

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

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Stanford GSB and SIEPR

December 2024

E61 MICRO 4 MACRO WORKSHOP

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.

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**This Paper:** Insurance vs. Moral Hazard

- + Insurance
  - Disincentivize labor supply
  - + Encourage investment & risk-taking
  - Incentivize over-borrowing
  - Adverse selection

Conditional on ex-ante choices + taxes/transfers, how does income-contingent repayment affect **labor supply** and welfare?

- ① **Setting:** Australian government's income-contingent student loan program
  - **Variation:** discontinuities in repayment rates + policy change to these rates
  - **Identification:** limited room for 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

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  - **Positive**: translate responses into estimates of preference parameters
  - **Normative**: characterize optimal amount and form of income-contingent repayment

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  - **Caveat**: compute optimal contracts taking ex-ante choices as given  $\approx$  **restructuring**

- ① **Empirics:** borrowers reduce labor supply to ↓ income-contingent repayments
  - Larger responses in occupations with more hourly flexibility
  - Responses increase with liquidity constraints and decrease with  $P$ (repayment)
- ② **Structural estimation:** labor supply elasticity of **0.16** + adjustment frictions
- ③ **Contract design:** moral hazard reduces optimal amount of insurance
  - Moral hazard ≈ **60%** of fiscal cost from fixed → income-contingent repayment
  - Fixed repayment → optimal income-contingent loan ⇒ ↑ **0.8%** lifetime consumption
  - Income-contingent **loans** outperform other income-contingent contracts

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**Takeaway:** income-contingent repayment creates **moral hazard** that affects contract design, but **too small** to justify fixed repayment

# OUTLINE

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# STUDENT LOANS IN AUSTRALIA: HELP

- Australian citizens eligible for government-provided student loans through **HELP**
- **Initial debt** = tuition – government contribution – upfront payment (avg.  $\approx \$20K$  USD)
- 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

# WHY STUDY INCOME-CONTINGENT REPAYMENT IN AUSTRALIA?

- Benefit #1: only one government contract + no private market
  - Only choice is between borrowing and paying upfront; former **heavily** subsidized
  - ✓ Limited scope for **adverse selection** (or selection on moral hazard)
- Benefit #2: loans can only be used for tuition
  - Tuition is government-controlled at public universities (94% of enrollment)
  - ✓ 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

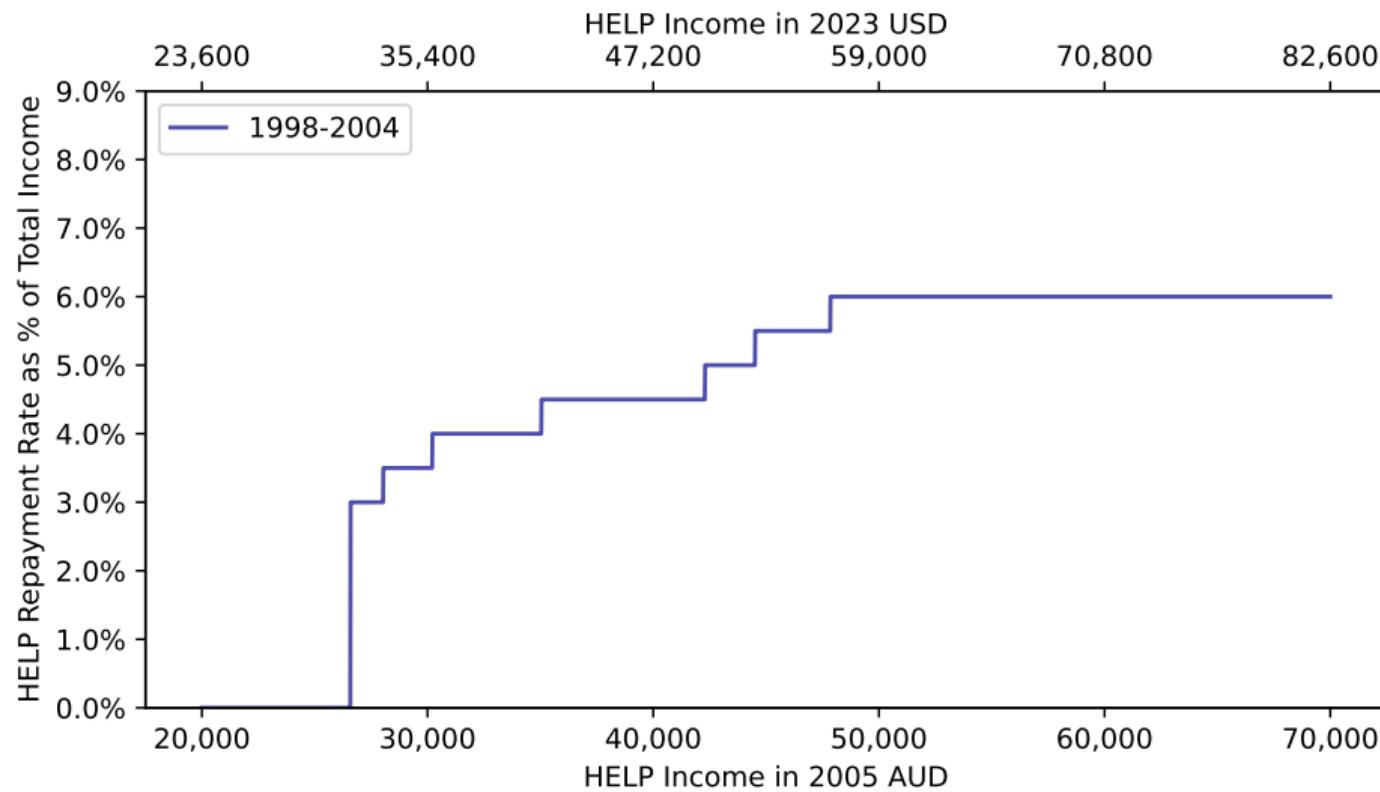
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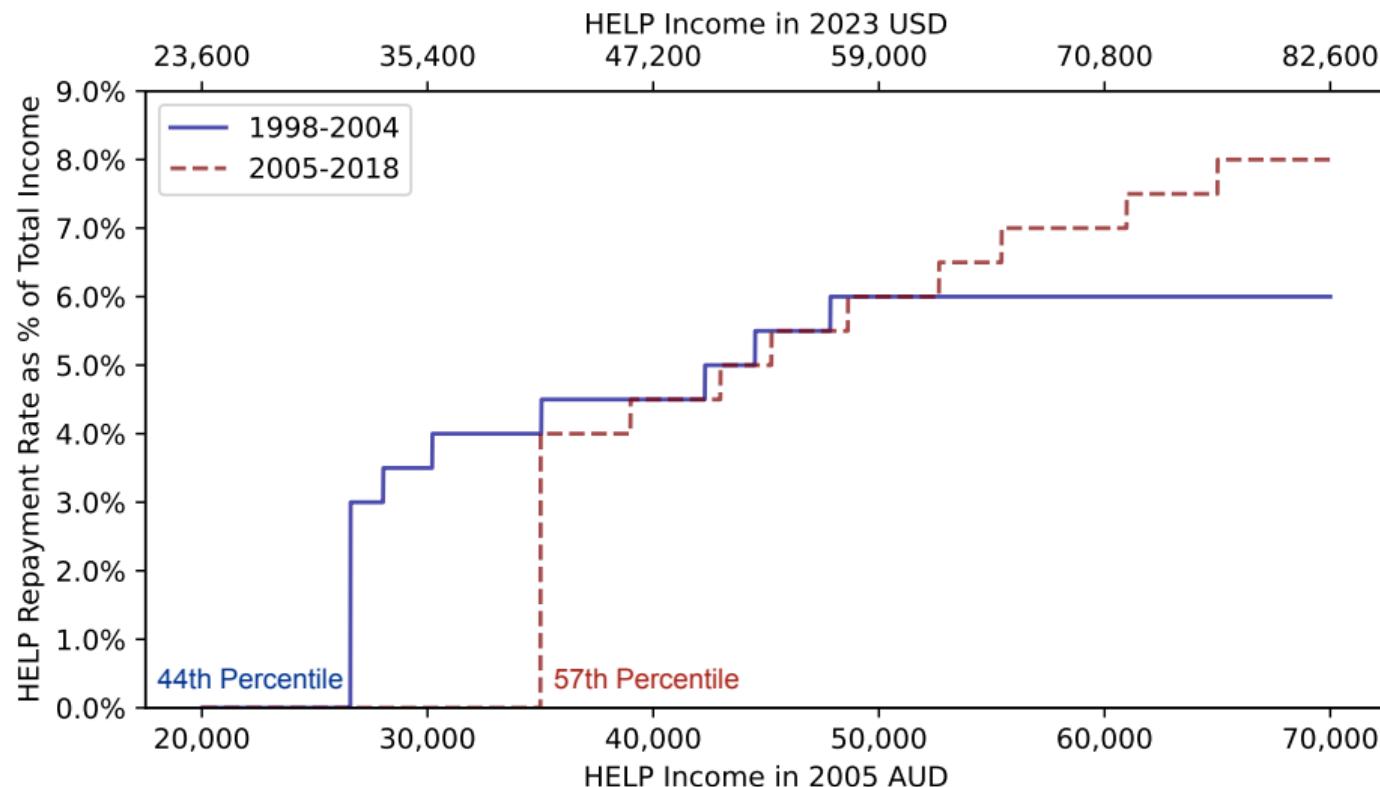
Good setting to identify **labor supply responses** to income-contingent repayment

► Differences from US

# IDENTIFYING VARIATION: DISCONTINUITIES IN REPAYMENT RATES

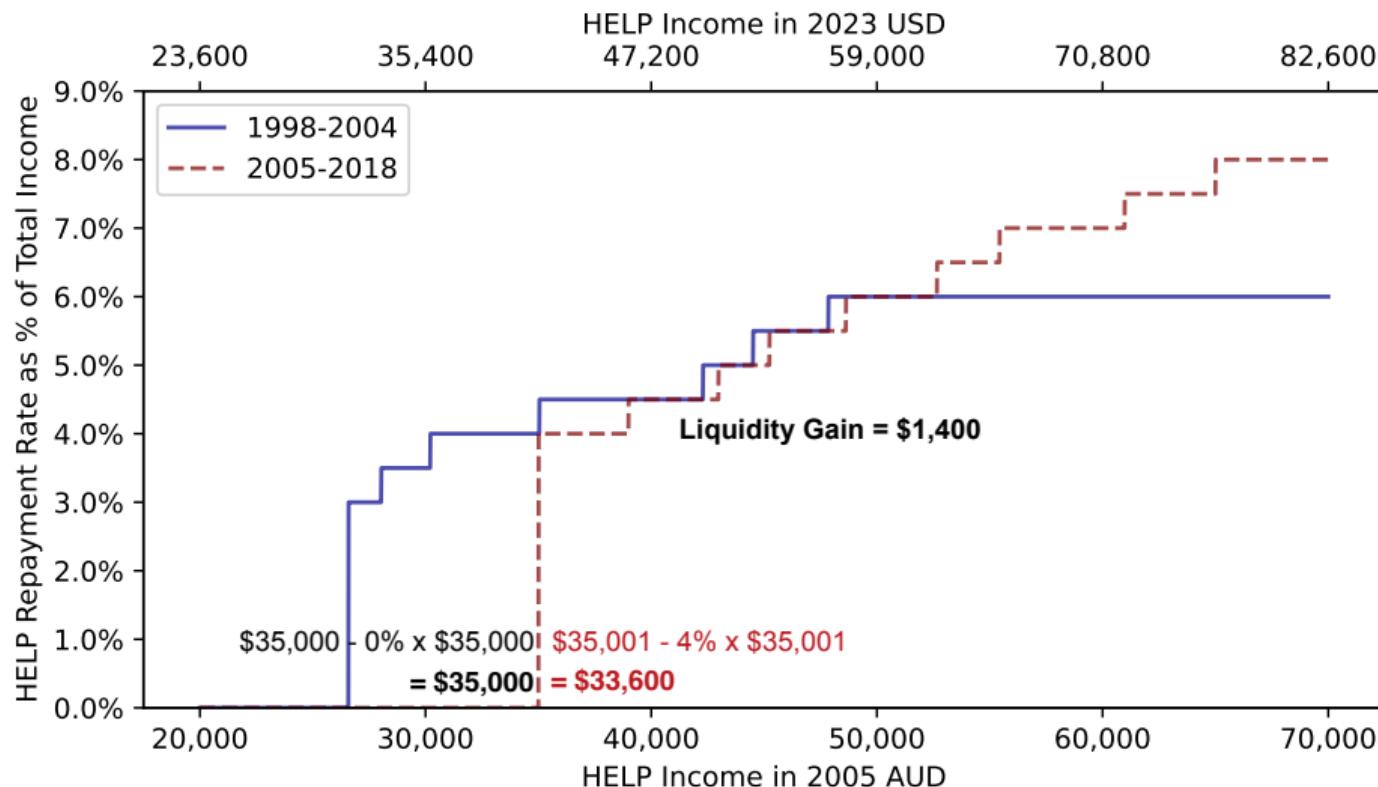


# IDENTIFYING VARIATION: POLICY CHANGE TO REPAYMENT RATES



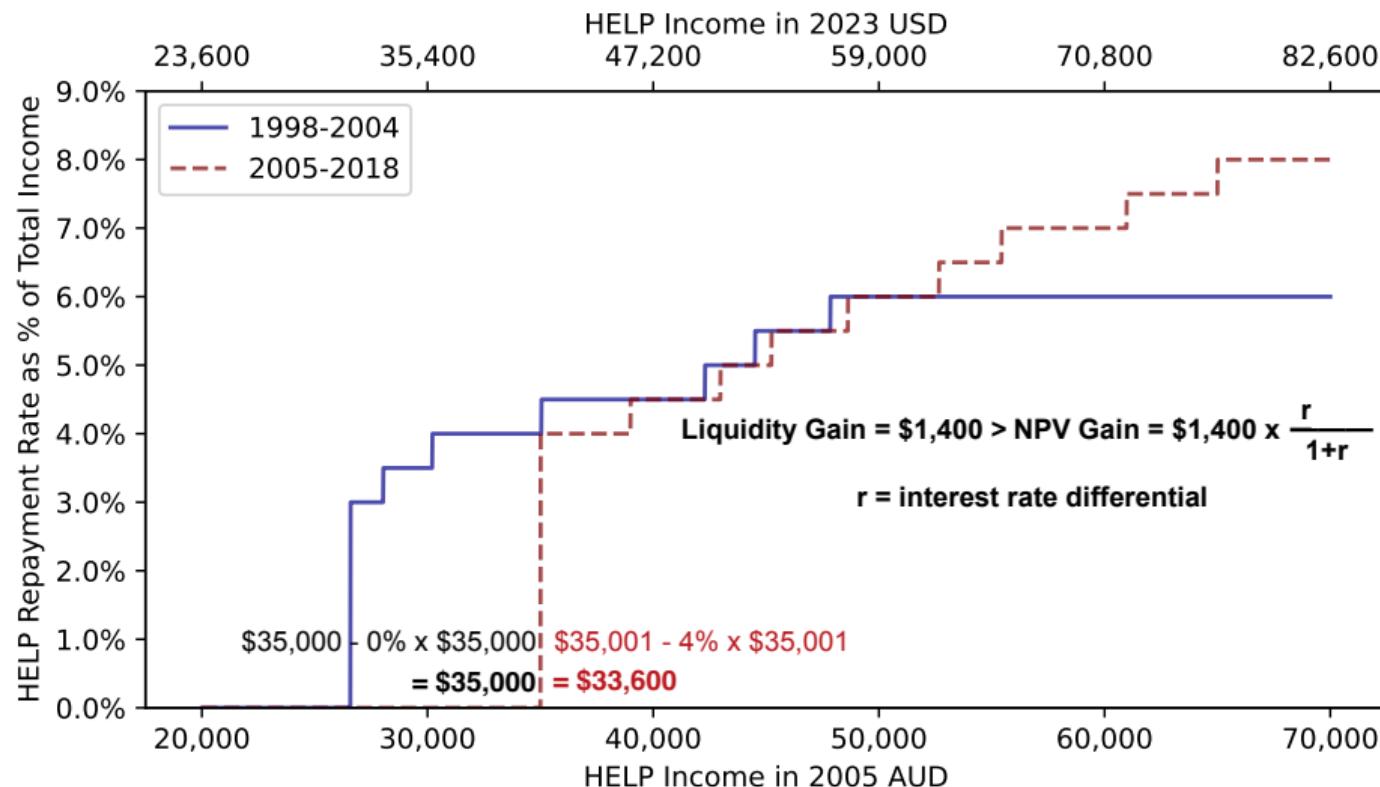
Note: policy change applied to new and existing debtholders

# REPAYMENT THRESHOLD INCREASES AVERAGE REPAYMENT RATE



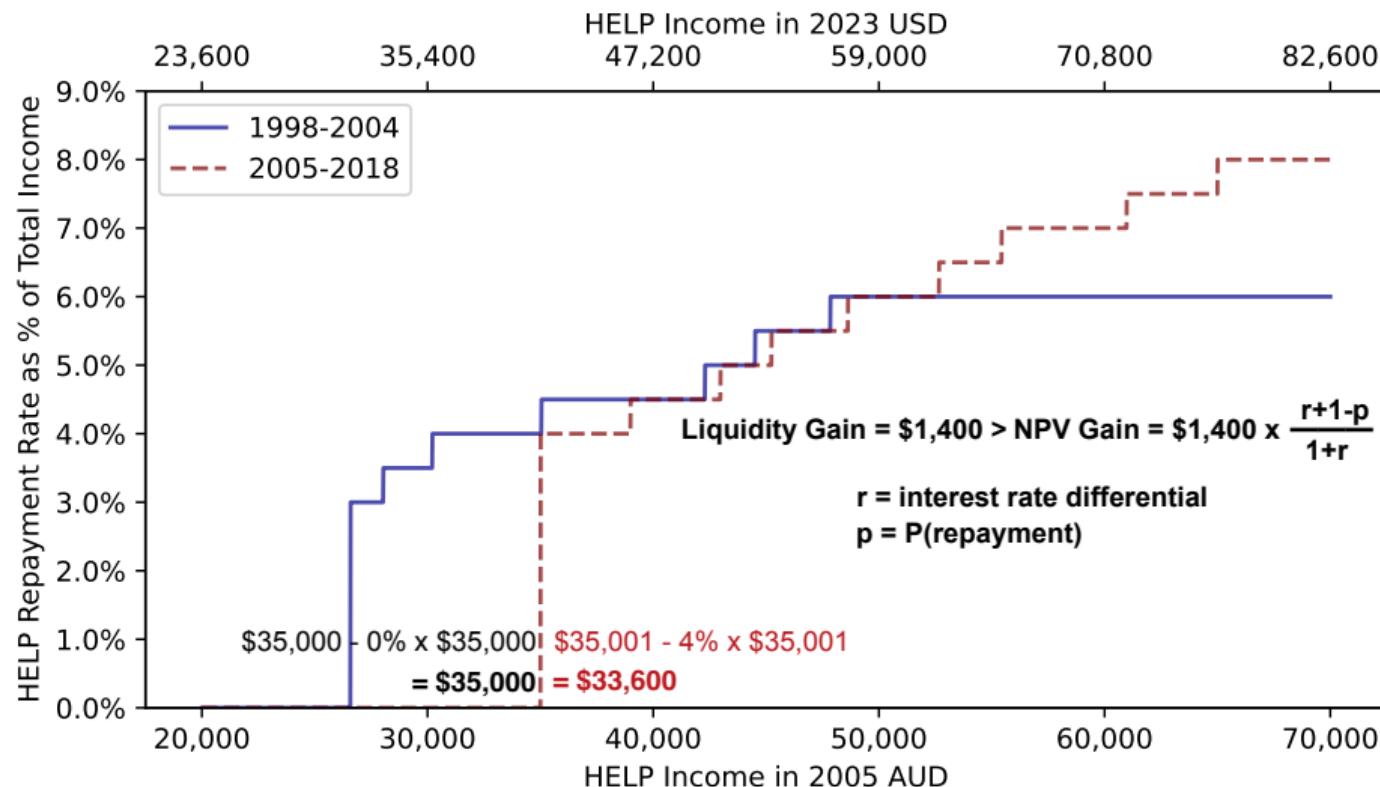
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# REPAYMENT THRESHOLD INCREASES LIQUIDITY MORE THAN WEALTH



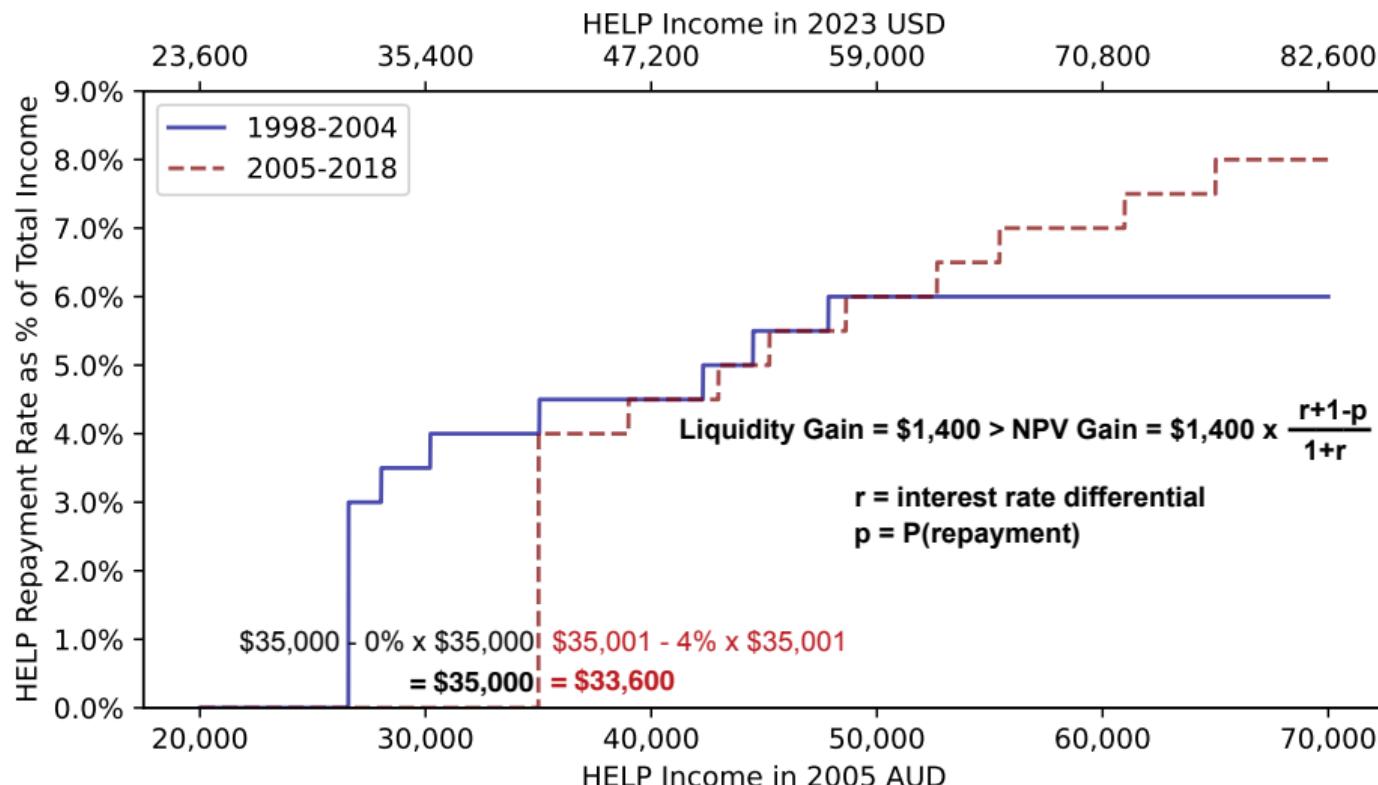
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► Marginal Rates

► Payments

► News

► Occupations

- ① Universe of individual tax returns from Australian Tax Office (~ US Form 1040)
- ② Administrative HELP data: debt balances and repayments
- ③ 2016 Household Census: self-reported hours and mortgage + rent payments
- ④ Administrative retirement savings data: superannuation balances
- ⑤ HILDA: survey data on hours worked and asset holdings

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**Sample:**  $\sim$  4 million **unique** debtholders between ages 20-64 from 1991-2018

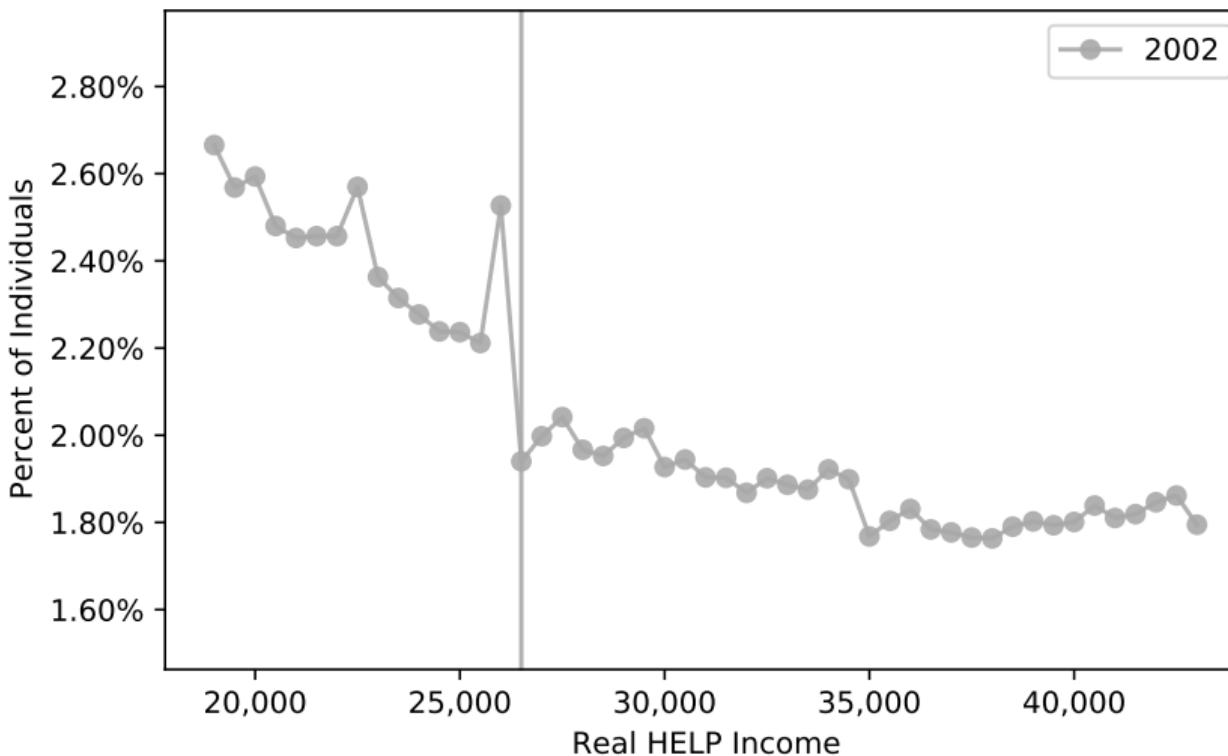
- Mean HELP Income at age 26 = \$34K with 98% from labor income

**Limitation:** no information about borrowing (e.g., degree, institution) (in progress!)

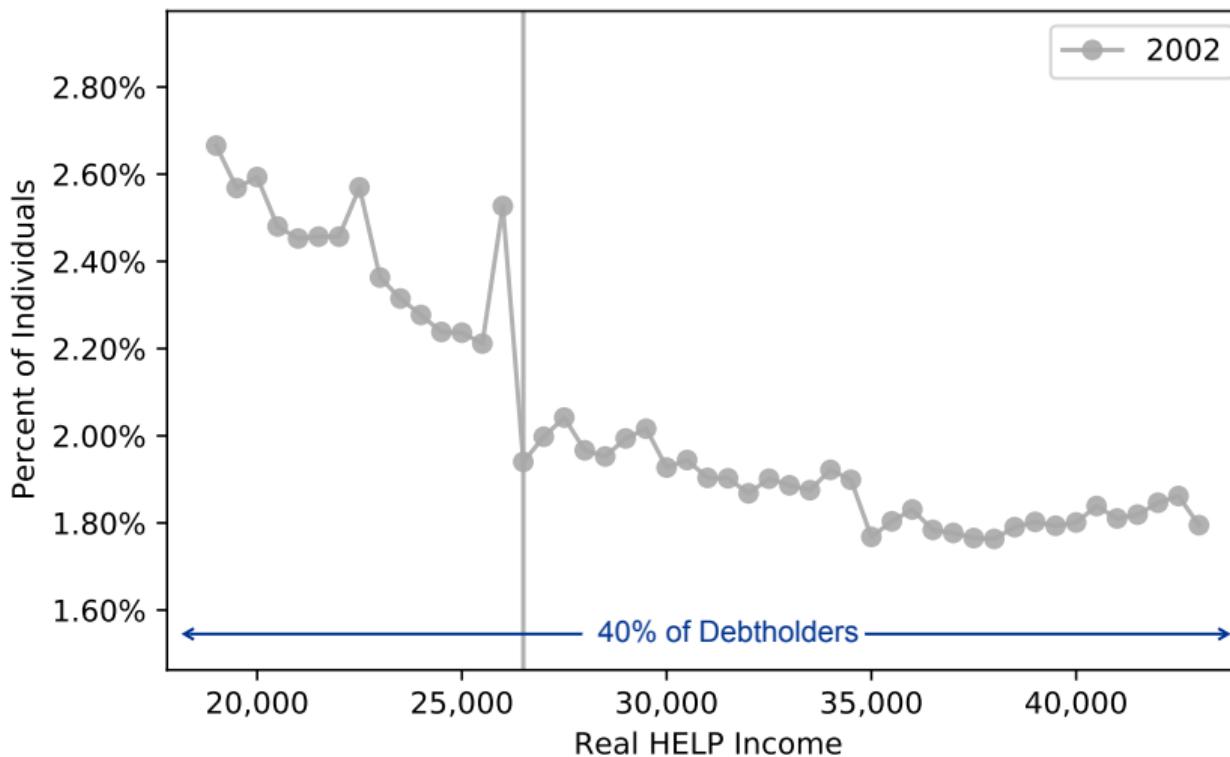
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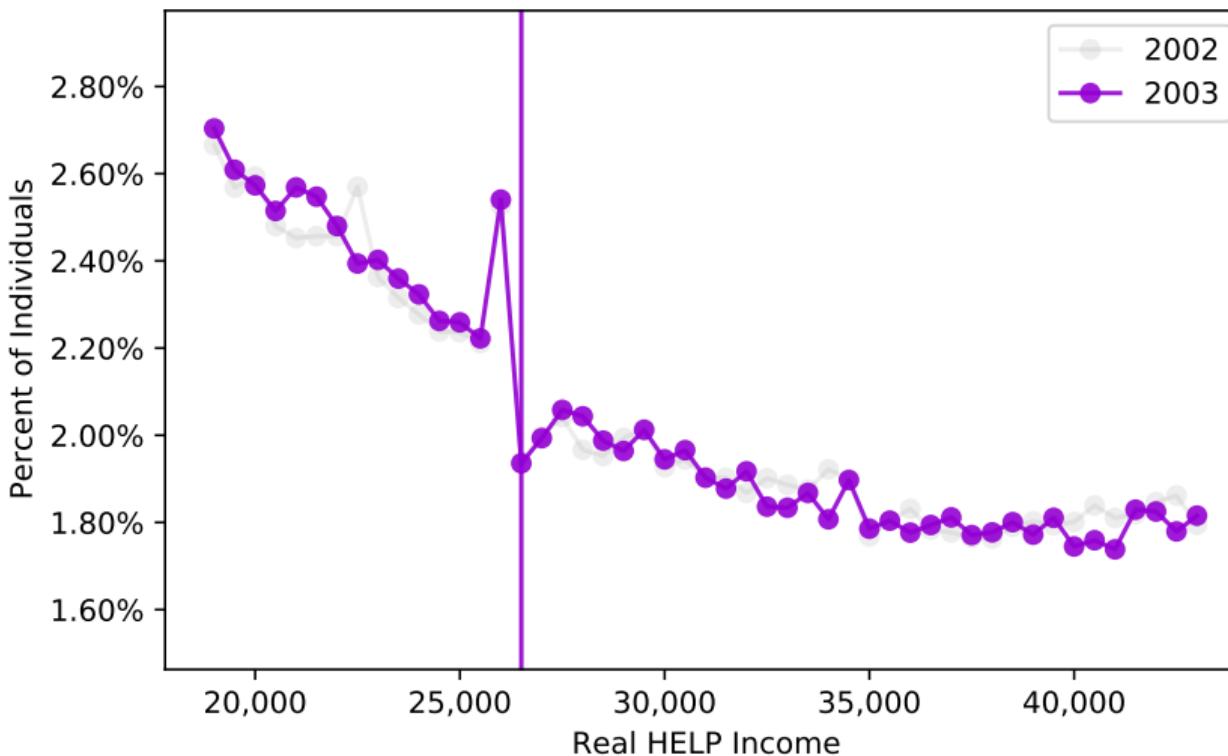
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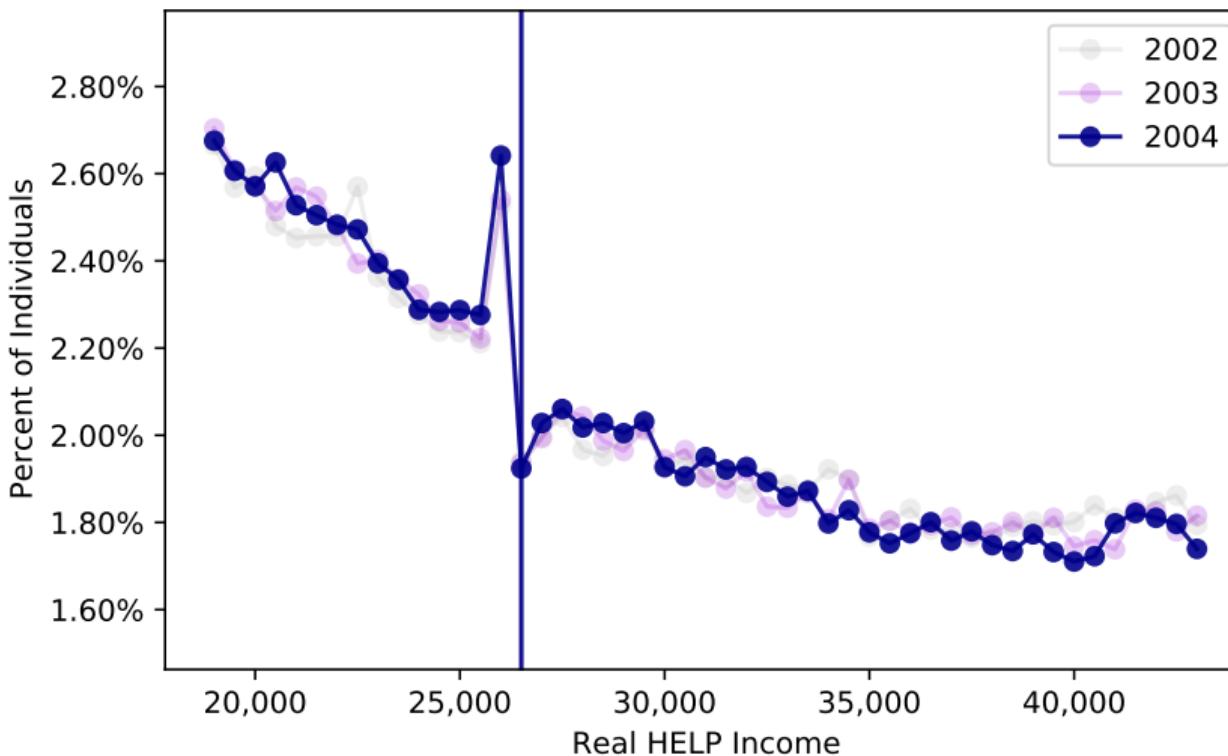
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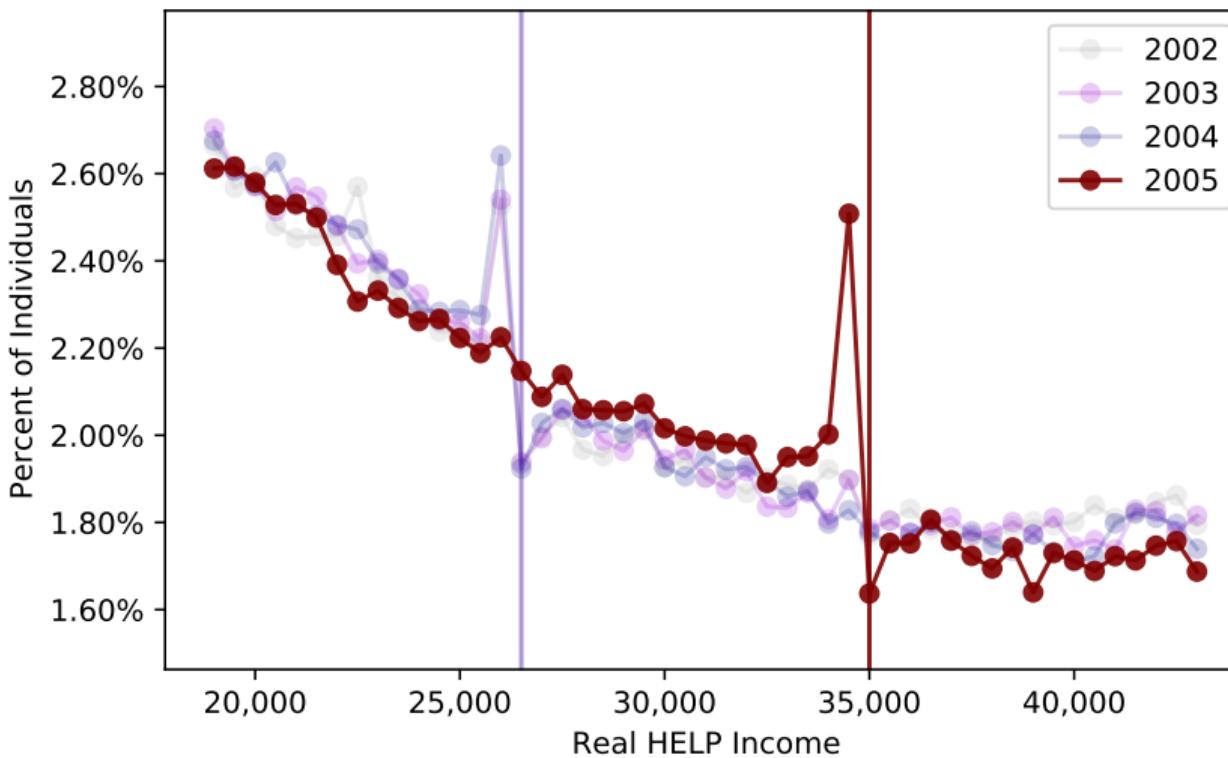
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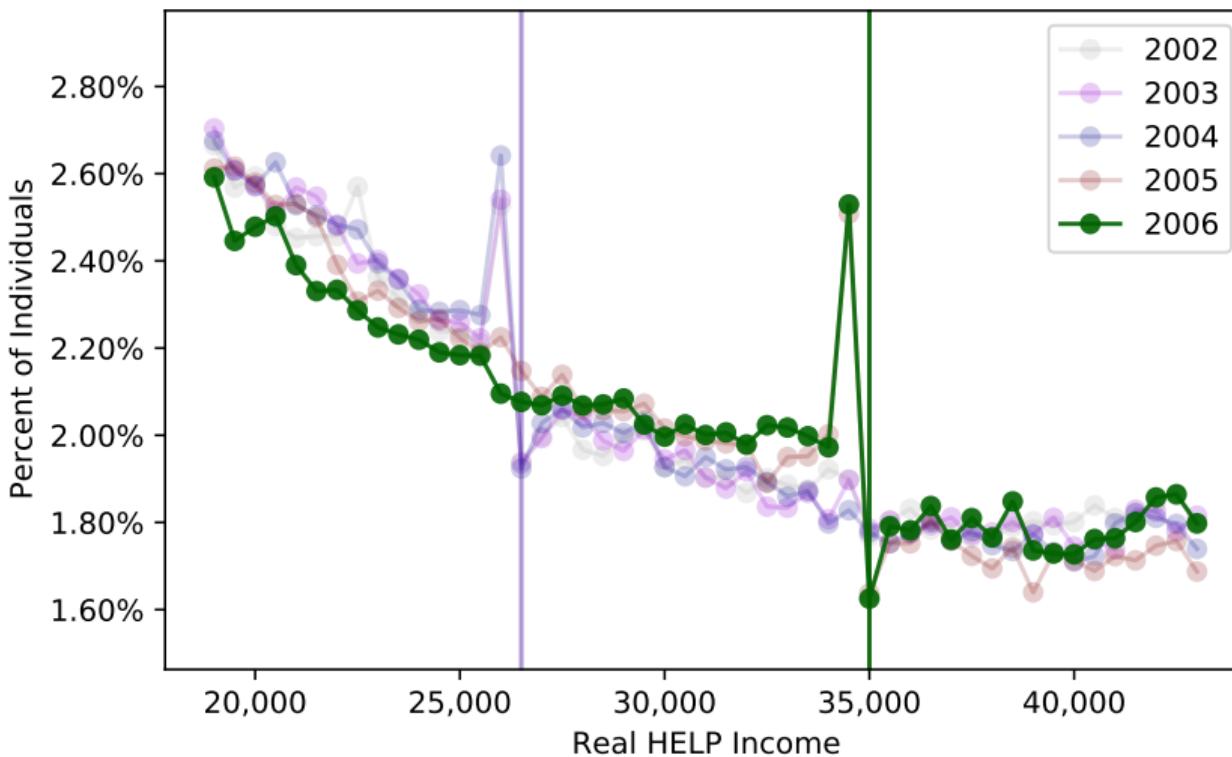
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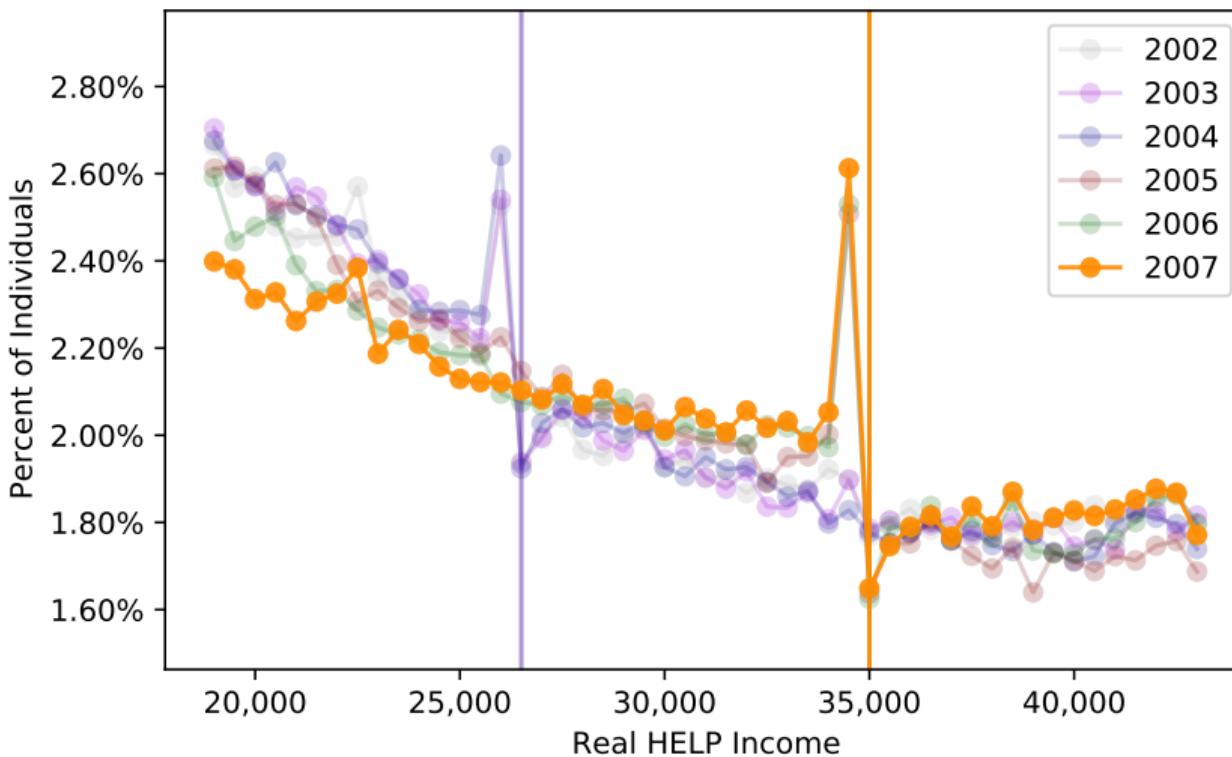
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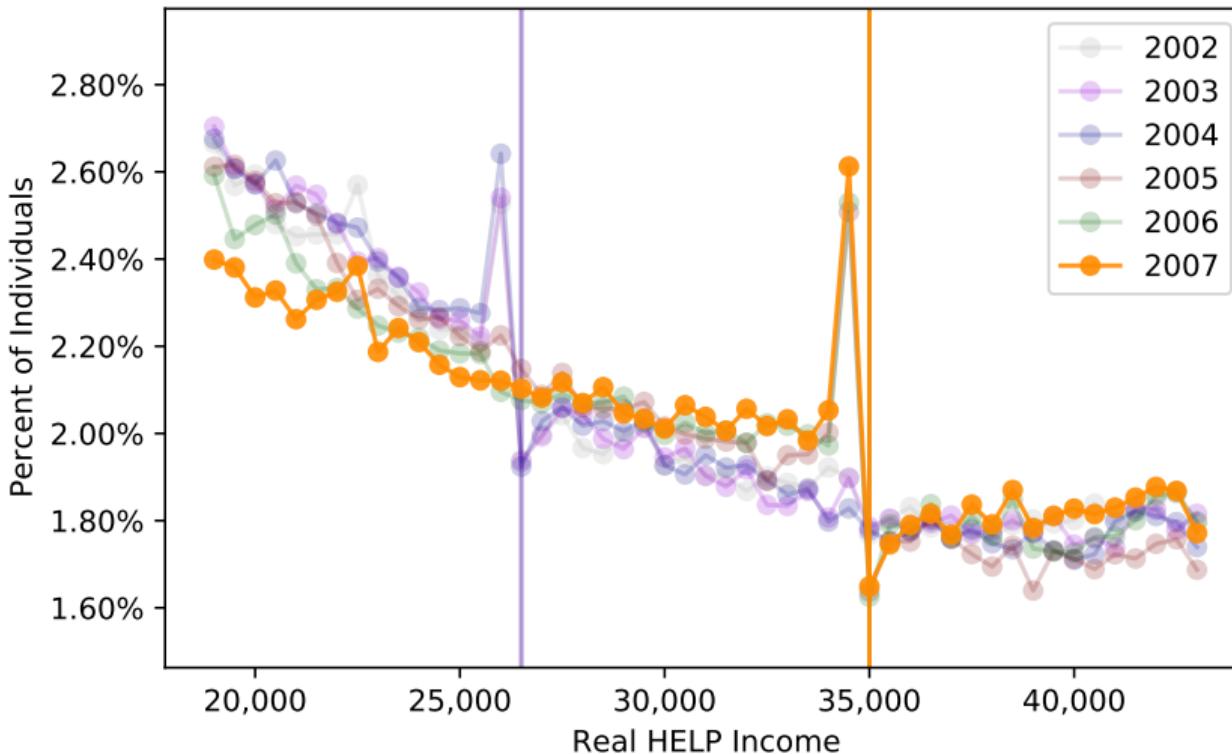
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- Next: does bunching reflect labor supply or evasion?

