

# INSURANCE VERSUS MORAL HAZARD IN INCOME-CONTINGENT STUDENT LOAN REPAYMENT

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MIT Sloan

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Disclaimer: The results of these studies are based, in part, on Australian Business Registrar (ABR) data supplied by the Registrar to the ABS under A New Tax System (Australian Business Number) Act 1999 and tax data supplied by the ATO to the ABS under the Taxation Administration Act 1953. These require that such data is only used for the purpose of carrying out functions of the ABS. No individual information collected under the Census and Statistics Act 1905 is provided back to the Registrar or ATO for administrative or regulatory purposes. Any discussion of data limitations or weaknesses is in the context of using the data for statistical purposes, and is not related to the ability of the data to support the ABR or ATO's core operational requirements. Legislative requirements to ensure privacy and secrecy of these data have been followed. Source data are de-identified and so data about specific individuals or firms has not been viewed in conducting this analysis. In accordance with the Census and Statistics Act 1905, results have been treated where necessary to ensure that they are not likely to enable identification of a particular person or organisation.

## GOVERNMENT-FINANCED HIGHER EDUCATION

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  - Student loans = \$1.6 trillion in US and 10% of household debt in US and UK

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- Share of earnings
- Limited successful examples

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|---|---|---|
| <ul style="list-style-type: none"><li>• Standard contract in US</li><li>• Hard to discharge</li></ul> | <ul style="list-style-type: none"><li>• Used in US, UK, Australia, Canada</li></ul> | <ul style="list-style-type: none"><li>• Share of earnings</li><li>• Limited successful examples</li></ul> |

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✗ Disincentivize labor supply

✓ Encourage risk-taking

✗ Incentivize over-borrowing

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| <b>This Paper:</b> Insurance vs. Moral Hazard   |   |   |

Conditional on borrowing, how does income-contingent repayment affect **labor supply** and welfare?

① **Setting:** Australia's Higher Education Loan Program

- **Variation:** discontinuities in repayment rates + policy change to these rates
- **Identification:** limited room for adverse selection and ex-ante responses

② **Research design:** bunching at discontinuities before and after policy change

- **Data:** universe of income tax returns + student debt balances

Conditional on borrowing, how does income-contingent repayment  
affect labor supply and **welfare**?

- ① Setting: Australia's Higher Education Loan Program
- ② Research design: bunching at discontinuities before and after policy change
- ③ **Model**: life cycle model with endogenous labor supply + uninsurable wage risk
  - **Positive**: translate responses into preference parameters
  - **Normative**: characterize optimal amount of income-contingent repayment

# SUMMARY OF RESULTS

## ① **Empirics:** borrowers adjust labor supply to ↓ income-contingent repayments

- Larger responses in occupations with more hourly flexibility
- Responses increase with debt balances and proxies for liquidity constraints

## ② **Structural estimation:** responses are small quantitatively

- Model replicates evidence with Frisch elasticity of **0.11** & adjustment frictions
- Important drivers of responses: liquidity constraints and dynamics

## ③ **Welfare:** gains to increasing insurance with income-contingent repayment

- Fixed repayment → optimal income-contingent loan  $\Rightarrow \uparrow$  **1.3%** lifetime consumption
- Moral hazard reduces optimal amount of insurance, but welfare cost small
- Forbearance + fixed repayment does worse because of slower repayment

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**Takeaway:** Income-contingent repayment creates **moral hazard** that changes optimal contract, but **too small** to justify fixed repayment

# RELATED LITERATURE & CONTRIBUTIONS

① **Insurance vs. moral hazard in social insurance** Baily 1978, Gruber 1997, Chetty 2006, 2008, Chetty-Finkelstein 2013, Einav et al. 2017, Ganong-Noel 2019, 2020, Auclert et al. 2019, Indarte 2023, ...

- **Student debt overhang** Mueller-Yannelis 2019, Luo-Mongey 2019, Mezza et al. 2020, Di Maggio et al. 2021, Folch-Mazzone 2021, Ji 2021, Hampole 2022, Murto 2022, Huang 2022
- **Insurance benefits of income-contingent loans** Herbst 2023, Mueller-Yannelis 2019, Gervais et al. 2022, Boutros et al. 2022, Catherine-Yannelis 2023

② **Human capital financing** Friedman 1955, Bovenberg-Jacobs 2005, Chapman 2006, Lochner-Monge-Naranjo 2016, Stantcheva 2017, Abbott et al. 2021, Ebrahimian 2021, Herbst-Hendren 2022

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## Contributions:

- ① Empirical **evidence** of moral hazard from income-contingent repayment  
Britton-Gruber 2020, Herbst et al. 2023
- ② **Dynamic model** of labor supply that replicates these responses
- ③ Quantification of how moral hazard affects optimal policy

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- ③ **State-contingent securities to reduce household debt overhang** Shiller 2004, Caplin et al. 2007, Mian-Sufi 2014, Greenwald et al. 2018, Ganong-Noel 2020, Campbell et al. 2021
- ④ **Bunching in response to taxes to identify labor supply elasticities** Saez 2010, Chetty et al. 2011, 2013, Kleven-Waseem 2013, Kleven 2016, Fagereng-Ring 2021

# OUTLINE

- 1 Institutional Background and Data
- 2 Labor Supply Responses to Income-Contingent Repayment
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# WHY STUDY INCOME-CONTINGENT REPAYMENT IN AUSTRALIA?

- Benefit #1: Only one government contract + no (domestic) private market
  - Choice is between HELP and paying up-front, with former heavily subsidized
  - ✓ Limited scope for **adverse selection**
- Benefit #2: debt can only be used for tuition
  - Tuition is government-controlled at 39/42 universities (public)
  - ✓ Less room for **ex-ante** moral hazard from changes in borrowing
- Benefit #3: first nationwide provider of income-contingent loans in 1989
  - ✓ Borrowers likely **understand** structure of repayment

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Good setting to identify **labor supply responses** to income-contingent repayment

## STUDENT LOANS IN AUSTRALIA: HELP

- Australian citizens eligible for government-provided student loans through **HELP**
- **Initial debt** = tuition – up-front payment – govt. contribution (mean = \$18K USD in 2023)
- Debt grows at CPI net of **income-contingent repayments**:

$$\text{Repayment}_{it} = \text{HELP Rate}_t (\text{HELP Income}_{it}) \times \text{HELP Income}_{it}$$

$$\text{HELP Income}_{it} = \text{Labor Income}_{it} + \text{Capital Income}_{it} - \text{Deductions}_{it}$$

- Repayments continue until remaining debt balance equals zero or death
  - ✗ Cannot be cancelled or discharged in bankruptcy
  - Note: collection done from individual (not household) tax returns

▶ Options

▶ Definitions

▶ Other Countries

- ① Universe of individual tax returns from ATO (~ US Form 1040)
  - Income components to construct HELP Income and superannuation balances
- ② Administrative HELP data: debt balances, repayments, and flag for new debt
- ③ 2016 Household Census: self-reported hours and mortgage + rent payments
- ④ HILDA: survey data on hours worked and asset holdings

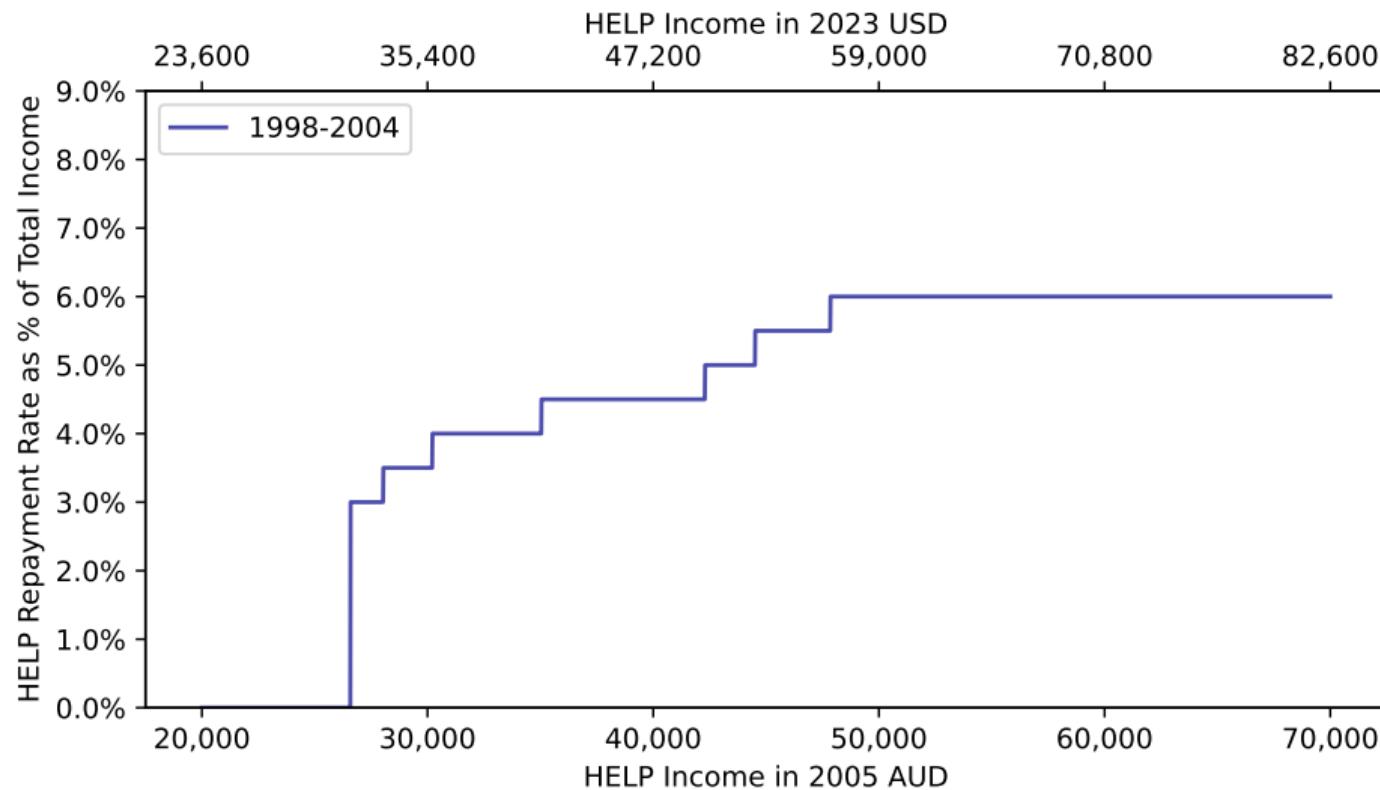
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**Sample:** ~ 4 million **unique** debtholders between ages 20-64 from 1991-2018

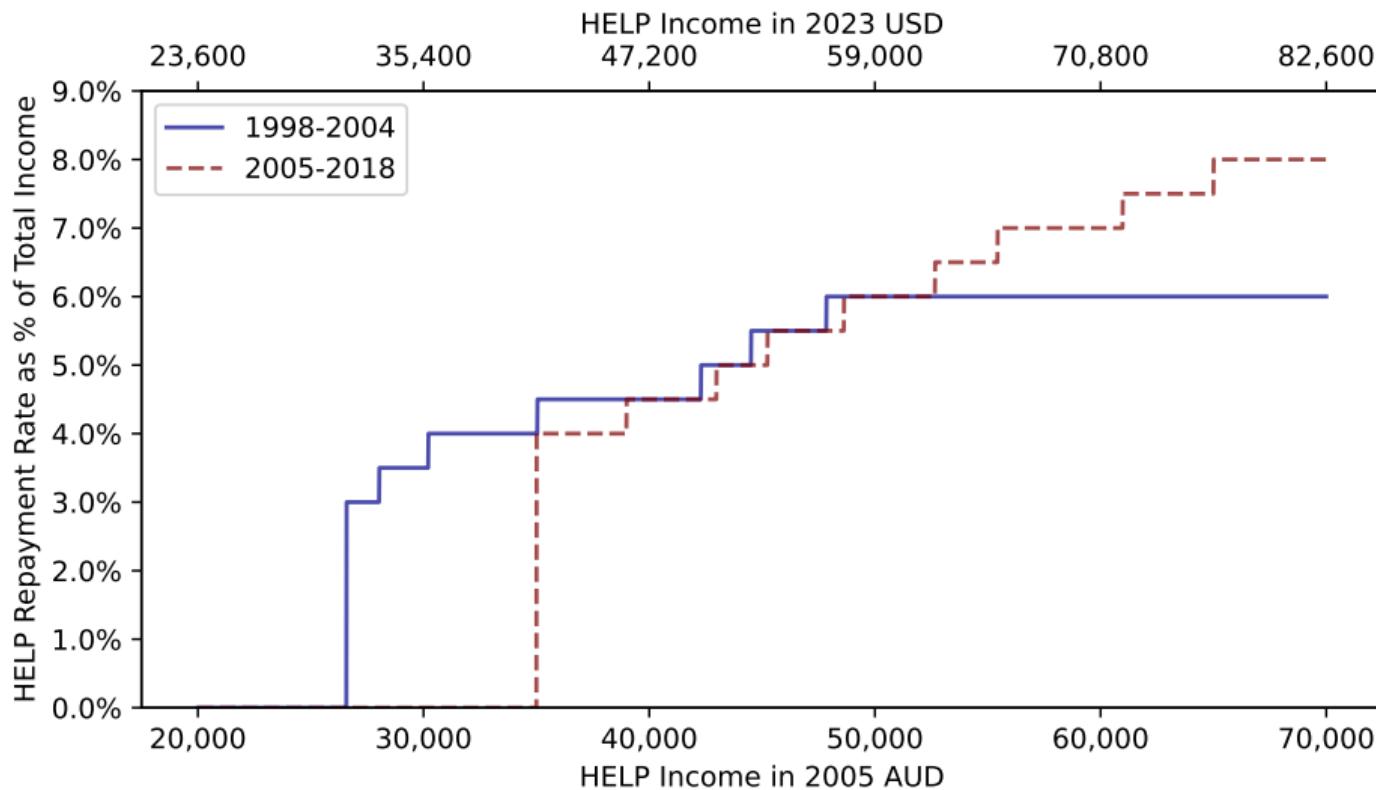
- At age 26, mean HELP Income = \$34K (98% labor income), mean debt = \$13K

**Limitation:** cannot identify anything about borrowing choice (e.g. degree, institution)

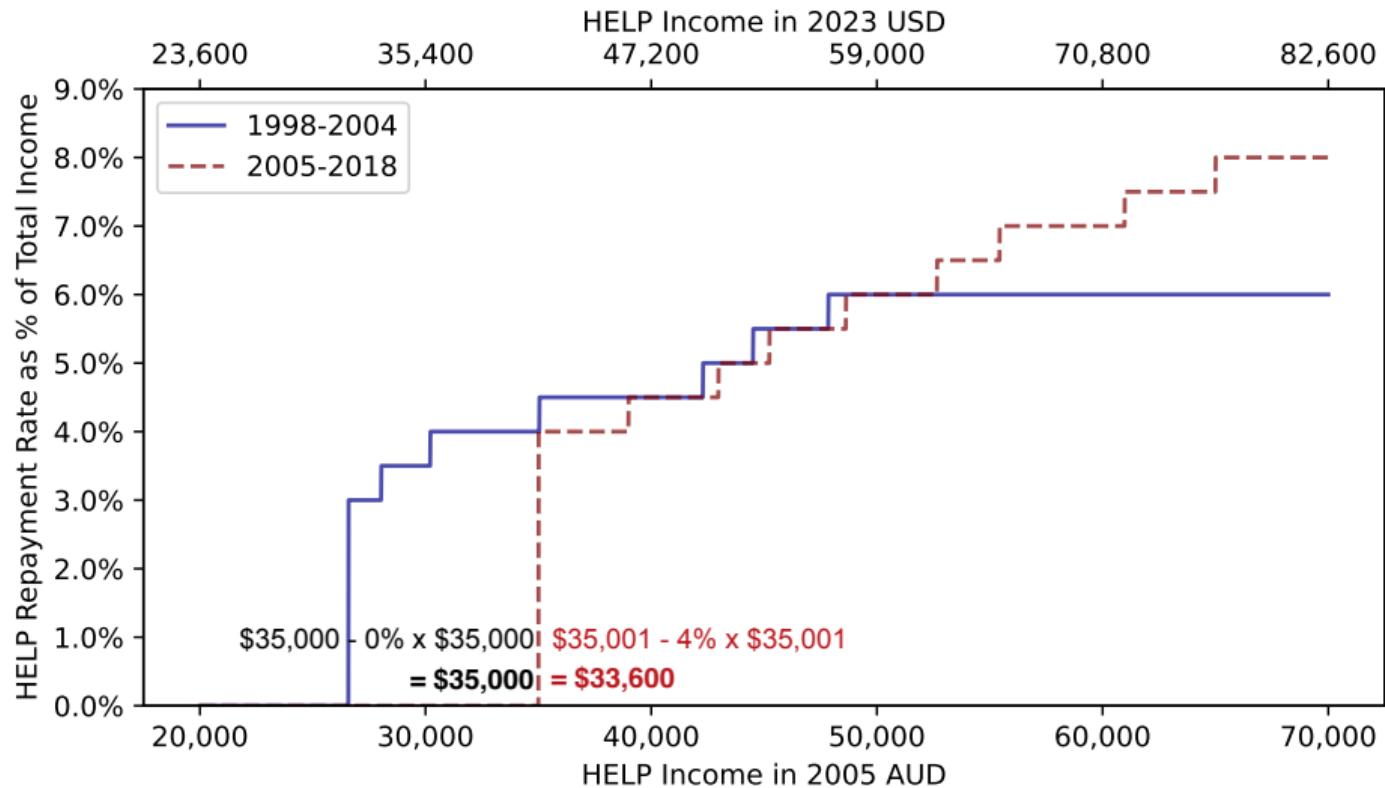
# IDENTIFYING VARIATION: DISCONTINUITIES IN REPAYMENT RATES



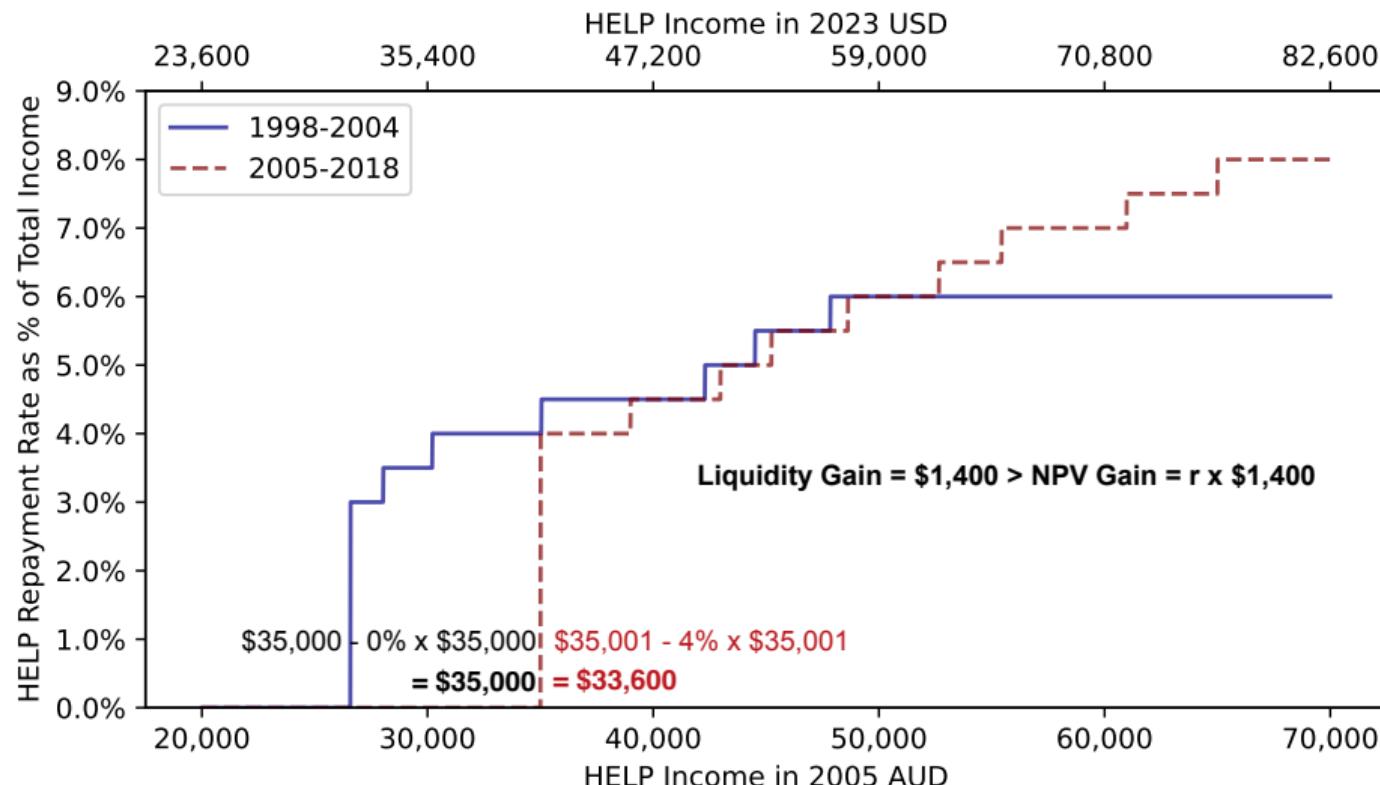
# IDENTIFYING VARIATION: POLICY CHANGE TO REPAYMENT RATES



# REPAYMENT THRESHOLD INCREASES AVERAGE REPAYMENT RATE



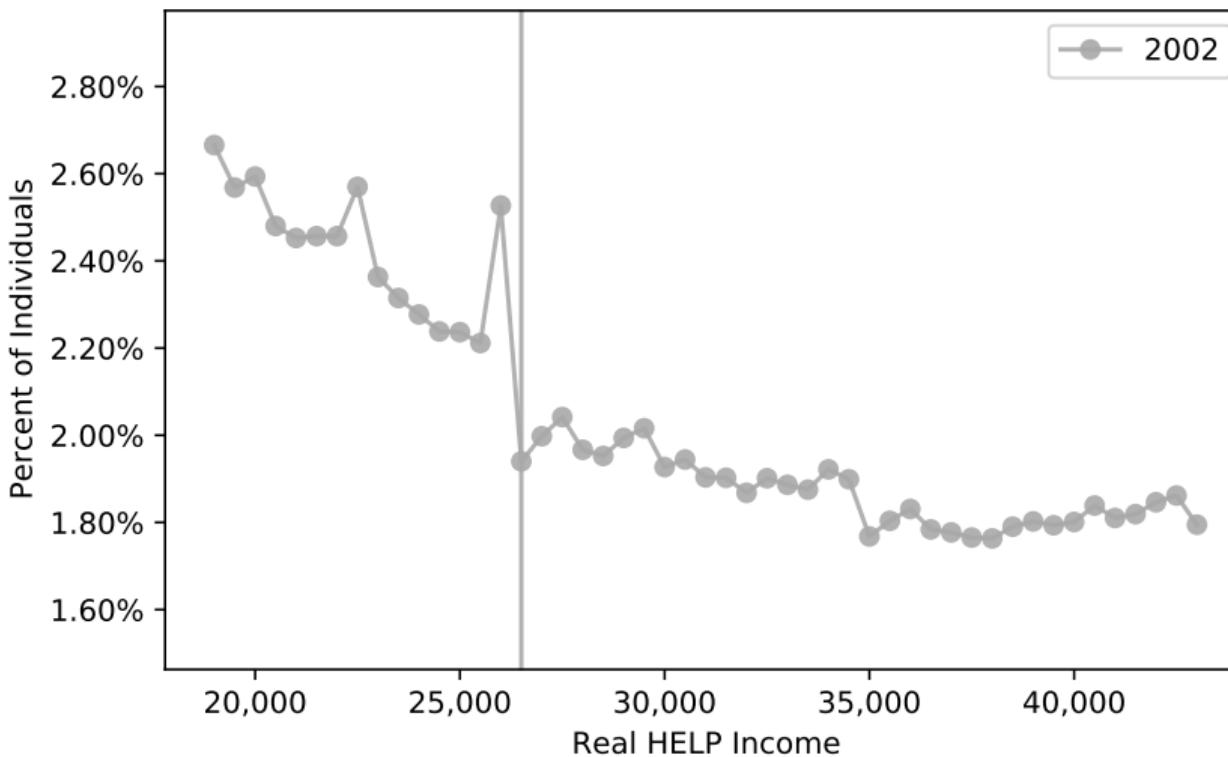
# REPAYMENT THRESHOLD INCREASES LIQUIDITY MORE THAN WEALTH



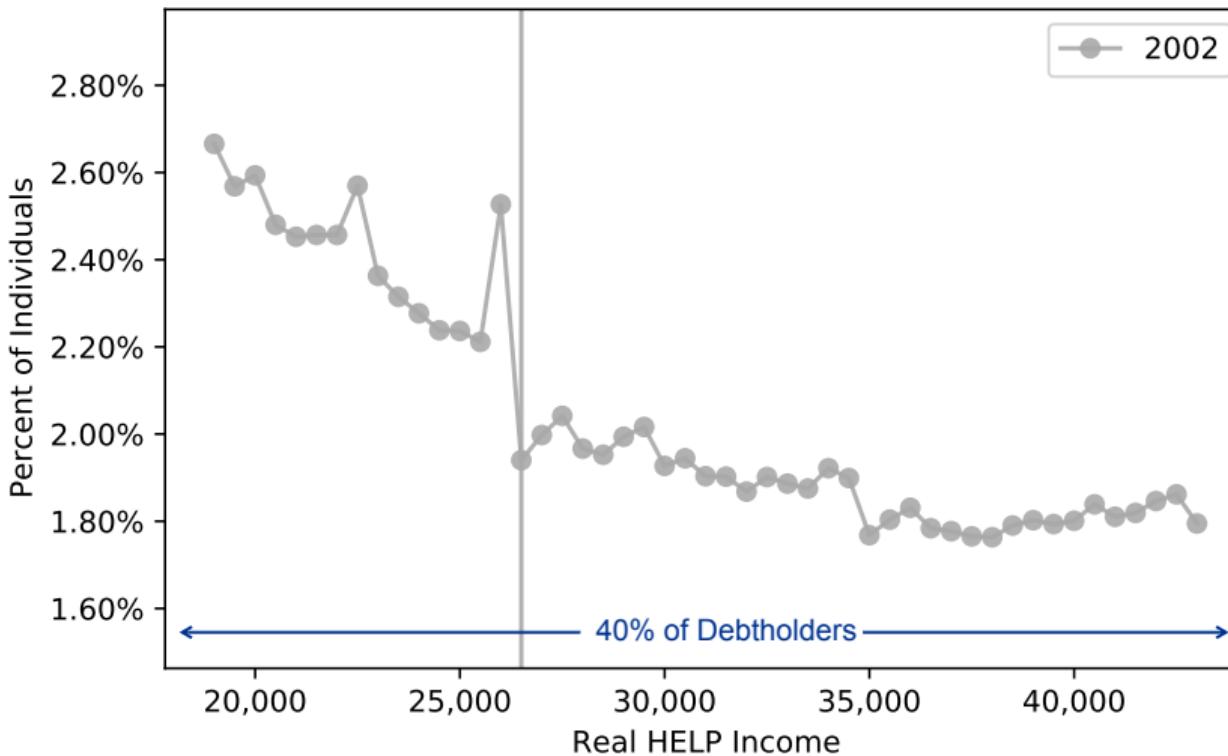
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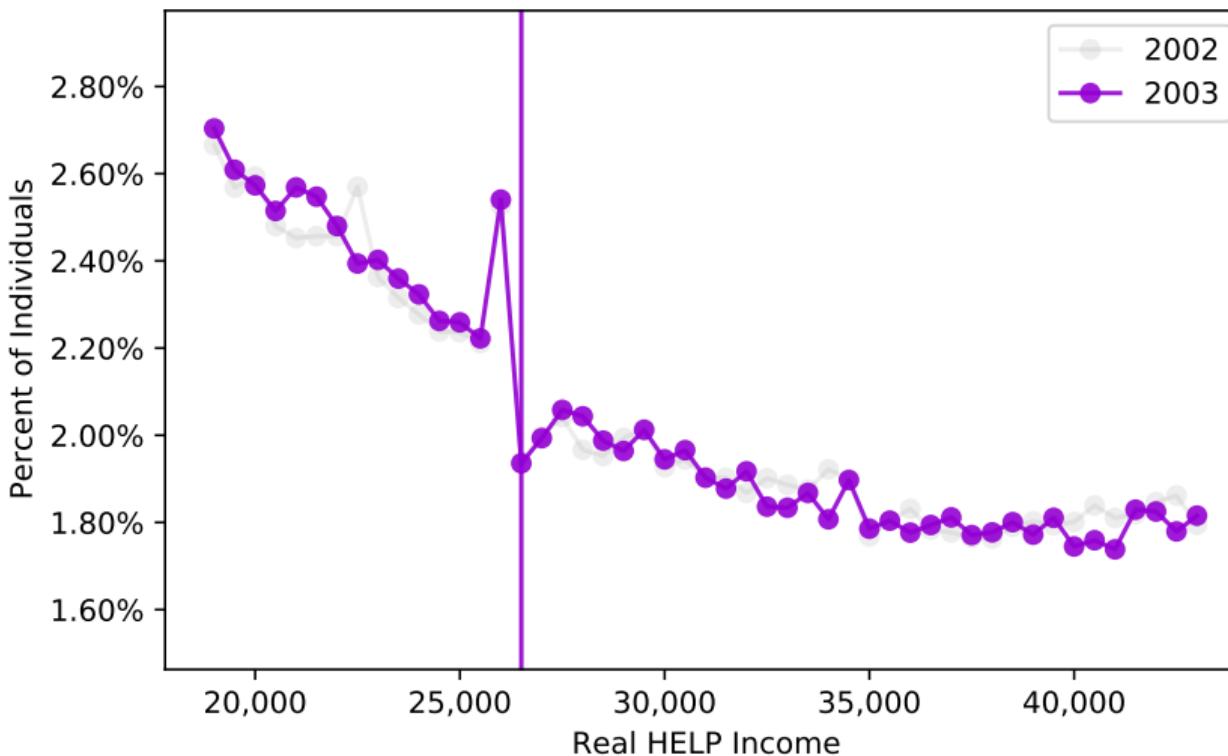
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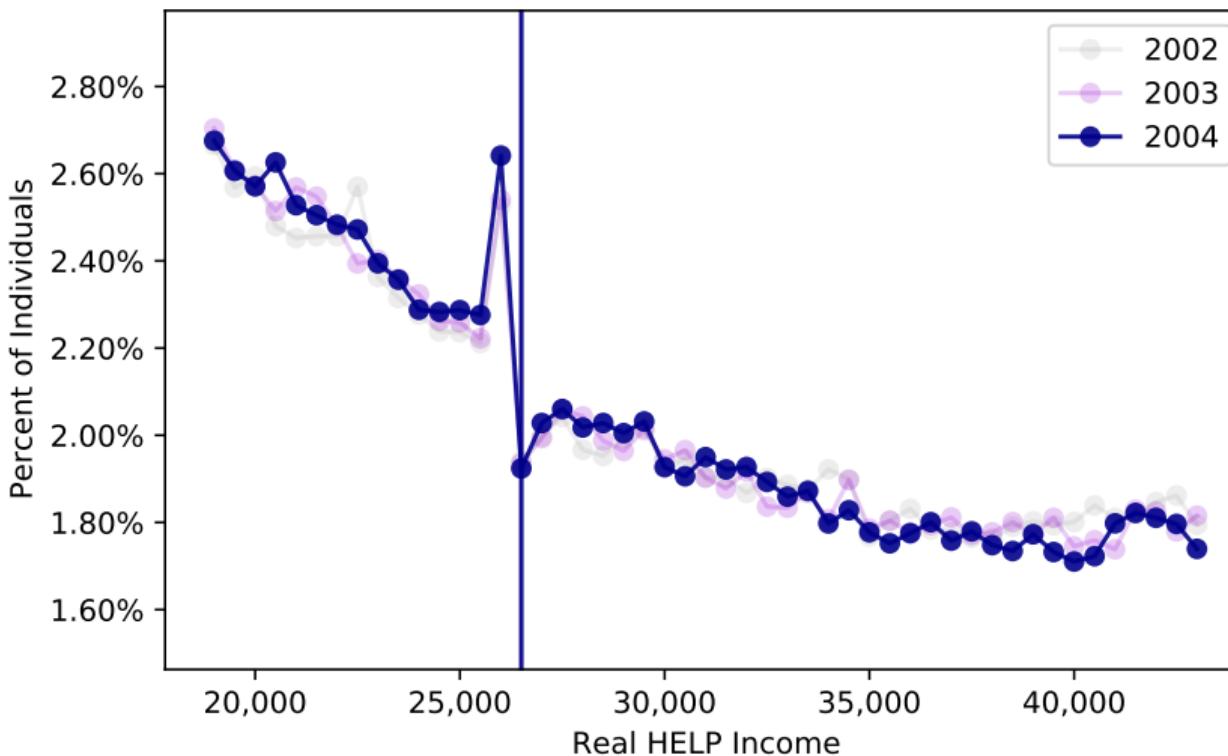
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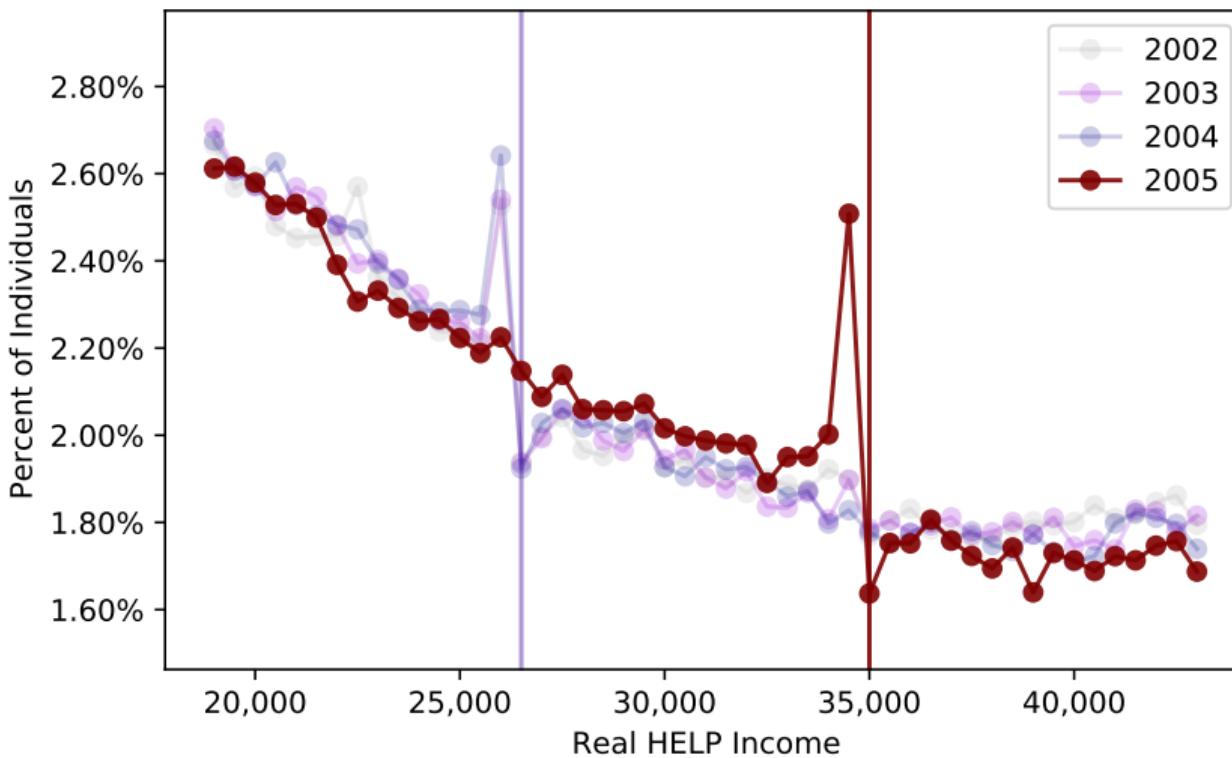
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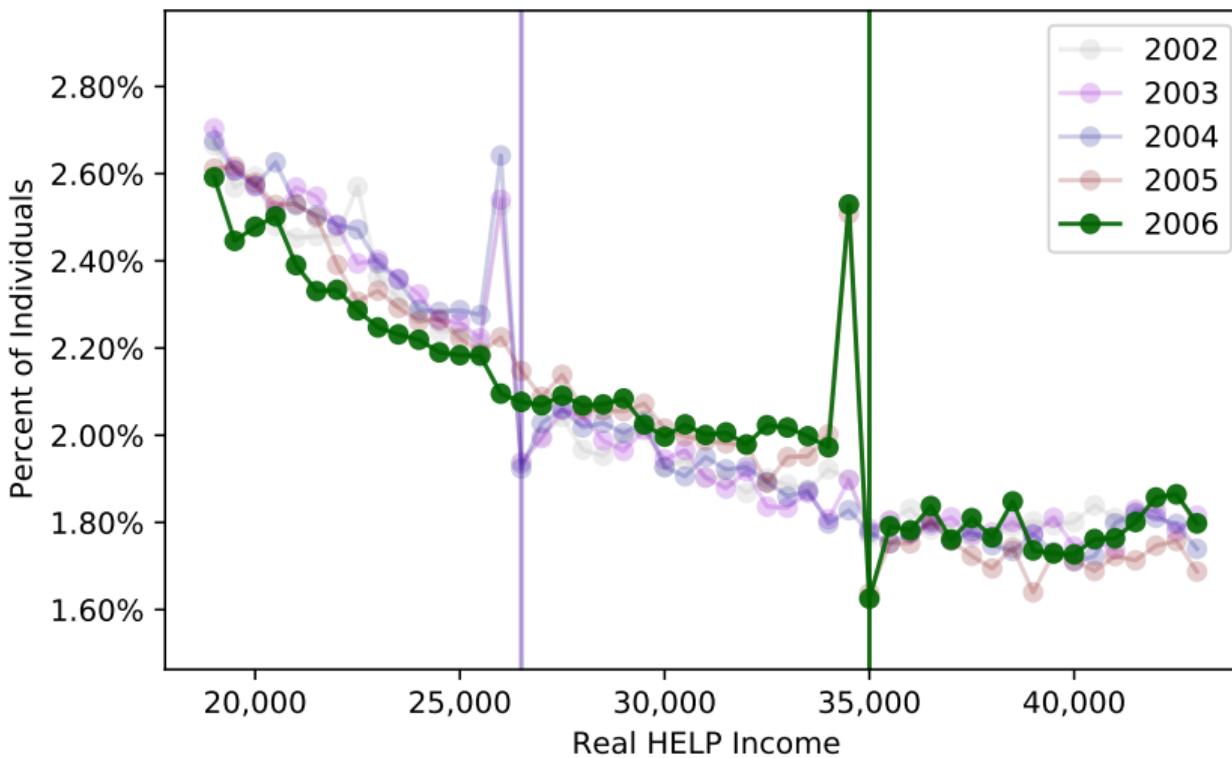
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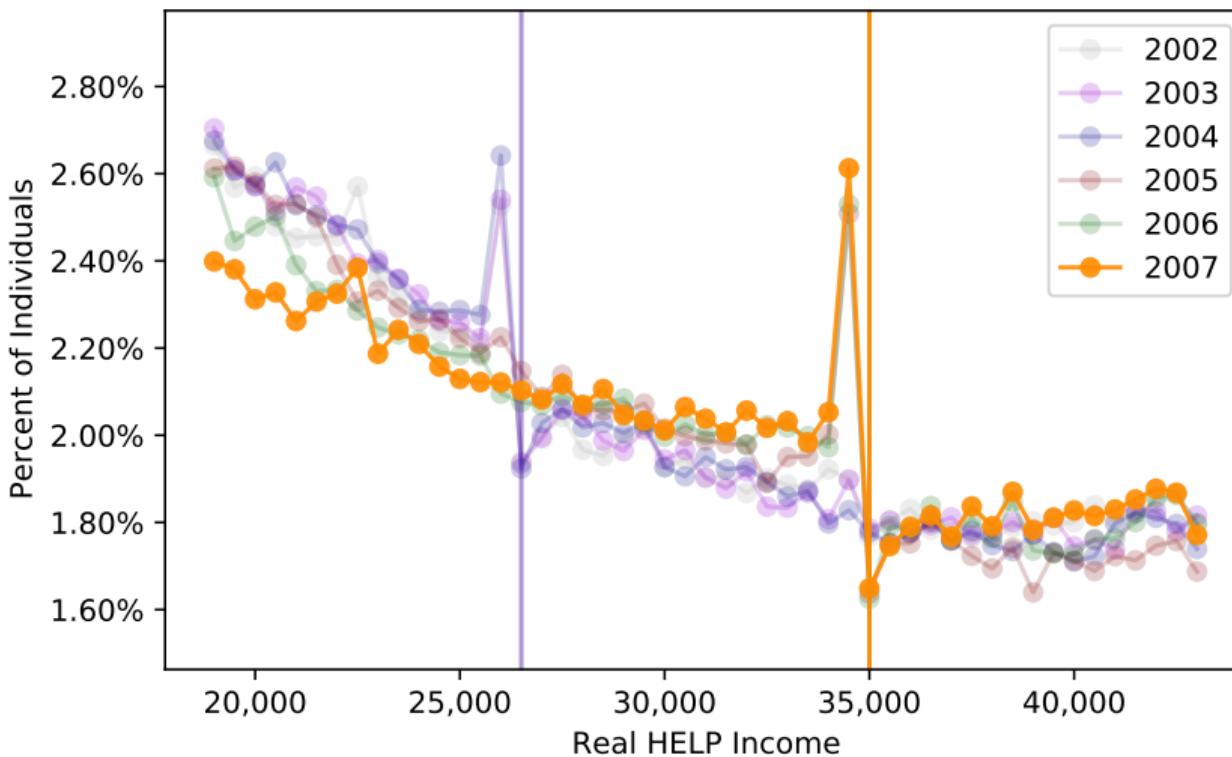
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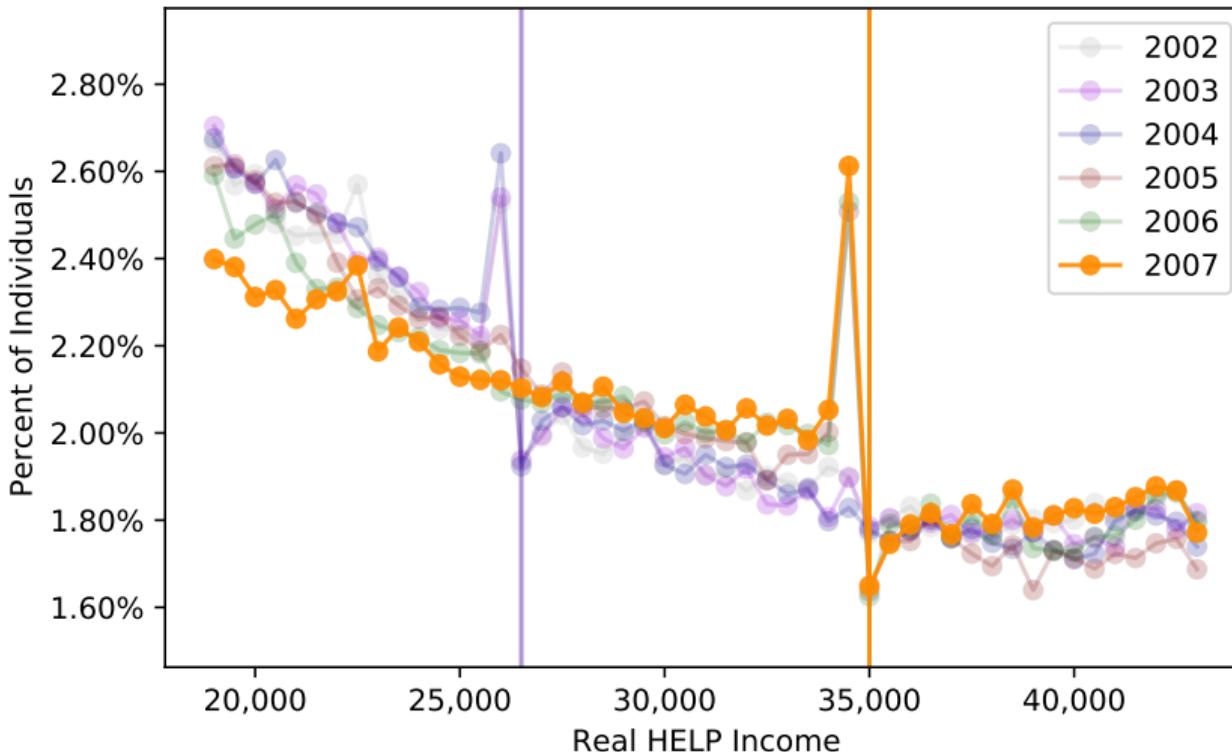
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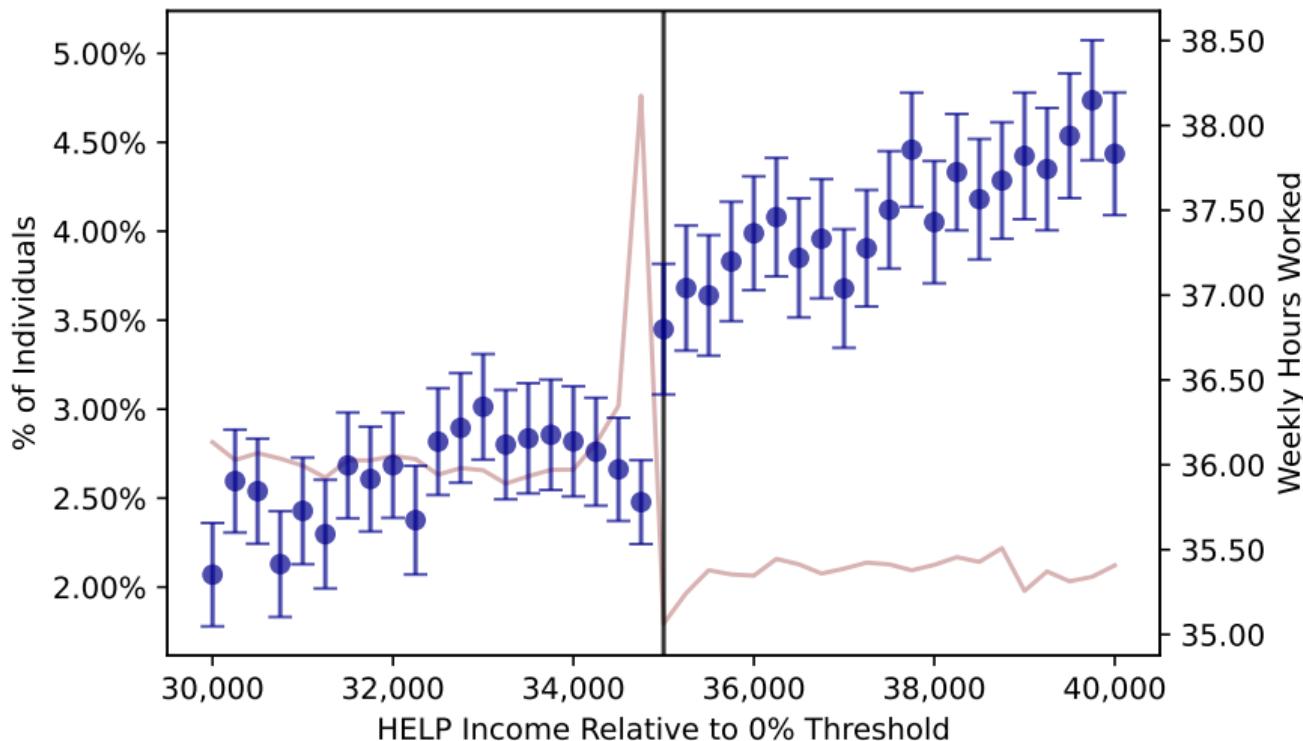
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- Next: does bunching reflect labor supply or evasion?

