- **Different information set**
  - Banks cannot observe payday variables (p, p', and PD)
- **Different operating costs:** $r_p \gg r_f$
- **Different default probabilities**
  - Banks: Formal default
  - Payday lenders: Formal default, payday default
- Both can't see z (i.i.d.) and β (persistent) $\rightarrow$ Type score s
- Perfect competition: Risk-based discount loan prices $\boldsymbol{q_b}$ and $\boldsymbol{q_p}$

▸ Bank Problem ▸ Bank Loan Price Schedule ▸ Payday Problem ▸ Payday Loan Price Schedule

Information Structure



Unobservable to Both

β — type (discount factor)
z — transitory earnings

Unobservable to Banks only

p/p' — old/new payday loans
PD — payday default

Observable to Both

e — persistent earnings
s — prior type score
b/b' — old/new bank assets
μ — cross-sectional distribution

Type Score Updating

- Bank-observable choice probabilities $\omega_b \equiv (e, b, s)$:

$$\sigma^{(d,b',p')}(\beta, z, \omega_b, \boldsymbol{p}) \xrightarrow{\tilde{\boldsymbol{\mu}}(\boldsymbol{p})} \sigma^{(\boldsymbol{d},b',\boldsymbol{p}')}(\beta, z, \omega_b) \xrightarrow{\boldsymbol{p}', \tilde{\boldsymbol{d}} = \mathrm{R} \vee \boldsymbol{PD}} \tilde{\sigma}_b^{(\tilde{d},b')}(\beta, z, \omega_b)$$

- Type score s (Prob. of β_H) updated via Bayes rule:

$$\underbrace{s'(\beta_H)}_{\text{posterior}} = \overbrace{Q^{\beta}_{H \to H}}^{\text{transition}} \cdot \frac{\overbrace{\tilde{\sigma}_b^{(\tilde{d},b')}(\beta_H)}^{\text{updating}} \cdot \overbrace{s(\beta_H)}^{\text{prior}}}{\sum_{\hat{\beta}} \tilde{\sigma}_b^{(\tilde{d},b')}(\hat{\beta}) \cdot s(\hat{\beta})} + Q^{\beta}_{L \to H} \cdot \frac{\tilde{\sigma}_b^{(\tilde{d},b')}(\beta_L) \cdot (1 - s(\beta_H))}{\sum_{\hat{\beta}} \tilde{\sigma}_b^{(\tilde{d},b')}(\hat{\beta}) \cdot s(\hat{\beta})}$$

Rigorous ψ | Rigorous $\tilde{\sigma}_b$ | Likelihood Ratio and Type Score | Stationary Equilibrium | Grid Specification

Calibration

Strategy

- Model period is a year
- Whole population in 2004
- Two sets of parameters
  - Exogenouslly calibrated
    - Discount factors from Chatterjee et al. (2020)
    - Earnings processes from Floden and Linde (2001)
    - Standard values or direct empirical evidence
  - Internally calibrated to match formal and payday default rates

Exogenous Calibration

Parameter		Value	Source
Low discount factor	β_L	0.886	Chatterjee et al. (2020)
High discount factor	β_H	0.915	Chatterjee et al. (2020)
Transition from low to high	$Q^\beta(\beta_L\|\beta_H)$	0.013	Chatterjee et al. (2020)
Transition from high to low	$Q^\beta(\beta_H\|\beta_L)$	0.011	Chatterjee et al. (2020)
Discount factor at birth	G_β	(0.72,0.28)	Chatterjee et al. (2020)
AR(1) of persistent earnings	ρ_e	0.9136	Floden and Linde (2001)
S.D. of persistent earnings	σ_e^2	0.0426	Floden and Linde (2001)
S.D. of transitory earnings	σ_z^2	0.0421	Floden and Linde (2001)
Persistent earnings at birth	G_e	(1,0,0)	Upward earnings profile
Transitory earnings at birth	G_z	(1/3,1/3,1/3)	Upward earnings profile

Exogenous Calibration (cont.)

Parameter		Value	Source
CRRA	γ	2	Standard
Survival probability	ρ	0.975	40 years
Risk-free rate	r_f	0.014	Effective interest rate = 4%
Formal default cost	κ_{FD}	0.02	Albanesi and Nosal (2020)
Payday default cost	κ_{PD}	0.002	Montezemolo and Wolff (2015)
Operating cost for payday lenders	r_p	1.925	Flannery and Samolyk (2005)
Dispersion of extreme value shocks	α	0.005	

Internal Calibration

Parameter		Value	Target	Data	Model
Formal stigma cost	ξ_{FD}	0.02235	Formal default rate	0.99%	0.99%
Payday stigma cost	ξ_{PD}	0.00704	Payday default rate (cond.)	29.7%	29.7%

Source: ABI, CPS, Skiba and Tobacman (2018)

Untargeted Moments Aligned with Data

Moment (in %)	Data	Model
Households in Debt		
Fraction of bank loan users	20.9	24.26
Fraction of payday loan users	5.61	9.46
Bank debt-to-earnings (cond. on borr.)	11.75	6.48
Interest Rate		
Avg. interest rate for bank loans	9.26	8.56
Avg. interest rate for payday loans	447.88	410.85

Source: SCF (2004, 2010), Skiba and Tobacman (2018)

Pooling and Cross-Subsidization

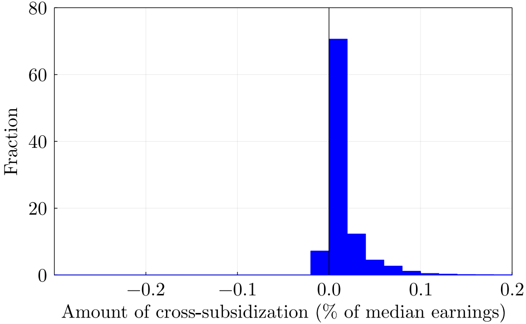
Pooling

- Banks cannot see types and payday loan choices
- Conditional on the same borrowing of bank loans
  - Impatient $\rightarrow$ Default $\uparrow$ $\rightarrow$ **Riskier**
  - Payday loan users $\rightarrow$ Total debt burden $\uparrow$ $\rightarrow$ Default $\uparrow$ $\rightarrow$ **Riskier**
- **Riskier** faces lower bank loan rates than "actuarially fair rates" (FI)
- Cross-subsidization in "bank loan market"