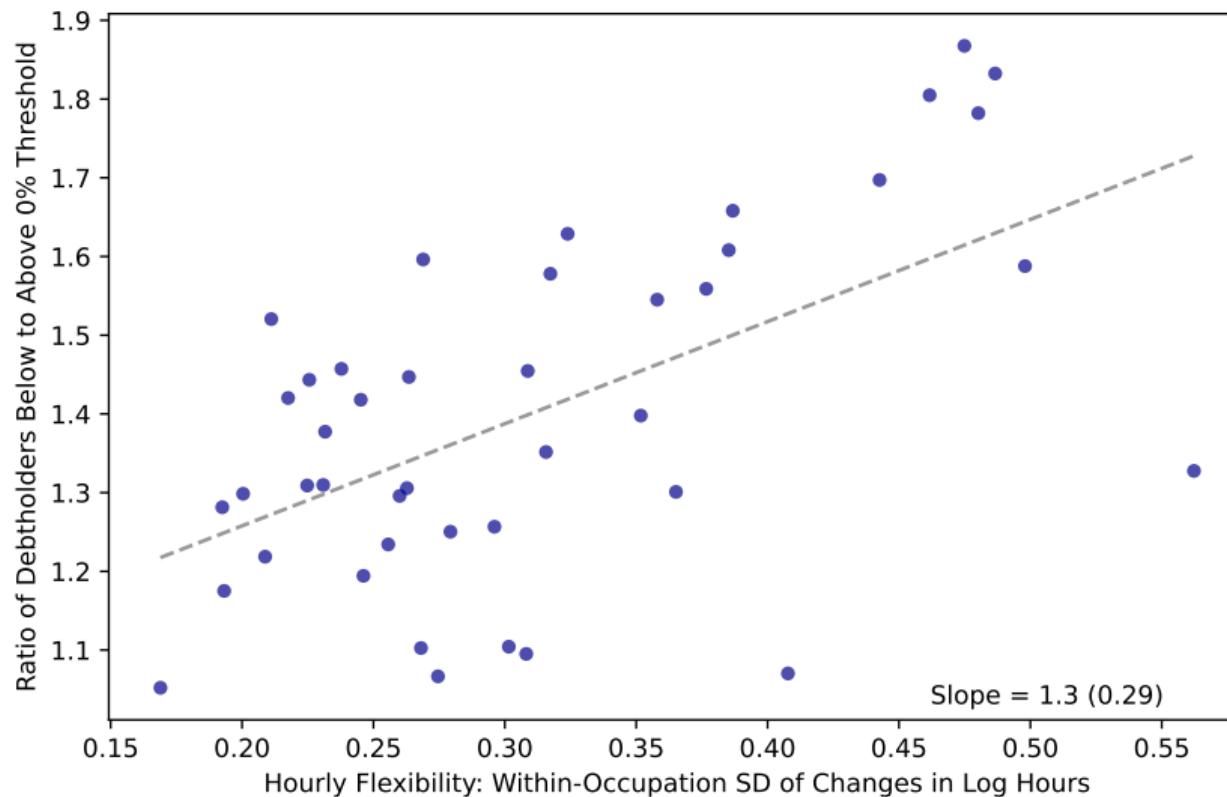
▶ Source

▶ Non-Debt

▶ Labor

▶ vs Tax

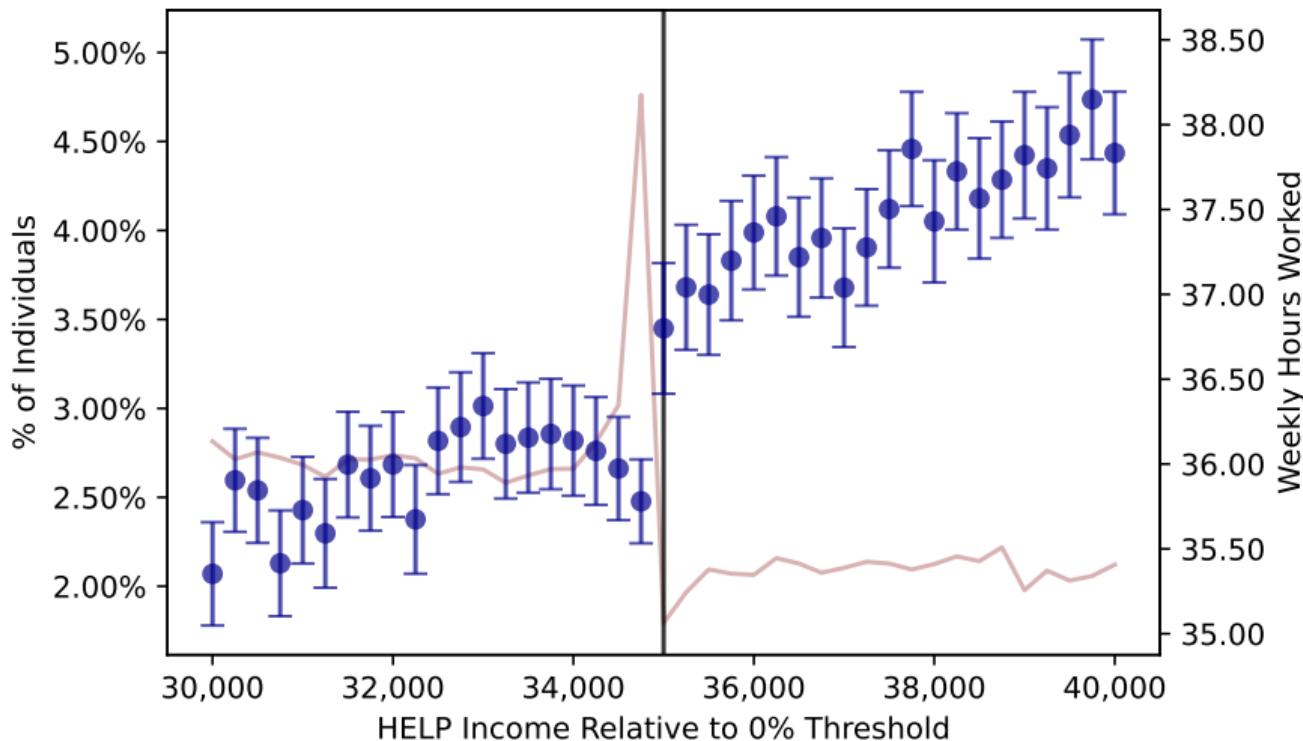
# MORE BUNCHING IN OCCUPATIONS WITH GREATER HOURLY FLEXIBILITY



Sample: all wage-earners between 2005-2018

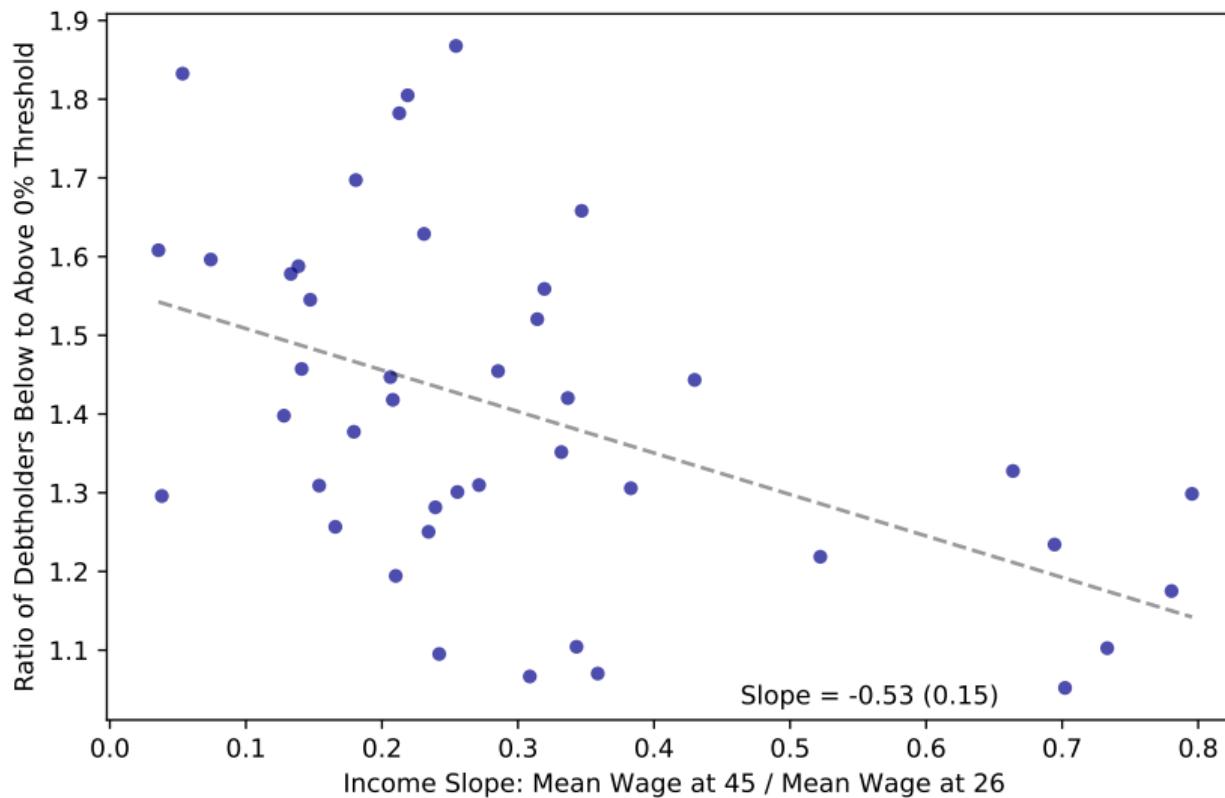
▶ Alt. Measure ▶ Evasion ▶ Table ▶ Profiles ▶ Additional Results

# BORROWERS BELOW REPAYMENT THRESHOLD WORK FEWER HOURS



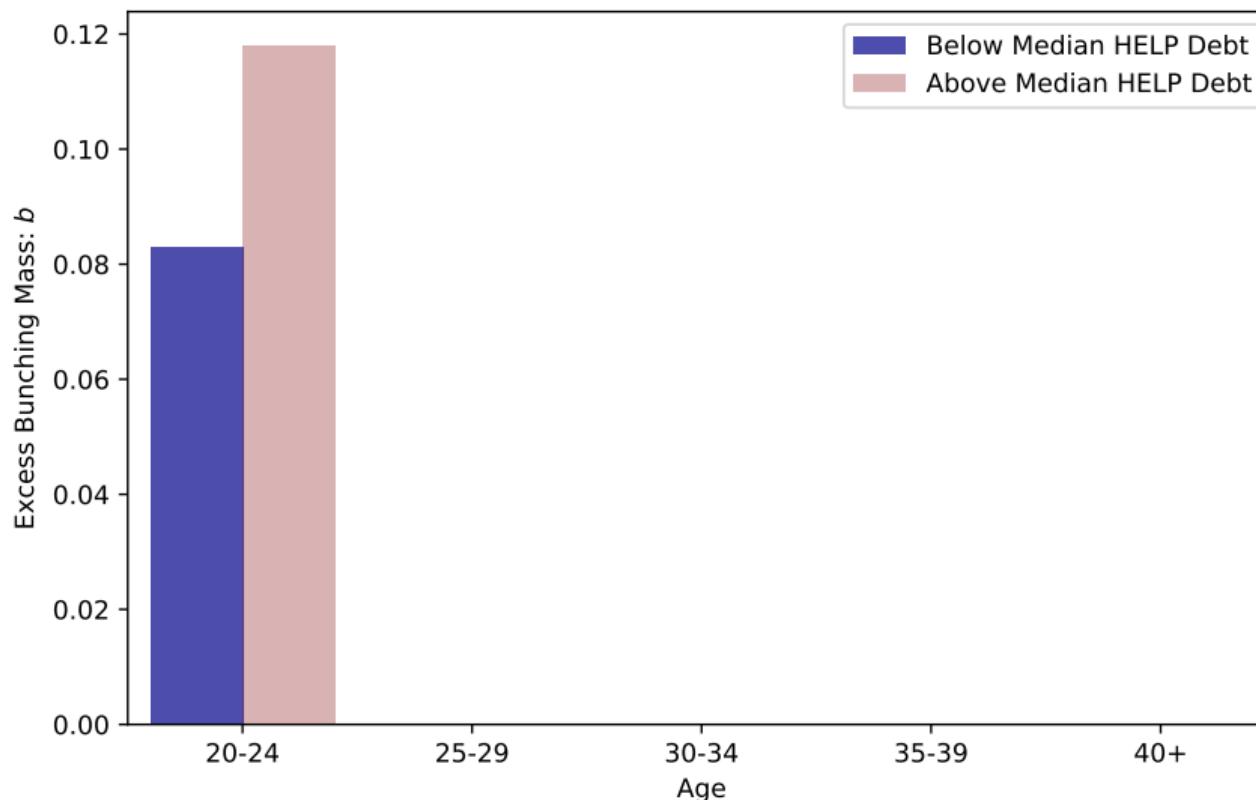
- In 2016, reduction is around **1** hour/week = 1.4 fewer weeks per year

# P(REPAYMENT) MATTERS: BUNCHING DECREASES WITH WAGE GROWTH



► Multivariate

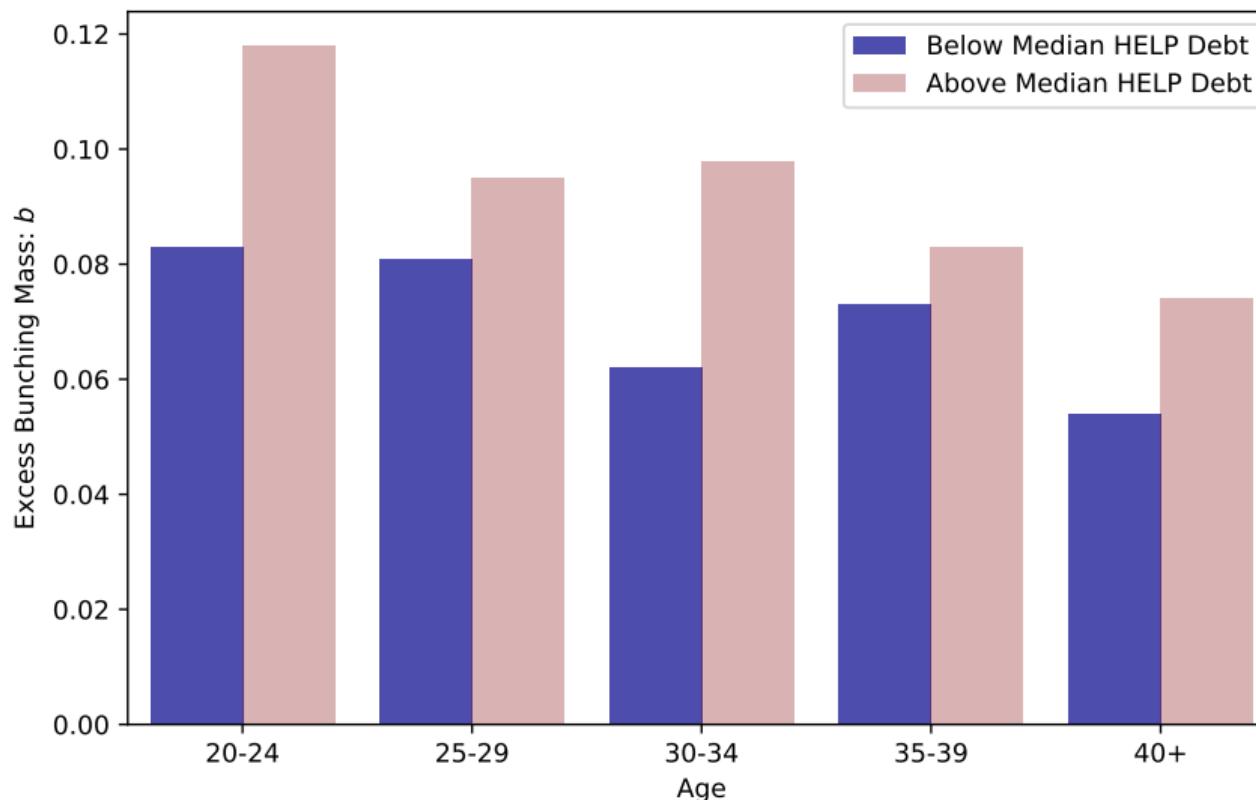
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Note: confidence intervals omitted due to small size

► *b* Details

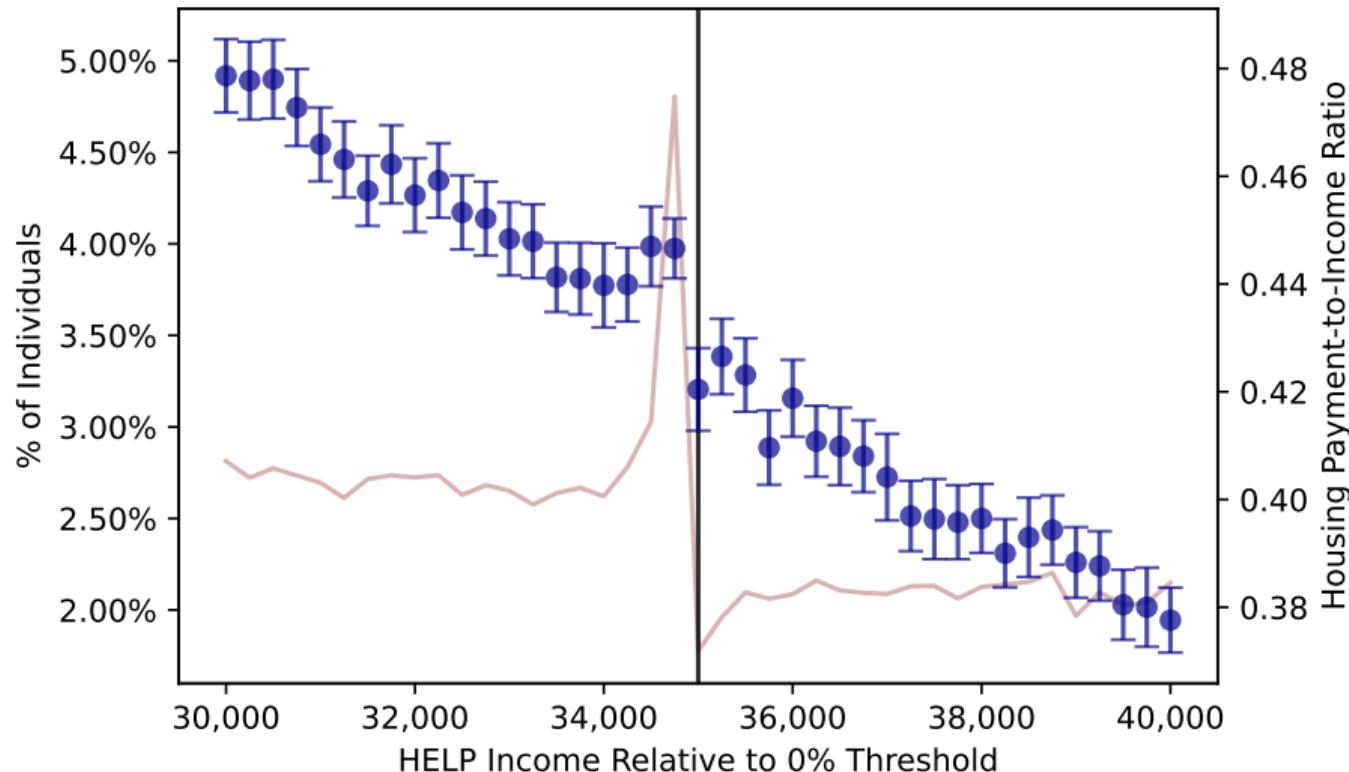
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# BUNCHING INCREASES WITH PROXIES FOR LIQUIDITY CONSTRAINTS



► Retirement Savings

► House Prices

## Empirical facts:

► Additional Results

- ① Borrowers reduce 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
  - **P(repayment)**: increases with debt, decreases with wage growth and peak
  - **Liquidity**: increases with liquidity demands, decreases with retirement wealth

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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

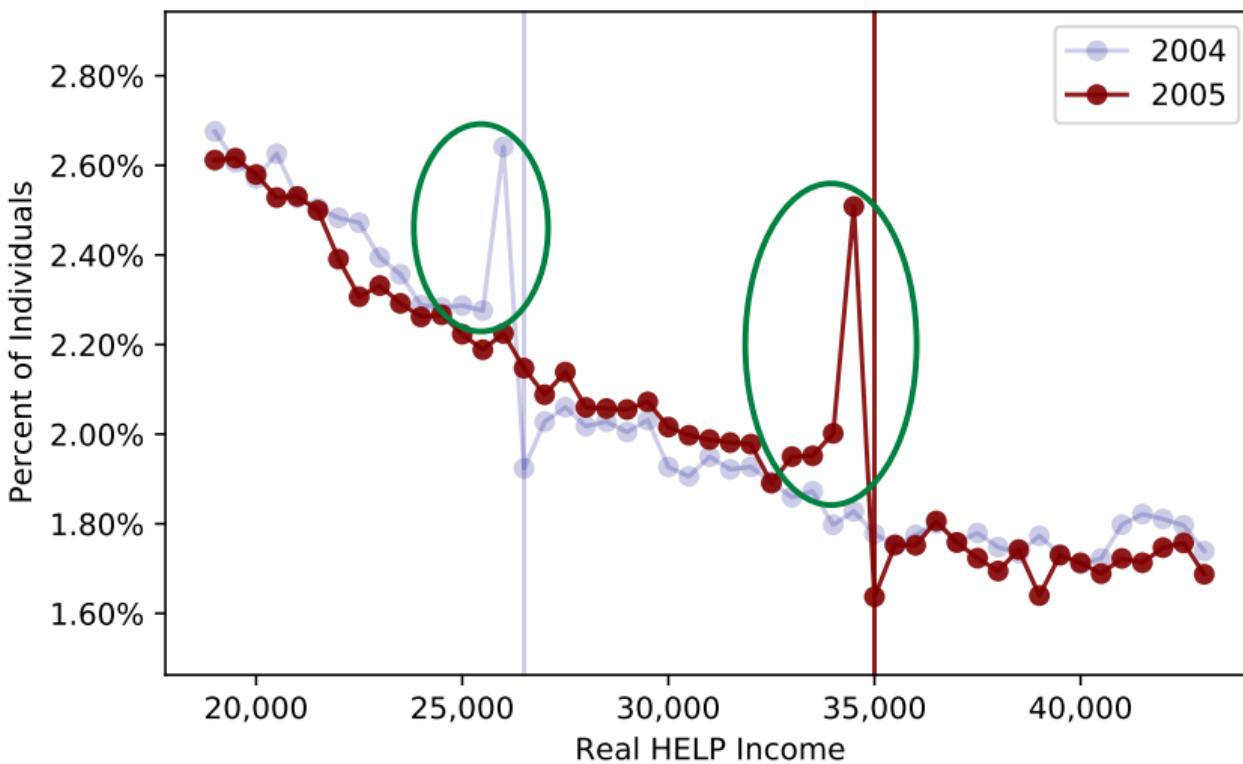
Life cycle model with debt + incomplete markets + endogenous labor supply

- 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 aggregate risk, partial equilibrium)
  - Shocks are **uninsurable**: borrowing allowed up to age-dependent limit with interest
- After age 64, individuals retire and choose consumption  $c_a$

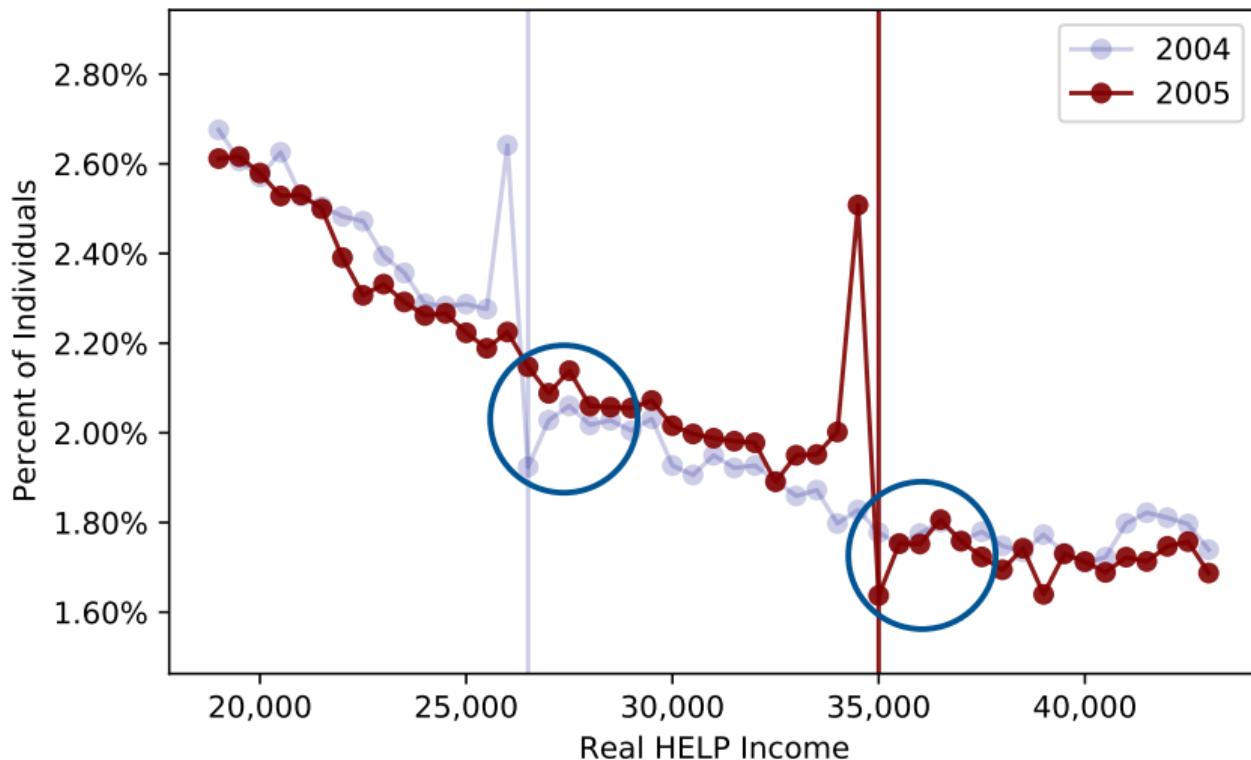
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- **Government**
  - Revenues: progressive income taxes, debt repayments
  - Expenses: means-tested unemployment benefits & retirement pension, initial debt

# 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

# LABOR SUPPLY OPTIMIZATION FRICTION

- Adjusting labor supply requires paying **stochastic** fixed cost Nakamura-Steinsson 2010

$$f_a = \omega_a \underline{f} + (1 - \omega_a) \bar{f}, \quad \omega_a \sim \text{Bernoulli}(\lambda), \quad \underline{f} < \bar{f}$$

- Nests the two canonical adjustment models:

- ①  $\underline{f} = 0, \bar{f} = \infty \Rightarrow$  Calvo model Andersen et al. 2020, Giglio et al. 2021
- ②  $\lambda = 1 \Rightarrow (S, s)$  model Abel et al. 2013, Handel 2013, Choukhmane 2021

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- $\underline{f}, \bar{f} \approx$  real or psychological costs of changing hours/jobs Chetty 2012

- Adjustment is **time-dependent** if  $\lambda < 1$

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- Key concern:  $\lambda, \underline{f}, \bar{f}$  not policy-invariant  $\Rightarrow$  compute values that overturn results

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

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

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

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

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

$$y_a = \ell_a w_a, \quad \log w_a = g_a + \theta_a + \epsilon_a$$

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

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

$$y_a = \ell_a w_a, \quad \log w_a = g_a + \theta_a + \epsilon_a$$

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

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

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

$$y_a = \ell_a w_a, \quad \log w_a = g_a + \theta_a + \epsilon_a$$

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

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

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

$$y_a = \ell_a w_a, \quad \log w_a = g_a + \theta_a + \epsilon_a$$

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

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

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

$$y_a = \ell_a w_a, \quad \log w_a = g_a + \theta_a + \epsilon_a$$

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

- $\ell_{a-1}$  = labor supply from previous period
- $\omega_a$  = shock that determines fixed cost

# INDIVIDUAL'S RECURSIVE PROBLEM

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

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

$$y_a = \ell_a w_a, \quad \log w_a = g_a + \theta_a + \epsilon_a$$

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

- 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 tax office
- **Initial conditions:** assets and debt distributions taken from data at age 22
- **Baseline RRA/EIS:**  $\sigma = 2.23$  Choukhmane-de Silva 2023
  - Welfare analysis: alternative values + preference for timing of uncertainty resolution

## SECOND-STAGE SIMULATED METHOD OF MOMENTS

Parameters =  $\left( \begin{array}{c} \\ \\ \\ \\ \end{array} \right)$

- **Estimation** via SMM with 44 moments + 16 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

$$\text{Parameters} = \begin{pmatrix} \text{labor supply} \\ \phi & \underline{f} & \lambda \end{pmatrix}$$

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

## SECOND-STAGE SIMULATED METHOD OF MOMENTS: IDENTIFICATION

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

- **Labor supply elasticity**: identified by bunching below repayment threshold
- **Frictions**: identified by mass above repayment threshold
- Separate identification of **frictions**
  - **Intuition**: with  $\lambda = 1$ , bunching is quite persistent
  - Moment:  $P(\text{bunching}_{2005} | \text{bunching}_{2004})$

## SECOND-STAGE SIMULATED METHOD OF MOMENTS: IDENTIFICATION

$$\text{Parameters} = \left( \overbrace{\phi \quad f \quad \lambda}^{\text{labor supply}} \quad \beta \right)$$

- Labor supply elasticity: identified by bunching below repayment threshold
- Frictions: identified by mass above repayment threshold
- Separate identification of frictions
- Identification of time preferences
  - Intuition: ICL looks like a tax to a myopic agent  $\Rightarrow$  bunching  $\perp$  debt
  - Moment: heterogeneity in bunching with debt

## SECOND-STAGE SIMULATED METHOD OF MOMENTS: IDENTIFICATION

$$\text{Parameters} = \left( \overbrace{\phi \ f \ \lambda}^{\text{labor supply}} \ \beta \ \bar{f} \right)$$

- Labor supply elasticity: identified by bunching below repayment threshold
- Frictions: identified by mass above repayment threshold
- Separate identification of frictions
- Identification of time preferences
- Identification of **upper** adjustment cost
  - Moment: kurtosis of changes in labor supply Alvarez et al. 2016
  - Use survey data + allow for measurement error
  - Alternative: fix  $\bar{f} = \infty$

## SECOND-STAGE SIMULATED METHOD OF MOMENTS: IDENTIFICATION

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

- Labor supply elasticity: identified by bunching below repayment threshold
- Frictions: identified by mass above repayment threshold
- Separate identification of frictions
- Identification of time preferences
- Identification of upper adjustment cost
- No panel data on **hours**  $\Rightarrow$  wage profile & wage risk estimated **jointly**

# ESTIMATION RESULTS

Parameter	Estimation	
	No Frictions	
Labor supply elasticity	$\phi$	0.004
Lower fixed cost	$f$	0
Adjustment probability	$\lambda$	1
Upper fixed cost	$\bar{f}$	$\infty$
Time discount factor	$\beta$	0.999
Labor supply scaling parameter	$\log \kappa$	0.889
Wage profile parameters	$\delta_0$	9.591
	$\delta_1$	0.075
	$\delta_2$	-0.001
	$\delta_{0,E}$	-0.408
	$\delta_{1,E}$	0.023
Persistence of permanent shock	$\rho$	0.961
Standard deviation of permanent shock	$\sigma_\nu$	0.068
Standard deviation of transitory shock	$\sigma_\epsilon$	0.650
Standard deviation of individual FE	$\sigma_i$	0.191
Measurement error in hours	$\xi$	.

