Insurance versus Moral Hazard in Income-Contingent Student Loan Repayment

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

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This Paper: Insurance vs. Moral Hazard

Conditional on ex-ante choices, 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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3. **Model**: life cycle model with endogenous labor supply $+$ uninsurable wage risk
   - **Positive**: translate responses into estimates of preference parameters
   - **Normative**: characterize optimal amount and form of income-contingent repayment

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   - **Normative**: characterize optimal amount and form of income-contingent repayment
   - **Caveat**: compute optimal contracts taking ex-ante choices as given $\approx$ **restructuring**

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 **0.11** $+$ adjustment frictions
3. **Contract design**: moral hazard reduces optimal amount of insurance
   - Fixed repayment $\rightarrow$ optimal income-contingent loan $\Rightarrow \uparrow$ **1.3%** lifetime consumption
   - Forbearance $+$ fixed repayment does worse because of slower repayment

Main Results

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

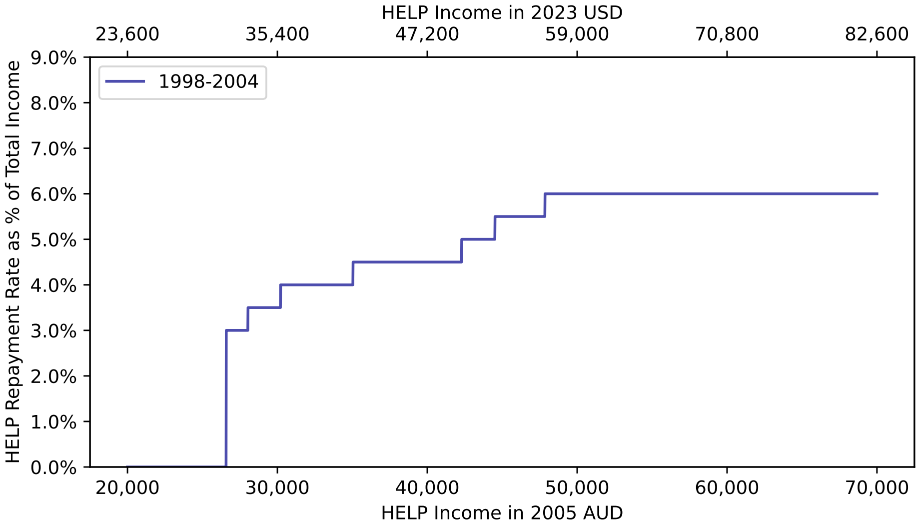
ICL Prevalence Variable Definitions

Why Study Income-Contingent Repayment in Australia?

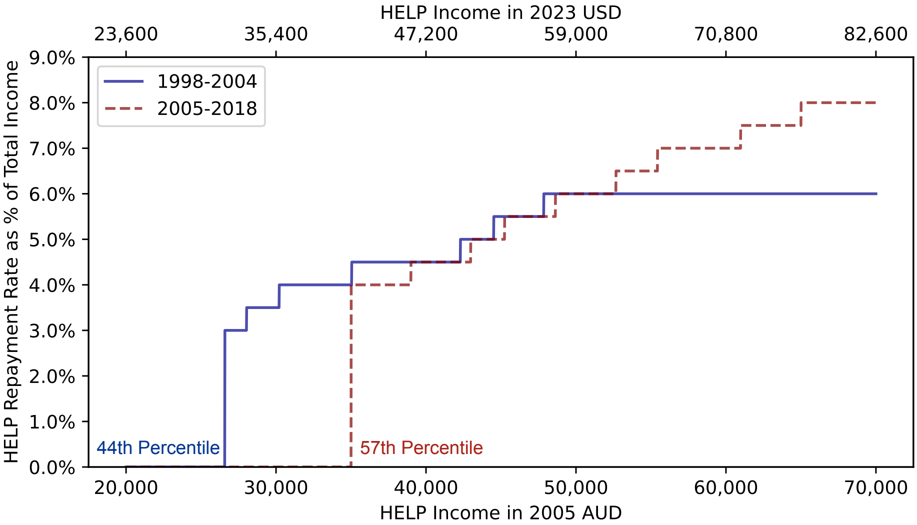
- Benefit #1: only one government contract + no private market
  - Only choice is between borrowing and paying upfront; former heavily subsidized
  - ✓ Limited scope for **adverse selection** (or selection on moral hazard)
- Benefit #2: loans can only be used for tuition
  - Tuition is government-controlled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