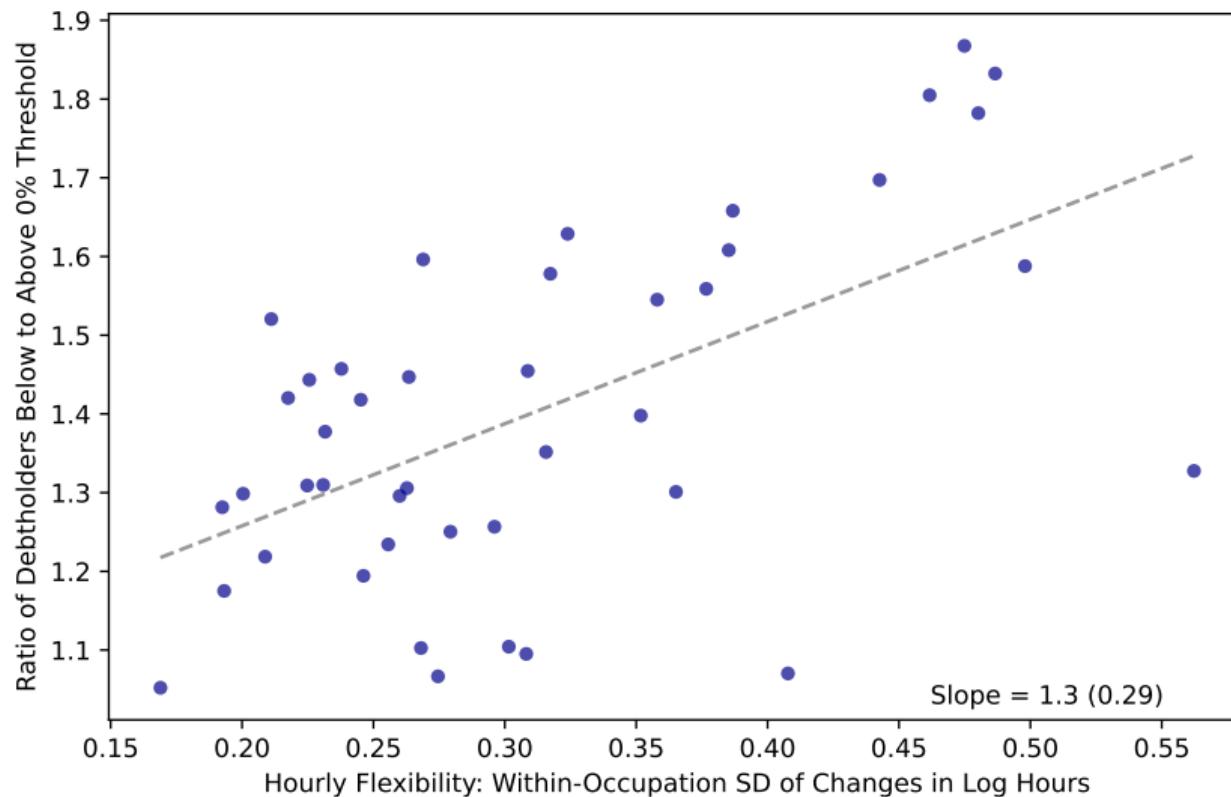
Labor Non-Debt

# BORROWERS BELOW REPAYMENT THRESHOLD WORK FEWER HOURS



- In 2016, reduction is around **1** hour/week = 2.6% of standard workweek

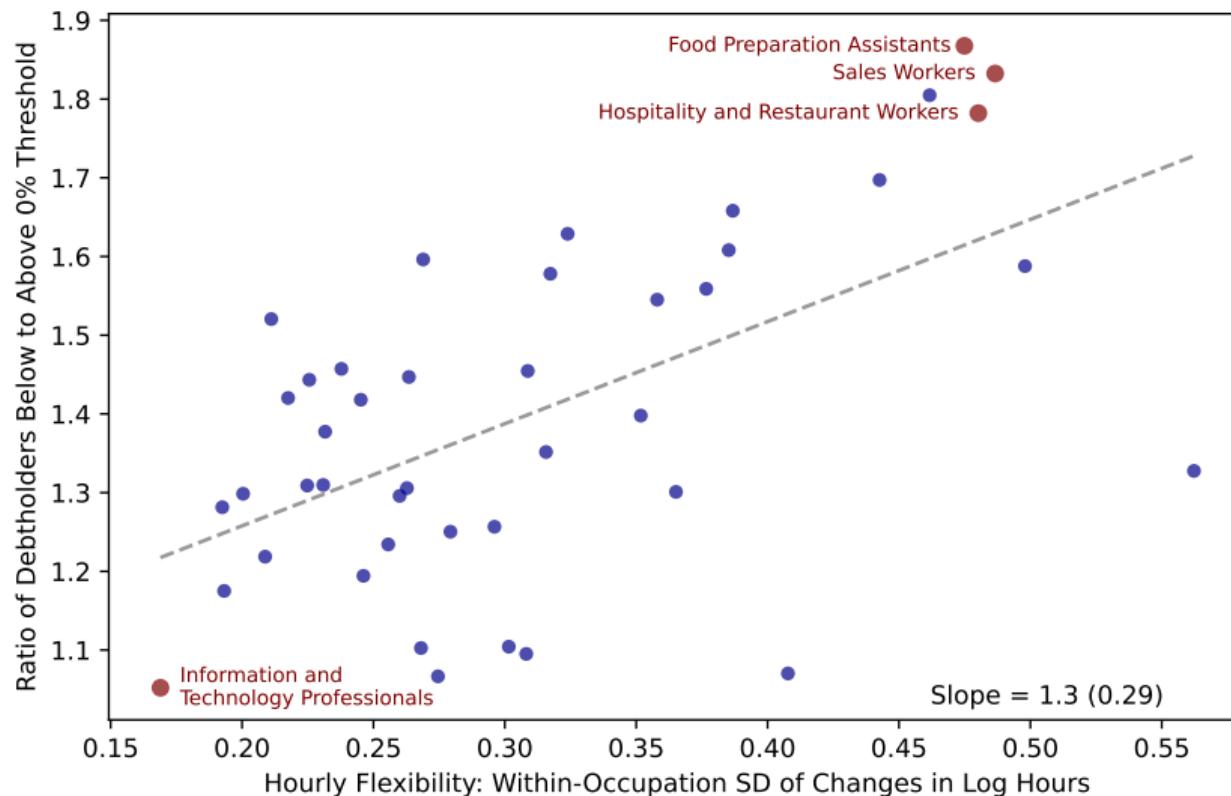
# MORE BUNCHING IN OCCUPATIONS WITH GREATER HOURLY FLEXIBILITY



Sample: All wage-earners between 2005-2018

▶ Alt. Measure ▶ Evasion ▶ Table ▶ Profiles

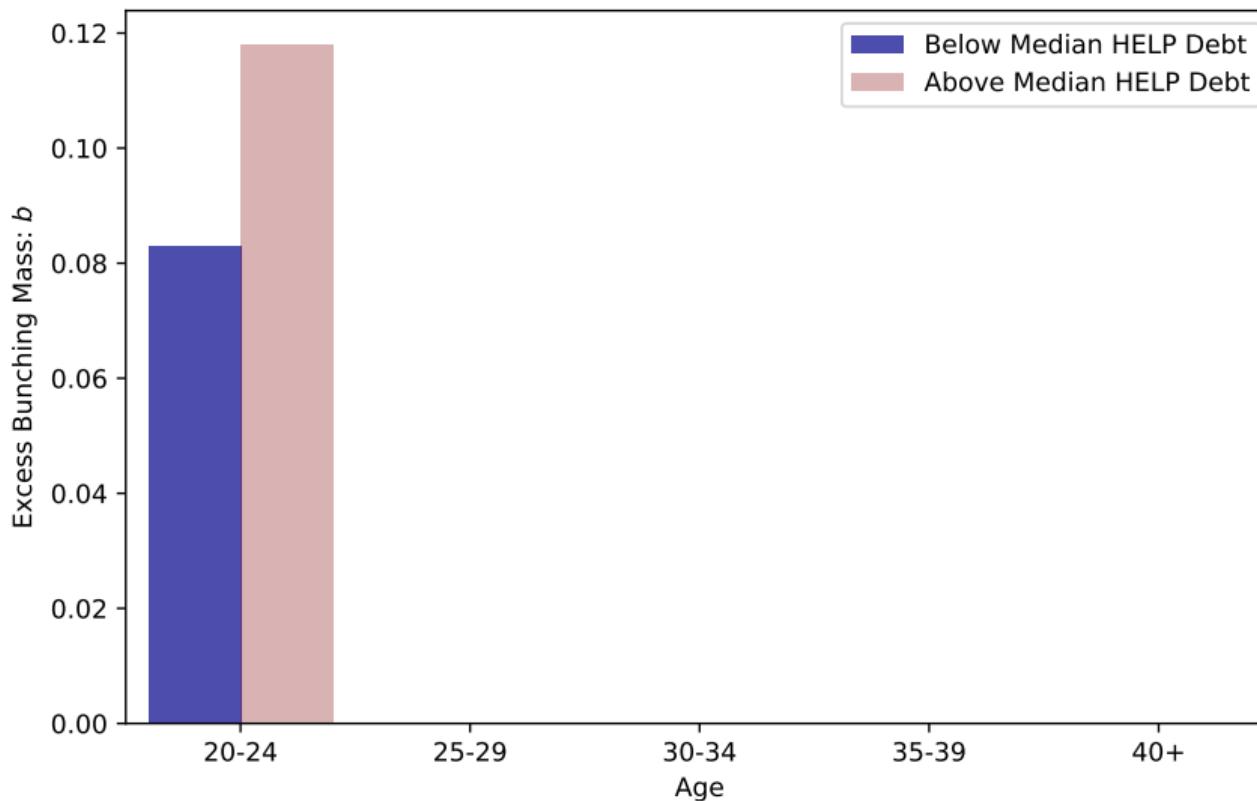
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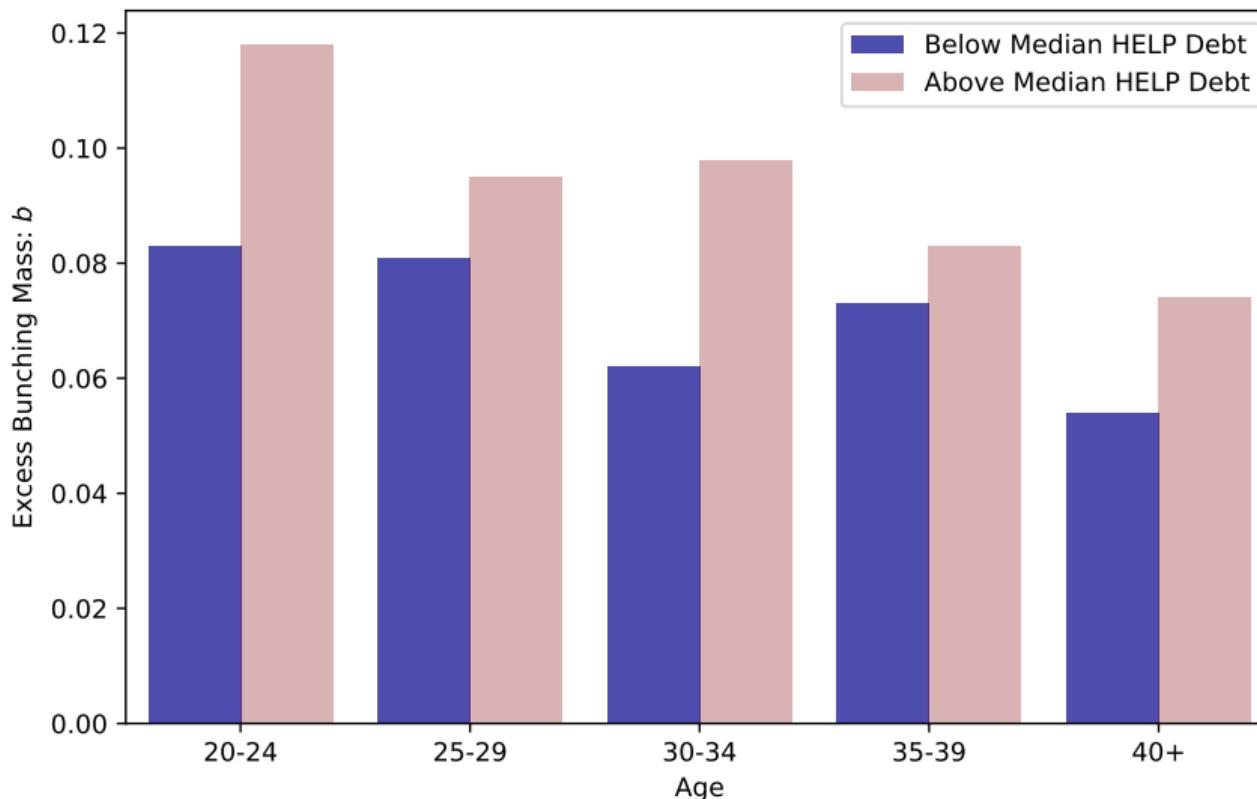
# BUNCHING INCREASES WITH DEBT



Note: Confidence intervals omitted due to small size

► *b* Details

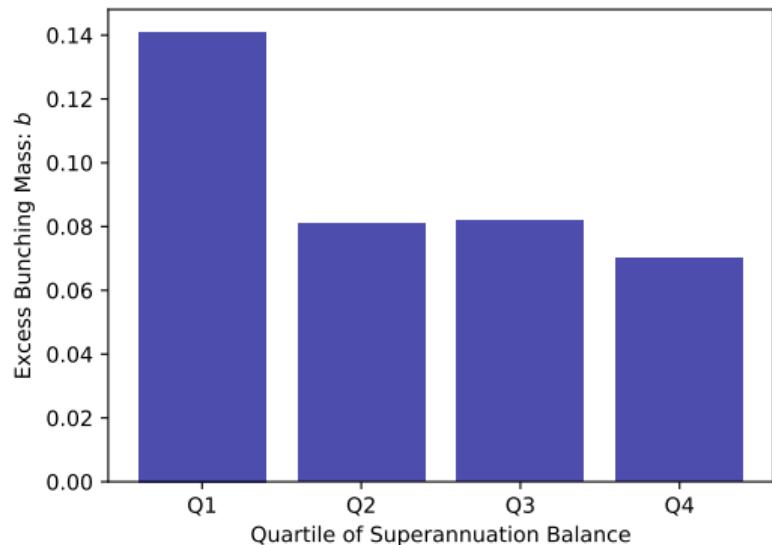
# BUNCHING INCREASES WITH DEBT AND DECREASES WITH AGE



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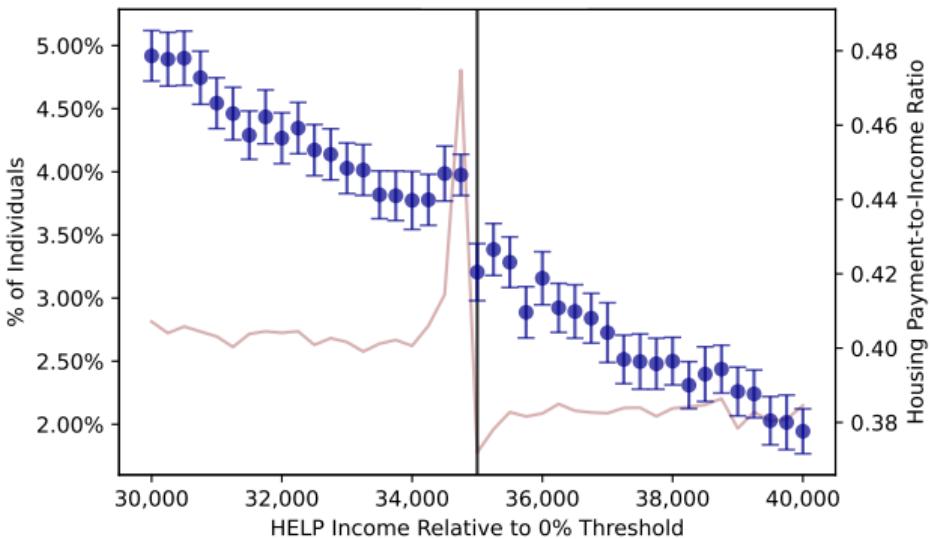
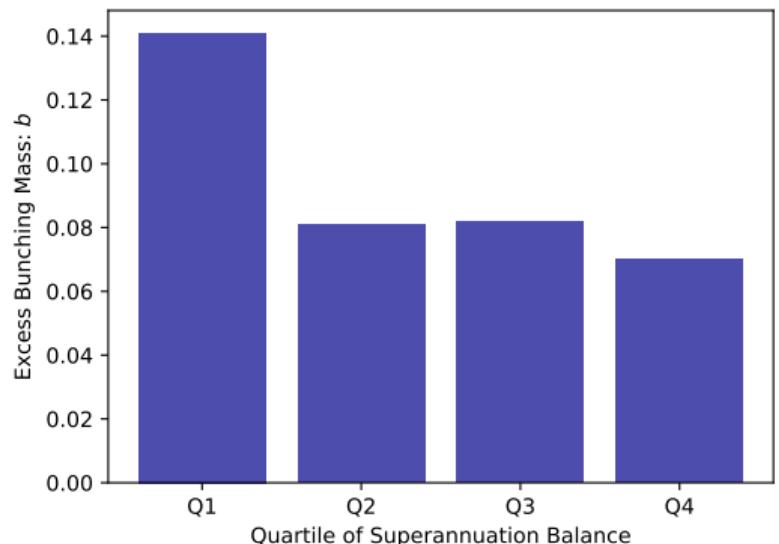
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► Within Age    ► House Prices

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## Facts about moral hazard:

- ① Borrowers reduce labor income in response to income-contingent repayment
  - Reflects labor supply: “bunchers” work fewer hours and in more flexible occupations
- ② Size of responses depends on
  - **Liquidity**: increases with liquidity demands, decreases with retirement wealth
  - **Dynamics**: increases with debt, decreases with lifetime income 
- ③ Limited evidence of future wage reductions from reducing labor supply 

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## Questions for model:

- ① How large are these labor supply responses quantitatively?
- ② Do they imply the costs of income-contingent repayment exceed the benefits?

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# MODEL DESCRIPTION

## OVERVIEW

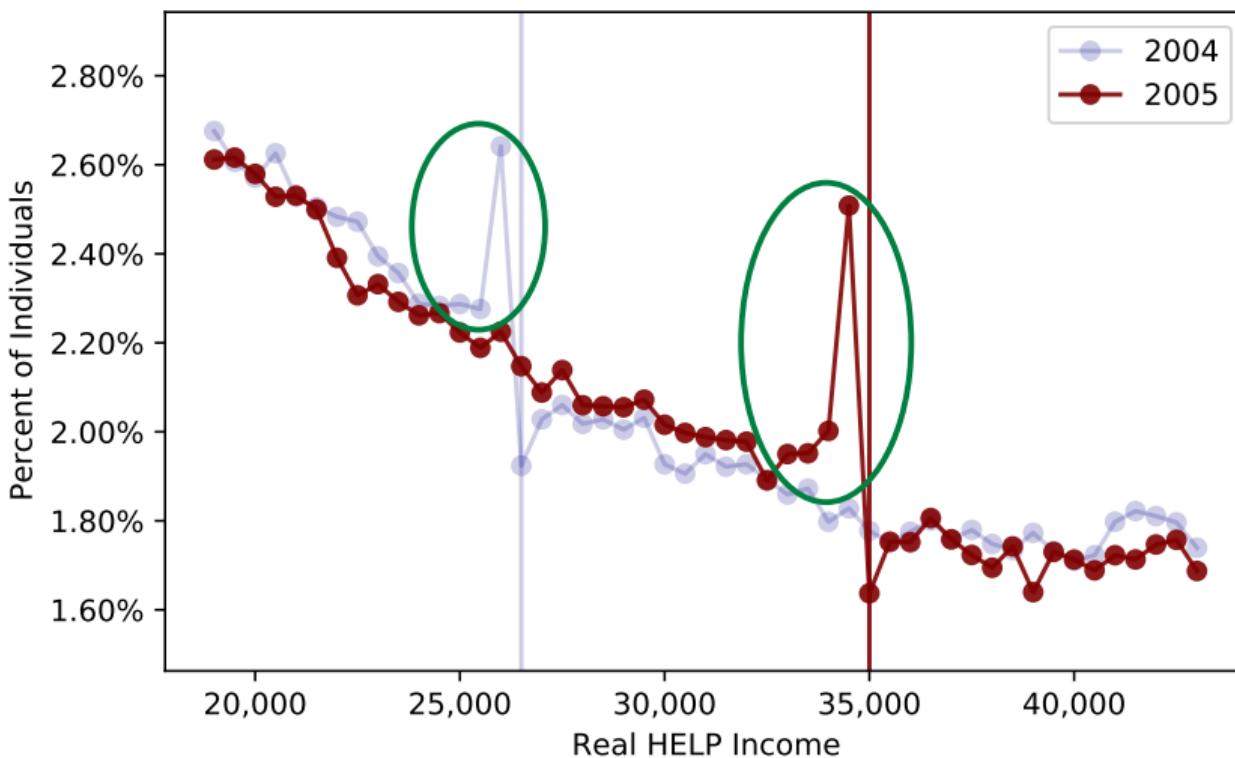
Life cycle model with debt + incomplete markets + endogenous labor supply

- Overlapping generations born at 22 with heterogeneous assets, wage, and debt
- From 22 to 64, individuals choose consumption,  $c_a$ , and labor supply,  $\ell_a$ 
  - Wage rate subject to idiosyncratic shocks (no agg. risk, partial eq.)
  - Shocks are **uninsurable**: borrowing allowed up to age-dependent limit with interest
- After age 64, individuals retire and choose consumption  $c_a$

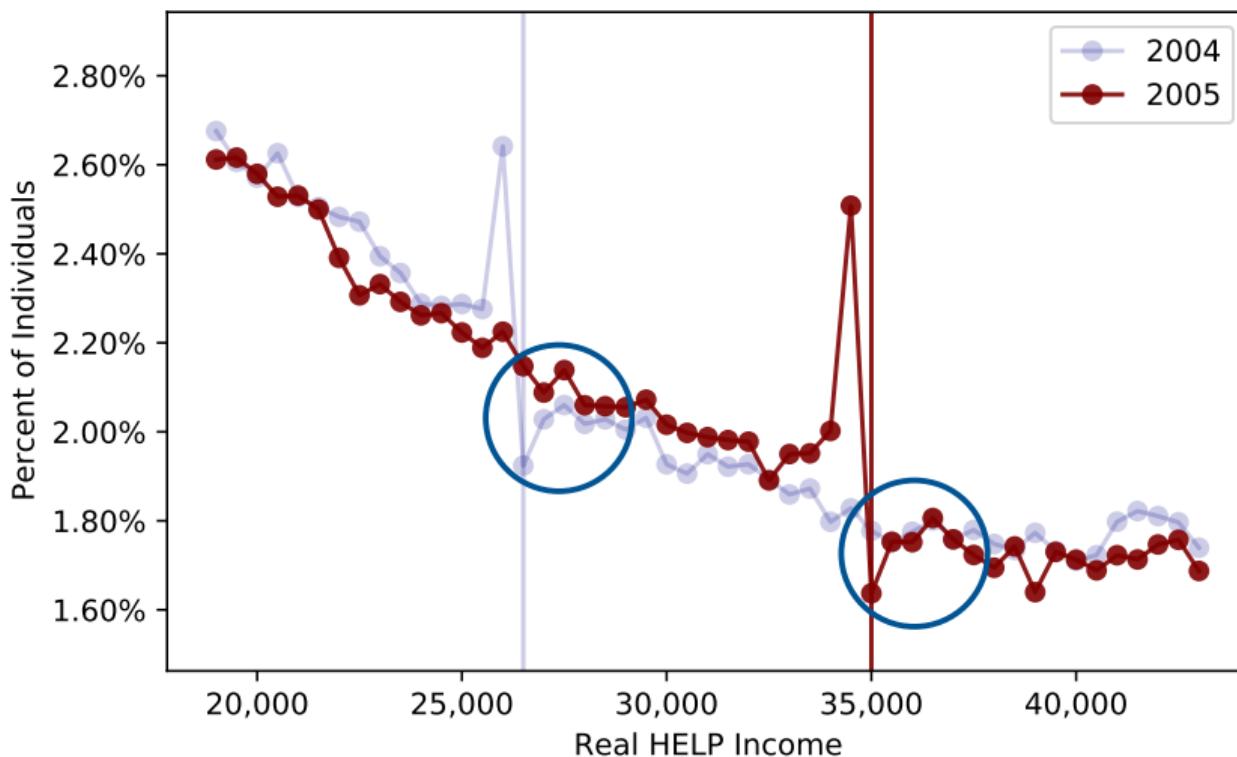
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- **Government**
  - Revenues: progressive income taxes, debt repayments
  - Expenses: means-tested unemployment benefits & retirement pension, initial debt

# BUNCHING CONSISTENT WITH POSITIVE LABOR SUPPLY ELASTICITY



# MASS ABOVE THRESHOLD INCONSISTENT WITH FRICTIONLESS MODEL



- Moving above to below threshold  $\Rightarrow$  more leisure **and** \$1400 more cash-on-hand

- Choice of  $\ell_a$  subject to two **optimization frictions** to give mass above threshold
- **Time**-dependent adjustment (Calvo):
  - Fraction  $\lambda$  hit by shock and adjust  $\ell_a$ , other  $1 - \lambda$  set  $\ell_a = \ell_{a-1}$
  - E.g. inattention, arrival of opportunities to change hours/jobs
- **State**-dependent adjustment ( $sS$ ):
  - Individuals hit by **Calvo shock** incur utility cost  $f$ , if they choose  $\ell_a \neq \ell_{a-1}$
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# LABOR SUPPLY OPTIMIZATION FRICTIONS

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  - E.g. real or psychological costs of changing hours/jobs
- Extension: add learning-by-doing to generate long-run cost of bunching

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$$V_a(\mathbf{s}_a) = \max_{\substack{A_{a+1} \geq \underline{A}_{a+1}, \\ \ell_a}} \underbrace{c_a - \kappa \frac{\ell_a^{1+\phi^{-1}}}{1 + \phi^{-1}}}_{\text{utility of consumption} \\ \& \text{disutility of labor}}$$

# OPTIMIZATION PROBLEM OF INDIVIDUALS HIT BY CALVO SHOCK

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$$c_a + A_{a+1} + \underbrace{d(y_a, D_a, t)}_{\text{debt repayment}} + \underbrace{\tau(y_a)}_{\text{taxes + ui}} = \underbrace{y_a}_{\text{labor income}} + \underbrace{A_a R}_{\text{capital income}}$$

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$$c_a + A_{a+1} + d(y_a, D_a, t) + \tau(y_a) = y_a + A_a R$$

$$y_a = \ell_a w_a, \quad \log w_a = \underbrace{g_a}_{\text{age profile}} + \underbrace{\theta_a}_{\text{permanent income}} + \underbrace{\epsilon_a}_{\text{transitory shock}}$$

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$$c_a + A_{a+1} + d(y_a, D_a, \textcolor{blue}{t}) + \tau(y_a) = y_a + A_a R$$

$$y_a = \ell_a w_a, \quad \log w_a = \textcolor{blue}{g}_a + \theta_a + \epsilon_a$$

$$\mathbf{s}_a = (\textcolor{blue}{a} \quad \textcolor{blue}{t} \quad A_a \quad D_a \quad \theta_a \quad \epsilon_a \quad \ell_{a-1} \quad \omega_a)$$

- $a$  = age
- $t$  = year to keep track of policy change

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$$\mathbf{s}_a = (a \quad t \quad A_a \quad D_a \quad \theta_a \quad \epsilon_a \quad \ell_{a-1} \quad \omega_a)$$

- $A_a$  = savings from previous period
- $D_a$  = debt =  $R_d D_{a-1} - d(y_{a-1}, D_{a-1}, t)$

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- $\theta_a$  = permanent income =  $\rho \theta_{a-1} + \nu_a$   $\nu_a \sim N(0, \sigma_\nu^2)$
- $\epsilon_a$  = transitory shock  $\sim N(0, \sigma_\epsilon^2)$