► Comparison with Literature

► All Results with SE

# ESTIMATION RESULTS

Parameter		Estimation	
		No Frictions	+ $(S, s)$
Labor supply elasticity	$\phi$	0.004	0.089
Lower fixed cost	$f$	0	\$1401
Adjustment probability	$\lambda$	1	1
Upper fixed cost	$\bar{f}$	$\infty$	$\infty$
Time discount factor	$\beta$	0.999	0.934
Labor supply scaling parameter	$\log \kappa$	0.889	0.027
Wage profile parameters	$\delta_0$	9.591	9.514
	$\delta_1$	0.075	0.064
	$\delta_2$	-0.001	-0.001
	$\delta_{0,E}$	-0.408	-0.473
	$\delta_{1,E}$	0.023	0.023
Persistence of permanent shock	$\rho$	0.961	0.936
Standard deviation of permanent shock	$\sigma_\nu$	0.068	0.214
Standard deviation of transitory shock	$\sigma_\epsilon$	0.650	0.176
Standard deviation of individual FE	$\sigma_i$	0.191	0.618
Measurement error in hours	$\xi$	.	.

► Comparison with Literature

► All Results with SE

# ESTIMATION RESULTS

Parameter		Estimation		
		No Frictions	+ ( $S, s$ )	+ Calvo
Labor supply elasticity	$\phi$	0.004	0.089	0.130
Lower fixed cost	$f$	0	\$1401	\$775
Adjustment probability	$\lambda$	1	1	0.186
Upper fixed cost	$\bar{f}$	$\infty$	$\infty$	$\infty$
Time discount factor	$\beta$	0.999	0.934	0.936
Labor supply scaling parameter	$\log \kappa$	0.889	0.027	-0.250
Wage profile parameters	$\delta_0$	9.591	9.514	9.108
	$\delta_1$	0.075	0.064	0.069
	$\delta_2$	-0.001	-0.001	-0.001
	$\delta_{0,E}$	-0.408	-0.473	-0.481
	$\delta_{1,E}$	0.023	0.023	0.021
Persistence of permanent shock	$\rho$	0.961	0.936	0.915
Standard deviation of permanent shock	$\sigma_\nu$	0.068	0.214	0.254
Standard deviation of transitory shock	$\sigma_\epsilon$	0.650	0.176	0.111
Standard deviation of individual FE	$\sigma_i$	0.191	0.618	0.609
Measurement error in hours	$\xi$	.	.	.

► Comparison with Literature

► All Results with SE

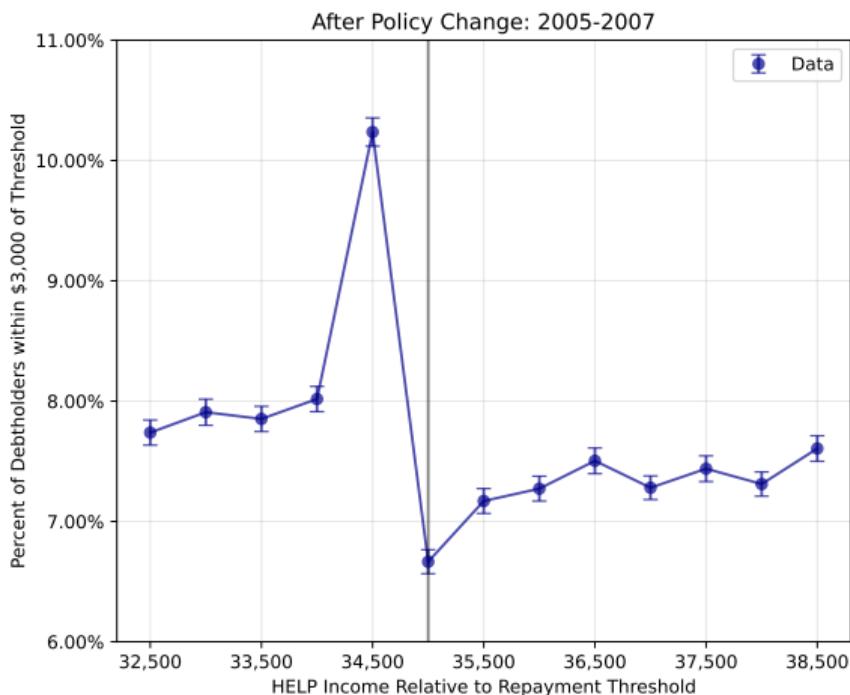
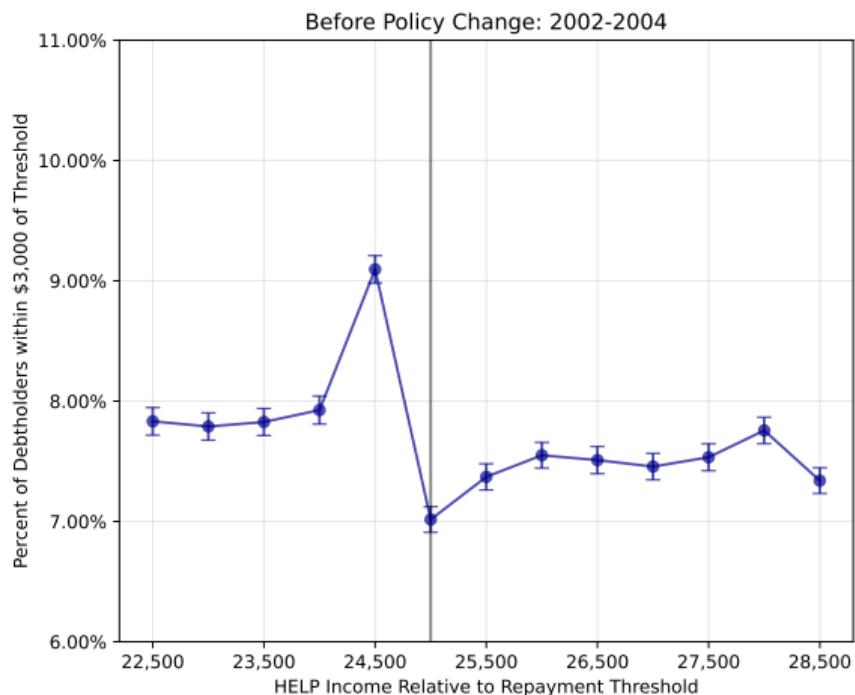
# ESTIMATION RESULTS

Parameter		Estimation			
		No Frictions	+ $(S, s)$	+ Calvo	+ $\bar{f} < \infty$
Labor supply elasticity	$\phi$	0.004	0.089	0.130	0.158
Lower fixed cost	$\underline{f}$	0	\$1401	\$775	\$1110
Adjustment probability	$\lambda$	1	1	0.186	0.242
Upper fixed cost	$\bar{f}$	$\infty$	$\infty$	$\infty$	\$5375
Time discount factor	$\beta$	0.999	0.934	0.936	0.896
Labor supply scaling parameter	$\log \kappa$	0.889	0.027	-0.250	-0.518
Wage profile parameters	$\delta_0$	9.591	9.514	9.108	8.922
	$\delta_1$	0.075	0.064	0.069	0.069
	$\delta_2$	-0.001	-0.001	-0.001	-0.001
	$\delta_{0,E}$	-0.408	-0.473	-0.481	-0.487
	$\delta_{1,E}$	0.023	0.023	0.021	0.021
Persistence of permanent shock	$\rho$	0.961	0.936	0.915	0.945
Standard deviation of permanent shock	$\sigma_\nu$	0.068	0.214	0.254	0.193
Standard deviation of transitory shock	$\sigma_\epsilon$	0.650	0.176	0.111	0.168
Standard deviation of individual FE	$\sigma_i$	0.191	0.618	0.609	0.556
Measurement error in hours	$\xi$	.	.	.	0.031

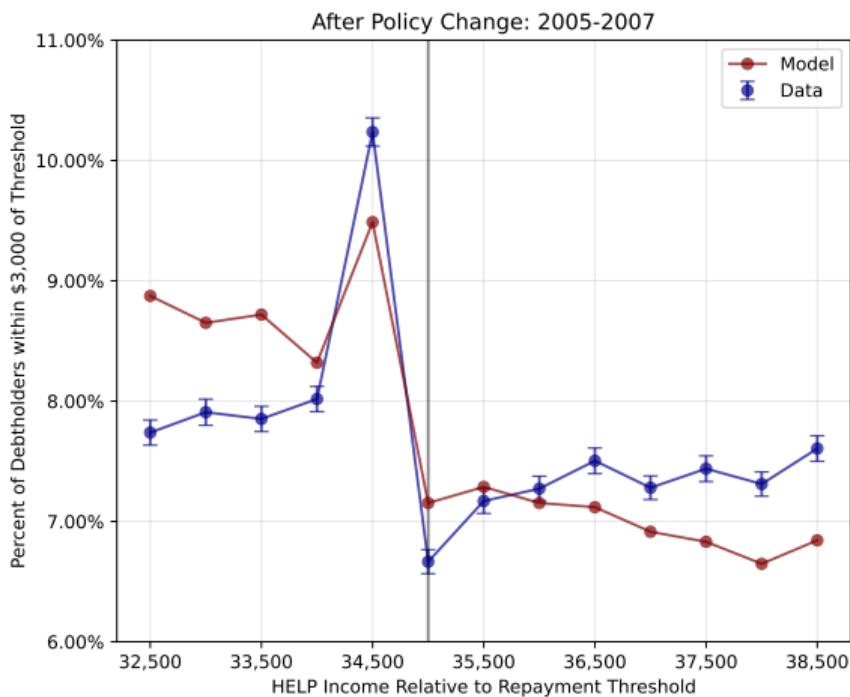
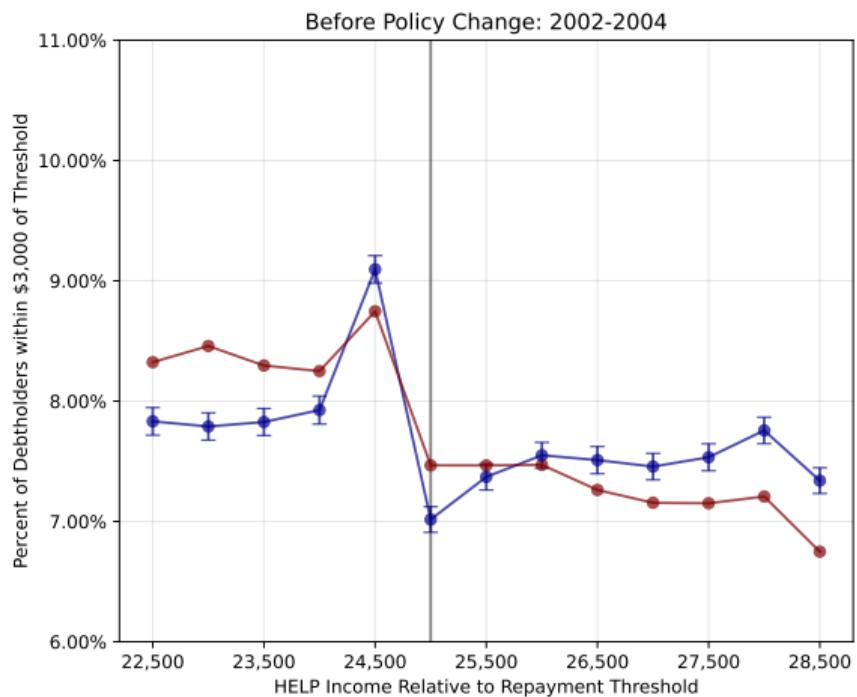
► Comparison with Literature

► All Results with SE

# MODEL FIT: BUNCHING BEFORE AND AFTER POLICY CHANGE



# MODEL FIT: BUNCHING BEFORE AND AFTER POLICY CHANGE



# OUTLINE

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

Conditional on government subsidy for higher education + existing taxes/transfers,  
what contract best balances **insurance** with **moral hazard**?

- **Perspective:** 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, prices held fixed
  - **Caveat:** borrowing and education choices held fixed  $\approx$  debt **restructuring**

# NORMATIVE ANALYSIS

Conditional on government subsidy for higher education + existing taxes/transfers,  
what contract best balances **insurance** with **moral hazard**?

- Perspective: social planner that maximizes borrower welfare with one contract
- **Government budget:**

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

- **Step 1: Existing** income-contingent loans vs. fixed repayment (not budget-neutral)

# NORMATIVE ANALYSIS

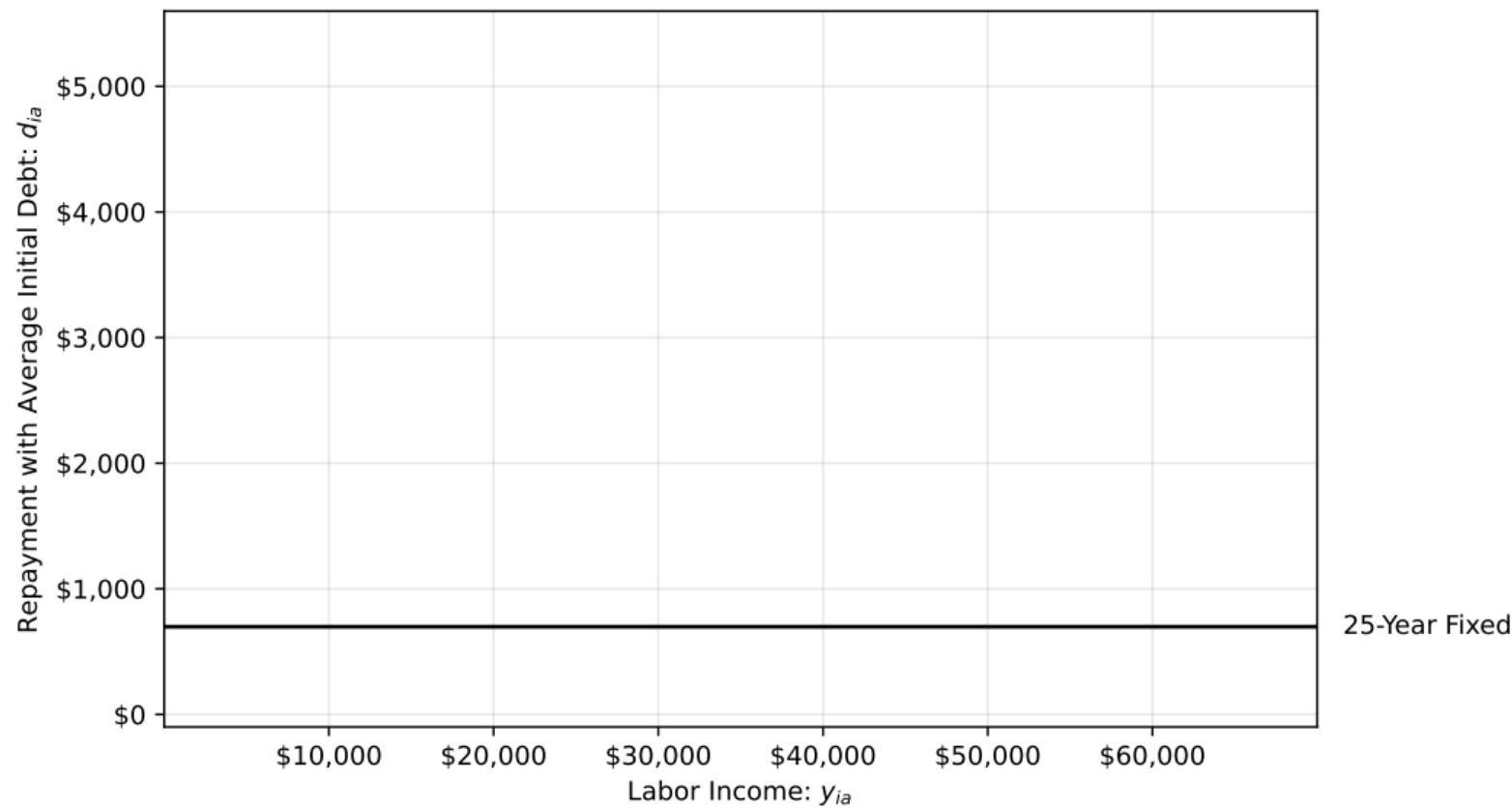
Conditional on government subsidy for higher education + existing taxes/transfers,  
what contract best balances **insurance** with **moral hazard**?

- Perspective: social planner that maximizes borrower welfare with one contract
- Government budget:

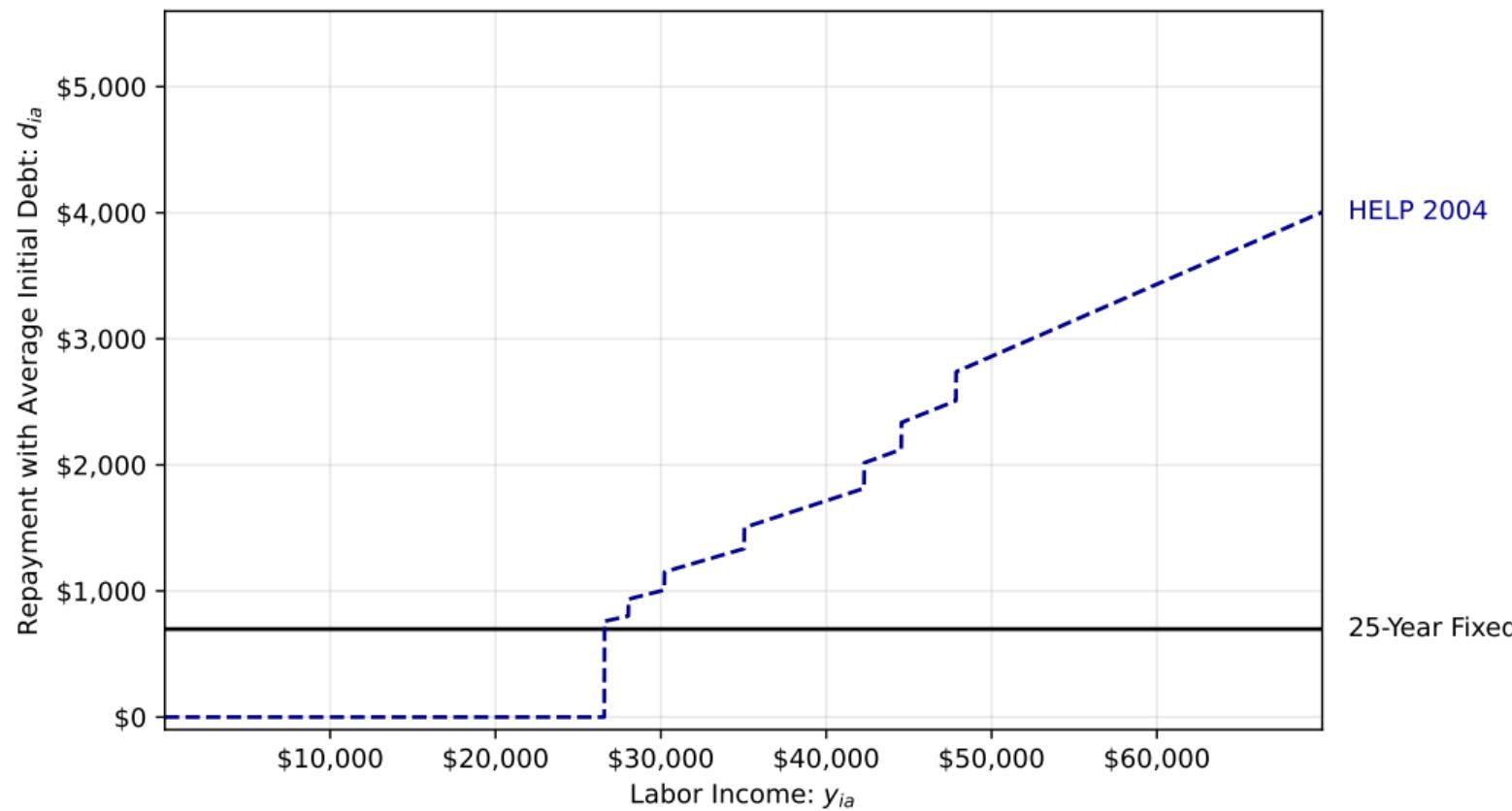
$$\mathcal{G} \equiv \mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a + \text{Taxes}_a - \text{Transfers}_a}{(R)^{a-a_0}}$$

- Step 1: Existing income-contingent loans vs. fixed repayment (not budget-neutral)
- **Step 2:** Construct income-contingent loans with **same** fiscal cost (budget-neutral)

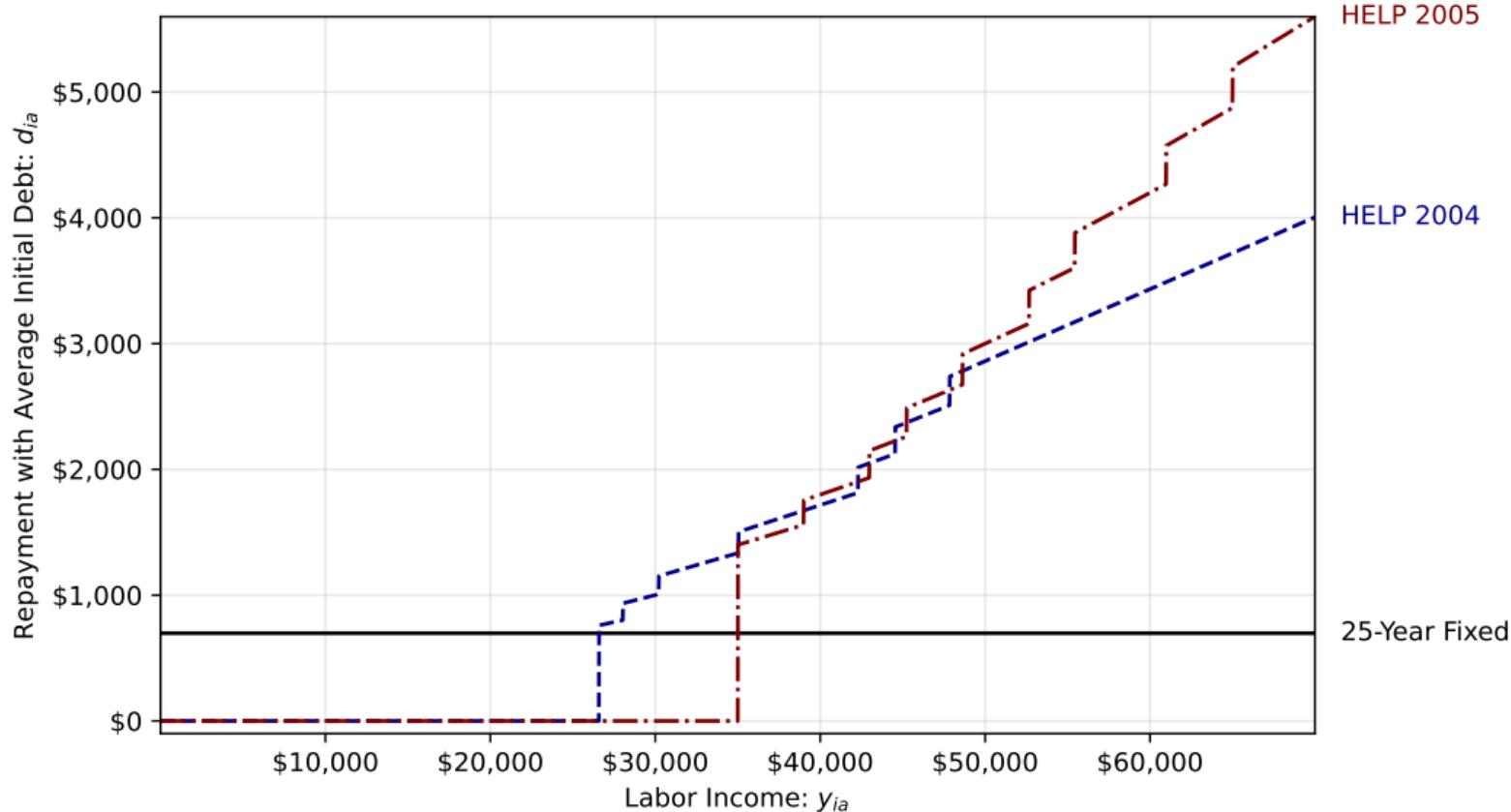
# EXISTING INCOME-CONTINGENT LOANS



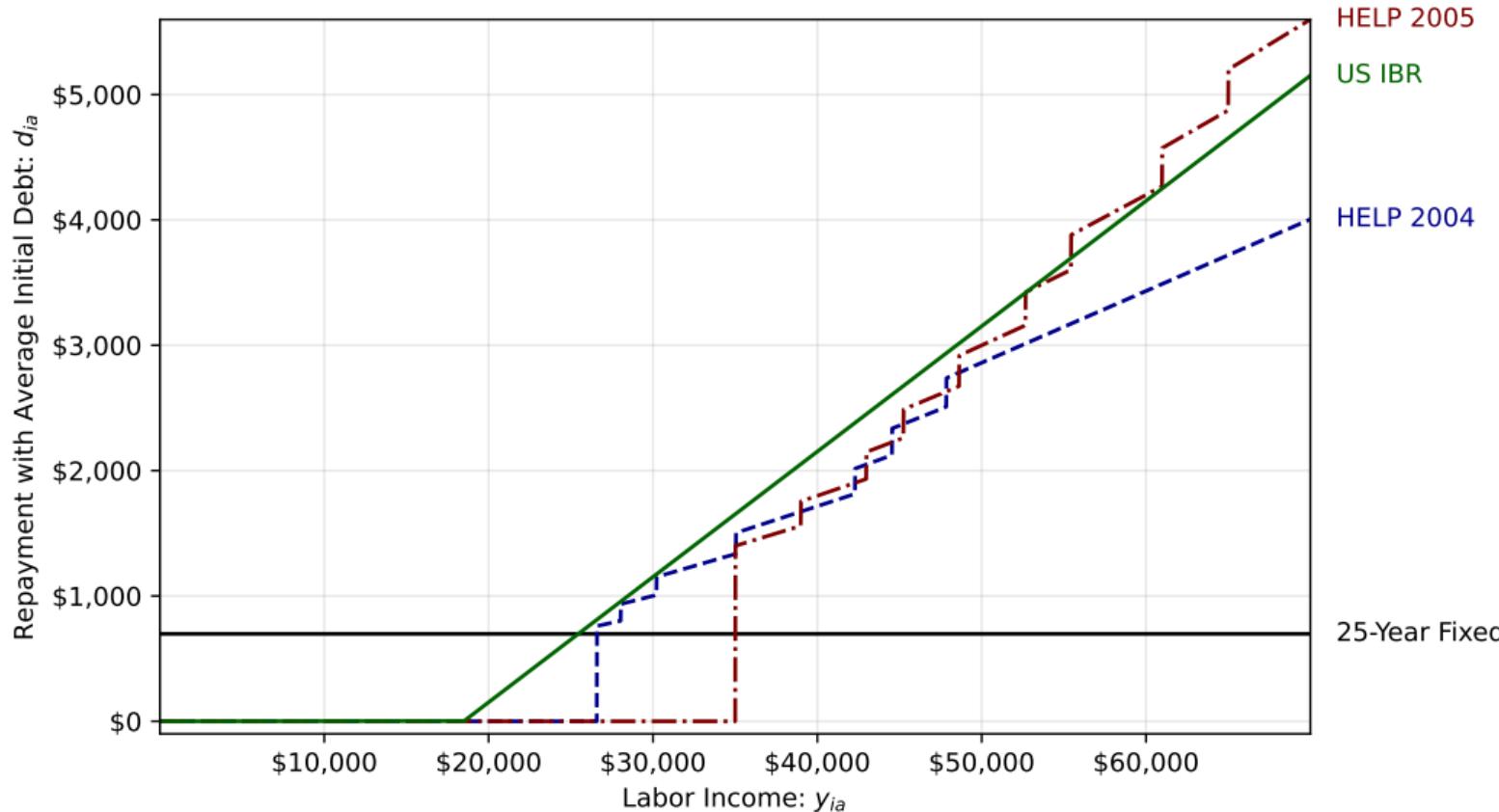
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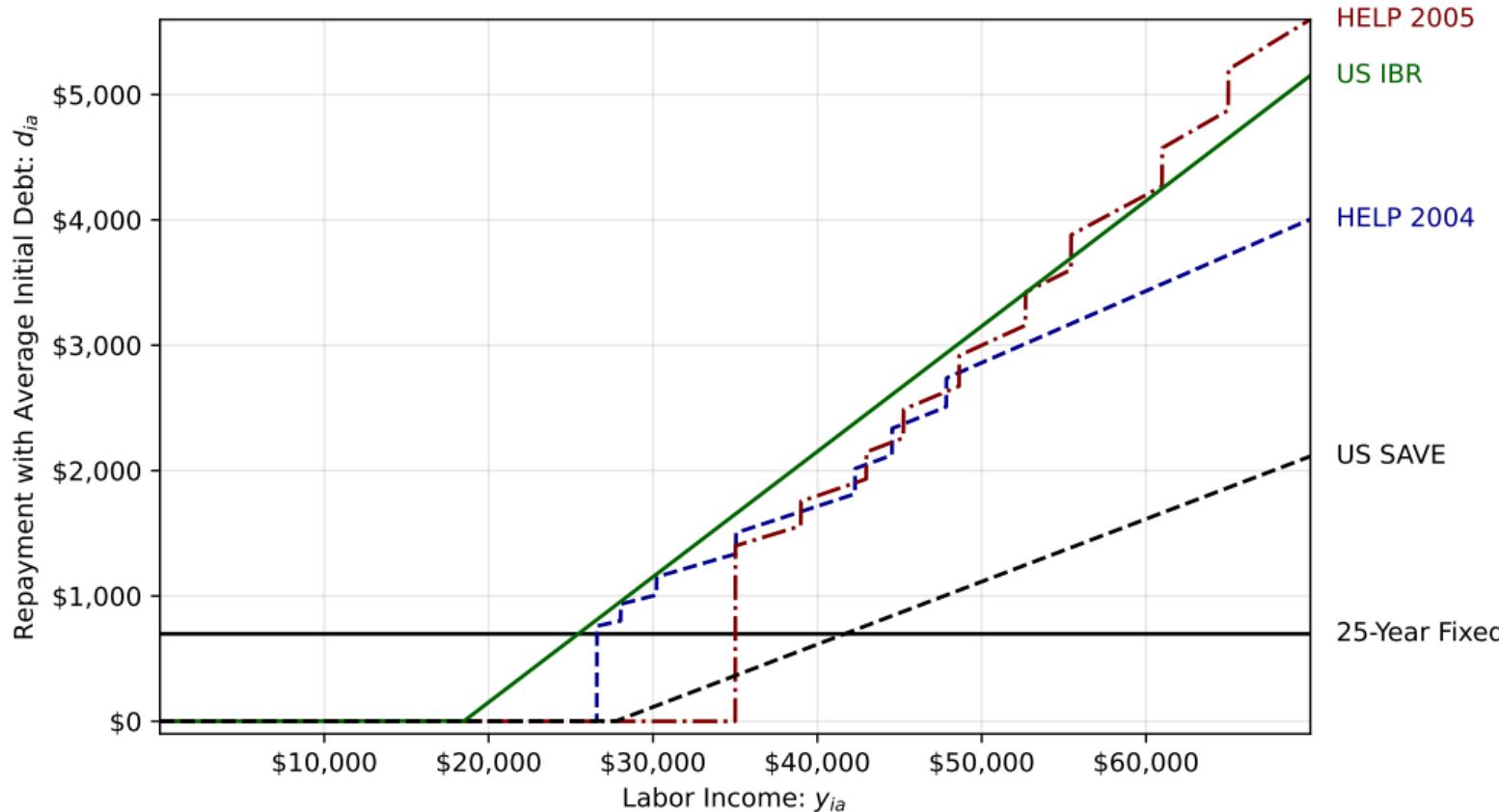
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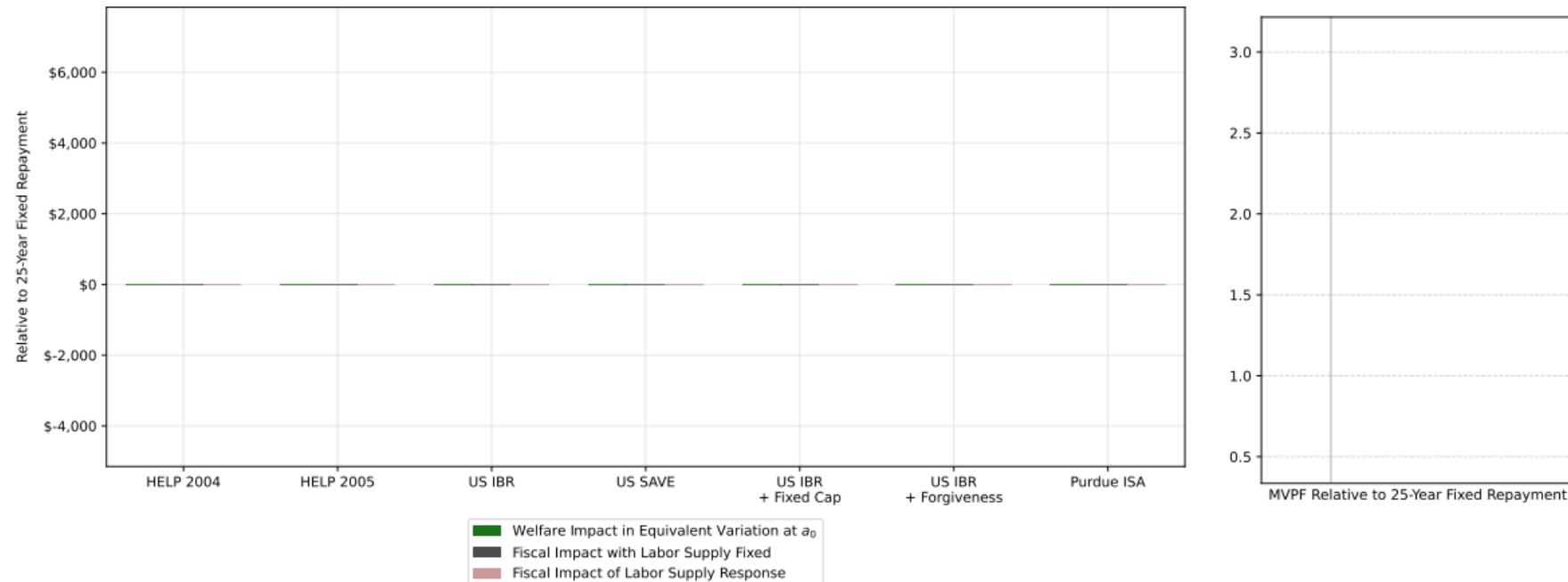
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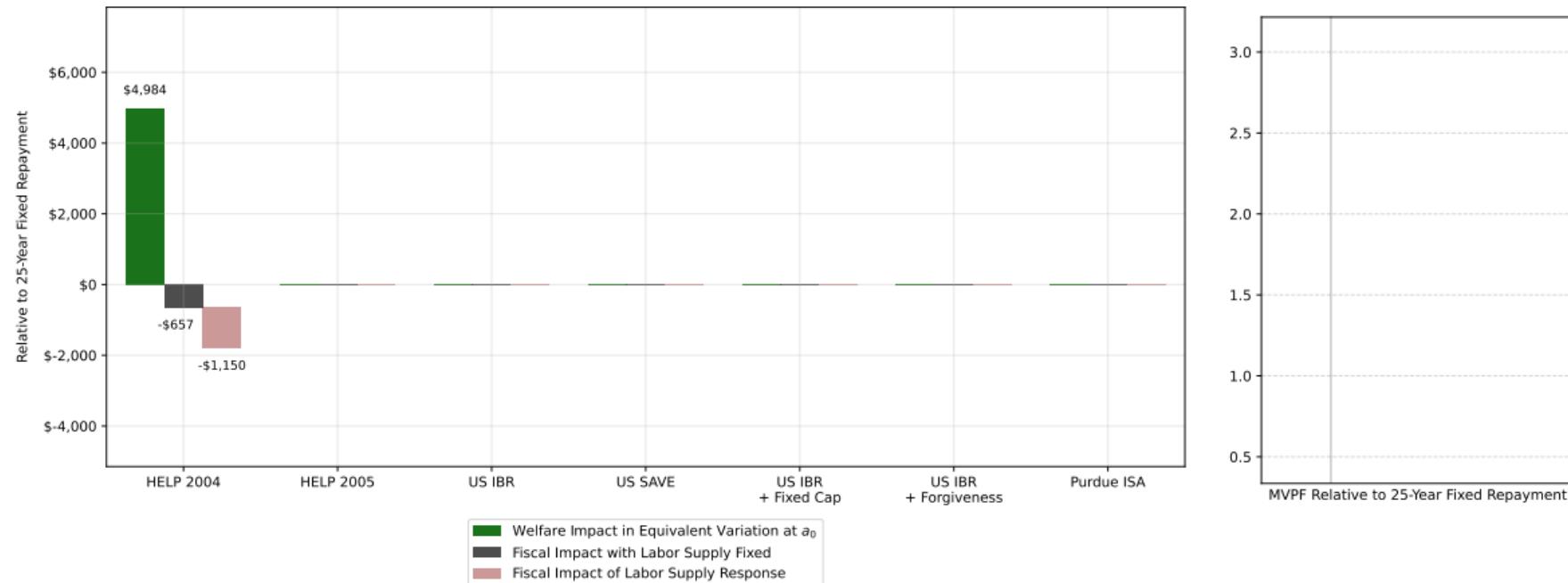


# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS

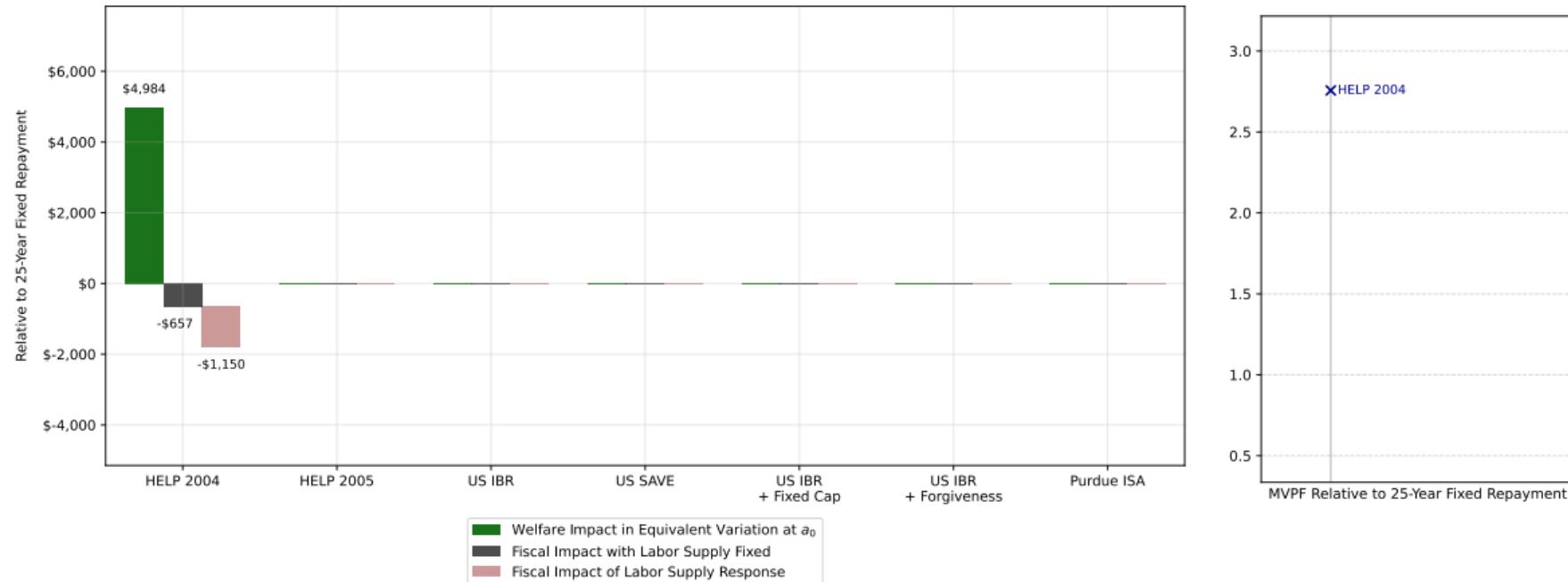


**Benchmark:** 25-Year Fixed Repayment = similar duration, not income-contingent

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



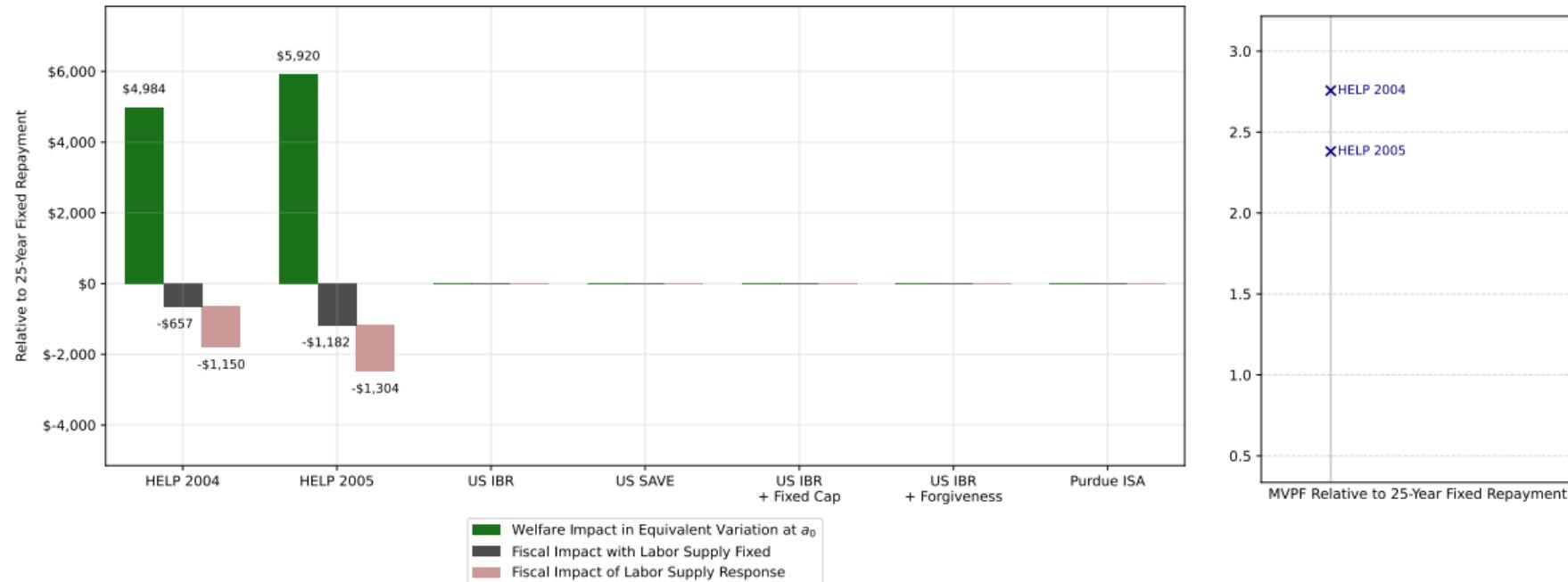
# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



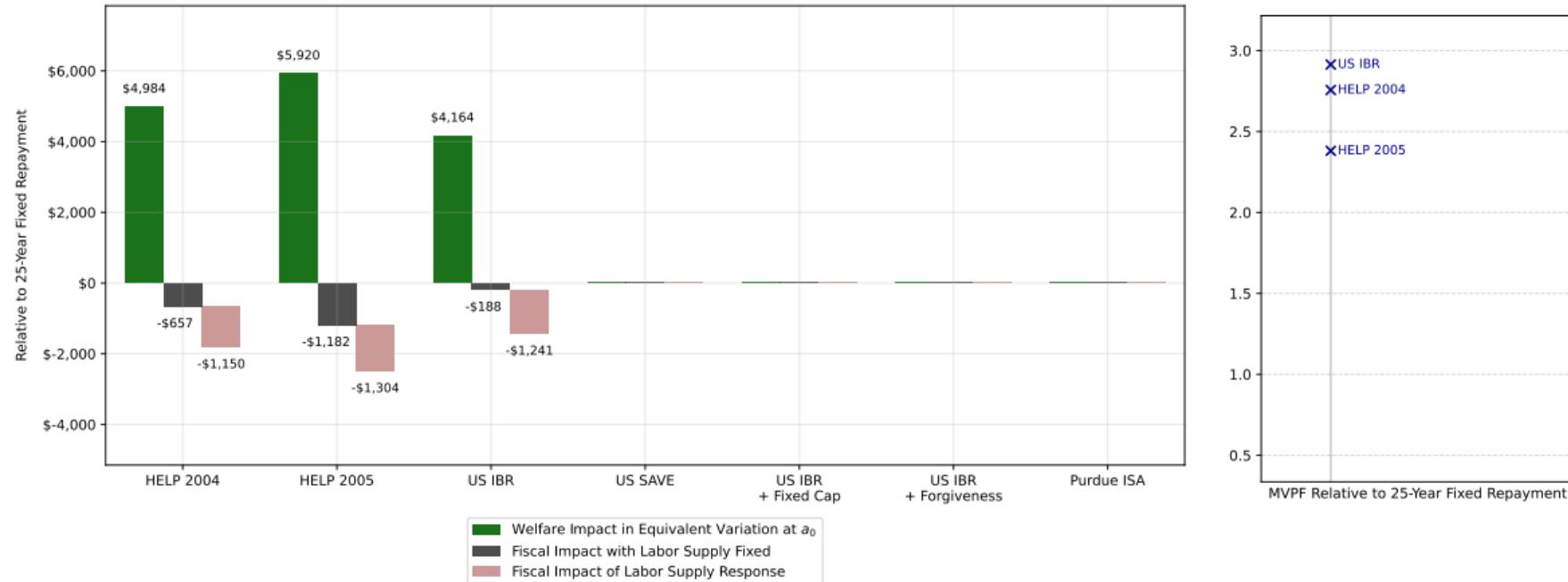
$$MVPF = WTP / (\text{mechanical fiscal impact} + \text{fiscal externality})$$

Hendren-Sprung-Keyser 2020

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS

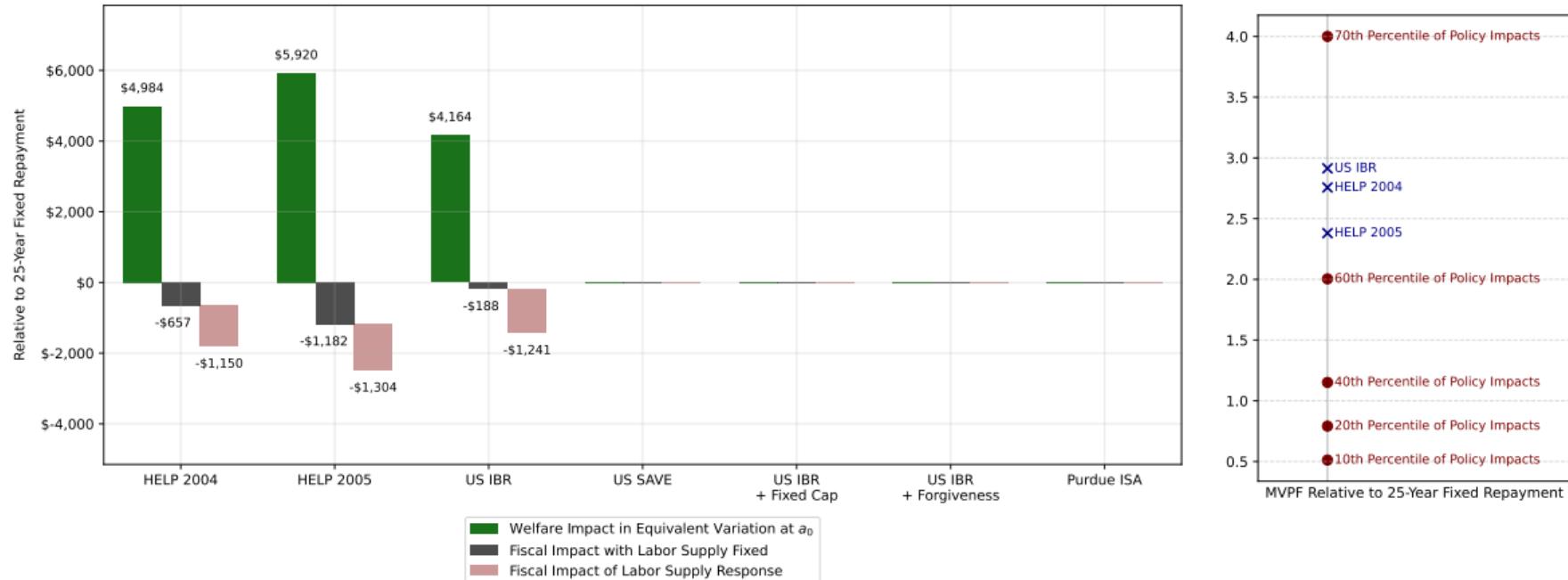


# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



**Result #1:** Moral hazard  $\Rightarrow$  50-80% of fiscal cost from income-contingent repayment

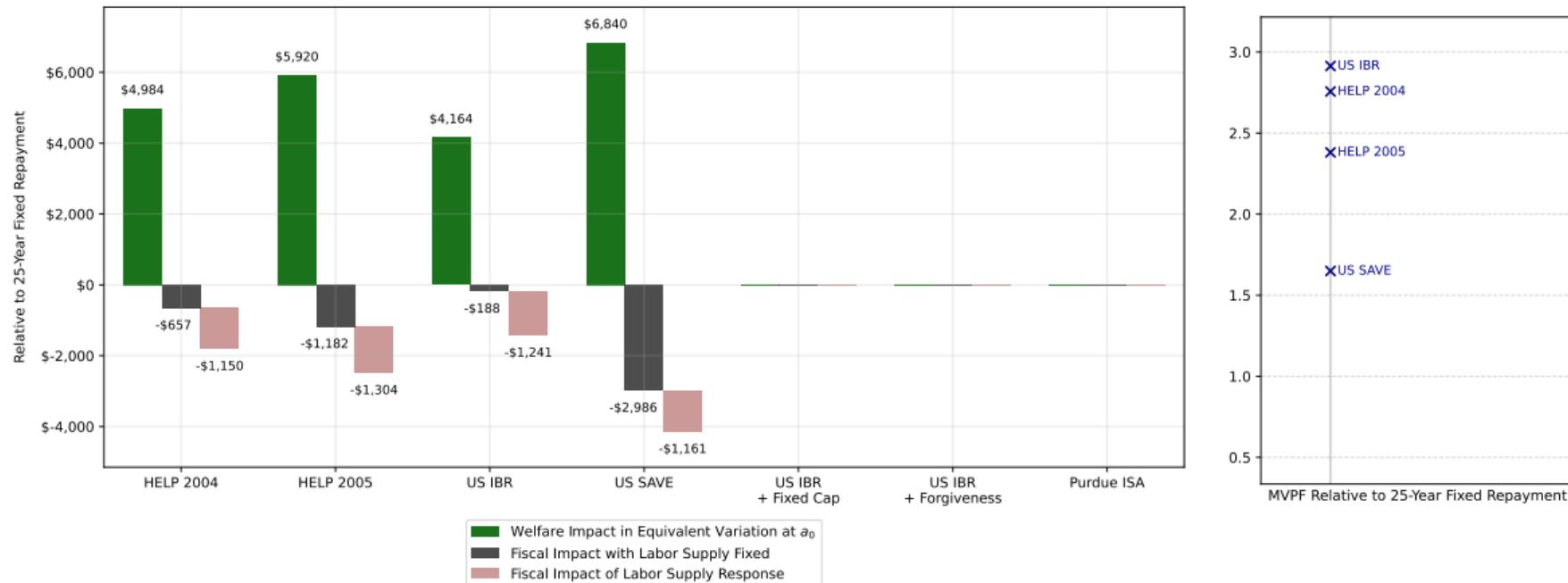
# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



**Result #2:** Significant welfare gains from fixed → income-contingent repayment

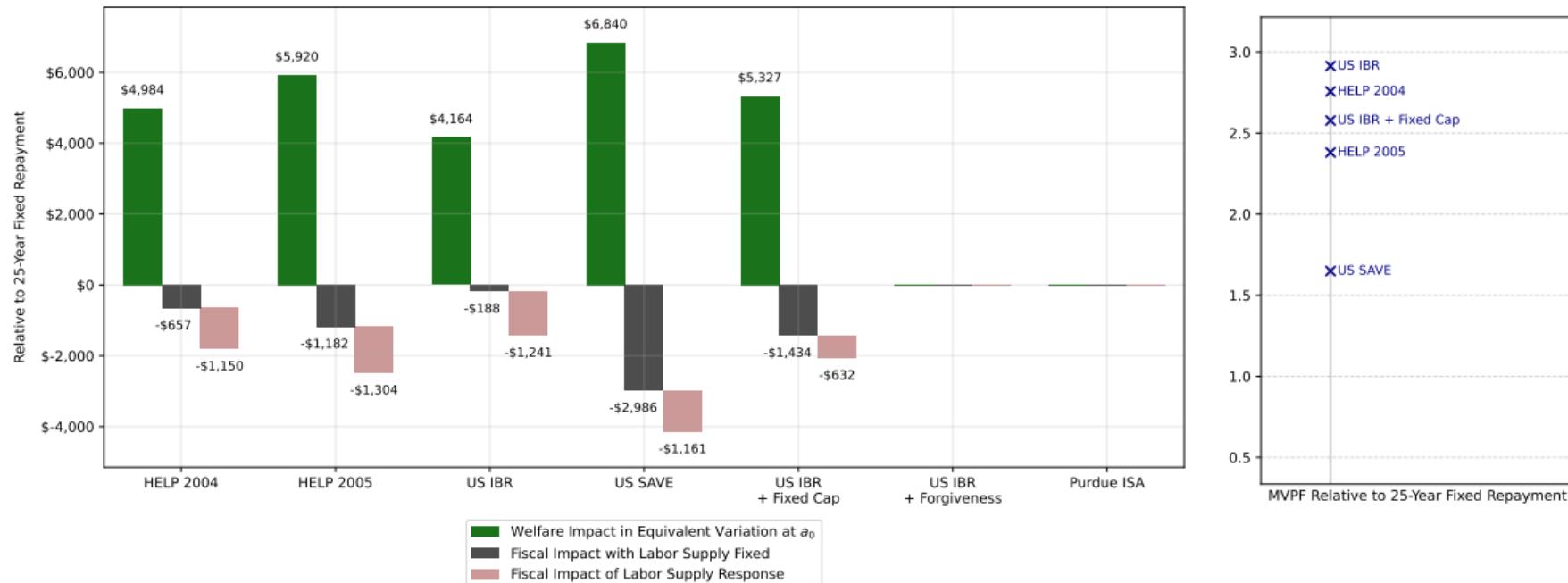
Source: <https://policyimpacts.org/>

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



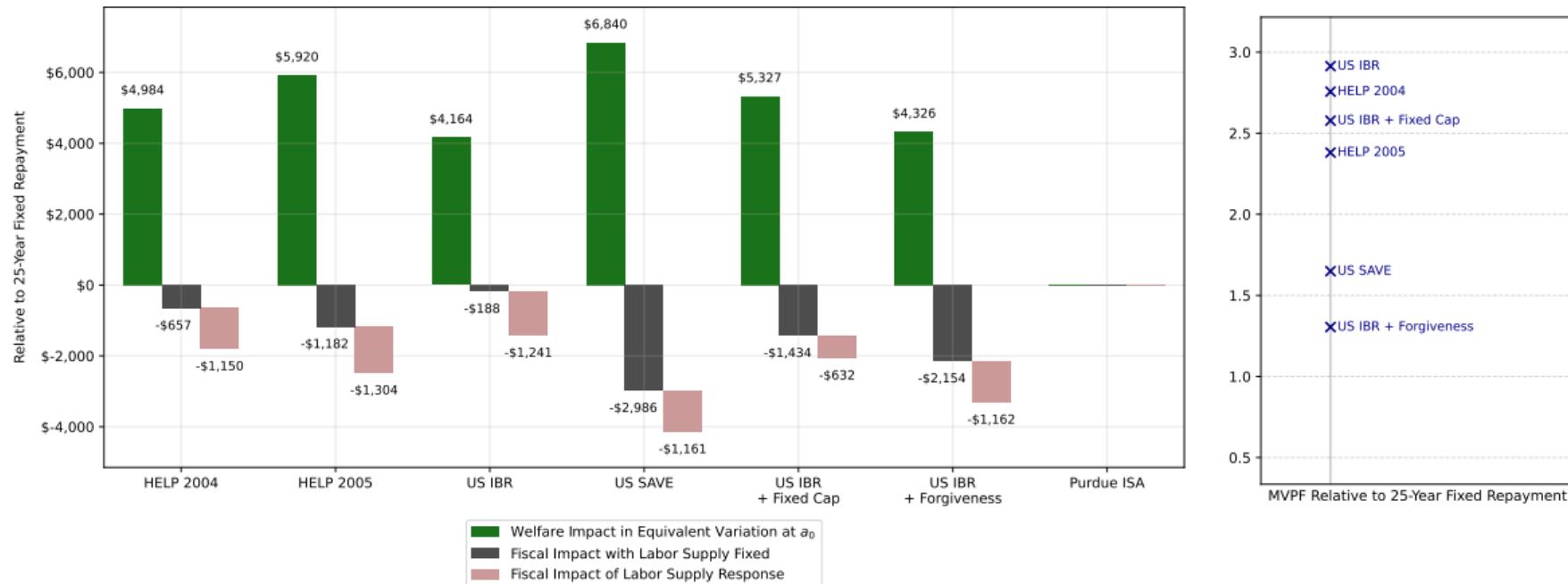
**Result #2:** Significant welfare gains from fixed → income-contingent repayment

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



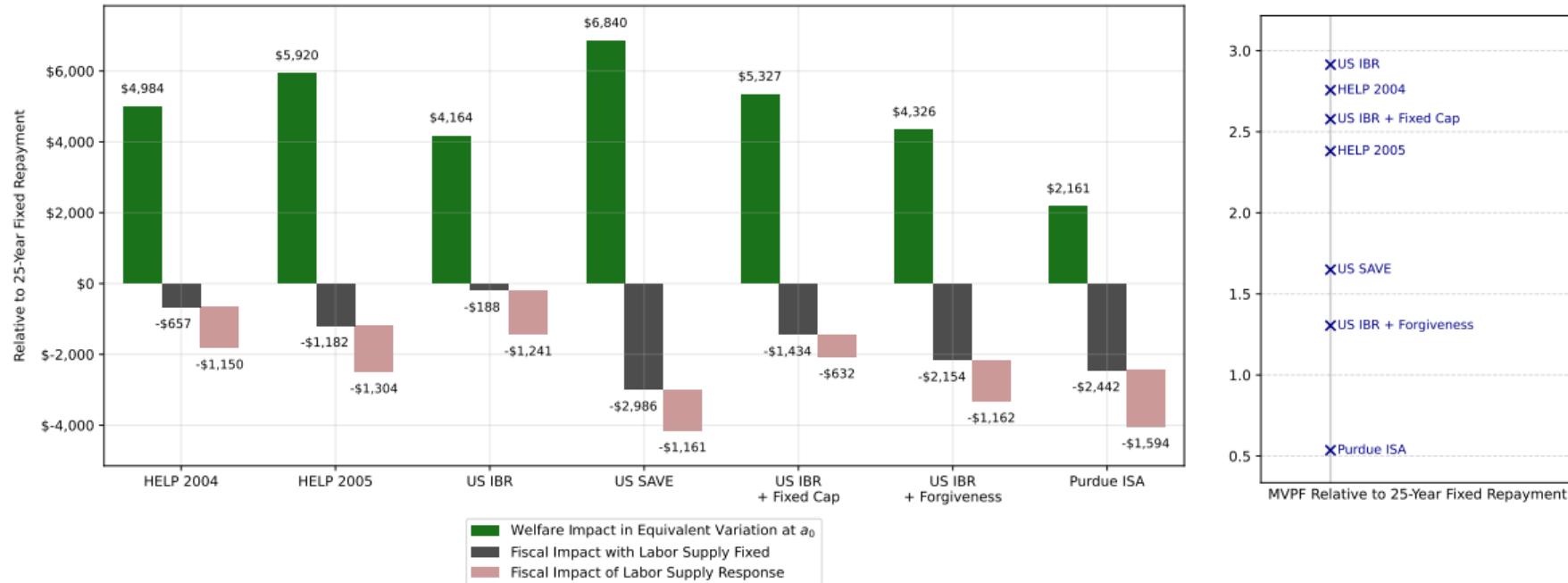
**Result #3:** Accelerating repayments from high-income borrowers  $\Rightarrow \uparrow \text{MVPF}$

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



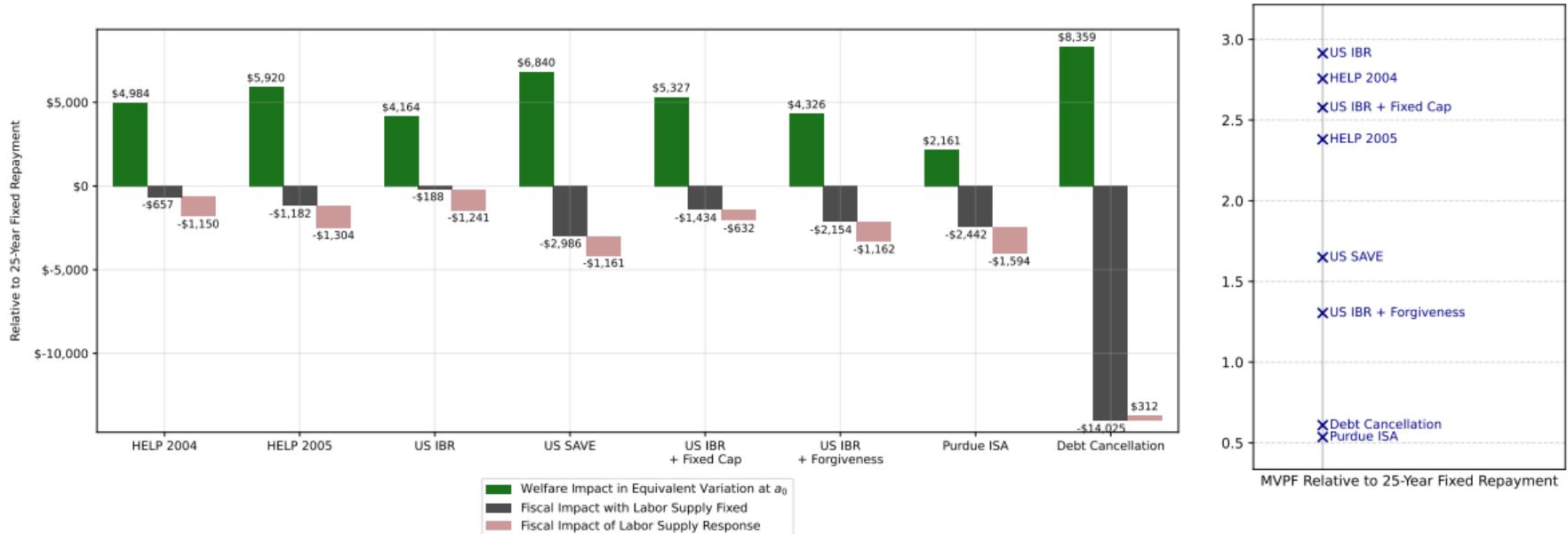
**Result #4:** Forgiveness not needed with income-contingent repayment

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



**Result #5:** Equity contract (4% of income for 9 years) is worse than all ICLs

# STEP 1: EFFECTS OF EXISTING INCOME-CONTINGENT LOANS



**Result #6:** Gains from ICLs  $\approx 50\%$  of full forgiveness at  $\approx 10\%$  fiscal cost

## STEP 2: CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

Constrained-planner's problem:

$$\max_{\theta} \mathbf{E}_0 V_{a_0}(\theta)$$

(2)

## STEP 2: CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

Constrained-planner's problem:

$$\max_{\theta} \mathbf{E}_0 V_{a_0}(\theta) \quad (\text{behind the "veil-of-ignorance"})$$

(2)

## STEP 2: CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

Constrained-planner's problem:

$$\max_{\theta} \mathbf{E}_0 V_{a_0}(\theta)$$

subject to: (à la Ramsey, not Mirrlees)

$$\text{Repayments}_a(\theta) = \max \{\theta_0 + \theta_1 y_a + \theta_2 y_a^2, 0\} \quad (1)$$

(2)

## STEP 2: CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

Constrained-planner's problem:

$$\max_{\theta} \mathbf{E}_0 V_{a_0}(\theta)$$

subject to:

$$\text{Repayments}_a(\theta) = \min \left\{ \max \left\{ \theta_0 + \theta_1 y_a + \theta_2 y_a^2, 0 \right\}, D_a \right\} \quad (1)$$

(2)

## STEP 2: CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

Constrained-planner's problem:

$$\max_{\theta} \mathbf{E}_0 V_{a_0}(\theta)$$

subject to:

$$\text{Repayments}_a(\theta) = \min \left\{ \max \left\{ \theta_0 + \theta_1 y_a + \theta_2 y_a^2, 0 \right\}, D_a \right\} \quad (1)$$

$$\mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a(\theta) + \text{Taxes}_a(\theta) - \text{Transfers}_a(\theta)}{(R)^{a-a_0}} \quad (2)$$

## STEP 2: CONSTRAINED-OPTIMAL INCOME-CONTINGENT LOANS

Constrained-planner's problem:

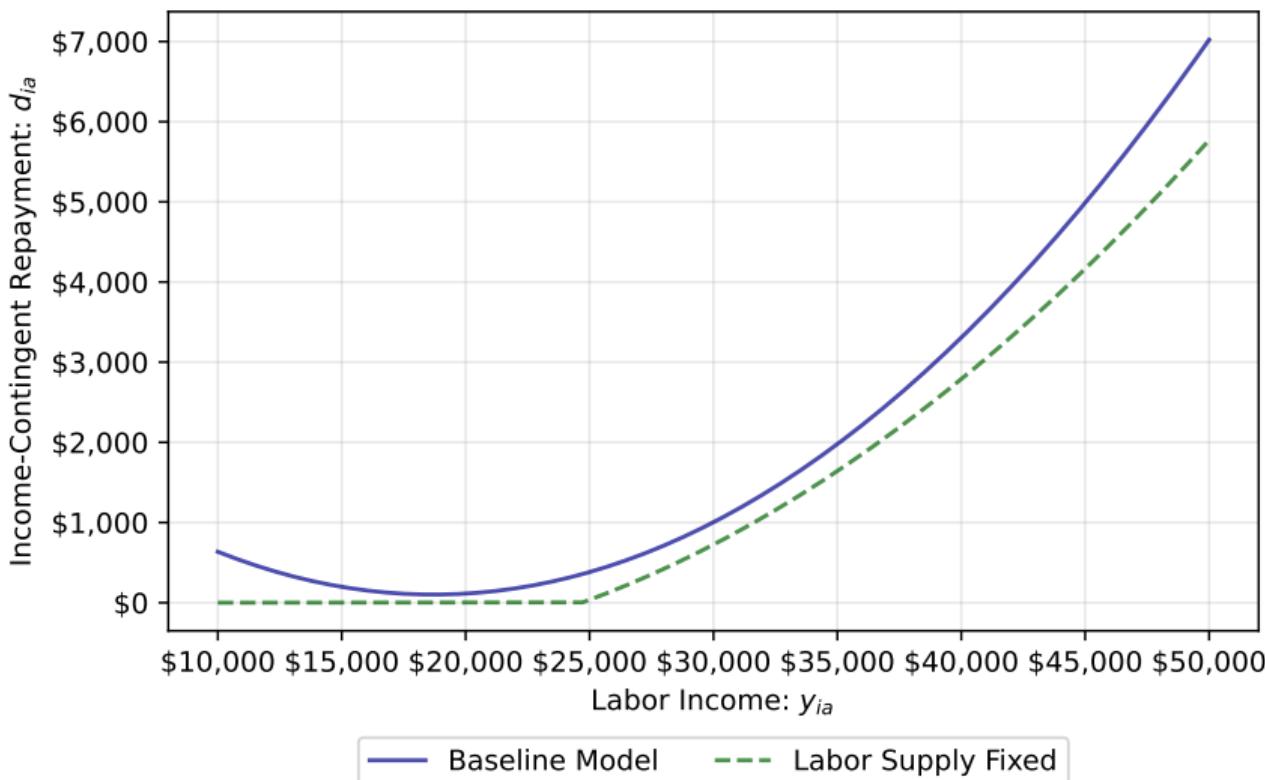
$$\max_{\theta} \mathbf{E}_0 V_{a_0}(\theta)$$

subject to:

$$\text{Repayments}_a(\theta) = \min \left\{ \max \left\{ \theta_0 + \theta_1 y_a + \theta_2 y_a^2, 0 \right\}, D_a \right\} \quad (1)$$

$$\mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a(\theta) + \text{Taxes}_a(\theta) - \text{Transfers}_a(\theta)}{(R)^{a-a_0}} \geq \mathcal{G}_{25\text{-Year Fixed}} \quad (2)$$

# SOLUTION: 0.76% ↑ IN LIFETIME CONSUMPTION, SAME FISCAL COST



# OUTLINE

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

- US “student debt crisis”: 25% of borrowers default within 5 years of graduation
  - Possible solution = change contracts to be **income-contingent** (e.g., SAVE)
- **This paper:** evidence + model to calibrate the effects of debt restructuring
  - ① Ex-post moral hazard is not a reason to avoid **income-contingent** contracts
  - ② Among these contracts, **income-contingent loans** seem effective and robust
- **Open question:** effects of income-contingent contracts on ex-ante choices?
- **Broader question:** is more state-contingent repayment useful for other liabilities?
  - HHs: shared-appreciation/partial-ownership mortgages (Norway, UK, Canada, AU)
  - Firms: revenue-based financing

# THANK YOU!

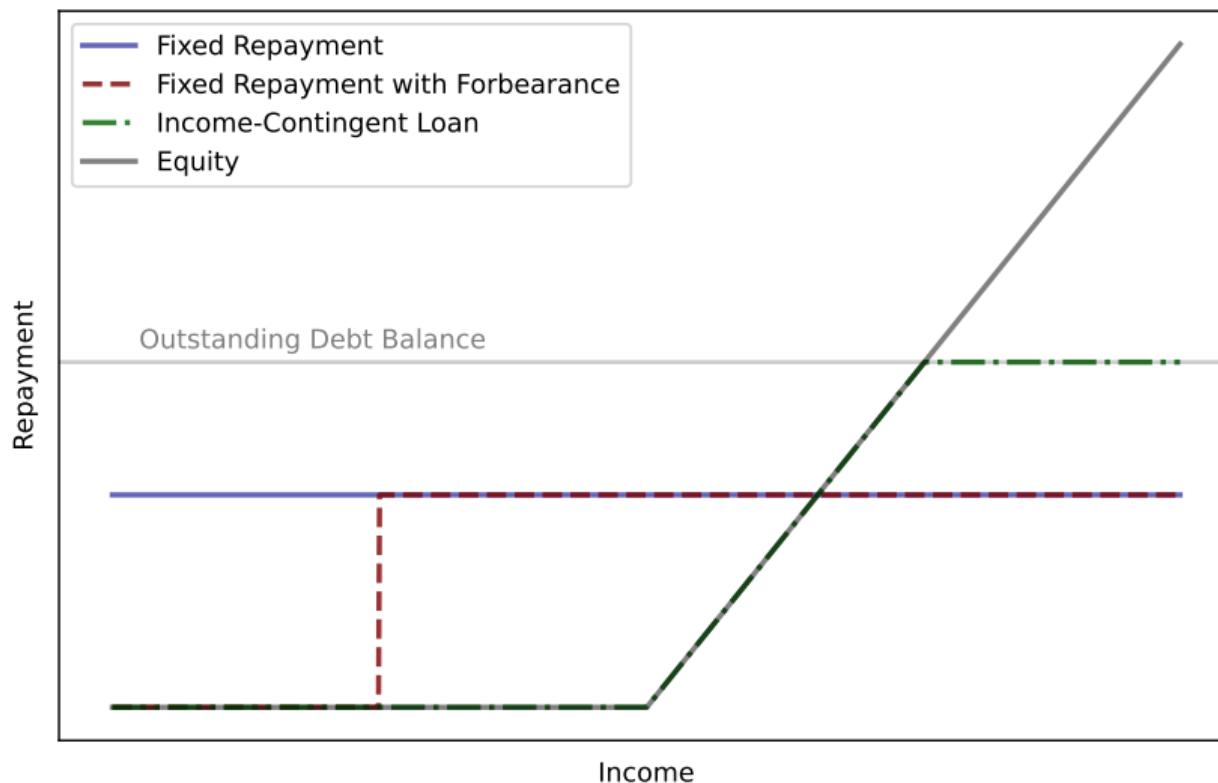
[www.timdesilva.me](http://www.timdesilva.me)

[tdesilva@stanford.edu](mailto:tdesilva@stanford.edu)

# APPENDIX

# START OF APPENDIX

# ILLUSTRATION OF DIFFERENT REPAYMENT CONTRACTS

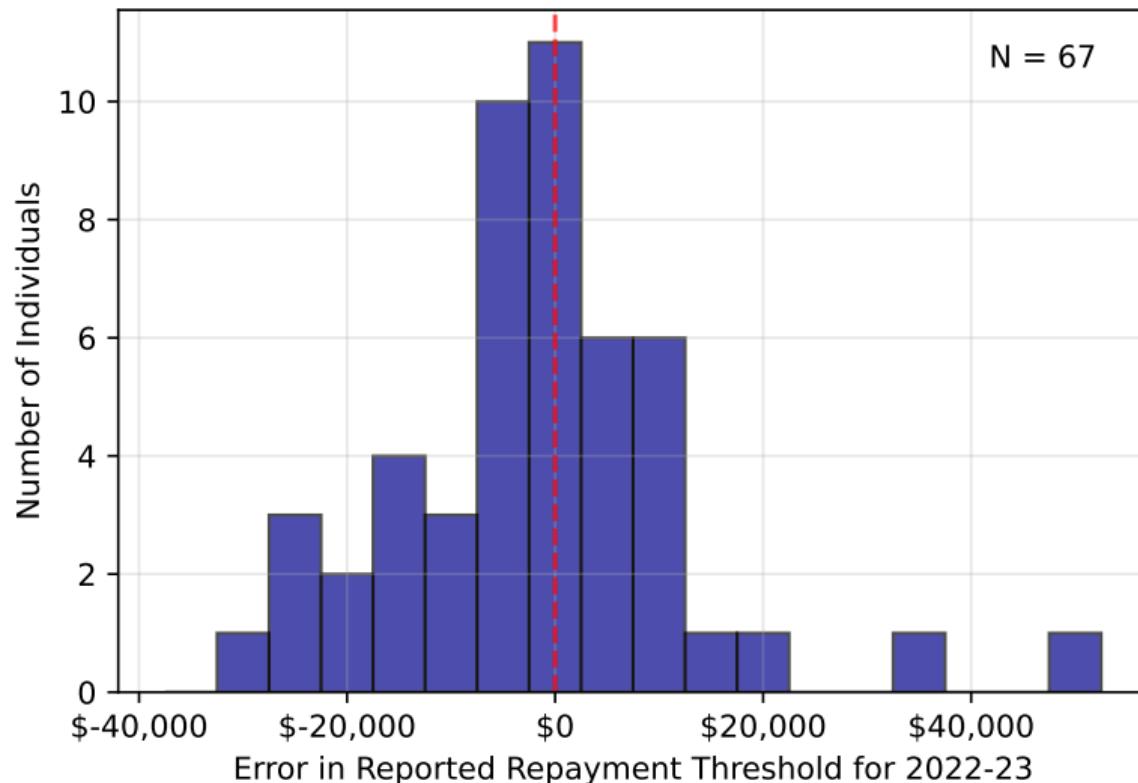


◀ Back: Introduction

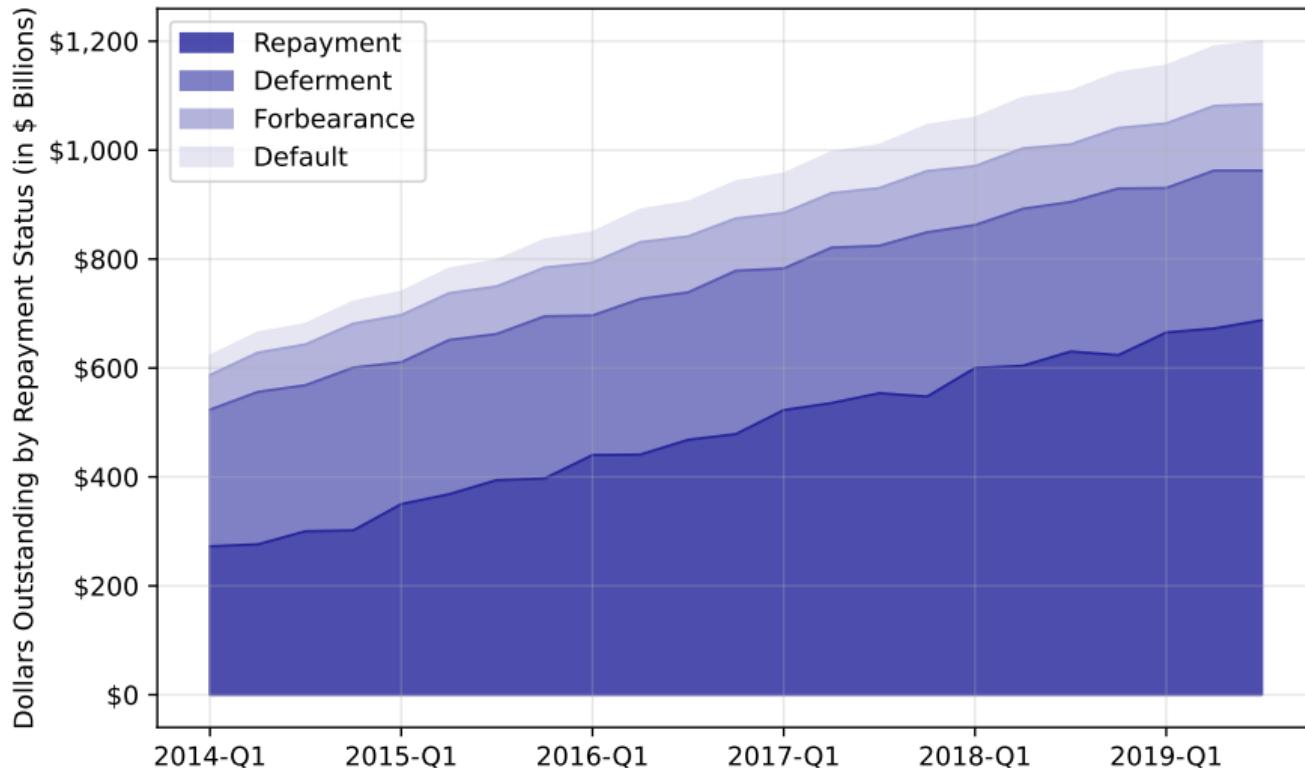
◀ Back: This Paper

◀ Back: Main Results

# SURVEY OF THRESHOLD LOCATION



# REPAYMENT STATUS OF US STUDENT LOANS



# PREVALENCE OF GOVERNMENT-PROVIDED INCOME-CONTINGENT LOANS

- Countries with **universal** adoption: Australia (1989), New Zealand (1991), UK (1998), Hungary (2001)
- Countries with **partial** adoption: US (1994), Thailand (2006), South Korea (2009), Brazil (2016), the Netherlands (2016), Japan (2017), Canada (2017), Colombia (2023)
- Countries **considering** adoption (as of 2022): Chile, France, Malaysia, Ireland