▸ Differences from US

Identifying Variation: Discontinuities in Repayment Rates

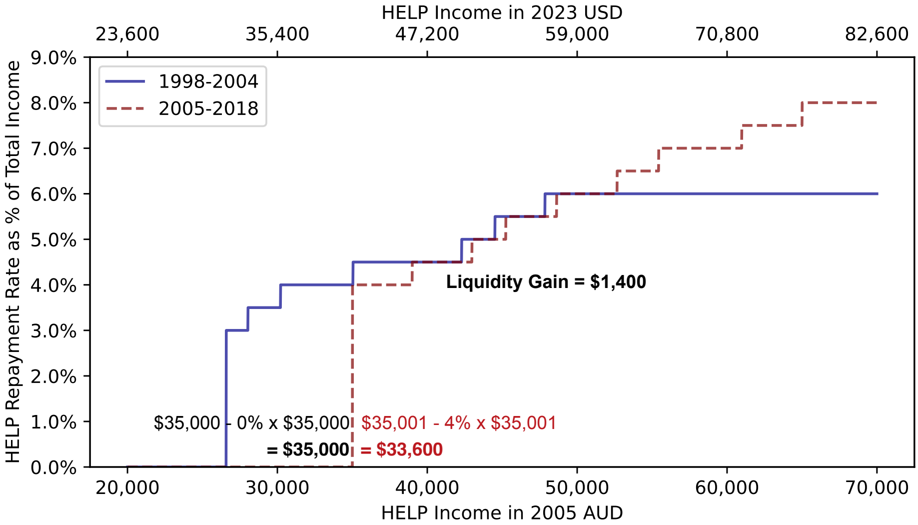


Identifying Variation: Policy Change to Repayment Rates



Note: policy change applied to new and existing debtholders

Repayment Threshold Increases **Average** Repayment Rate



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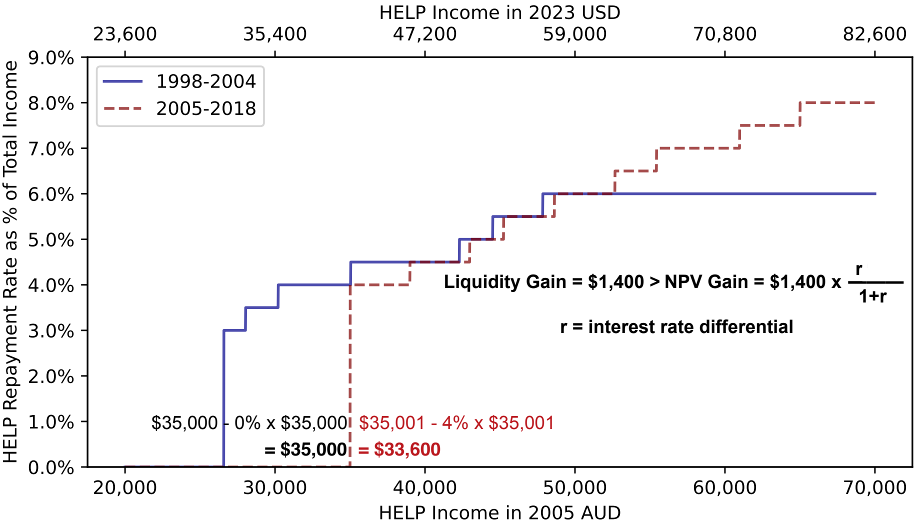
REPAYMENT THRESHOLD INCREASES **LIQUIDITY** MORE THAN **WEALTH**



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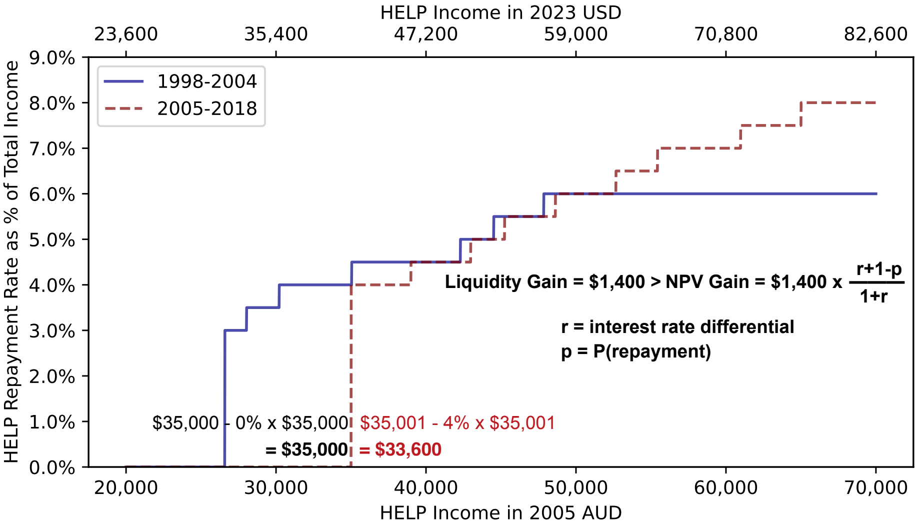

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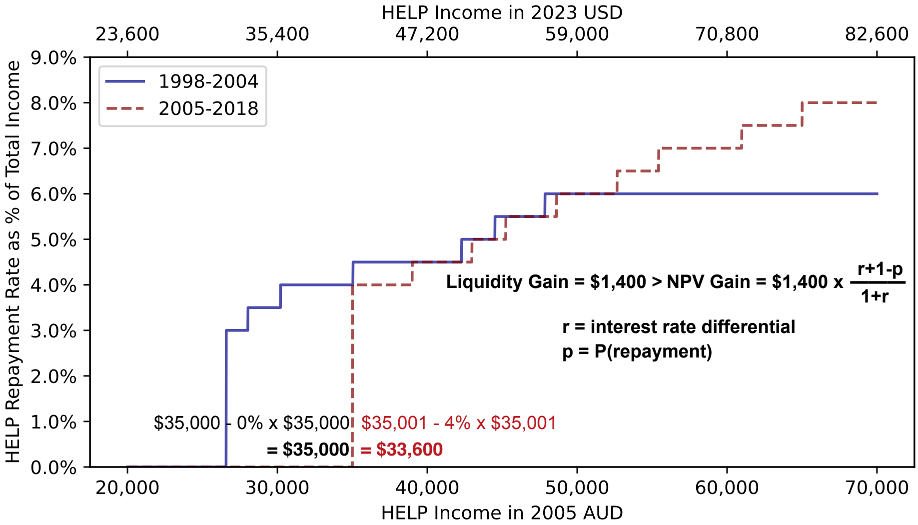

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Marginal Rates | Payments | News | Occupations

Outline

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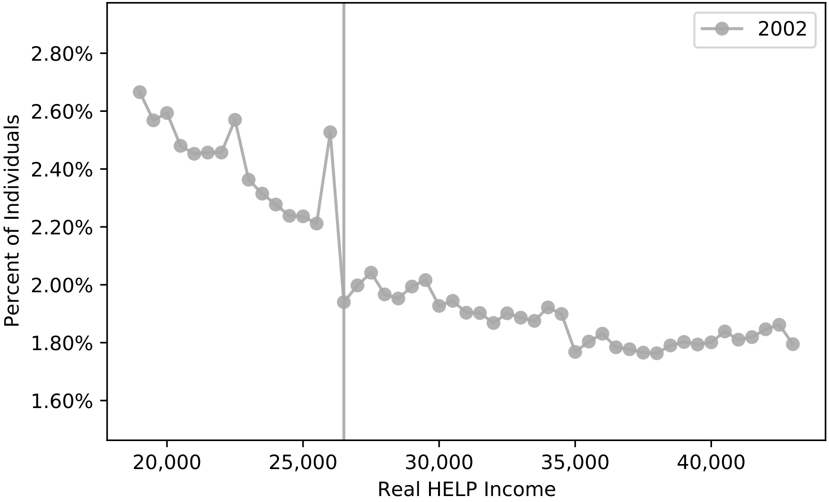

