Insurance versus Moral Hazard in Income-Contingent Student Loan Repayment

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Stanford GSB and SIEPR

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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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– Borrowers bear most of risk

➥ US "crisis": 25% default within 5 years

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This Paper: Insurance vs. Moral Hazard

This Paper

Conditional on ex-ante choices + taxes/tranfers, 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**

Main Results

1. **Empirics**: borrowers reduce labor supply to $\downarrow$ 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 **0.15** $+$ adjustment frictions

3. **Contract design**: moral hazard reduces optimal amount of insurance
   - Moral hazard = most of fiscal cost from fixed $\rightarrow$ income-contingent repayment
   - Fixed repayment $\rightarrow$ optimal income-contingent loan $\Rightarrow \uparrow$ **0.8%** lifetime consumption
   - Forbearance $+$ fixed repayment does worse because of slower repayment

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

Related Literature & Contributions

1. Financing of human capital Bovenberg-Jacobs 2005, Lochner-Monge-Naranjo 2016, Stantcheva 2017
2. Empirical effects of student loans
   - $\uparrow$ Debt $\Rightarrow$ $\uparrow$ delinquencies, $\downarrow$ mobility, $\downarrow$ income Di Maggio et al. 2021, $\downarrow$ homeownership Mezza et al. 2020, Δ occupation Luo-Mongey 2019, Δ major Hampole 2022
   - Income-contingent loans $\Rightarrow$ $\downarrow$ delinquencies Herbst 2023, $\downarrow$ defaults Mueller-Yannelis 2019

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Contributions:

1. Empirical evidence of moral hazard from income-contingent repayment
   Britton-Gruber 2020
2. Structural model of labor supply that replicates these responses
   - ✓ Choice of labor supply is **dynamic**: income-contingent repayment + frictions
3. Quantification of how moral hazard affects optimal contract design

Related Literature & Contributions

3. Insurance vs. moral hazard in social insurance: UI Gruber 1997, Chetty 2008, Ganong-Noel 2019, HH bankruptcy Dobbie-Song 2015, Indarte 2023, health insurance Einav et al. 2015

4. Mortgages with more risk-sharing Shiller 2004, Caplin et al. 2007, Mian-Sufi 2014, Piskorski-Seru 2018, Hartman-Glaser-Hébert 2020, Greenwald et al. 2021, Campbell et al. 2021, Benetton et al. 2022

5. Bunching at discontinuities in tax rates Saez 2010, Chetty et al. 2011, Kleven-Waseem 2013

6. Determinants of labor supply Blundell-MaCurdy 1999, Keane 2011, Chetty 2012, ...

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

Outline

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**:

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

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

- 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

▸ ICL Prevalence ▸ Variable Definitions

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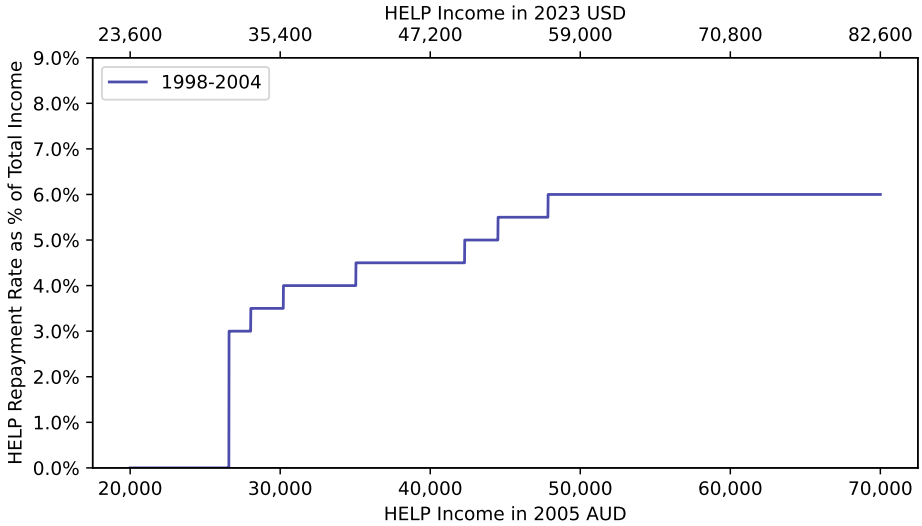
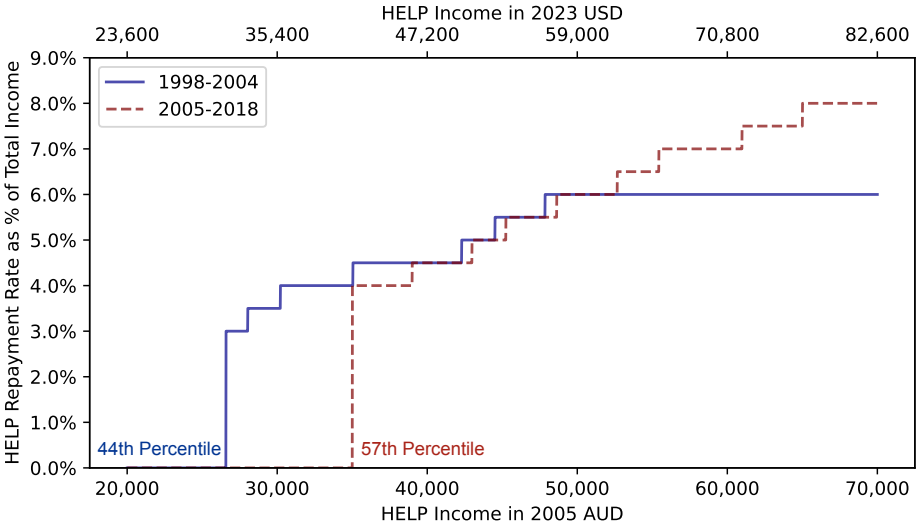
Good setting to identify labor supply responses to income-contingent repayment

▸ Differences from US

Identifying Variation: Discontinuities in Repayment Rates

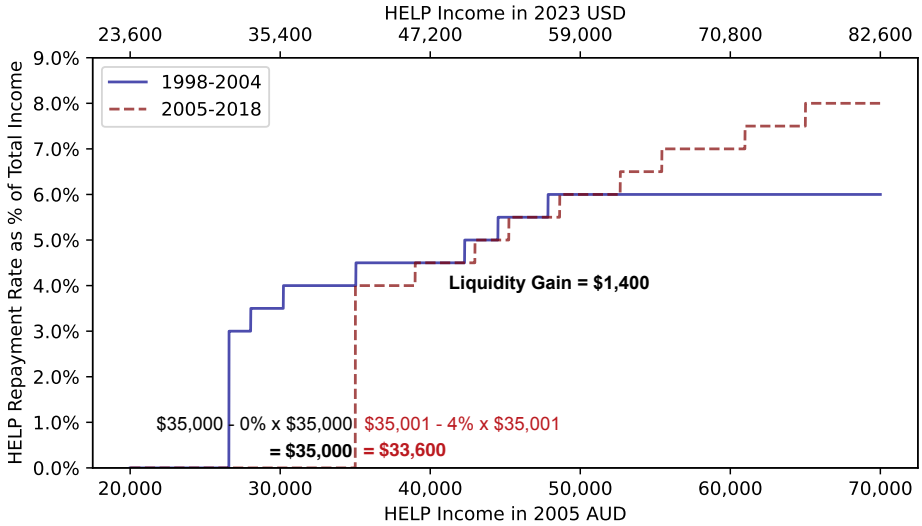


Identifying Variation: Policy Change to Repayment Rates



Note: policy change applied to new and existing debtholders

Repayment Threshold Increases **Average** Repayment Rate



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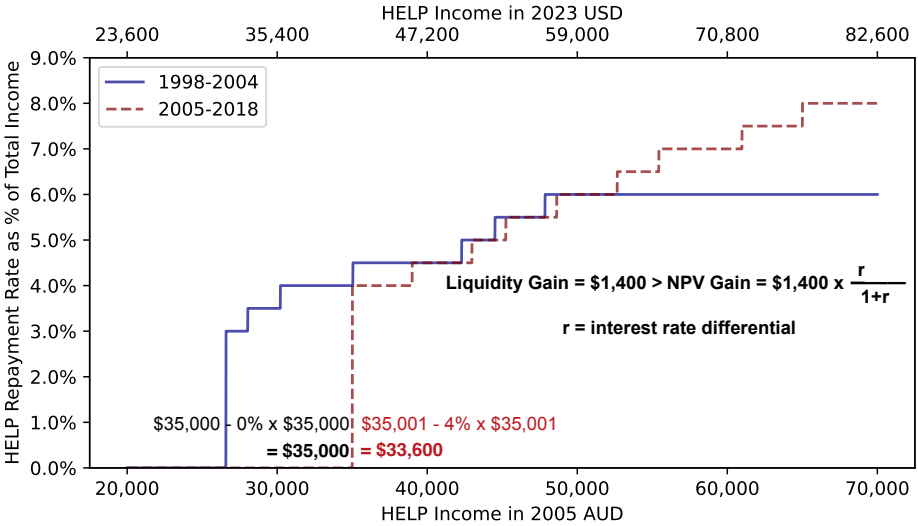
REPAYMENT THRESHOLD INCREASES **LIQUIDITY** MORE THAN **WEALTH**



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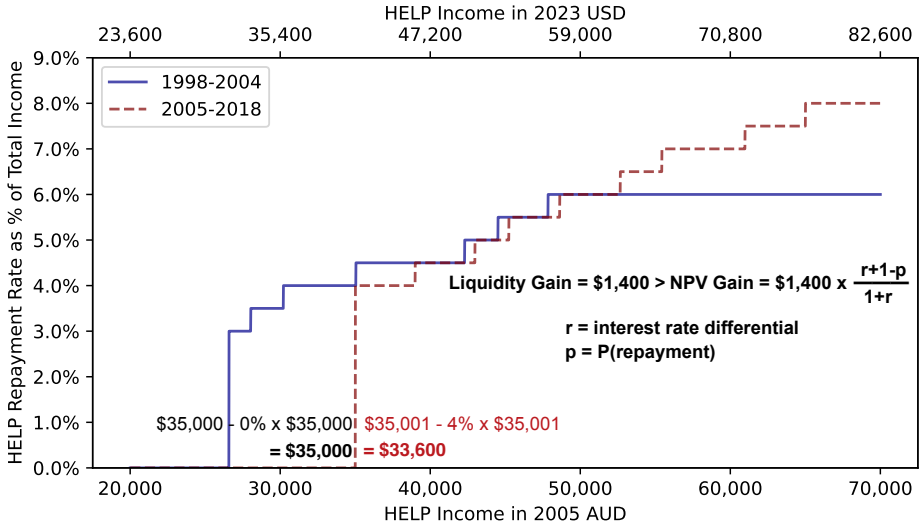

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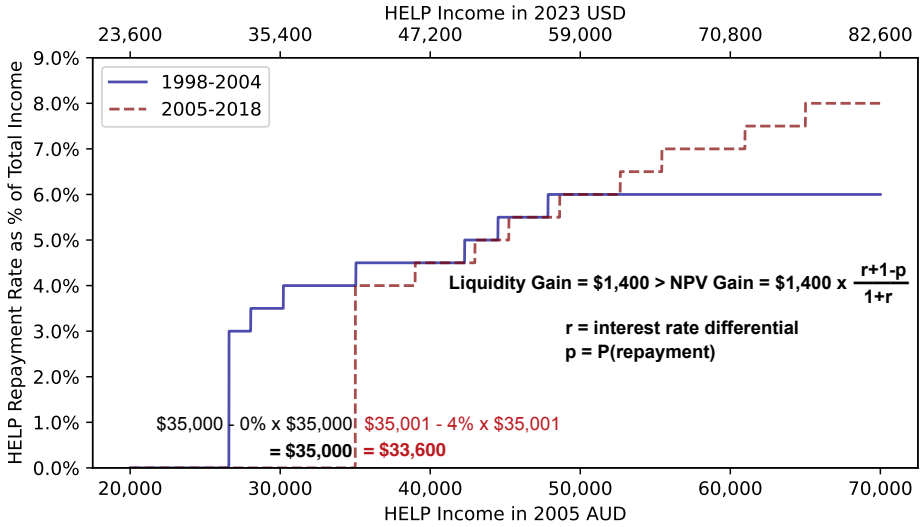

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▸ Marginal Rates ▸ Payments ▸ News ▸ Occupations

DATA

1. Universe of individual tax returns from Australian Tax Office ($\sim$ 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

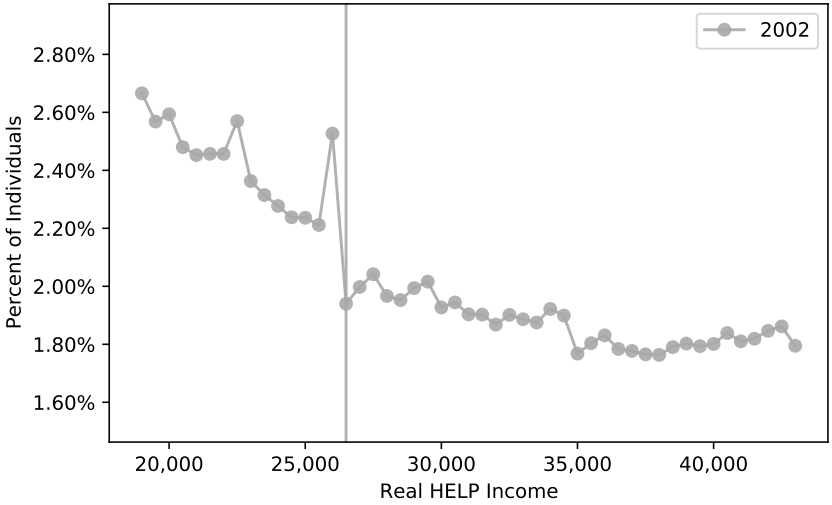
- Mean HELP Income at age 26 = \$34K with 98% from labor income

Limitation: no information about borrowing (e.g., degree, institution)

▸ Summary Stats ▸ Debt by Age ▸ Debt Repay

Outline

Borrowers Adjust Income to Reduce Repayments



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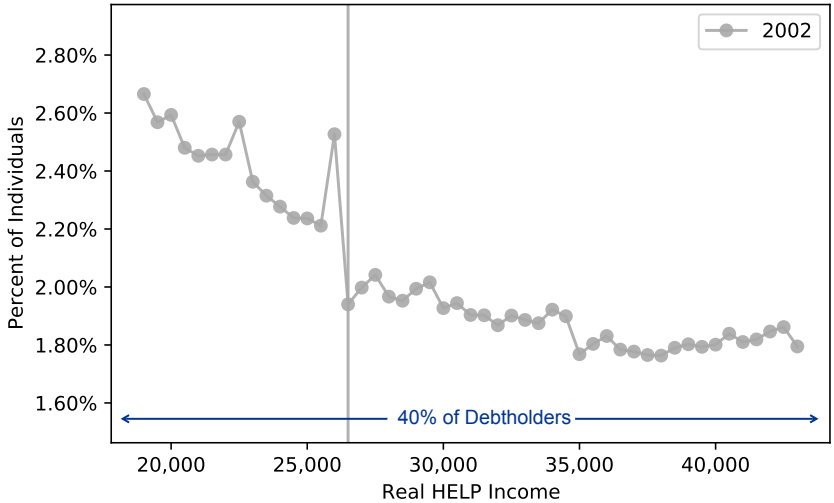