Source: Chapman-Dearden 2022

◀ 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

# AU-US DIFFERENCES MOST LIKELY TO AFFECT CONTRACT DESIGN

- ① More debt in US due to higher tuition, longer degrees, and discretionary items
  - Larger demand for insurance in US, but also more moral hazard
  - Discretionary borrowing in US ⇒ possible ex-ante moral hazard
- ② Active private market in US cream-skims high-income borrowers Bachas 2019
  - Amount of insurance that can be provided might be lower in US
- ③ Student loans more subsidized in Australia than US
  - Different moral hazard in US (if there is selection on moral hazard) Karlan-Zinman 2009
- ④ Tuition and enrollment caps at public universities in Australia
  - Supply-side responses could increase fiscal cost of ICLs in US Kargar-Mann 2023
  - Note: I compare contracts with identical subsidy

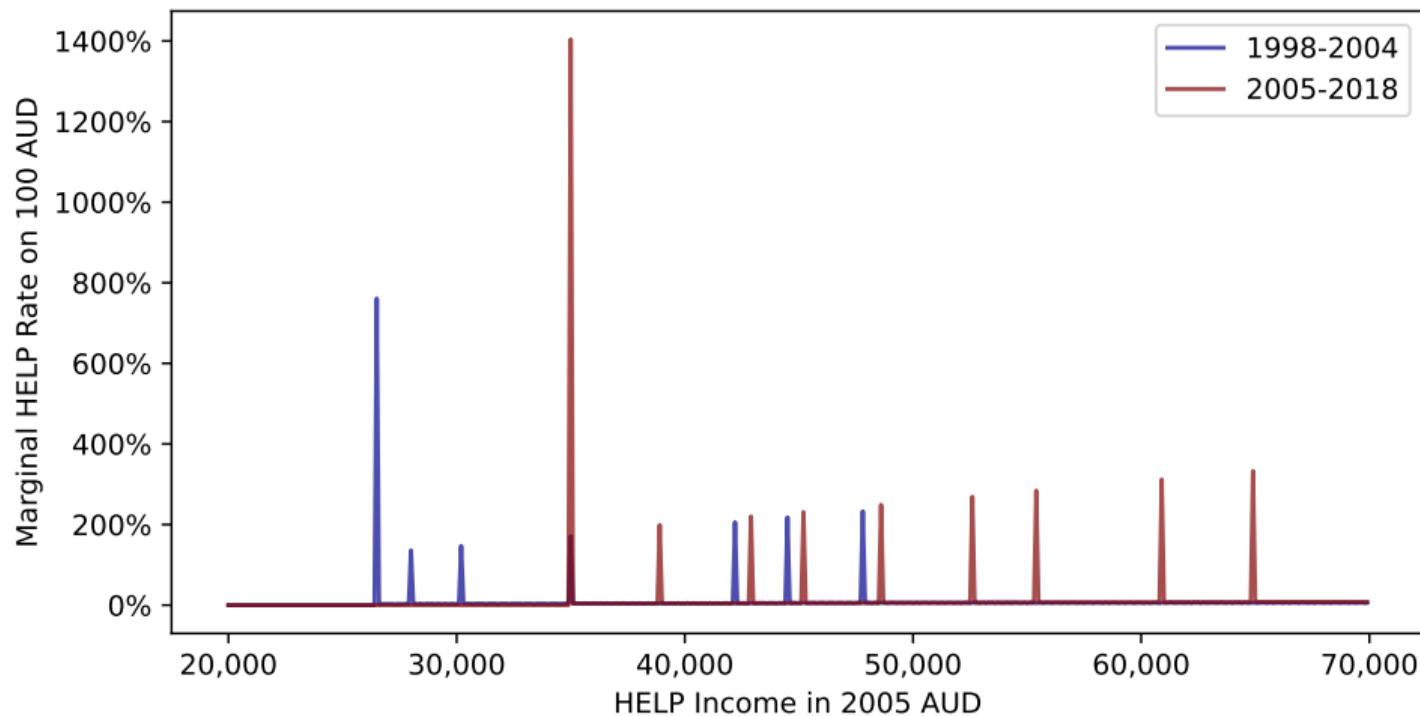
# DIFFERENCES BETWEEN AUSTRALIA AND US: STATISTICS

Feature of Environment	Australia	US
<b>Cost of Higher Education</b>		
Public Undergraduate Tuition Cost	\$2,700–\$10,100 USD per year for CSPs	\$9,500 USD per year for 4-Year In-State \$39,000 USD per year for 4-Year Private Nonprofit
Total Cost of Attendance	\$15,850 USD per year	\$22,700 USD per year
Prevalence of Scholarships	Rare	Common
Initial Student Debt Borrowed	\$8,100–\$30,300 USD	\$51,800 USD (Average)
<b>Student Population</b>		
% of Population with Undergraduate Degree	38%	32%
% of Undergraduates at Private Universities	6%	26%
% of Undergraduates from Abroad	16%	5%
% of Current Students Employed	50%	40%
<b>Income Distribution and Taxes/Transfers</b>		
Median Personal Income	\$33,500 USD	\$40,500 USD
Poverty Line for Single Individual	\$16,200 USD	\$14,580 USD
Gini Coefficient for Income	0.32	0.38
Marginal Tax Rate at Average Income	41%	41%
Heathcote et al. (2017) Tax Progressivity	0.133	0.184
1-Month Individual UI Replacement Rate	23%	35%
Union Membership Rate	13.7%	10.3%

[◀ Back: Benefits](#)

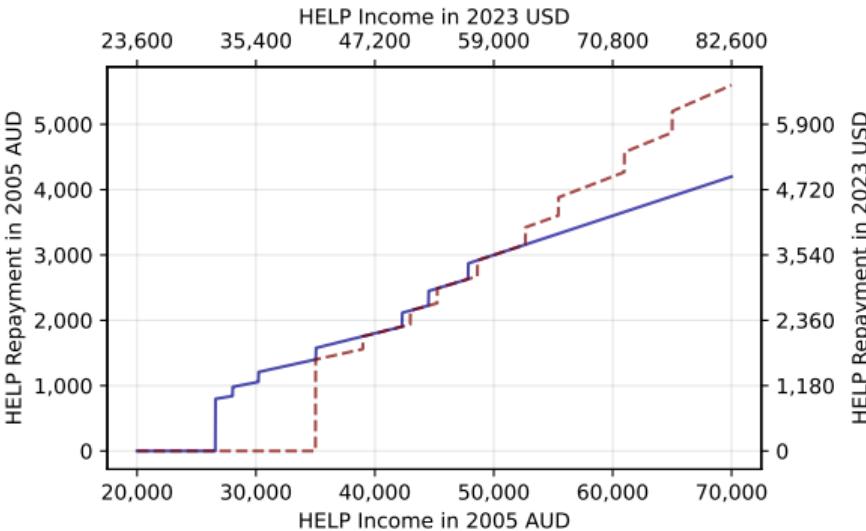
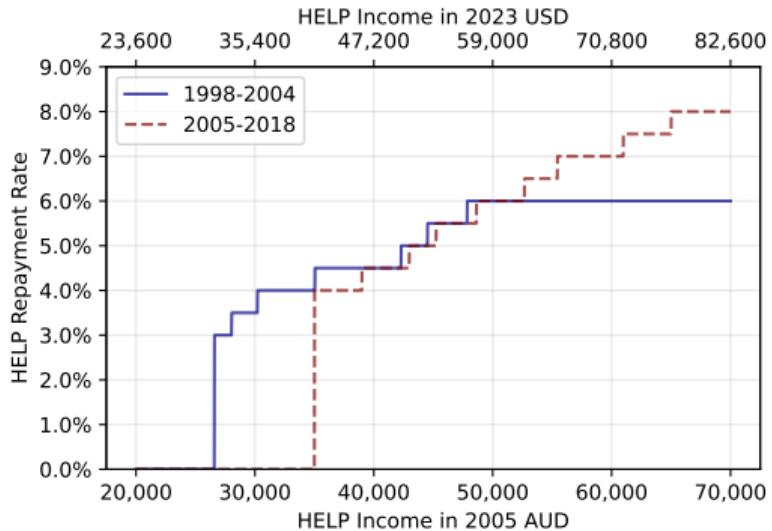
[◀ Back: Differences](#)

# MARGINAL HELP REPAYMENT RATES ON 100 AUD



◀ Back

# HELP REPAYMENT RATES AND REPAYMENTS



◀ Back

# NEWS ARTICLE: POLICY CHANGE



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## Ease HECS burden on students, say universities

Kate Marshall

Jan 9, 2003 - 11.00am



Save

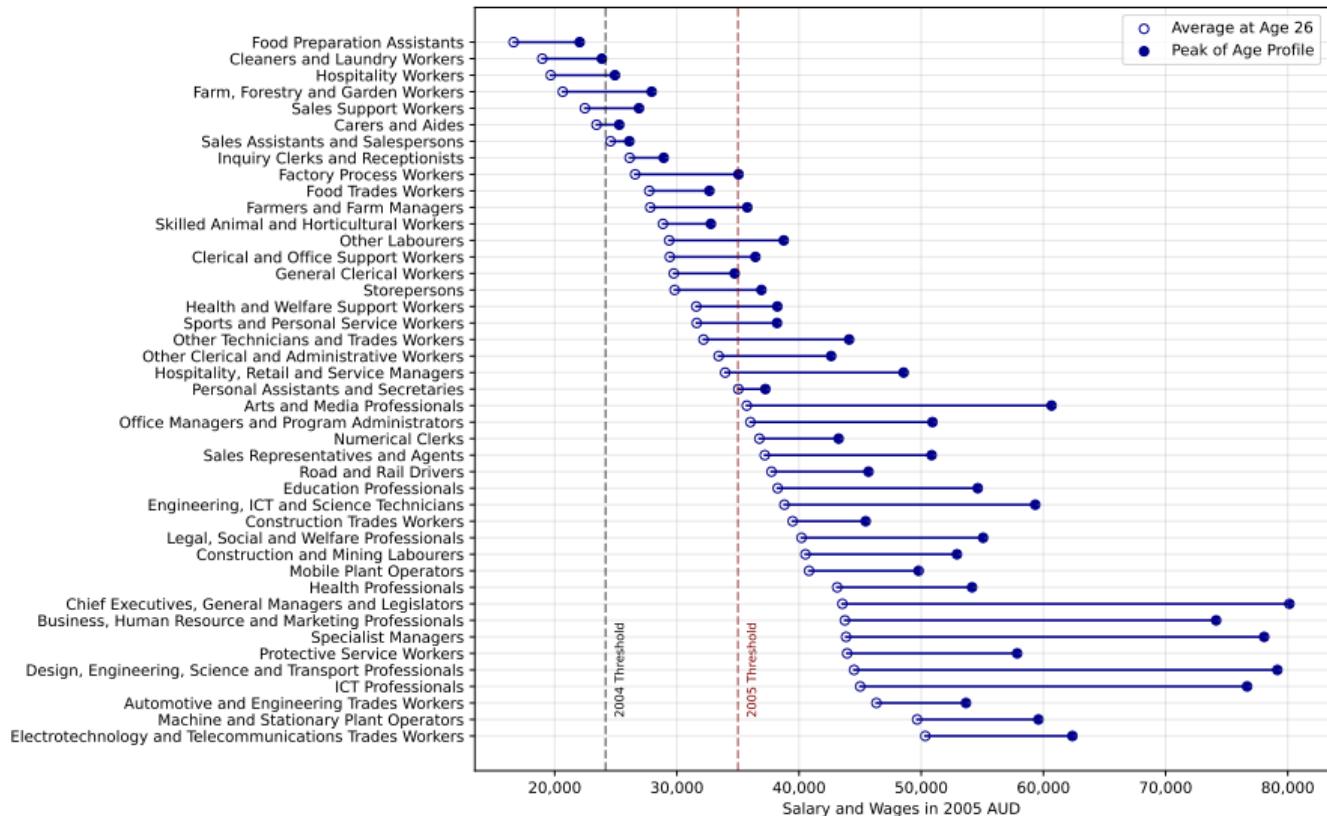


Share

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

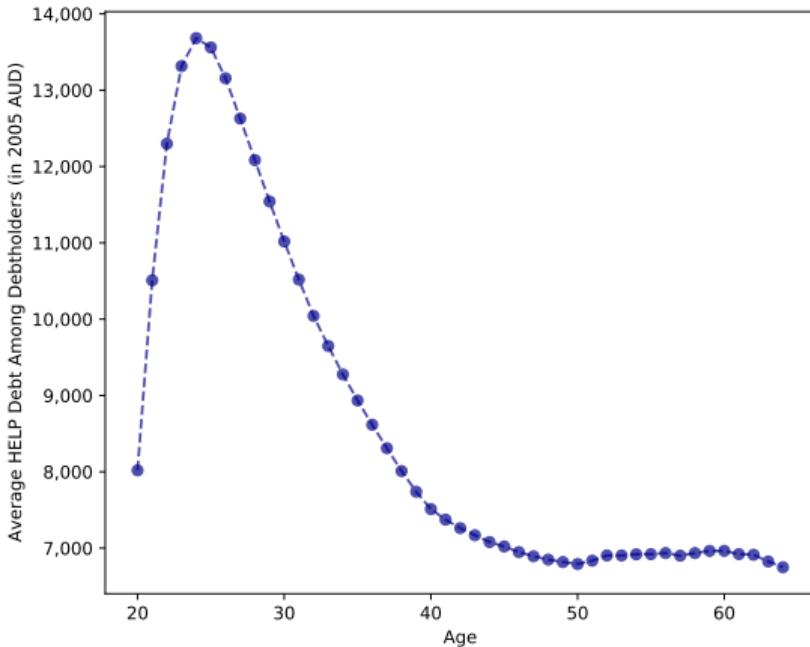
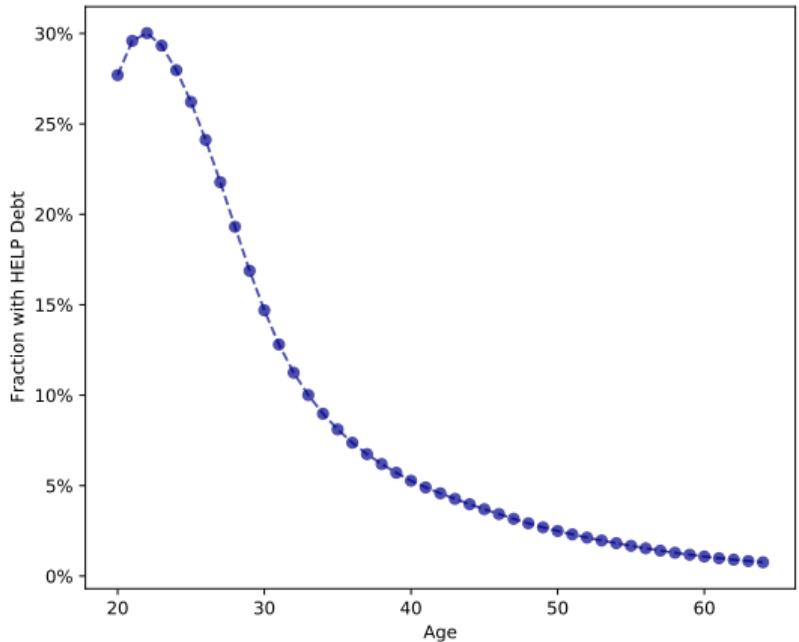
◀ Back: Table

# SUMMARY STATISTICS

	Non-Debtholders (1)	Debtholders (2)
<b>Demographics</b>		
Age	41.1	29.5
Female	0.46	0.60
Wage-Earner	0.85	0.91
<b>Income Totals (in 2005 AUD)</b>		
Taxable Income	37,695	27,796
HELP Income	38,756	28,586
<b>Income Components (in 2005 AUD)</b>		
Salary & Wages	32,415	26,068
Labor Income	35,480	27,136
Interest & Dividend Income	726	242
Capital Income	1,221	324
Net Deductions	-1,548	-1,099
<b>HELP Variables</b>		
HELP Debt (in 2005 AUD)	.	10,830
HELP Payment (in 2005 AUD)	.	991
HELP Debt at Age 26 (in 2005 AUD)	.	13,156
HELP Payment at Age 26 (in 2005 AUD)	.	1,305
HELP Income < 0% Threshold	0.50	0.65
HELP Income < 2004 0% Threshold	0.37	0.51
HELP Income < 2005 0% Threshold	0.52	0.67
Number of Unique Individuals	19,484,517	4,013,382
Number of Individual-Year Observations	247,118,713	27,316,037

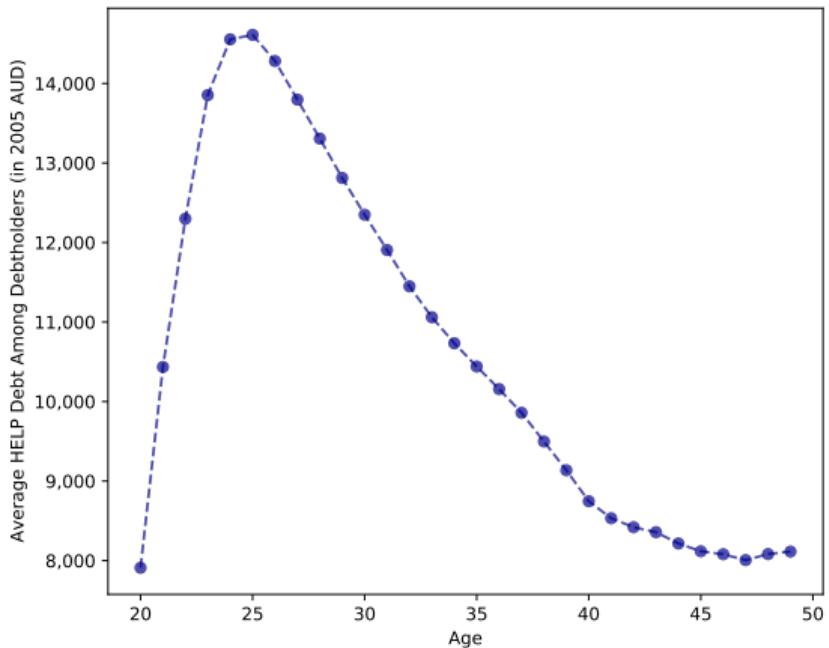
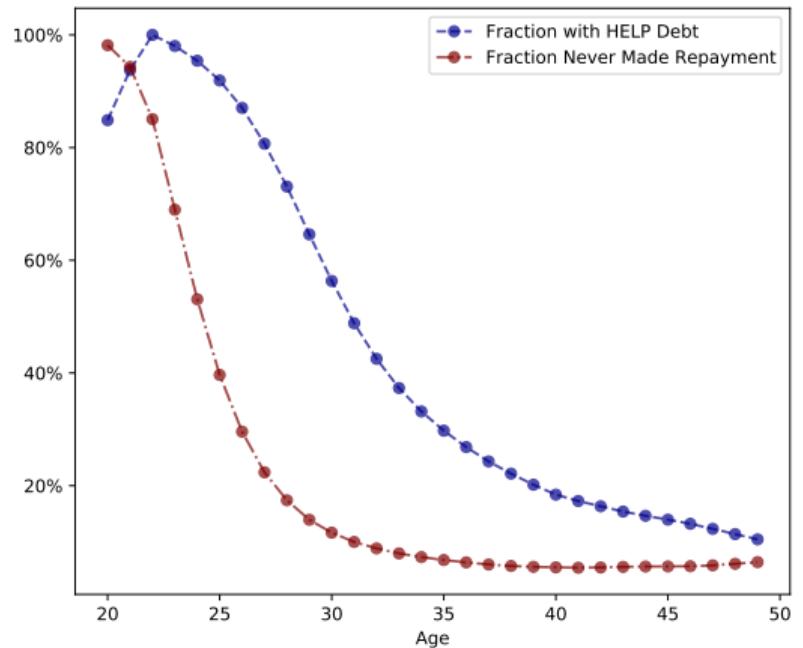
◀ Back

# DEBT BALANCES BY AGE



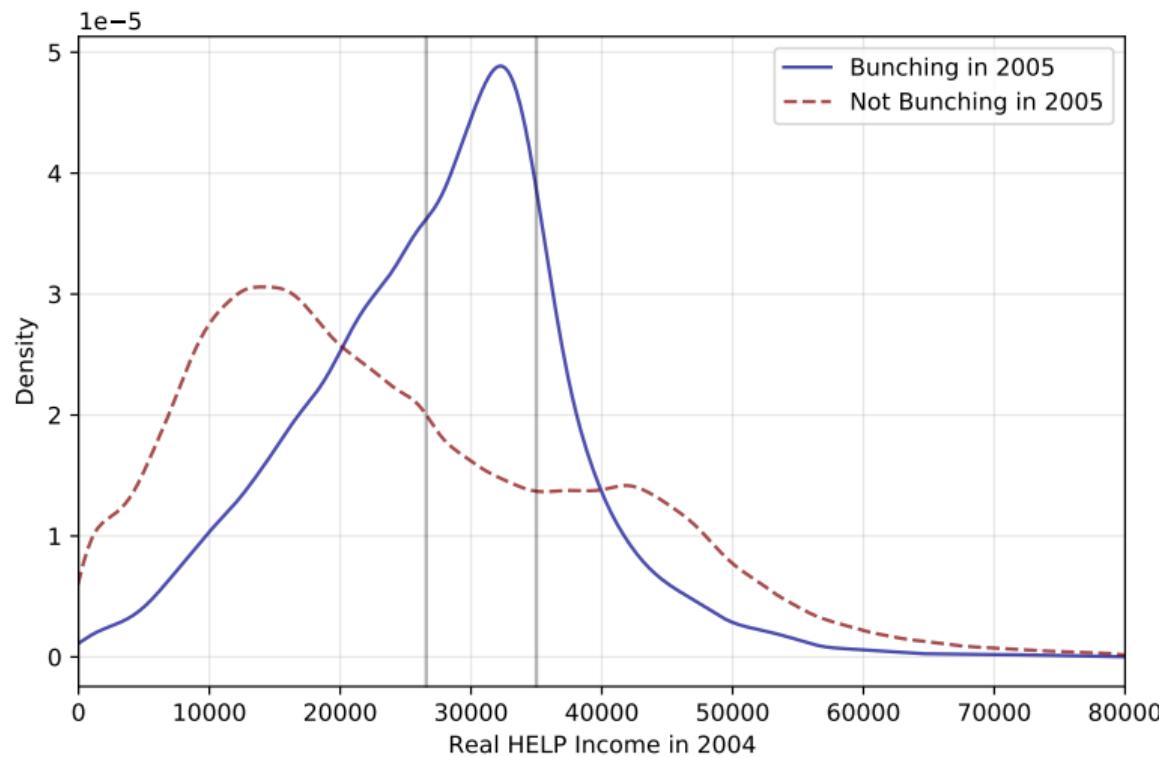
◀ Back

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



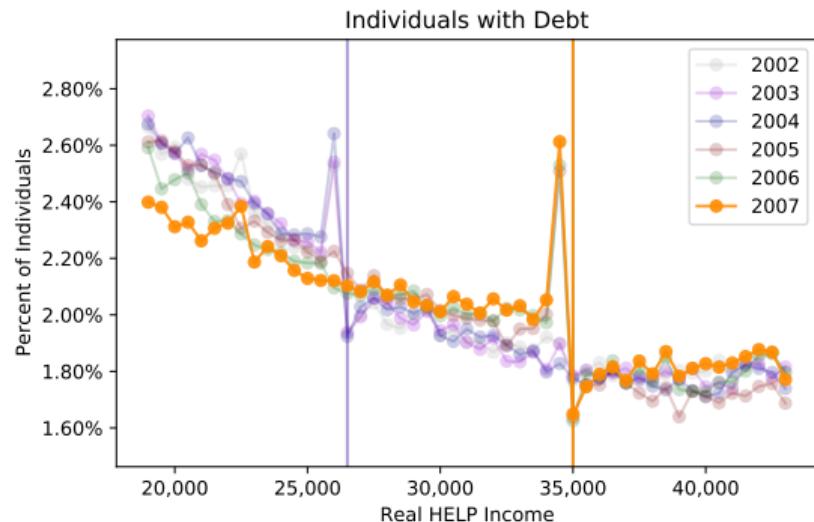
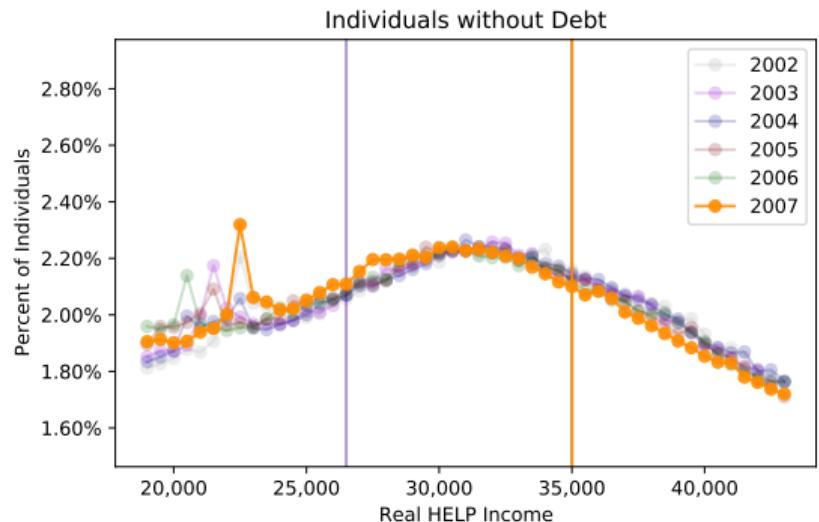
◀ Back

# NEW BUNCHING COMES FROM BETWEEN OLD AND NEW THRESHOLDS



◀ Back

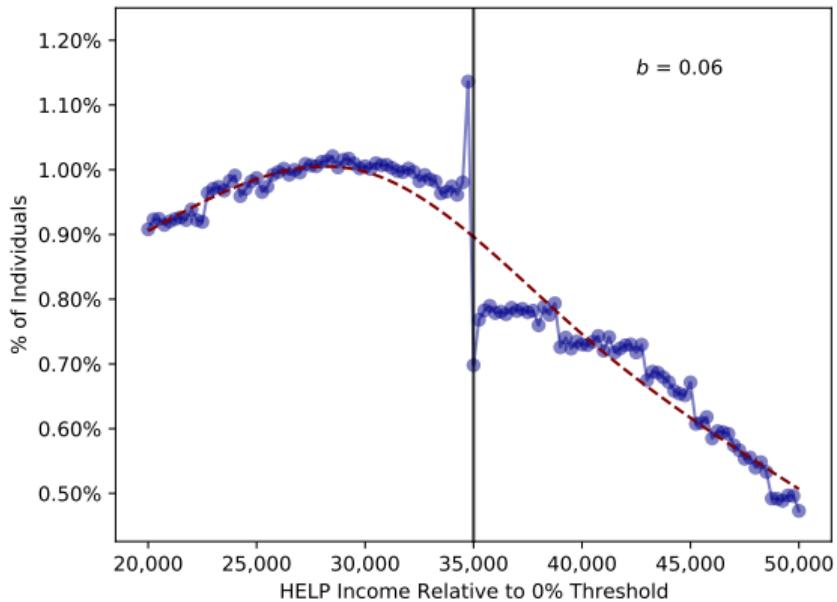
# No BUNCHING AT REPAYMENT THRESHOLD FOR NON-DEBTHOLDERS



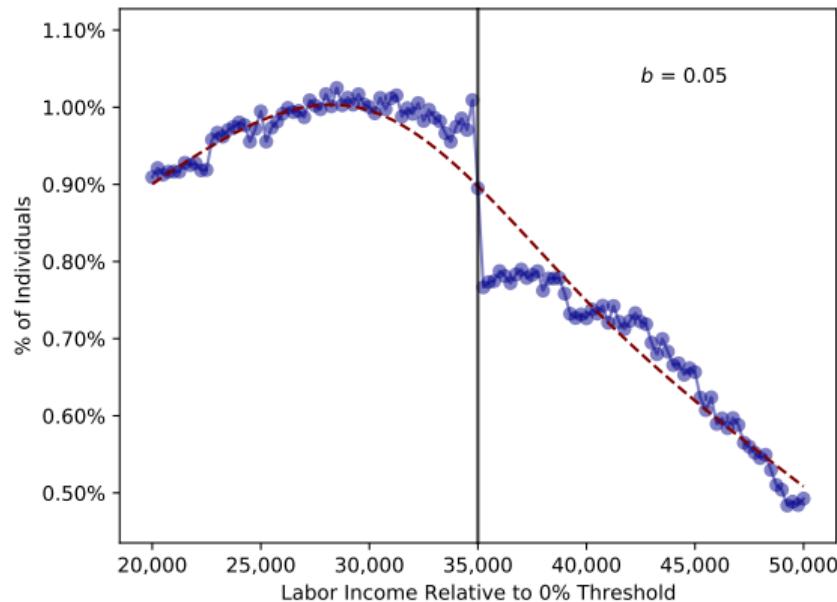
◀ Back

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

## HELP Income

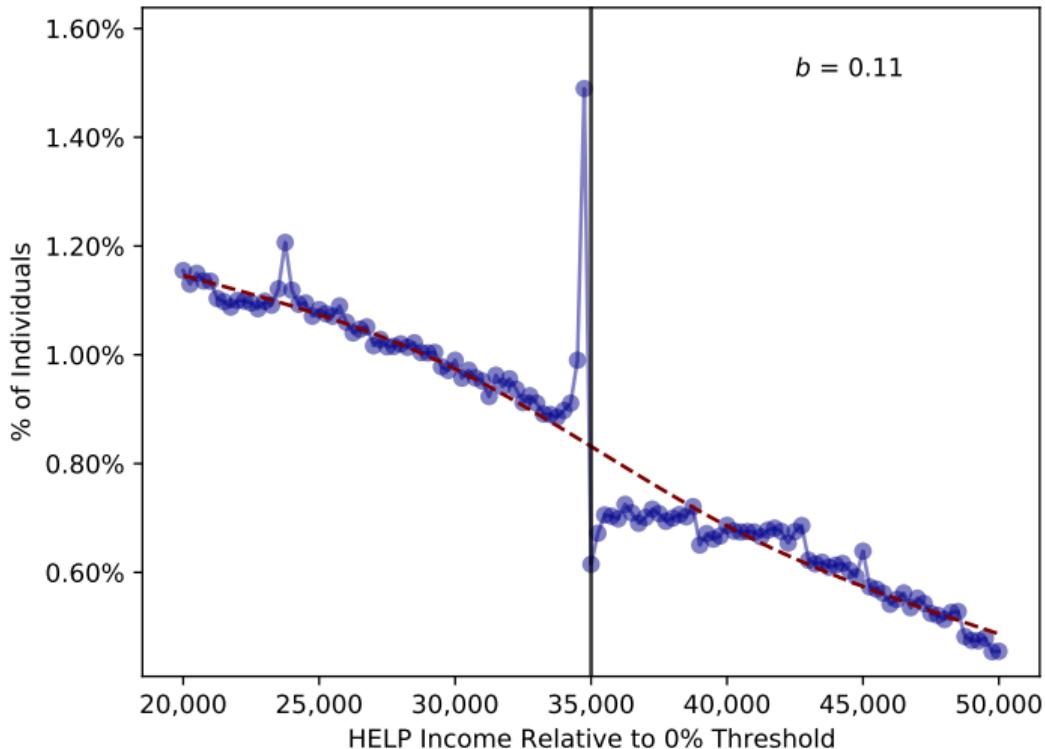


## Labor Income



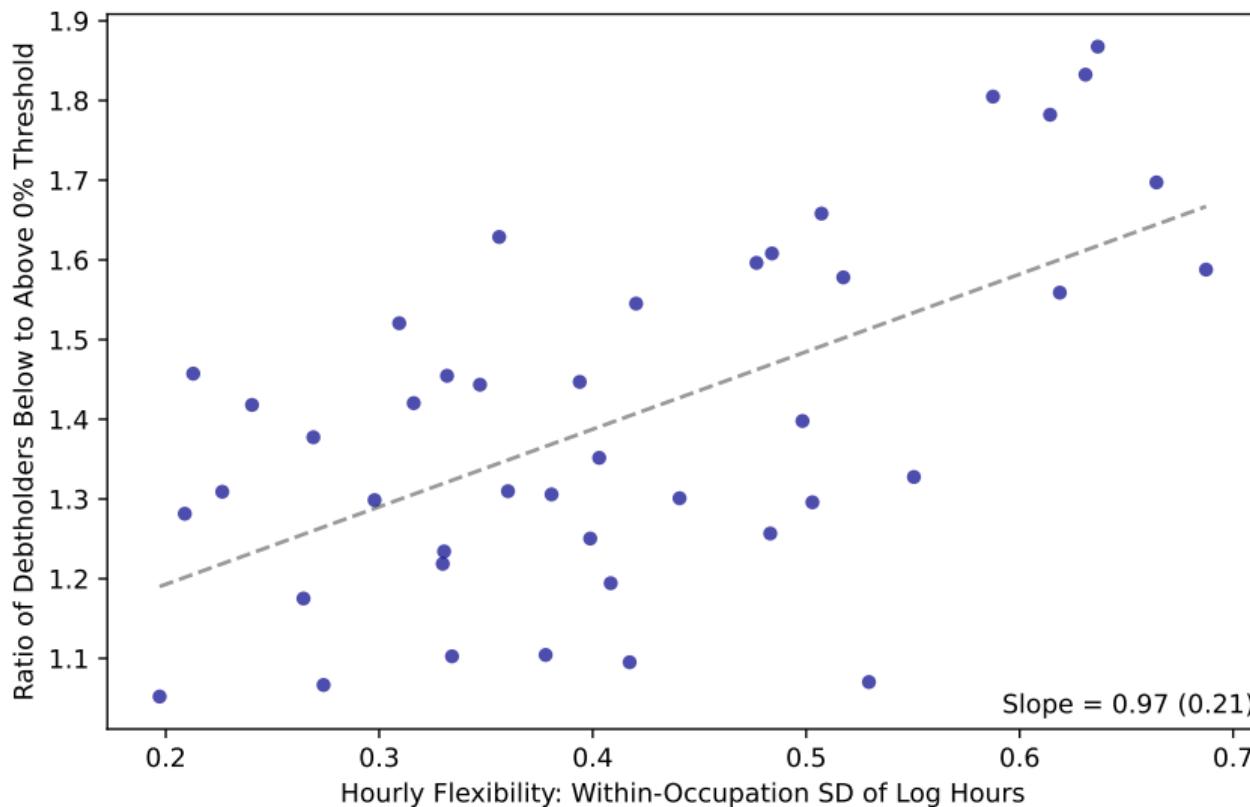
◀ Back

# BUNCHING AT THRESHOLD IS LARGER THAN AT TAX KINK: 2016



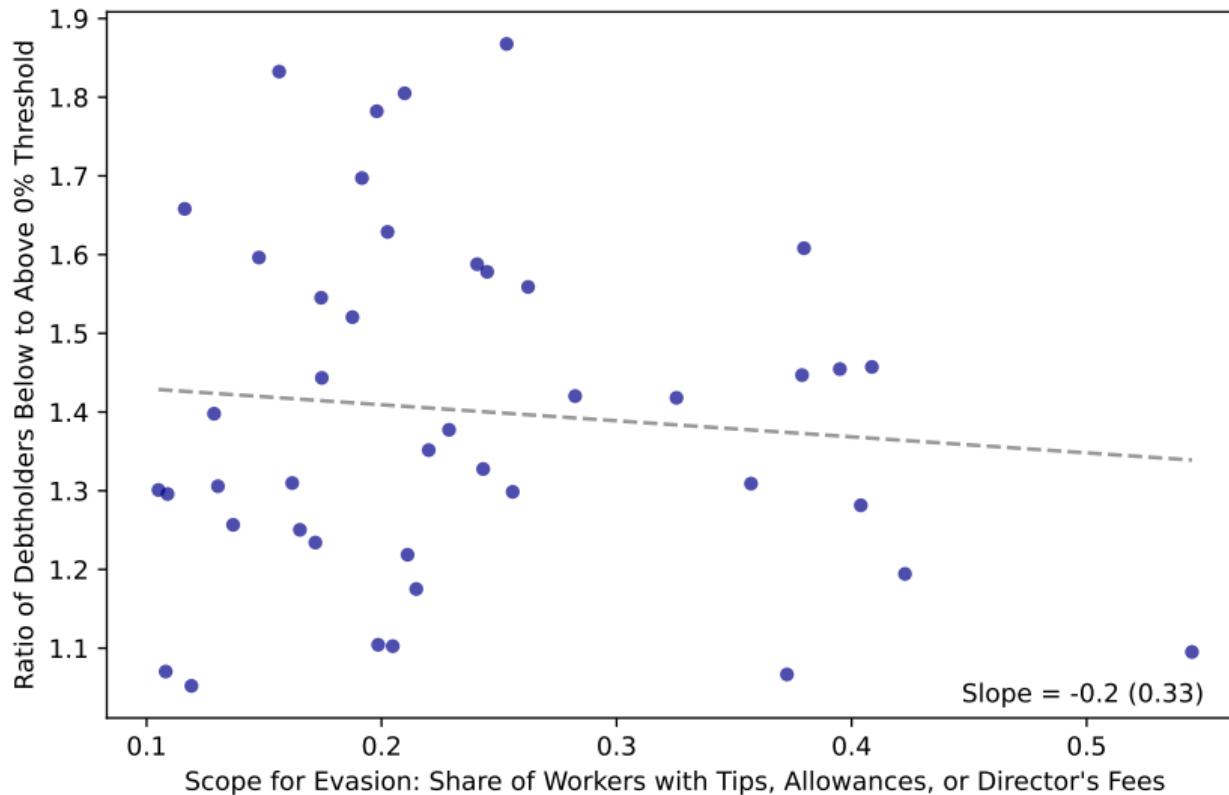
◀ Back

# ALTERNATIVE MEASURE OF HOURLY FLEXIBILITY



◀ Back

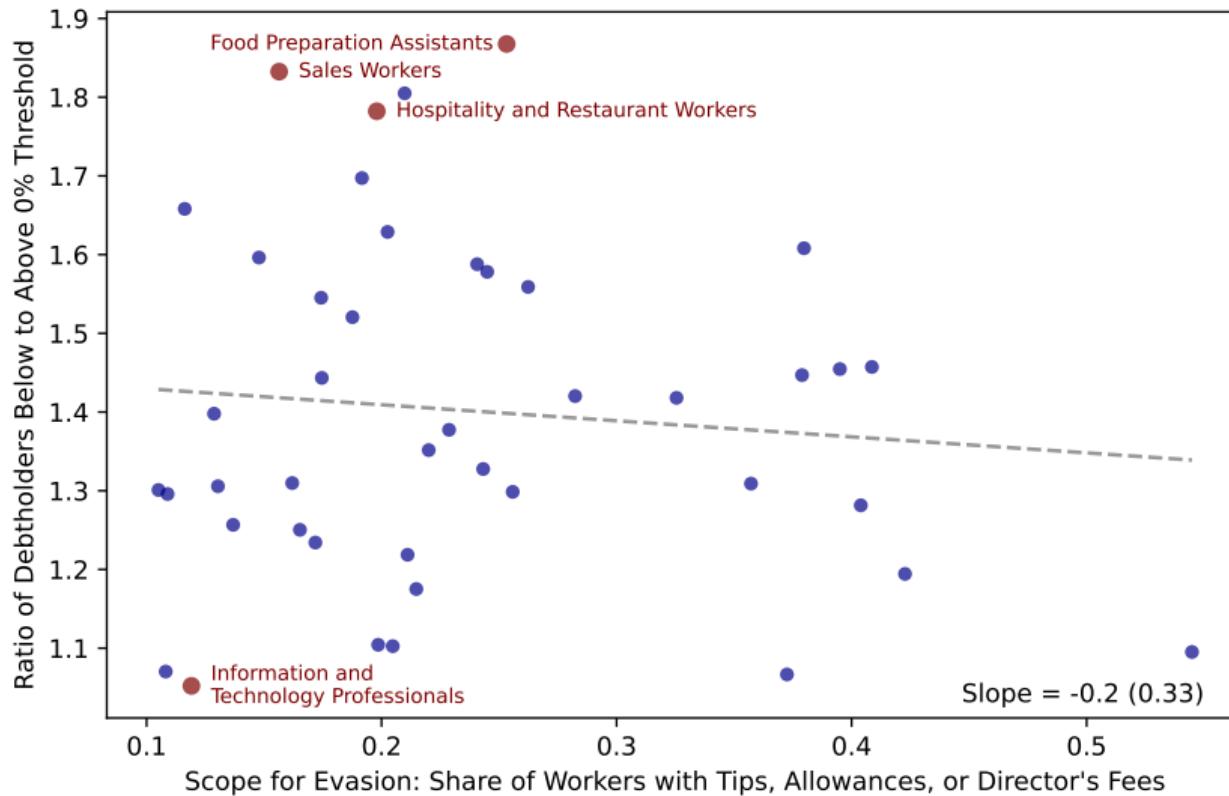
# BUNCHING UNCORRELATED WITH MEASURE OF EVASION



Easier to misreport non-salary and wage income Paetzold-Winner 2016, Slemrod 2019