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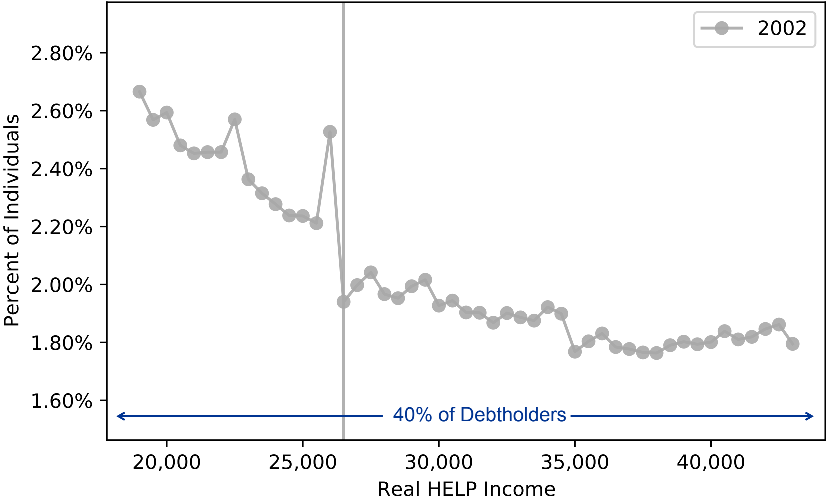

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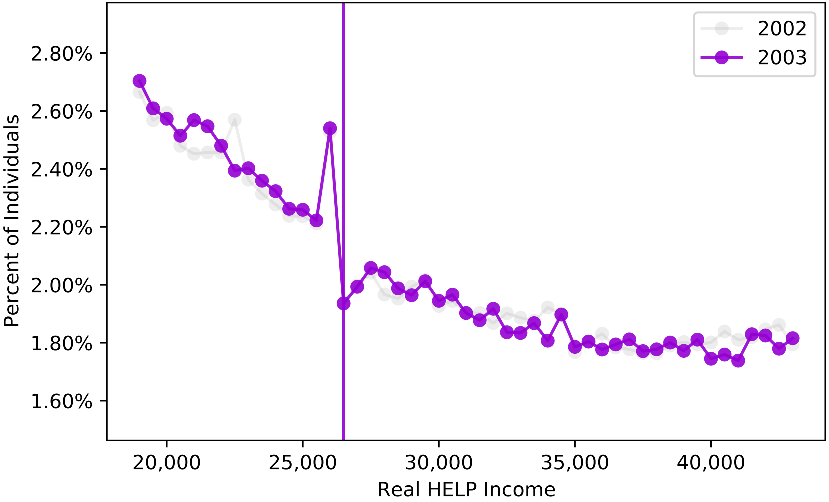

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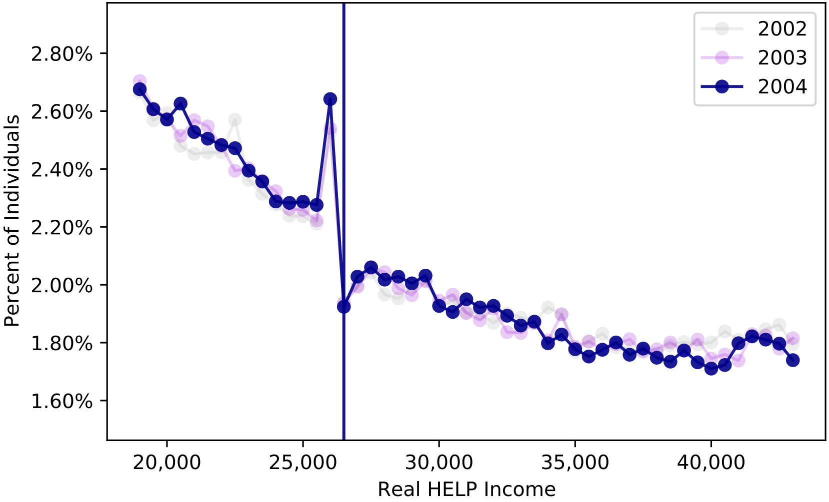

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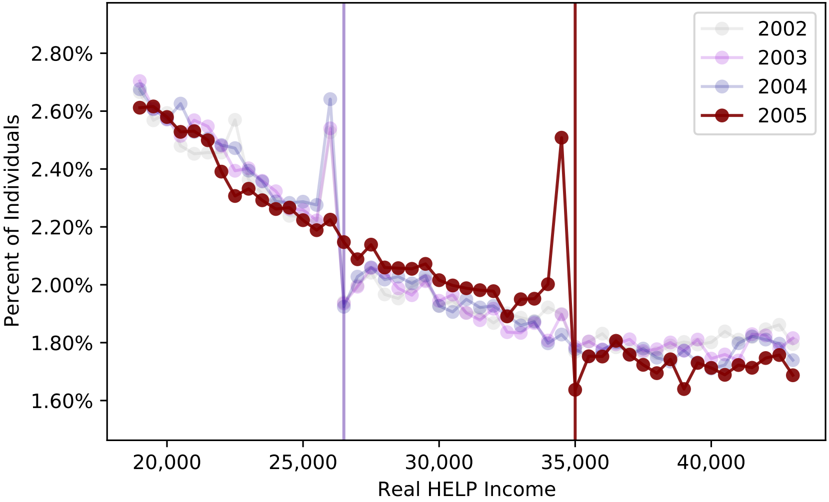

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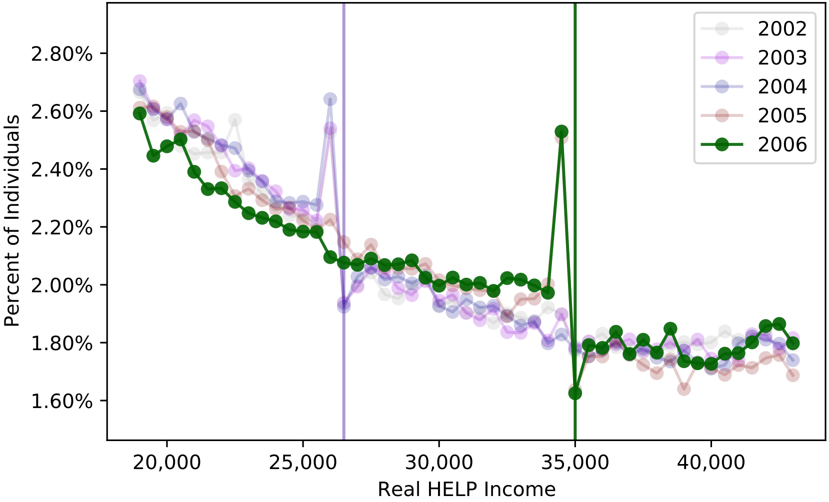