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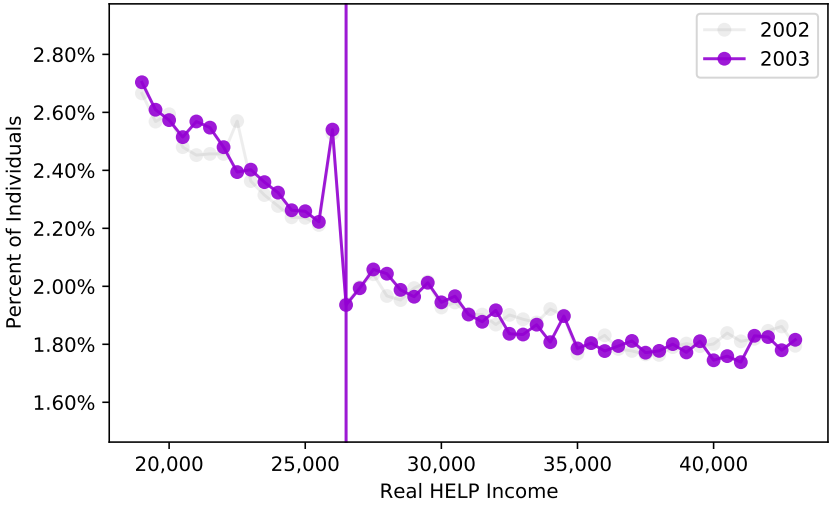

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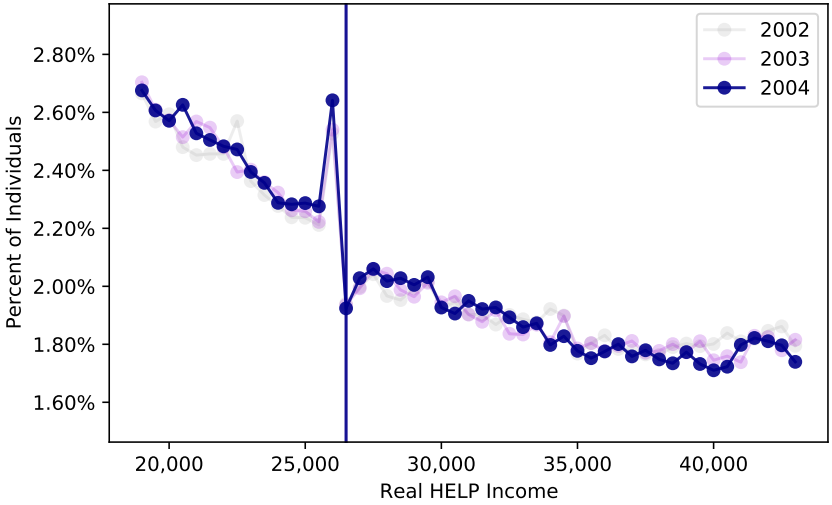

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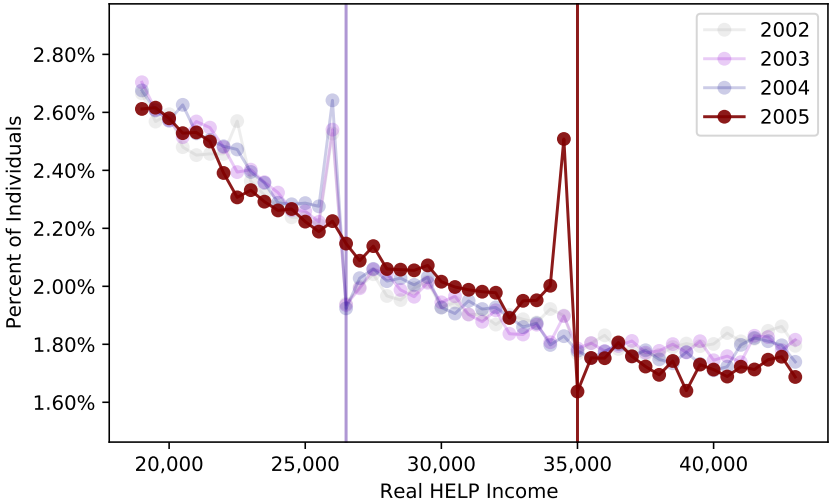

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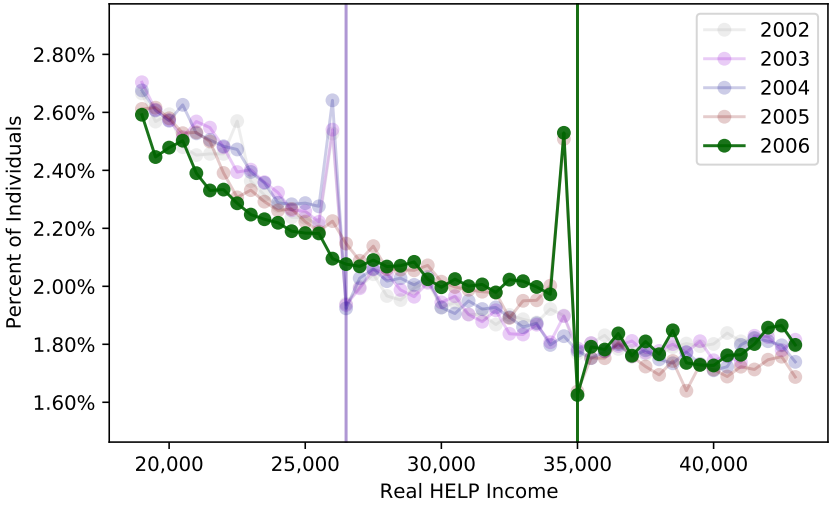

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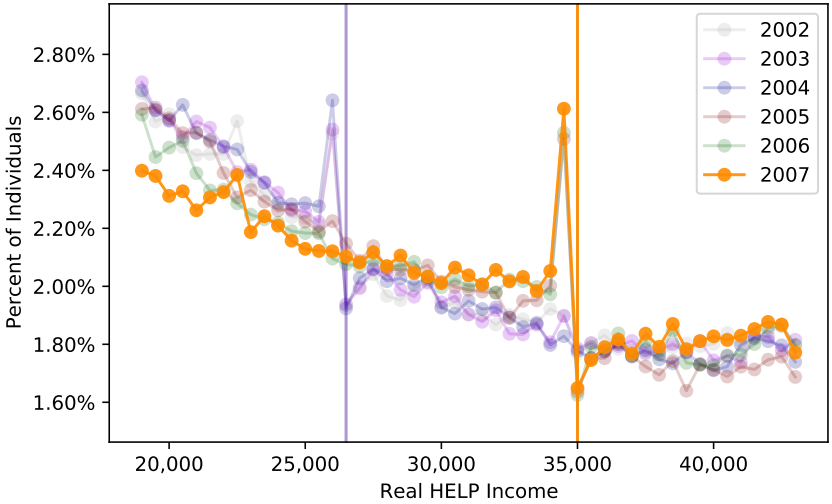

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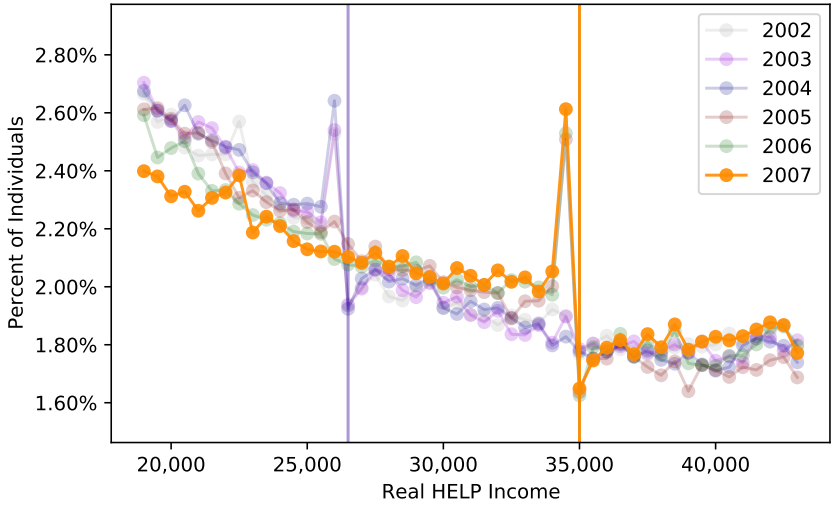
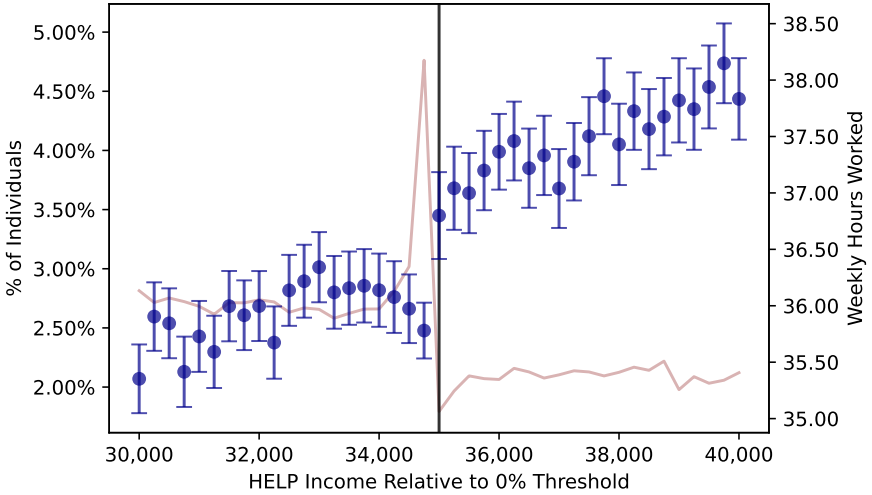


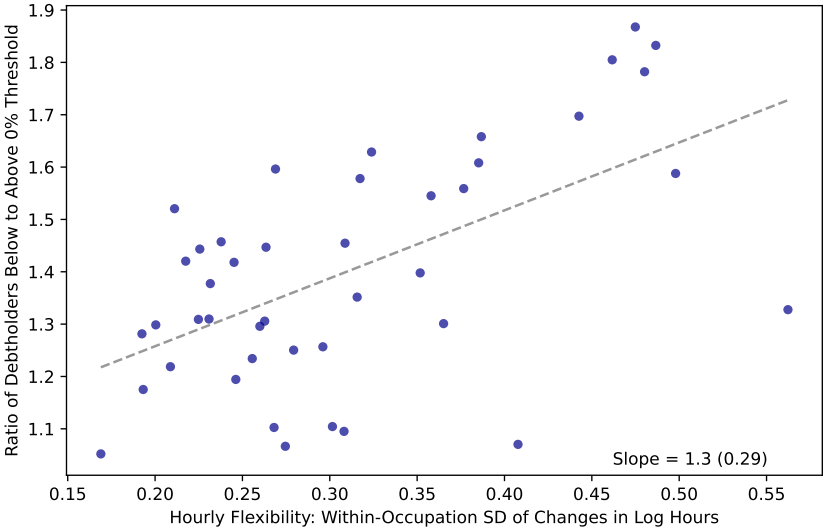
- Next: does bunching reflect labor supply or evasion? ▸ Source ▸ Non-Debt ▸ Labor ▸ vs Tax

Borrowers Below Repayment Threshold Work Fewer Hours



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

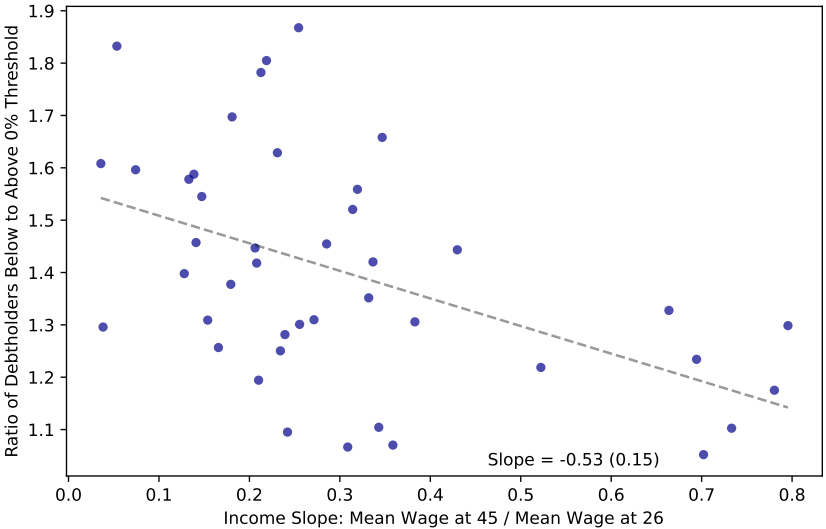
More Bunching in Occupations with Greater Hourly Flexibility



Sample: all wage-earners between 2005-2018

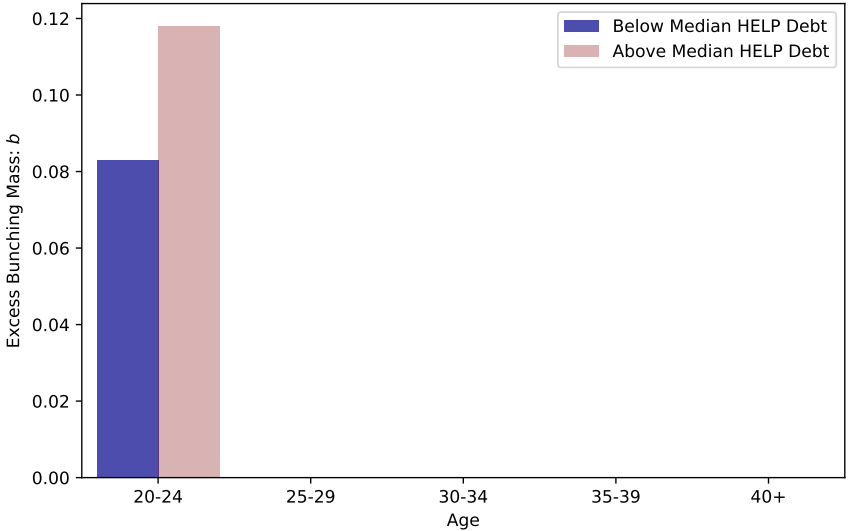
▸ Alt. Measure ▸ Evasion ▸ Table ▸ Profiles ▸ Additional Results

P(Repayment) Matters: Bunching Decreases with Wage Growth



Multivariate

P(Repayment) Matters: Bunching Increases with Debt



Note: confidence intervals omitted due to small size

▸ *b* Details

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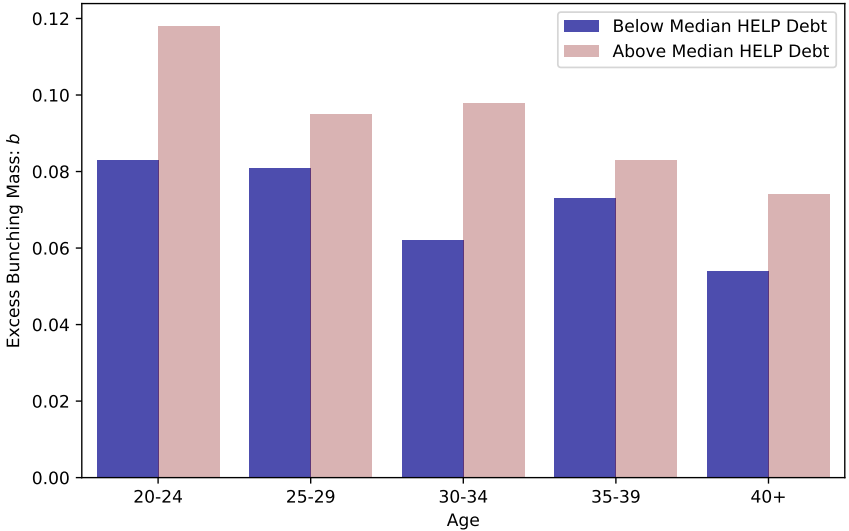

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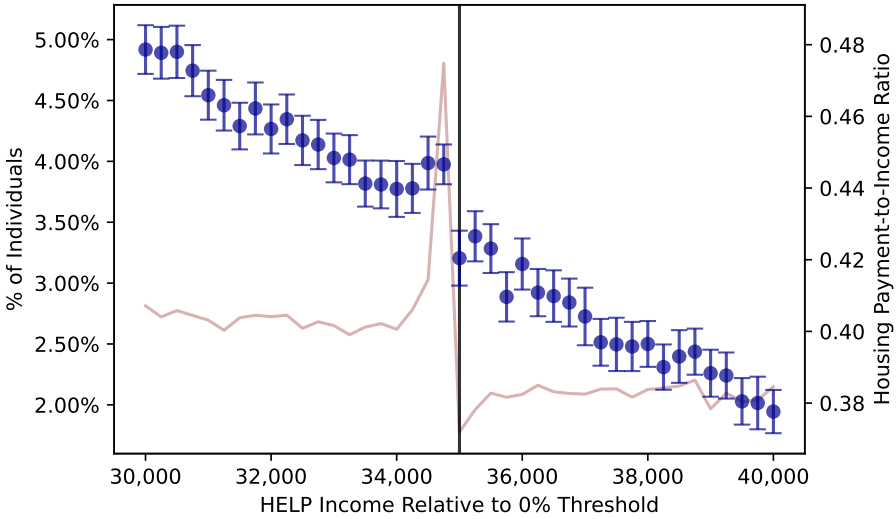
Bunching Increases with Proxies for Liquidity Constraints



▸ 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?