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- $\theta_a$  = permanent income =  $\rho \theta_{a-1} + \nu_a + \alpha \log \ell_{a-1}$     $\nu_a \sim N(0, \sigma_\nu^2)$
- $\epsilon_a$  = transitory shock  $\sim N(0, \sigma_\epsilon^2)$       Extension: learning-by-doing

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$$V_a(\mathbf{s}_a) = \max_{\substack{A_{a+1} \geq A_{a+1}, \\ \ell_a}} \left\{ \left[ c_a - \kappa \frac{\ell_a^{1+\phi^{-1}}}{1 + \phi^{-1}} - f * \mathbf{1}_{\ell_a \neq \ell_{a-1}} \right]^{1-\sigma} + \beta \left[ m_a \mathbf{E}_{\mathbf{a}} (V_{a+1}(\mathbf{s}_{a+1})^{1-\gamma}) \right]^{\frac{1-\sigma}{1-\gamma}} \right\}^{\frac{1}{1-\sigma}}$$

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- $\ell_{a-1}$  = labor supply from previous period
- $\omega_a$  = Calvo shock that determines whether  $\ell_a$  can be adjusted  $\sim$  Bernoulli( $\lambda$ )

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$$\mathbf{s}_a = (a \quad t \quad A_a \quad D_a \quad \theta_a \quad \epsilon_a \quad \ell_{a-1} \quad \omega_a)$$

- Sources of ex-ante heterogeneity:
  - $\theta_0$  = initial permanent income  $\sim N(0, \sigma_i^2)$
  - $D_0$  = initial debt,  $A_0$  = initial assets

# ESTIMATION

- **Interest rates and borrowing:**
  - Interest rate = 1.84%, borrowing rate = CC rate, debt interest rate = 0%
  - Borrowing limit = average CC limit by age
- **Demographics:** cohort birth rates and mortality risk taken from life tables
  - Consumption adjusted for equivalence scale using HH size (Lusardi et al. 2017)
- **Government:** use exact (non-smooth) formulas provided by ATO
- **Initial conditions:** assets and debt distributions taken from data at age 22
- **Baseline RRA and EIS:**  $\gamma = \frac{1}{\sigma} = 2.23$  (Choukhmane-de Silva 2023)
  - Welfare analysis: consider alternative values + preference for early resolution

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  - Welfare analysis: consider alternative values + preference for early resolution
- **Learning-by-doing extension:**  $\alpha = 0.24$  (median value from Best-Kleven 2013)

## SECOND-STAGE SIMULATED METHOD OF MOMENTS

$$\text{Parameters} = \begin{pmatrix} & \\ & \\ & \end{pmatrix}$$

- **Estimation** via SMM with 47 moments + 14 parameters
    - Find parameters that minimize % difference between data & model moments
  - **Simulated policy change:** unanticipated change in HELP formula at  $t = 2005$

## SECOND-STAGE SIMULATED METHOD OF MOMENTS: IDENTIFICATION

$$\text{Parameters} = \left( \begin{array}{c} \overbrace{\phi \ f \ \lambda}^{\text{labor supply}} \\ \end{array} \right)$$

- **Labor supply elasticity:** identified by bunching below repayment threshold
- **Frictions:** identified by mass above repayment threshold

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  - Moments: heterogeneity in bunching with **debt**, bunching at **0.5%** threshold
  - **Intuition:** with  $f = 0$ , decision to bunch depends on Calvo shock not incentives

## SECOND-STAGE SIMULATED METHOD OF MOMENTS: IDENTIFICATION

$$\text{Parameters} = \left( \underbrace{\phi, f, \lambda}_{\text{preferences}} \quad \underbrace{\kappa, \beta}_{\text{labor supply}} \quad \underbrace{\delta_0, \delta_1, \delta_2}_{\text{wage profile}} \quad \underbrace{\delta_0^E, \delta_1^E}_{\text{wage profile}} \quad \underbrace{\rho, \sigma_\nu, \sigma_\epsilon, \sigma_i}_{\text{wage risk}} \right)$$

- **Labor supply elasticity**: identified by bunching below repayment threshold
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- Separate identification of **frictions**
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  - **Intuition**: with  $f = 0$ , decision to bunch depends on Calvo shock not incentives
- Note: wage profile & risk cannot be estimated separately in first-stage

▶ Other Parameters

▶ Elasticities

▶ SMM Objective

# PARAMETER ESTIMATES

| Parameter                              | Estimation        |          |
|--|-------------------|----------|
|  |                   | Baseline |
| Labor supply elasticity                | $\phi$            | 0.114    |
| Fixed adjustment cost                  | $f$               | \$377    |
| Calvo parameter                        | $\lambda$         | 0.183    |
| Labor supply scaling parameter         | $\kappa$          | 0.560    |
| Time discount factor                   | $\beta$           | 0.973    |
| Wage profile parameters                | $\delta_0$        | 8.922    |
|  | $\delta_1$        | 0.073    |
|  | $\delta_2$        | -0.001   |
|  | $\delta_0^E$      | -0.487   |
|  | $\delta_1^E$      | 0.020    |
| Persistence of permanent shock         | $\rho$            | 0.930    |
| Standard deviation of permanent shock  | $\sigma_\nu$      | 0.236    |
| Standard deviation of transitory shock | $\sigma_\epsilon$ | 0.130    |
| Standard deviation of individual FE    | $\sigma_i$        | 0.599    |

► Comparison with Literature   ► Standard Errors

# PARAMETER ESTIMATES

| Parameter                              |                   | Estimation |              |
|--|-------------------|------------|--------------|
|  |                   | Baseline   | No Frictions |
| Labor supply elasticity                | $\phi$            | 0.114      | 0.005        |
| Fixed adjustment cost                  | $f$               | \$377      | .            |
| Calvo parameter                        | $\lambda$         | 0.183      | .            |
| Labor supply scaling parameter         | $\kappa$          | 0.560      | 0.030        |
| Time discount factor                   | $\beta$           | 0.973      | 0.996        |
| Wage profile parameters                | $\delta_0$        | 8.922      | 9.862        |
|  | $\delta_1$        | 0.073      | 0.111        |
|  | $\delta_2$        | -0.001     | -0.002       |
|  | $\delta_0^E$      | -0.487     | -0.294       |
|  | $\delta_1^E$      | 0.020      | 0.032        |
| Persistence of permanent shock         | $\rho$            | 0.930      | 0.914        |
| Standard deviation of permanent shock  | $\sigma_\nu$      | 0.236      | 0.076        |
| Standard deviation of transitory shock | $\sigma_\epsilon$ | 0.130      | 0.504        |
| Standard deviation of individual FE    | $\sigma_i$        | 0.599      | 0.101        |

► Comparison with Literature

► Standard Errors

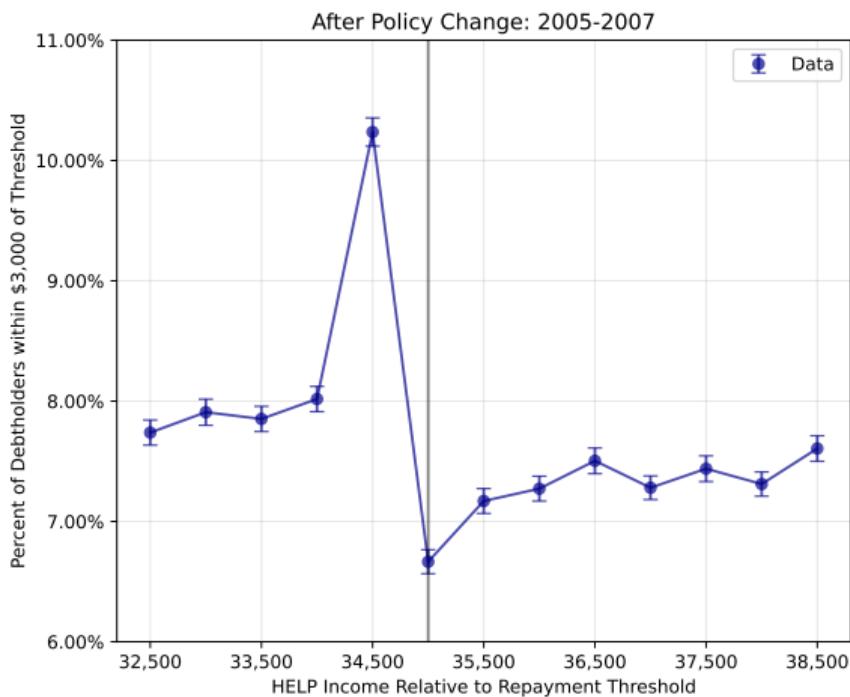
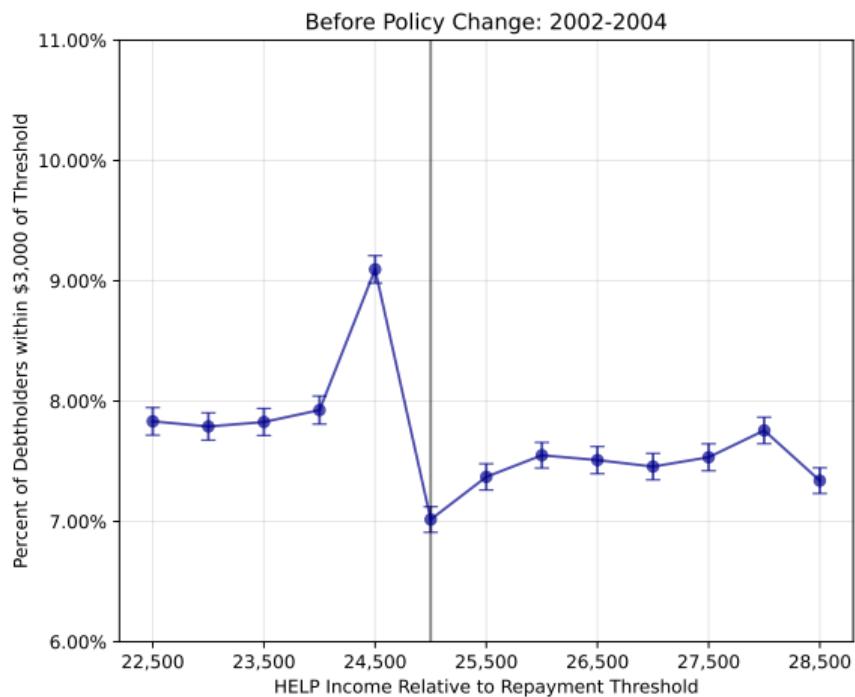
# PARAMETER ESTIMATES

| Parameter                              |                   | Estimation |              |        |
|--|-------------------|------------|--------------|--------|
|  |                   | Baseline   | No Frictions | LBD    |
| Labor supply elasticity                | $\phi$            | 0.114      | 0.005        | 0.082  |
| Fixed adjustment cost                  | $f$               | \$377      | .            | \$762  |
| Calvo parameter                        | $\lambda$         | 0.183      | .            | 0.346  |
| Labor supply scaling parameter         | $\kappa$          | 0.560      | 0.030        | 1.242  |
| Time discount factor                   | $\beta$           | 0.973      | 0.996        | 0.951  |
| Wage profile parameters                | $\delta_0$        | 8.922      | 9.862        | 9.197  |
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|  | $\delta_2$        | -0.001     | -0.002       | -0.001 |
|  | $\delta_0^E$      | -0.487     | -0.294       | -0.480 |
|  | $\delta_1^E$      | 0.020      | 0.032        | 0.018  |
| Persistence of permanent shock         | $\rho$            | 0.930      | 0.914        | 0.889  |
| Standard deviation of permanent shock  | $\sigma_\nu$      | 0.236      | 0.076        | 0.288  |
| Standard deviation of transitory shock | $\sigma_\epsilon$ | 0.130      | 0.504        | 0.064  |
| Standard deviation of individual FE    | $\sigma_i$        | 0.599      | 0.101        | 0.625  |

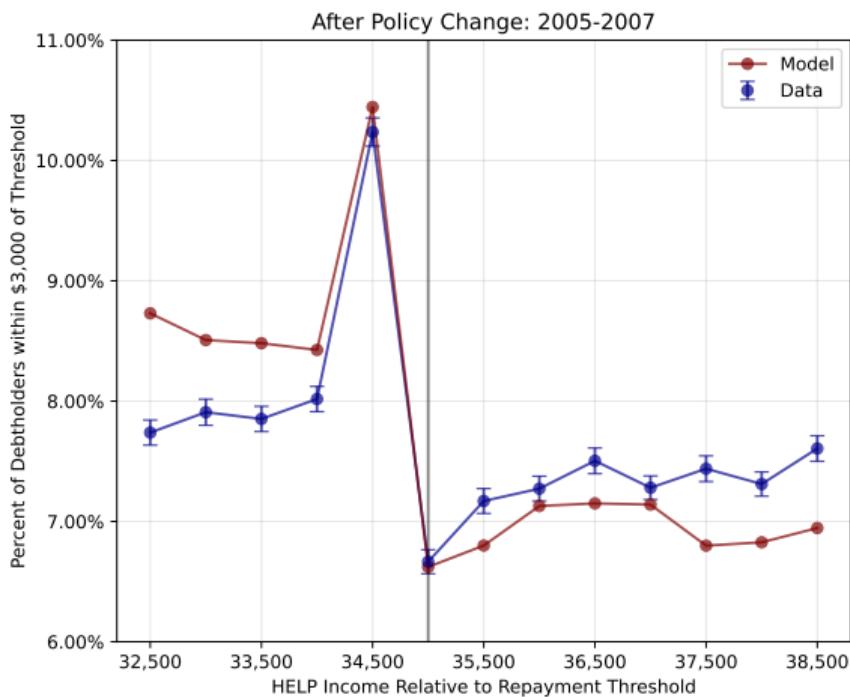
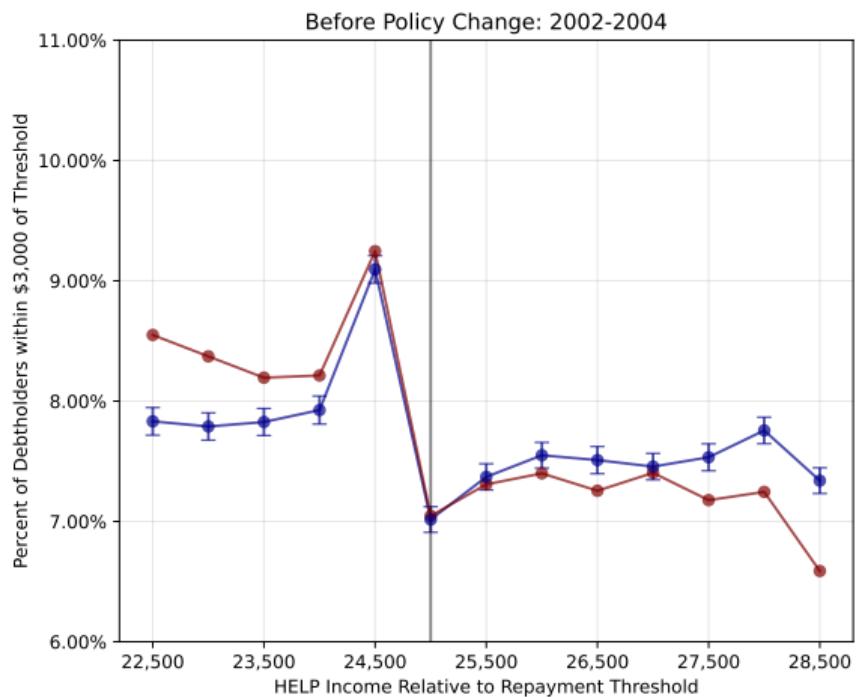
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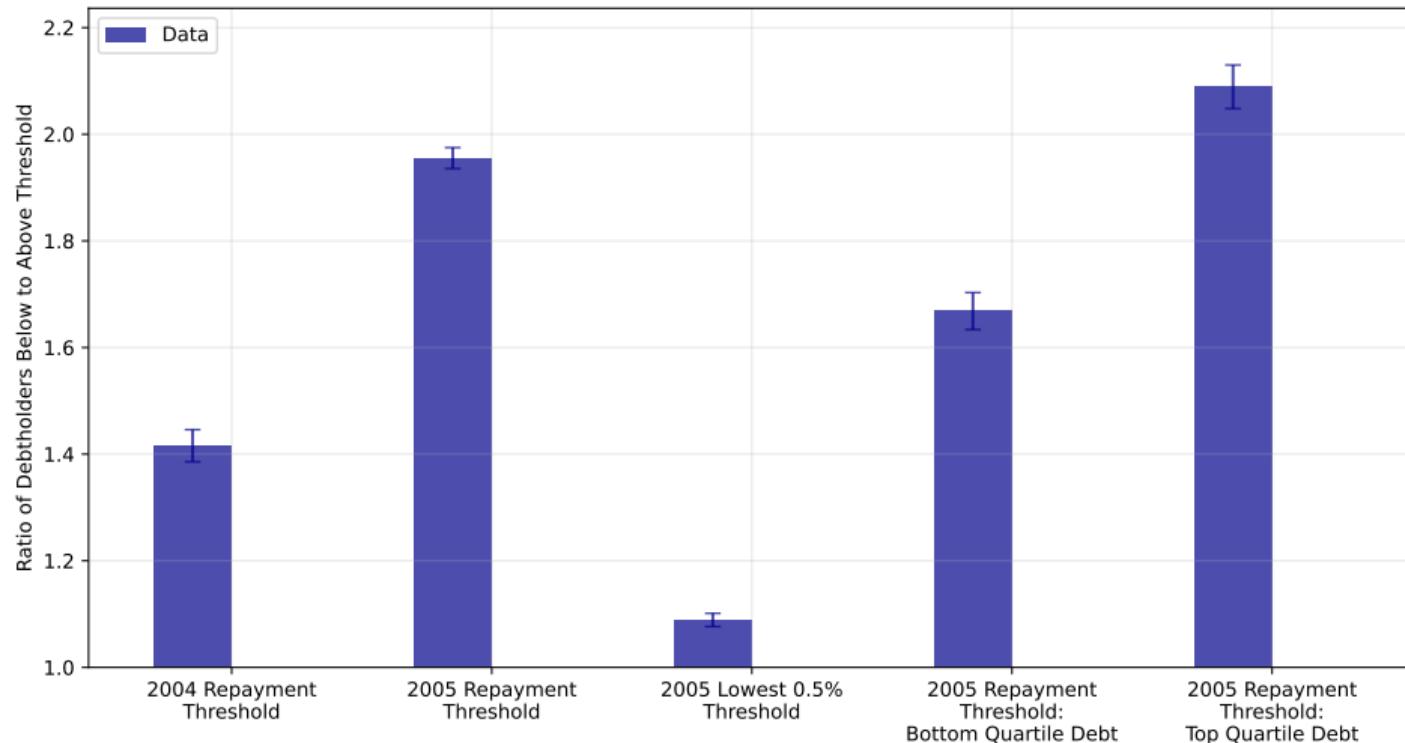
# MODEL FIT: BUNCHING BEFORE AND AFTER POLICY CHANGE



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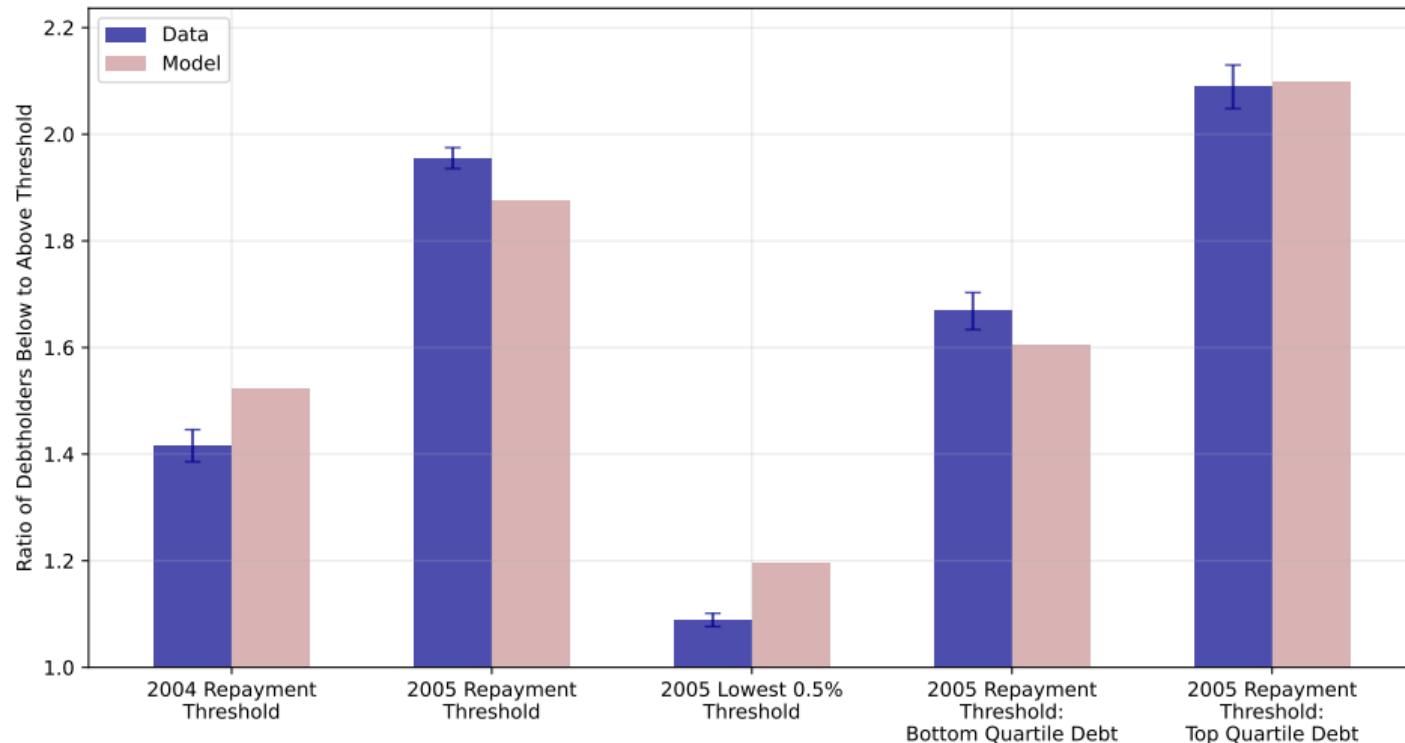


# MODEL FIT: BUNCHING HETEROGENEITY



► Other Moments   ► Liquidity   ► Dynamics

# MODEL FIT: BUNCHING HETEROGENEITY



► Other Moments   ► Liquidity   ► Dynamics

# OUTLINE

- 1 Institutional Background and Data
- 2 Labor Supply Responses to Income-Contingent Repayment
- 3 Life Cycle Model with Endogenous Labor Supply
- 4 Welfare and Fiscal Impacts of Income-Contingent Repayment
- 5 Conclusion

What repayment contract best balances **insurance** with **moral hazard**?

- Consider social planner that maximizes borrower welfare with **one** contract
  - Problem faced by governments with one contract (e.g. Australia, UK)
  - Contract is subsidized with zero interest rate, borrowing & prices held fixed

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- **Step 1: Existing** income-contingent loans vs. fixed repayment (not budget-neutral)
  - Four contracts: HELP 2004, HELP 2005, US Old & New IBR =  $\psi * \max\{y - K, 0\}$
- **Step 2: Optimal** income-contingent contracts vs. fixed repayment (budget-neutral)

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- Note: consider effect of forgiveness in Step 2

# GOVERNMENT BUDGET = EXPECTED DISCOUNTED VALUE OF PAYMENTS

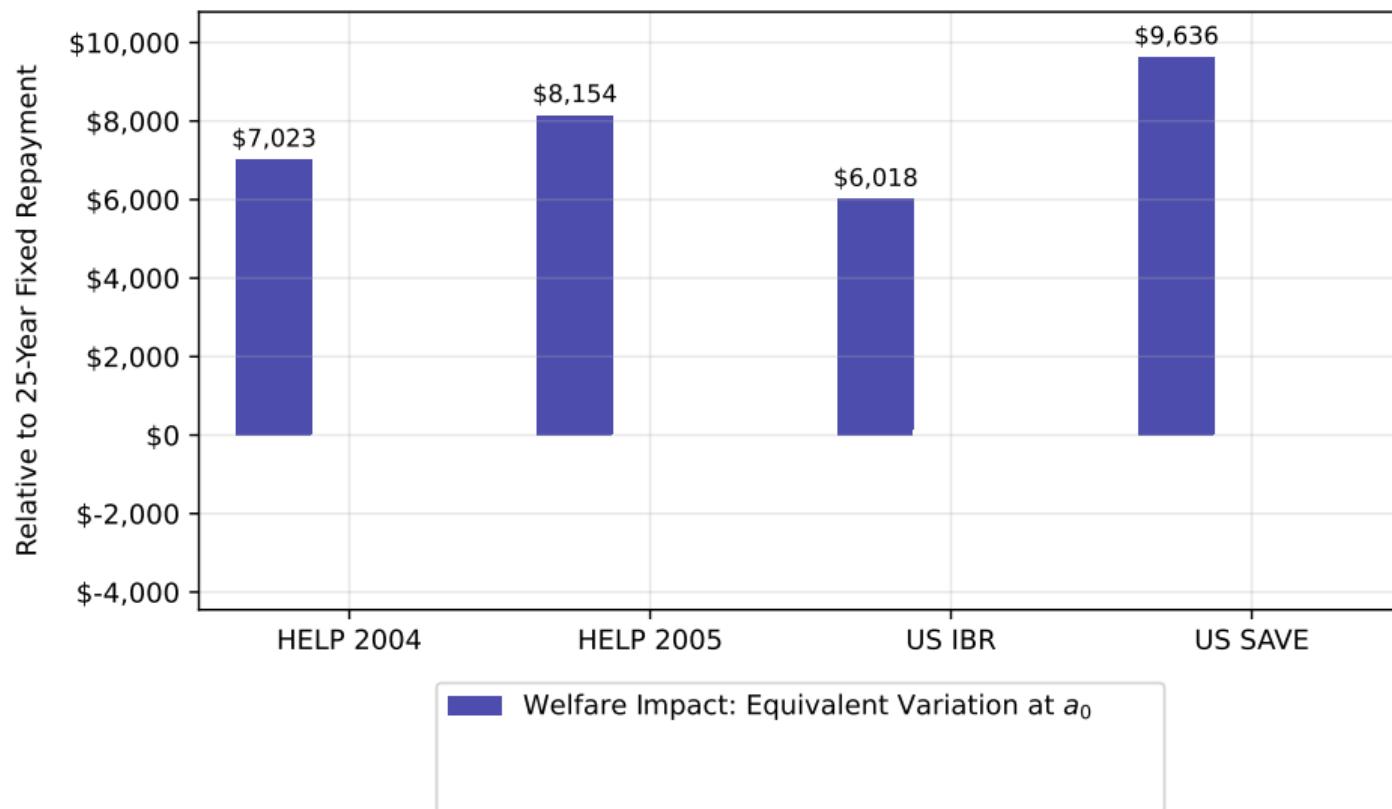
- **Government budget** defined as:

$$\mathcal{G} = \mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a + \text{Taxes}_a - \text{Transfers}_a}{\mathcal{R}_a}$$

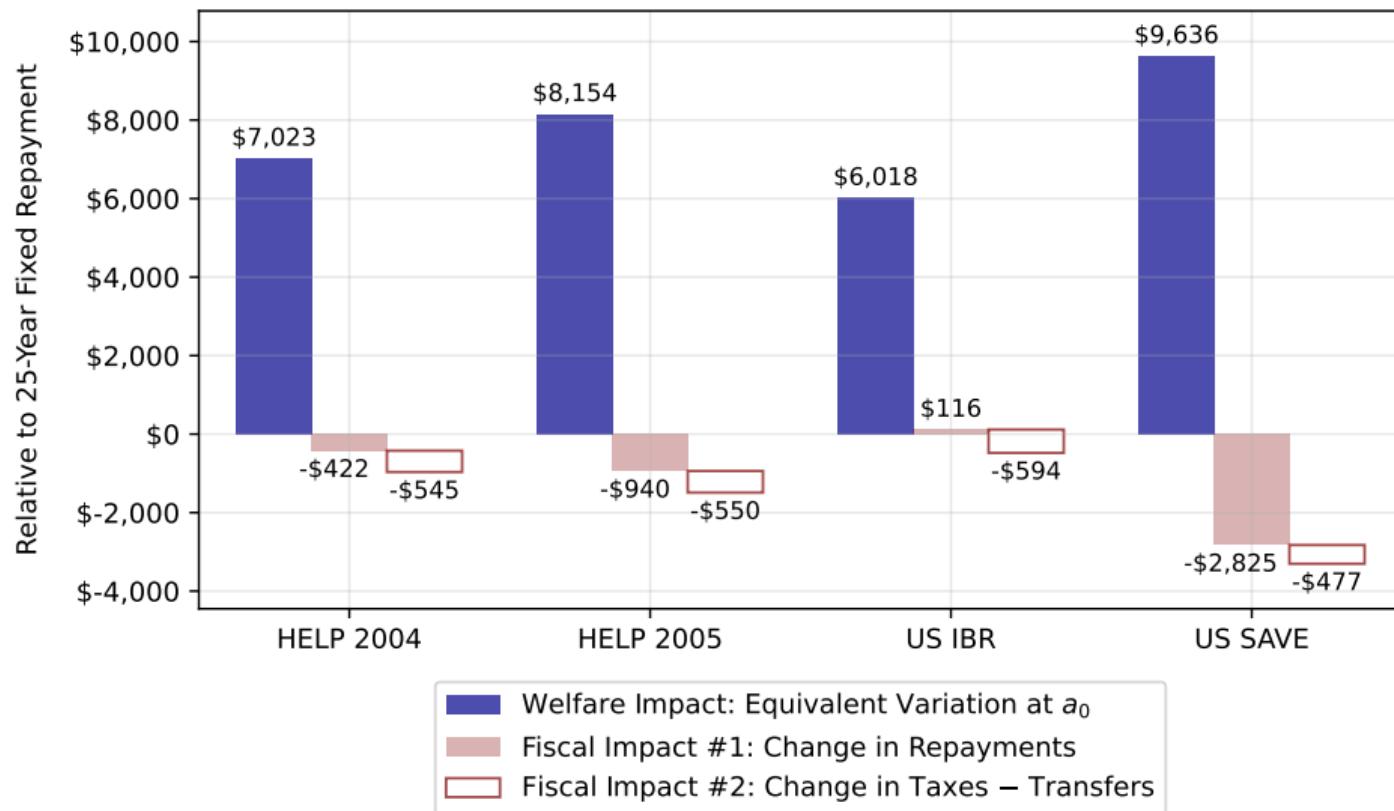
$$\mathcal{R}_a = \underbrace{\beta^{-(a-a_0)}}_{\text{individual time preference}} * \underbrace{\prod_{s=0}^{a-a_0} m_s}_{\text{mortality}}$$

- **Benchmark:** 25-Year Fixed Repayment = similar duration, not income-contingent
- Robustness with  $\mathcal{R}_a$  = risk-free rate &  $\mathcal{R}_a$  = risk-free rate + 4%

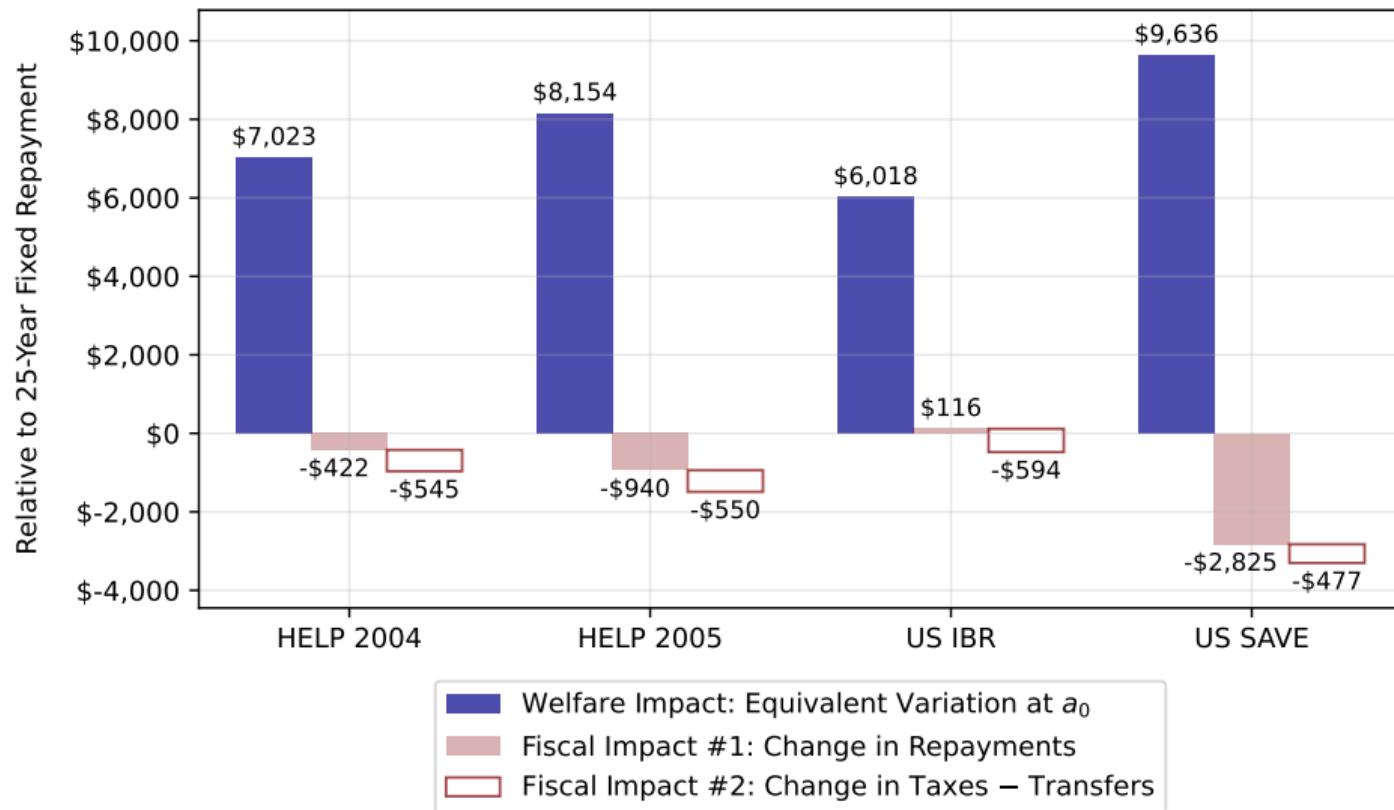
## EXISTING INCOME-CONTINGENT LOANS VS. FIXED REPAYMENT



# EXISTING INCOME-CONTINGENT LOANS VS. FIXED REPAYMENT



# EXISTING INCOME-CONTINGENT LOANS VS. FIXED REPAYMENT



► Decomposition

► MVPF

# CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

- Contracts have different fiscal costs  $\Rightarrow$  need to balance government budget
- **Next:** solve **constrained** planner's problem to construct contracts with **same cost**