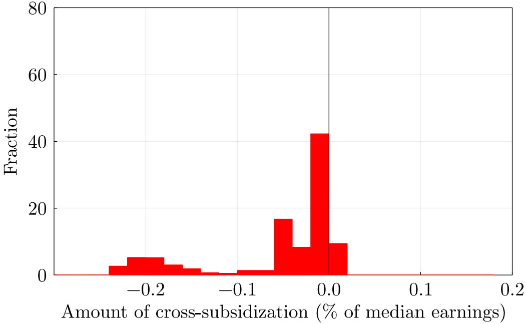
▸ Formal Default Prob. by Types and Payday Users ▸ Equilibrium Outcomes by Types

Cross-Subs. of Bank Loans across Types

(a) Impatient Households

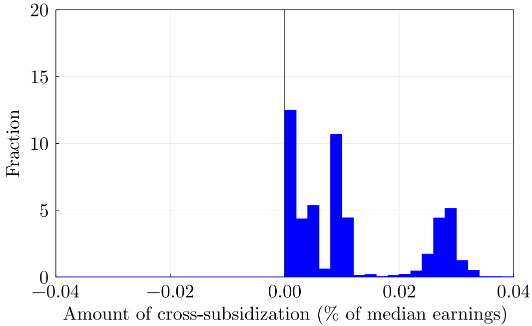


(b) Patient Households

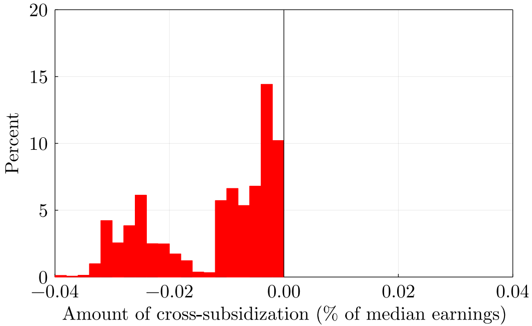


Cross-Subs. of Bank Loans across Payday Loan Users

(a) Payday Loan Users



(b) Non Payday Loan Users



Payday Loan Puzzle

Account for 40% of Puzzle Occurrence

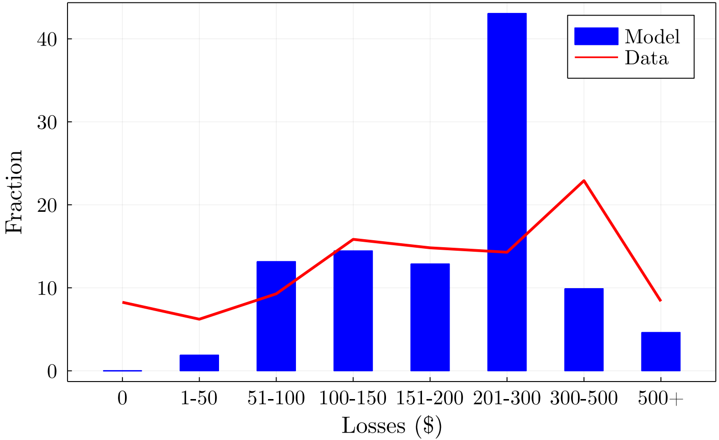
- Payday loan puzzle: Using payday loans before maxing out credit cards
- In data $\approx 66\%$ (Agarwal et al., 2009)
- Define **"Rate of Puzzle Occurrence"** as:

$$\left(\frac{\text{Both loan users making \textbf{``Seeming Pecuniary Mistake''}}}{\text{Both loan users}} \right) \times 100$$

- In model $= 26.44\% \implies 40\%$ of puzzle occurrence
- Puzzle users: HHs of this puzzling behavior

▸ Rigorous Puzzle Definition ▸ Type Score Protection

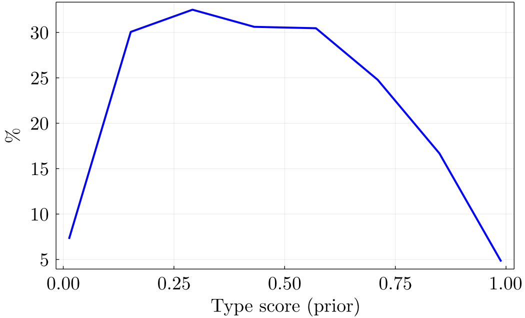
Match Magnitude of Monetary Losses



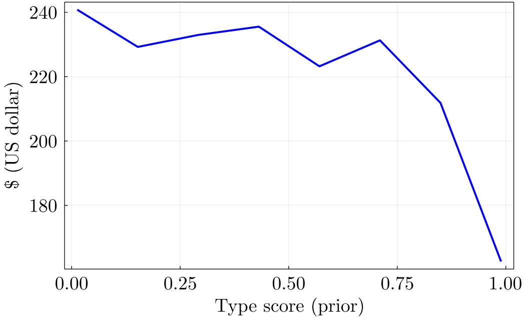
Source: Agarwal et al. (2009)

Reputation Gain vs. Interest Loss

(a) Reputation Gain



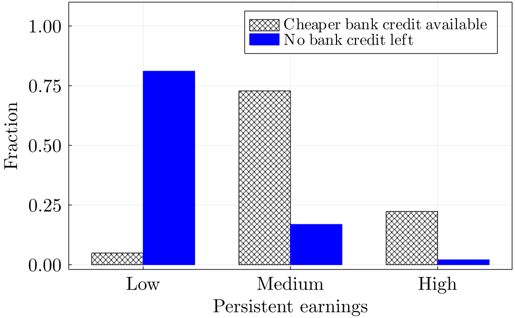
(b) Interest Loss



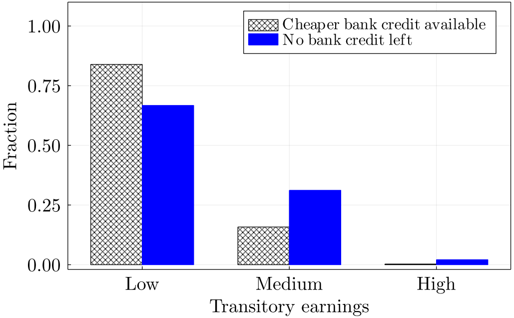
▸ Type Score Dynamics ▸ Interest Loss Dynamics Note: Avg. Losses ≈ \$200 (Agarwal et al., 2009)

Why? Smooth Out Temporary Shortfall in Earnings

(a) Persistent Earnings (Observable)



(b) Transitory Earnings (Unobservable)