Outline

Model Description

Life cycle model with debt + $\underbrace{\text{incomplete markets}}_{\Rightarrow \text{demand for insurance}}$ + $\underbrace{\text{endogenous labor supply}}_{\Rightarrow \text{moral hazard}}$

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, ℓ_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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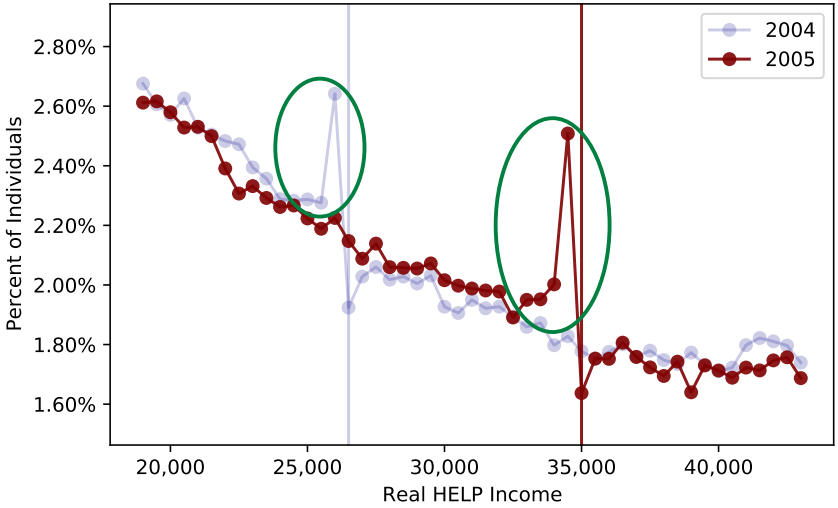
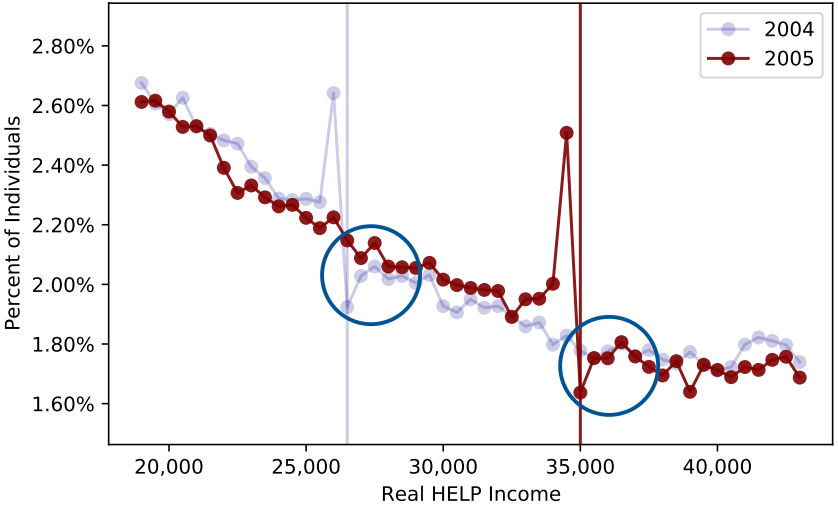
- After age 64, individuals retire and choose consumption c_a
- **Government**
  - Revenues: progressive income taxes, debt repayments
  - Expenses: means-tested unemployment benefits & retirement pension, initial debt

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 Frictions

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

$$f_a = \omega_a f_L + (1 - \omega_a) f_H, \quad \omega_a \sim \text{Bernoulli}(\lambda), \quad f_L < f_H$$

- Nests the two canonical adjustment models:
  1. $f_L = 0$, $f_H = \infty \Rightarrow$ 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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- Adjustment is **state-dependent** if $f_L > 0$
  - $f_L, f_H \approx$ real or psychological costs of changing hours/jobs Chetty 2012

- Adjustment is **time-dependent** if $\lambda < 1$
  - $\omega_a \approx$ inattention, arrival of opportunities to change hours/jobs DMP, Kleven et al. 2023

Individual's Recursive Problem

$$V_a(\mathbf{s}_a) =$$

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$$V_a(\mathbf{s}_a) = \max_{\substack{A_{a+1} \geq \underline{A}_{a+1}, \\ \ell_a}} -\left[\underbrace{c_a - \kappa \frac{\ell_a^{1+\phi^{-1}}}{1+\phi^{-1}}}_{\text{utility of consumption \& disutility of labor}} - \underbrace{f_a * \mathbf{1}_{\ell_a \neq \ell_{a-1}}}_{\text{adjustment cost}} \right]^{1-\sigma} + \beta m_a \mathbf{E_a} \underbrace{V_{a+1}(\mathbf{s}_{a+1})}_{\text{continuation value}}$$

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

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

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

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

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

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

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

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

$$\mathbf{s}_a = \begin{pmatrix} a & t & A_a & D_a & \theta_a & \epsilon_a & \ell_{a-1} & \omega_a \end{pmatrix}$$

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

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$$\mathbf{s}_a = \begin{pmatrix} a & t & A_a & D_a & \theta_a & \epsilon_a & \ell_{a-1} & \omega_a \end{pmatrix}$$

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

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

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

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

$$\mathbf{s}_a = \begin{pmatrix} a & t & A_a & D_a & \theta_a & \epsilon_a & \ell_{a-1} & \omega_a \end{pmatrix}$$

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

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

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

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

$$\mathbf{s}_a = \begin{pmatrix} a & t & A_a & D_a & \theta_a & \epsilon_a & \ell_{a-1} & \omega_a \end{pmatrix}$$

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

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

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

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

$$\mathbf{s}_a = \begin{pmatrix} a & t & A_a & D_a & \theta_a & \epsilon_a & \ell_{a-1} & \omega_a \end{pmatrix}$$

- ℓ_{a-1} = labor supply from previous period
- ω_a = shock that determines fixed cost

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

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

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

$$\mathbf{s}_a = \begin{pmatrix} a & t & A_a & D_a & \theta_a & \epsilon_a & \ell_{a-1} & \omega_a \end{pmatrix}$$

- Sources of ex-ante heterogeneity:
  - θ_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

$$\text{Parameters} = \left(\qquad \right)$$

- **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 $t = 2005$

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

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

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

- 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: $\mathbf{P}(\text{bunching}_{2005} | \text{bunching}_{2004})$

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

- 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**

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

- 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

$$\text{Parameters} = \Big(\overbrace{\underbrace{\phi \quad f_L \quad \lambda}_{\text{labor supply}} \quad \beta \quad f_H \quad \kappa}^{\text{preferences}} \quad \underbrace{\delta_0 \quad \delta_1 \quad \delta_2 \quad \delta_0^E \quad \delta_1^E}_{\text{wage profile}} \quad \underbrace{\rho \quad \sigma_\nu \quad \sigma_\epsilon \quad \sigma_i}_{\text{wage risk}} \quad \xi \Big)$$

- 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**

▸ Other Parameters

Estimation Results

Parameter		Estimation (1)
Labor supply elasticity	ϕ	0.003
Lower fixed cost	f_L	\$0
Adjustment probability	λ	1
Upper fixed cost	f_H	∞
Time discount factor	β	0.998
Scaling parameter	κ	0.179
Wage profile parameters	δ_0	10.170
	δ_1	0.067
	δ_2	-0.001
	δ_0^E	-0.442
	δ_1^E	0.025
Persistence of permanent shock	ρ	0.824
Std. deviation of permanent shock	σ_ν	0.057
Std. deviation of transitory shock	σ_ϵ	0.431
Std. deviation of individual FE	σ_i	0.575
Measurement error in hours	ι	0

▸ Comparison with Literature ▸ All Results with SE

Estimation Results

Parameter		Estimation (1)	Estimation (2)
Labor supply elasticity	ϕ	0.003	0.167
Lower fixed cost	f_L	\$0	\$1377
Adjustment probability	λ	1	1
Upper fixed cost	f_H	∞	∞
Time discount factor	β	0.998	0.914
Scaling parameter	κ	0.179	1.233
Wage profile parameters	δ_0	10.170	9.360
	δ_1	0.067	0.074
	δ_2	-0.001	-0.001
	δ_0^E	-0.442	-0.440
	δ_1^E	0.025	0.019
Persistence of permanent shock	ρ	0.824	0.927
Std. deviation of permanent shock	σ_ν	0.057	0.223
Std. deviation of transitory shock	σ_ϵ	0.431	0.133
Std. deviation of individual FE	σ_i	0.575	0.569
Measurement error in hours	ι	0	0

▸ Comparison with Literature ▸ All Results with SE

Estimation Results

Parameter		Estimation (1)	(2)	(3)
Labor supply elasticity	ϕ	0.003	0.167	0.084
Lower fixed cost	f_L	\$0	\$1377	\$0
Adjustment probability	λ	1	1	0.124
Upper fixed cost	f_H	∞	∞	∞
Time discount factor	β	0.998	0.914	0.934
Scaling parameter	κ	0.179	1.233	0.236
Wage profile parameters	δ_0	10.170	9.360	9.089
	δ_1	0.067	0.074	0.073
	δ_2	-0.001	-0.001	-0.001
	δ_0^E	-0.442	-0.440	-0.480
	δ_1^E	0.025	0.019	0.022
Persistence of permanent shock	ρ	0.824	0.927	0.922
Std. deviation of permanent shock	σ_ν	0.057	0.223	0.252
Std. deviation of transitory shock	σ_ϵ	0.431	0.133	0.113
Std. deviation of individual FE	σ_i	0.575	0.569	0.541
Measurement error in hours	ι	0	0	0

▸ Comparison with Literature ▸ All Results with SE

Estimation Results

Parameter		Estimation (1)	(2)	(3)	(4)
Labor supply elasticity	ϕ	0.003	0.167	0.084	0.146
Lower fixed cost	f_L	\$0	\$1377	\$0	\$454
Adjustment probability	λ	1	1	0.124	0.161
Upper fixed cost	f_H	∞	∞	∞	∞
Time discount factor	β	0.998	0.914	0.934	0.958
Scaling parameter	κ	0.179	1.233	0.236	0.697
Wage profile parameters	δ_0	10.170	9.360	9.089	9.243
	δ_1	0.067	0.074	0.073	0.078
	δ_2	-0.001	-0.001	-0.001	-0.001
	δ_0^E	-0.442	-0.440	-0.480	-0.496
	δ_1^E	0.025	0.019	0.022	0.021
Persistence of permanent shock	ρ	0.824	0.927	0.922	0.934
Std. deviation of permanent shock	σ_ν	0.057	0.223	0.252	0.222
Std. deviation of transitory shock	σ_ϵ	0.431	0.133	0.113	0.164
Std. deviation of individual FE	σ_i	0.575	0.569	0.541	0.591
Measurement error in hours	ι	0	0	0	0

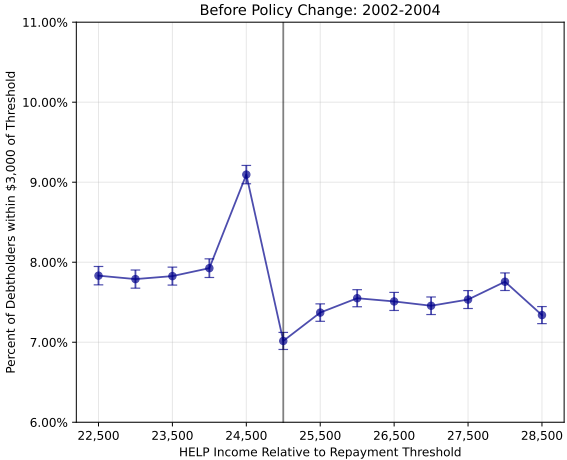
▸ Comparison with Literature ▸ All Results with SE

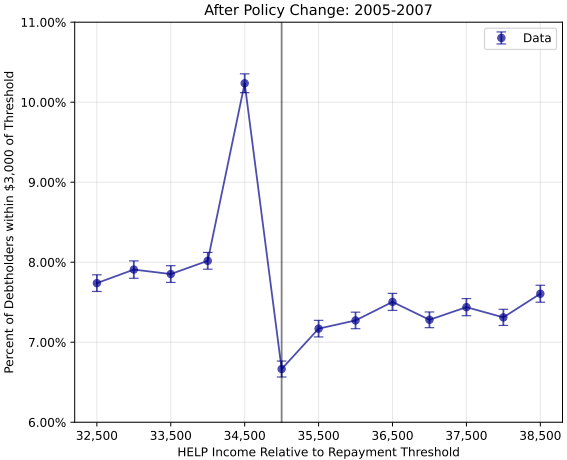
Estimation Results

Parameter		Estimation (1)	(2)	(3)	(4)	(5)
Labor supply elasticity	ϕ	0.003	0.167	0.084	0.146	0.149
Lower fixed cost	f_L	\$0	\$1377	\$0	\$454	\$378
Adjustment probability	λ	1	1	0.124	0.161	0.153
Upper fixed cost	f_H	∞	∞	∞	∞	\$3191
Time discount factor	β	0.998	0.914	0.934	0.958	0.937
Scaling parameter	κ	0.179	1.233	0.236	0.697	2.667
Wage profile parameters	δ_0	10.170	9.360	9.089	9.243	9.667
	δ_1	0.067	0.074	0.073	0.078	0.064
	δ_2	-0.001	-0.001	-0.001	-0.001	-0.001
	δ_0^E	-0.442	-0.440	-0.480	-0.496	-0.473
	δ_1^E	0.025	0.019	0.022	0.021	0.019
Persistence of permanent shock	ρ	0.824	0.927	0.922	0.934	0.929
Std. deviation of permanent shock	σ_ν	0.057	0.223	0.252	0.222	0.224
Std. deviation of transitory shock	σ_ϵ	0.431	0.133	0.113	0.164	0.150
Std. deviation of individual FE	σ_i	0.575	0.569	0.541	0.591	0.569
Measurement error in hours	ι	0	0	0	0	0.034

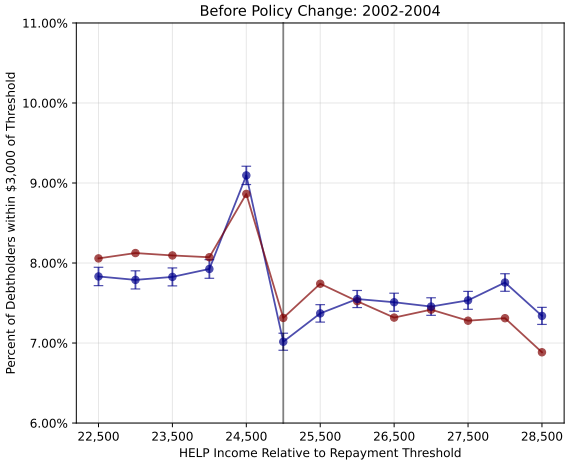
▸ Comparison with Literature ▸ All Results with SE

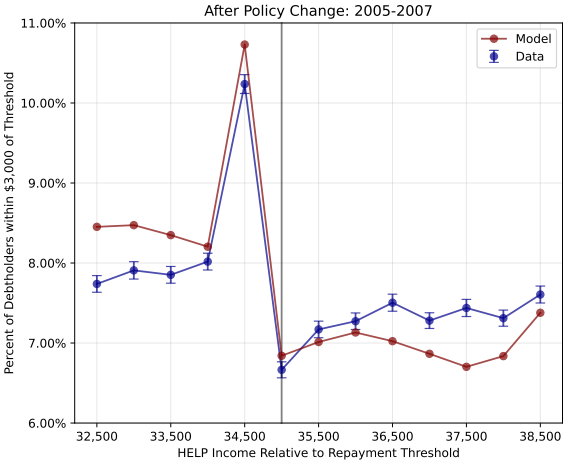
Model Fit: Bunching Before and After Policy Change