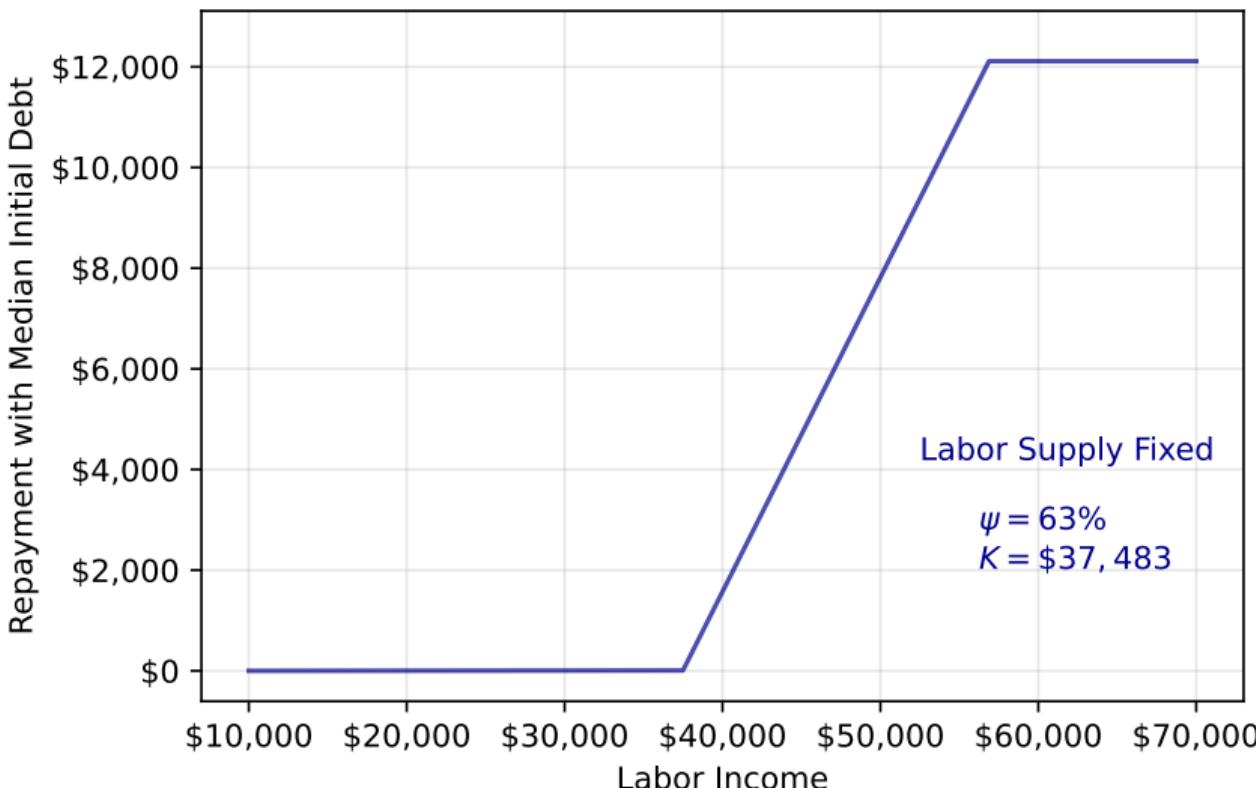
$$\max_{\psi, K} \mathbf{E}_0 \left( V_{a_0}^{1-\gamma} \right)^{\frac{1}{1-\gamma}}$$

subject to:

$$\mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a + \text{Taxes}_a - \text{Transfers}_a}{\mathcal{R}_a} \geq \mathcal{G}_{\text{25-Year Fixed}} \quad (1)$$

$$\text{Repayments}_a = \min \{ \psi * \max \{ y_a - K, 0 \}, D_a \} \quad (2)$$

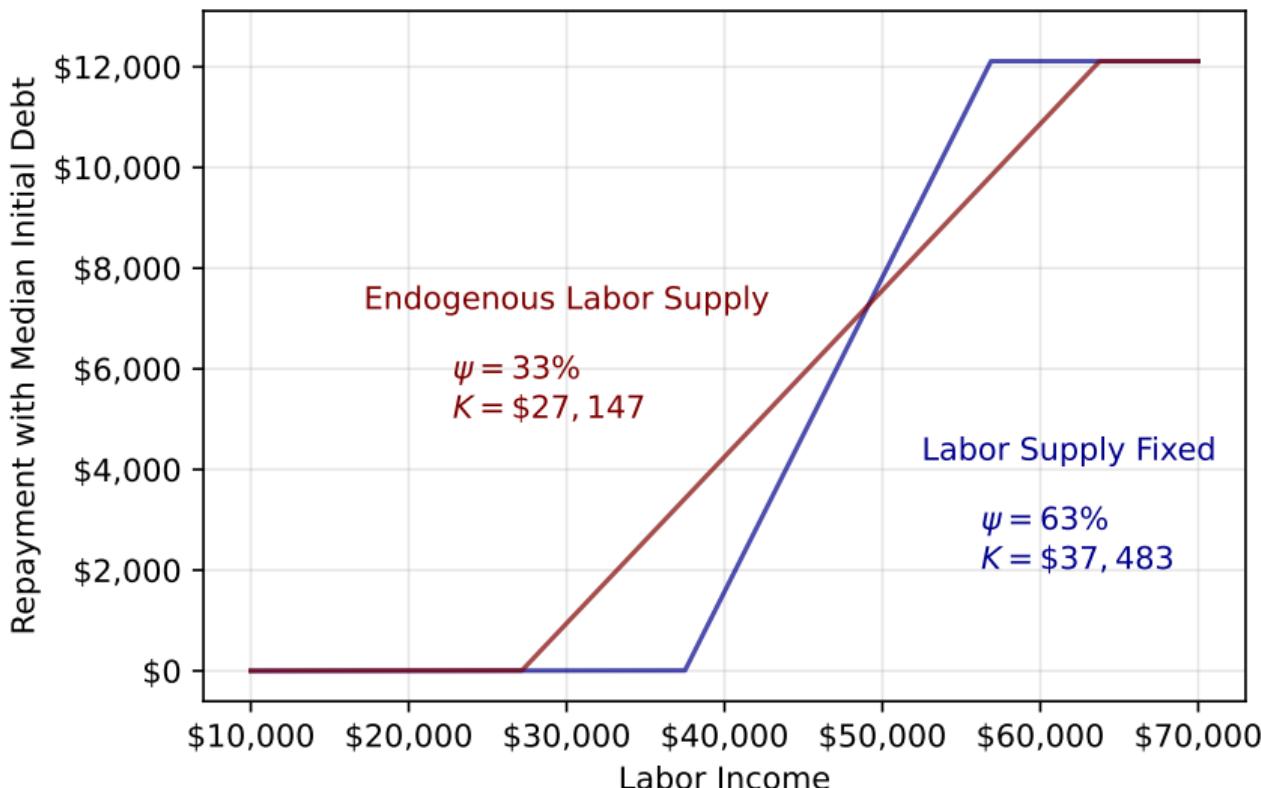
# SOLUTION TO CONSTRAINED PLANNER'S PROBLEM



▶ Smooth

▶ vs. Existing

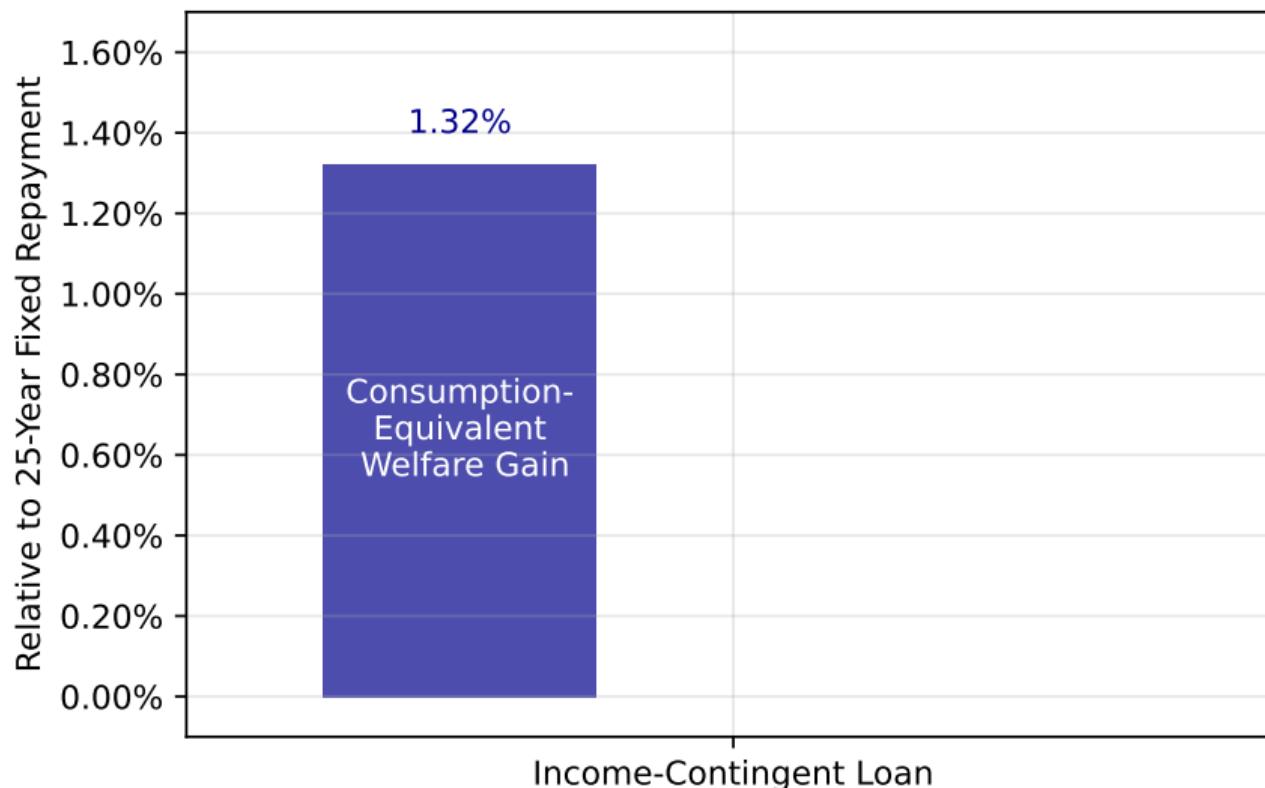
# SOLUTION TO CONSTRAINED PLANNER'S PROBLEM



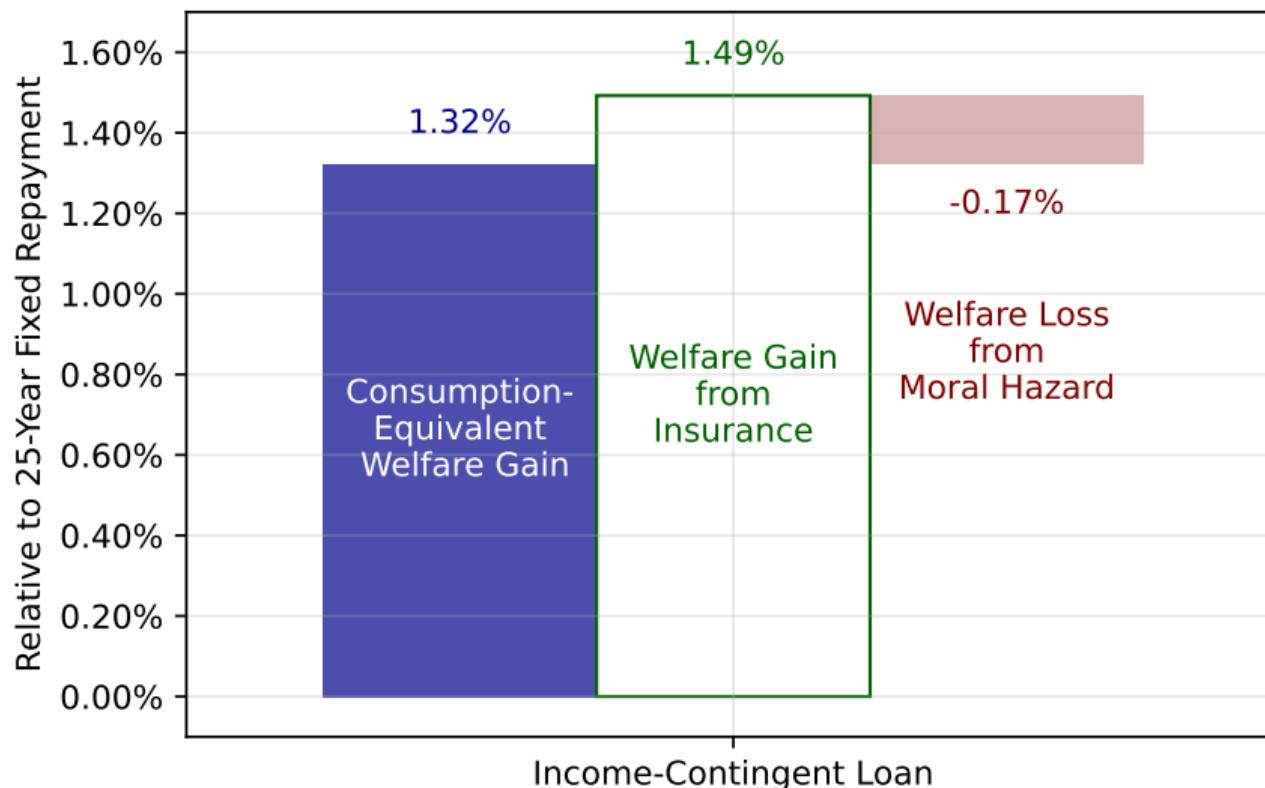
▶ Smooth

▶ vs. Existing

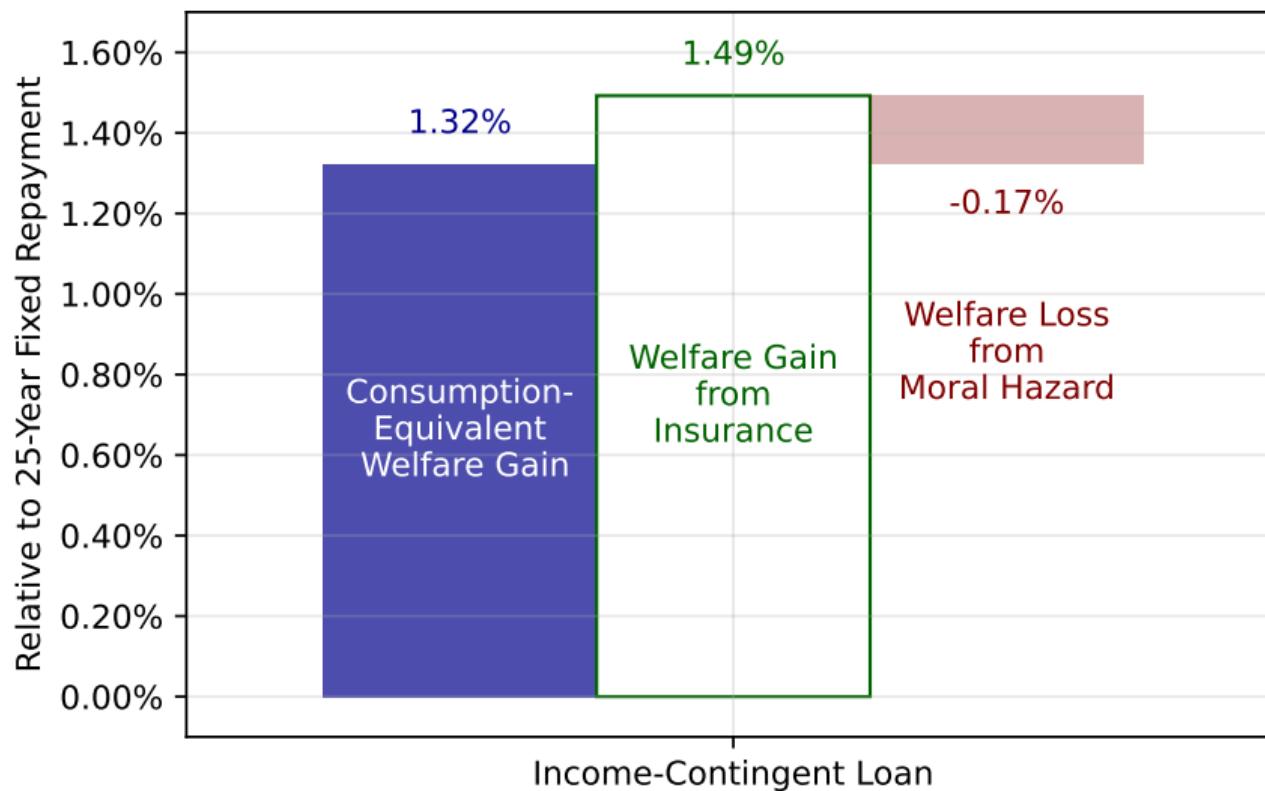
# CONSTRAINED-OPTIMUM = 1.3% INCREASE IN LIFETIME CONSUMPTION



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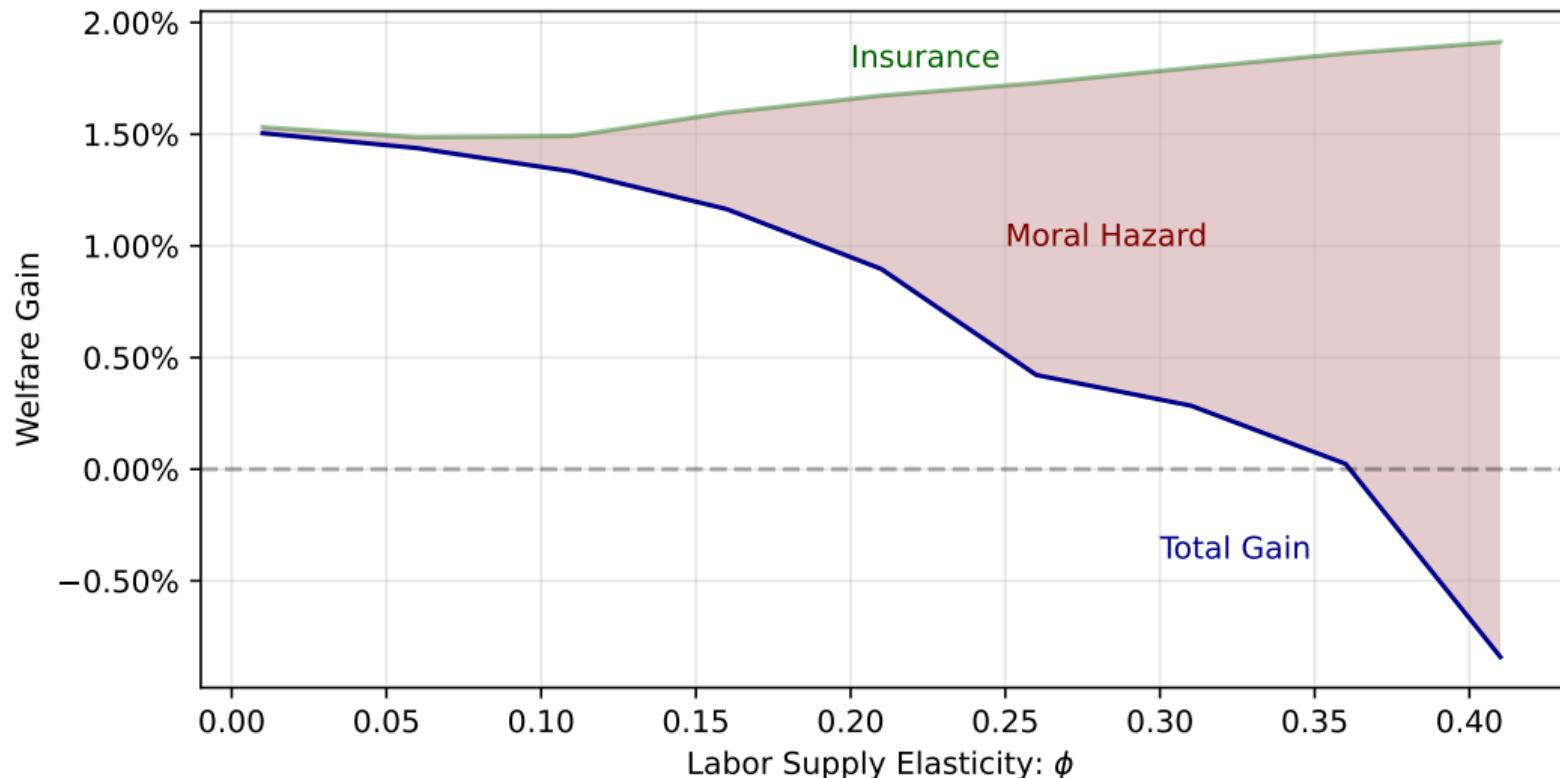


# CONSTRAINED-OPTIMUM = 1.3% INCREASE IN LIFETIME CONSUMPTION

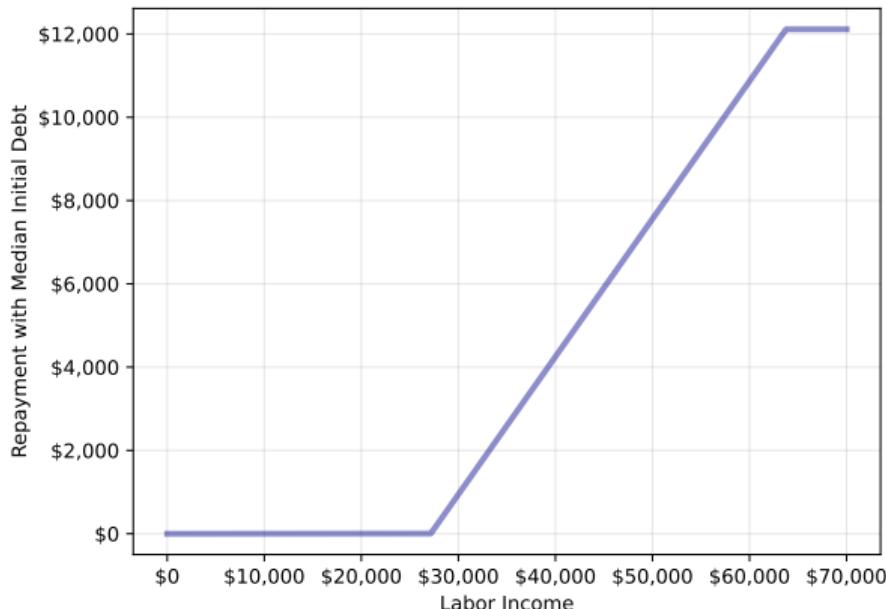
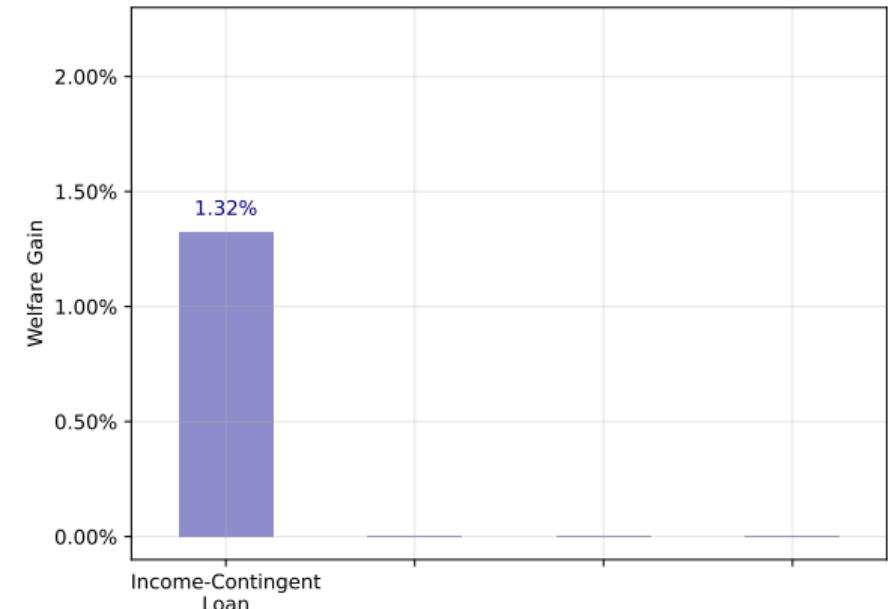


► Alt. Models   ► Distribution   ► Restrict  $\psi \leq 10\%$    ► Forgiveness

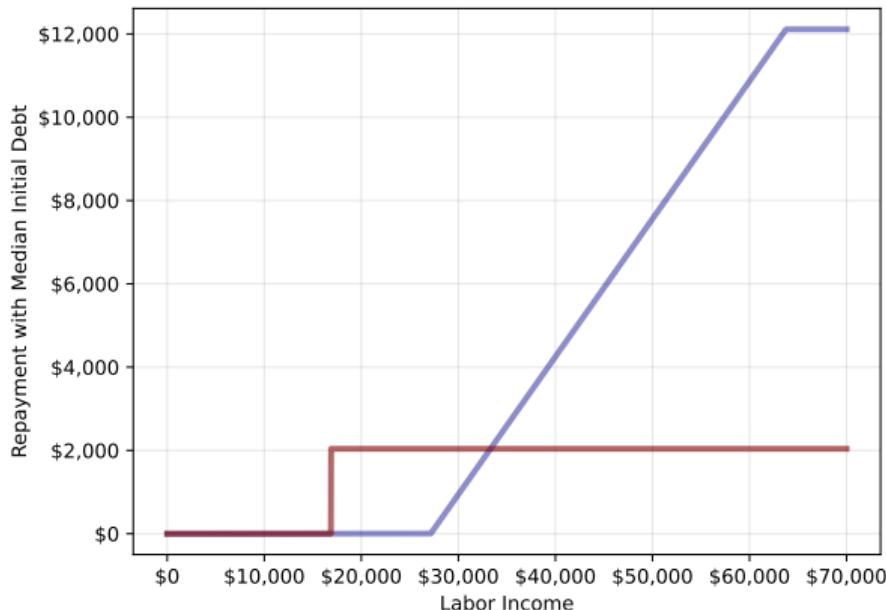
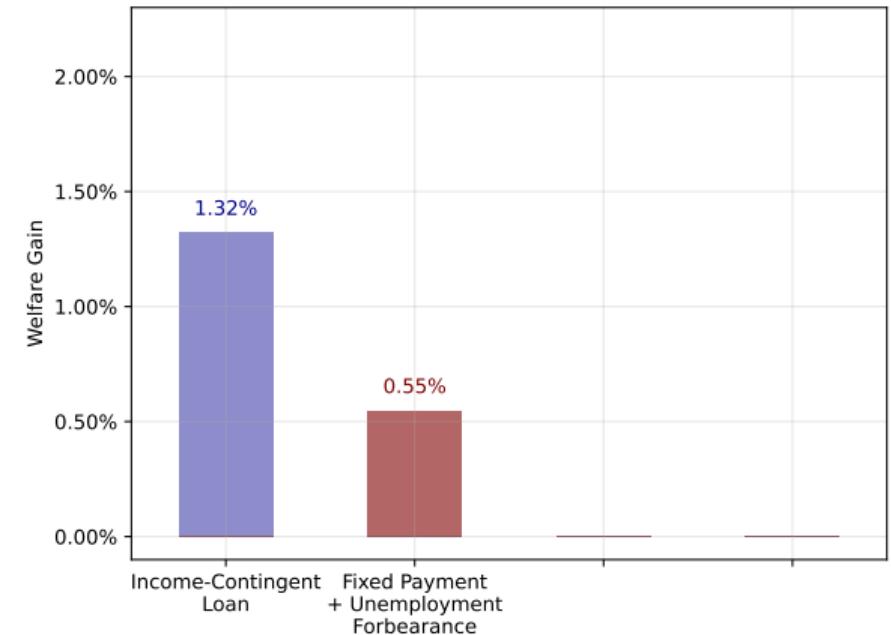
# WELFARE GAIN IS POSITIVE AS LONG AS $\phi < 0.37$



## NEXT: OTHER BUDGET-NEUTRAL CONTRACTS...

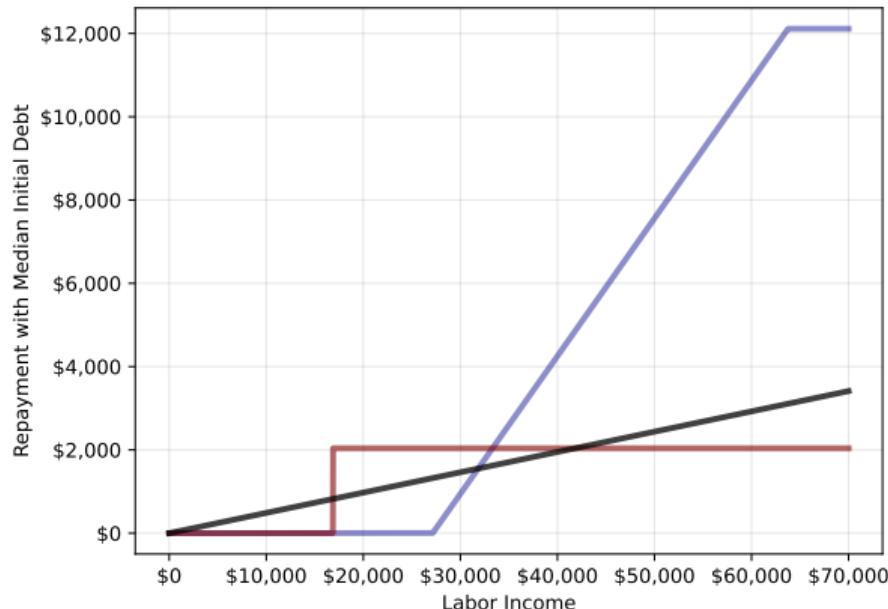
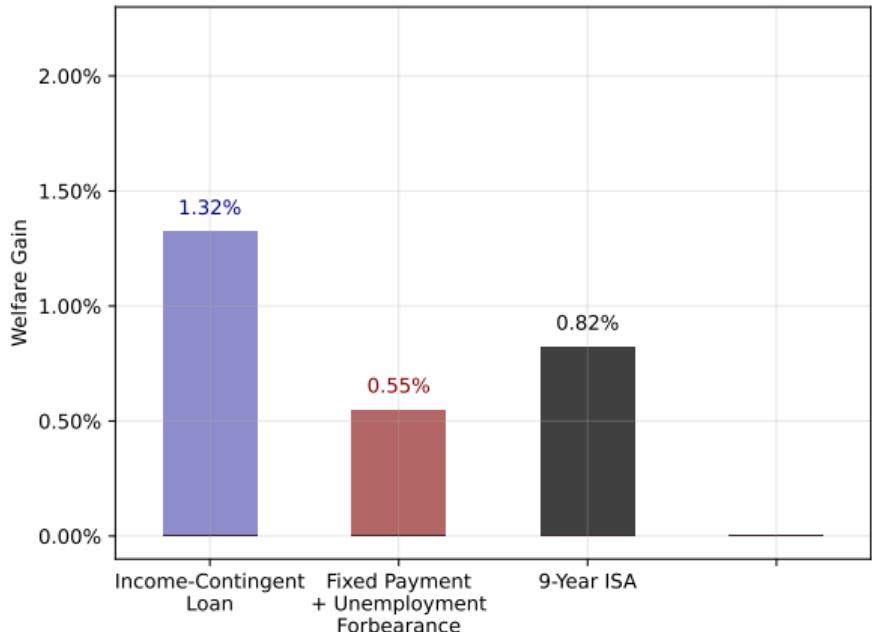


# JUST PROVIDING FORBEARANCE GIVES SMALLER GAINS



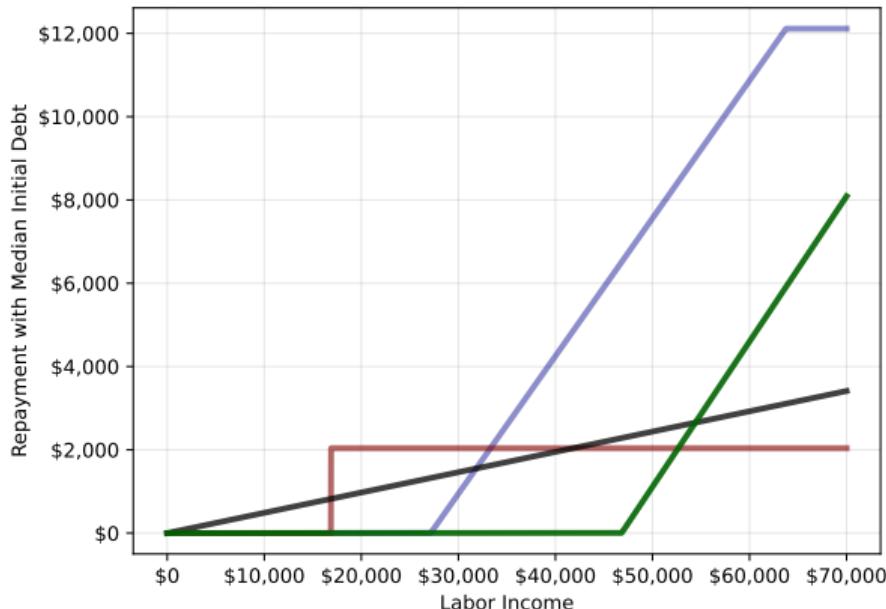
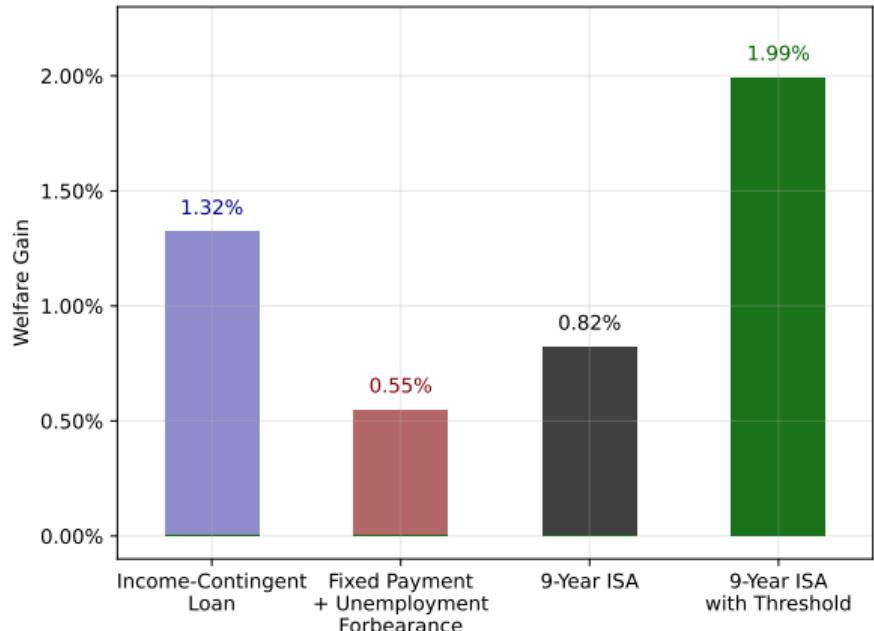
- **Benefit** of income-contingent loan: accelerate payments from high-income ► ICL+UI

# PURE EQUITY CONTRACT GIVES SMALLER GAINS



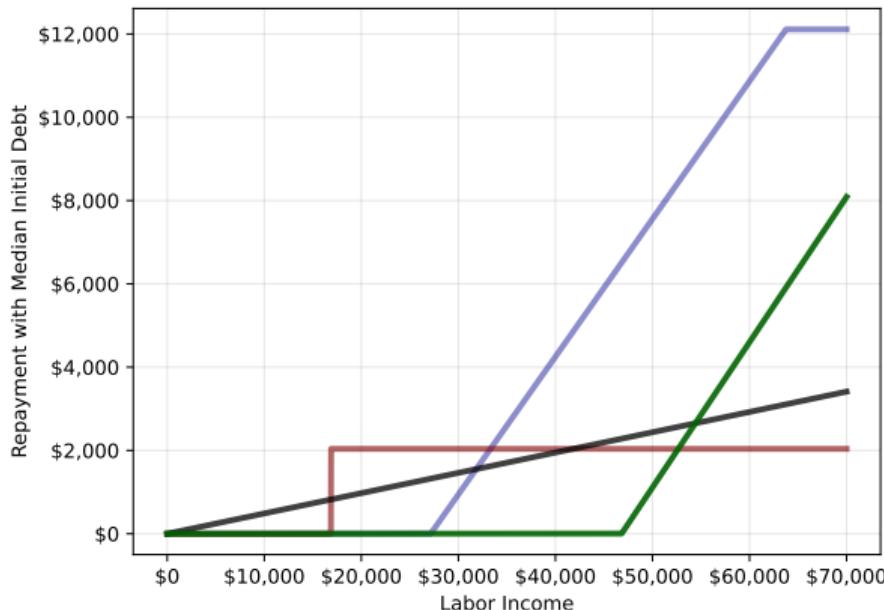
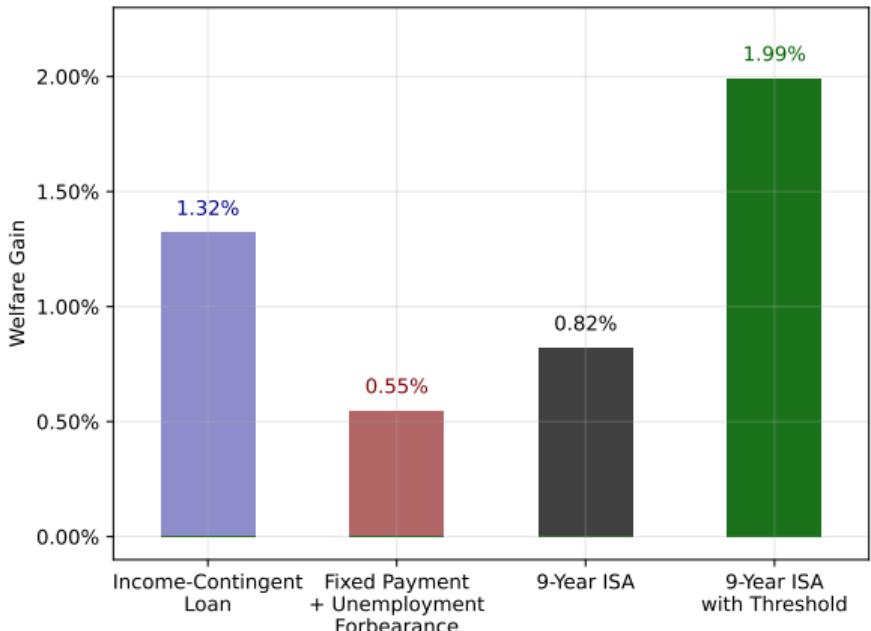
- Losses to transferring payments from (low-income) young → (high-income) old

# EQUITY + THRESHOLD GIVES LARGER GAINS



- **Benefit of ISA:** uncapped payments from high-income  $\Rightarrow$  70% higher threshold

# EQUITY + THRESHOLD GIVES LARGER GAINS, BUT MORE DISPERSED



- **Cost of ISA:** gains more dispersed  $\Rightarrow$  likely to cause **ex-ante** responses

Distribution

# OUTLINE

- 1 Institutional Background and Data
- 2 Labor Supply Responses to Income-Contingent Repayment
- 3 Life Cycle Model with Endogenous Labor Supply
- 4 Welfare and Fiscal Impacts of Income-Contingent Repayment
- 5 Conclusion

# SUMMARY OF RESULTS

## ① **Empirics:** borrowers adjust labor supply to ↓ income-contingent repayments

- Larger responses in occupations with more hourly flexibility
- Responses increase with debt balances and proxies for liquidity constraints

## ② **Structural estimation:** responses are small quantitatively

- Model replicates evidence with Frisch elasticity of **0.11** & adjustment frictions
- Important drivers of responses: liquidity constraints and dynamics

## ③ **Welfare:** gains to increasing insurance with income-contingent repayment

- Fixed repayment → optimal income-contingent loan  $\Rightarrow \uparrow$  **1.3%** lifetime consumption
- Moral hazard reduces optimal amount of insurance, but welfare cost small
- Forbearance + fixed repayment does worse because of slower repayment

# SUMMARY OF RESULTS

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**Takeaway:** Income-contingent repayment creates **moral hazard** that changes optimal contract, but **too small** to justify fixed repayment

- US “student debt crisis”: **25%** of borrowers default within 5 years of graduation
  - Possible solution = put borrowers on income-contingent repayment (e.g. SAVE)
- **This paper:**
  - ① Ex-post moral hazard not a reason to avoid income-contingent repayment
  - ② Empirical evidence + model to calibrate effects of different contracts
- **Remaining questions:**
  - ① Should income-contingent repayment be mandated to remove selection?
  - ② Effect of income-contingent repayment on borrowing?
- **Broader question:** Is state-contingent repayment useful for other liabilities?
  - HHs: government-provided shared-appreciation mortgages (UK, Canada)
  - Firms: revenue-based financing

# THANK YOU!

# APPENDIX

# START OF APPENDIX

# SUMMARY OF FINANCING OPTIONS TO POTENTIAL BORROWERS

## ① HECS-HELP

- Loans to students approved for CSP-place at public undergraduate institution
- Covers most undergraduate degrees

## ② FEE-HELP

- Loans to students at non-CSPs that are FEE-HELP approved
- Covers private undergraduate (uncommon) and post-graduate degrees