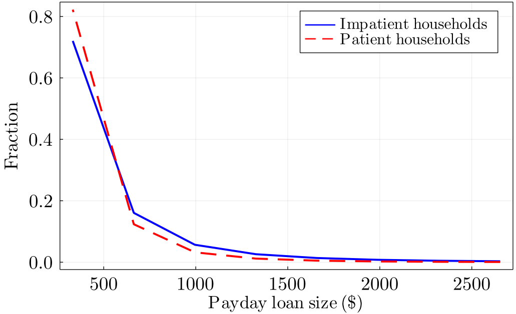


▸ Payday Loan Users Across Earnings
▸ Type Score Updating Across e
▸ Fraction of Payday Users Across Income in SCF

Quantity Caps

Policy Debate about Payday Lending

- Hotly debated policy topic
- Benchmark: $p \in [0, \$6000]$
- Two counterfactuals
  - Quantity Cap: $p \in [0, \$300]$
  - Full Ban: $p = 0$



Pooling vs. Insurance of Payday Loans

Variables	Benchmark	Quantity Cap	Full Ban
Welfare (CEV)	–	-0.0012%	-0.0291%
Welfare (CEV) – Impatient	–	-0.0029%	-0.0331%
Welfare (CEV) – Patient	–	0.0013%	-0.0233%
Avg. Cross-Sub. of Bank Loans (β_L)	\$4.57	\$4.09	\$3.88
Avg. Cross-Sub. of Bank Loans ($p' < 0$)	\$30.33	\$23.95	–

- Quantity cap $\rightarrow$ Less pooling $\rightarrow$ Good: Patient / Bad: Impatient
- Insurance of payday loans $\rightarrow$ Smoothing bad shocks (e.g., puzzle users)

Moments

Conclusion

Conclusion

- Payday loan puzzle can be rationalized by "credit scoring protection"
  - Account for 40% of puzzle occurrence
  - Match magnitude of monetary losses
- Puzzle users are not "stupid"—They want to maintain access to credit market in the future via type score protection!
- Restricting the size of payday loans affects (im)patient HHs differently: Impatient, worse off while patient, better off
  - Less cross-subsidization in bank loan market (less pooling)
- Eliminating payday loans is overall welfare-reducing
  - Both types do use payday loans to smooth out bad shocks (insurance)

Feedback

Thank you for listening!

If you have any suggestions or comments, please let me know
“**tsli@mail.uni-mannheim.de**”

Appendix

Facts

- Cash vs. card payments in U.S.: 20% v.s. 65% (SCPC)
- Revolving consumer debt (essentially credit card debts) $\approx$ 800 billion in 2004 (Federal Reserve Board of Governors series G.19)
- Elliehausen and Lawrence (2001): 56.5% having credit cards (nation-wide representative sample of 1,000 payday loan customers) / Io Data Corporation (2002): 55% (2,600 payday borrowers)
- Payday lending regulations: Max loan amount, term, APR, charges, number of outstanding (state by state)
- Why don't payday lenders report? Small fees and use Teletrack
- Could borrowing and repaying regularly build up the score? No

Back

Bankruptcy Regimes in the U.S.

- Chapter 7
  - Most unsecured debts are discharged in exchange for non-exempt assets
  - Filers do not have to use future income to repay debts
  - Filers must pay filing and legal fees
  - Such record stays on credit report for 10 years
  - In 2017 the percentage of non-business bankruptcy filings under Chapter 7 $\approx 60\%$
- Chapter 13
  - It involves reorganization
  - Filers have to make a plan to repay debtors over 3 to 5 years
  - Filers can keep property
  - Such record stays on credit report for 7 years

Credit Scores

- Statistic for credit worthiness/default risk
- Most well-known in U.S.—FICO score
  - Based on credit history from Experian, Equifax, and TransUnion
  - 35% payment history (e.g. bankruptcy, late payments)
  - 30% debt burden (e.g. debt-to-limit ratio on credit card)
  - Other
- Influences
  - Credit access, limit, interest rate
  - Mortgages
  - Job application (Corbae and Glover, 2020)

Back

[HH] Consumption $c^{(d,b',p')}(z,\omega_b,p)$

- If choosing to repay $(d,b',p') = (R,b',p')$,

$$c = e \cdot z + b + p - q_b^{(NFD,b')}(\omega_b) \cdot b' - q_p^{(R,b',p')}(\omega_b) \cdot p'$$

- If choosing to default on payday loans only $(d,b',p') = (PD,b',0)$,

$$c = e \cdot z - \kappa_{PD} + b - q_b^{(NFD,b')}(\omega_b) \cdot b'$$

- If choosing to formally default on both loans $(d,b',p') = (FD,0,0)$,

$$c = e \cdot z - \kappa_{FD}$$

Back

[HH] Value Functions V, v, and W

- Recursive decision problem:

$$V(\epsilon, \beta, z, \omega_B, p) = \max_{(d,b',p')} v^{(d,b',p')}(\beta, z, \omega_B, p) + \epsilon^{(d,b',p')}$$

- Conditional value function is:

$$v^{(d,b',p')}(\beta, z, \omega_b, p) = u\left(c^{(d,b',p')}(z, \omega_b, p)\right) - \xi_{PD} \cdot \mathbb{I}_{[d=PD]} - \xi_{FD} \cdot \mathbb{I}_{[d=FD]}$$
$$+ \beta\rho \cdot \sum_{(\beta',z',e',s')} Q^{\beta}(\beta'|\beta) Q^{z}(z') Q^{e}(e'|e) \psi_{\beta'_H}^{(\tilde{d},b')}(\omega_b) W(\beta', z', \omega_b', p')$$

- Unconditional value function:

$$W(\beta, z, \omega_B, p) = \int V(\epsilon, z, \beta, \omega_B, p) \, d\, EV(\epsilon)$$

Back

[HH] Choice Probability σ

- Choice probability for a particular action is computed as its associated value relative to sum of values over all feasible actions:

$$\sigma^{(d,b',p')}(\beta, z, \omega_b, p) = \frac{\exp\left\{v^{(d,b',p')}(\beta, z, \omega_b, p)/\alpha\right\}}{\sum_{(\hat{d},\hat{b}',\hat{p}')} \exp\left\{v^{(\hat{d},\hat{b}',\hat{p}')}(\beta, z, \omega_b, p)/\alpha\right\}}$$

- Note: Well-defined, higher v with higher σ, α controls dispersion

Back

[Bank] Type Scoring Updating ψ

- s' is updated as:

$$\psi^{(\tilde{d},b')}_{\beta'_H}(\omega_b) = \begin{cases} \sum_z Q^z(z) \cdot \sum_\beta Q^\beta(\beta'|\beta) \cdot \frac{\tilde{\sigma}^{(\tilde{d},b')}_b(\beta,z,\omega_b)\cdot s(\beta)}{\sum_{\hat{\beta}} \tilde{\sigma}^{(\tilde{d},b')}_b(\hat{\beta},z,\omega_b)\cdot s(\hat{\beta})} \\ \sum_\beta Q^\beta(\beta'|\beta) \cdot s(\beta) \end{cases}$$