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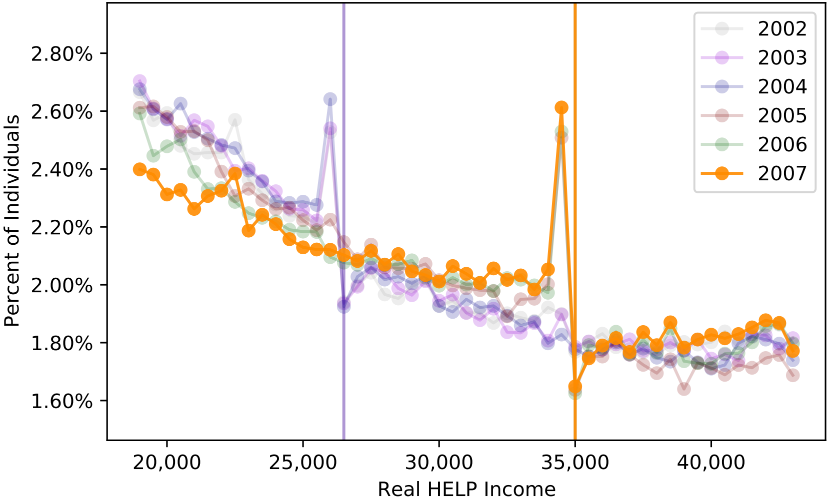

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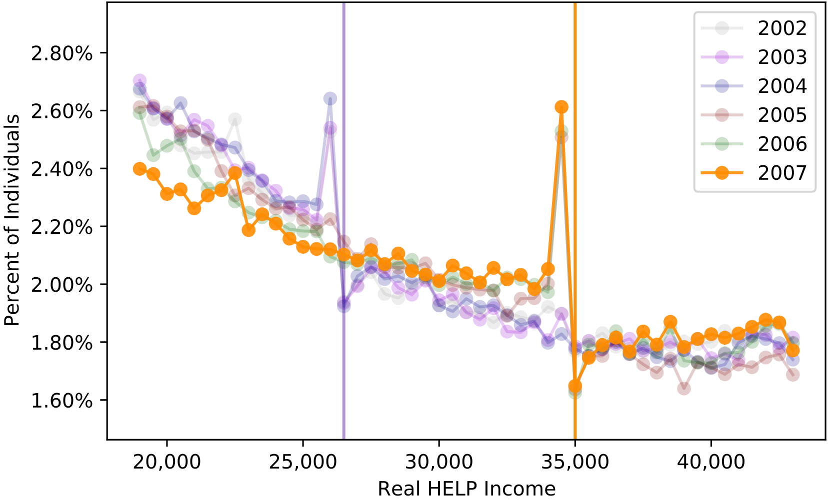
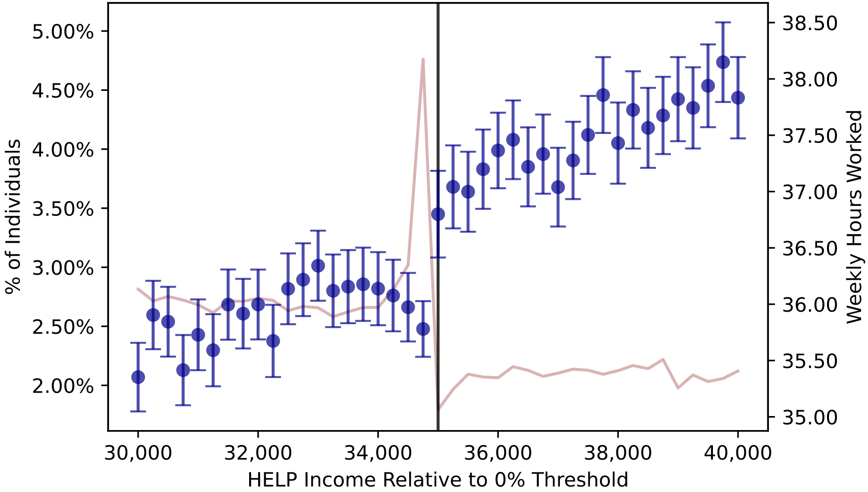


- Next: does bunching reflect labor supply or evasion? ▸ Source ▸ Non-Debt ▸ Labor ▸ vs Tax

Borrowers Below Repayment Threshold Work Fewer Hours



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

By Occupations

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

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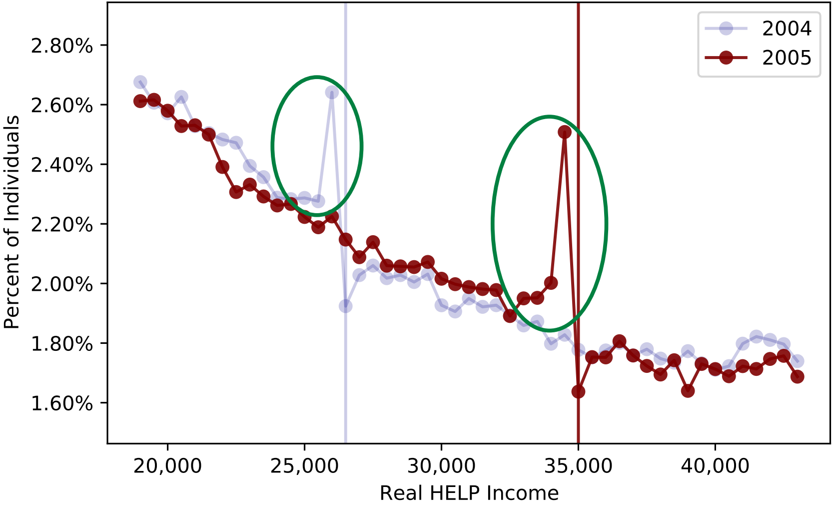
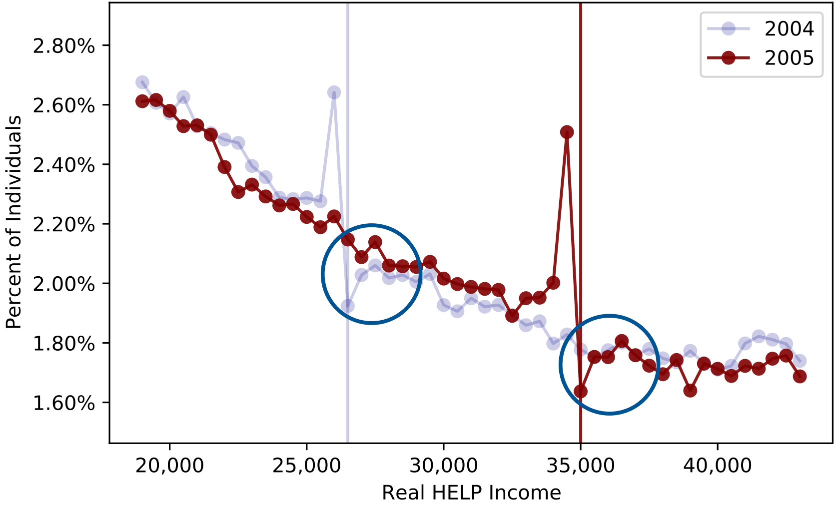
- **Government**
  - Revenues: progressive income taxes, debt repayments
  - Expenses: means-tested unemployment benefits & retirement pension, initial debt