## ③ Private loans from universities or banks

- Common option for international students, not used by domestic students

## ④ Pay tuition in full up-front

- Around 10% of HELP-eligible students do this
- Mostly borrowers with family support (Norton 2018)

◀ Back

## VARIABLE DEFINITIONS

- HELP Income = Taxable Income + Fringe Benefits + Foreign Employment Income + Investment or Property Losses + Employer Super Contributions
- Labor Income = Salary/Wages + Allowances & Tips + Self-Employment Income
- Capital Income = Interest and Dividend Income + Annuity Income + Capital Gains + Rental Income + Managed Trust Income
- Net Deductions = Labor Income + Capital Income - HELP Income

◀ Back

# WORLDWIDE INTEREST IN INCOME-CONTINGENT REPAYMENT

## United States:

**Forbes**

PERSONAL FINANCE

## Student Loan Forgiveness: 'We're Going To Win' Says Top Democrat, As Poll Shows Broad Support For Debt Cancellation

**Student-loan payment plans that are based on income have failed borrowers — a new report revealed they're 'worse than we expected,' a top Democrat says**

April 6, 2022 2:05 PM

**npr**

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INVESTIGATIONS

### Exclusive: How the most affordable student loan program failed low-income borrowers

Updated April 1, 2022 · 9:28 AM ET  
Heard on Morning Edition

TOPICS PROJECTS FEATURES ABOUT GET INVOLVED SEARCH

**PEW**

## Redesigned Income-Driven Repayment Plans Could Help Struggling Student Loan Borrowers

Research indicates that policymakers should address enrollment, affordability, and balance growth

REPORT | February 8, 2022 | Read time: 63 min

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# WORLDWIDE INTEREST IN INCOME-CONTINGENT REPAYMENT

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**Students**

### Student loan changes in England will cost middle earners £30k, analysis says

IFS says from 2023, expected future earnings will be crucial in deciding whether to take gap year

**Richard Adams**  
*Education editor*

Sat 9 Apr 2022 00.34  
AEST

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## Australia:

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Australia Coronavirus World AU politics Environment Football Indigenous Australia Immigration Media E

**Australian education**

### Hecs debt repayment changes: why more people will be forced to pay off student loans

The income threshold for repaying university fees has dropped to just \$45,881. Here's what you need to know

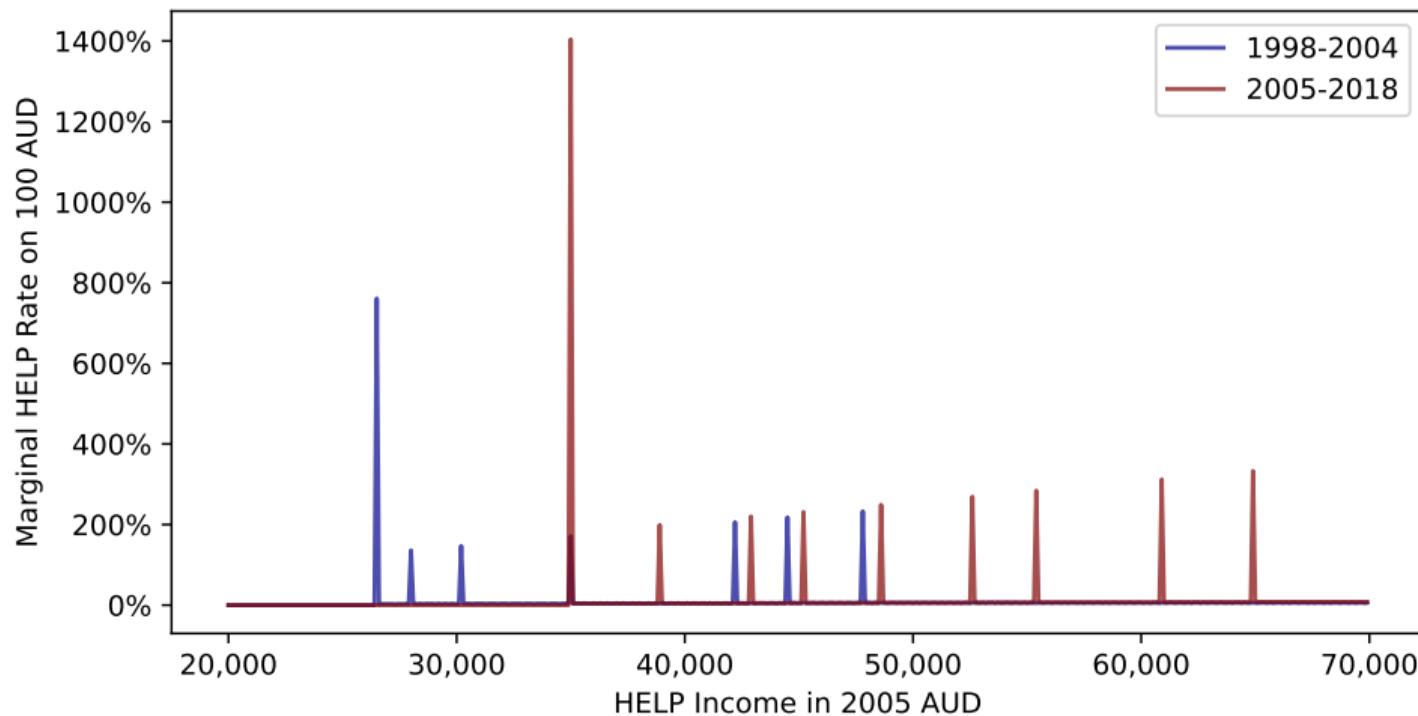
**Naaman Zhou**  
*@naamanzhou*  
Wed 3 Jul 2019 12.44  
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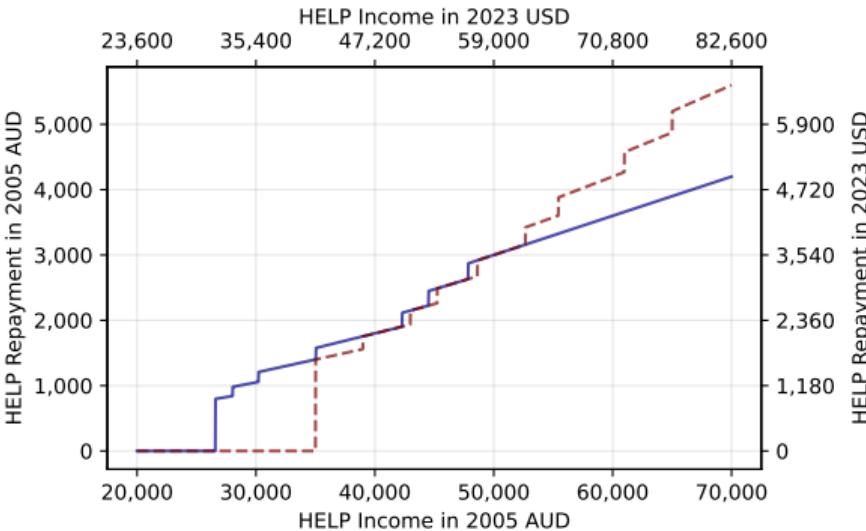
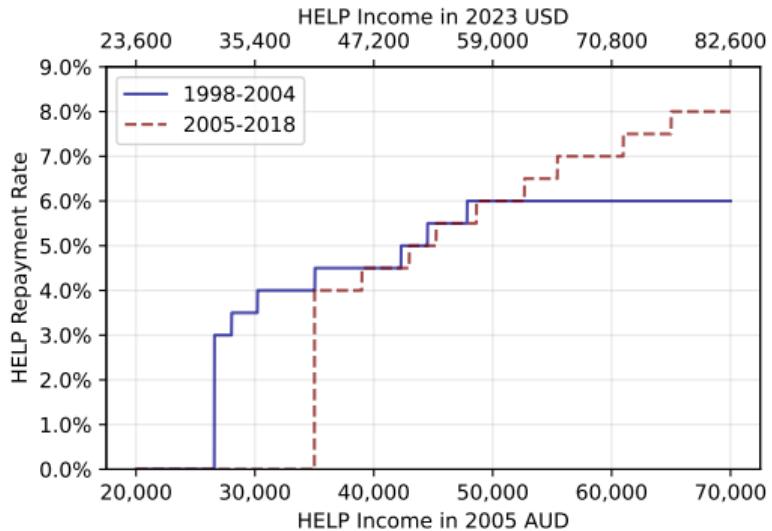
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# MARGINAL HELP REPAYMENT RATES ON 100 AUD



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# HELP REPAYMENT RATES AND REPAYMENTS



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## Ease HECS burden on students, say universities

Kate Marshall

Jan 9, 2003 - 11.00am



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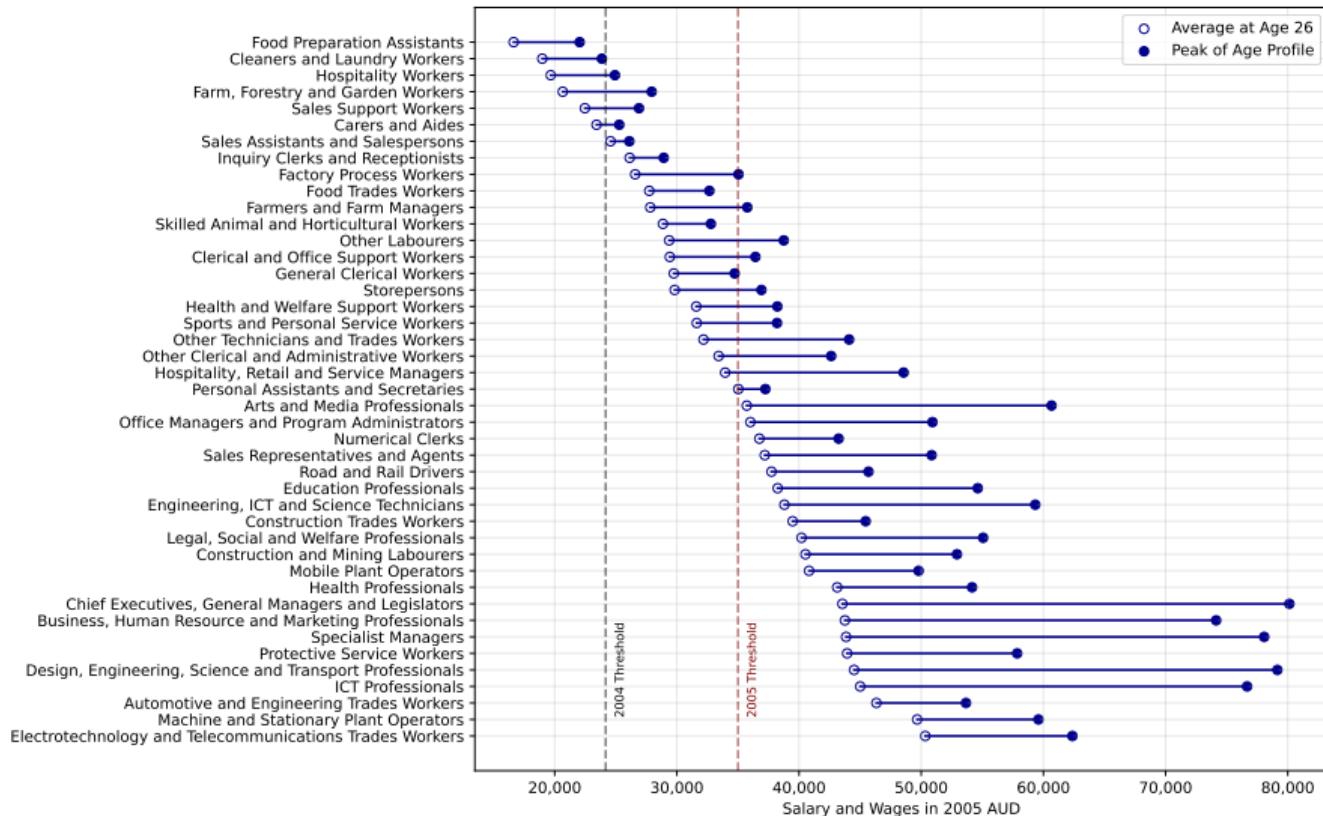


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Australian students owing more than \$9 billion of debts to the federal government should be spared financial heartache under a proposal to lift the income threshold for repayments, the Australian Vice-Chancellors Committee said yesterday.

◀ Back

# OCCUPATION-SPECIFIC INCOME PROFILES RELATIVE TO THRESHOLDS



◀ Back: Policy

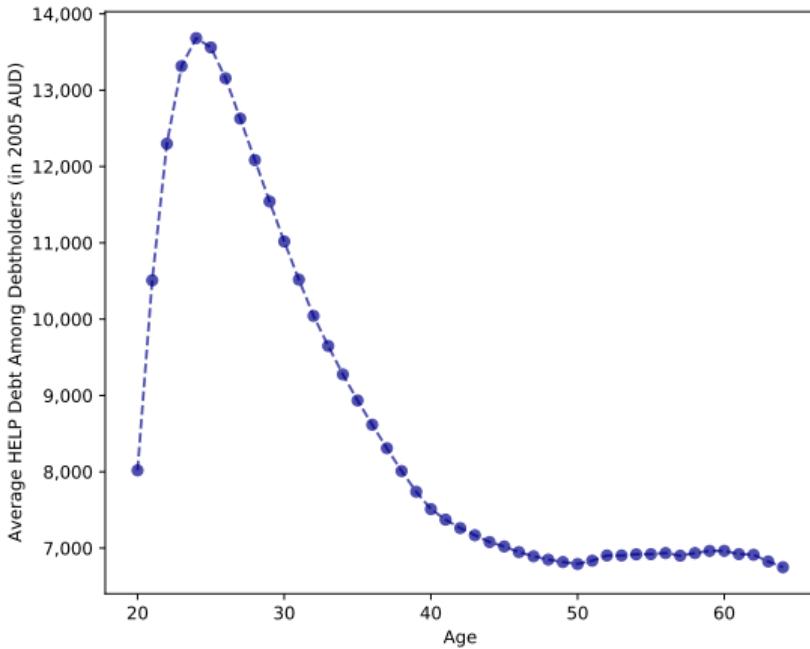
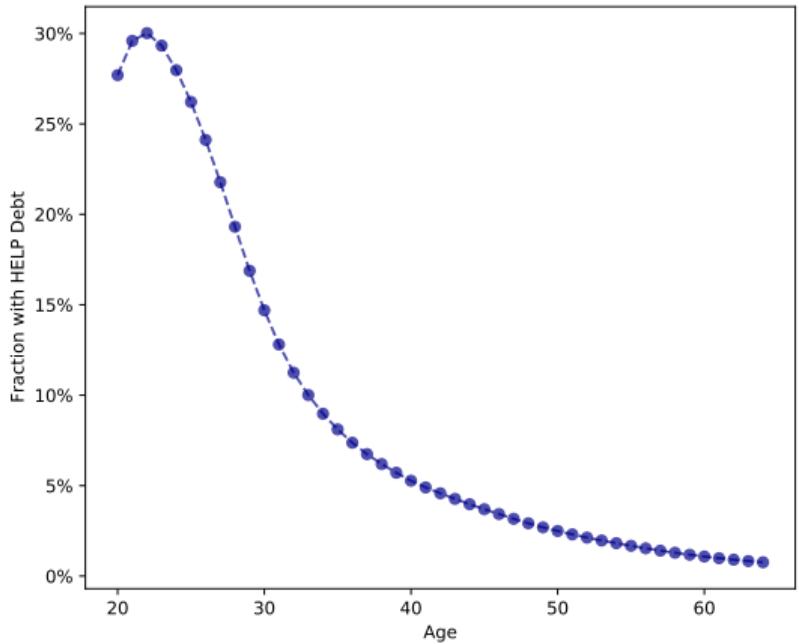
◀ Back: Hours

# SUMMARY STATISTICS

|                                 | Sample of Individuals  |                    |                                |
|---------------------------------|------------------------|--------------------|--------------------------------|
|                                 | Non-Debtholders<br>(1) | Debtholders<br>(2) | 26-Year-Old Debtholders<br>(3) |
|                                 |                        |                    |                                |
| <b>Demographics</b>             |                        |                    |                                |
| Age                             | 41.1                   | 29.5               | 26                             |
| Female                          | 0.46                   | 0.60               | 0.57                           |
| Wage-Earner                     | 0.85                   | 0.91               | 0.93                           |
| <b>Income Totals</b>            |                        |                    |                                |
| Taxable Income                  | 37,695                 | 27,796             | 32,929                         |
| HELP Income                     | 38,756                 | 28,586             | 33,721                         |
| <b>Income Components</b>        |                        |                    |                                |
| Salary & Wages                  | 32,415                 | 26,068             | 32,091                         |
| Labor Income                    | 35,480                 | 27,136             | 32,999                         |
| Interest & Dividend Income      | 726                    | 242                | 224                            |
| Capital Income                  | 1,221                  | 324                | 184                            |
| Net Deductions                  | -1,548                 | -1,099             | -554                           |
| <b>HELP Variables</b>           |                        |                    |                                |
| HELP Debt                       | .                      | 10,830             | 13,156                         |
| HELP Payment                    | .                      | 991                | 1,305                          |
| HELP Income < 2004 0% Threshold | 0.50                   | 0.65               | 0.51                           |
| HELP Income < 2005 0% Threshold | 0.37                   | 0.51               | 0.35                           |
| HELP Income < 2006 0% Threshold | 0.52                   | 0.67               | 0.55                           |
| Number of Observations          | 247,118,713            | 27,316,037         | 1,701,464                      |

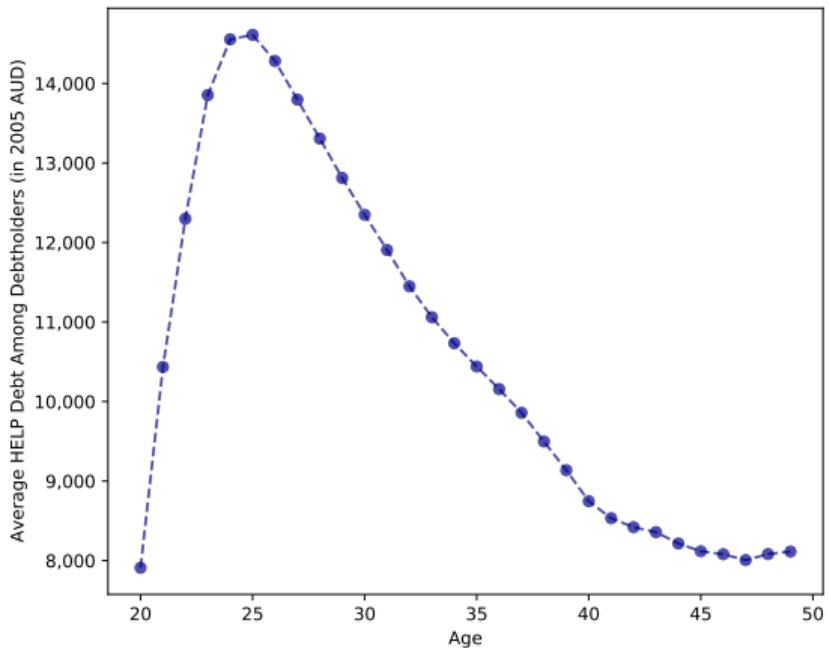
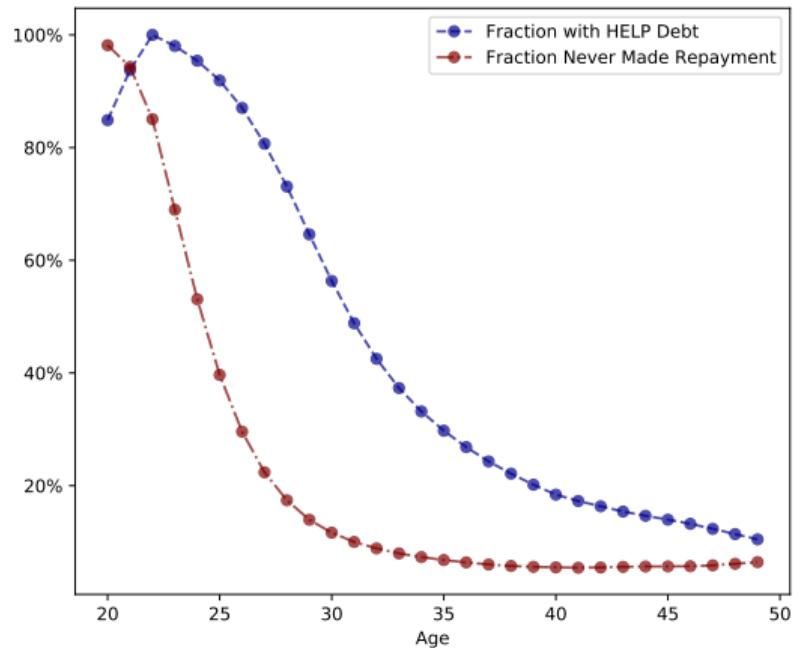
◀ Back

# DEBT BALANCES BY AGE



◀ Back

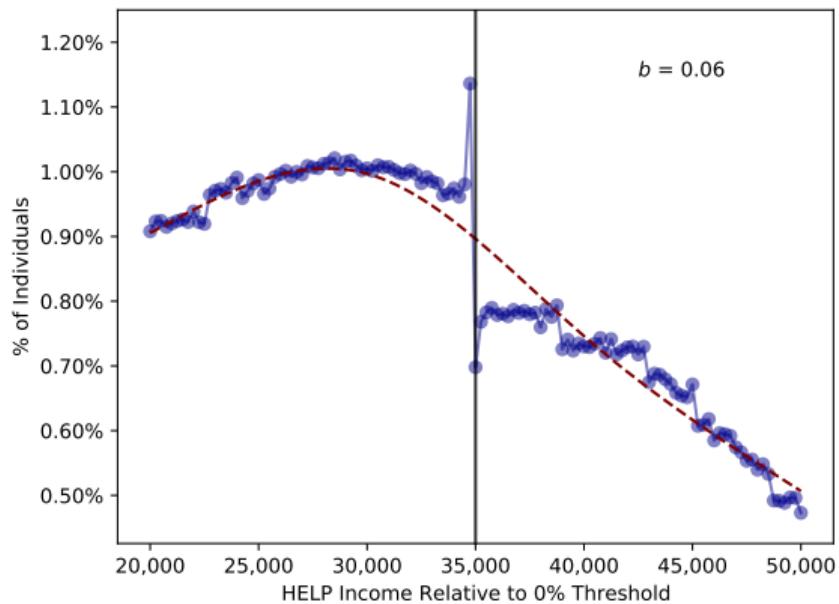
# DEBT BALANCES BY AGE: INDIVIDUALS WITH POSITIVE DEBT AT AGE 22



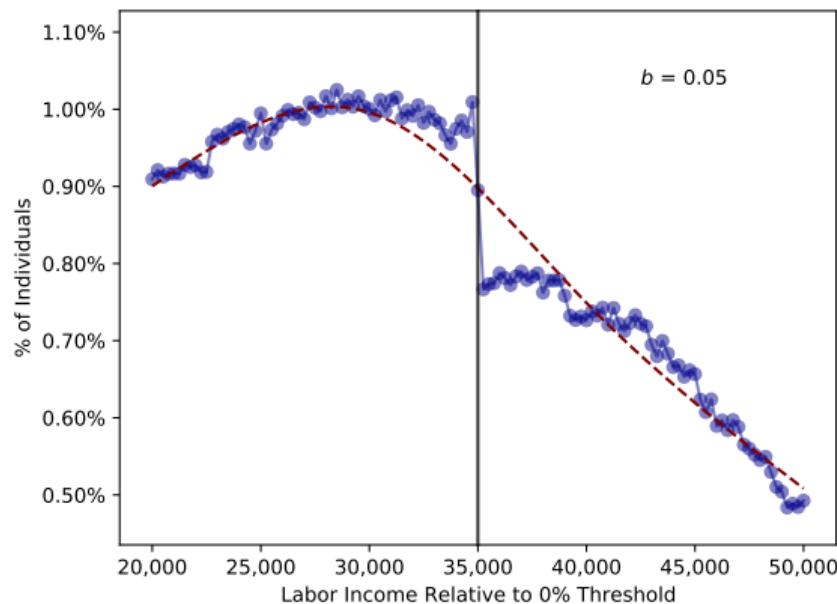
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# 83% OF BUNCHING IN HELP INCOME PRESENT IN LABOR INCOME

## HELP Income

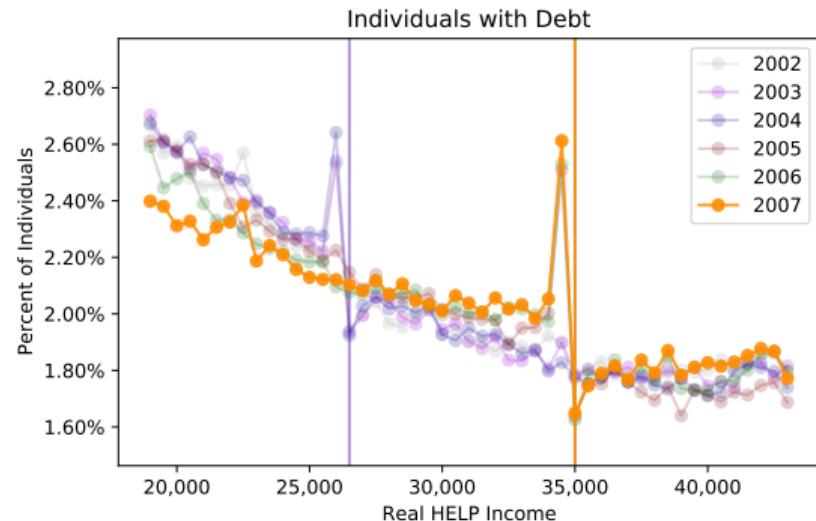
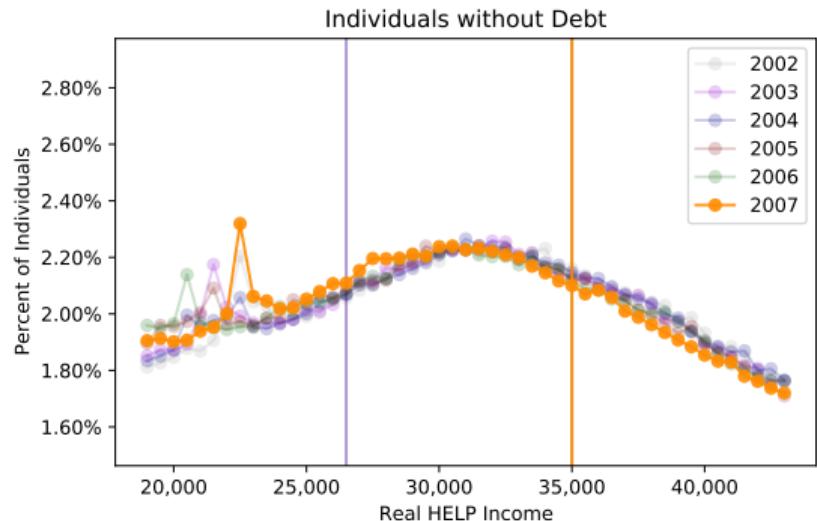


## Labor Income



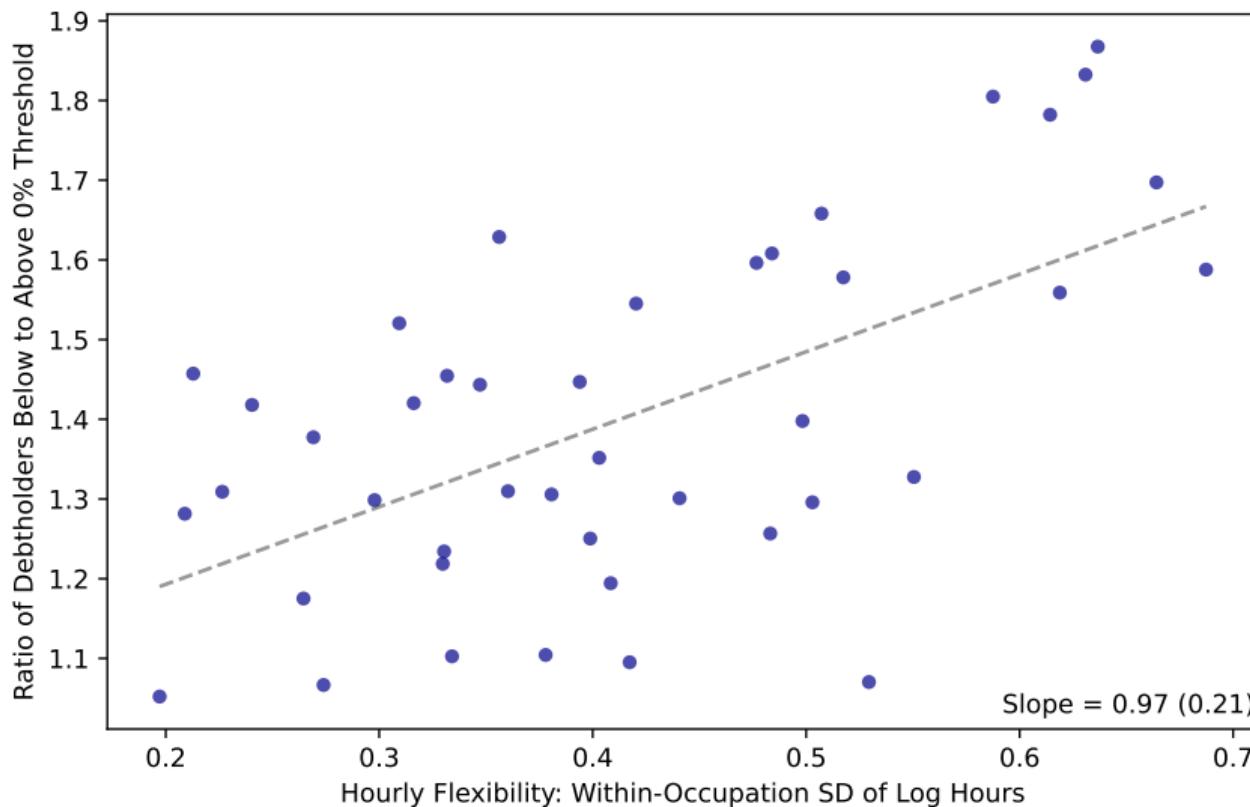
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# No BUNCHING AT REPAYMENT THRESHOLD FOR NON-DEBTHOLDERS



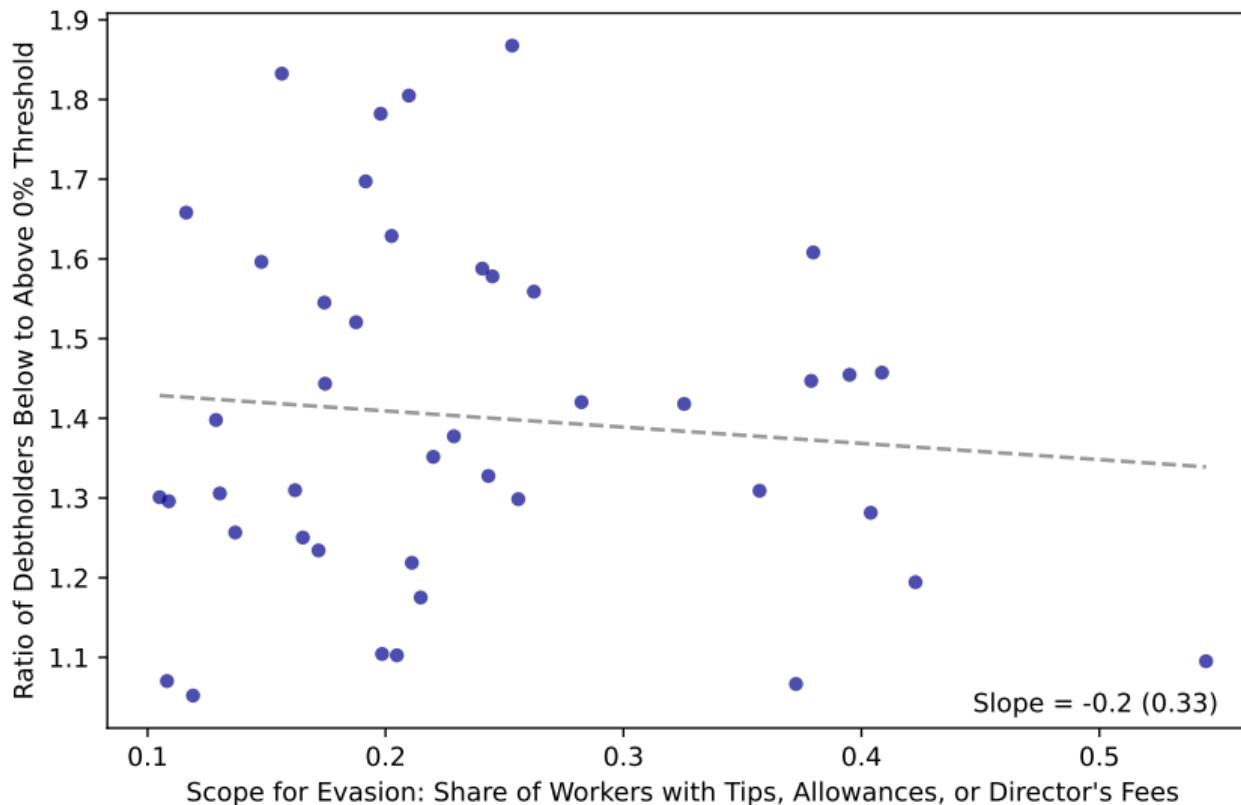
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# ALTERNATIVE MEASURE OF HOURLY FLEXIBILITY



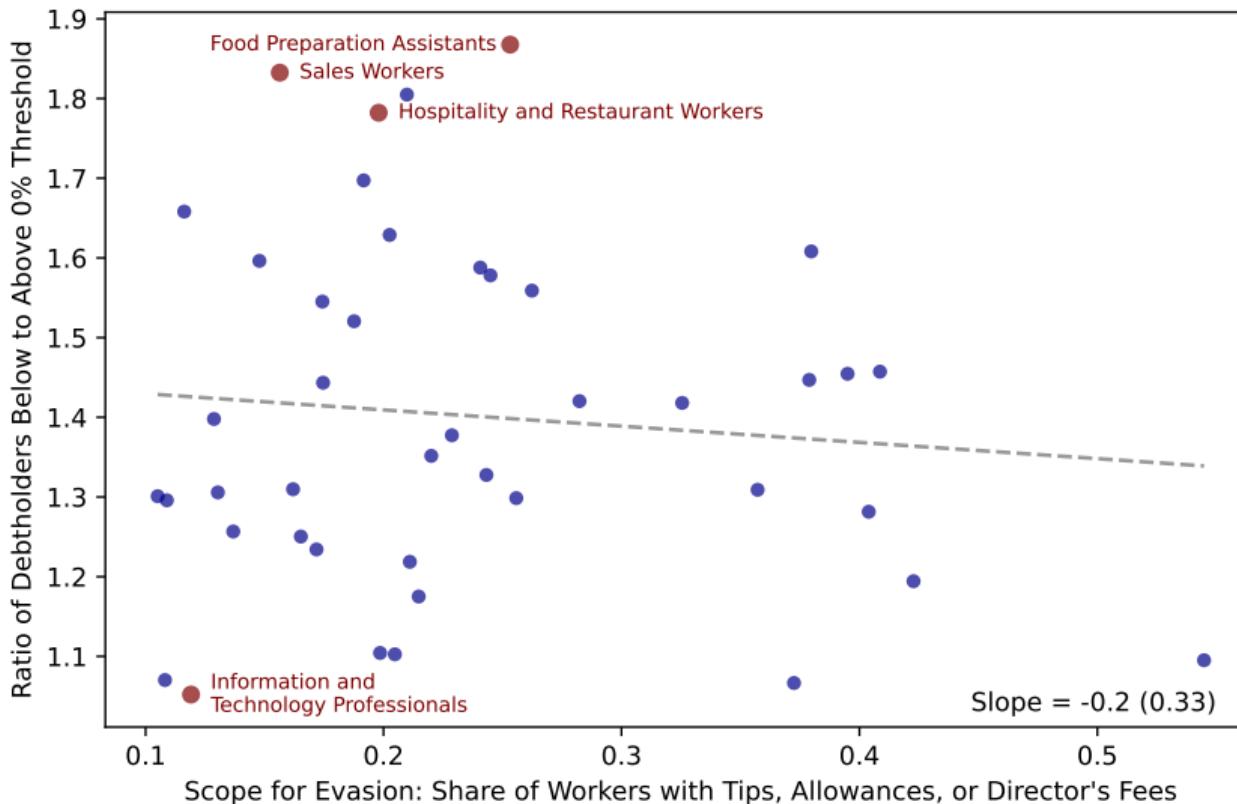
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# BUNCHING UNCORRELATED WITH MEASURE OF EVASION



◀ Back

## BUNCHING UNCORRELATED WITH MEASURE OF EVASION



 Back

# OCCUPATION-LEVEL REGRESSIONS

|   | Ratio of Debtholders Below to Above Threshold |                 |                 |                 |                 |                 |                 |
|---|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
|   | (1)   | (2)             | (3)             | (4)             | (5)             | (6)             | (7)             |
| Hourly Flexibility: SD of Changes in Log Hours  | 1.30<br>(0.35)                                | .               | .               | .               | 1.30<br>(0.35)  | 1.05<br>(0.28)  | 0.50<br>(0.23)  |
| Evasion: Share with Non-Wage Income             | .   | -0.20<br>(0.30) | .               | .               | -0.02<br>(0.30) | -0.17<br>(0.30) | 0.05<br>(0.25)  |
| Income Slope: Mean Wage at 45 / Mean Wage at 26 | .   | .               | -0.53<br>(0.10) | .               | .               | -0.40<br>(0.12) | .               |
| Income Peak: Maximum Wage in Occupation Profile | .   | .               | .               | -0.48<br>(0.06) | .               | .               | -0.40<br>(0.07) |
| <i>R</i> <sup>2</sup>                           | 0.34  | 0.01            | 0.23            | 0.58            | 0.34            | 0.46            | 0.62            |
| Number of Occupations                           | 43  | 43              | 43              | 43              | 43              | 43              | 43              |