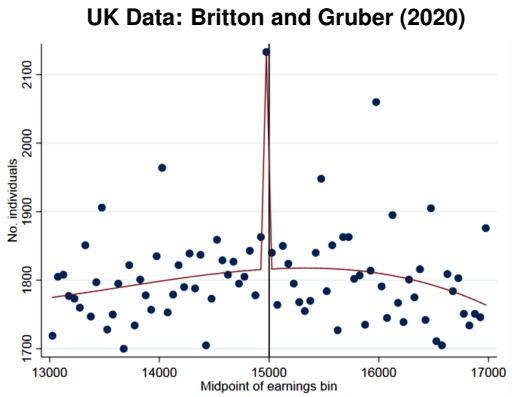
Model Fit: Bunching Before and After Policy Change

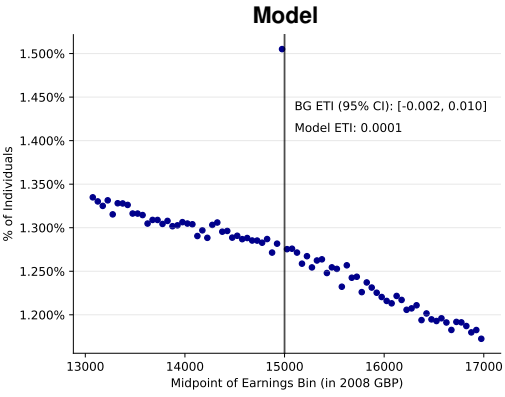




▸ Model Fit: Other Moments

Out-of-Sample Validation: UK Data





▸ Heterogeneity ▸ Speed ▸ Panel ▸ Decomposition

Outline

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**

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)

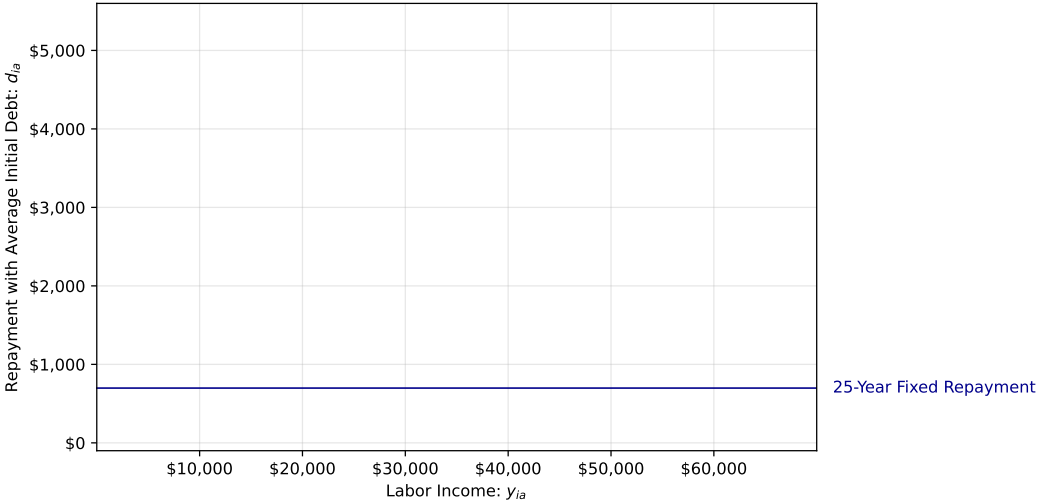
Conditional on government subsidy for higher education + existing taxes/transfers, what contract best balances insurance with moral hazard?

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

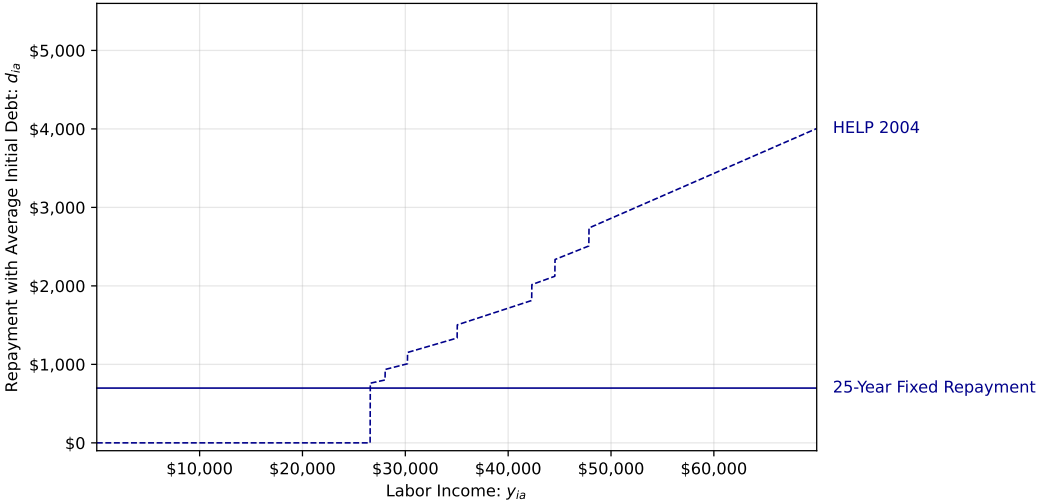
$$\mathcal{G} \equiv \mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a + \text{Taxes}_a - \text{Transfers}_a}{R^{a-a_0}}$$

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

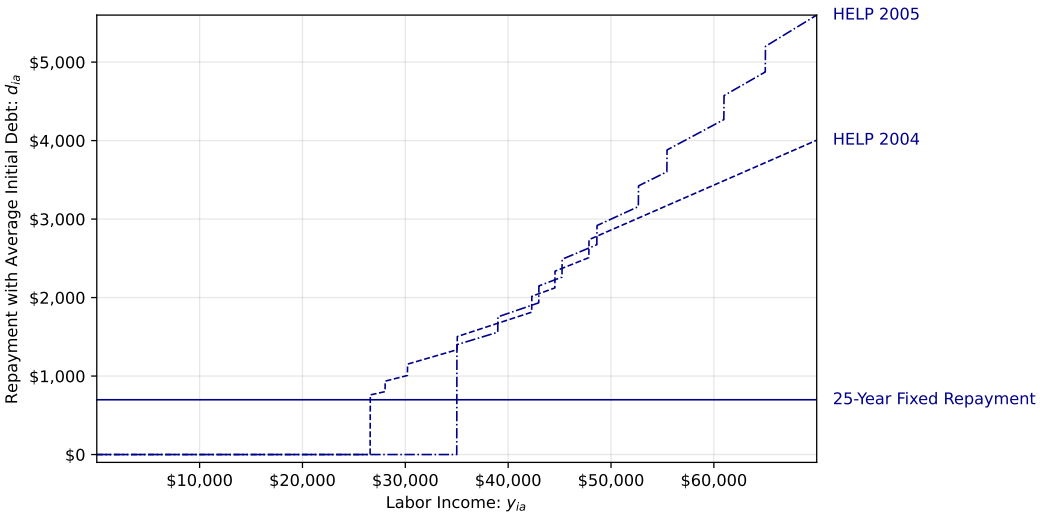
Existing Income-Contingent Loans



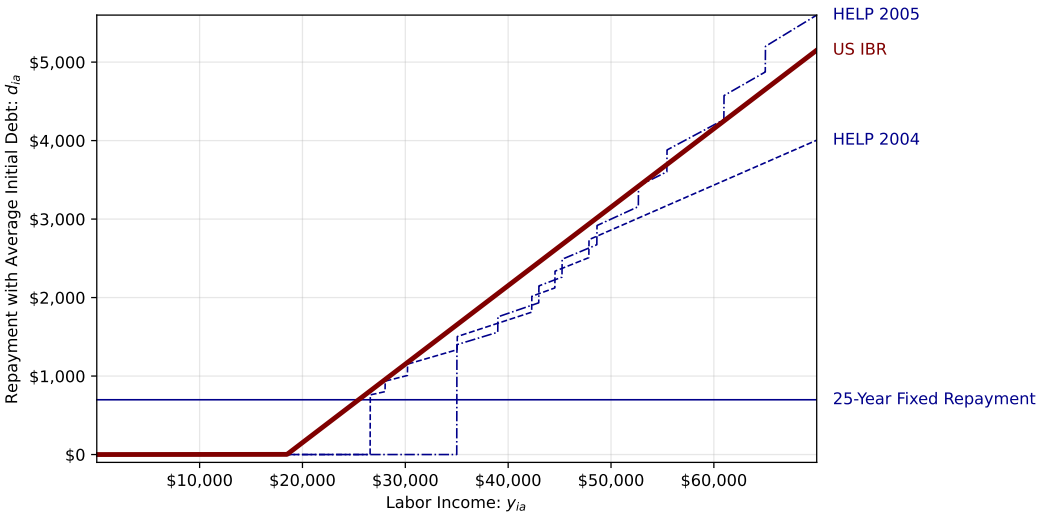
Existing Income-Contingent Loans



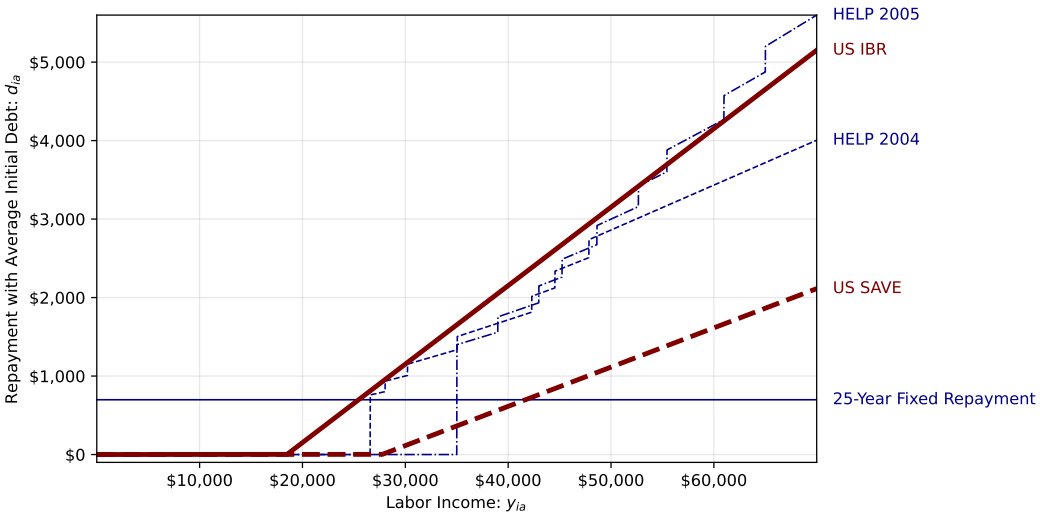
Existing Income-Contingent Loans



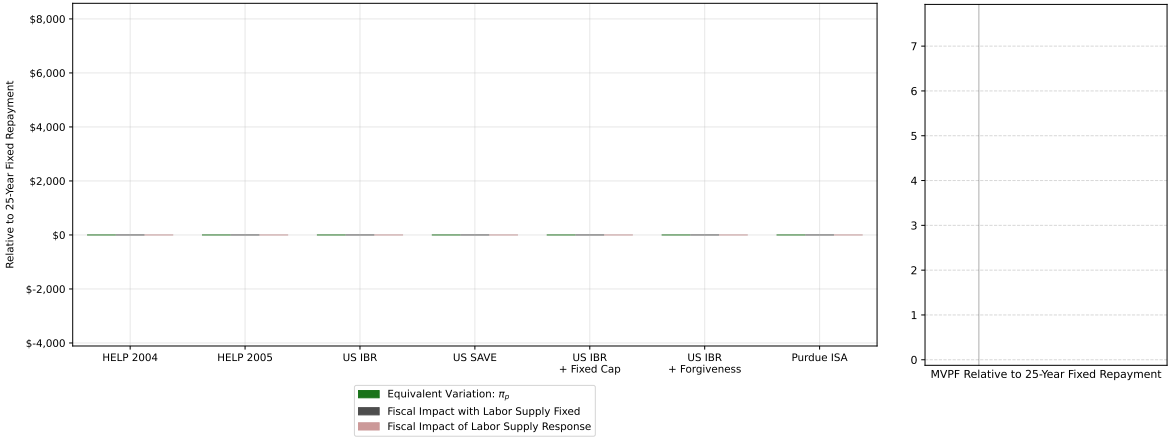
Existing Income-Contingent Loans



Existing Income-Contingent Loans

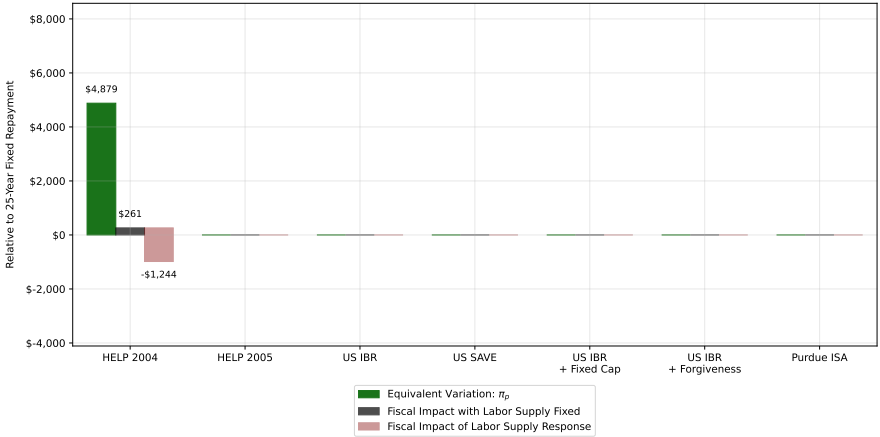


Step 1: Effects of Existing Income-Contingent Loans



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

Step 1: Effects of Existing Income-Contingent Loans



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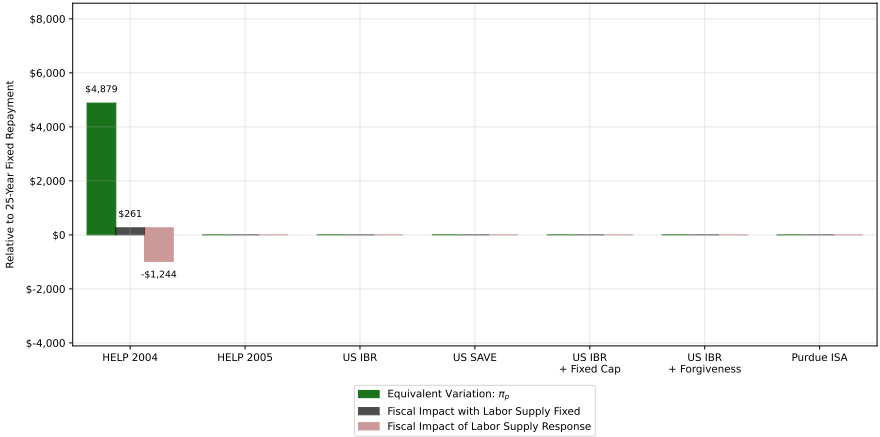
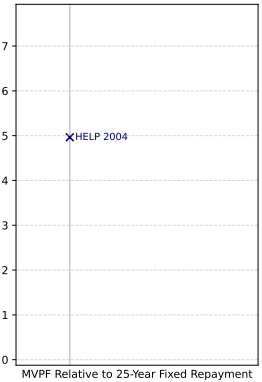
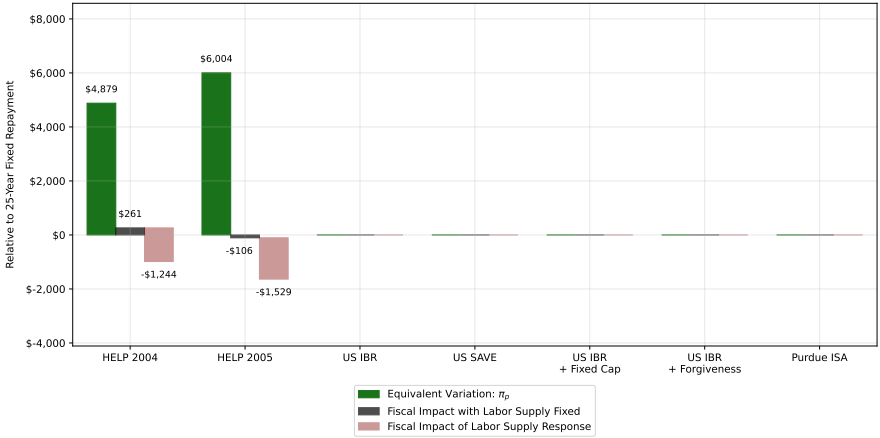
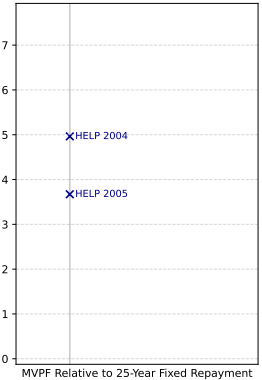