Bunching Consistent with Positive Labor Supply Elasticity



Mass Above Threshold **Inconsistent** with Frictionless Model



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

- Choice of ℓ_a subject to two **optimization frictions** to give mass above threshold
  - Similar to models of pricing Nakamura-Steinsson 2010 and refinancing Andersen et al. 2020

1. Canonical model of **time**-dependent adjustment (Calvo):
   - Fraction λ hit by shock and adjust l_a, other $1-\lambda$ set $l_a = l_{a-1}$
   - E.g., inattention, arrival of opportunities to change hours/jobs

2. Canonical model of **state**-dependent adjustment (sS):
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   - Robustness: linear adjustment costs

- Extension: add learning-by-doing to generate long-run cost of bunching

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Optimization Problem of Individuals Hit by Calvo Shock

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

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

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

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

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

Optimization Problem of Individuals Hit by Calvo Shock

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

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

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

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

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

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

Optimization Problem of Individuals Hit by Calvo Shock

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

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

- ℓ_{a-1} = labor supply from previous period
- ω_a = Calvo shock that determines whether ℓ_a can be adjusted $\sim$ Bernoulli(λ)

Optimization Problem of Individuals Hit by Calvo Shock

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

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

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

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

- Sources of ex-ante heterogeneity:
  - θ_0 = initial permanent income $\sim N(0, \sigma_i^2)$
  - D_0 = initial debt, A_0 = initial assets

$$\text{Parameters} = \Bigg(\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \Bigg)$$

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

Simulated Method of Moments: Identification

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

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

First-Stage Estimation   Elasticities   SMM Objective

Simulated Method of Moments: Identification

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

- Labor supply elasticity: identified by bunching below repayment threshold
- Frictions: identified by mass above repayment threshold
- Separate identification of frictions
  - **Intuition**: with $f = 0$, decision to bunch depends on Calvo shock not incentives
  - Moments: heterogeneity in bunching with **debt**, bunching at **0.5%** threshold

▸ First-Stage Estimation ▸ Elasticities ▸ SMM Objective

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

- Labor supply elasticity: identified by bunching below repayment threshold
- Frictions: identified by mass above repayment threshold
- Separate identification of frictions
  - **Intuition**: with $f = 0$, decision to bunch depends on Calvo shock not incentives
  - Moments: heterogeneity in bunching with **debt**, bunching at **0.5%** threshold
- No panel data on hours $\Rightarrow$ wage profile & wage risk estimated **jointly**

▸ Other Parameters ▸ First-Stage Estimation ▸ Elasticities ▸ SMM Objective

Parameter		Estimation
		Baseline
Labor supply elasticity	ϕ	0.114
Fixed adjustment cost	f	\$377
Calvo parameter	λ	0.183
Time discount factor	β	0.973
Labor supply scaling parameter	κ	0.560
Wage profile parameters	δ_0	8.922
	δ_1	0.073
	δ_2	-0.001
	δ_0^E	-0.487
	δ_1^E	0.020
Persistence of permanent shock	ρ	0.930
Standard deviation of permanent shock	σ_ν	0.236
Standard deviation of transitory shock	σ_ϵ	0.130
Standard deviation of individual FE	σ_i	0.599

▸ Comparison with Literature ▸ All Results with SE

Estimation Results

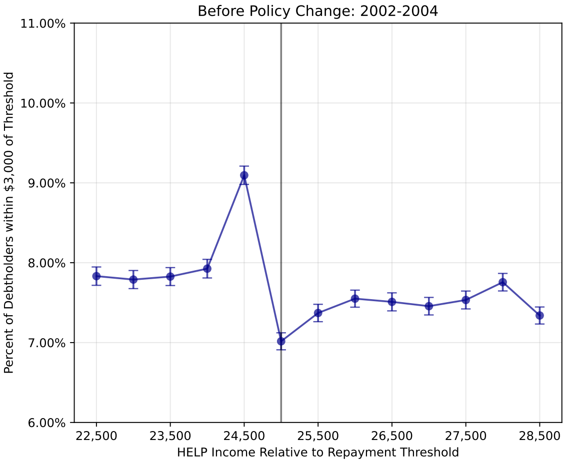
Parameter		Estimation: Baseline	Estimation: No Frictions
Labor supply elasticity	ϕ	0.114	0.005
Fixed adjustment cost	f	\$377	·
Calvo parameter	λ	0.183	·
Time discount factor	β	0.973	0.996
Labor supply scaling parameter	κ	0.560	0.030
Wage profile parameters	δ_0	8.922	9.862
	δ_1	0.073	0.111
	δ_2	-0.001	-0.002
	δ_0^E	-0.487	-0.294
	δ_1^E	0.020	0.032
Persistence of permanent shock	ρ	0.930	0.914
Standard deviation of permanent shock	σ_ν	0.236	0.076
Standard deviation of transitory shock	σ_ϵ	0.130	0.504
Standard deviation of individual FE	σ_i	0.599	0.101

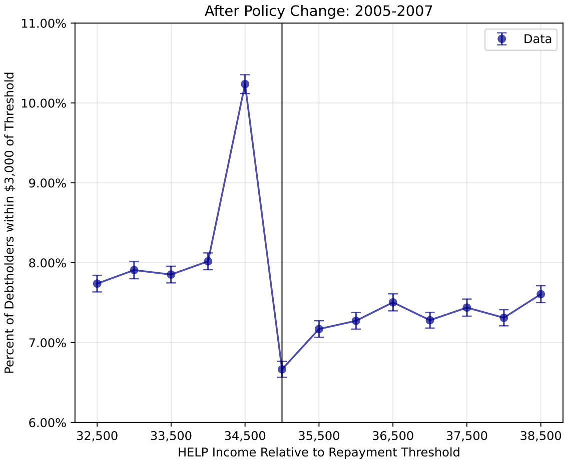
▸ Comparison with Literature ▸ All Results with SE