◀ Back: Hours

◀ Back: Summary

## COMPUTATION OF BUNCHING STATISTIC

- Bunching statistic calculated as in prior literature (Chetty et al. 2011, Kleven-Waseem 2013)

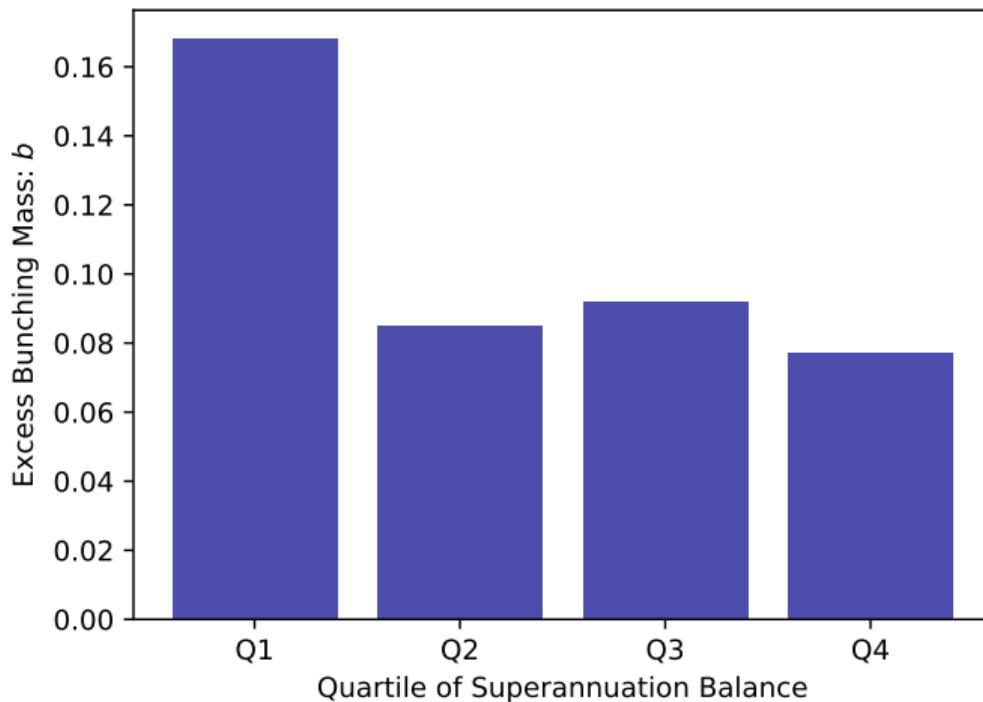
- ① Fit 5-piece spline leaving out  $[\$32,500, \$35,000 + X]$  ⇒ **counterfactual density**
- ② Iterate and choose  $X$  so that counterfactual density integrates to 1
- ③

$$b = \frac{\text{observed mass in } [\$32,500, \$35,000]}{\text{counterfactual mass in } [\$32,500, \$35,000]} - 1$$

- $b = 0.1 \Rightarrow 10\%$  more people below threshold than would be absent discontinuity
  - Note: normalization makes  $b$  comparable across distributions of different shapes
- **Sample:** All debtholders age 20 to 64 pooled across 2005 to 2018
  - Income deflated to 2005 so 0% threshold constant in real terms at **\$35,000**

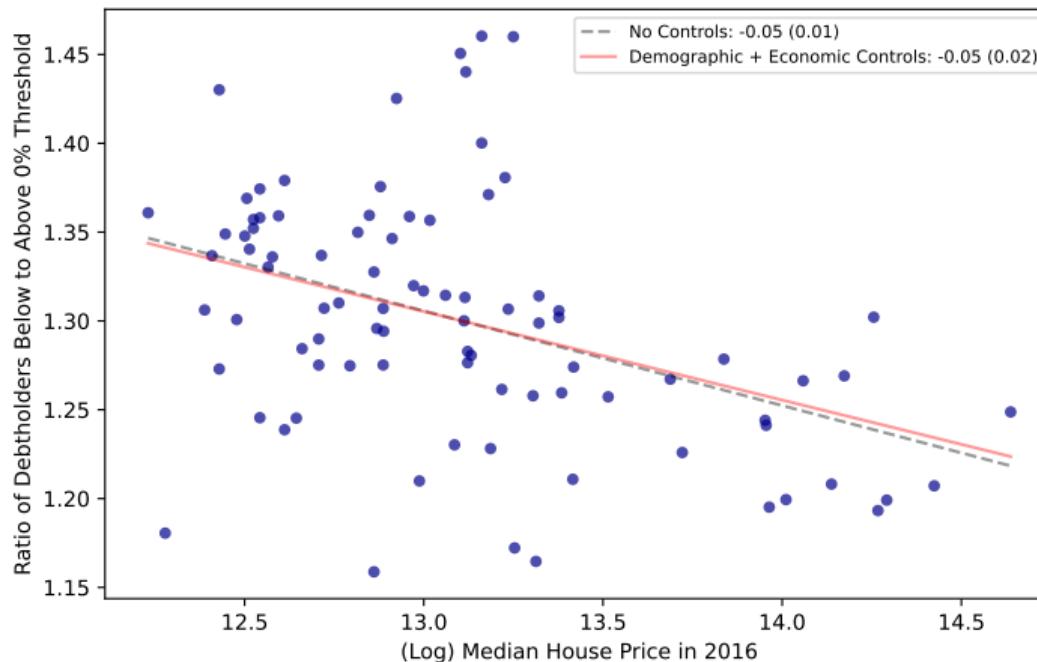
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# BUNCHING HETEROGENEITY BY SUPER WEALTH: AGES 20-29



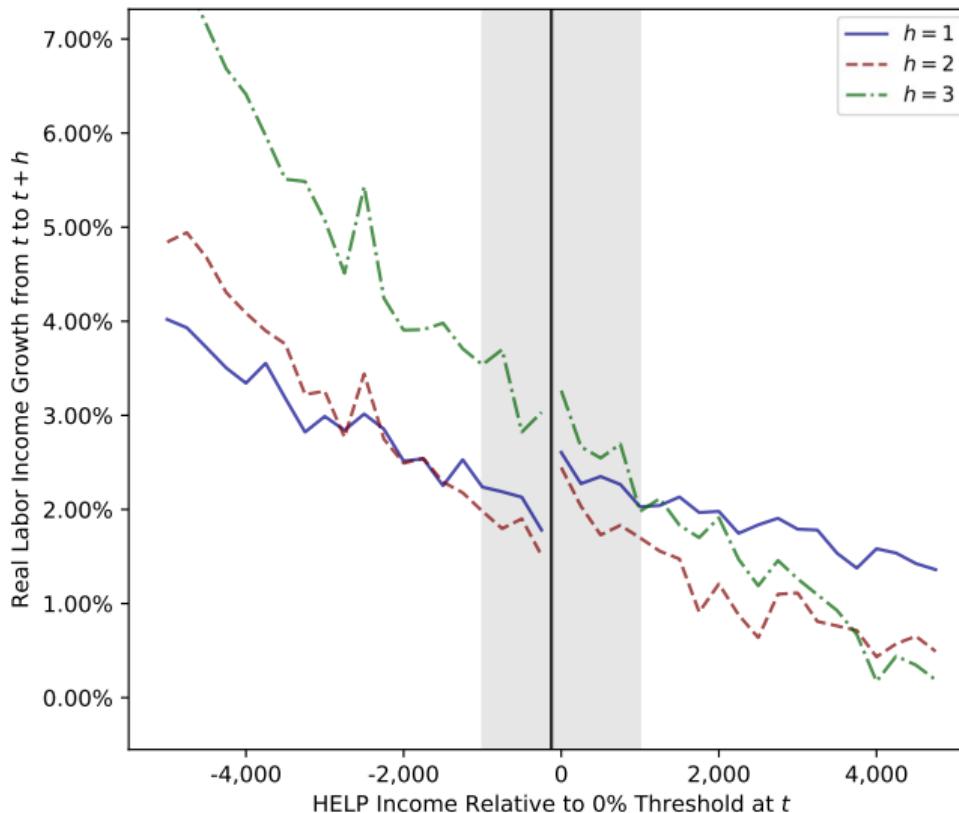
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# LESS BUNCHING IN REGIONS WITH MORE HOUSING WEALTH



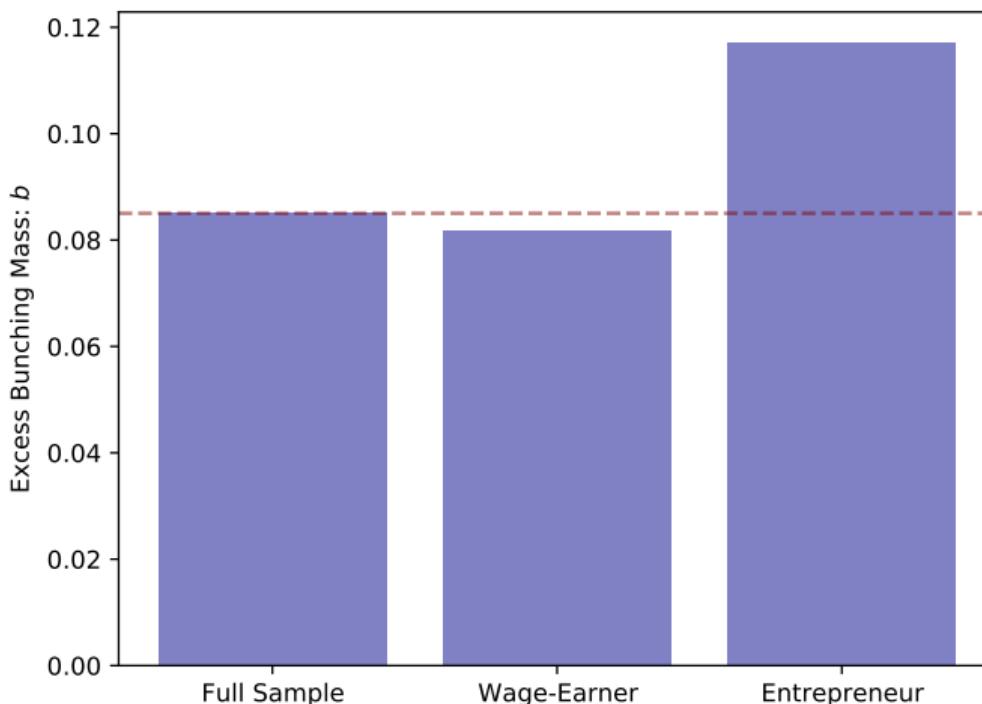
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# LIMITED EVIDENCE OF DYNAMIC COST TO BUNCHING



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# BUNCHING AMONG WAGE-EARNERS VS. ENTREPRENEURS



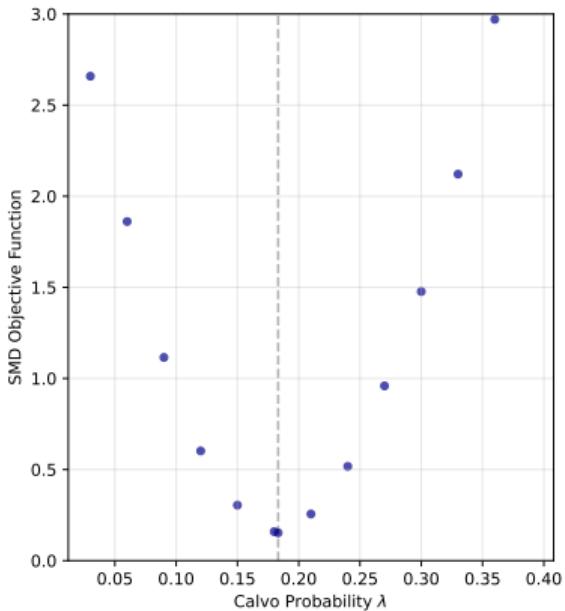
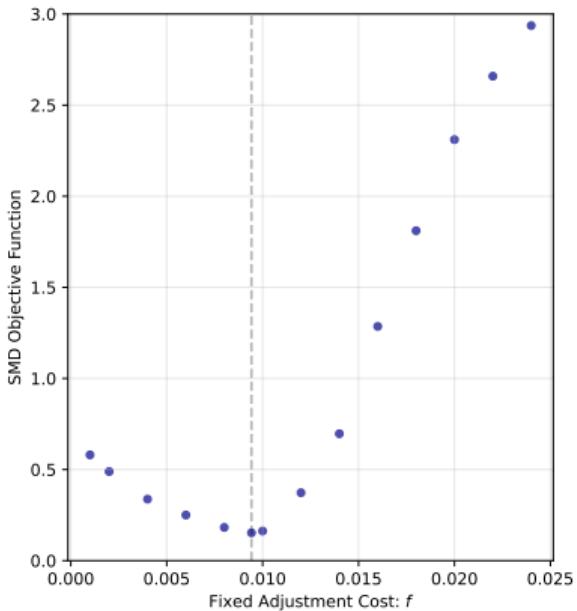
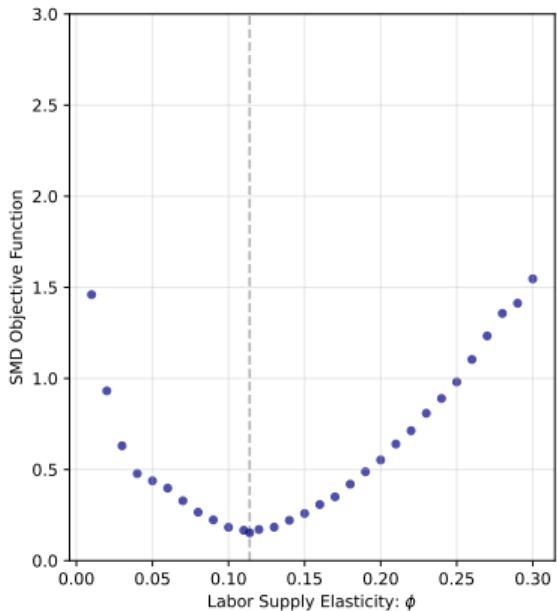
Note: Entrepreneur defined as having positive sole trader, partnership, or personal services income

## ELASTICITY OF MOMENTS WITH RESPECT TO PARAMETERS

|                           | $\phi$ | $f$   | $\lambda$ |
|---------------------------|--------|-------|-----------|
| Mass Below 2004 Threshold | 0.08   | -0.16 | 0.21      |
| Mass Above 2004 Threshold | -0.03  | 0.09  | -0.13     |
| Mass Below 2005 Threshold | 0.12   | -0.16 | 0.28      |
| Mass Above 2005 Threshold | -0.04  | 0.09  | -0.19     |
| Ratio 2005 0%             | 0.22   | -0.34 | 0.64      |
| Ratio 2005 0.5%           | 0.13   | -0.12 | 0.16      |
| Ratio 2005 0%, Q1 Debt    | 0.22   | -0.34 | 0.37      |
| Ratio 2005 0%, Q4 Debt    | 0.20   | -0.33 | 0.82      |

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# SMM OBJECTIVE IS SMOOTH IN LABOR SUPPLY PARAMETERS



◀ Back

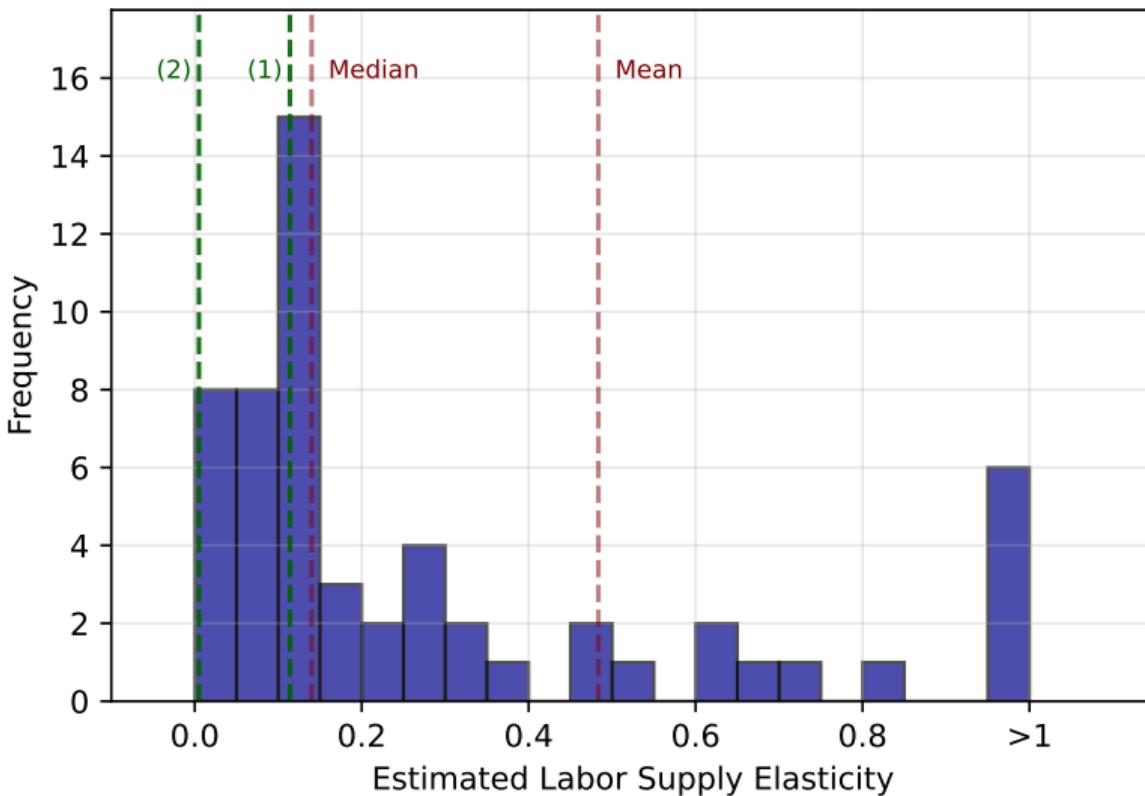
## SECOND-STAGE SIMULATED MINIMUM DISTANCE: OTHER MOMENTS

$$\text{Parameters} = \left( \underbrace{\phi \ f \ \lambda \ \kappa \ \beta}_{\text{preferences}} \quad \underbrace{\delta_0 \ \delta_1 \ \delta_2 \ \delta_0^E \ \delta_1^E}_{\text{wage profile}} \quad \underbrace{\rho \ \sigma_\nu \ \sigma_\epsilon \ \sigma_i}_{\text{wage risk}} \right)$$

- Age profiles of salary & wages  $\Rightarrow$  wage profile parameters
- Moments in Guvenen et al. 2022  $\Rightarrow$  wage risk parameters
- Average capital income at ages 40-44  $\Rightarrow$   $\beta$
- Average labor supply  $\Rightarrow$   $\kappa$

◀ Back

# COMPARISON OF ESTIMATED ELASTICITY WITH EXISTING LITERATURE



Source: intensive-margin Hicks and Frisch elasticities in Keane (2011) and Chetty (2012)

◀ Back

# COMPARISON WITH EXISTING LITERATURE ON LABOR SUPPLY

## Reasons why elasticity may be smaller:

- ① Different **sample** of college graduates: less flexibility and further from  $y = wL$
- ② Elasticity is **local** to threshold: no high-income individuals Gruber-Saez 2002
- ③ No **extensive** margin responses, which are likely smaller for this group

## Contributions:

- ① **Empirical** characterization of responses to income-contingent repayment
  - Labor supply responds to liquidity not wealth, like consumption Ganong-Noel 2020
- ② **Dynamic** model of labor supply with time- and state-dependent adjustment

◀ Back

# FULL ESTIMATION RESULTS

| Parameter                              |                   | Estimation       |                  |                  |                  |                  |                  |
|--|-------------------|------------------|------------------|------------------|------------------|------------------|------------------|
|  |                   | (1)              | (2)              | (3)              | (4)              | (5)              | (6)              |
| Labor supply elasticity                | $\phi$            | 0.114<br>(.004)  | 0.005<br>(.000)  | 0.188<br>(.003)  | 0.053<br>(.002)  | 0.082<br>(.002)  | 0.111<br>(.004)  |
| Adjustment cost parameter              | $f$               | \$377<br>(\$13)  | \$0<br>. .       | \$2278<br>(\$21) | \$0<br>. .       | \$762<br>(\$10)  | \$513<br>(\$19)  |
| Calvo parameter                        | $\lambda$         | 0.183<br>(.003)  | 1<br>. .         | 1<br>. .         | 0.147<br>(.002)  | 0.346<br>(.009)  | 0.191<br>(.003)  |
| Labor supply scaling parameter         | $\kappa$          | 0.560<br>(.007)  | 0.030<br>(.003)  | 0.059<br>(.014)  | 0.510<br>(.012)  | 1.242<br>(.116)  | 0.593<br>(.001)  |
| Time discount factor                   | $\beta$           | 0.973<br>(.001)  | 0.996<br>(.000)  | 0.972<br>(.001)  | 0.944<br>(.001)  | 0.951<br>(.001)  | 0.951<br>(.001)  |
| Wage profile parameters                | $\delta_0$        | 8.922<br>(.009)  | 9.862<br>(.002)  | 8.680<br>(.006)  | 9.389<br>(.007)  | 9.197<br>(.007)  | 9.143<br>(.008)  |
|  | $\delta_1$        | 0.073<br>(.000)  | 0.111<br>(.000)  | 0.073<br>(.000)  | 0.063<br>(.000)  | 0.070<br>(.000)  | 0.075<br>(.000)  |
|  | $\delta_2$        | -0.001<br>(.000) | -0.002<br>(.000) | -0.001<br>(.000) | -0.001<br>(.000) | -0.001<br>(.000) | -0.001<br>(.000) |
|  | $\delta_0^E$      | -0.487<br>(.002) | -0.294<br>(.000) | -0.450<br>(.001) | -0.530<br>(.002) | -0.480<br>(.002) | -0.478<br>(.002) |
|  | $\delta_1^E$      | 0.020<br>(.000)  | 0.032<br>(.000)  | 0.018<br>(.000)  | 0.021<br>(.000)  | 0.018<br>(.000)  | 0.020<br>(.000)  |
| Persistence of permanent shock         | $\rho$            | 0.930<br>(.000)  | 0.914<br>(.000)  | 0.943<br>(.000)  | 0.922<br>(.000)  | 0.889<br>(.000)  | 0.907<br>(.001)  |
| Standard deviation of permanent shock  | $\sigma_\nu$      | 0.236<br>(.000)  | 0.076<br>(.000)  | 0.196<br>(.000)  | 0.268<br>(.000)  | 0.288<br>(.000)  | 0.275<br>(.001)  |
| Standard deviation of transitory shock | $\sigma_\epsilon$ | 0.130<br>(.000)  | 0.504<br>(.000)  | 0.168<br>(.000)  | 0.077<br>(.002)  | 0.064<br>(.002)  | 0.080<br>(.002)  |
| Standard deviation of individual FE    | $\sigma_i$        | 0.599<br>(.003)  | 0.101<br>(.001)  | 0.541<br>(.003)  | 0.654<br>(.003)  | 0.625<br>(.003)  | 0.612<br>(.003)  |
| Learning-by-doing parameter            | $\alpha$          | 0<br>Fixed       | 0<br>Fixed       | 0<br>Fixed       | 0<br>Fixed       | 0.24<br>Fixed    | 0<br>Linear      |
| Adjustment cost function               |                   |                  |                  |                  |                  |                  |                  |

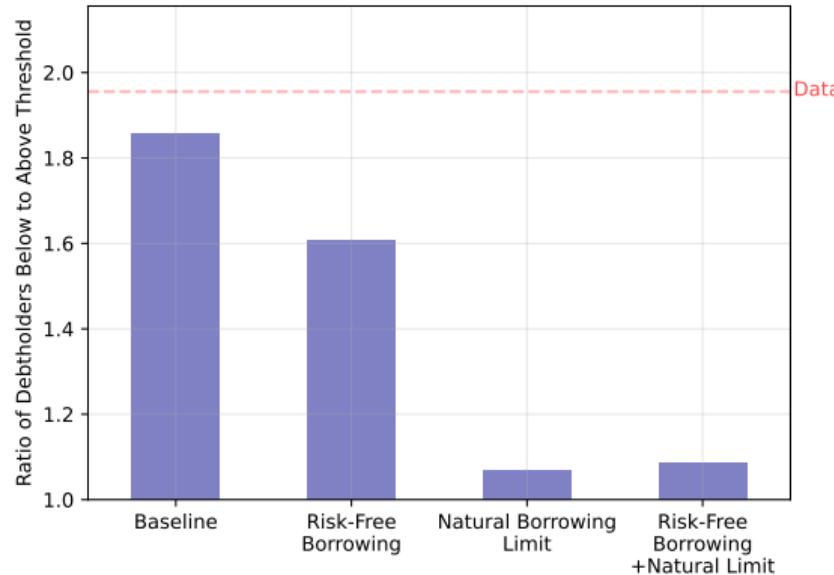
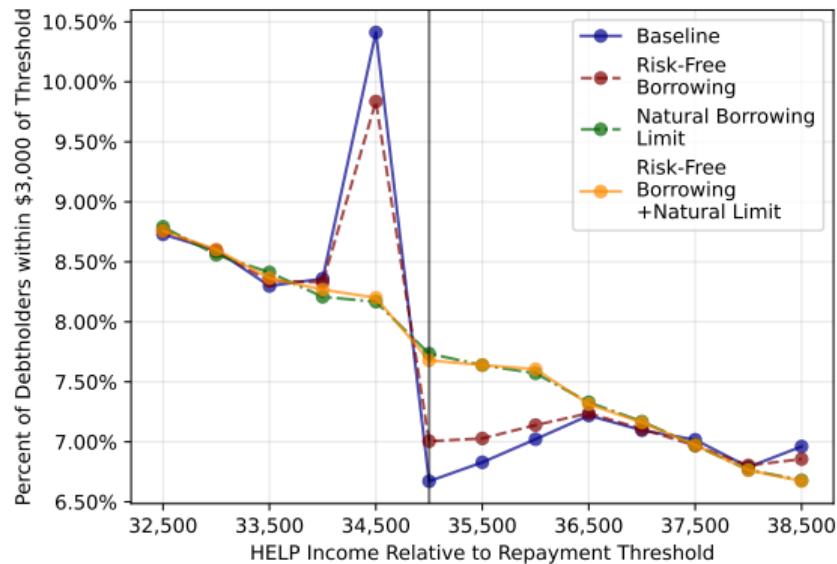
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## MODEL FIT: OTHER TARGET MOMENTS

| Estimation Target                                      | Data      | Model     |
|--|-----------|-----------|
| Average Labor Income                                   | 42639.373 | 45581.953 |
| Cross-Sectional Variance of Log Labor Income at Age 22 | 0.453     | 0.462     |
| Cross-Sectional Variance of Log Labor Income at Age 32 | 0.555     | 0.491     |
| Cross-Sectional Variance of Log Labor Income at Age 42 | 0.577     | 0.525     |
| Cross-Sectional Variance of Log Labor Income at Age 52 | 0.539     | 0.580     |
| Cross-Sectional Variance of Log Labor Income at Age 62 | 0.608     | 0.657     |
| Linear Age Profile Term                                | 0.077     | 0.080     |
| Quadratic Age Profile Term                             | -0.001    | -0.001    |
| Education Income Premium Constant                      | -0.574    | -0.554    |
| Education Income Premium Slope                         | 0.023     | 0.023     |
| 10th Percentile of 1-Year Labor Income Growth          | -0.387    | -0.392    |
| 10th Percentile of 5-Year Labor Income Growth          | -0.667    | -0.705    |
| 90th Percentile of 1-Year Labor Income Growth          | 0.415     | 0.393     |
| 90th Percentile of 5-Year Labor Income Growth          | 0.698     | 0.710     |
| Average Labor Supply                                   | 1.000     | 0.963     |
| Average Capital Income between Ages 40 and 44          | 1338.846  | 1332.459  |

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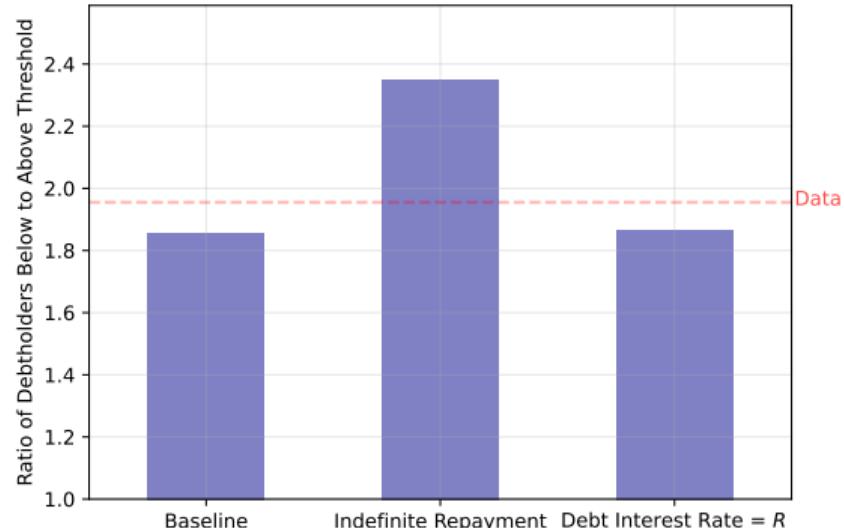
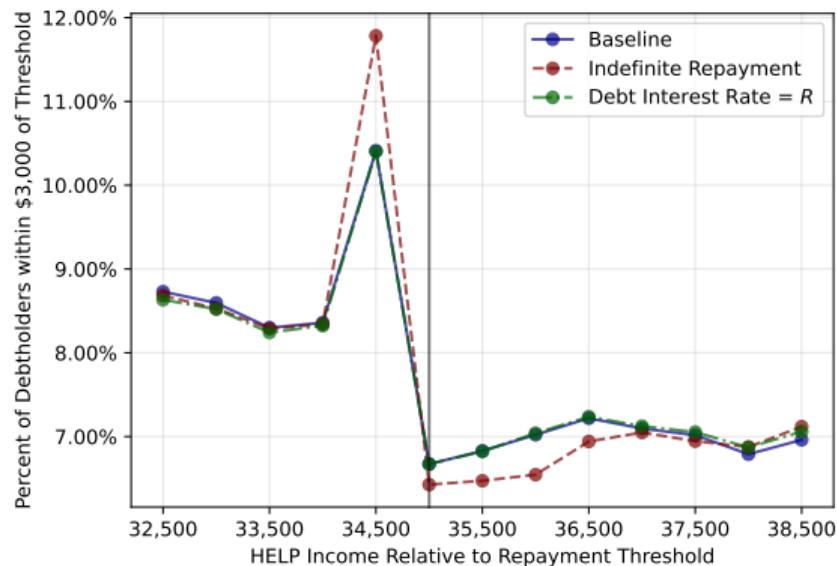
# LIQUIDITY: BORROWING CONSTRAINTS AMPLIFY RESPONSES



- **Model:** complete markets  $\Rightarrow \downarrow$  value of repayment reduction  $\Rightarrow$  bunching  $\downarrow 90\%$
- **Data:** bunching  $\downarrow$  in wealth and  $\uparrow$  in liquidity demands

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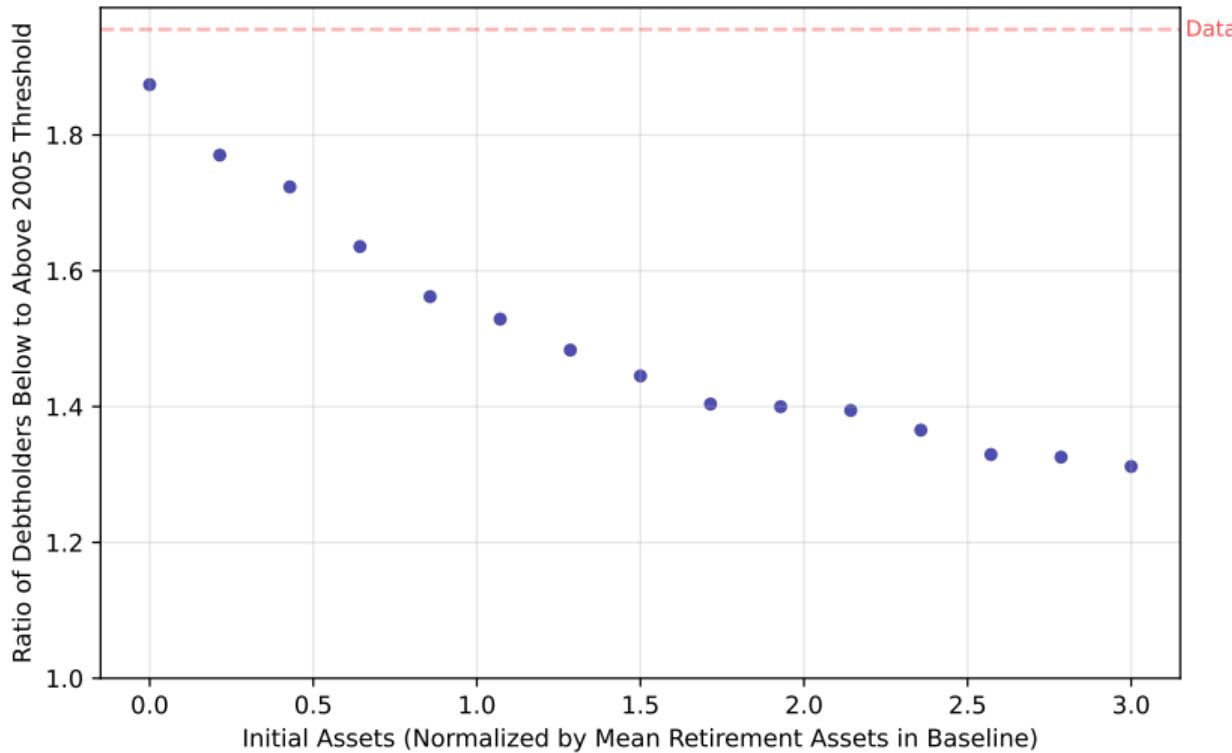
# DYNAMICS: BUNCHING DEPENDS ON PROBABILITY OF REPAYMENT



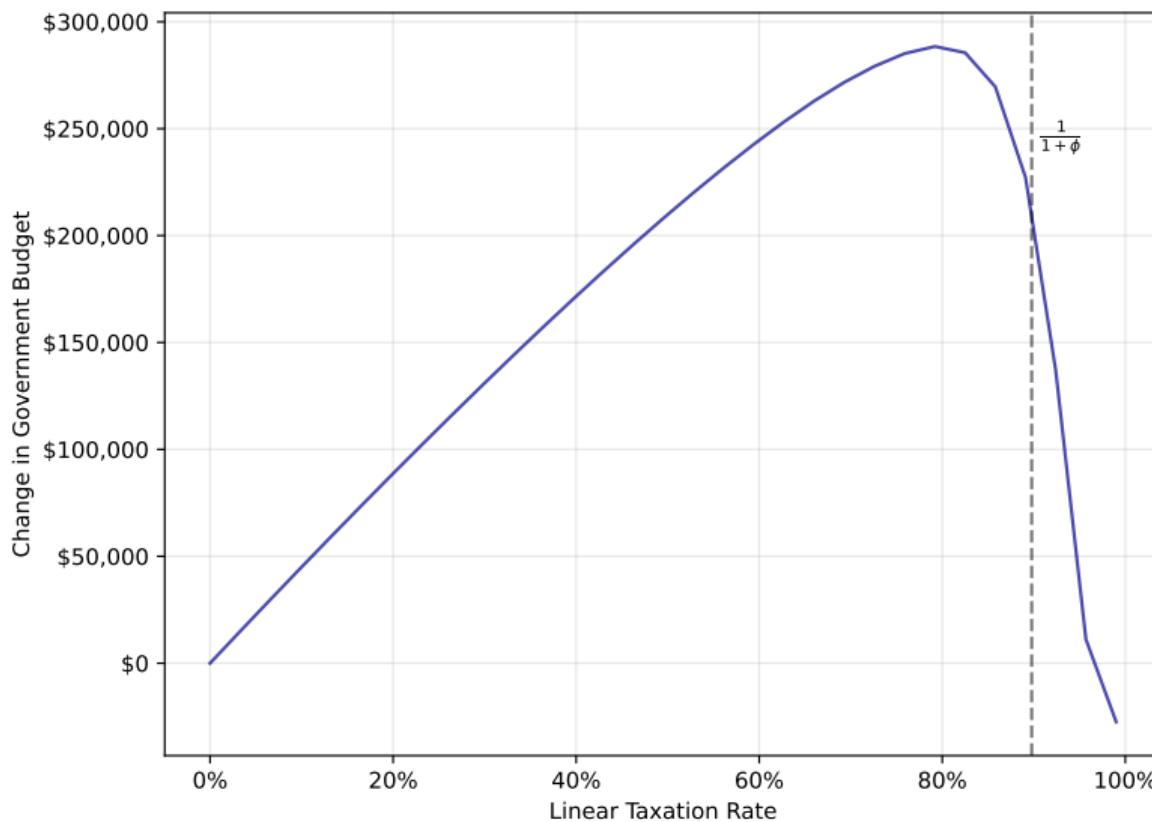
- **Model:** no repayment limit  $\Rightarrow \uparrow$  PDV of repayment reduction  $\Rightarrow$  bunching  $\uparrow 70\%$
- **Data:** bunching increases with debt and decreases with lifetime income