- Lower case for infeasible actions

Back

[Bank] Bank-Observable Choice Probability

- As **banks cannot observe the payday loan usage**, they use aggregate information μ to weight out p and sum out p':

$$\sigma_b^{(d,b')}(\beta, z, \omega_b) = \sum_{p'} \left[\sum_p \sigma^{(d,b',p')}(\beta, z, \omega_b, p) \cdot \frac{\mu(\beta, z, \omega_b, p)}{\sum_{\hat{p}} \mu(\beta, z, \omega_b, \hat{p})} \right]$$

- As **banks cannot distinguish *R* and *PD***, they form FD/NFD actions:

$$\tilde{\sigma}_b^{(\tilde{d},b')}(\beta, z, \omega_b) = \begin{cases} \sigma_b^{(d,b')}(\beta, z, \omega_b) & \text{if } \tilde{d} = FD \\ \sum_{d \in \{R,PD\}} \sigma_b^{(d,b')}(\beta, z, \omega_b) & \text{if } \tilde{d} = NFD \end{cases}$$

Back

[Bank] Repayment Probability and Price

- Bank asset discounted price is given by:

$$q_b^{(NFD,b')}(\omega_b) = \begin{cases} \rho \cdot \frac{\mathbb{P}_b^{(NFD,b')}(\omega_b)}{1+r_f} & \text{if } b' < 0 \\ \frac{\rho}{1+r_f} & \text{if } b' \geq 0 \end{cases}$$

- Expected repayment probability is calculated as:

$$\mathbb{P}_b^{(NFD,b')}(\omega_b) = \sum_{(\beta',z',e',s')} s'(\beta') \cdot Q^z(z') \cdot Q^e(e'|e) \cdot Q^s\left(s'(\beta') \,\middle|\, \psi_{\beta'}^{(NFD,b')}(\omega_b)\right)$$

$$\left[\mathcal{W}_{PD}^{b'}(\omega_b) \cdot \left(1 - \sigma^{(FD,0,0)}(\beta', z', \omega_b', p' = 0)\right) + \right.$$

$$\left. \left(1 - \mathcal{W}_{PD}^{b'}(\omega_b)\right) \cdot \sum_{p'} \mathcal{W}_{p'}^{(R,b')}(\omega_b) \cdot \left(1 - \sigma^{(FD,0,0)}(\beta', z', \omega_b', p')\right)\right]$$

Back

[Bank] Weighting Factors

- $\mathcal{W}_{PD}$ denotes the probability that a household in bank-observable state ω_b and bank loan choice b' will choose to partially default $d = PD$

$$\mathcal{W}_{PD}^{b'}(\omega_b) = \sum_z Q^z(z) \cdot \frac{\sum_\beta s(\beta) \cdot \sigma_b^{(PD,b')}(\beta, z, \omega_b)}{\sum_{\hat{d} \in \{PD,R\}} \sum_\beta s(\beta) \cdot \sigma_b^{(\hat{d},b')}(\beta, z, \omega_b)}$$

- Conditional on full repayment, $\mathcal{W}_{p'}$ denotes the probability of the household choosing a certain payday loan p'

$$\mathcal{W}_{p'}^{(R,b')}(\omega_b) = \sum_z Q^z(z) \cdot \frac{\sum_\beta s(\beta) \cdot \hat{\sigma}_b^{(R,b',p')}(\beta, z, \omega_b)}{\sum_{\hat{p}'} \sum_\beta s(\beta) \cdot \hat{\sigma}_b^{(R,b',\hat{p}')}(\beta, z, \omega_b)}$$

Back

[Payday] Repayment Probability and Price

- Payday loan discounted price is given by:

$$q_p^{(R,b',p')}(\omega_b) = \rho \cdot \frac{\mathbb{P}_p^{(R,b',p')}(\omega_b)}{1+r_p}$$

- Expected repayment probability is calculated as:

$$\mathbb{P}_p^{(R,b',p')}(\omega_b) = \sum_{(\beta',z',e',s')} s(\beta') \cdot Q^z(z') \cdot Q^e(e'|e) \cdot Q^s\left(s'(\beta')|\psi_{\beta'}^{(NFD,b')}(\omega_b)\right)$$
$$\left(1 - \sum_{d' \in \{FD,PD\}} \sum_{b''<0} \sigma^{(d',b'',0)}(\beta', z', \omega_b', p')\right)$$

◂ Back

Stationary Recursive Competitive Equilibrium

[...] is a set of (un)conditional value functions v^* and W^*, bank loan pricing functions q_b^* and repayment probability $\mathbb{P}_b^*$, payday loan pricing functions q_p^* and repayment probability $\mathbb{P}_p^*$, a type scoring function ψ^*, choice probability functions σ^* and $\tilde{\sigma}_b^*$, and a steady state distribution $\overline{\mu}^*$ such that:

- HH Optimality: $v^{*(d,b',p')}(\beta, z, \omega_b, p), W^*(\beta, z, \omega_b, p), \sigma^{(d,b',p')*}(\beta, z, \omega_b, p)$
- Zero Profits for Bank Lenders: $q_b^{*(NFD,b')}, \mathbb{P}_b^{*(NFD,b')}(\omega_b)$
- Zero Profits for Payday Lenders: $q_p^{*(R,b',p')}, \mathbb{P}_p^{*(R,b',p')}(\omega_b)$
- Bayesian Updating: $\psi_{\beta'}^{*(\tilde{d},b')}(\omega_b), \tilde{\sigma}_b^{*(\tilde{d},b')}(\beta, \omega_b)$
- Stationary Distribution: $\overline{\mu}^*(\beta, z, \omega_b, p)$ Mapping for μ

Back

Evolution of Distribution

- The probability for an individual to move from state (β, z, e, b, s, p) to $(\beta', z', e', b', s', p')$ is governed by the following mapping:

$$
\begin{aligned}
& T^*(\beta', z', \omega_b', p' | \beta, z, \omega_b, p) \\
& = \rho \cdot Q^\beta(\beta'|\beta) \cdot Q^z(z') \cdot Q^e(e'|e) \cdot \sigma^{(d,b',p')}(\beta, z, \omega_b, p) \cdot \psi_{\beta'}^{(\tilde{d},b')}(\omega_b) \\
& + (1-\rho) \cdot G_\beta(\beta') \cdot G_z(z') \cdot G_e(e') \cdot \mathbb{1}_{b'=0} \cdot \mathbb{1}_{s'=G_\beta} \cdot \mathbb{1}_{p'=0}
\end{aligned}
$$