		Estimation		
Parameter		Baseline	No Frictions	LBD
Labor supply elasticity	ϕ	0.114	0.005	0.082
Fixed adjustment cost	f	\$377	·	\$762
Calvo parameter	λ	0.183	·	0.346
Time discount factor	β	0.973	0.996	0.951
Labor supply scaling parameter	κ	0.560	0.030	1.242
Wage profile parameters	δ_0	8.922	9.862	9.197
	δ_1	0.073	0.111	0.070
	δ_2	-0.001	-0.002	-0.001
	δ_0^E	-0.487	-0.294	-0.480
	δ_1^E	0.020	0.032	0.018
Persistence of permanent shock	ρ	0.930	0.914	0.889
Standard deviation of permanent shock	σ_ν	0.236	0.076	0.288
Standard deviation of transitory shock	σ_ϵ	0.130	0.504	0.064
Standard deviation of individual FE	σ_i	0.599	0.101	0.625

Comparison with Literature
All Results with SE

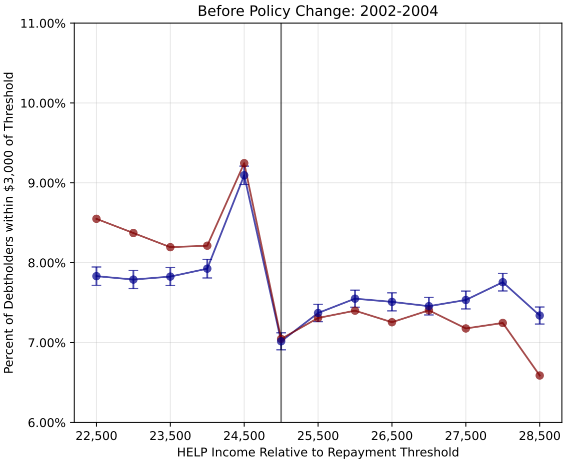
Model Fit: Bunching Before and After Policy Change

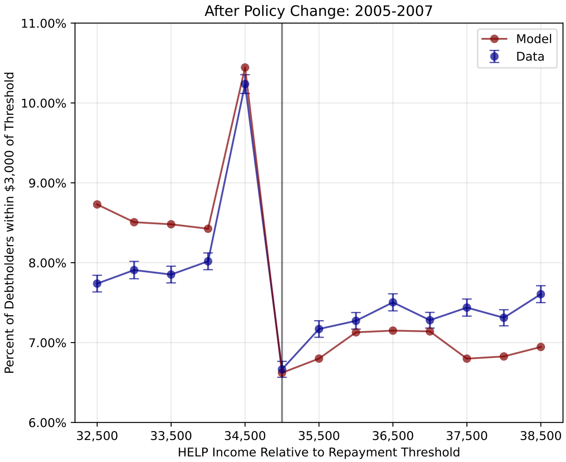




▸ Model Fit: Heterogeneity ▸ Model Fit: Other Moments ▸ Additional Results

Model Fit: Bunching Before and After Policy Change

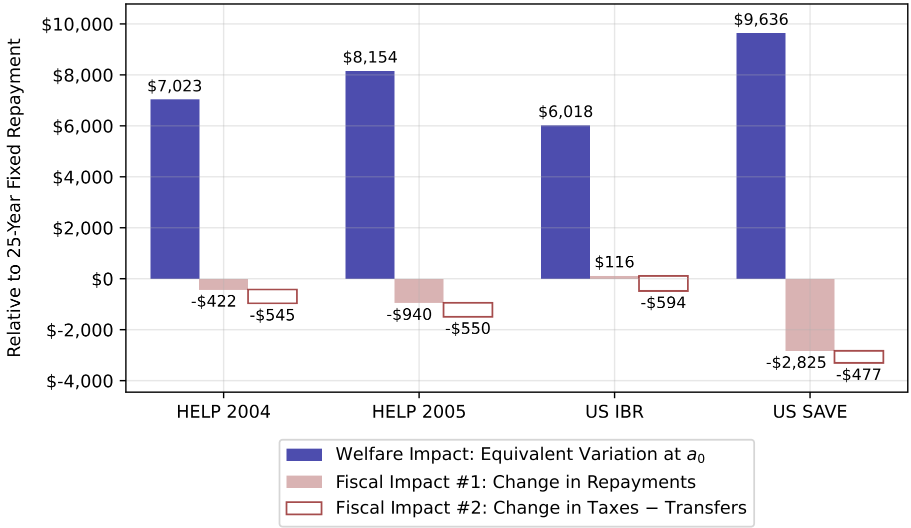




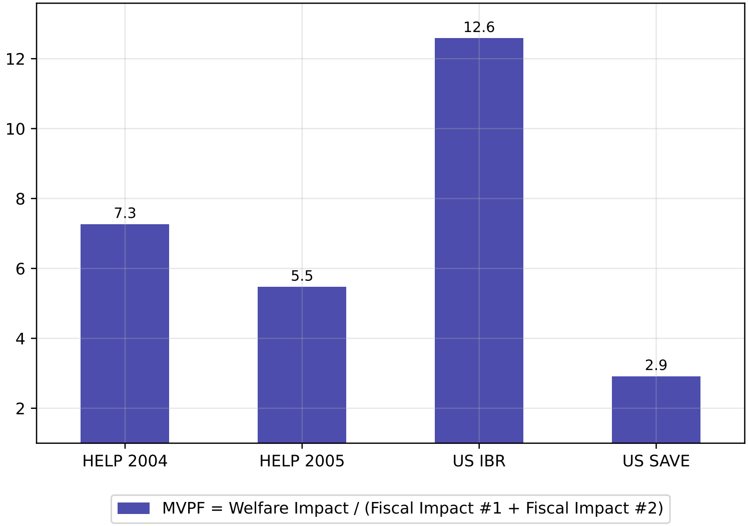
▸ Model Fit: Heterogeneity ▸ Model Fit: Other Moments ▸ Additional Results

Outline

Existing Income-Contingent Loans vs. Fixed Repayment



MVPF: Fixed Repayment → Existing Income-Contingent Loans



Constrained-Optimal Repayment Contracts

Conditional on government subsidy for higher education, what repayment contract best balances insurance with moral hazard?