◀ Back

# BUNCHING UNCORRELATED WITH MEASURE OF EVASION



Easier to misreport non-salary and wage income Paetzold-Winner 2016, Slemrod 2019

◀ 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 (0.35)	.	.	.	1.30 (0.35)	1.05 (0.28)	0.50 (0.23)
Evasion: Share with Non-Wage Income	.	-0.20 (0.30)	.	.	-0.02 (0.30)	-0.17 (0.30)	0.05 (0.25)
Income Slope: Mean Wage at 45 / Mean Wage at 26	.	.	-0.53 (0.10)	.	.	-0.40 (0.12)	.
Income Peak: Maximum Wage in Occupation Profile	.	.	.	-0.48 (0.06)	.	.	-0.40 (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

[▶ Profiles](#)
[◀ Back: Hours](#)
[◀ Back: Slope](#)
[◀ Back: Summary](#)

# COMPUTATION OF BUNCHING STATISTIC

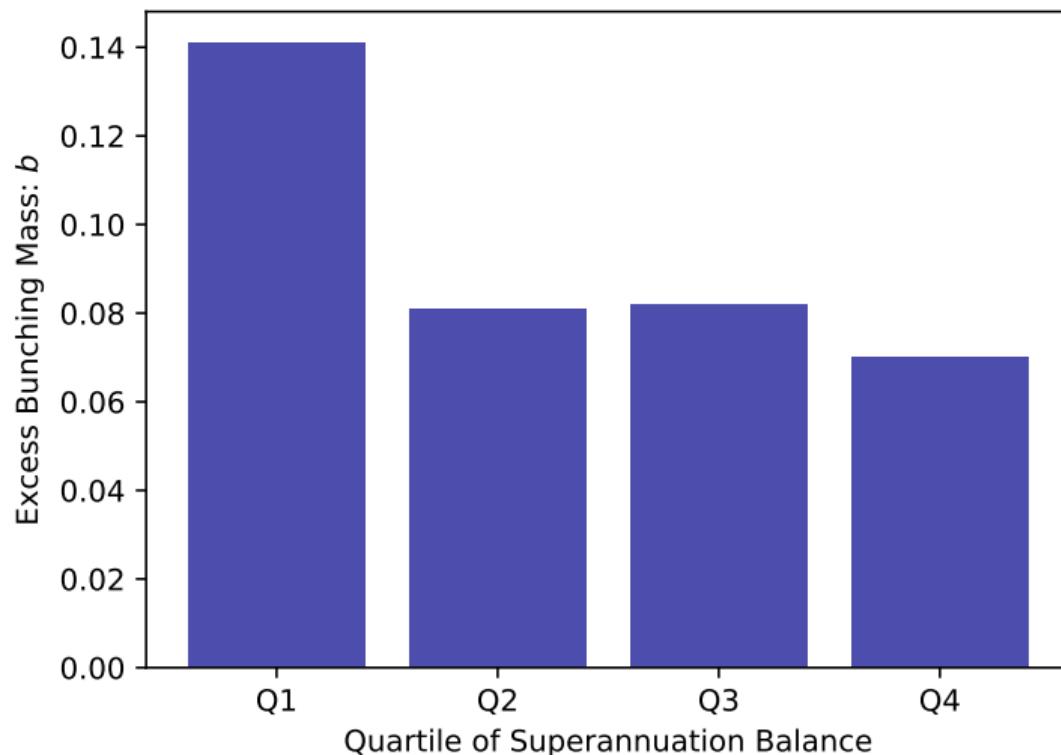
- Bunching statistic calculated as in prior literature Chetty et al. 2011, Kleven-Waseem 2013

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

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

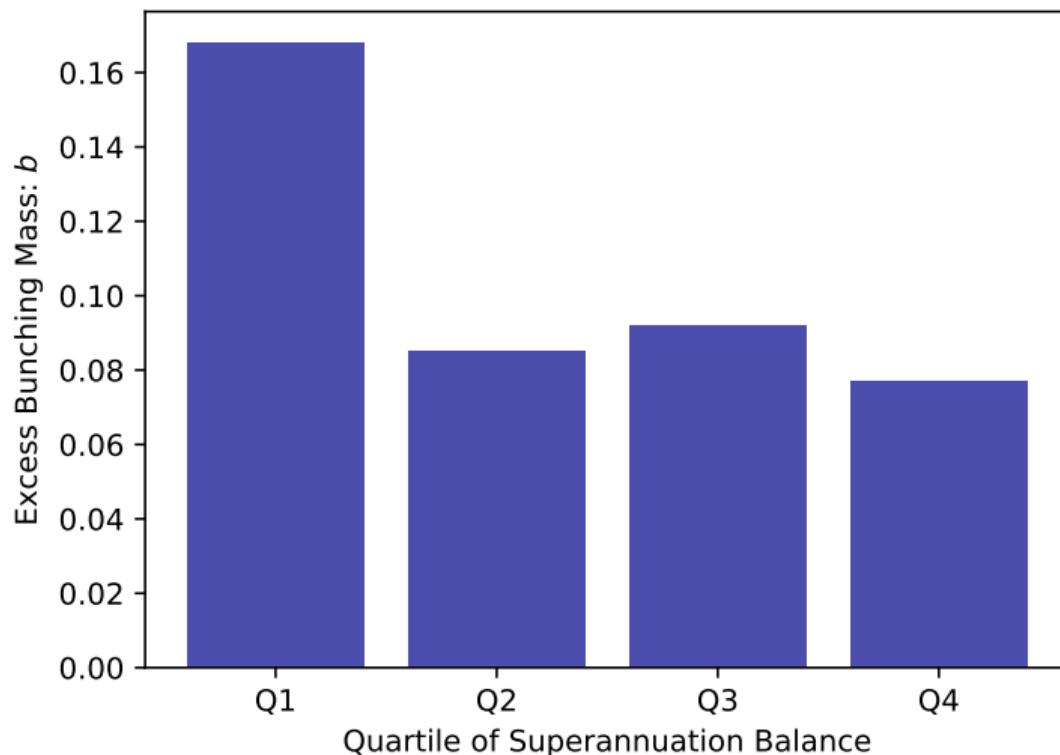
- $b = 0.1 \Rightarrow$  10% more people below threshold than would be absent discontinuity
  - Note: normalization makes  $b$  comparable across distributions of different shapes
- Sample:** All debtholders age 20 to 64 pooled across 2005 to 2018
  - Income deflated to 2005 so 0% threshold constant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

# BUNCHING DECREASES WITH SUPERANNUATION BALANCES



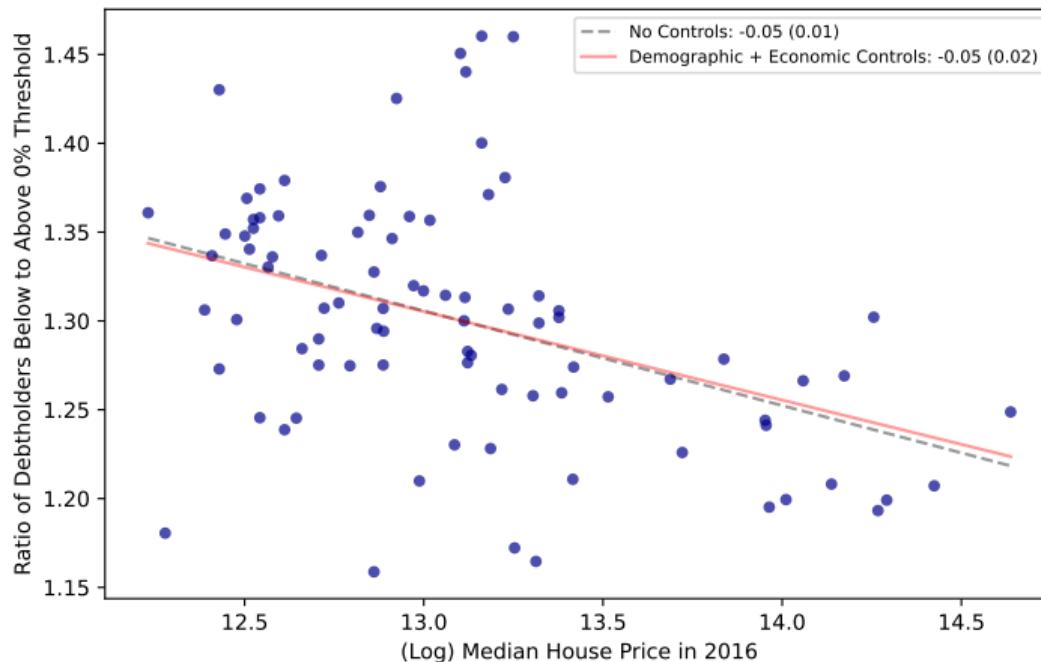
◀ Back

## BUNCHING HETEROGENEITY BY SUPER WEALTH: AGES 20-29



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# LESS BUNCHING IN REGIONS WITH MORE HOUSING WEALTH



◀ Back

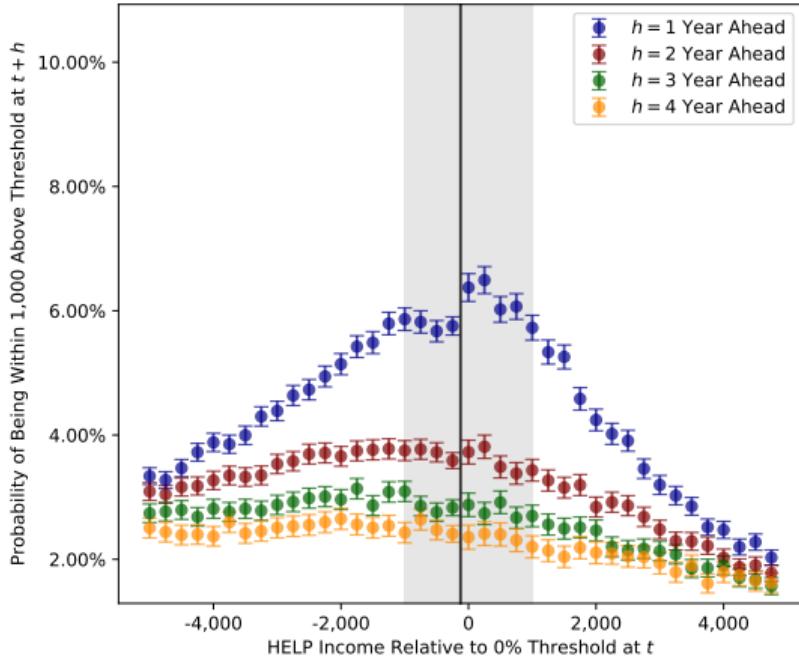
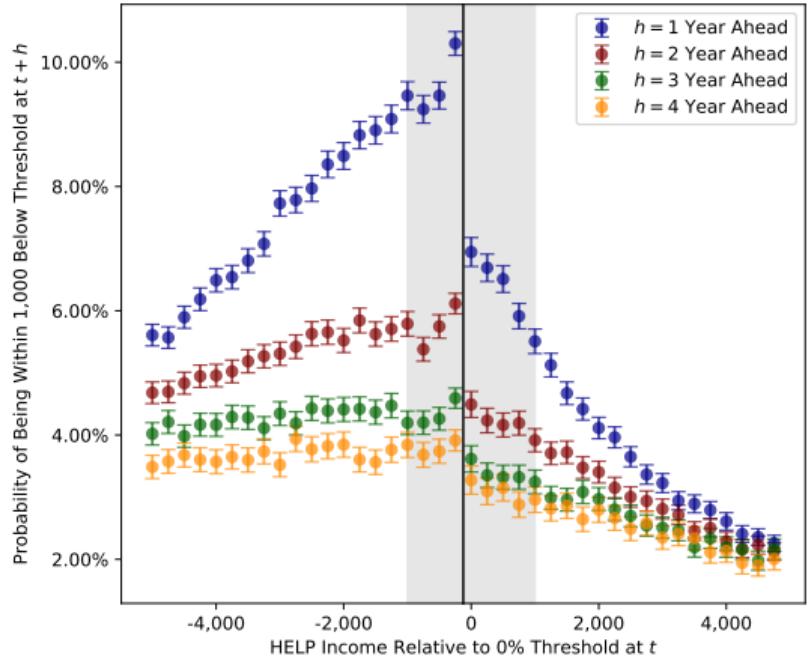
# ADDITIONAL EMPIRICAL RESULTS

- ① **Persistence** of bunching below threshold lasts around three years 
- ② **Long-run**: income of “bunchers” similar to “non-bunchers” after two years 
- ③ No discontinuity in probability of **switching occupations** around threshold 
- ④ Limited heterogeneity in bunching with household **demographics** 
  - Caveat: no extensive margin responses, which can vary across groups Saez et al. 2012
- ⑤ Limited evidence of bunching coming from **firm responses** (as in Chetty et al. 2011) 
- ⑥ Additional tests for **evasion**:
  - Bunching present in **salary and wages**, which is harder to misreport Slemrod 2019 
  - Minimal difference in bunching based on **filing type** 
  - Bunching declines by only 4% when dropping **self-employed** 
  - Borrowers are median income ⇒ less avoidance **opportunities** Slemrod-Yitzhaki 2002

 Back: Hours

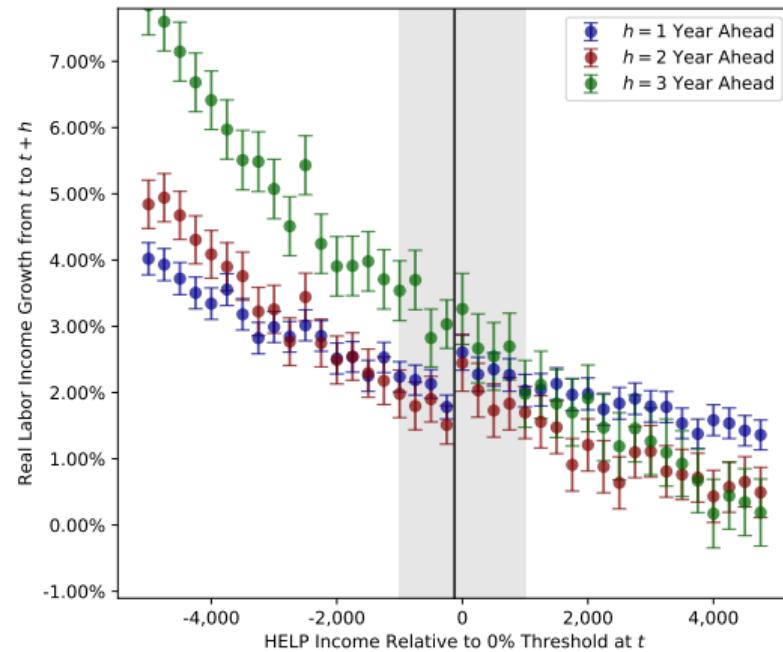
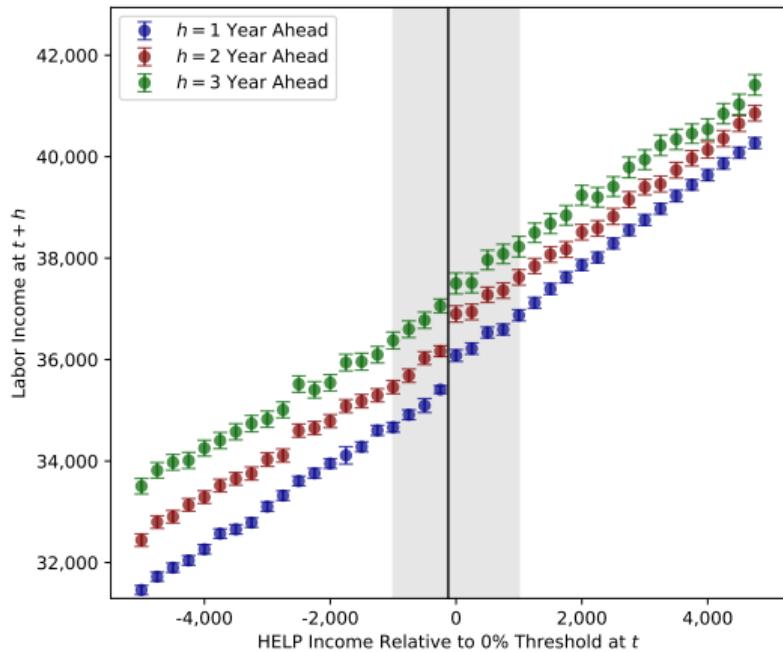
 Back: Summary

# PERSISTENCE OF BUNCHING LASTS AROUND THREE YEARS



◀ Back

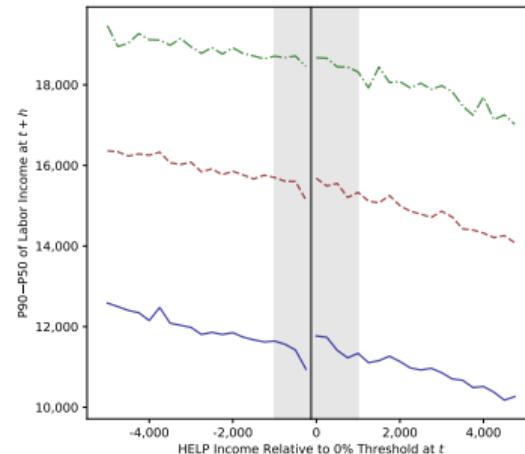
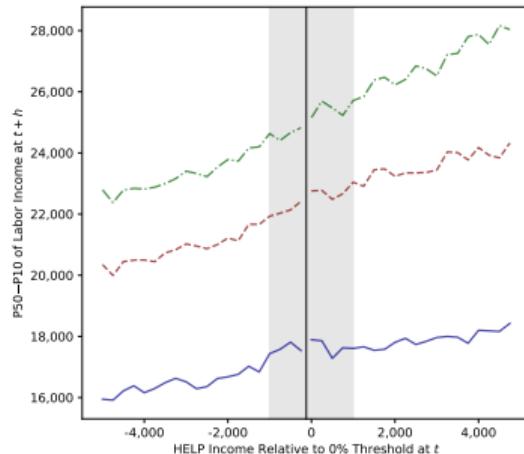
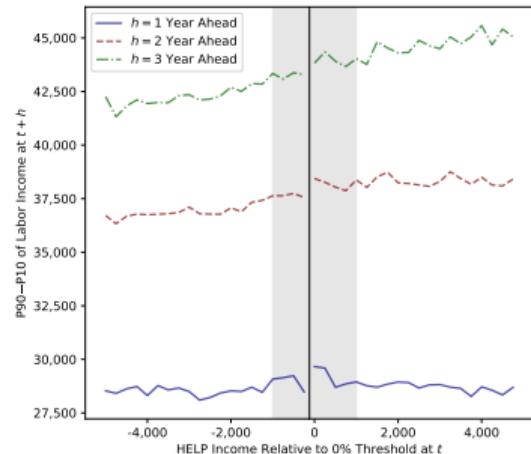
# LIMITED EVIDENCE OF DYNAMIC COST TO BUNCHING



▶ Distribution

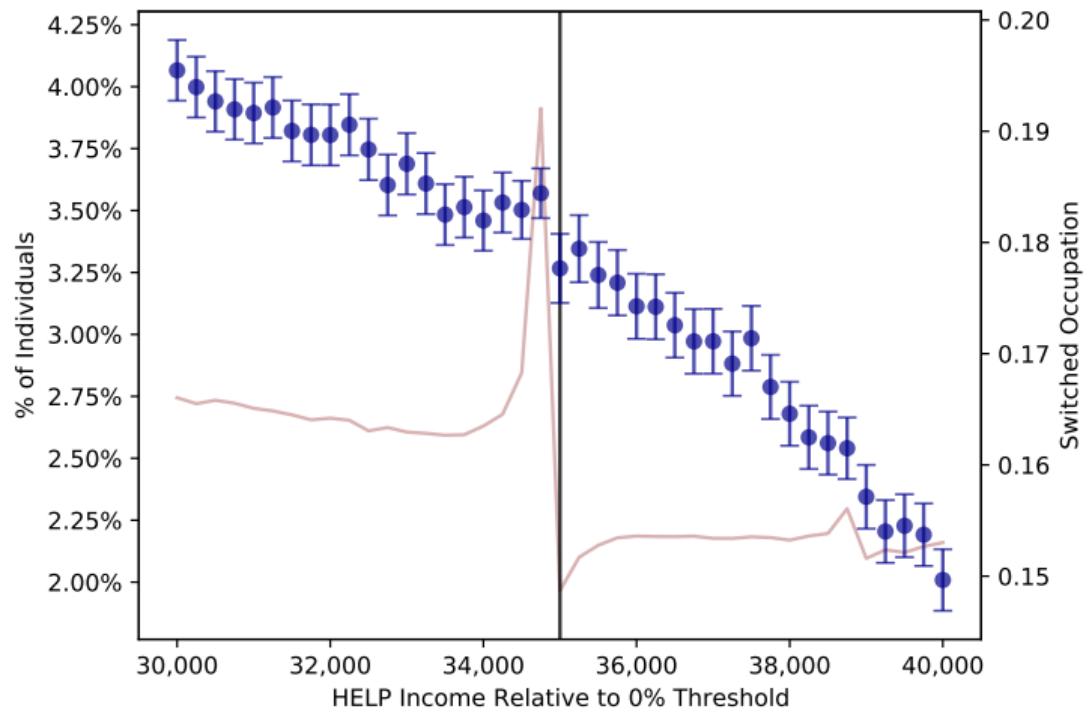
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# LITTLE DIFFERENCE IN DISTRIBUTION OF FUTURE INCOME



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# No Discontinuity in the Probability of Switching Occupations



◀ Back

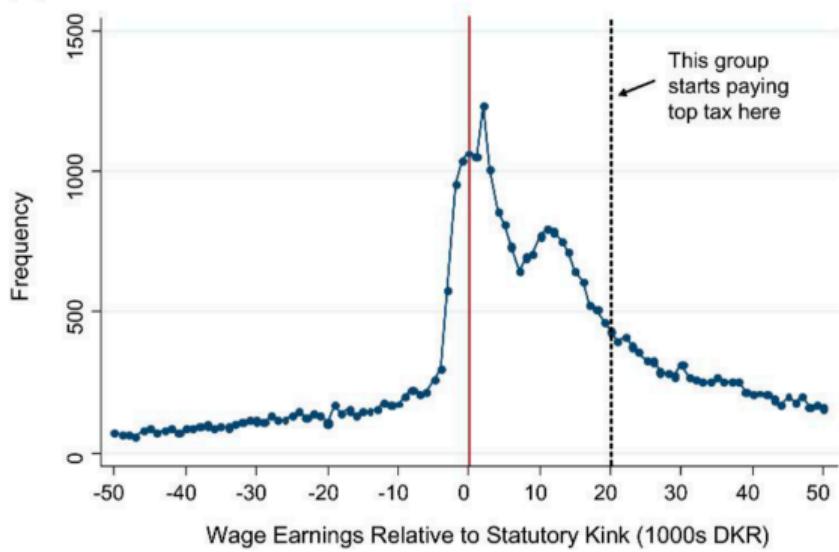
## DEMOGRAPHIC HETEROGENEITY IN BUNCHING

Sample	Estimated Bunching Statistic: b
Non-Electronic Filers	0.086
Electronic Filers	0.082
Wage-Earners	0.081
Entrepreneurs (Not Wage-Earners)	0.117
Females	0.081
Males	0.083
No Dependent Children	0.086
Has Dependent Children	0.077
No Spouse	0.085
Has Spouse	0.081
<b>Full Sample</b>	<b>0.084</b>

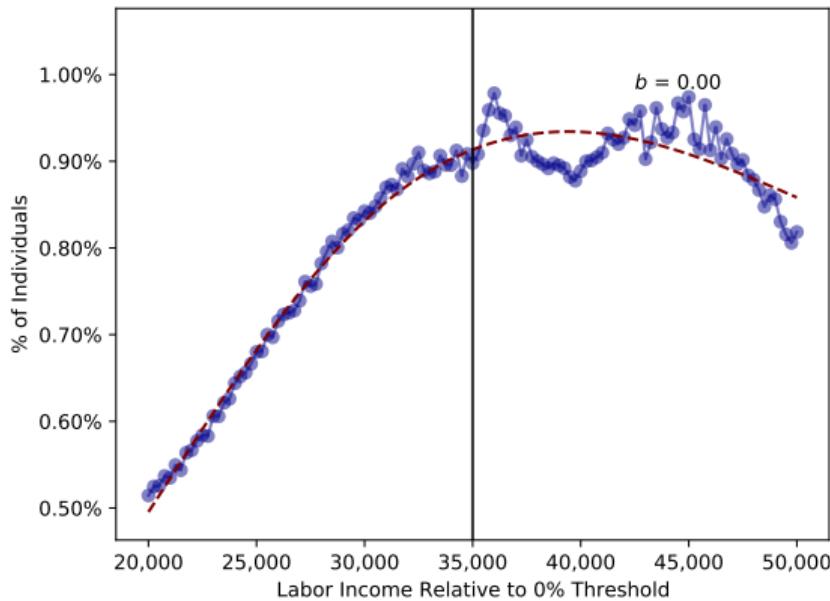
◀ Back

# CHETTY ET AL. (2011) TEST OF FIRM RESPONSES

## Chetty et al: Teacher Wages



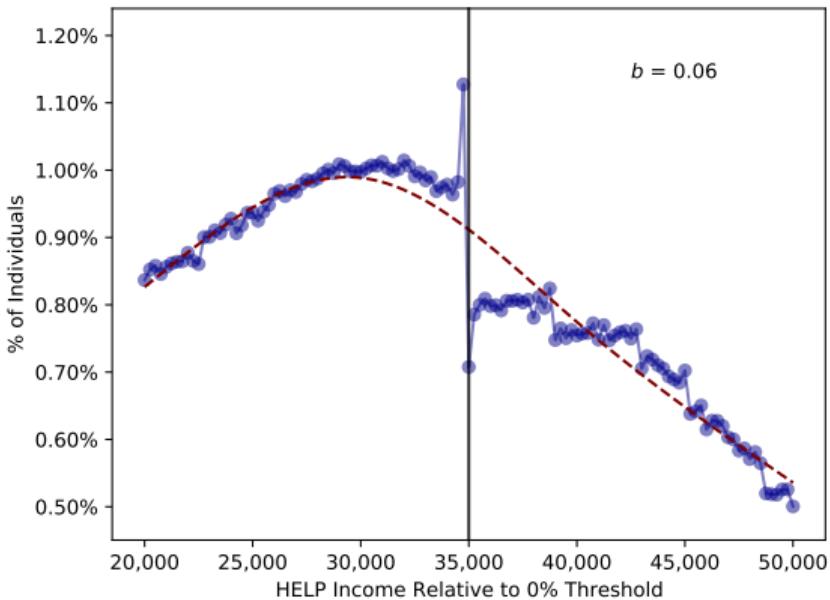
## Borrower Labor Income



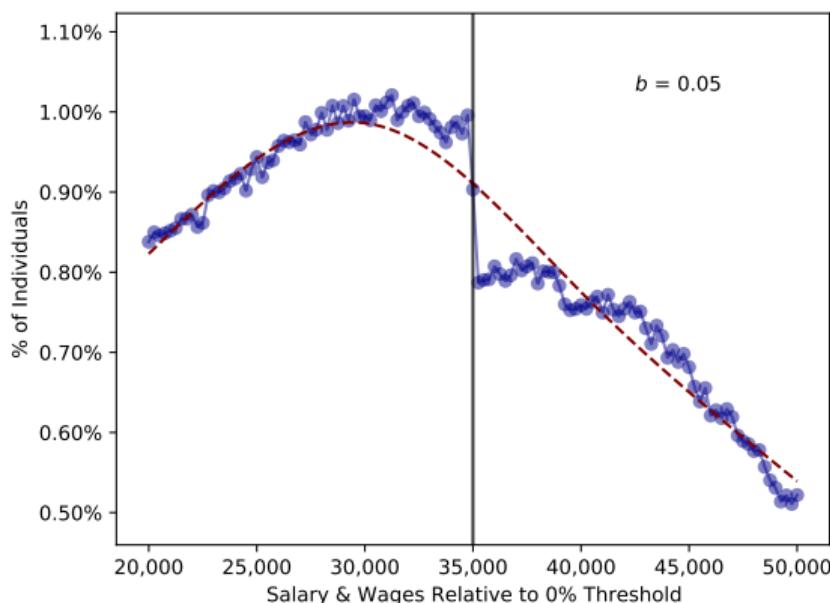
◀ Back

# BUNCHING IN DISTRIBUTION OF SALARY AND WAGES

## HELP Income



## Salary and Wages



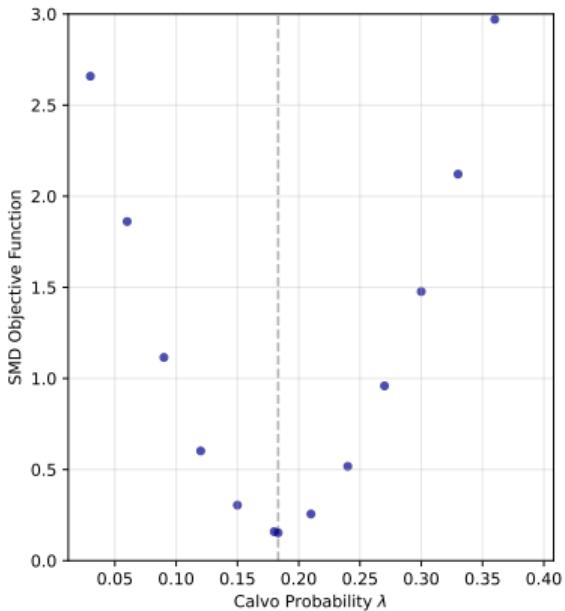
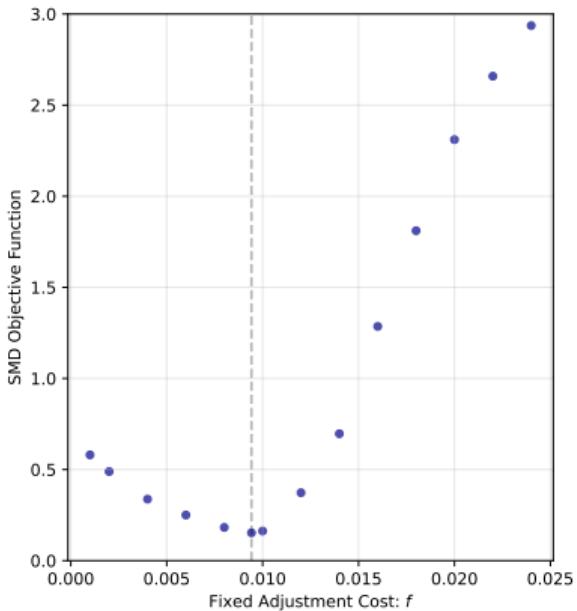
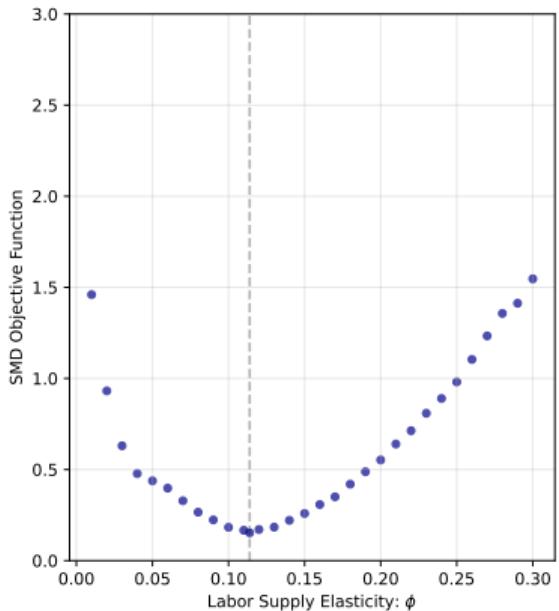
[◀ Back](#)

## 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

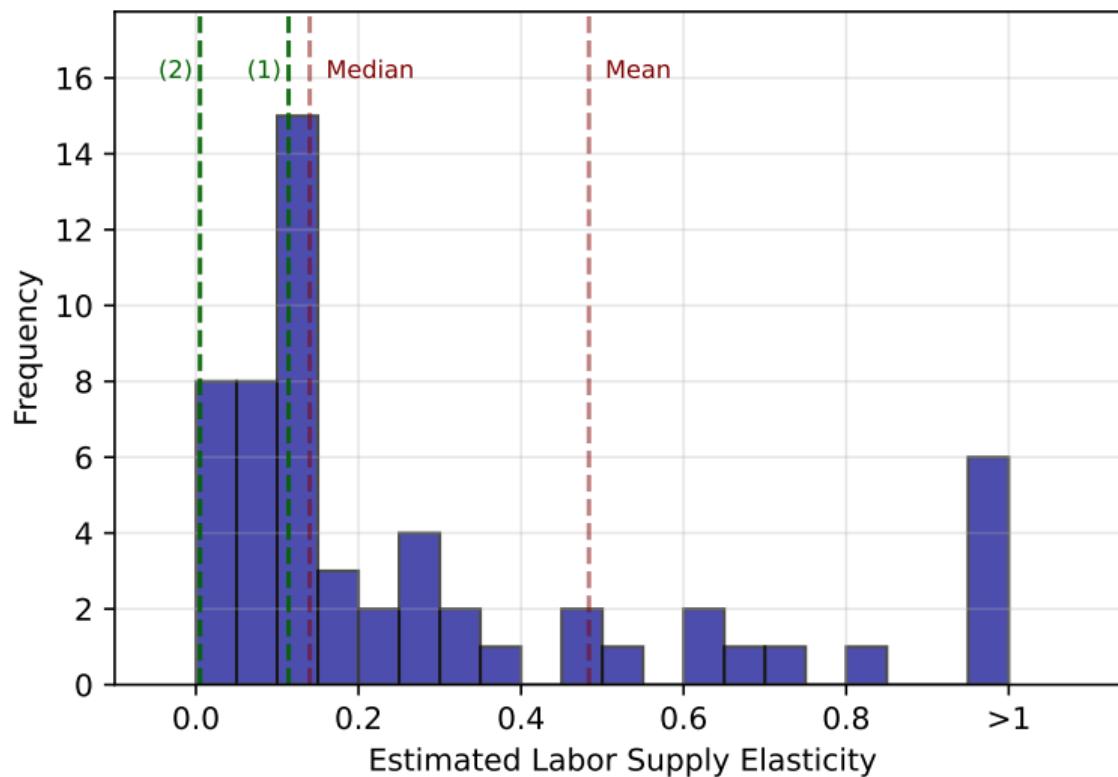
## SIMULATED MINIMUM DISTANCE: OTHER MOMENTS

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

- 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  $\Rightarrow$   $\kappa$

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## COMPARISON WITH EXISTING LITERATURE ON LABOR SUPPLY (1/2)



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

## COMPARISON WITH EXISTING LITERATURE ON LABOR SUPPLY (2/2)

### Reasons why elasticity may be smaller:

- ① Different **sample**: college graduates with less flexibility and further from  $y_t = w_t l_t$
- ② Elasticity is **local** to threshold: no high-income individuals Gruber-Saez 2002
- ③ Bunching does not identify **extensive** margin responses Saez et al. 2012

### Contributions:

- ① **Empirical** characterization of responses to income-contingent repayment
  - $\ell_t$  of indebted households responds to liquidity not wealth, like  $c_t$  Ganong-Noel 2020
- ② **Dynamic** model of labor supply with time- and state-dependent adjustment
  - ✓ First paper (to my knowledge) to explicitly estimate different types of frictions

◀ Back

# FULL ESTIMATION RESULTS

Parameter		Estimation						
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Labor supply elasticity	$\phi$	0.114 (.004)	0.005 (.000)	0.188 (.003)	0.053 (.002)	0.082 (.002)	0.111 (.004)	0.067 (.002)
Adjustment cost	$f$	\$377 (\$13)	\$0 . .	\$2278 (\$21)	\$0 . .	\$762 (\$10)	\$513 (\$19)	\$848 (\$11)
Calvo probability	$\lambda$	0.183 (.003)	1 . .	1 . .	0.147 (.002)	0.346 (.009)	0.191 (.003)	0.266 (.005)
Scaling parameter	$\kappa$	0.560 (.007)	0.030 (.003)	0.059 (.014)	0.510 (.012)	1.242 (.116)	0.593 (.001)	0.448 (.001)
Time discount factor	$\beta$	0.973 (.001)	0.996 (.000)	0.972 (.001)	0.944 (.001)	0.951 (.001)	0.951 (.001)	0.946 (.001)
Wage profile parameters	$\delta_0$	8.922 (.009)	9.862 (.002)	8.680 (.006)	9.389 (.007)	9.197 (.007)	9.143 (.008)	9.211 (.008)
	$\delta_1$	0.073 (.000)	0.111 (.000)	0.073 (.000)	0.063 (.000)	0.070 (.000)	0.075 (.000)	0.074 (.000)
	$\delta_2$	-0.001 (.000)	-0.002 (.000)	-0.001 (.000)	-0.001 (.000)	-0.001 (.000)	-0.001 (.000)	-0.001 (.000)
	$\delta_0^E$	-0.487 (.002)	-0.294 (.000)	-0.450 (.001)	-0.530 (.002)	-0.480 (.002)	-0.478 (.002)	-0.505 (.002)
	$\delta_1^E$	0.020 (.000)	0.032 (.000)	0.018 (.000)	0.021 (.000)	0.018 (.000)	0.020 (.000)	0.021 (.000)
Persistence of permanent shock	$\rho$	0.930 (.000)	0.914 (.000)	0.943 (.000)	0.922 (.000)	0.889 (.000)	0.907 (.001)	0.931 (.001)
Std. deviation of permanent shock	$\sigma_\nu$	0.236 (.000)	0.076 (.000)	0.196 (.000)	0.268 (.000)	0.288 (.000)	0.275 (.001)	0.246 (.001)
Std. deviation of transitory shock	$\sigma_\epsilon$	0.130 (.000)	0.504 (.000)	0.168 (.000)	0.077 (.002)	0.064 (.002)	0.080 (.002)	0.116 (.001)
Std. deviation of individual FE	$\sigma_i$	0.599 (.003)	0.101 (.001)	0.541 (.003)	0.654 (.003)	0.625 (.003)	0.612 (.003)	0.632 (.003)
Learning-by-doing parameter	$\alpha$	0 Fixed No	0 Fixed No	0 Fixed No	0 Fixed No	0.24 Fixed No	0 Linear No	0 Fixed Yes
Adjustment cost function								
Misperception of debt payoff								