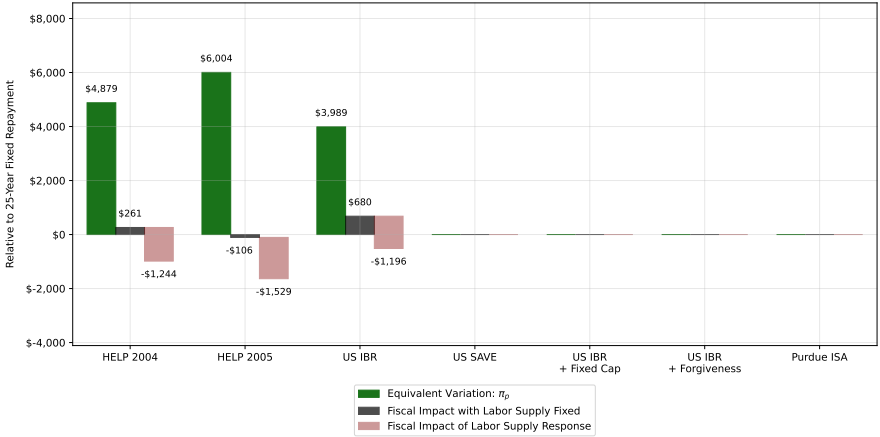
MVPF = WTP / (mechanical fiscal impact + fiscal externality) Hendren-Sprung-Keyser 2020

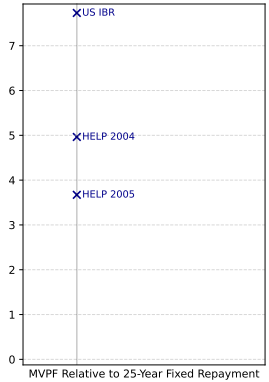
Step 1: Effects of Existing Income-Contingent Loans





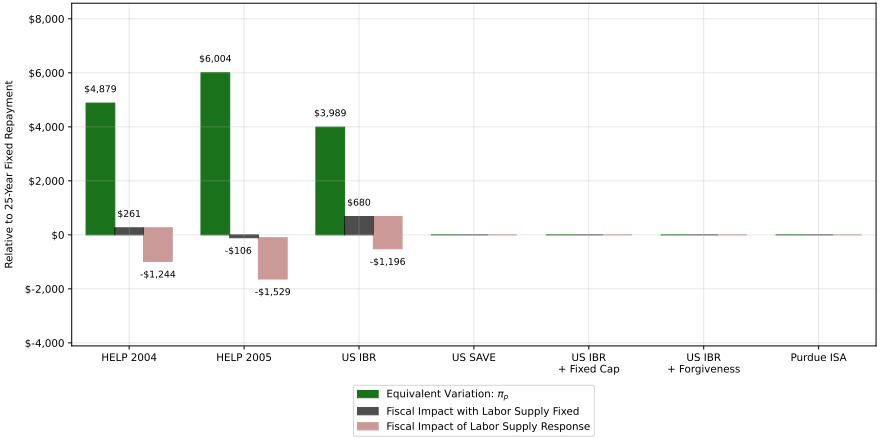
Step 1: Effects of Existing Income-Contingent Loans

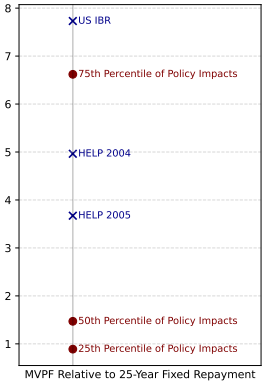




Result #1: Moral hazard $\geq$ 100% of fiscal cost from income-contingent repayment

Step 1: Effects of Existing Income-Contingent Loans

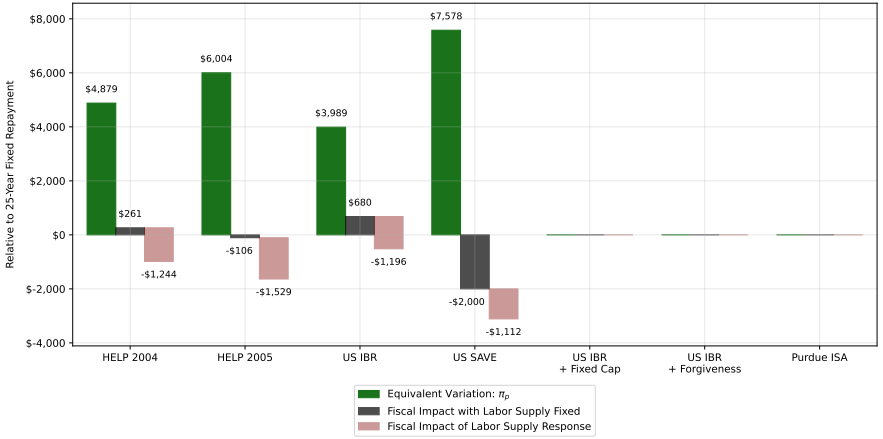


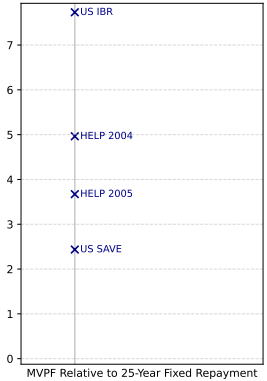


Result #2: Significant welfare gains from fixed $\longrightarrow$ income-contingent repayment

Source: https://policyimpacts.org/

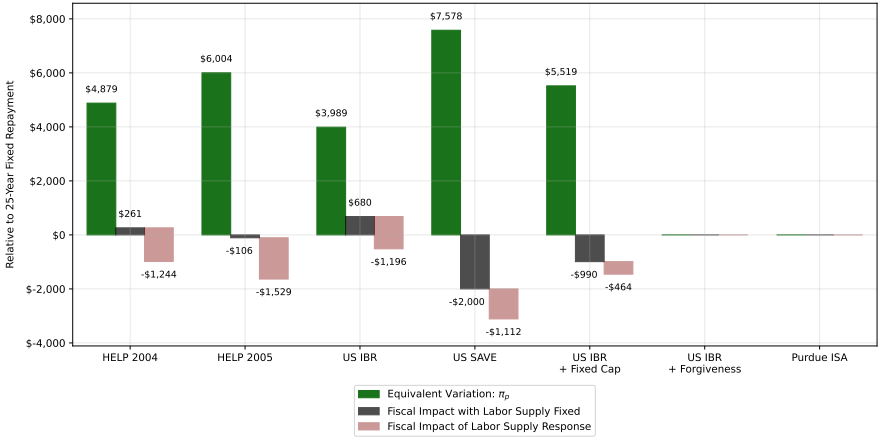
Step 1: Effects of Existing Income-Contingent Loans

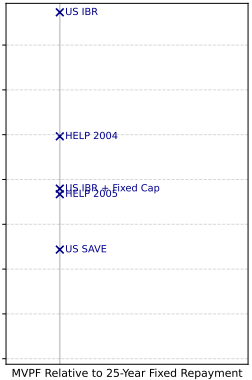




Result #2: Significant welfare gains from fixed $\longrightarrow$ income-contingent repayment

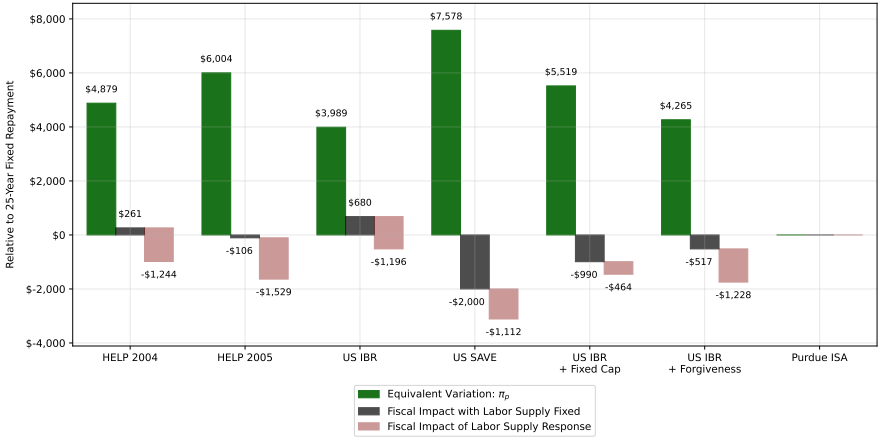
Step 1: Effects of Existing Income-Contingent Loans

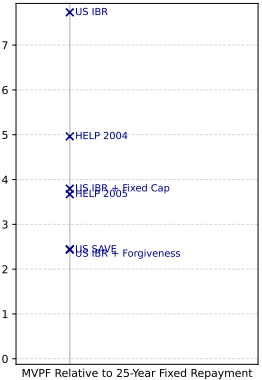




Result #3: Accelerating repayments from high-income borrowers $\Rightarrow \uparrow$ MVPF

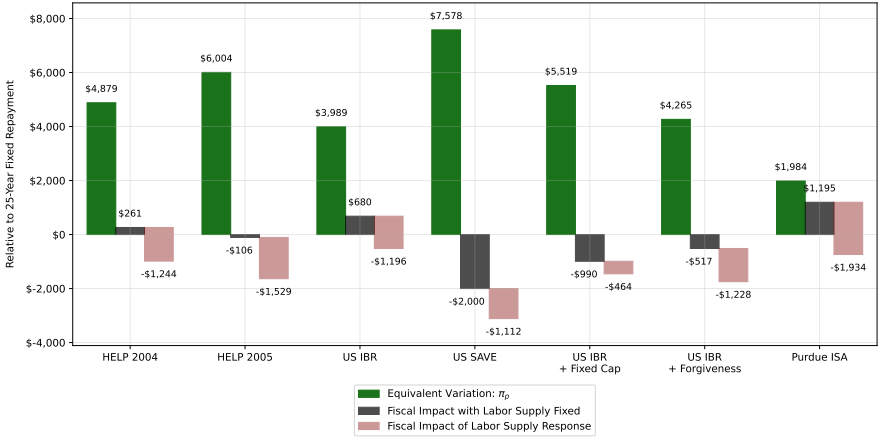
Step 1: Effects of Existing Income-Contingent Loans

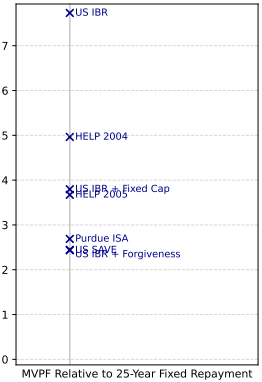




Result #4: Forgiveness not needed with income-contingent repayment

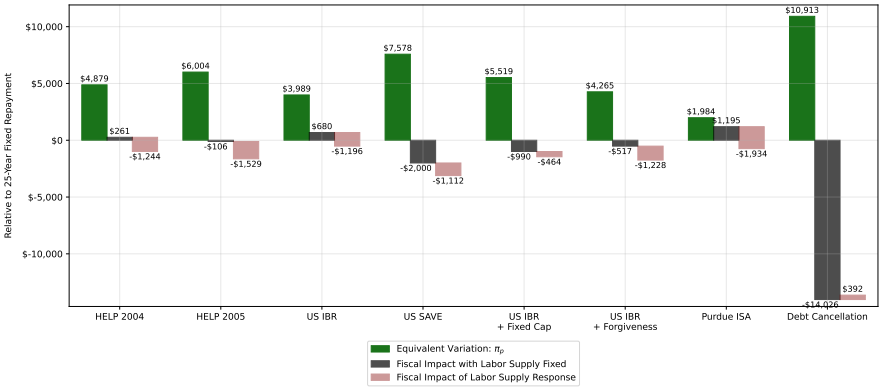
Step 1: Effects of Existing Income-Contingent Loans

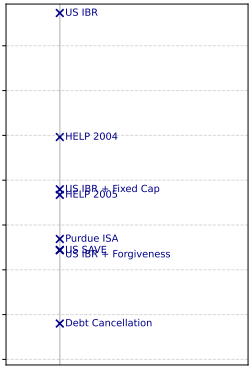




Result #5: Equity contract (4% of income for 9 years) is worse than all ICLs

Step 1: Effects of Existing Income-Contingent Loans





Result #6: Gains from ICLs $\approx 40\%$ of full forgiveness at $\approx 4\%$ of fiscal cost

Constrained-planner's problem:

$$\max_{\psi, K} \mathbf{E}_0 V_{a_0}(\psi, K) \tag{2}$$

Constrained-planner's problem:

$$\max_{\psi, K} \mathbf{E}_0 V_{a_0}(\psi, K) \qquad \text{(behind the "veil-of-ignorance")} \tag{2}$$

Constrained-planner's problem:

$$\max_{\psi,K} \mathbf{E}_0 V_{a_0}(\psi, K)$$

subject to: (à la Ramsey, not Mirrlees)

$$\text{Repayments}_a(\psi, K) = \psi * \max\{y_a - K, 0\} \quad (1)$$

(2)

Constrained-planner's problem:

$$\max_{\psi,K} \mathbf{E}_0 V_{a_0}(\psi, K)$$

subject to:

$$\text{Repayments}_a(\psi, K) = \min\left\{\psi * \max\left\{y_a - K, 0\right\}, D_a\right\} * \mathbf{1}_{a \le a_R} \tag{1}$$

(2)

Constrained-planner's problem:

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

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Welfare Gains from Constrained-Optimal Contracts

Contract Space: p	ψ_p	K_p	π_p	g_p	$\psi_p^{\ell \text{ fixed}}$	$K_p^{\ell \text{ fixed}}$
Income-Contingent Loan	16%	\$19,188	\$2,778	0.79%	38%	\$39,702
Income-Contingent Loan with Notch	9.6%	\$24,093	\$1,508	0.46%	15%	\$47,001
Income-Contingent Loan + 20 Year Forgiveness	23%	\$17,533	\$1,128	0.36%	32%	\$29,516
Income Sharing Agreement (9 Years)	4.1%	.	\$1,730	0.52%	3.6%	.
Income Sharing Agreement ($a_R - a_0$ Years)	0.87%	.	\$6,549	1.82%	0.78%	.

Result #1: Income-Contingent Loan increases welfare without additional costs

- Welfare gain = \$2800 or 0.8% of lifetime consumption
- Constrained-optimal repayment threshold is below HELP, but close to US IBR

▸ Robustness ▸ Sensitivity ▸ Decomposition ▸ Targeting vs. Taxes

Welfare Gains from Constrained-Optimal Contracts

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Income Sharing Agreement ($a_R - a_0$ Years)	0.87%	.	\$6,549	1.82%	0.78%	.