- **Perspective**: social planner that maximizes borrower welfare with **one** contract
  - 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, what repayment contract best balances insurance with moral hazard?

- **Approach**: solve constrained-planner's problem:

$$\max \mathbf{E}_0 \left(V_{a_0}^{1-\gamma} \right)^{\frac{1}{1-\gamma}} \qquad \text{(behind the "veil-of-ignorance")} \tag{2}$$

Conditional on government subsidy for higher education, what repayment contract best balances insurance with moral hazard?

- **Approach**: solve constrained-planner's problem:

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

subject to: (à la Ramsey, not Mirrlees)

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

$$\tag{2}$$

Conditional on government subsidy for higher education, what repayment contract best balances insurance with moral hazard?

- **Approach**: solve constrained-planner's problem:

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

subject to:

$$\text{Repayments}_a = \min \left\{ \psi * \max \left\{ y_a - K, 0 \right\}, D_a \right\} \tag{1}$$

$$\tag{2}$$

Conditional on government subsidy for higher education, what repayment contract best balances insurance with moral hazard?

- **Approach**: solve constrained-planner's problem:

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

subject to:

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

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

Conditional on government subsidy for higher education, what repayment contract best balances insurance with moral hazard?

- **Approach**: solve constrained-planner's problem:

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

subject to:

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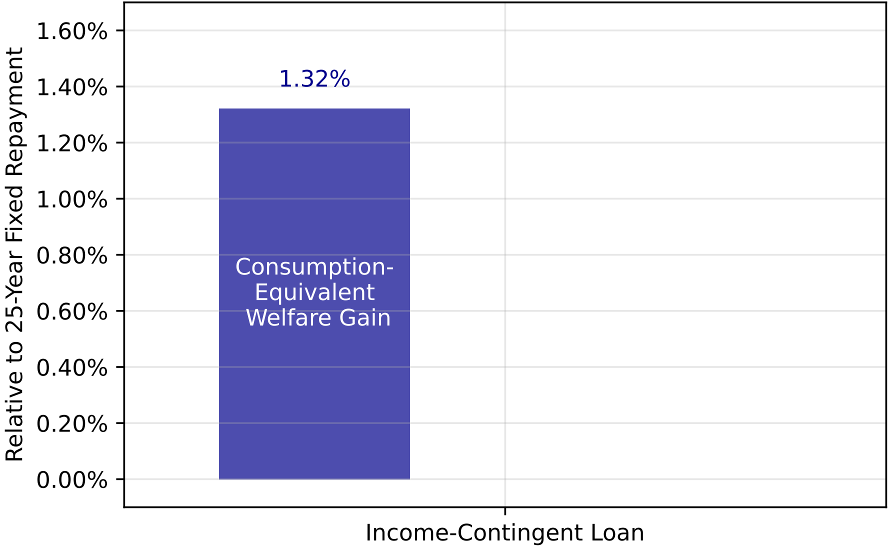
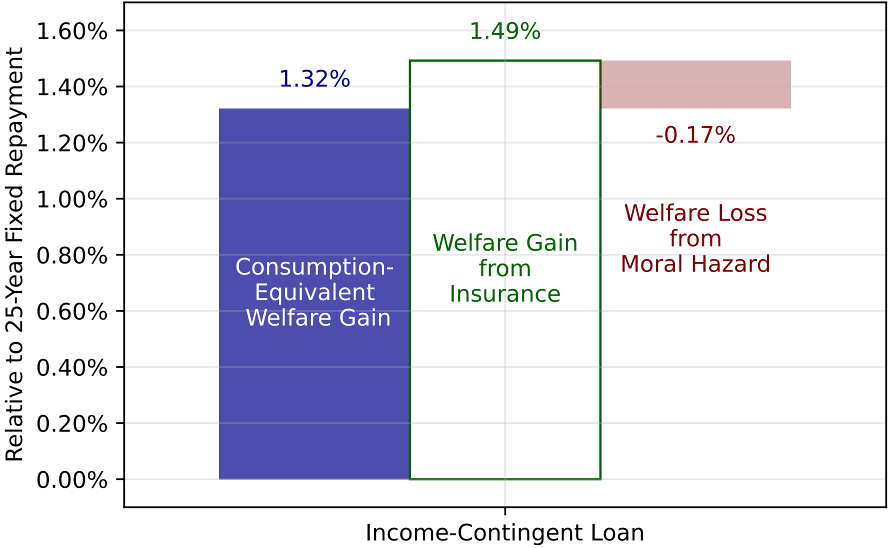
$$\mathcal{G} \equiv \mathbf{E}_0 \sum_{a=a_0}^{a_T} \frac{\text{Repayments}_a + \text{Taxes}_a - \text{Transfers}_a}{\mathcal{R}_a} \geq \mathcal{G}_{\text{25-Year Fixed}} \quad (2)$$

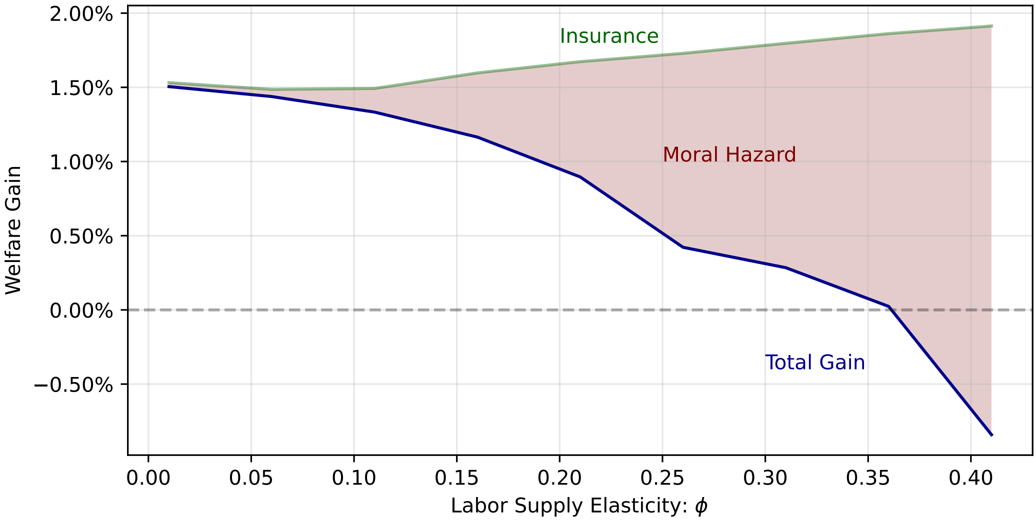
Constrained-Optimum = 1.3% Increase in Lifetime Consumption