- Then, the cross-sectional distribution μ evolves according to:

$$
\mu'(\beta', z', \omega_b', p') = \sum_{(\beta, z, \omega_b, p)} T^*(\beta', z', \omega_b', p' | \beta, z, \omega_b, p) \cdot \mu(\beta, z, \omega_b, p)
$$

◂ Back

Identification of Payday Loan Puzzle

- For each state (β, z, ω_b, p), $(R, b' < 0, p' < 0)$ such that:

$$\left| q_b^{(NFD,b')}(\omega_b) \cdot b' + q_p^{(R,b',p')}(\omega_b) \cdot p' \right| < \left| q_b^{(NFD,\hat{b}')}(\omega_b) \cdot \hat{b}' \right| \qquad (1)$$

$$v^{(R,b',p')}(\beta, z, \omega_b, p) > v^{(R,\hat{b}',p=0)}(\beta, z, \omega_b, p) \qquad (2)$$

  where $b' + p' = \hat{b}'$ denotes total borrowing
- The choices satisfying (1) and (2) are choices that we classify as the payday loan puzzle, denoted as $\mathcal{P}(\beta, z, \omega_b, p)$

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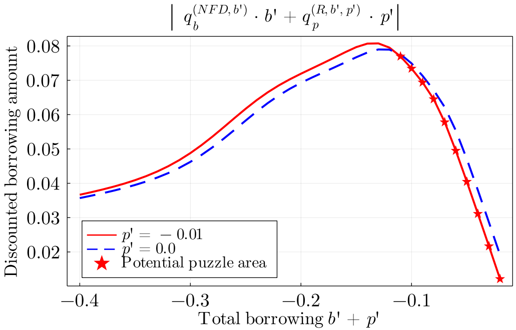
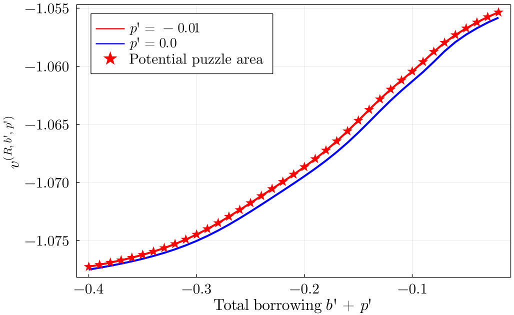
Example

(a) Condition (1)



(b) Condition (2)



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Rate of the Puzzle Occurrence

- The rate of the payday loan puzzle occurrence is defined as:

$$\mathcal{R} \equiv \frac{\sum_{\beta,z,\omega_b,p} \mu(\beta,z,\omega_b,p) \cdot \sum_{(d,b',p')\in\mathcal{P}(\beta,z,\omega_b,p)} \sigma^{(d,b',p')}(\beta,z,\omega_b,p)}{\sum_{\beta,z,\omega_b,p} \mu(\beta,z,\omega_b,p) \cdot \sum_{(d,b',p')\in\mathcal{F}_{both}(z,\omega_b,p)} \sigma^{(d,b',p')}(\beta,z,\omega_b,p)}$$

where $\mathcal{F}^{-}_{both}(z,\omega_b,p)$, the set of borrowing choices with both loans

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Grids Used in Computation

Variable	Symbol	# Grid points	Range
Persistent earnings	e	3	$\{0.57, 1.00, 1.74\}$
Transitory earnings	z	3	$\{0.78, 1.00, 1.29\}$
Bank assets	b	191	$[-0.40, 15.00]$
Payday loans	p	16	$[-0.15, 0.00]$
Type score	s	8	$[0.013, 0.989]$

- E.g., $\sigma^{(d,b',p')}(\beta, z, e, b, s, p)$
  - Actions: $1 + 191 + 16 \times 41 + 150 = 998$
  - States: $2 \times 3 \times 3 \times 8 \times (16 \times 41 + 150) = 116,064$
  - Total: $998 \times 116,064 = 115,831,872 \approx 116$ million points

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External Validation: Credit Ranking Age Profile

Moment	Data	Model	Chatterjee et al. (2020)
Intercept (mean credit ranking)	0.281	0.278	0.355
Slope (mean credit ranking)	0.037	0.004	0.029
Intercept (S.D. credit ranking)	0.216	0.219	0.255
Slope (S.D. credit ranking)	0.011	0.002	0.004
Ave. autocor. credit ranking	-0.202		-0.109

We then compute the means and standard deviations of credit rankings within each age bin. With these age bin data values, we estimate affine age profiles for means, standard deviations, and autocorrelations of year-to-year changes in credit rankings (2004Q1, 2005Q1 and 2006Q1)

Type Score Protection via Payday Loans

- Proposed "rational" explanation:
  Households use payday loans to protect their credit scores
- How does it work in the model?
  - More bank loans $\implies$ Worse type score
  - Worse type score $\implies$ Higher interest rates
- Incentive to use payday loans to obtain lower interest costs in future

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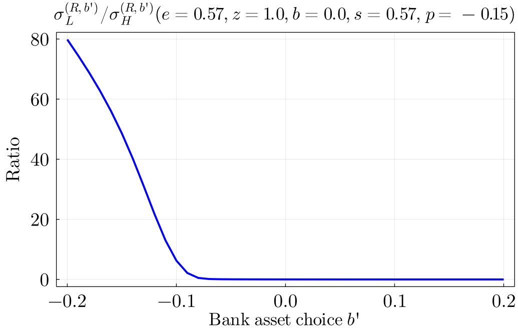
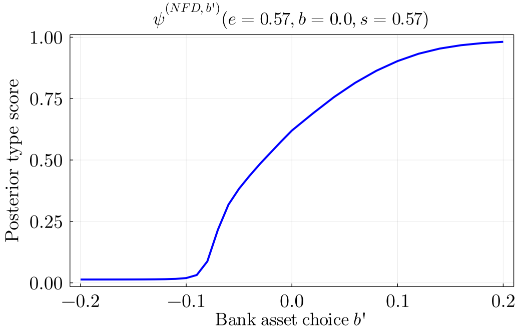
More Bank Loans $\implies$ Worse Type Score