Result #2: Effect of moral hazard on contract design is substantial

- Optimal ψ and K would be over twice as large without labor supply responses

$\Rightarrow$ Welfare loss from moral hazard $\approx$ 0.9pp of lifetime consumption

▸ Robustness ▸ Sensitivity ▸ Decomposition ▸ Targeting vs. Taxes

Welfare Gains from Constrained-Optimal Contracts

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Result #3: Having a notch instead of a kink reduces welfare gains

▸ Robustness ▸ Sensitivity ▸ Decomposition ▸ Targeting vs. Taxes

Welfare Gains from Constrained-Optimal Contracts

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Result #4: Forgiveness reduces welfare gains because of poor targeting

- Transfers repayment from older to younger liquidity-constrained borrowers

▸ Robustness ▸ Sensitivity ▸ Decomposition ▸ Targeting vs. Taxes

Welfare Gains from Constrained-Optimal Contracts

Contract Space: p	ψ_p	K_p	π_p	g_p	$\psi_p^{\ell \text{ fixed}}$	$K_p^{\ell \text{ fixed}}$
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Income Sharing Agreement ($a_R - a_0$ Years)	0.87%	.	\$6,549	1.82%	0.78%	.

Result #5: Equity contracts outperform ICLs, if horizon is sufficiently long

- **Problem**: gain from equity contracts comes entirely from redistribution
  - $\Rightarrow$ Less robust to unmodeled ex-ante responses and selection
- In contrast, gains from ICL are 50-50 from insurance vs. redistribution

▸ Robustness ▸ Sensitivity ▸ Decomposition ▸ Targeting vs. Taxes

Outline

- 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!

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APPENDIX

START OF APPENDIX

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

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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

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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 $\Rightarrow$ 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

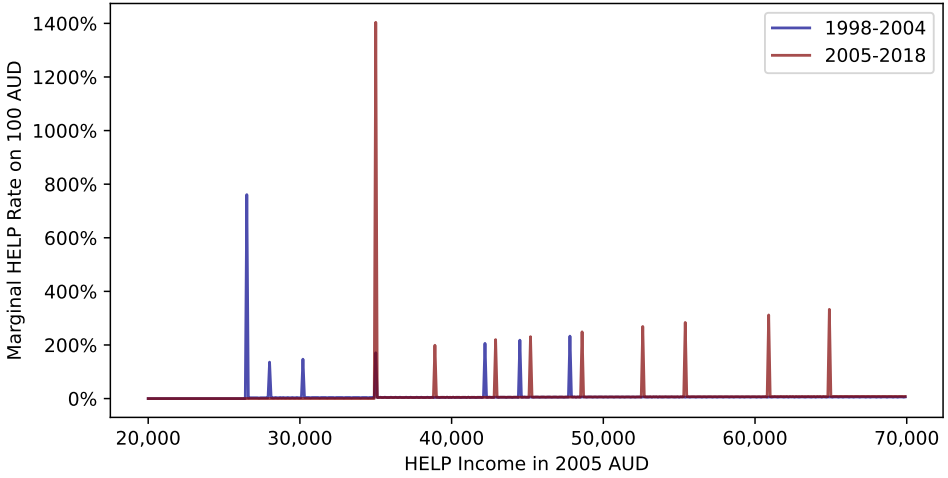
▸ Statistics ◂ Back

Differences between Australia and US: Statistics

Feature of Environment	Australia	US
Cost of Higher Education		
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)
Student Population		
% 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%
Income Distribution and Taxes/Transfers		
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



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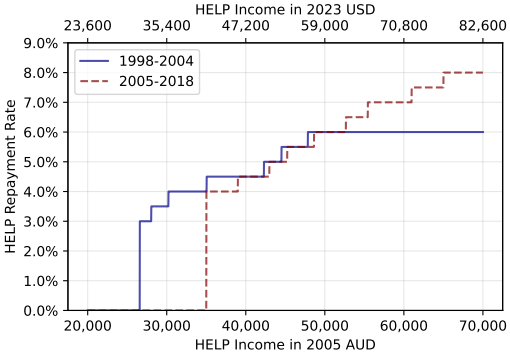
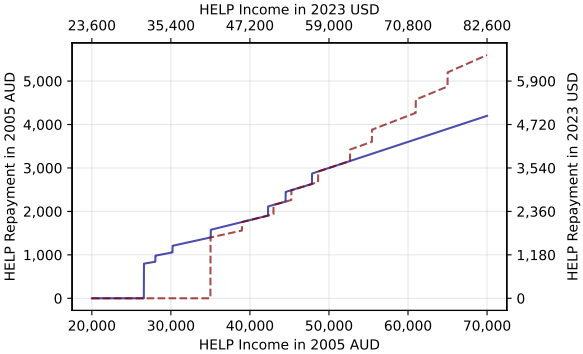
HELP Repayment Rates and Repayments





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FINANCIAL REVIEW

Newsfeed

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.

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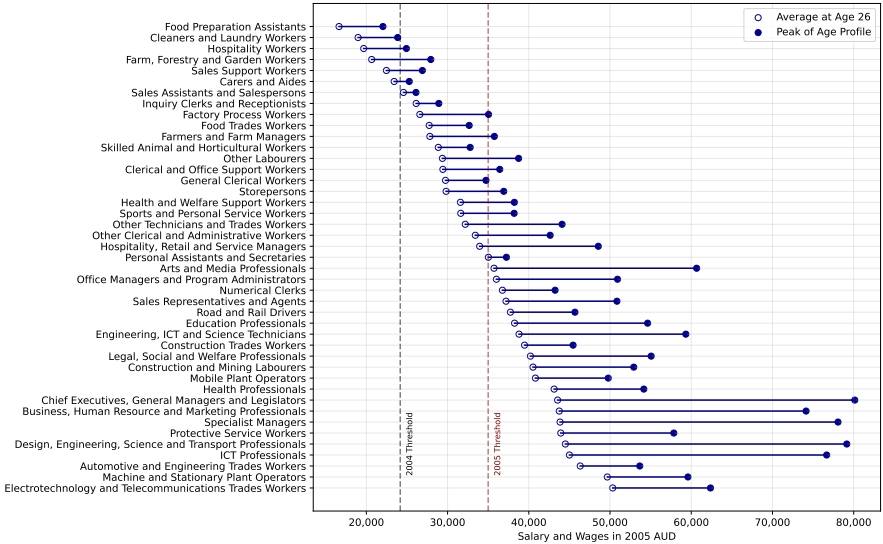
Occupation-Specific Income Profiles Relative to Thresholds



◂ Back: Policy ◂ Back: Hours ◂ Back: Table

Summary Statistics

	Non-Debtholders (1)	Debtholders (2)
Demographic Variables		
Age	41.1	29.5
Female	0.46	0.60
Wage-Earner	0.85	0.91
Income Variables (in 2005 AUD)		
Labor Income	35,480	27,136
Capital Income	1,221	324
Net Deductions	-1,548	-1,099
Taxable Income	37,695	27,796
HELP Income	38,756	28,586
HELP Variables		
HELP Debt (in 2005 AUD)	·	10,830
HELP Debt at Age 26 (in 2005 AUD)	·	13,156
HELP Payment (in 2005 AUD)	·	991
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

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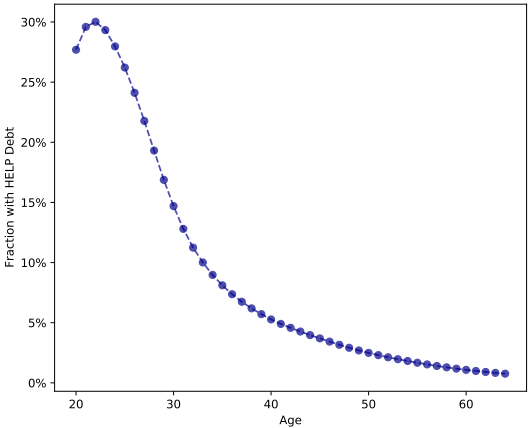
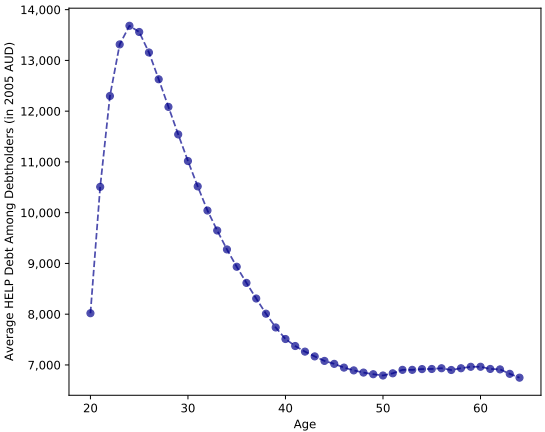
Debt Balances by Age





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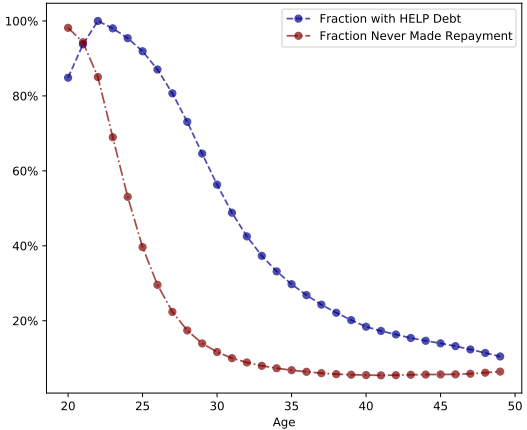
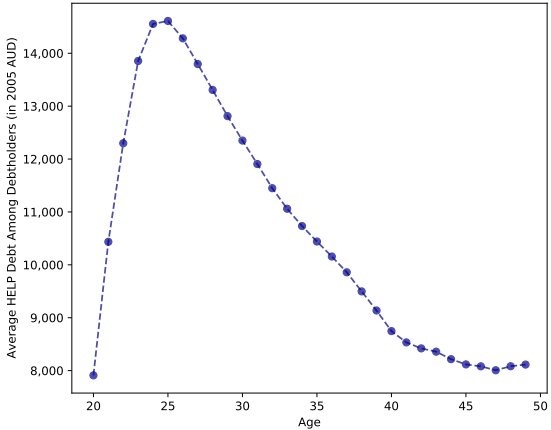
Debt Balances by Age: Individuals with Positive Debt at Age 22





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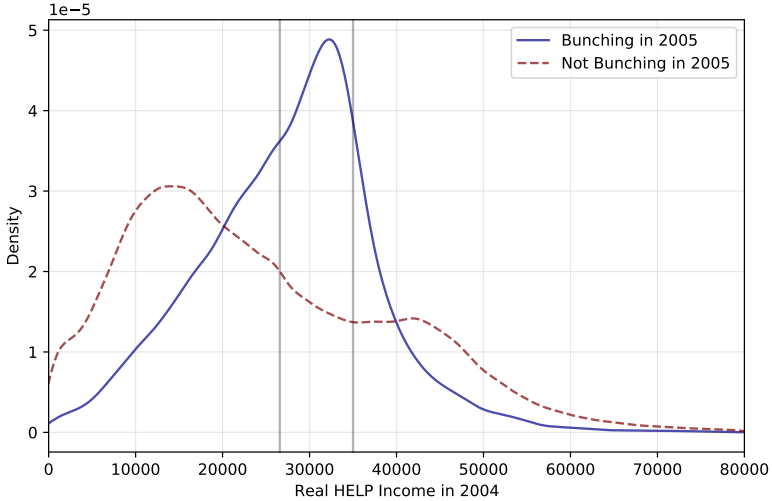
New Bunching Comes from Between Old and New Thresholds



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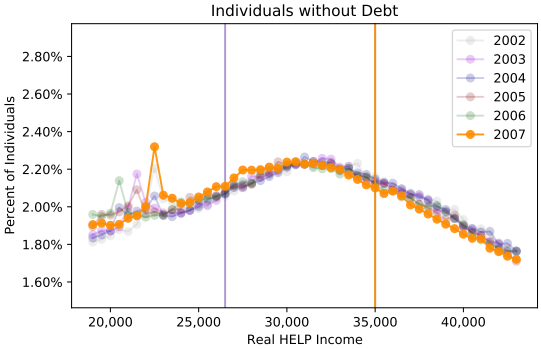
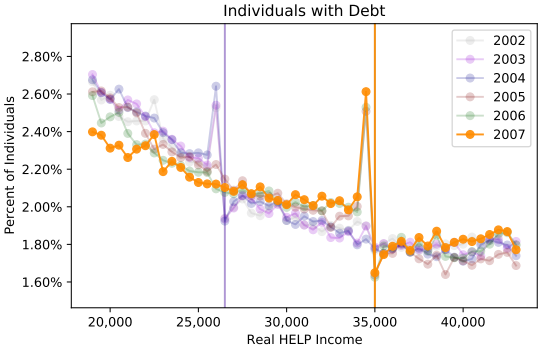
No Bunching at Repayment Threshold for Non-Debtholders





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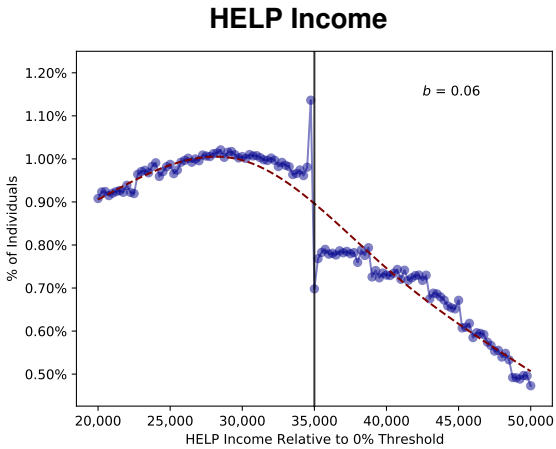
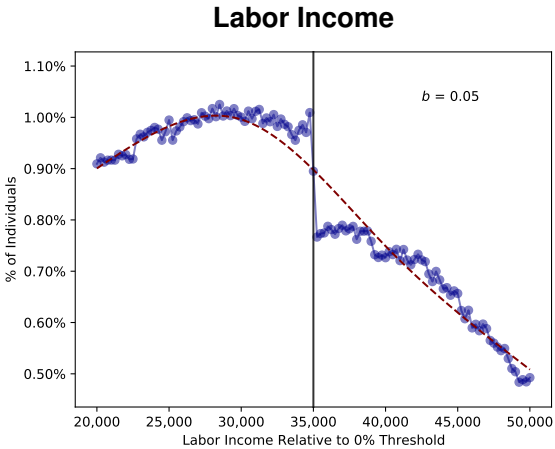
Bunching in Labor Income = 83% of Bunching in HELP Income





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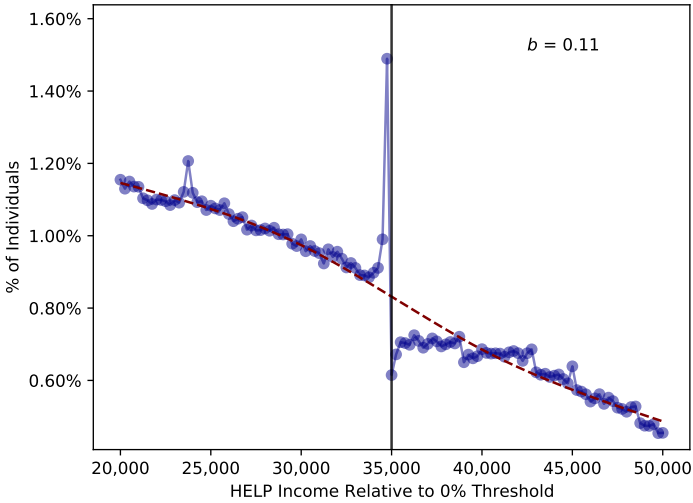
Bunching at Threshold is Larger than at Tax Kink: 2016