◀ Back: Estimation

◀ Back: Additional

## MODEL FIT: OTHER TARGET MOMENTS

Estimation Target	Data	Model
Average Labor Income	\$42,639	\$45,582
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	\$1,338	\$1,332

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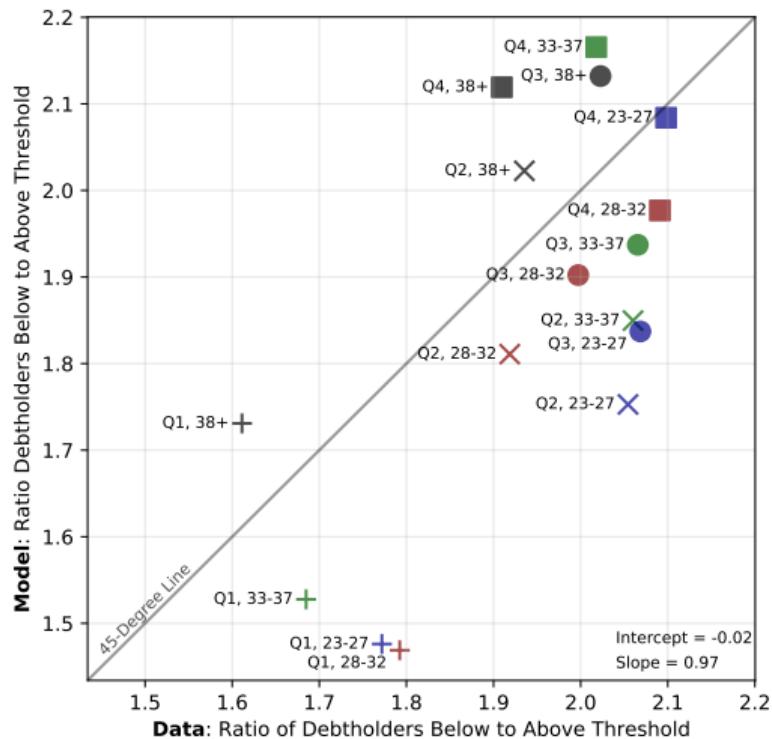
## ADDITIONAL MODEL RESULTS: POSITIVE

- ① **Robustness:**  $\hat{\phi} = 0.111$  with linear adjustment costs (vs. 0.114) 
- ② **Validation** of baseline model on nontargeted moments 
- ③ Bunching **decomposition**:  $P(\text{Repayment}) \approx 60\%$ , liquidity demands  $\approx 40\%$  
- ④ **Learning-by-doing**: cannot match heterogeneity in bunching by debt and age 

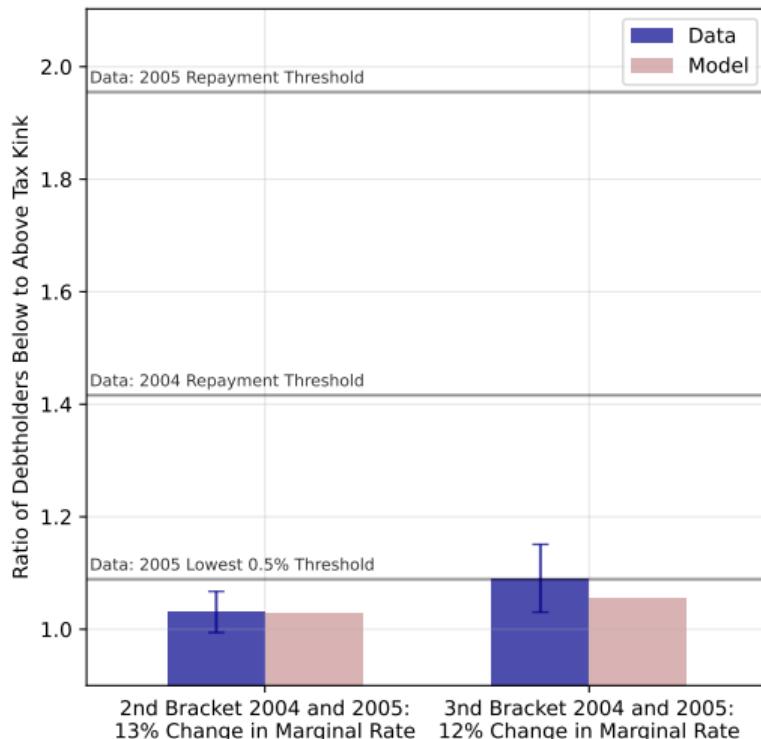
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# VALIDATION OF BASELINE MODEL ON NONTARGETED BUNCHING

## Heterogeneity by Debt and Age



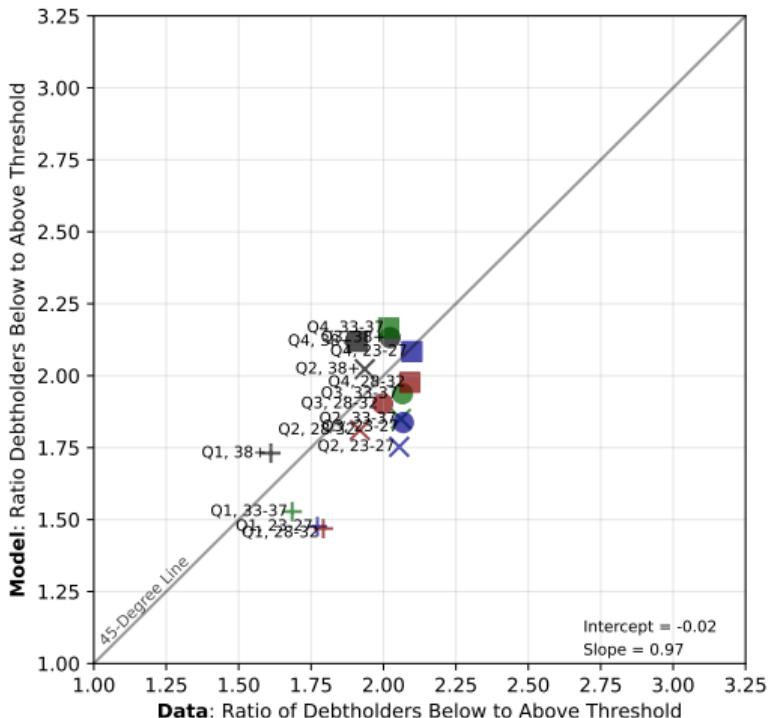
## Bunching at Changes in Tax Rates



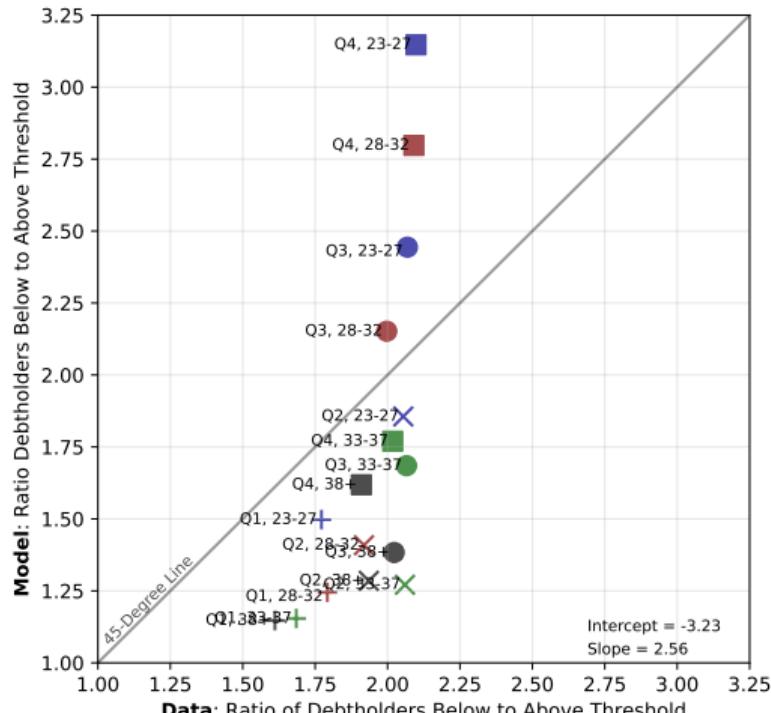
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# LEARNING-BY-DOING MODEL FITS WORSE THAN BASELINE MODEL

## Baseline Model

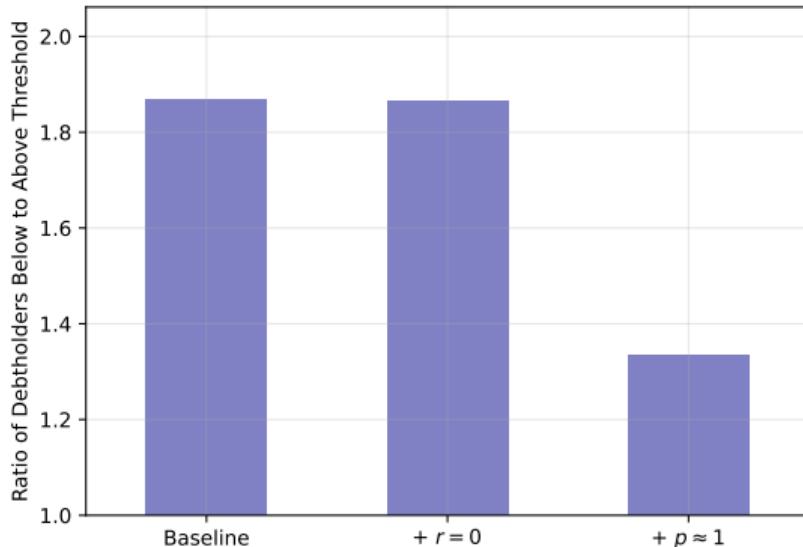
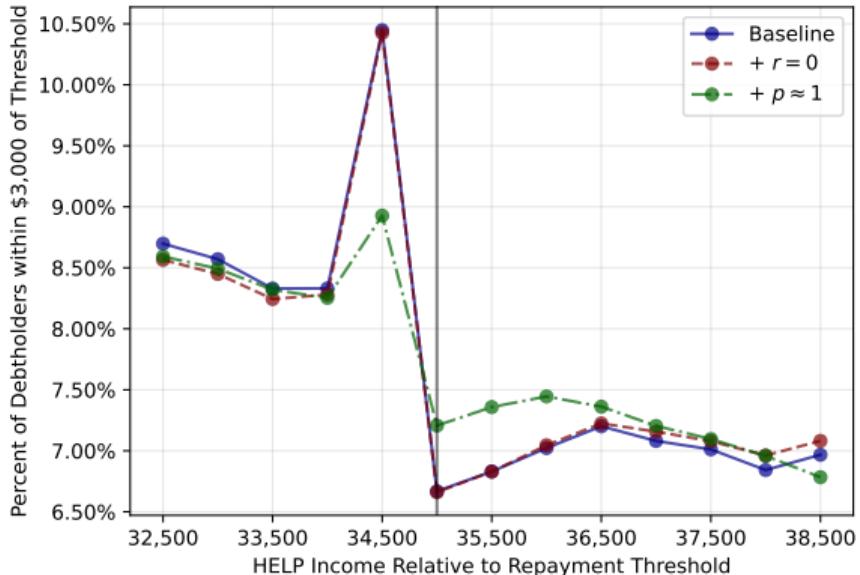


## Learning-by-Doing Model



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# DECOMPOSITION: RATE DIFFERENTIAL, REPAYMENT, AND LIQUIDITY

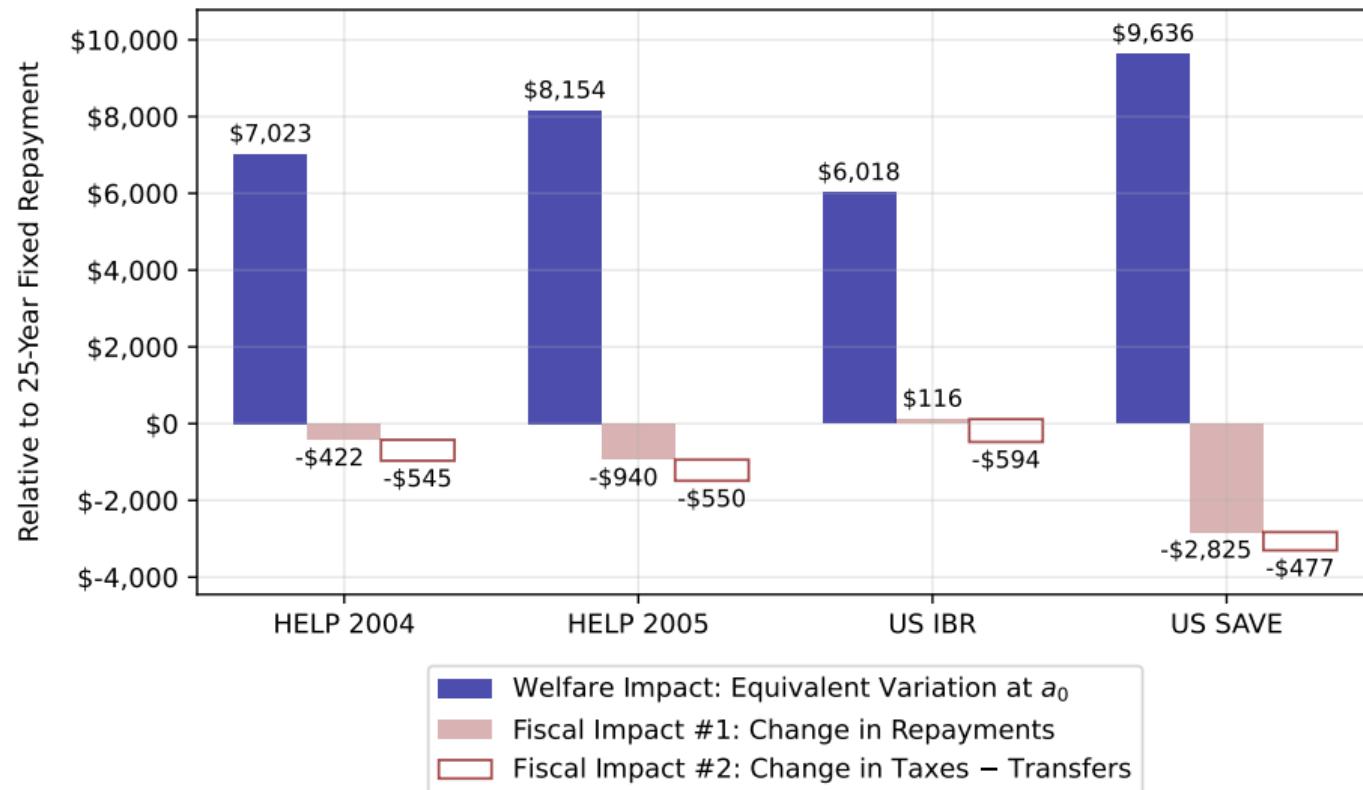


$$\text{Bunching Liquidity Gain} = \$1400 \geq \$1400 \times \frac{r + 1 - p}{1 + r} = \text{Bunching NPV Gain}$$

- Interest rate differential =  $r \Rightarrow 0\%$  of bunching
- Probability of repayment =  $p \Rightarrow 61\%$  of bunching
- Demand for liquidity  $\Rightarrow 39\%$  of bunching (Chetty 2008, Ganong-Noel 2023, Indarte 2023)

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# EXISTING INCOME-CONTINGENT LOANS VS. FIXED REPAYMENT

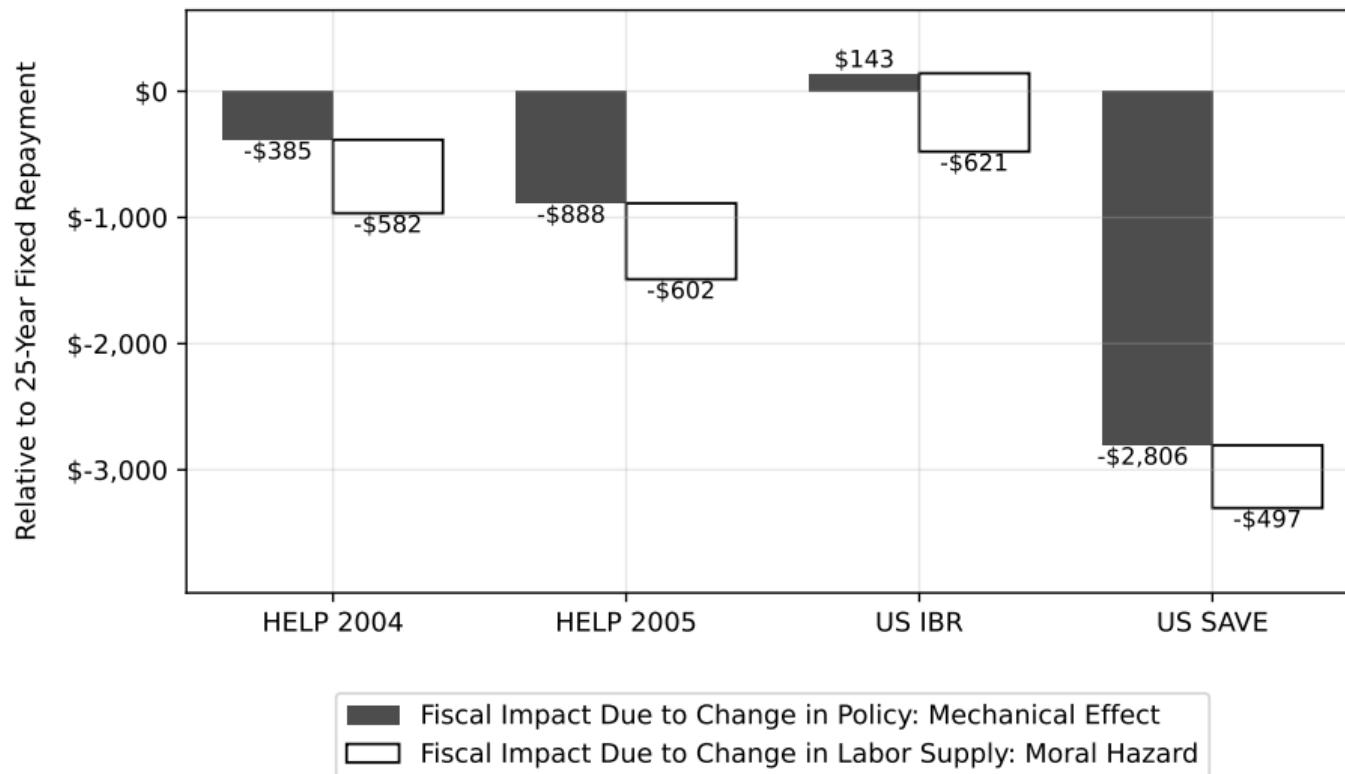


► Decomposition

► MVPF

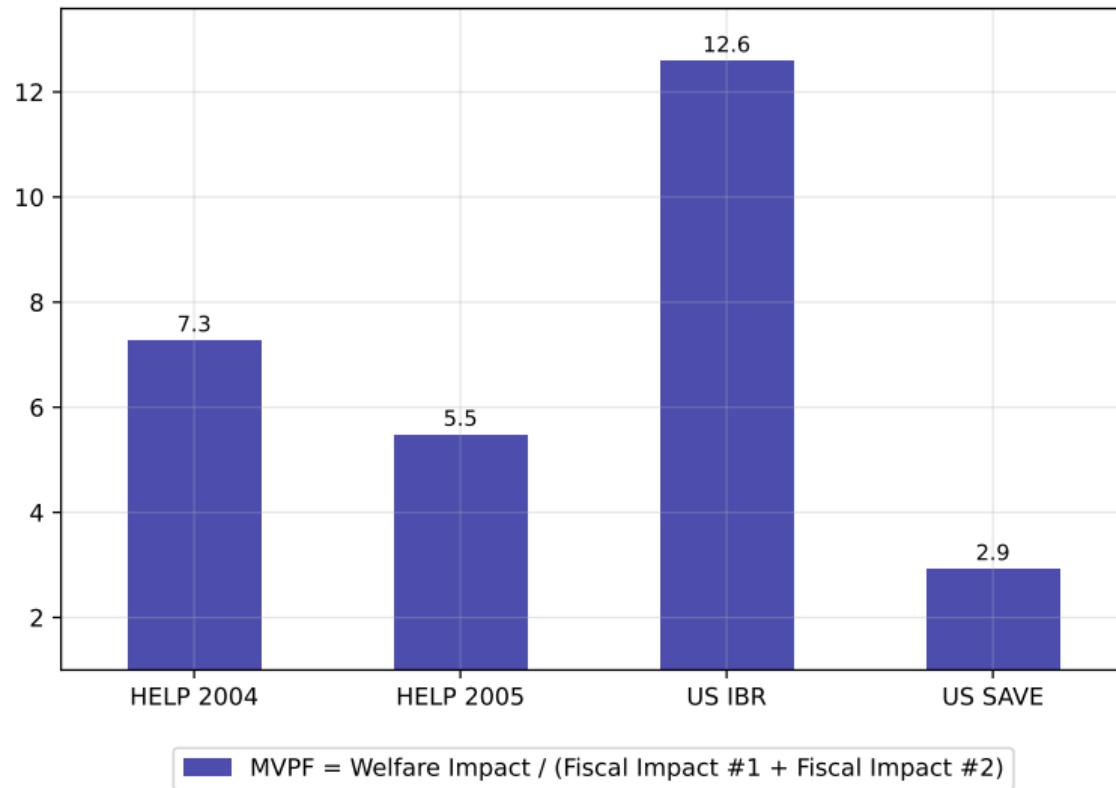
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# DECOMPOSITION OF FISCAL IMPACT: ENDOGENOUS LABOR SUPPLY



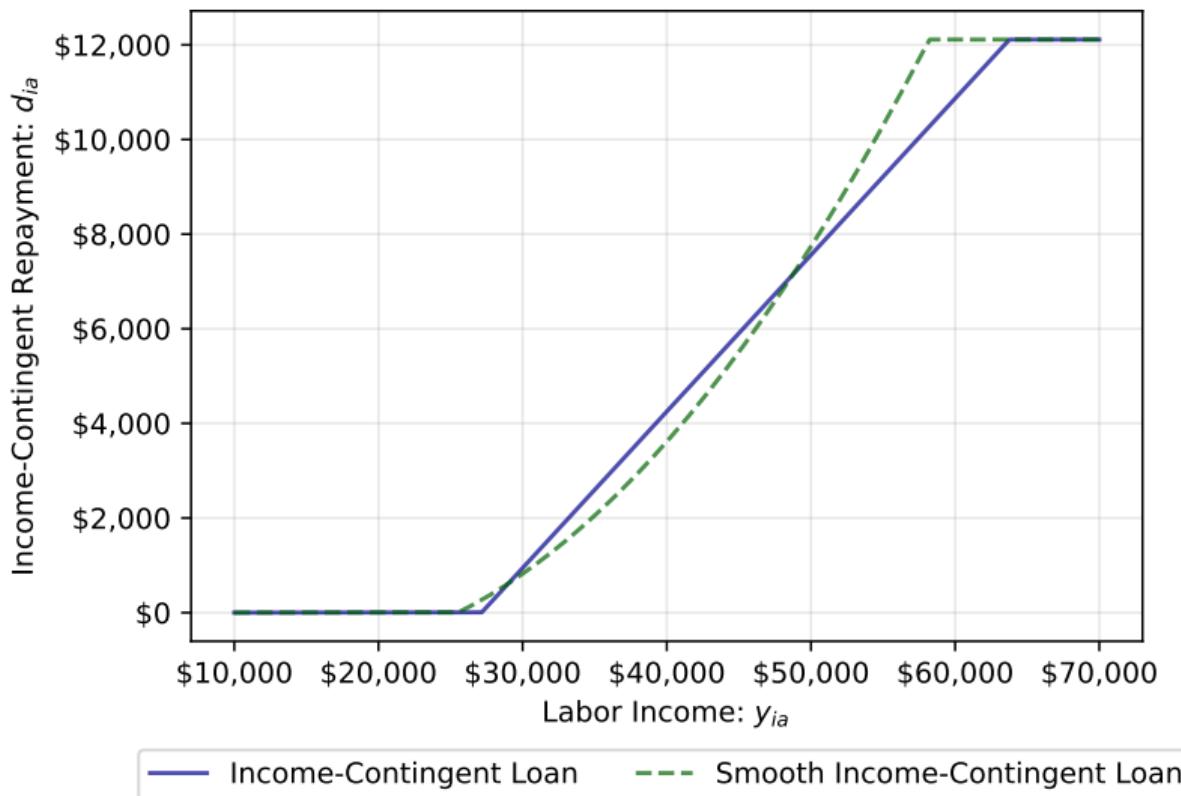
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# MARGINAL VALUE OF PUBLIC FUNDS



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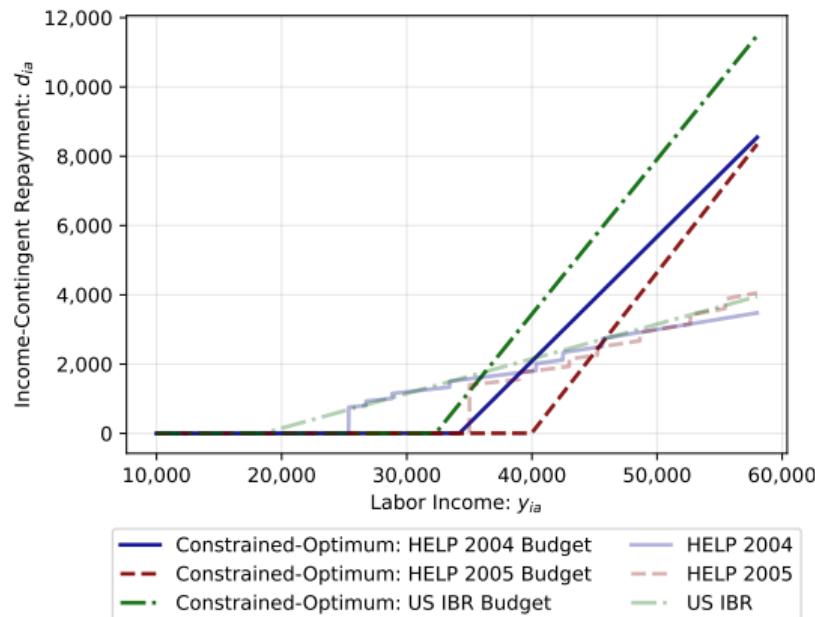
# SOLUTION TO CONSTRAINED-PLANNER'S PROBLEM: QUADRATIC



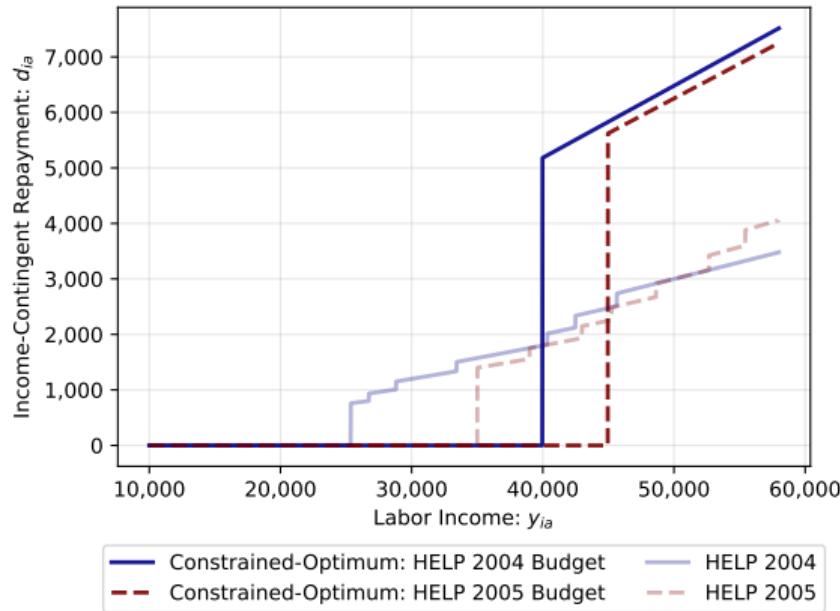
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# OPTIMAL VERSUS EXISTING INCOME-CONTINGENT LOANS

## Change in Marginal Rate

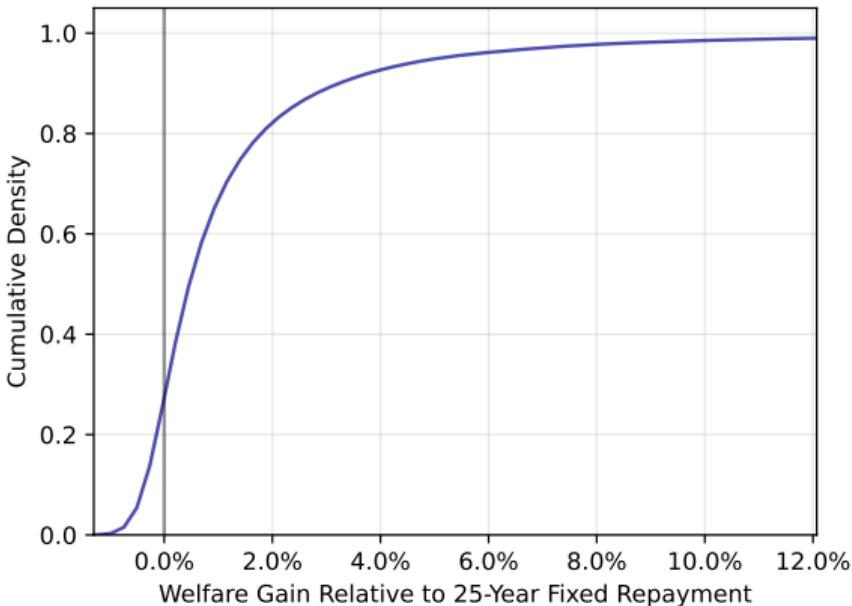
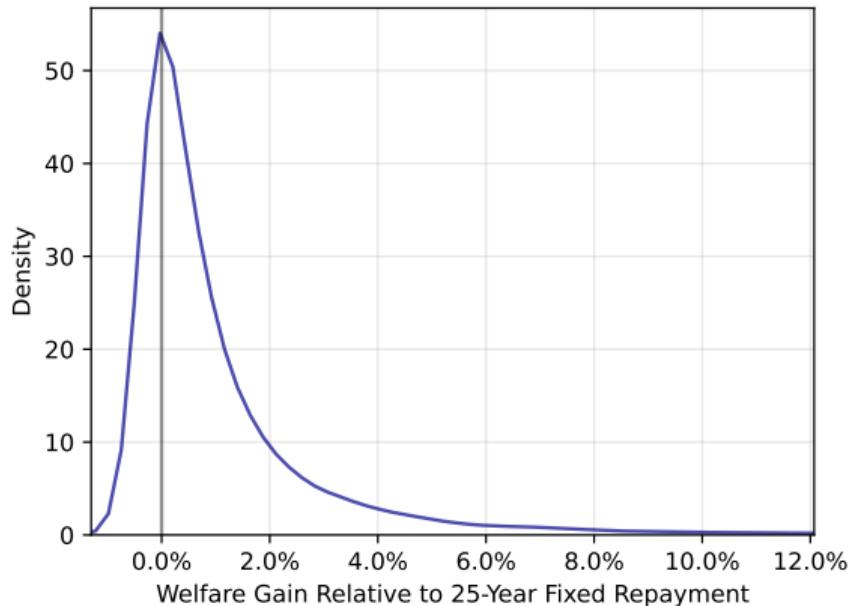


## Change in Average Rate



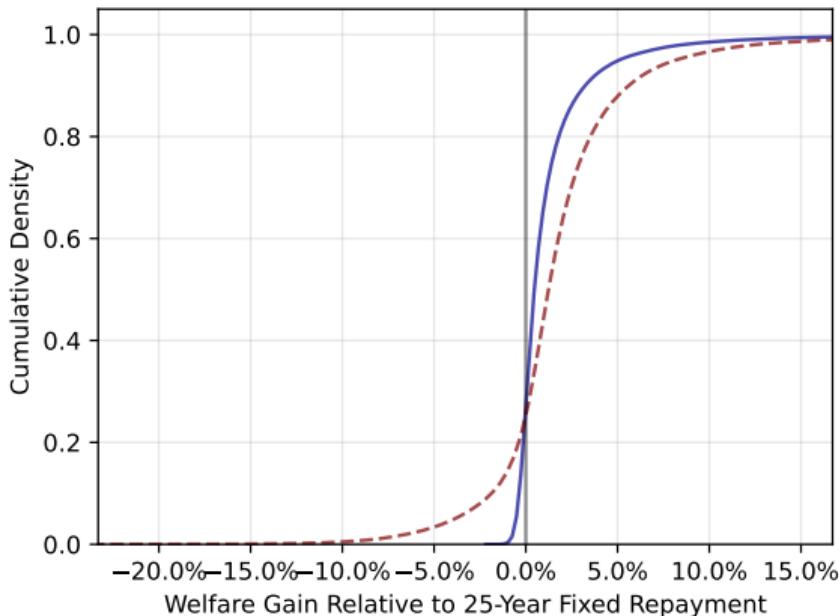
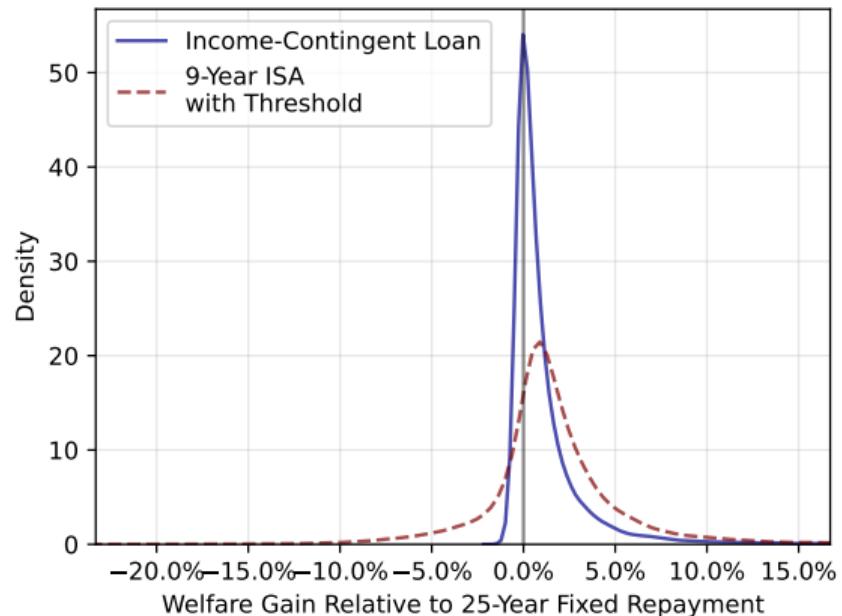
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# DISTRIBUTION OF INITIAL WELFARE GAINS: ICL



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

# DISTRIBUTION OF INITIAL WELFARE GAINS: ICL vs. EQUITY

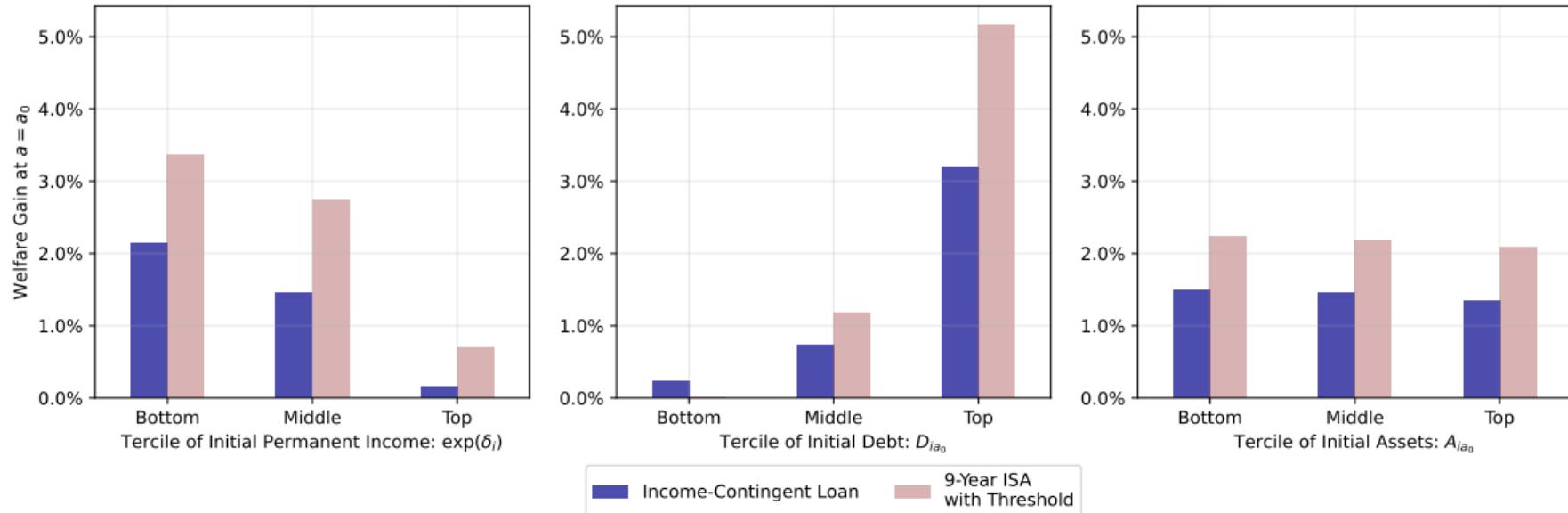


- **18%** of borrowers have welfare loss above 0.5% for equity vs. **1.2%** for ICL