(a) Choice Likelihood Ratio



(b) Type Score Update

Back to Type Score Updating
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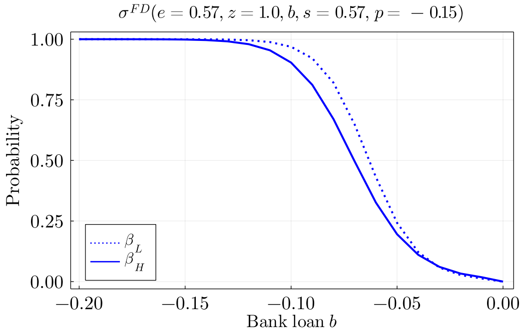
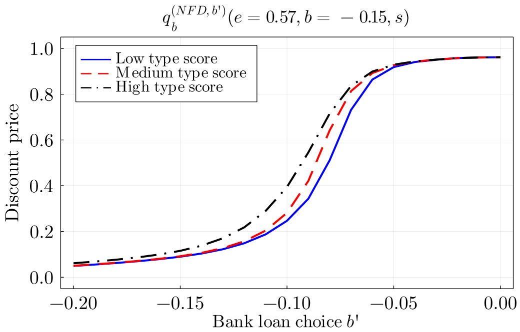
Worse Type Score $\implies$ Higher Bank Interest Rates



(a) Formal Default Probability



(b) Discount Bank Loan Price Schedule

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Impatient HHs Borrow and Default More

Moment	Aggregate	Impatient	Patient
Default			
Formal default rate	0.99	1.27	0.57
Payday default rate (cond.)	29.7	30.56	27.84
Households in debt			
Fraction of bank loan users	24.26	27.5	19.55
Fraction of payday loan users	9.46	10.7	7.65
Bank debt-to-earnings (cond.)	6.48	6.54	6.36
Interest rate			
Ave. interest rate for bank loans	8.56	8.79	8.06
Ave. interest rate for payday loans	410.85	433.89	362.74

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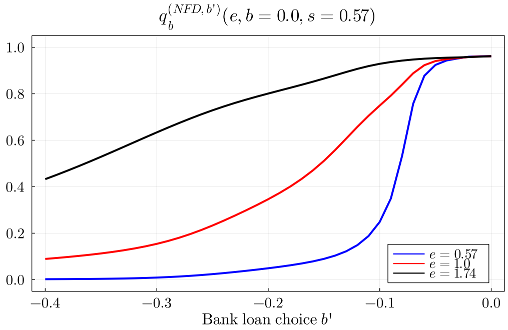
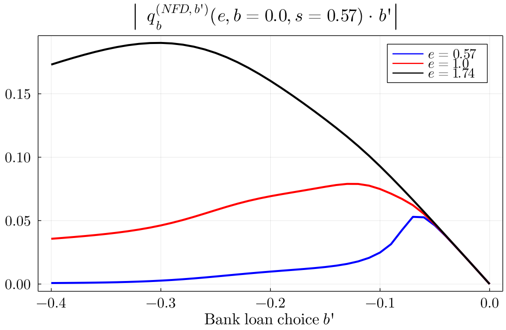
Bank Loan Pricing Schedule across Earnings

(a) Bank Loan Pricing Schedule



(b) Bank Loan Risky Borrowing Limit



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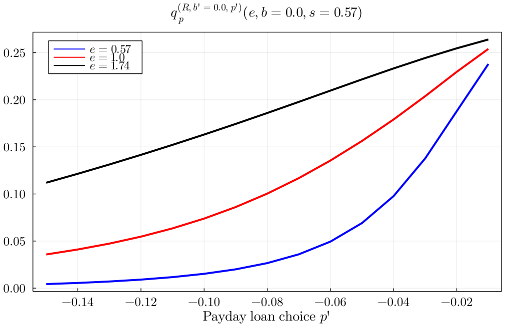
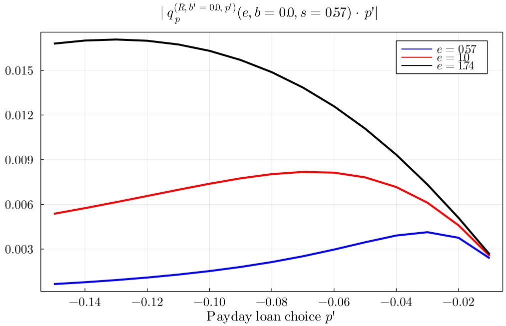
Payday Loan Pricing Schedule across Earnings

(a) Payday Loan Pricing Schedule



(b) Payday Loan Risky Borrowing Limit



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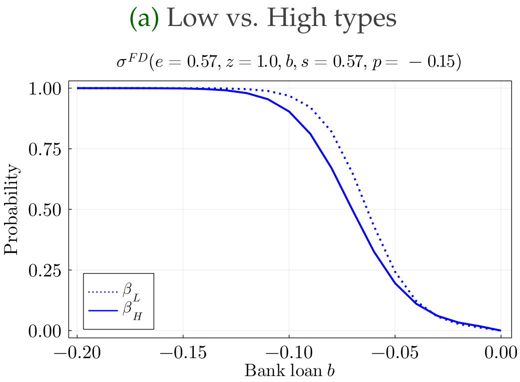
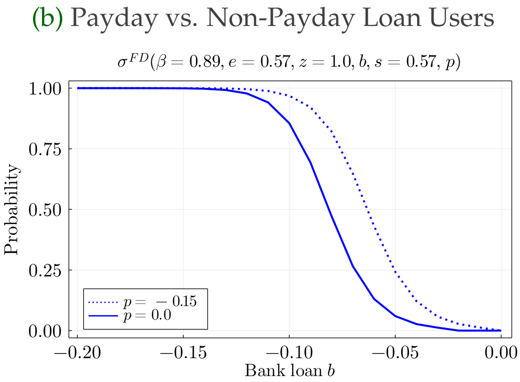
Formal Default Prob. across Types and Payday Users





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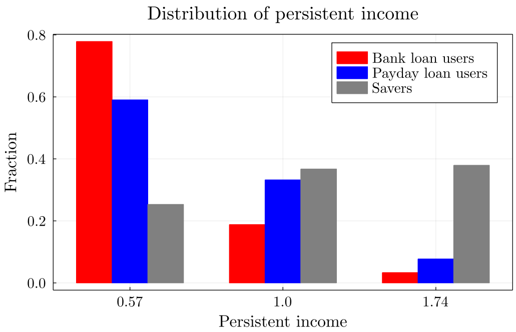
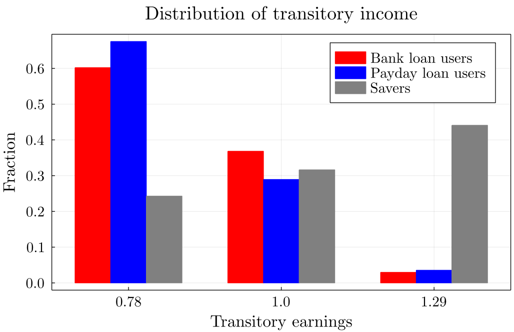
Payday Loan Users Across Earnings