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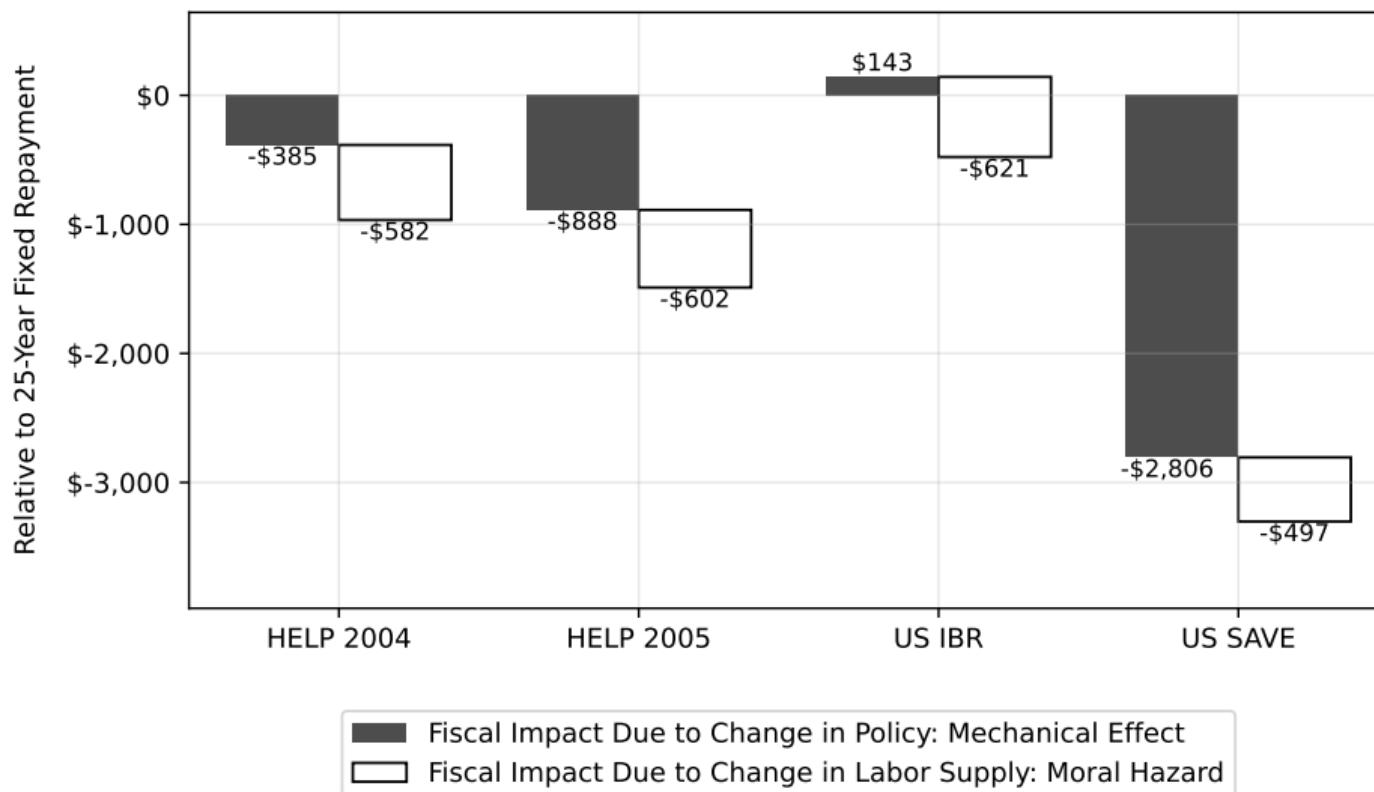
# MODEL: BUNCHING DECREASES IN INITIAL ASSETS



# LAFFER CURVE FROM LINEAR TAXATION



# DECOMPOSITION OF FISCAL IMPACT: ENDOGENOUS LABOR SUPPLY

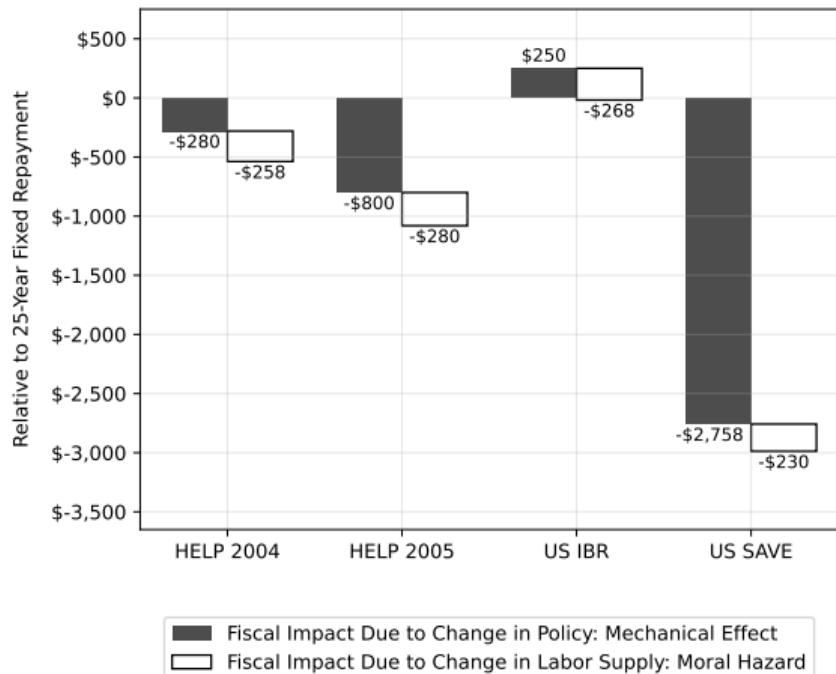


▶ Vary  $\phi$

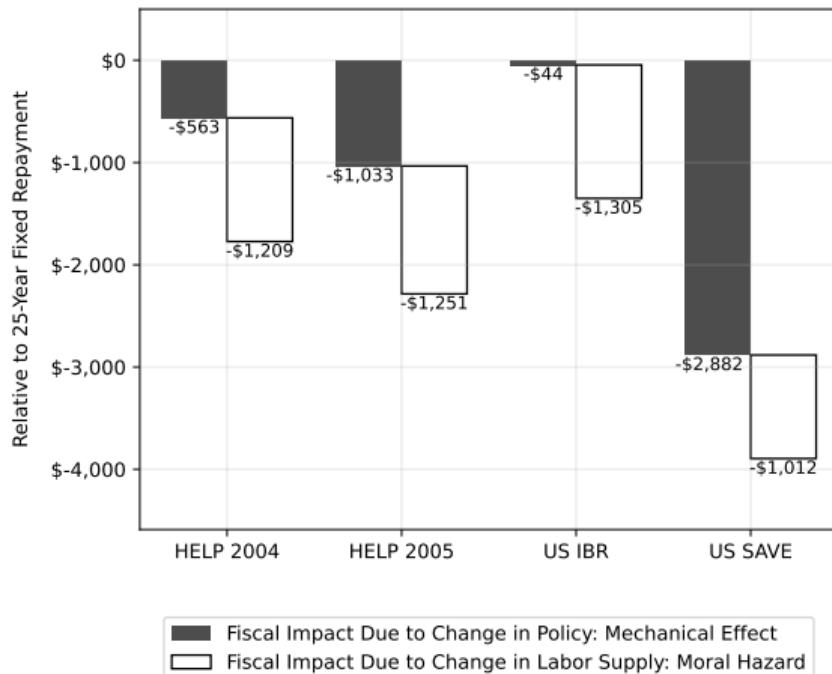
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# DECOMPOSITION OF FISCAL IMPACT: ALTERNATIVE $\phi$

$$\phi = 0.052$$

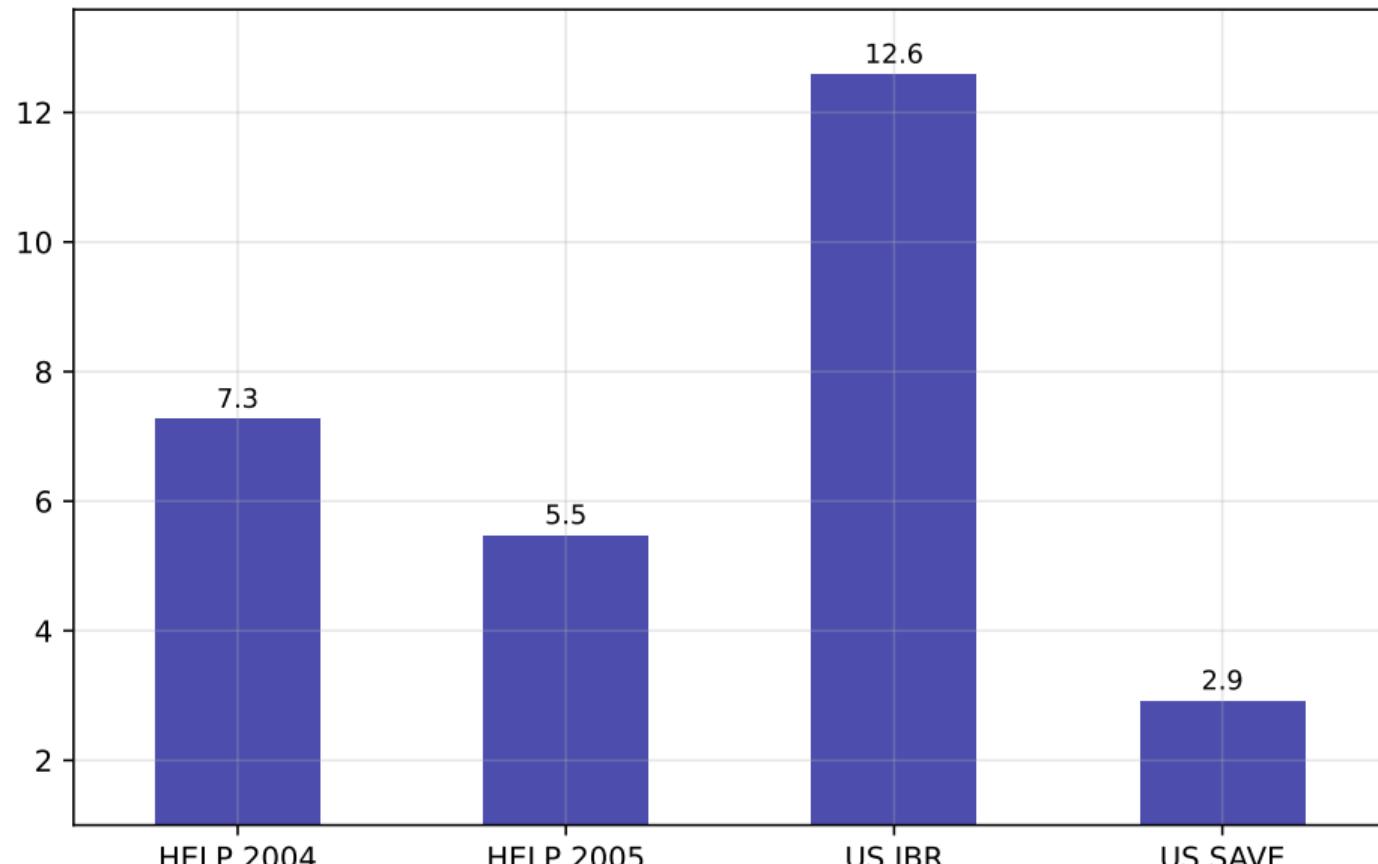


$$\phi = 0.21$$

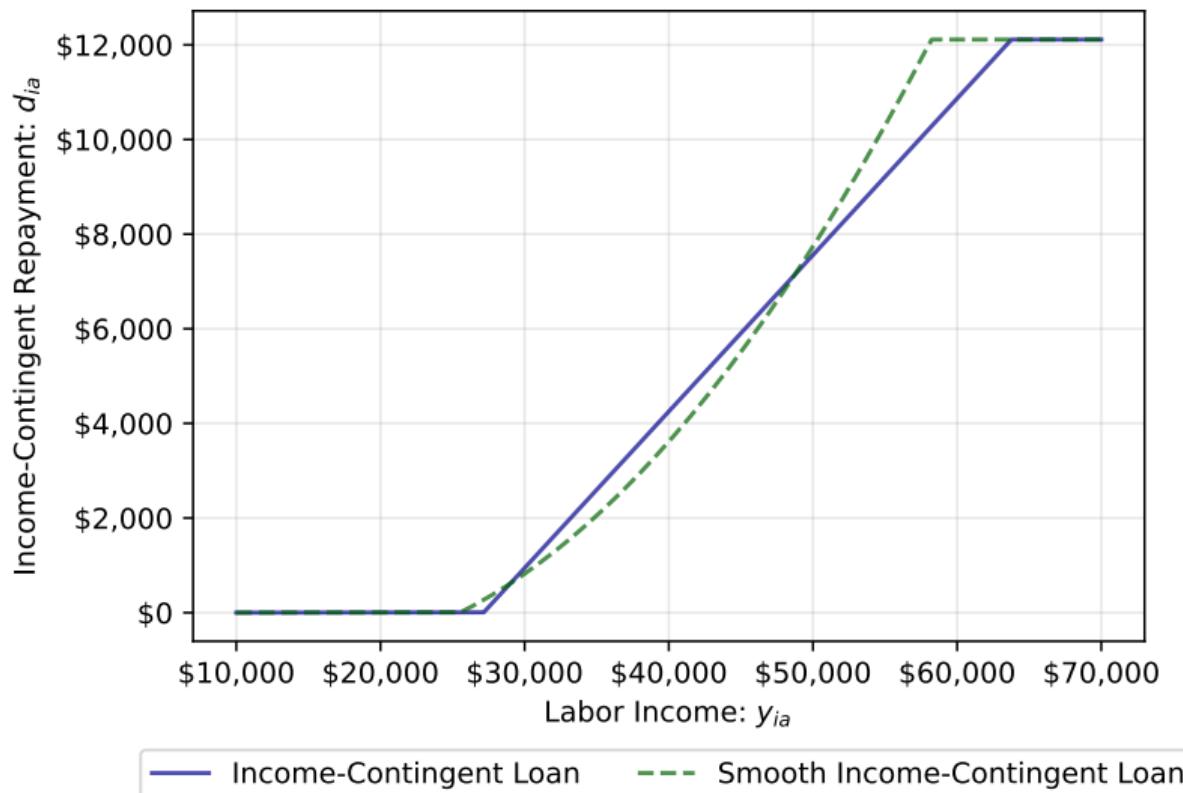


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# MARGINAL VALUE OF PUBLIC FUNDS

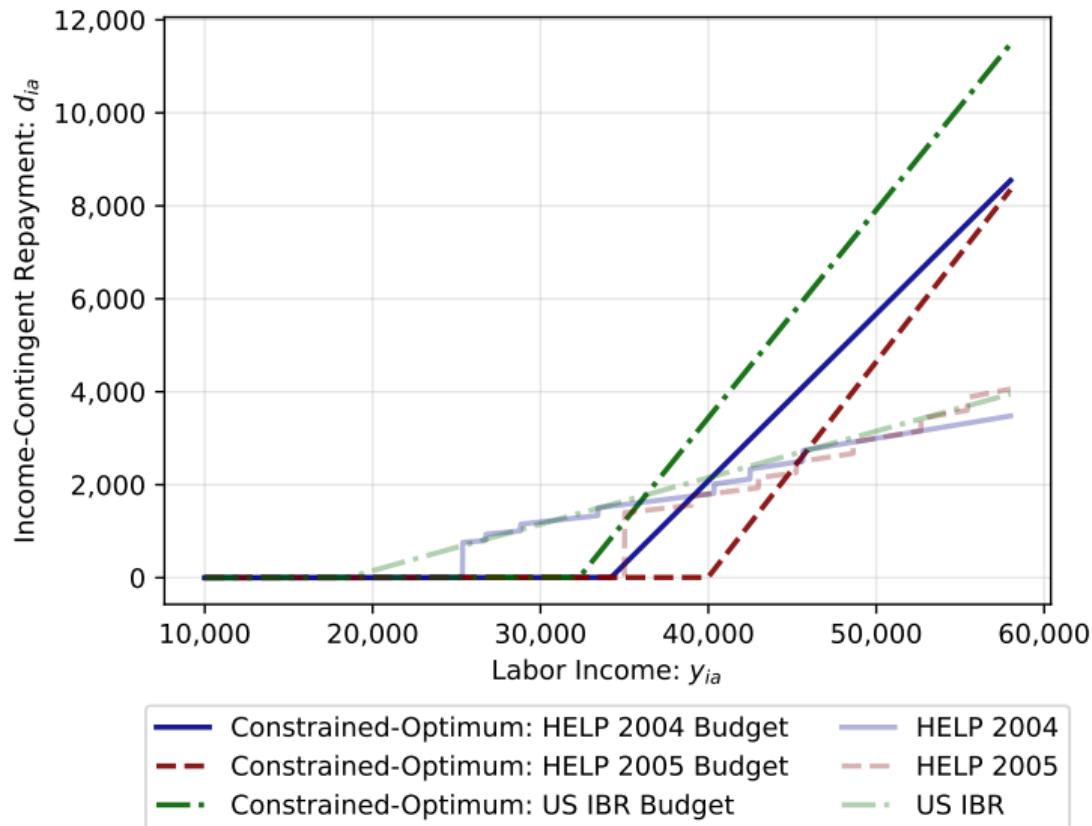


# SOLUTION TO CONSTRAINED PLANNER'S PROBLEM: QUADRATIC



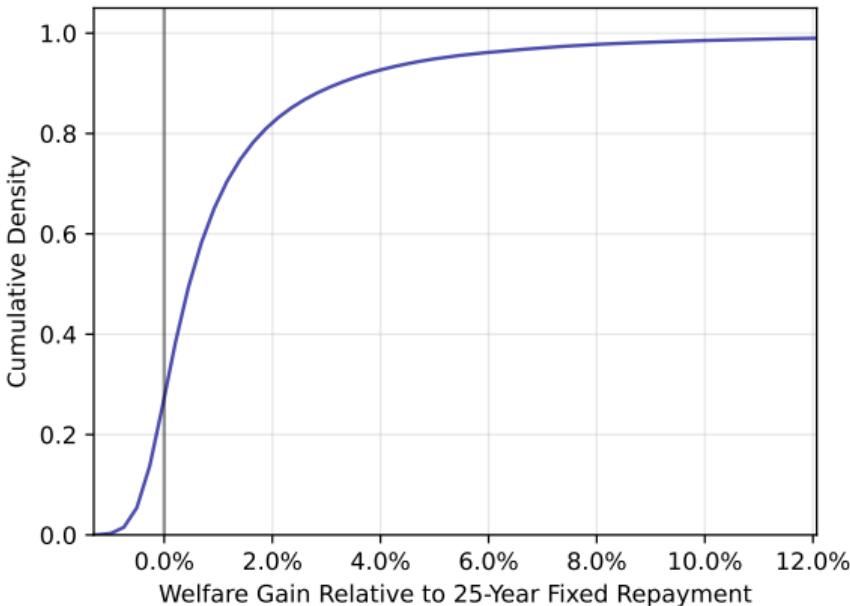
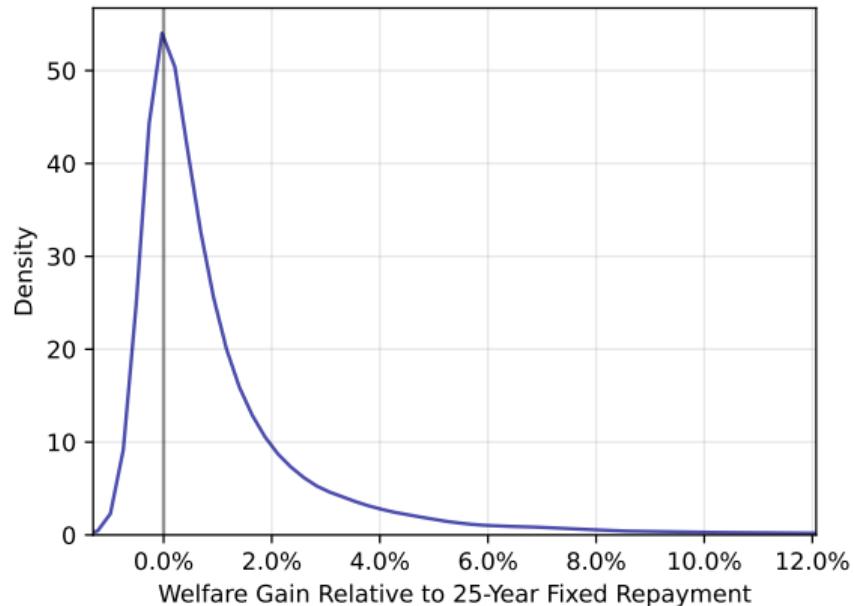
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# OPTIMAL VERSUS EXISTING INCOME-CONTINGENT LOANS



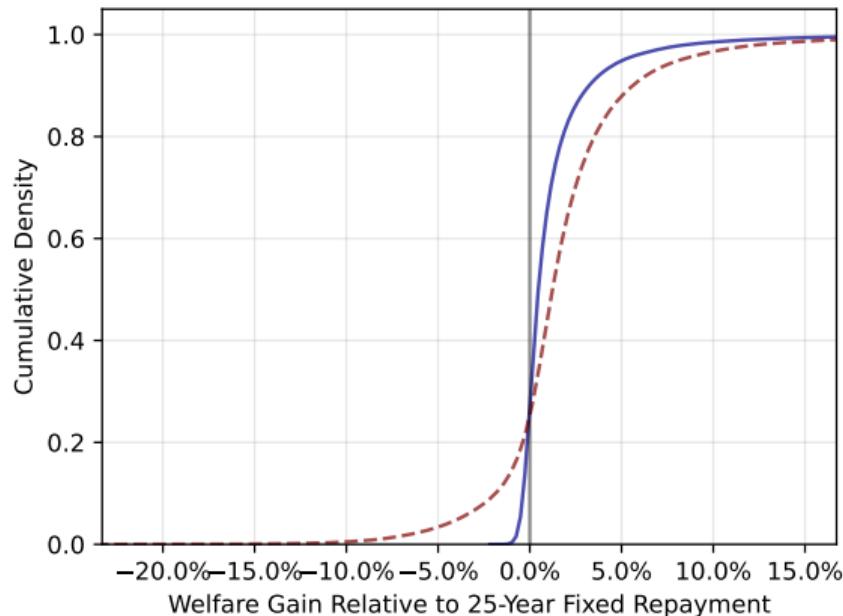
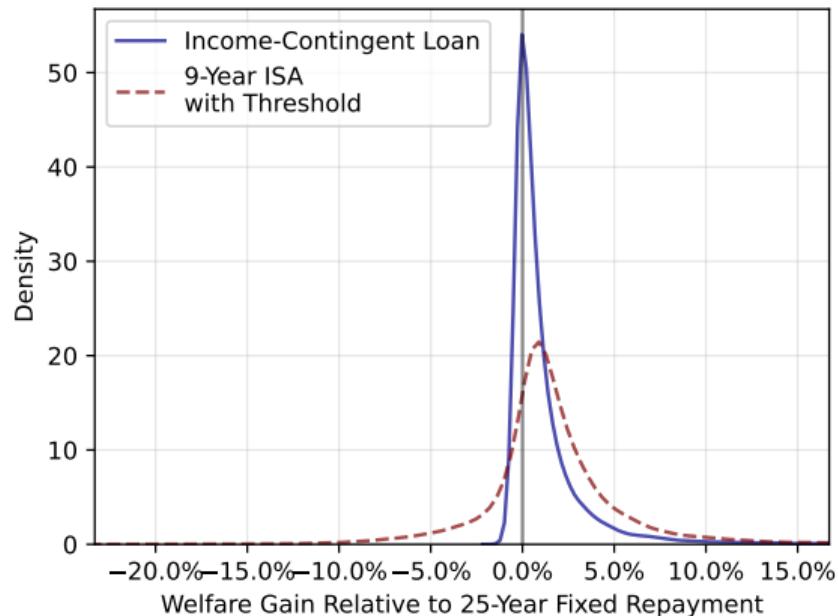
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# DISTRIBUTION OF INITIAL WELFARE GAINS: ICL



- Only **1.2%** of borrowers have welfare loss above 0.5%

# DISTRIBUTION OF INITIAL WELFARE GAINS: ISA

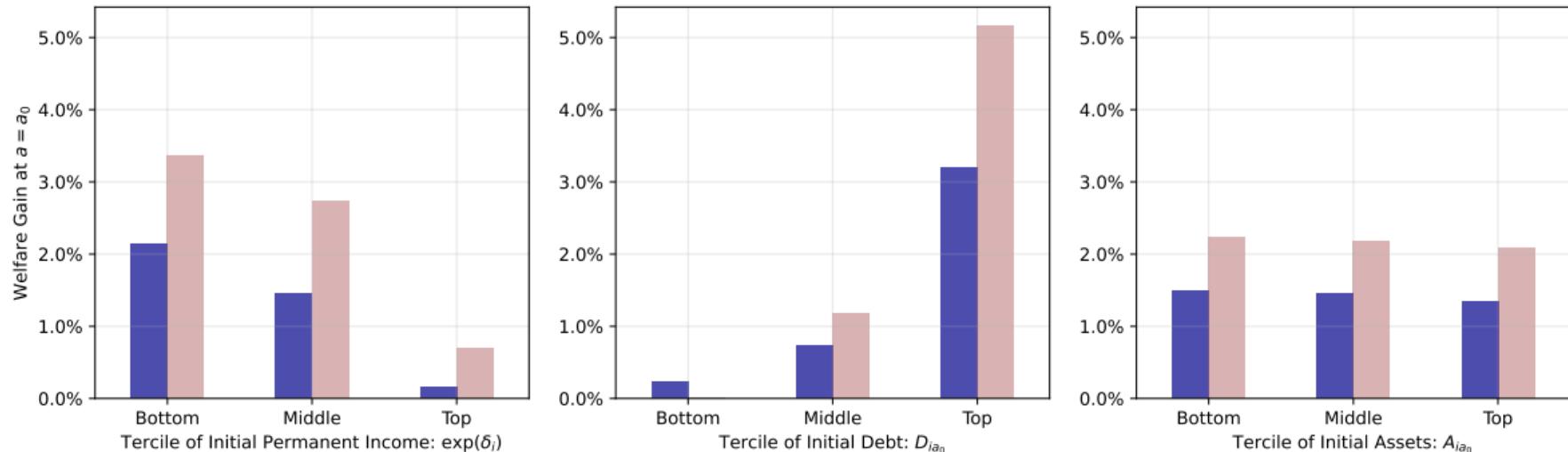


- 18% of borrowers have welfare loss above 0.5% for ISA vs. 1.2% for ICL

▶ Heterogeneity by States

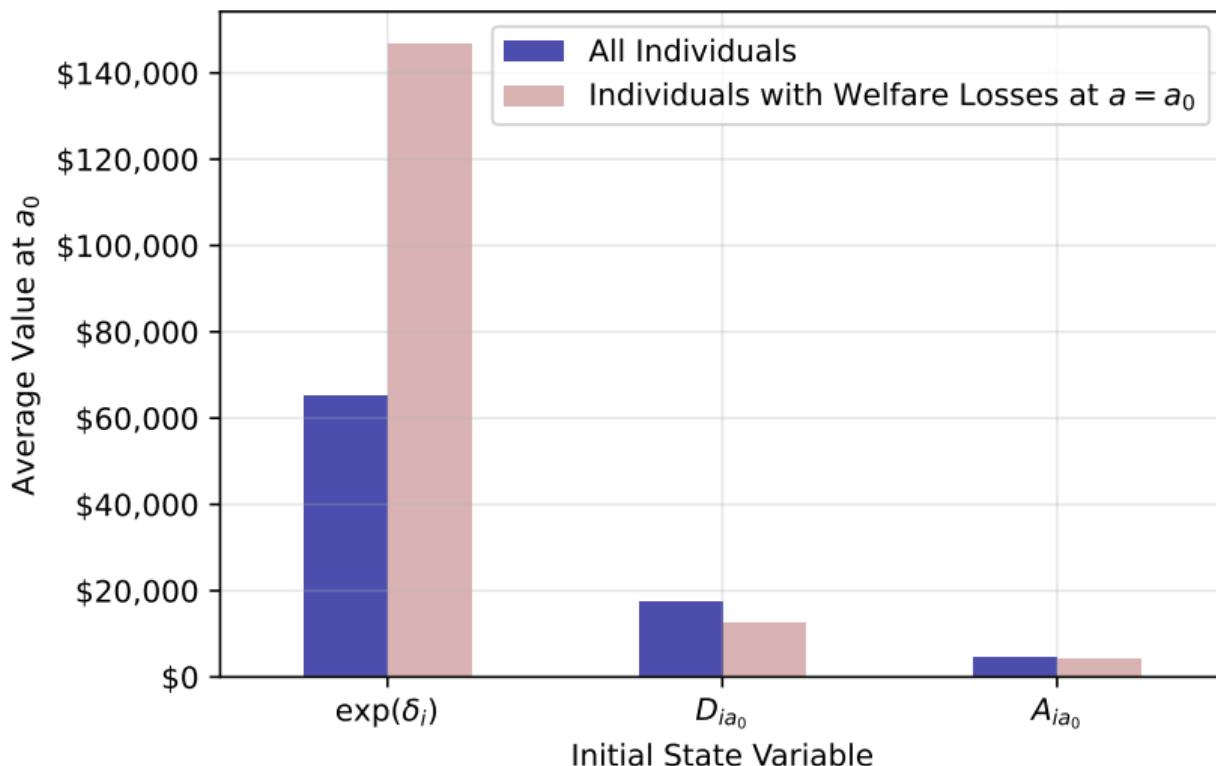
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# HETEROGENEITY IN WELFARE GAINS ACROSS INITIAL STATES



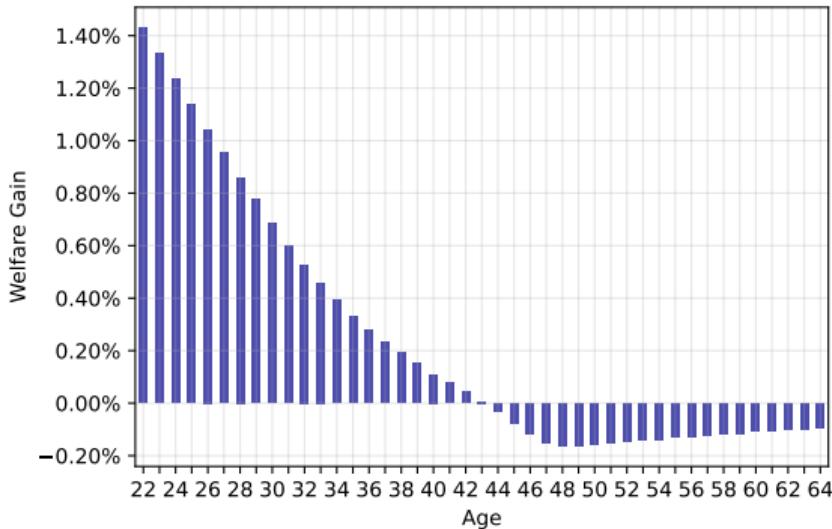
▶ Losers ICL ▶ Age ▶ Initial CEQ ▶ ICL ▶ ISA

# INDIVIDUALS WITH INITIAL WELFARE LOSSES: ICL

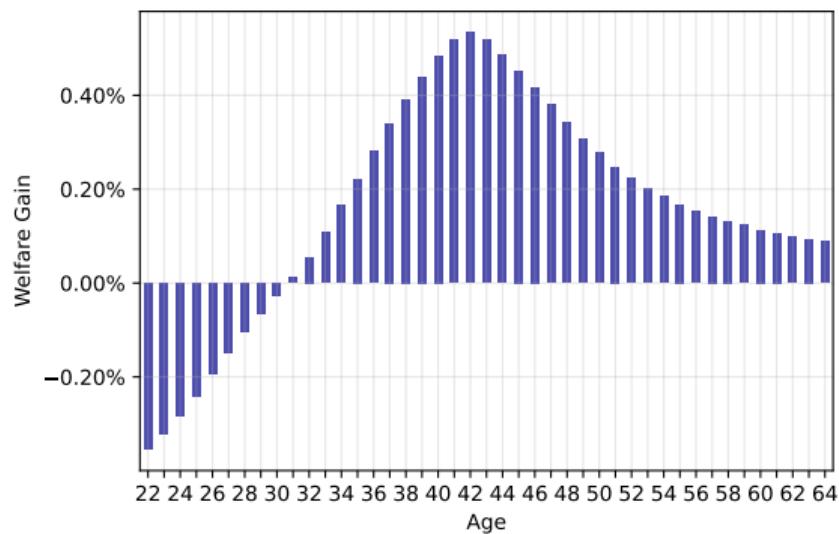


# WELFARE GAINS BY AGE

**ICL vs. 25-Year Fixed**

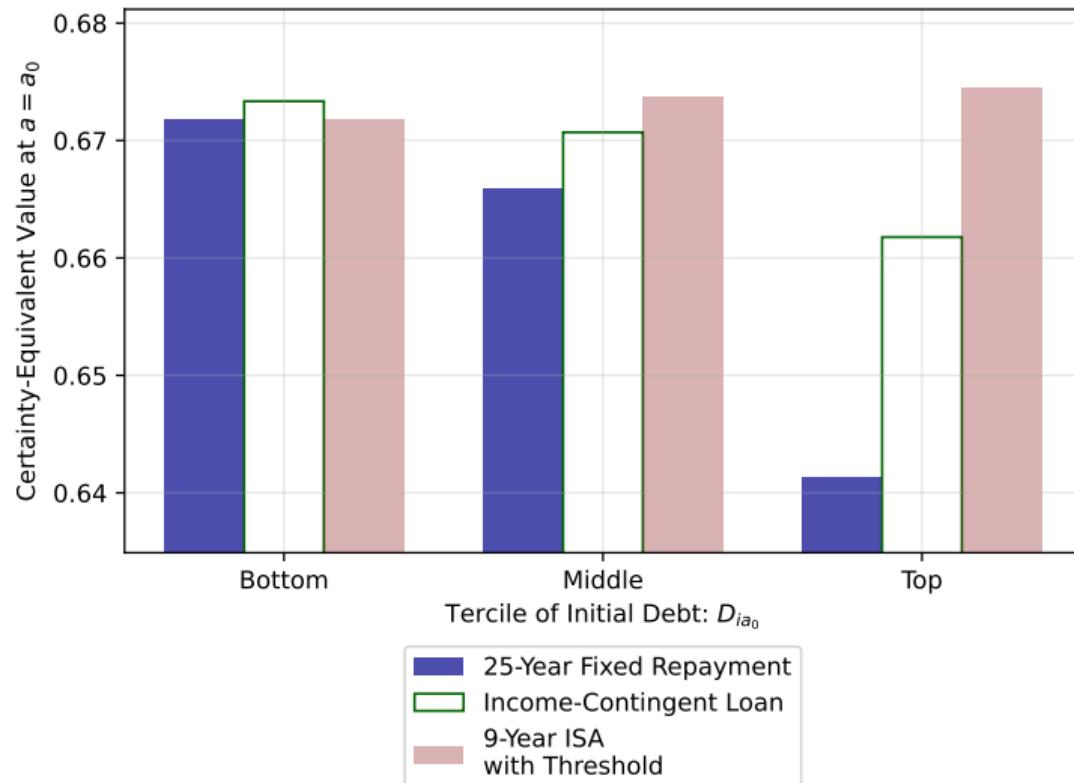


**ICL + 20-Year Forgiveness vs. ICL**



◀ ICL ▶ ISA

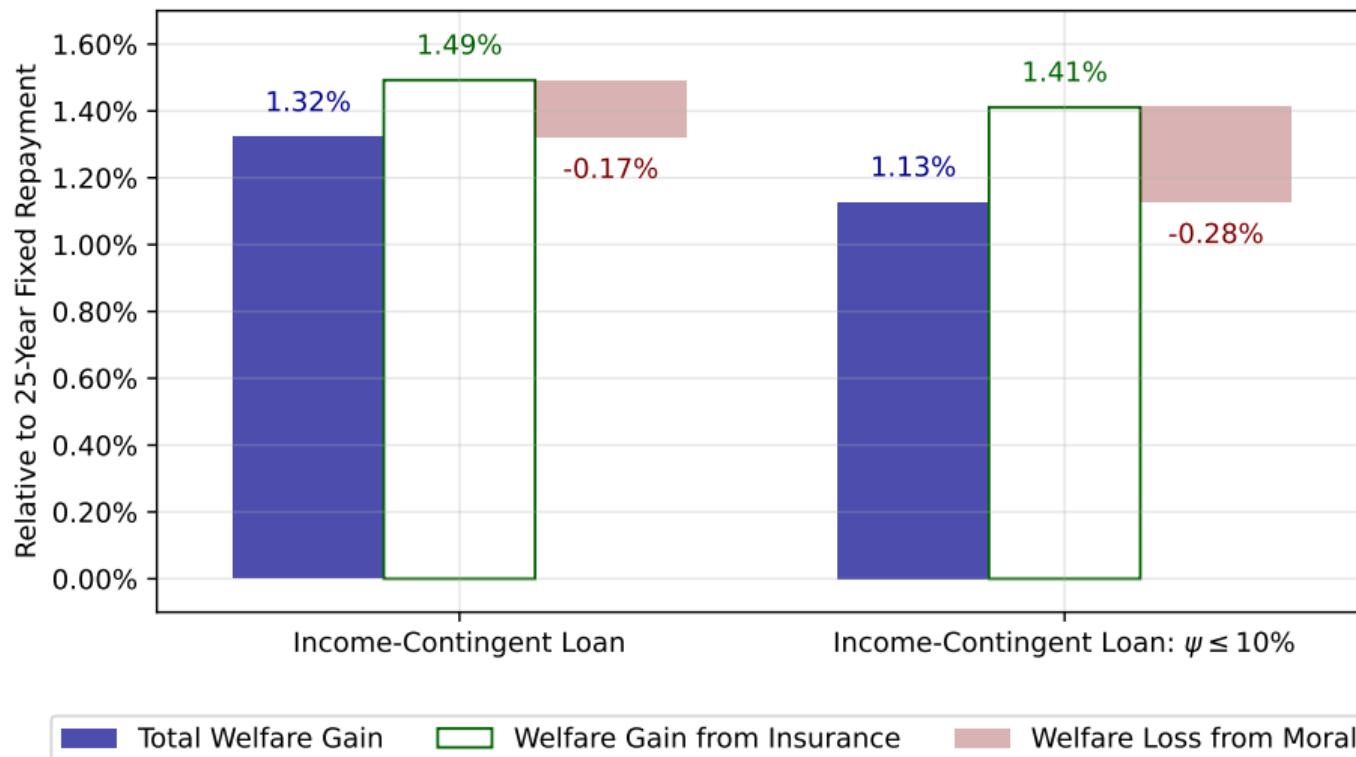
# CERTAINTY-EQUIVALENTS ACROSS INITIAL DEBT