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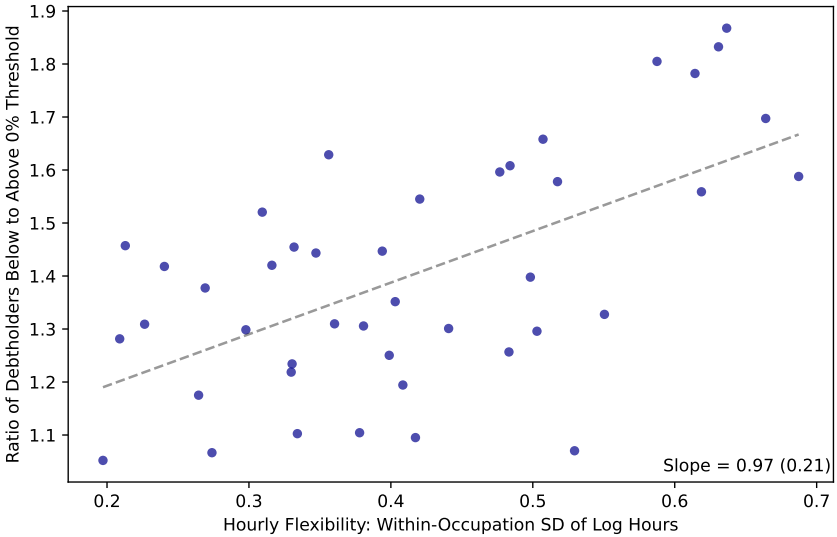
Alternative Measure of Hourly Flexibility



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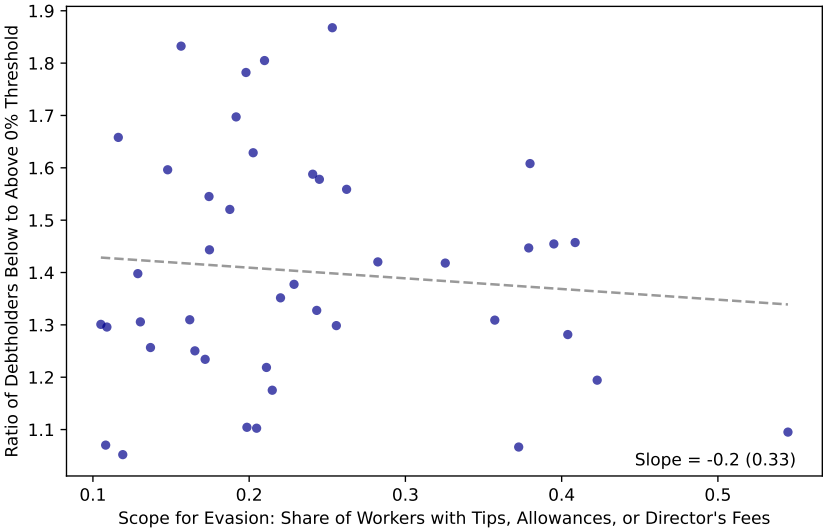
Bunching Uncorrelated with Measure of Evasion



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

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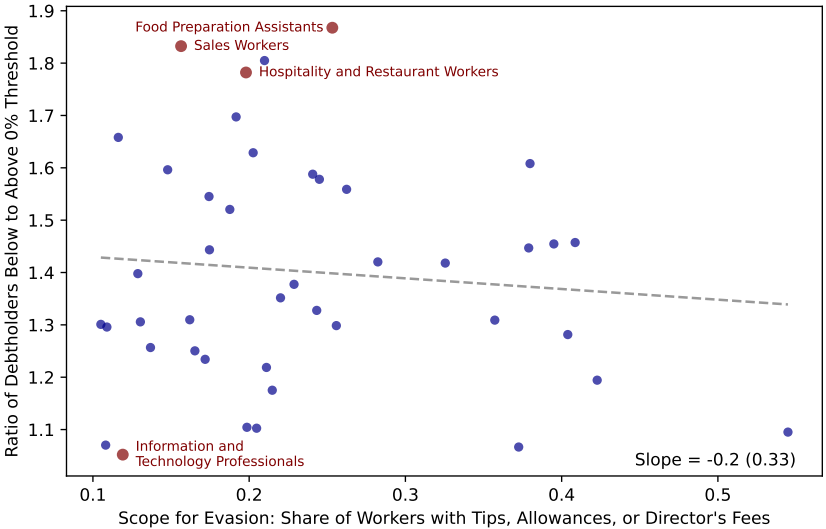
Bunching Uncorrelated with Measure of Evasion



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

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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	·	·	·	1.30	1.05	0.50
	(0.35)	·	·	·	(0.35)	(0.28)	(0.23)
Evasion: Share with Non-Wage Income	·	−0.20	·	·	−0.02	−0.17	0.05
	·	(0.30)	·	·	(0.30)	(0.30)	(0.25)
Income Slope: Mean Wage at 45 / Mean Wage at 26	·	·	−0.53	·	·	−0.40	·
	·	·	(0.10)	·	·	(0.12)	·
Income Peak: Maximum Wage in Occupation Profile	·	·	·	−0.48	·	·	−0.40
	·	·	·	(0.06)	·	·	(0.07)
R^2	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
  1. Fit 5-piece spline leaving out [\$32,500, \$35,000 + X] $\Rightarrow$ **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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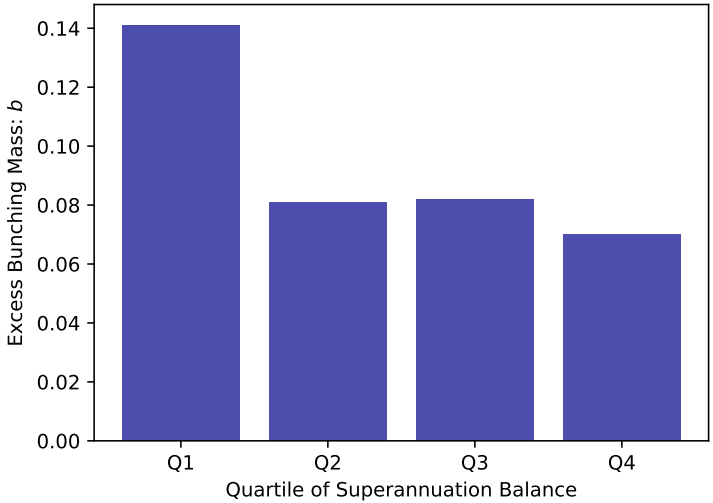
Bunching Decreases with Superannuation Balances



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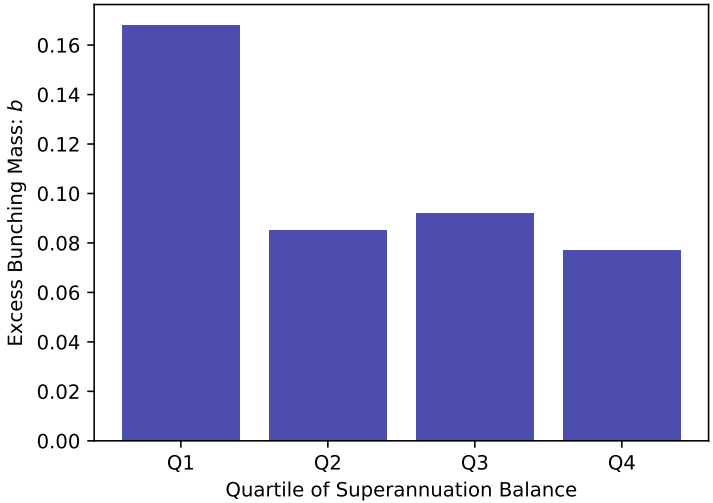
Bunching Heterogeneity by Super Wealth: Ages 20-29



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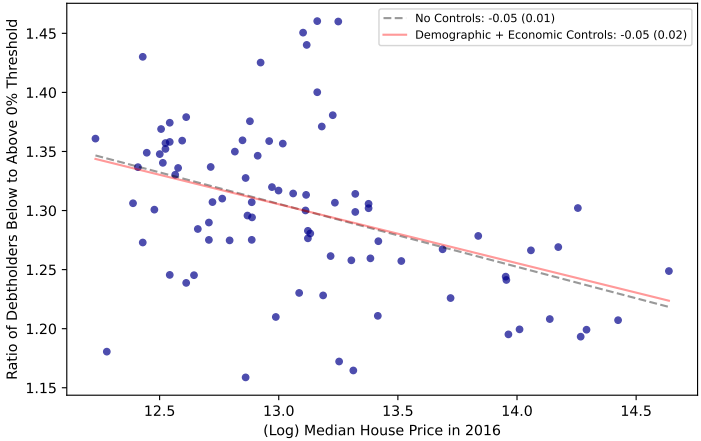
Less Bunching in Regions with More Housing Wealth



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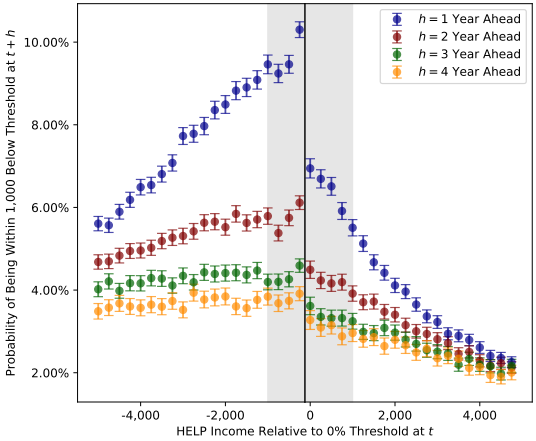
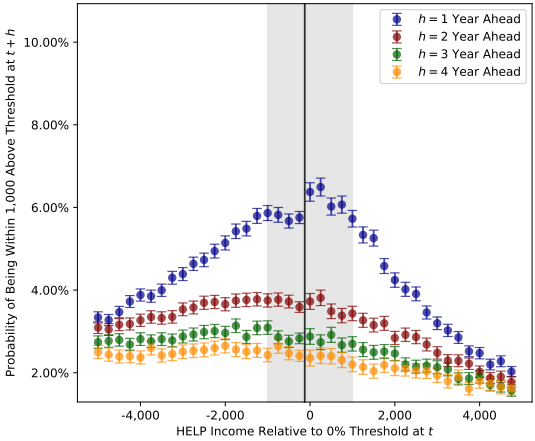
Additional Empirical Results

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 $\Rightarrow$ less avoidance opportunities Slemrod-Yitzhaki 2002

Back: Hours Back: Summary

Persistence of Bunching Lasts around Three Years





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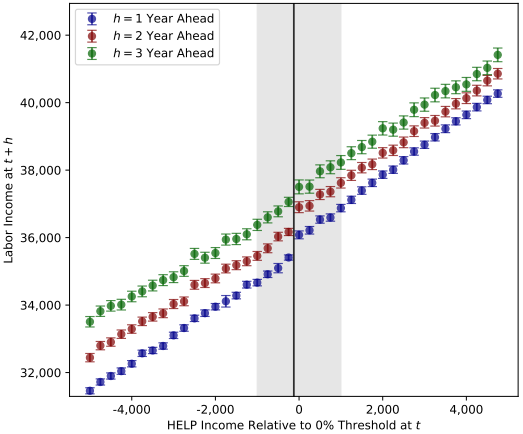
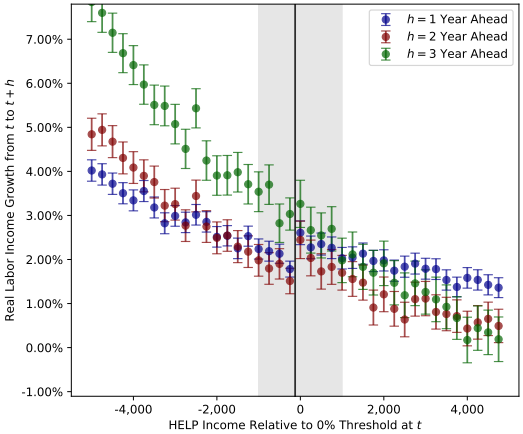
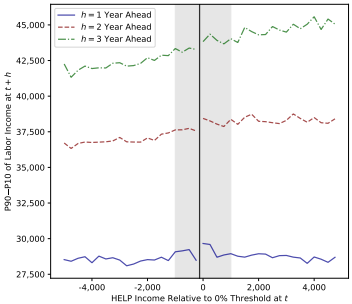
Limited Evidence of Dynamic Cost to Bunching

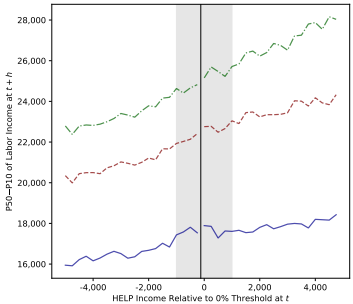


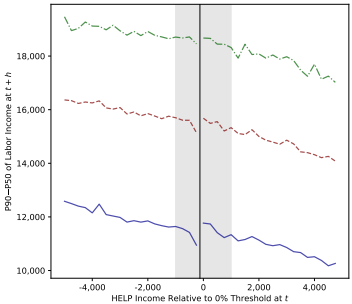


Distribution Back

Little Difference in Distribution of Future Income







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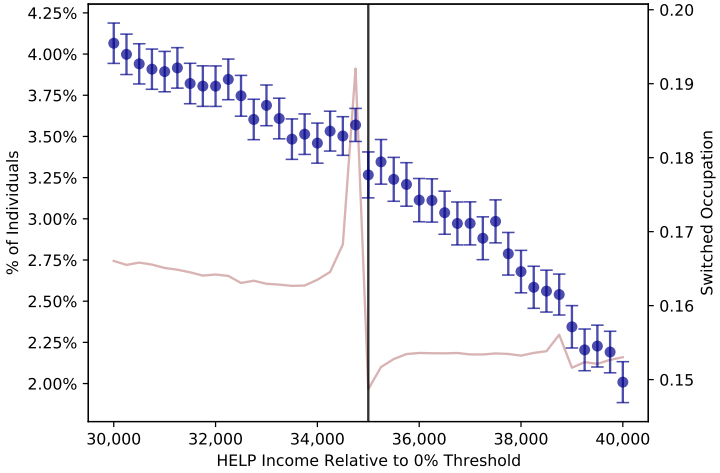
No Discontinuity in the Probability of Switching Occupations



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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
Full Sample	**0.084**

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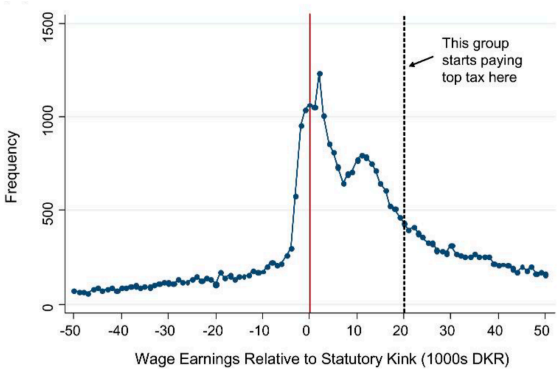
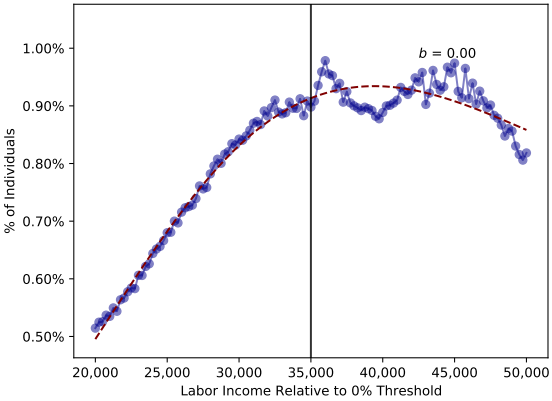
Chetty et al. (2011) Test of Firm Responses

Chetty et al: Teacher Wages



Borrower Labor Income



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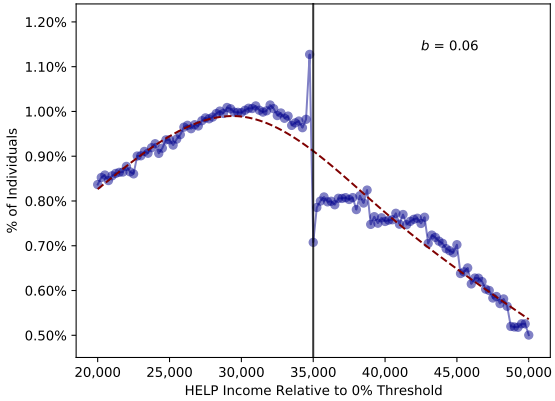
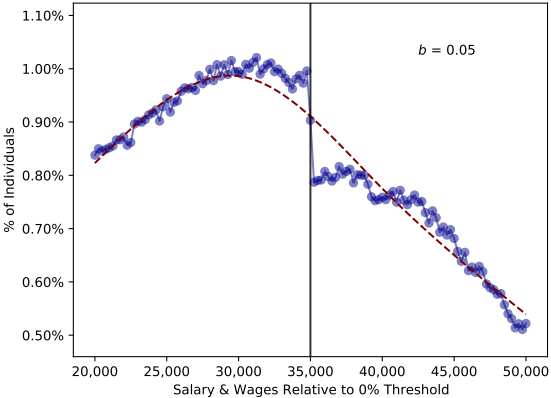
Bunching in Distribution of Salary and Wages