(a) Persistent Earnings



(b) Transitory Earnings



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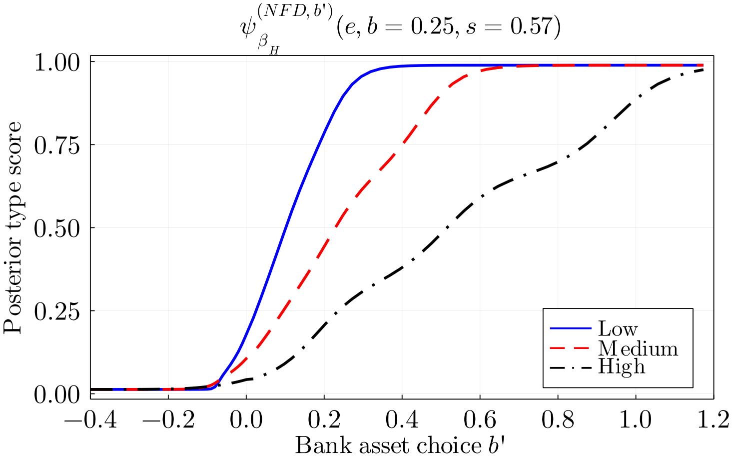
High Earner Suffer More from Borrowing



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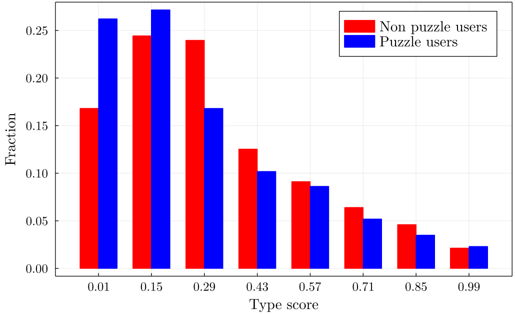
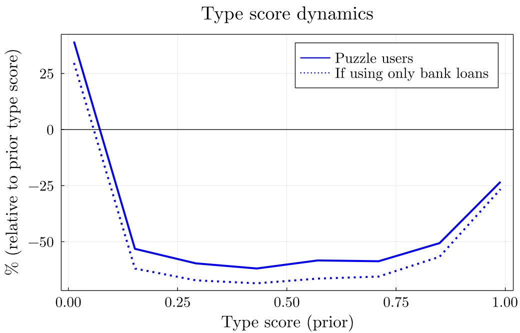
Puzzle Users: Lower Prior Score

(a) Prior Type Score Distribution



(b) Type Score Updating



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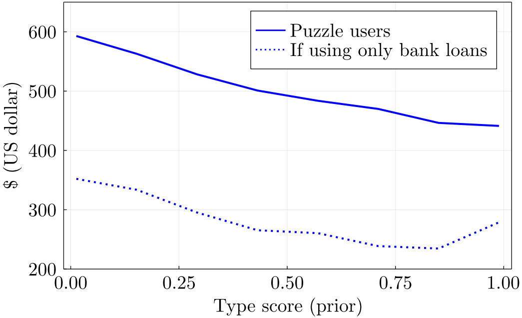
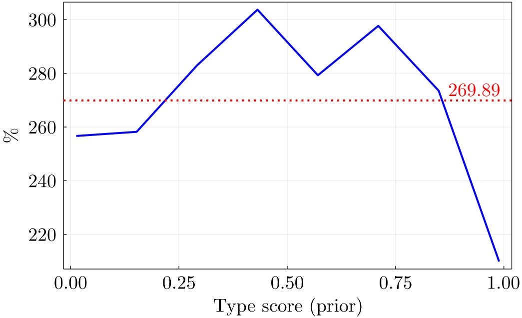
Puzzle Users: Interest Loss

(a) Interest Loss Dynamics



(b) Interest Loss (in %)



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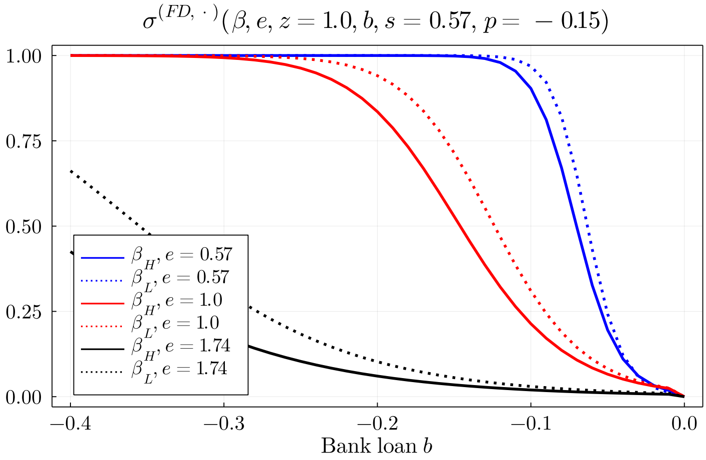
Impatient and Poor HHs Default More Formally



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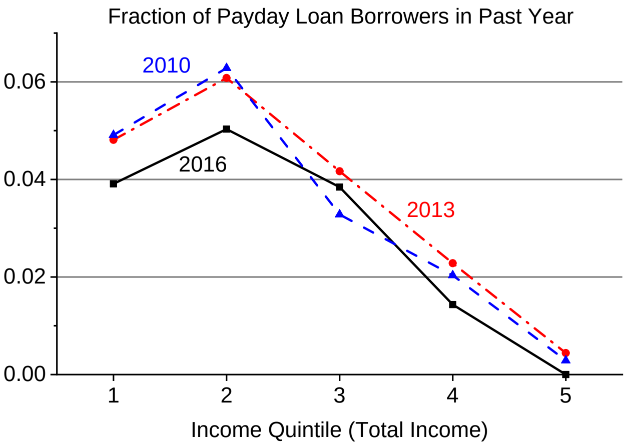
Payday Loan Users Not Extremely Poor



Bins: 23K/40K/65K/109K Back

U.S. Median Household Earnings

- Source: Current Population Survey (CPS)
- 2004: $\$638 \times 52 = \$33,176$ (current dollars)
- Among full-time employed, wage and salary workers
- Wage and salary workers for earnings purposes are workers age 16 and older who receive wages, salaries, commissions, tips, payments in kind, or piece rates
- Earnings before taxes and other deductions