▶ Heterogeneity by Initial States

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# HETEROGENEITY IN WELFARE GAINS ACROSS INITIAL STATES



▶ Losers under ICL

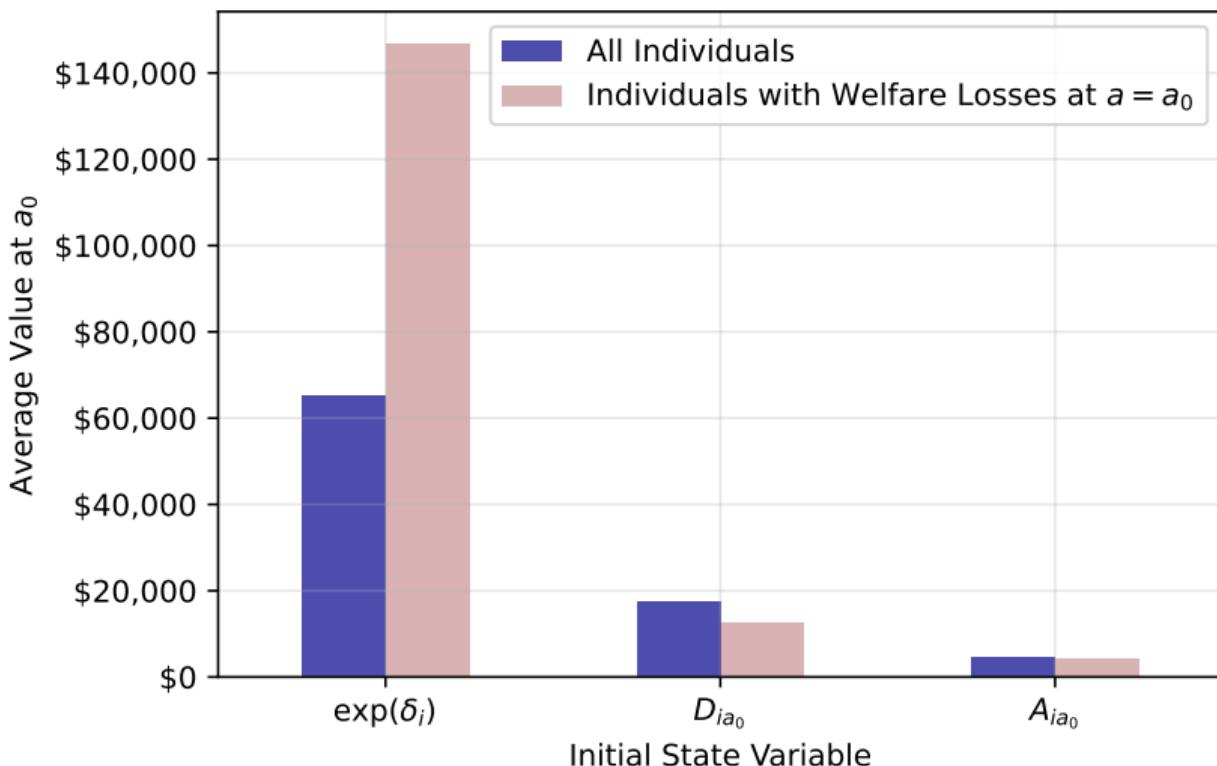
▶ Heterogeneity by Age

▶ Heterogeneity by Initial Debt

◀ Back: ICL Gain

◀ Back: Contracts

# INDIVIDUALS WITH INITIAL WELFARE LOSSES: ICL



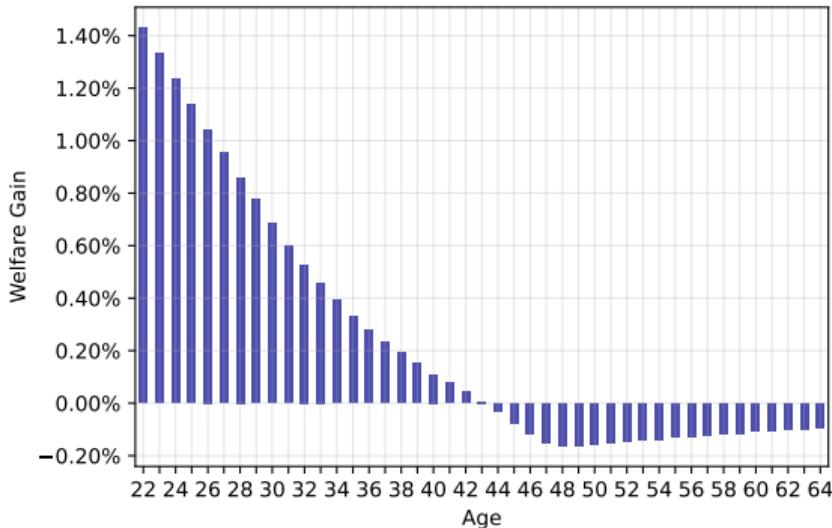
► Heterogeneity by Age

◀ Back: ICL Gain

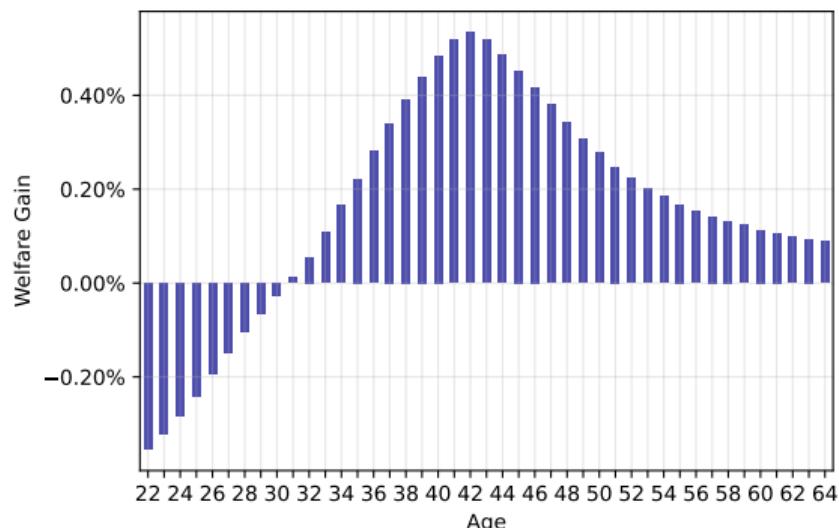
◀ Back: Contracts

# WELFARE GAINS BY AGE

**ICL vs. 25-Year Fixed**



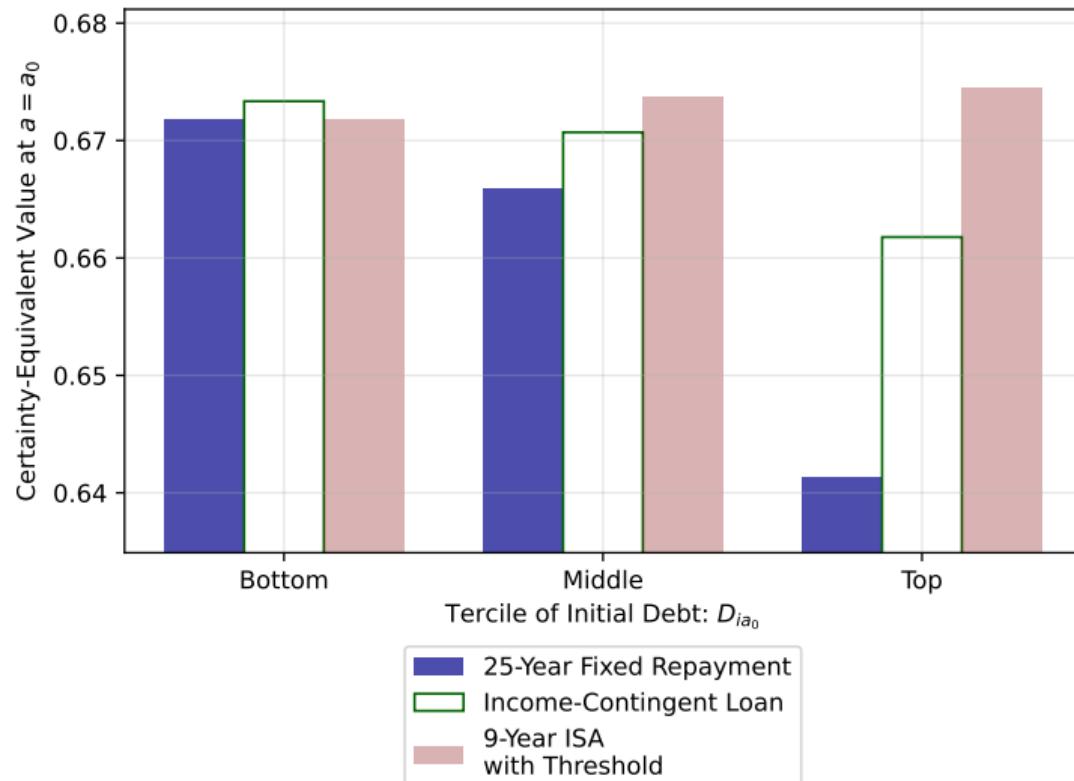
**ICL + 20-Year Forgiveness vs. ICL**



◀ Back: ICL Gain

◀ Back: Contracts

# CERTAINTY-EQUIVALENTS ACROSS INITIAL DEBT

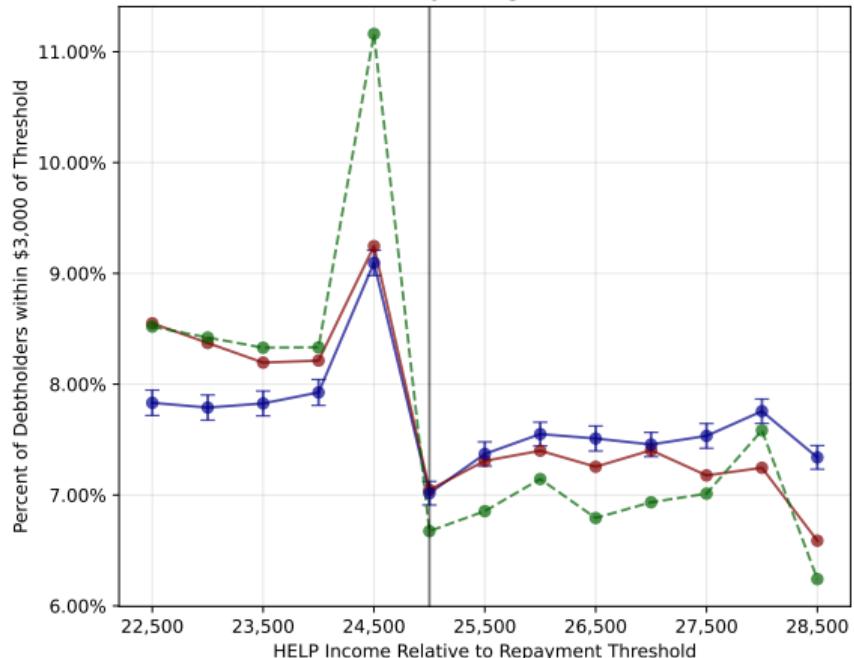


◀ Back: ICL Gain

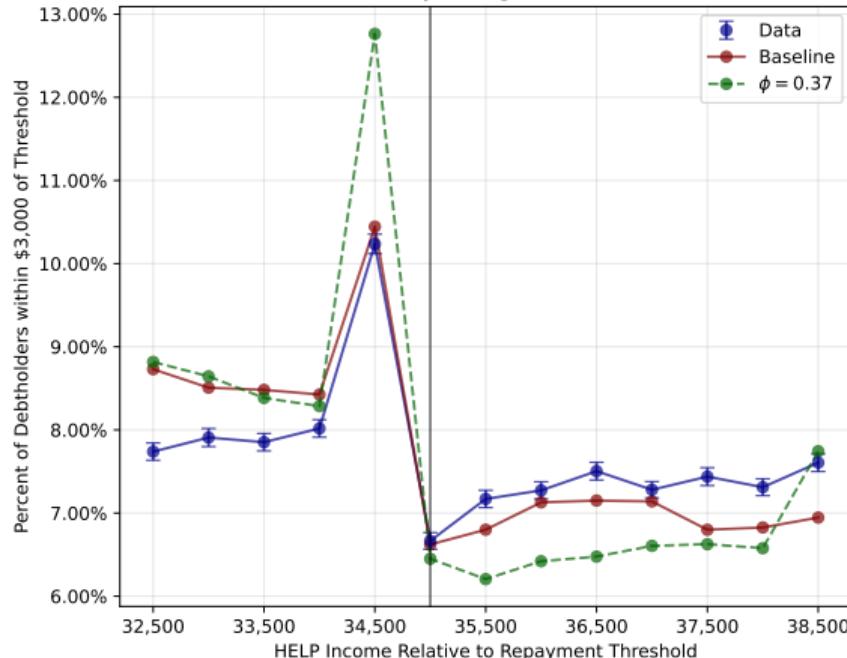
◀ Back: Contracts

# FIT OF MODEL IN WHICH FIXED REPAYMENT IS OPTIMAL

Before Policy Change: 2002-2004



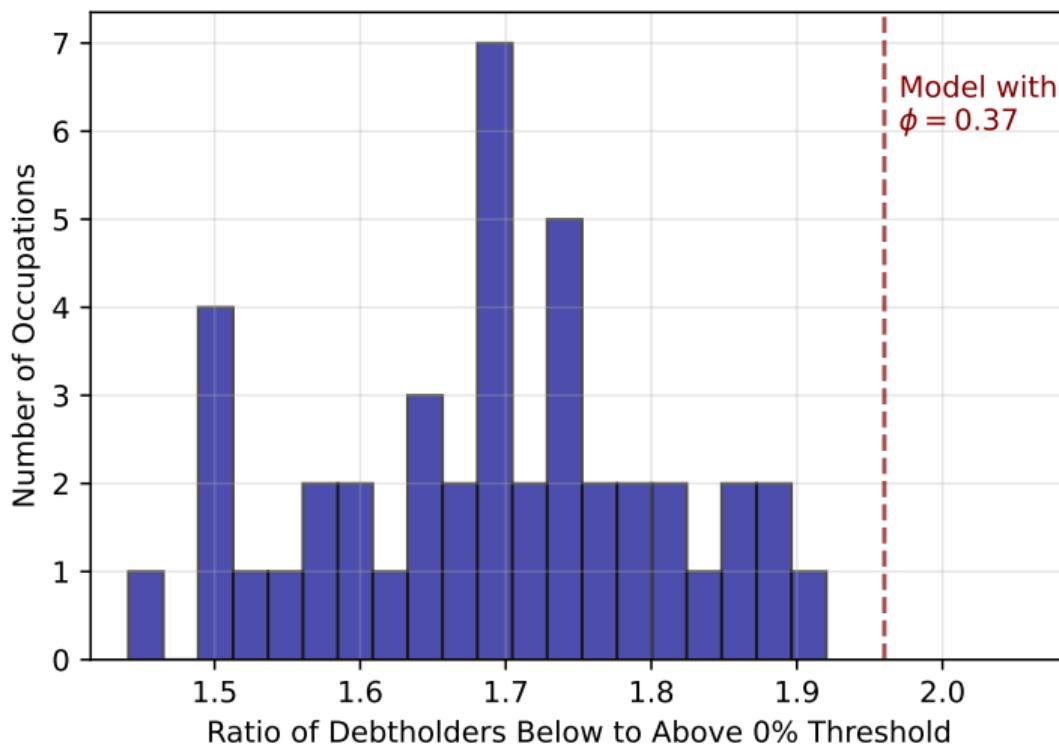
After Policy Change: 2005-2007



▶ Occupations

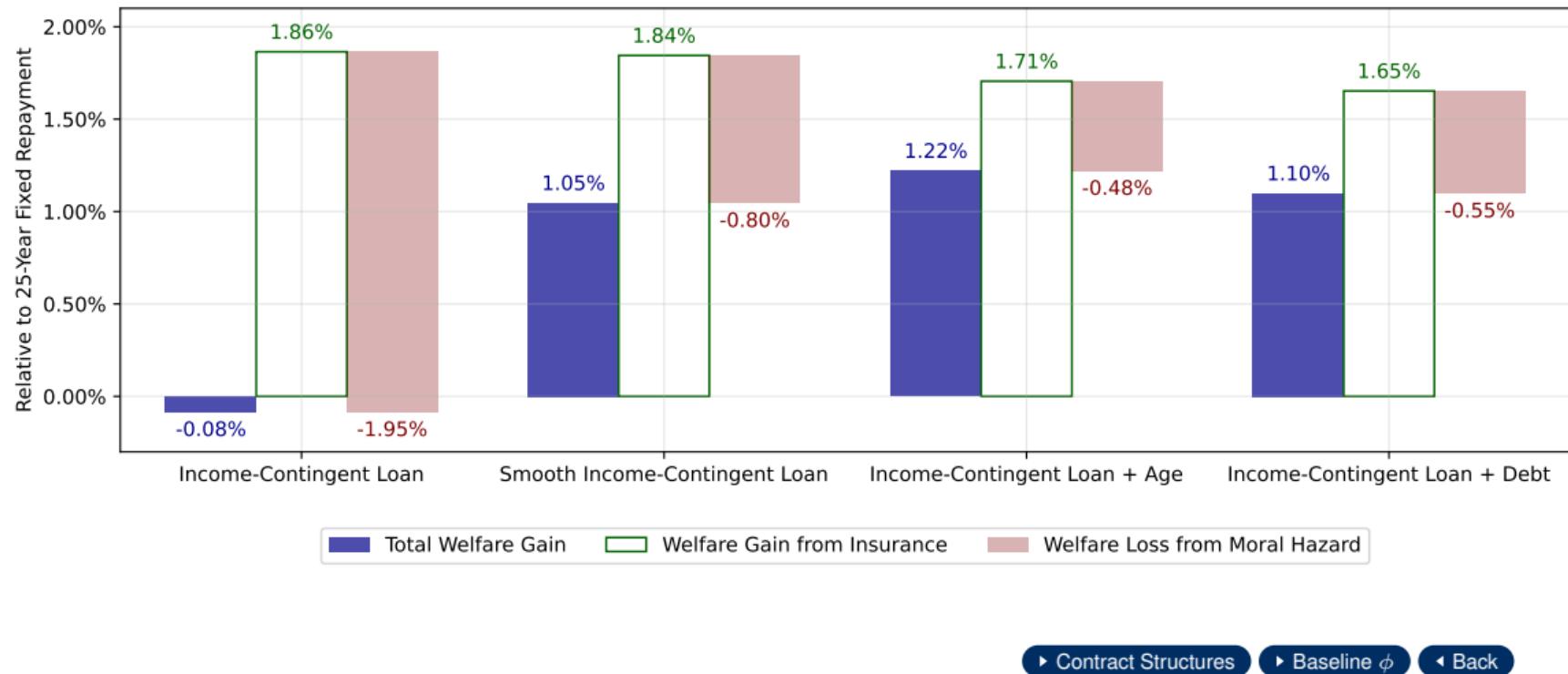
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# BUNCHING WHEN FIXED REPAYMENT IS OPTIMAL vs. OCCUPATIONS

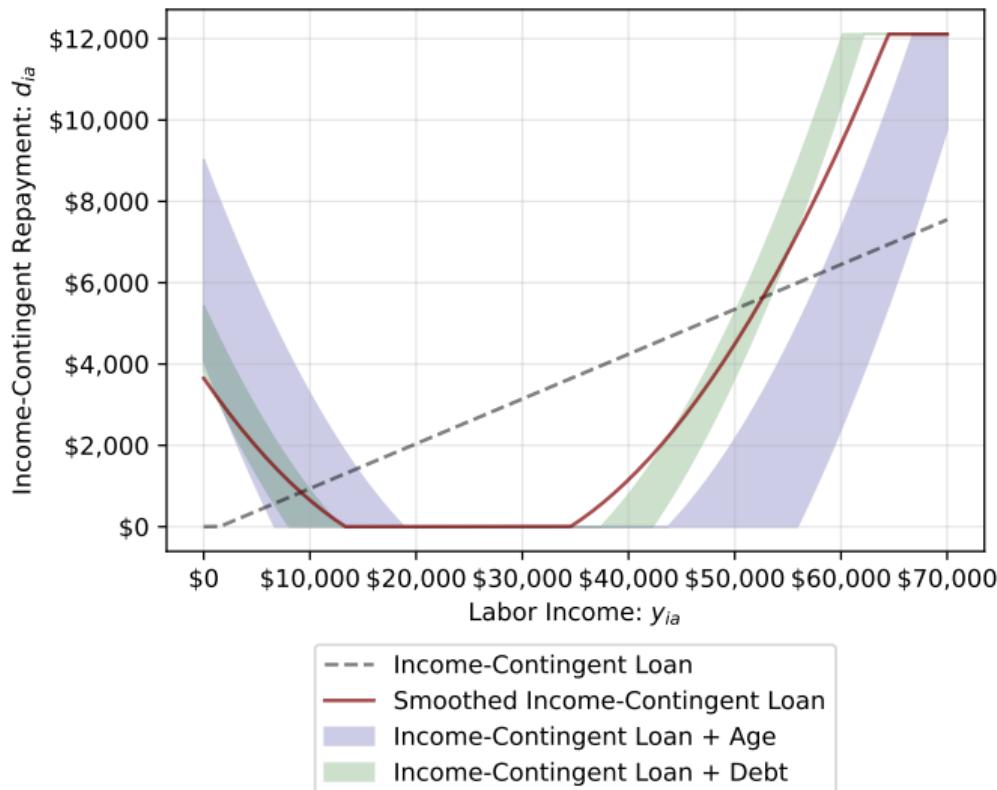


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# ALTERNATIVE CONTRACTS REDUCE WELFARE COST OF MORAL HAZARD

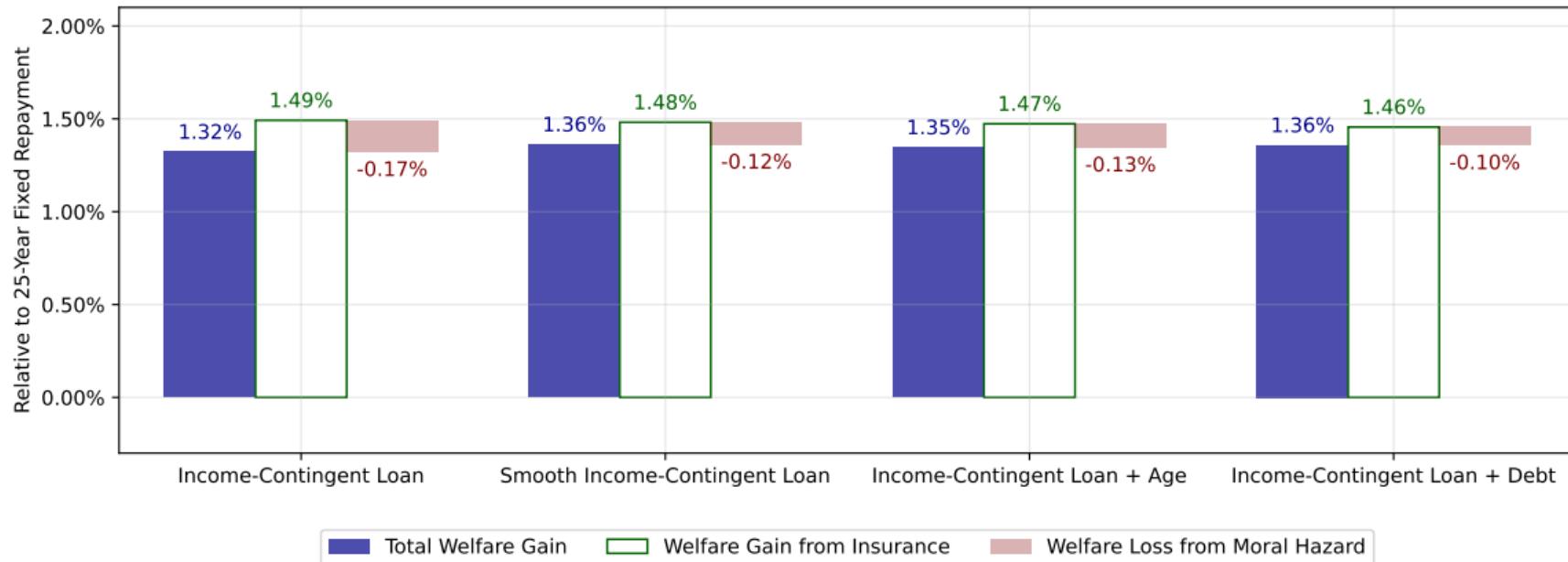


# ALTERNATIVE FORMS OF INCOME-CONTINGENT LOANS: $\phi = 0.37$



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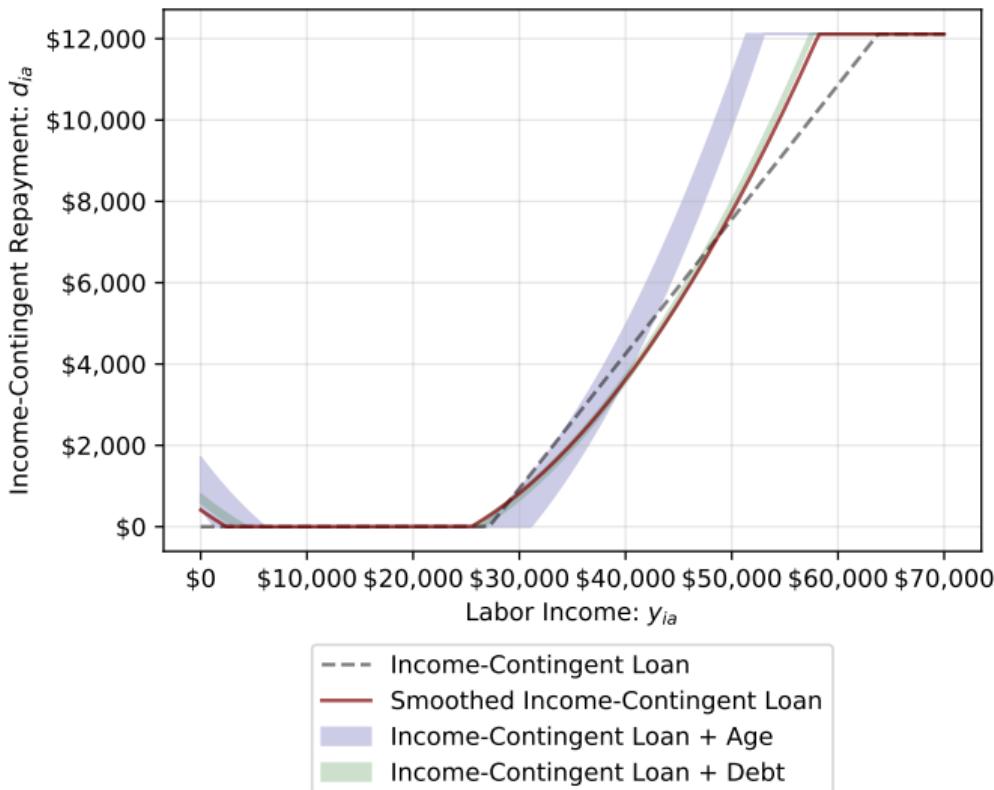
# REDUCING WELFARE COST OF MORAL HAZARD: BASELINE $\phi$



▶ Contract Structures

◀ Back

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



◀ Back

# ROBUSTNESS TO MODEL MISSPECIFICATION

	Difference from Baseline	Welfare Gain	= Insurance	+ Moral Hazard	$\psi^*$	$K^*$
(1)	Fixed Cost Only	1.00%	1.49%	-0.49%	21%	\$22,711
(2)	Calvo Only	2.02%	2.10%	-0.08%	64%	\$46,452
(3)	Linear Adjustment Cost	1.74%	1.87%	-0.13%	53%	\$43,560
(4)	Occupation Heterogeneity	1.32%	1.45%	-0.13%	41%	\$28,694
(5)	Learning-by-Doing	1.68%	.	.	35%	\$36,615
(6)	Wealth Effects	0.82%	1.05%	-0.23%	37%	\$30,307
(7)	Less Persistence: $\rho = 0.8$	0.90%	1.14%	-0.23%	42%	\$34,244
(8)	More Persistence: $\rho = 0.99$	1.35%	1.63%	-0.28%	35%	\$18,949
(9)	Non-Normal Shocks	1.14%	1.43%	-0.30%	28%	\$26,933
(10)	Debt Interest Rate = 2%	1.96%	2.14%	-0.18%	38%	\$47,731
(11)	Discount Rate = $R$	1.06%	1.41%	-0.35%	29%	\$22,696
(12)	Discount Rate = $R + 4\%$	1.60%	1.65%	-0.05%	46%	\$34,441
(13)	US Tax System	1.18%	1.36%	-0.19%	38%	\$28,838
(14)	US Initial Debt Levels	3.50%	4.72%	-1.22%	36%	\$18,867
(15)	Riskless Borrowing: $\tau_b = 0\%$	1.68%	1.82%	-0.15%	44%	\$39,809
(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	1.35%	1.64%	-0.28%	37%	\$30,939
	<b>Baseline Model</b>	<b>1.32%</b>	<b>1.47%</b>	<b>-0.15%</b>	<b>33%</b>	<b>\$27,147</b>

◀ Back: Additional Results

# ROBUSTNESS TO ALTERNATIVE MODELS OF FRICTIONS

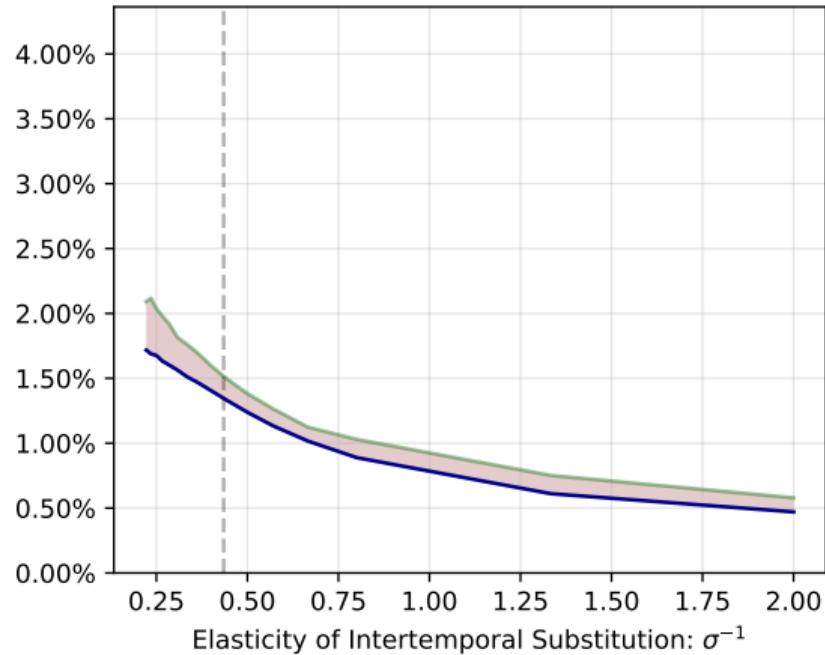
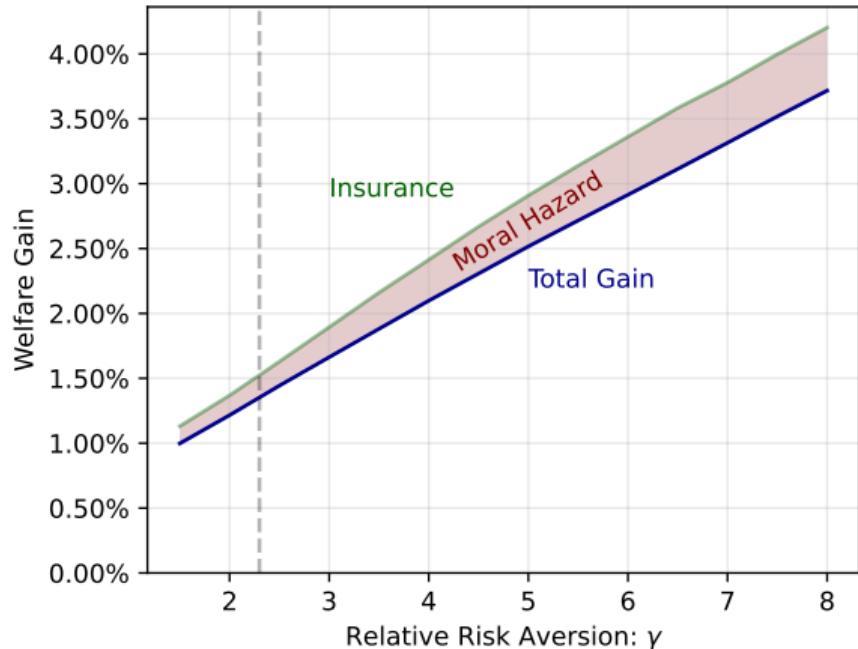
Difference from Baseline Model	Welfare Gain = Insurance	+ Moral Hazard	$\psi^*$	$K^*$
(1) $f = 0$	1.31%	1.61%	-0.3%	46% \$29,618
(2) $f = \$2278$	1.49%	1.65%	-0.16%	64% \$33,915
(3) $\lambda = 1$	1.27%	1.34%	-0.07%	38% \$28,191
(4) $\lambda = 0.147$	1.32%	1.47%	-0.15%	40% \$28,492
(5) Fixed Adjustment Cost Only	1.00%	1.49%	-0.49%	21% \$22,711
(6) Calvo Adjustment Only	2.02%	2.10%	-0.08%	64% \$46,452
(7) Linear Adjustment Cost	1.74%	1.87%	-0.13%	53% \$43,560
<b>Baseline Model</b>	<b>1.32%</b>	<b>1.47%</b>	<b>-0.15%</b>	<b>33% \$27,147</b>

- Loss from moral hazard is larger when adjustment is more **state**-dependent
- Larger gains with **linear** adjustment costs: more insurance and less moral hazard

◀ Back: Fixed Point  $\phi$

◀ Back: Additional Results

# EFFECTS OF CHANGING RISK AVERSION AND EIS



◀ Back: Fixed Point  $\phi$

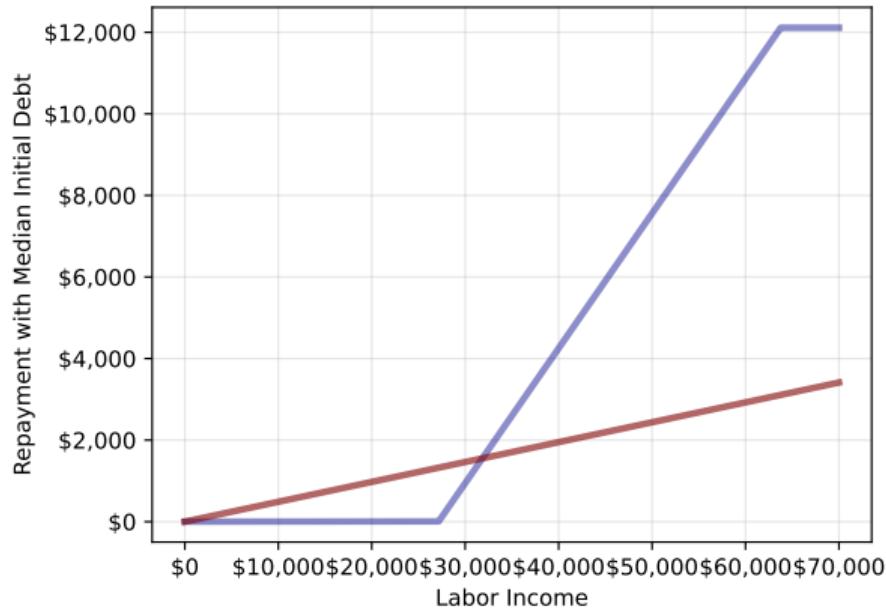
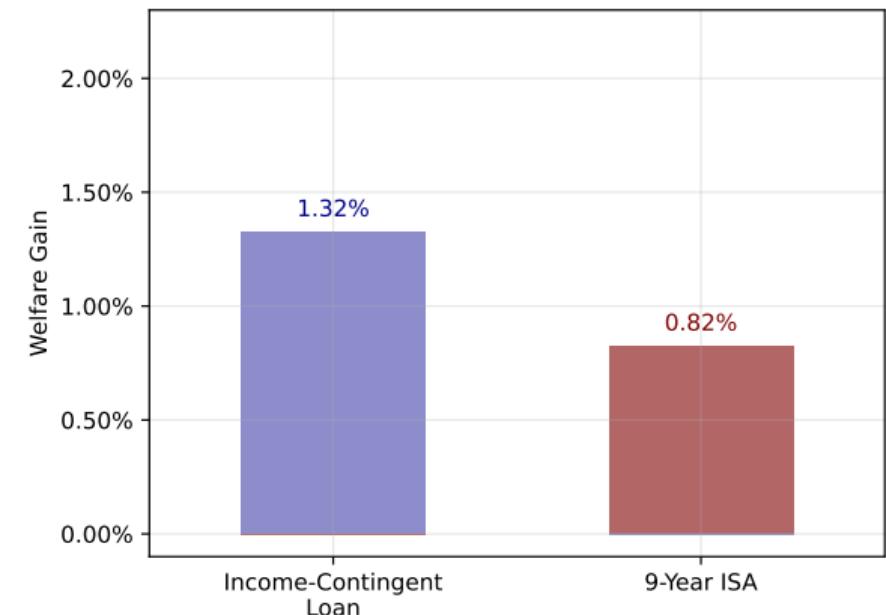
◀ Back: Additional Results

# ADDITIONAL MODEL RESULTS: NORMATIVE

- ① Robustness to
  - Different sources of **model mispecification** 
  - Different adjustment **frictions** 
  - Different values of **RRA** and **EIS** 
- ② **Pure equity** contract does worse than income-contingent loan 
- ③ With **optimal tax** progressivity, forbearance is enough and gains are smaller 

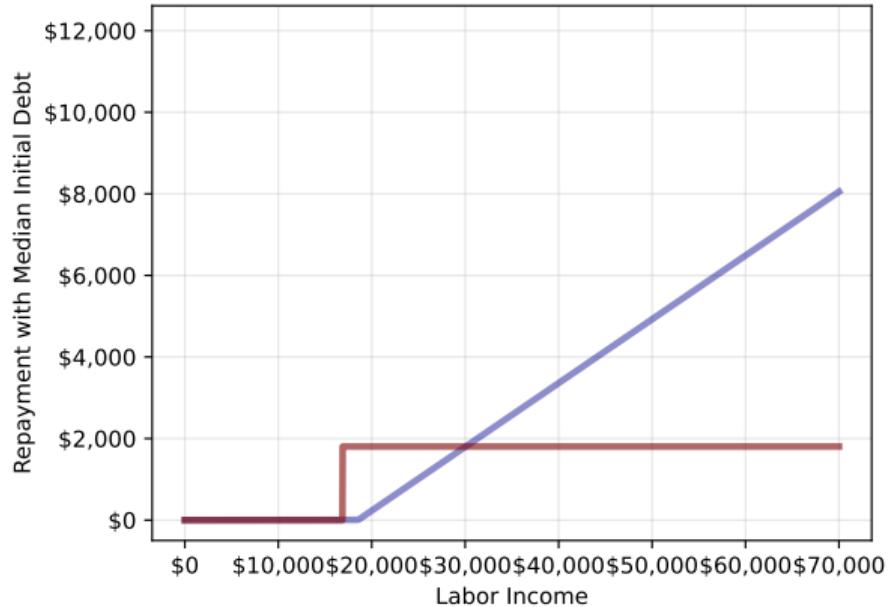
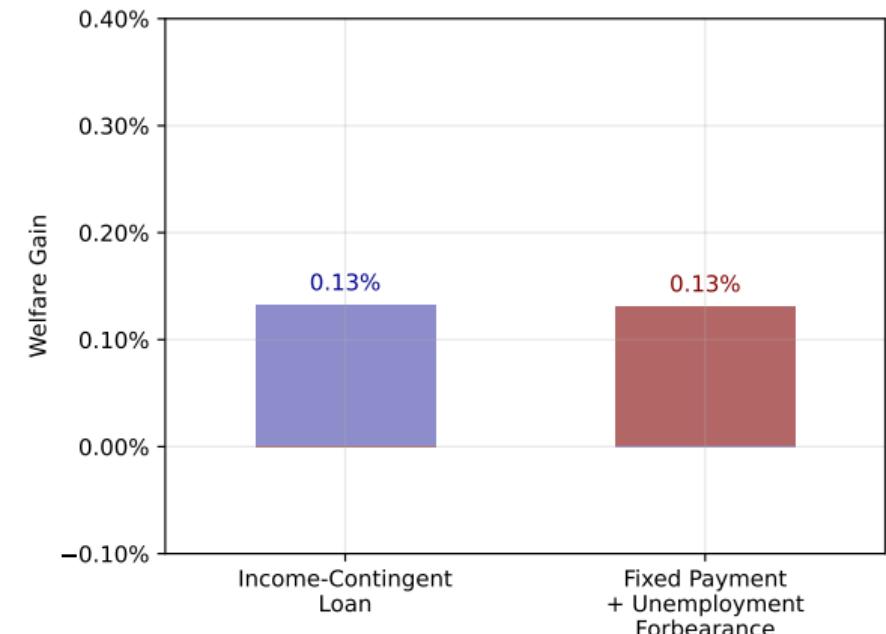
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# PURE EQUITY DOES WORSE THAN INCOME-CONTINGENT LOAN



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# WELFARE GAINS WITH OPTIMAL TAX PROGRESSIVITY



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- Mac: Cmd + K, uncheck "Use Logical Page Numbers"
- Always toggle on/off closing window and then reopening

## Jump to page numbers

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- Mac: Cmd + Shift + N