# WELFARE GAINS FROM INCOME-CONTINGENT LOANS: ALT. MODELS

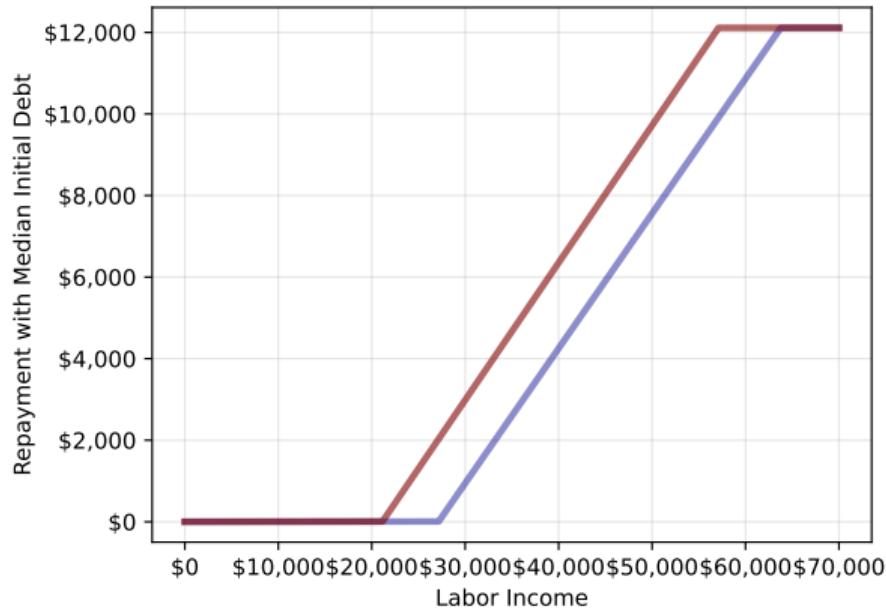
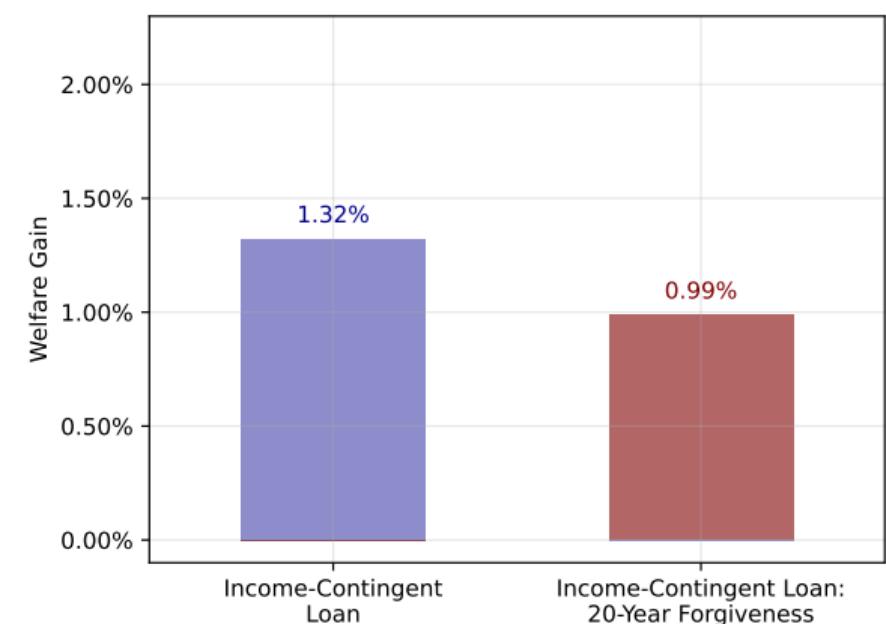
|      | Difference from Baseline Model        | Welfare Gain | = Insurance  | + Moral Hazard | $\psi^*$   | $K^*$           |
|------|---------------------------------------|--------------|--------------|----------------|------------|-----------------|
| (1)  | Occupation Heterogeneity              | 1.32%        | 1.45%        | -0.13%         | 41%        | \$28,694        |
| (2)  | Learning-by-Doing                     | 1.68%        | .            | .              | 35%        | \$36,615        |
| (3)  | Linear Adjustment Costs               | 1.74%        | 1.87%        | -0.13%         | 53%        | \$43,560        |
| (4)  | Wealth Effects on Labor Supply        | 0.82%        | 1.05%        | -0.23%         | 37%        | \$30,307        |
| (5)  | Less Persistent Shocks: $\rho = 0.8$  | 0.90%        | 1.14%        | -0.23%         | 42%        | \$34,244        |
| (6)  | More Persistent Shocks: $\rho = 0.99$ | 1.35%        | 1.63%        | -0.28%         | 35%        | \$18,949        |
| (7)  | Non-Normal Permanent Shocks           | 1.14%        | 1.43%        | -0.30%         | 28%        | \$26,933        |
| (8)  | Debt Interest Rate = 2%               | 1.96%        | 2.14%        | -0.18%         | 38%        | \$47,731        |
| (9)  | Planner Discount Rate = $R$           | 1.06%        | 1.41%        | -0.35%         | 29%        | \$22,696        |
| (10) | Planner Discount Rate = $R + 4\%$     | 1.60%        | 1.65%        | -0.05%         | 46%        | \$34,441        |
| (11) | US Tax System                         | 1.18%        | 1.36%        | -0.19%         | 38%        | \$28,838        |
| (12) | Larger Initial Debt Balances          | 3.50%        | 4.72%        | -1.22%         | 36%        | \$18,867        |
| (13) | High RRA: $\gamma = 7.5$              | 3.52%        | 4.00%        | -0.48%         | 50%        | \$27,607        |
| (14) | High EIS: $\sigma^{-1} = 1.5$         | 0.57%        | 0.70%        | -0.13%         | 42%        | \$30,905        |
| (15) | High RRA + High EIS                   | 1.87%        | 2.29%        | -0.43%         | 49%        | \$28,641        |
| (16) | No Ex-Post Uncertainty                | 0.58%        | 0.76%        | -0.17%         | 27%        | \$18,098        |
| (17) | No Uncertainty                        | -0.17%       | 0.15%        | -0.32%         | 21%        | \$26,906        |
|      | Average                               | 1.41%        | 1.62%        | -0.24%         | 36%        | \$28,492        |
|      | <b>Baseline Model</b>                 | <b>1.32%</b> | <b>1.47%</b> | <b>-0.15%</b>  | <b>33%</b> | <b>\$27,147</b> |

# CONSTRAINING REPAYMENT RATE REDUCES WELFARE GAINS



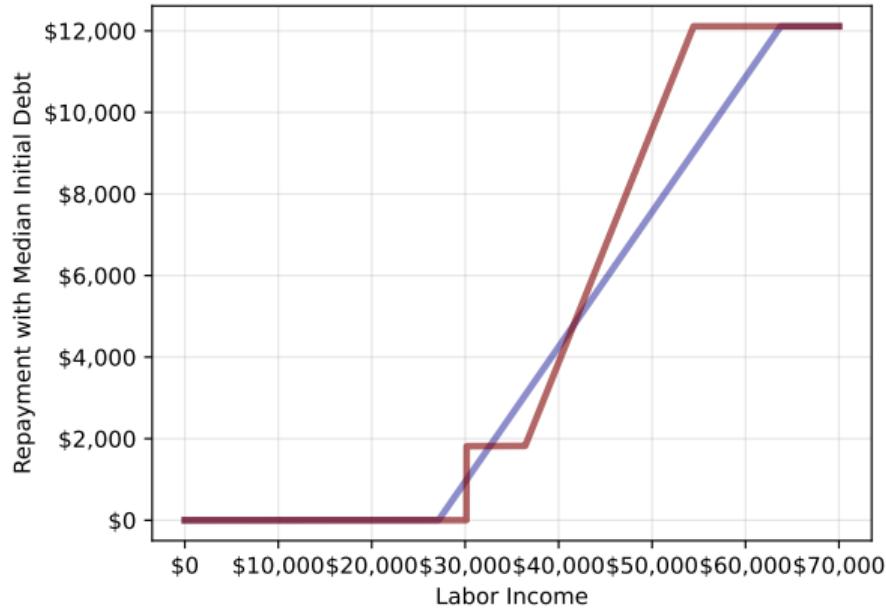
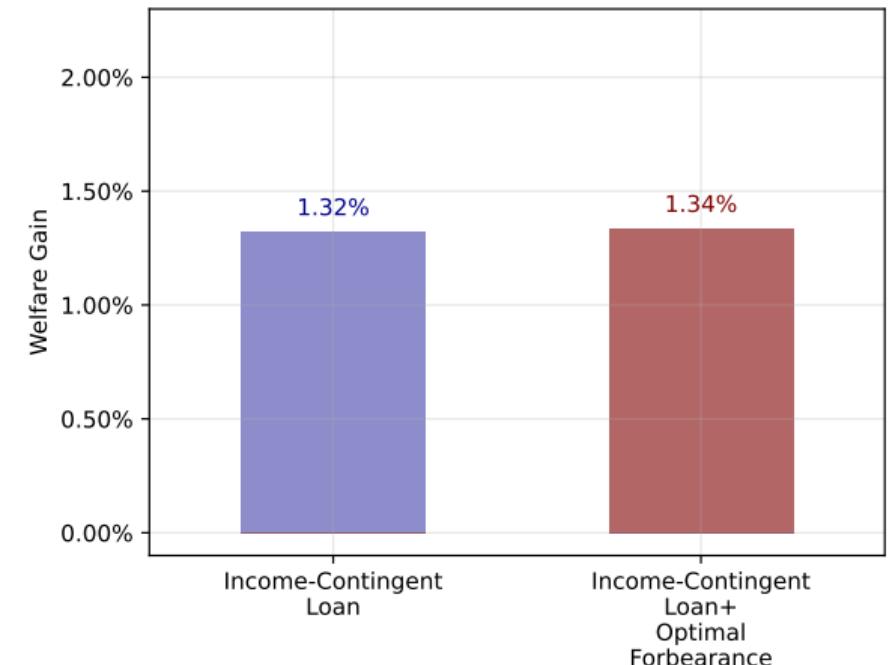
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# FORGIVENESS REDUCES WELFARE GAINS



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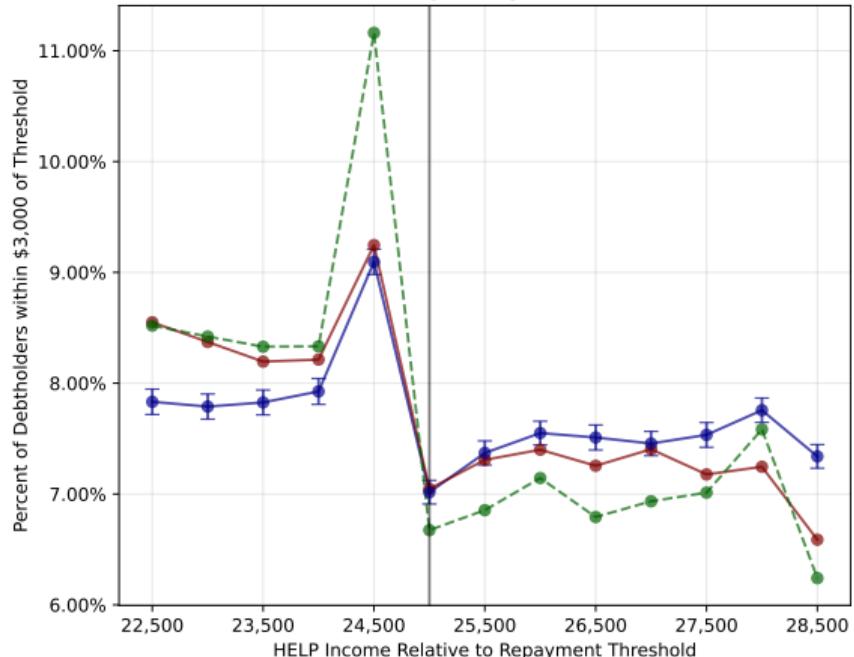
# No GAINS TO ADDING FORBEARANCE TO INCOME-CONTINGENT LOANS



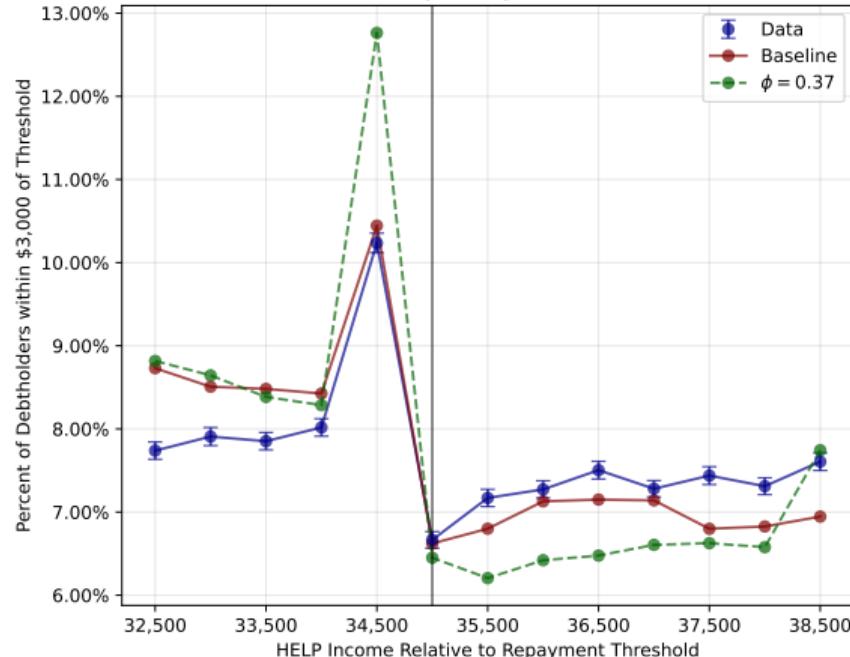
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# FIT OF MODEL IN WHICH FIXED REPAYMENT IS OPTIMAL

Before Policy Change: 2002-2004



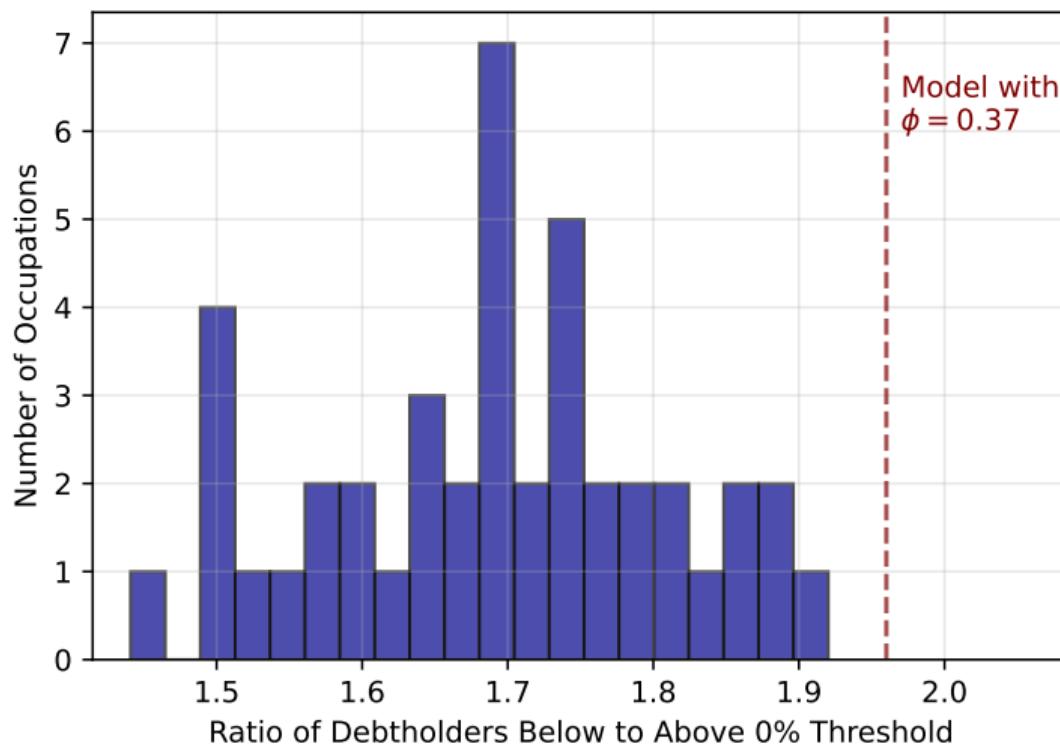
After Policy Change: 2005-2007



▶ Occupations

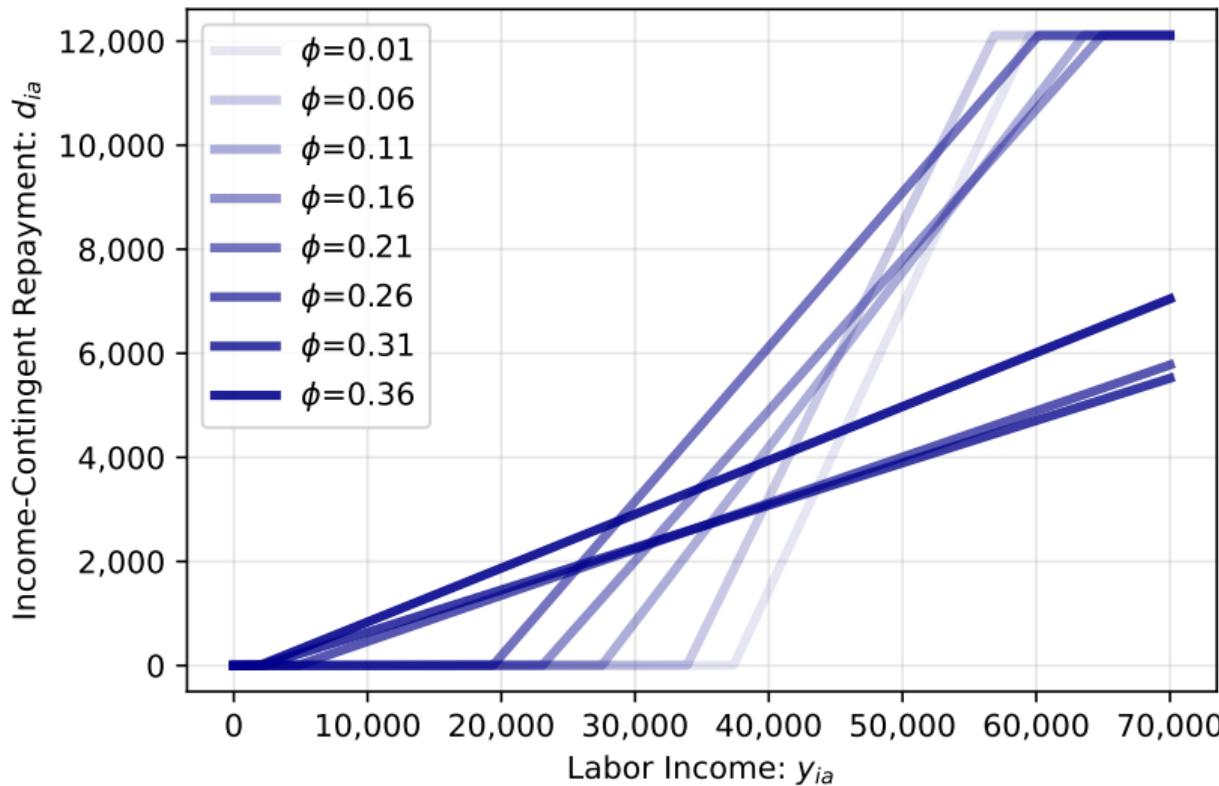
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# BUNCHING WHEN FIXED REPAYMENT IS OPTIMAL vs. OCCUPATIONS



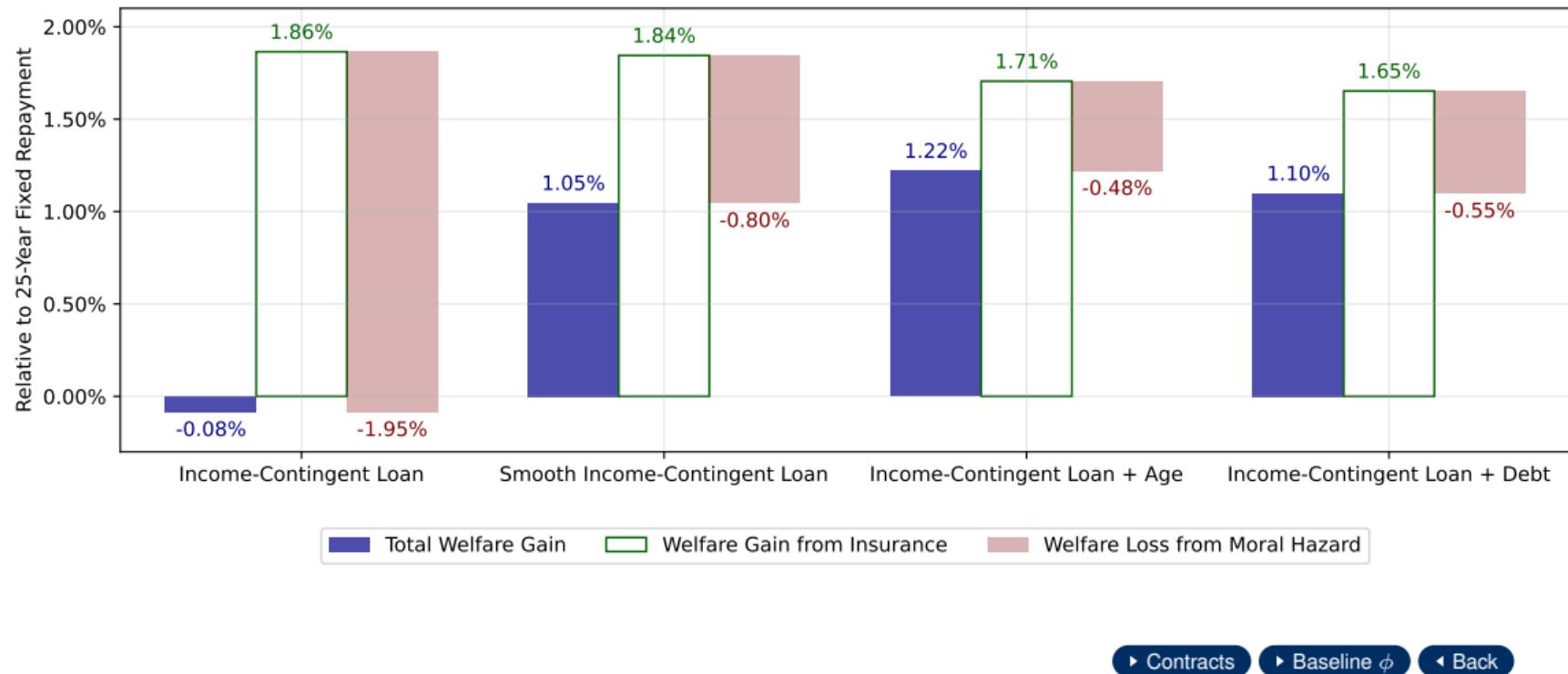
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# How INCOME-CONTINGENT LOANS VARY WITH $\phi$

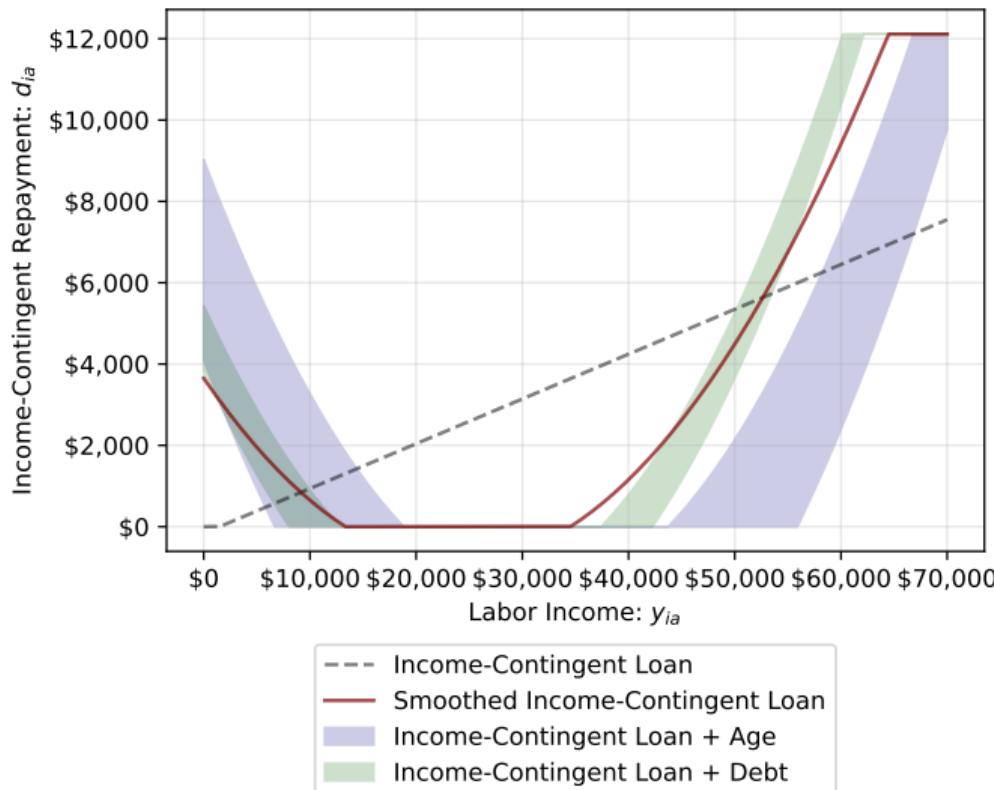


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# ALTERNATIVE CONTRACTS REDUCE WELFARE COST OF MORAL HAZARD

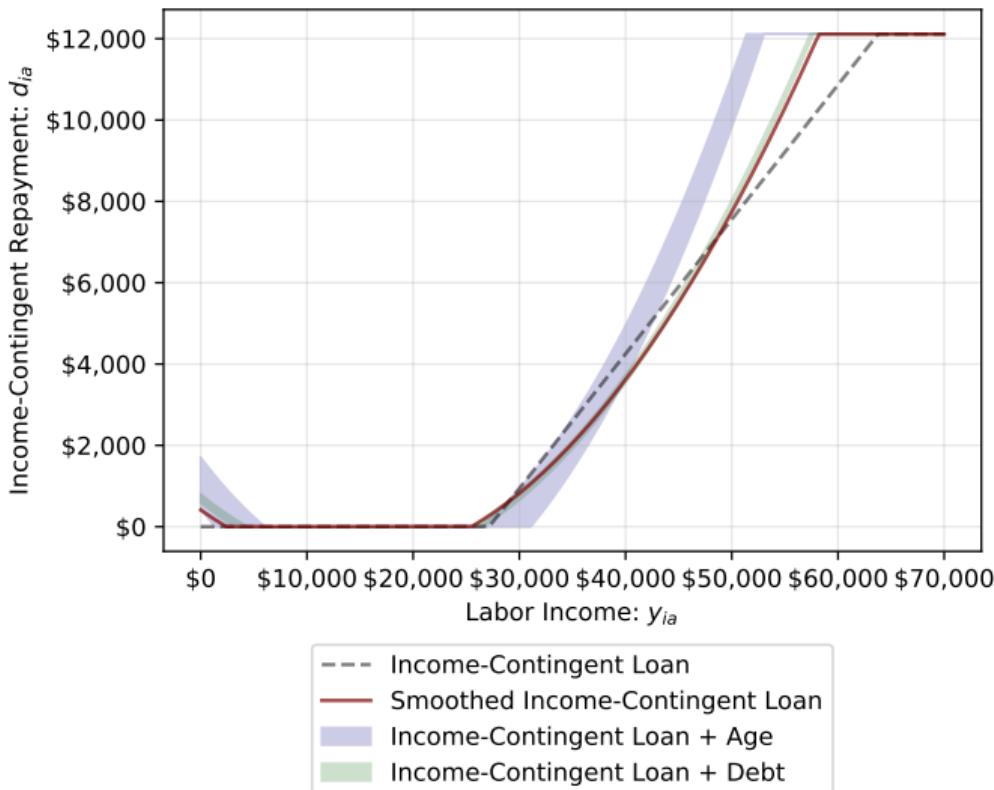


# ALTERNATIVE FORMS OF INCOME-CONTINGENT LOANS: $\phi = 0.37$



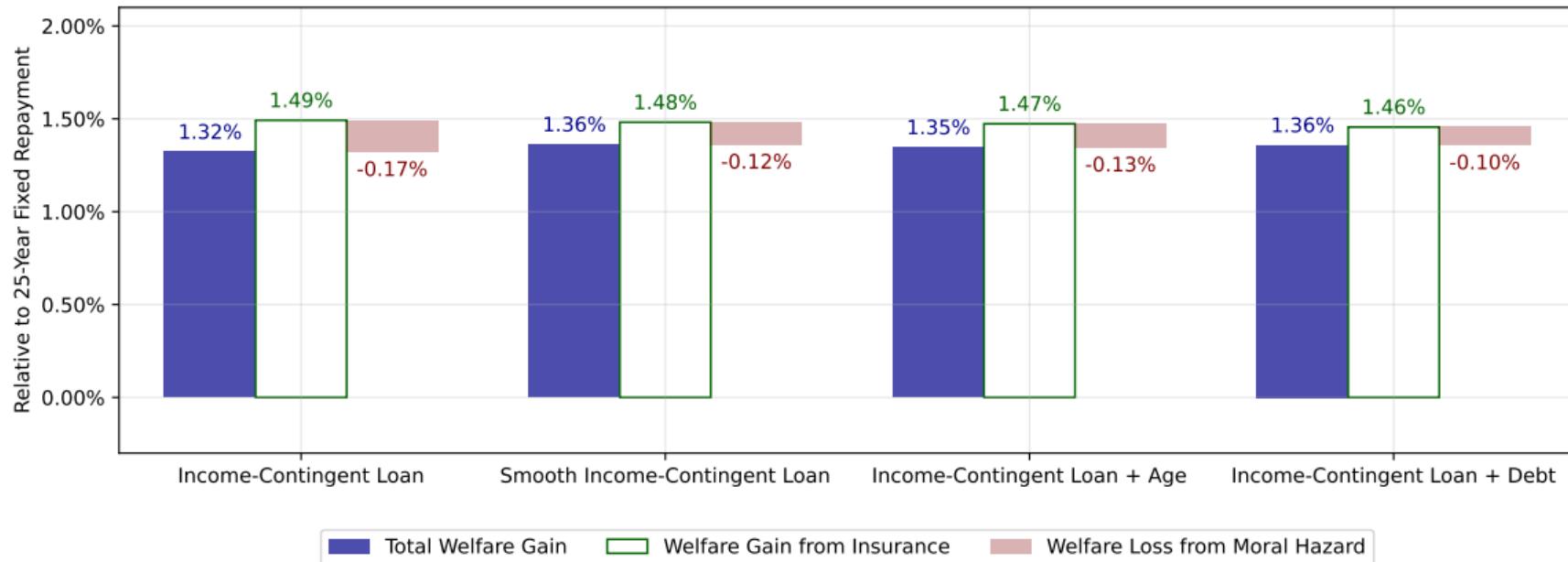
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# ALTERNATIVE FORMS OF INCOME-CONTINGENT LOANS: BASELINE $\phi$



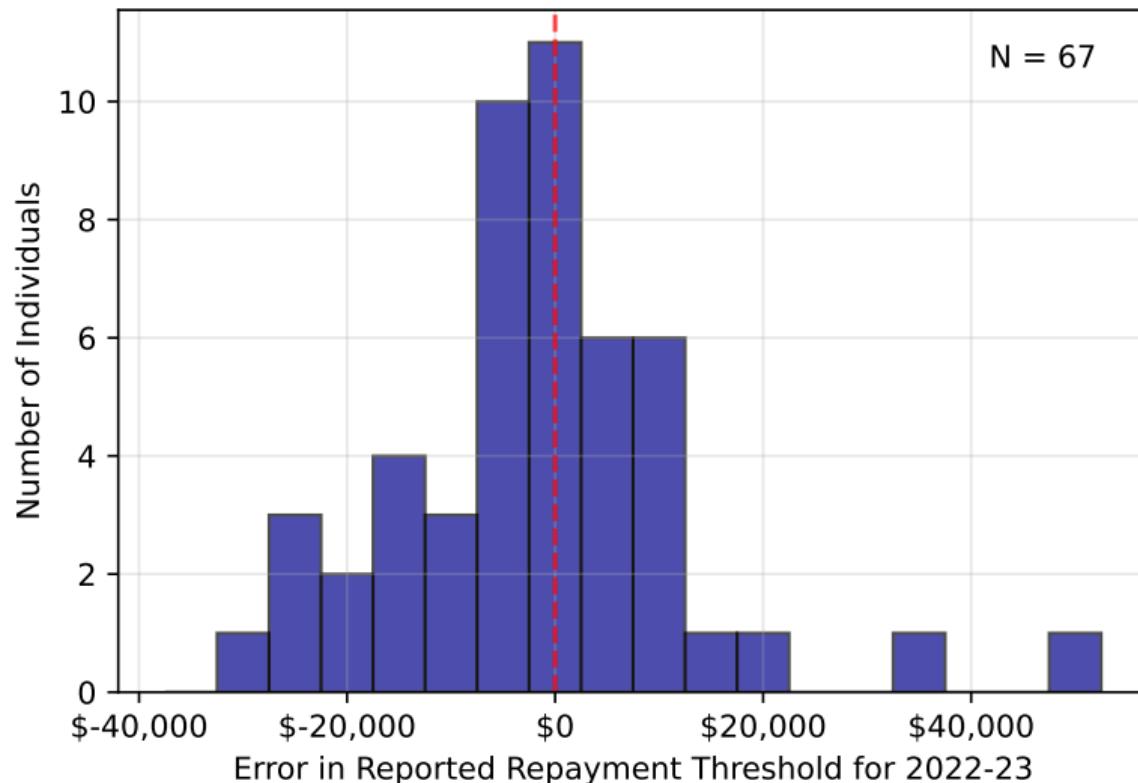
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# REDUCING WELFARE COST OF MORAL HAZARD: BASELINE $\phi$

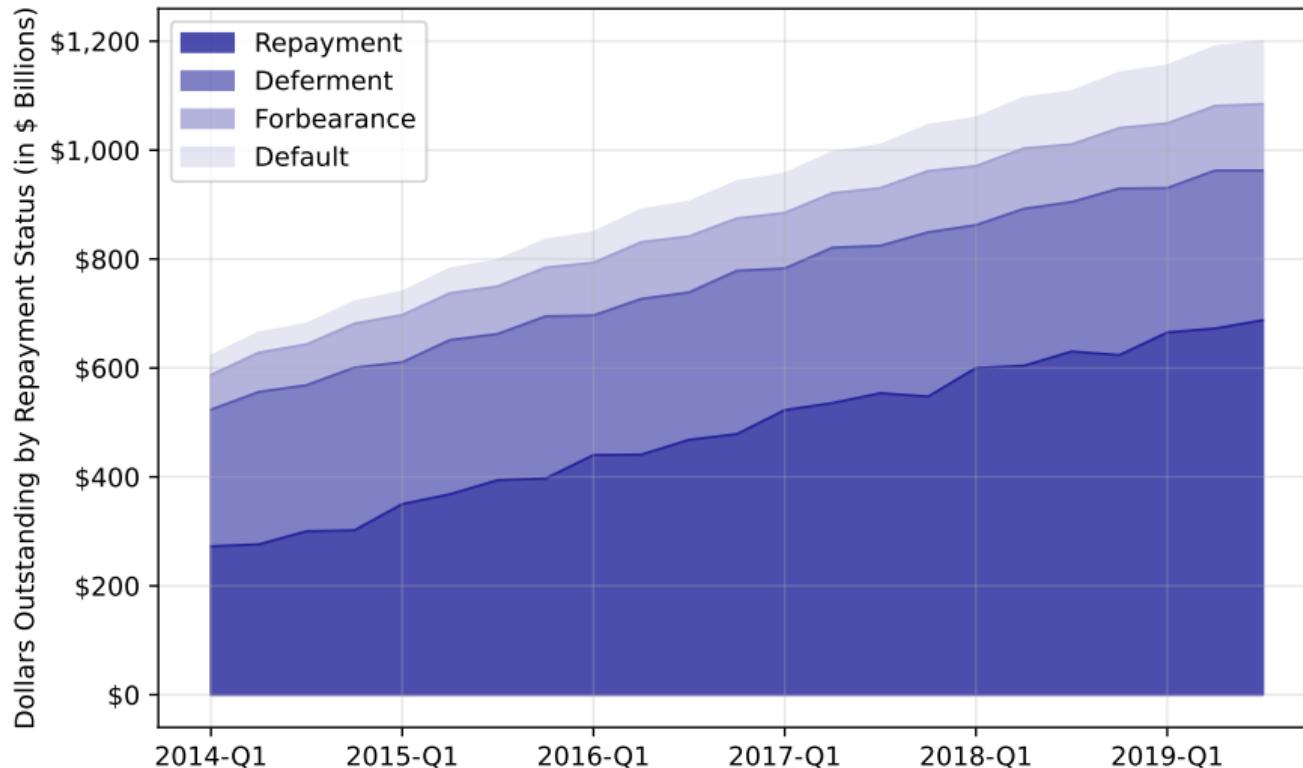


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# SURVEY OF THRESHOLD LOCATION



# REPAYMENT STATUS OF US STUDENT LOANS



## Physical vs. logical page numbers

- Windows: Ctrl + K, uncheck "Use Logical Page Numbers"
- Mac: Cmd + K, uncheck "Use Logical Page Numbers"
- Might have to toggle on/off if it's off already

## Jump to page numbers

- Windows: Ctrl + Shift + N
- Mac: Cmd + Shift + N

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  - 3 Government-Financed Higher Education
  - 4 Government-Financed Higher Education
  - 5 Government-Financed Higher Education
  - 6 Government-Financed Higher Education
  - 7 Government-Financed Higher Education
  - 8 Government-Financed Higher Education
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