▸ Alternative

Quantity Caps: Moments

Variables (in %)	Benchmark	Quantity Cap	Full Ban
Formal Default Rate	0.99	0.96	0.89
Payday Default Rate	2.81	2.19	–
Eff. Cond. Payday Default Rate	34.68	31.24	–
Fraction of Bank Loan Users	24.26	24.06	23.15
Fraction of Payday loan Users	9.46	8.22	–
Bank Debt-to-Earnings (cond.)	6.48	6.61	6.84
Ave. Bank Interest Rate	8.56	8.53	8.46
Ave. Payday Interest Rate	410.85	341.88	–

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Alternative for U.S. Median Household Earnings

- Source: SCF 2004
  - Median wage income: \$30,000 (among HH aged 20-60: \$41,000)
  - Median wage income + transfers : \$38,000 (among HH aged 20-60: \$44,000)
  - Median total income: \$42,000 (among HH aged 20-60: \$46,000)

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Calibrating Payday Lending Cost Exogenously

- Source: Flannery and Samolyk (2005)
- Average loan amount: \$227.54
- Average payday loan duration: 15.28 days
- Average store operation costs per loan: \$19.08
- Implied annual risk-free rate for (mature) payday lenders:

$$\frac{\$19.08}{\$227.54} \times \frac{365}{15.28} \approx 200\%$$

- It follows that $r_b = \rho \times (2.0 + 1) - 1 = 1.925$

Calibrating Formal Default Costs Exogenously

- Source: Albanesi and Nosal (2020)
- Out-of-pocket cost of filing for bankruptcy for Ch.7 pre-reform: \$697
- U.S. Median Household Earnings in 2004: \$33,176
- Formal (out-of-pocket) default cost:

$$\kappa_{FD} = \frac{\$697}{\$33,176} \approx 0.02$$

Calibrating Payday Default Costs Exogenously

- Source: Montezemolo and Wolff (2015)
- Bounced check and overdraft (NSF) fees: \$35 each
- Payday (out-of-pocket) default cost:

$$\kappa_{PD} = \frac{\$70}{\$33,176} \approx 0.002$$

Formal Default Rate

- Source: American Bankruptcy Institute (ABI)
- Total number of non-business Chapter 7 filings in 2004: $285,787 + 302,803 + 274,196 + 254,518 = 1,117,304$
- Use 2004 in order to avoid effects of 2005 BAPCPA reform
- Total number of U.S. households in 2004: 112,000,000
- Formal bankruptcy rate:

$$\frac{1,117,304}{112,000,000} = 0.00998 = 0.99\%$$

Payday Default Rate

- Source: Skiba and Tobacman (2018)
- Same payday loan dataset
- 29.7% of payday loan users defaults (write-off) during the course of a year since the first loan was taken

Fraction of Bank Loan Users

- Source: SCF 2004
- Net worth (Herkenhoff's definition: liquid assets minus unsecured debt)
- Negative net worth: 18.3% (for HHs aged 20-60: 20.9%)

Alternative

Fraction of Payday Loan Users

- Source: SCF 2010 (payday loan data first available in 2010 wave)
- For households between 20 and 60: 4.8% (uncond.: 3.9%)

Average Debt-to-Income Ratio

- Source: SCF 2004
- Total income (before taxes) = Wage income + government transfers (unemployment, childcare, ...) + interest income + dividends + realized capital gains + ...
- Using liquid net worth definition (following Herkenhoff)
  - Total income (cond. on borrowing): 14.8% (for HHs aged 20-60: 14.2%)

▸ Alternative

Average Credit Card Interest Rate

- Source: SCF 2004
- For households aged 20-60
- Exclude observations with 0 interest rate
- Average CC rate: 12.73% (cond. on borrowing: 12.96%)
- Adjusted by one-year ahead CPI inflation:
    - U.S. CPI Growth Rate in 2005: 3.388%
    - Real average CC rate (cond. on borrowing):

$$\frac{1+\frac{12.96}{100}}{1+\frac{3.388}{100}}-1=0.0926=9.26\%$$

Alternative

Average Payday Loan Interest Rate

- 391% (Source: St. Louis FED)
- 390 - 780% (Source: Consumer Federation of America)
- 400% (Source: CFPB)
- 400 - 1000% (Source: Stegman (2007, J Econ Perspective))
- Adjusted by one-year ahead CPI inflation:
  - U.S. CPI Growth Rate in 2005: 3.388%
  - Real average payday loan rate (cond. on borrowing):

$$\frac{1+\frac{400}{100}}{1+\frac{3.388}{100}} - 1 = 3.84 = 384\%$$

Alternative for Fraction of Bank Loan Users

- Source: SCF 2004
- Using gross unsecured debt: Balances on general purpose credit cards, e.g. Visa, Mastercard (follows Herkenhoff JMP): 40.14%
- Using net worth (SCF-defined): $\approx$ 10% (negative net worth)
- Using net worth (Herkenhoff's definition: liquid assets minus unsecured debt): 18.3% (20.9% for HH age between 20 and 60)

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Alternative for Average Credit Card Interest Rates

- Source: SCF 2004
  - Average CC rate: 11.49% (conditional on borrowing: 11.81%)
  - Among households aged 20-60: 11.64% (cond. on borrowing: 11.94%)
- Source: FED Board of Governors, G.19 (Consumer Credit)
  - Commercial bank interest rates in 2004
    - All credit card amounts: 12.72%
    - Credit card accounts assessed interest: 13.22%
    - 24-month personal loans: 11.89%

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Alternative for Debt-to-Income Ratio

- Source: SCF 2004
  - Using gross unsecured debt (credit cards only)
    - Total income (cond. on borrowing): 4.4% (11%)
    - Wage income + transfers (cond. on borrowing): 5% (12.4%)
    - Wage income (cond.): 6.4% (14%)
    - For households aged 20-60: total income (cond.): 4.8% (10.5%)
    - For households aged 20-60: Wage income + transfers (cond.): 5.3% (11.8%)
    - For households aged 20-60: Wage income (cond.): 5.6% (11.9%)
  - Using liquid net worth definition (following Herkenhoff) [conditional]
    - Wage income + transfers: 16.4% (for HHs aged 20-60: 15.5%)
    - Wage income: 20.8% (for HHs aged 20-60: 16.3%)
- Source: FoF and NIPA table 2.1
  - Using aggregate number (Revolving Consumer Debt/Personal Disposable Income): 8.7%

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