HELP Income



Salary and Wages



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Simulated Minimum Distance: Other Moments

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

- 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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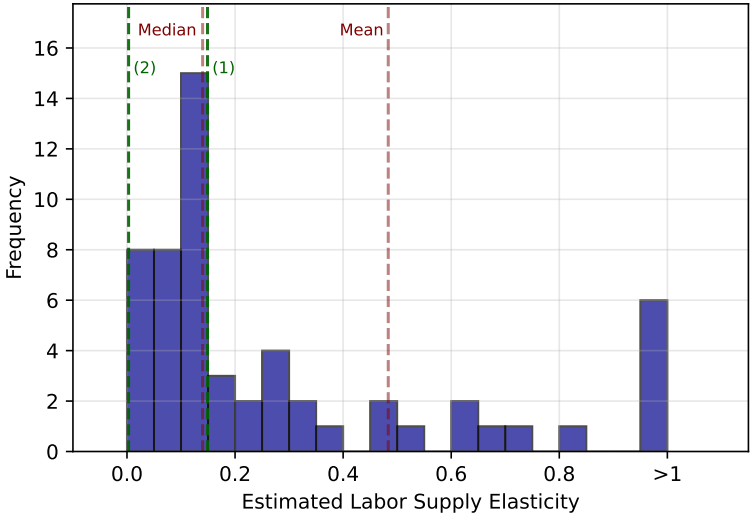
Comparison with Existing Literature on Labor Supply (1/2)



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
   - ℓ_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

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Full Estimation Results

Parameter		Estimation (1)	(2)	(3)	(4)	(5)
Labor supply elasticity	ϕ	0.003	0.167	0.084	0.146	0.149
		(.000)	(.001)	(.001)	(.001)	(.001)
Lower adjustment cost	f_L	\$0	\$1377	\$0	\$454	\$378
		.	(\$6)	.	(\$9)	(\$16)
Adjustment cost probability	λ	1	1	0.124	0.161	0.153
		.	.	(.002)	(.002)	(.004)
Upper adjustment cost	f_H	∞	∞	∞	∞	\$3191
		.	.	.	.	(\$105)
Time discount factor	β	0.998	0.914	0.934	0.958	0.937
		(.000)	(.001)	(.003)	(.001)	(.001)
Scaling parameter	κ	0.179	1.233	0.236	0.697	2.667
		(.000)	(.007)	(.001)	(.006)	(.032)
Wage profile parameters	δ_0	10.170	9.360	9.089	9.243	9.667
		(.002)	(.004)	(.004)	(.004)	(.003)
	δ_1	0.067	0.074	0.073	0.078	0.064
		(.000)	(.000)	(.000)	(.000)	(.000)
	δ_2	-0.001	-0.001	-0.001	-0.001	-0.001
		(.000)	(.000)	(.000)	(.000)	(.000)
	δ_0^E	-0.442	-0.440	-0.480	-0.496	-0.473
		(.000)	(.001)	(.001)	(.001)	(.001)
	δ_1^E	0.025	0.019	0.022	0.021	0.019
		(.000)	(.000)	(.000)	(.000)	(.000)
Persistence of permanent shock	ρ	0.824	0.927	0.922	0.934	0.929
		(.000)	(.000)	(.000)	(.000)	(.000)
Std. deviation of permanent shock	σ_ν	0.057	0.223	0.252	0.222	0.224
		(.000)	(.000)	(.001)	(.001)	(.001)
Std. deviation of transitory shock	σ_ϵ	0.431	0.133	0.113	0.164	0.150
		(.000)	(.001)	(.001)	(.001)	(.001)
Std. deviation of individual FE	σ_i	0.575	0.569	0.541	0.591	0.569
		(.001)	(.001)	(.002)	(.002)	(.002)
Std. deviation of measurement error	ι	0	0	0	0	0.034
		.	.	.	.	(.000)

◂ Back: Estimation

Model Fit: Other Target Moments

	Data	Model
Cross-Sectional Variance of Log Labor Income at Age 22	0.453	0.448
Cross-Sectional Variance of Log Labor Income at Age 32	0.555	0.470
Cross-Sectional Variance of Log Labor Income at Age 42	0.577	0.503
Cross-Sectional Variance of Log Labor Income at Age 52	0.539	0.568
Cross-Sectional Variance of Log Labor Income at Age 62	0.608	0.665
Linear Age Profile Term	0.077	0.071
Quadratic Age Profile Term	−0.001	−0.001
Education Income Premium Constant	−0.574	−0.559
Education Income Premium Slope	0.023	0.022
10th Percentile of 1-Year Labor Income Growth	−0.387	−0.407
10th Percentile of 5-Year Labor Income Growth	−0.667	−0.702
90th Percentile of 1-Year Labor Income Growth	0.415	0.407
90th Percentile of 5-Year Labor Income Growth	0.698	0.706
Average Labor Supply	1.000	0.813
Probability that Labor Supply Not Adjusted	0.422	0.375
Kurtosis of Changes in Log Hours	5.637	5.721
Bunching Ratio: Q4 Debt to Q1 Debt	1.173	1.222
Bunching Probability in 2005 Conditional on Bunching in 2004	0.020	0.020

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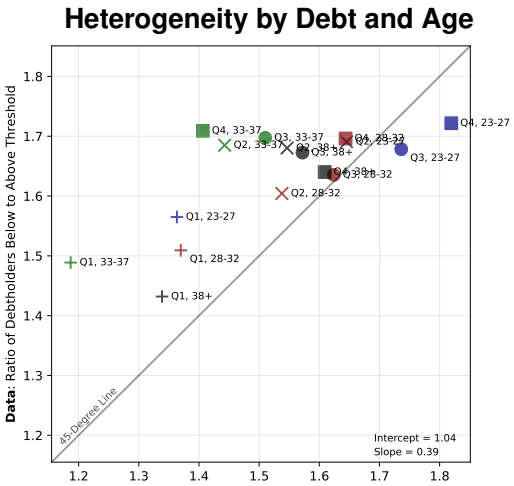
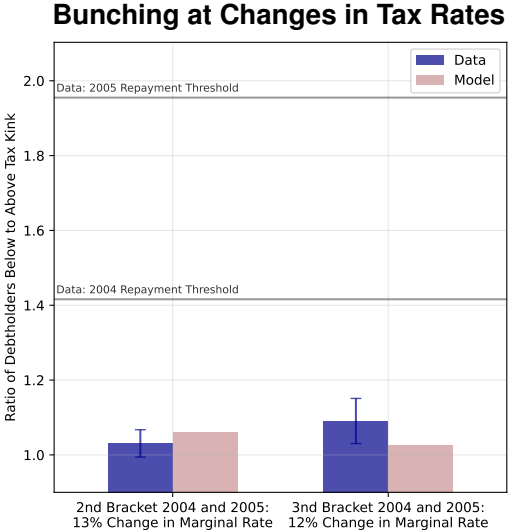
Out-of-Sample Validation: Bunching Heterogeneity





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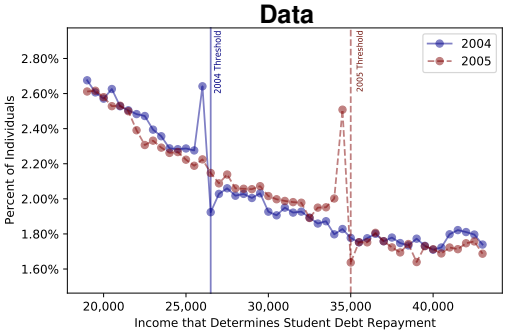
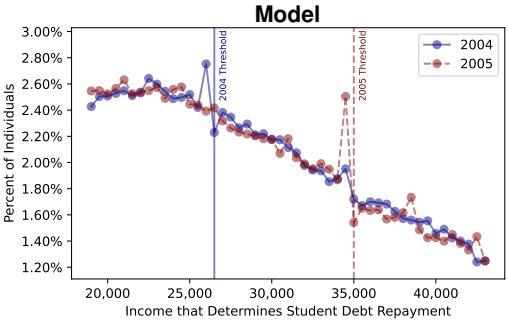
Out-of-Sample Validation: Speed of Response





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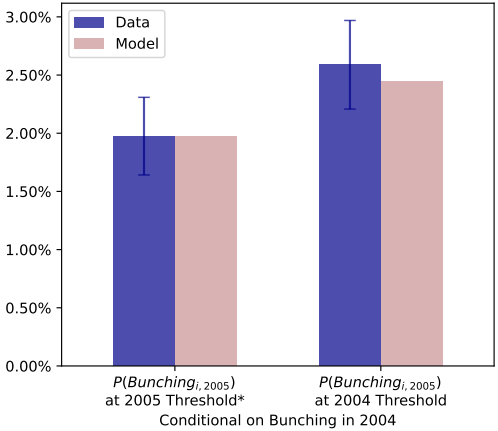
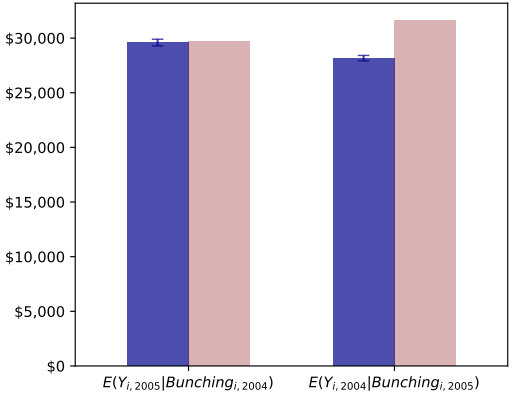
Out-of-Sample Validation: Panel





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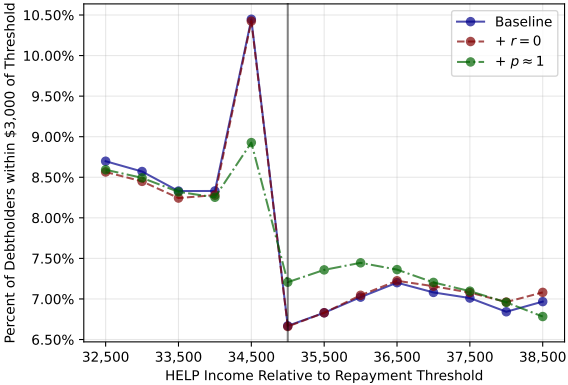
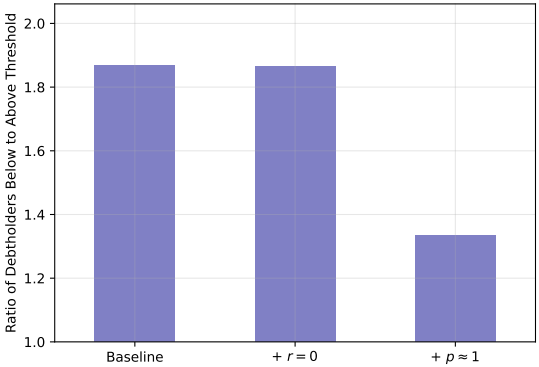
Decomposition: Rate Differential, Repayment, and Liquidity





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

- 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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Robustness to Model Misspecification

Estimated Models	ψ_p	K_p	π_p	g_p
Baseline Model	16%	\$19,188	\$2,778	0.79%
$f_L = f_H$ Model	16%	\$31,786	\$3,456	1.35%
$f_L = 0, f_H = \infty$ Model	37%	\$38,390	\$4,997	1.61%
$f_H = \infty$ Model	14%	\$31,055	\$4,821	1.18%
Deviation from Baseline Model	ψ_p	K_p	π_p	g_p
US Tax System	15%	\$18,539	\$2,599	0.65%
Optimized Tax System	6%	\$2,104	\$24	0.01%
Lower RRA = 1.5	14%	\$18,565	\$1,429	0.44%
Higher RRA = 4	22%	\$20,856	\$5,551	1.74%
Lower EIS = 0.25	18%	\$18,524	\$2,404	0.84%
Higher EIS = 1.5	11%	\$17,151	\$2,238	0.52%
Wealth Effects on ℓ	33%	\$34,083	\$3,129	0.76%
Less Persistence: ρ = 0.8	33%	\$37,518	\$2,963	0.83%
More Persistence: ρ = 0.99	8%	\$2,782	\$1,700	0.49%
US Initial Debt Levels	27%	\$16,994	\$9,838	3.03%
Higher Debt Interest Rate: $R_d = 2\%$	28%	\$43,863	\$6,776	1.88%
Government Discount Rate = $R + 2\%$	33%	\$33,095	\$5,044	1.43%

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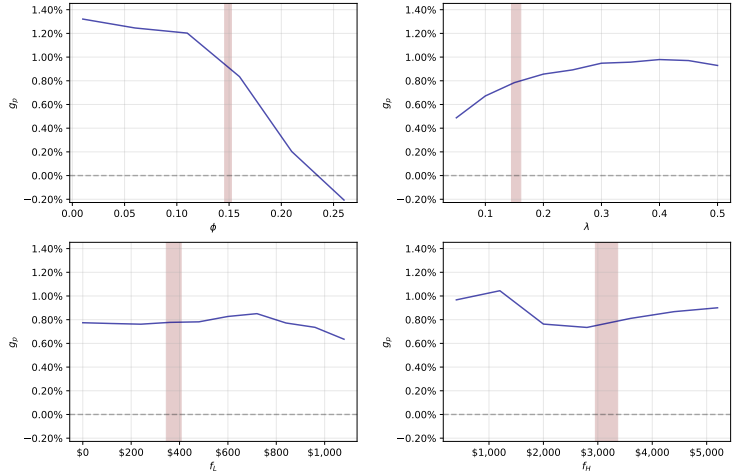
Sensitivity of Welfare Gains to Parameters



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Insurance-Redistribution Decomposition

Contract Space: p	π_p^{Before}	π_p^{After}	g_p^{Before}	g_p^{After}
Income-Contingent Loan	\$4,012	\$1,616	1.03%	0.50%
Income Sharing Agreement ($a_R - a_0$ Years)	\$6,182	.	1.75%	.

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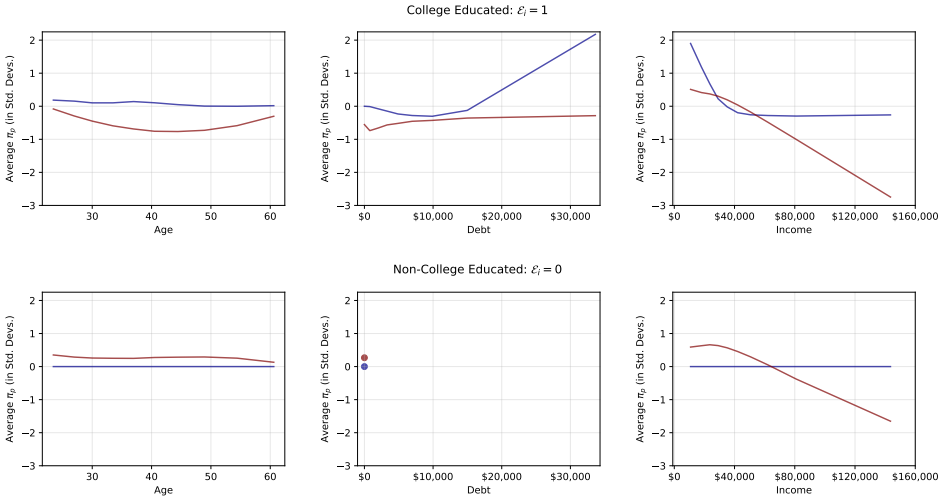
Targeting of Taxes vs. ICL



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Shortcuts in Adobe Acrobat

Physical vs. logical page numbers

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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

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