CONSTRAINED-OPTIMUM = 1.3% INCREASE IN LIFETIME CONSUMPTION

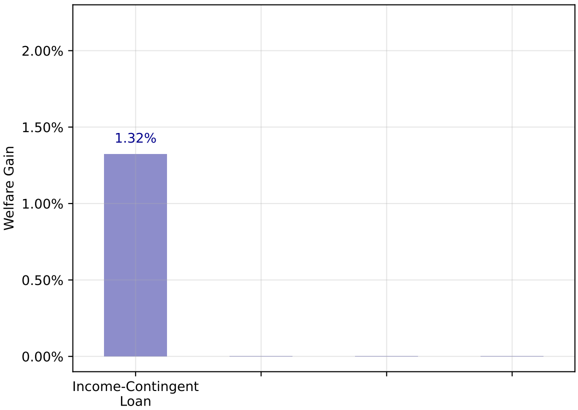


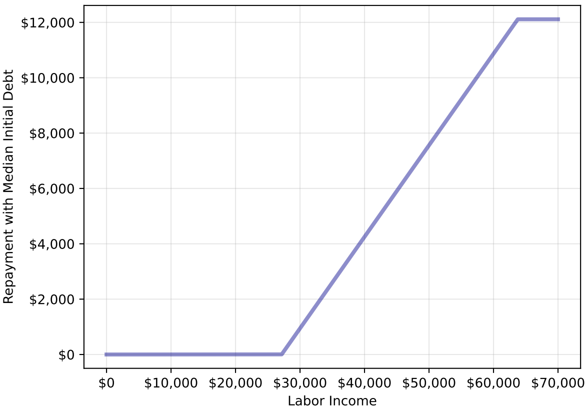
Welfare Gain is Positive as Long as $\phi < 0.37$



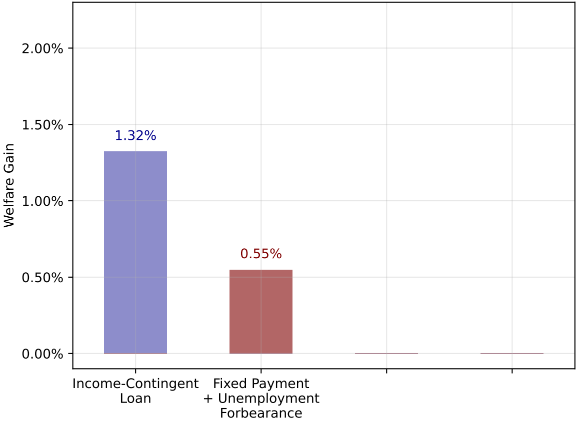
▸ Bunching at $\phi = 0.37$ ▸ Contracts to Reduce MH ▸ Robustness: Frictions ▸ Robustness: RRA + EIS

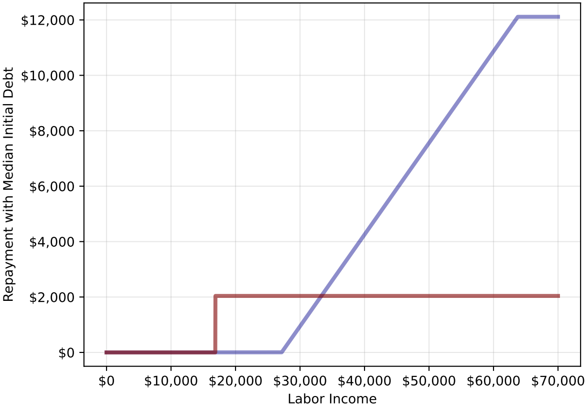
NEXT: ICLS VS. OTHER CONSTRAINED-OPTIMAL CONTRACTS...





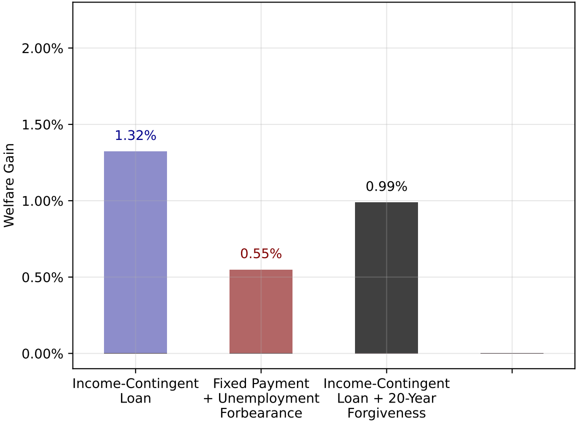
Just Providing Forbearance Gives Smaller Gains

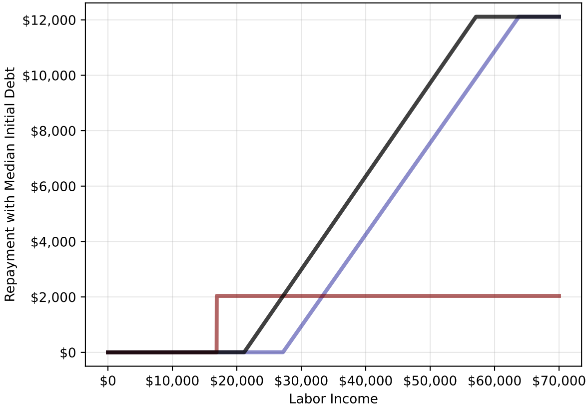




- **Benefit** of income-contingent loan: accelerate payments from high-income

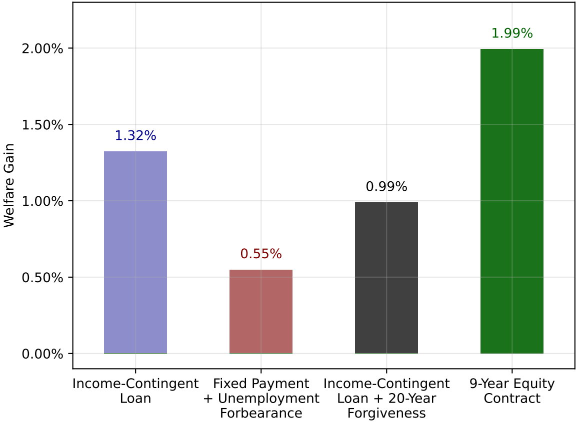
Adding Forgiveness Reduces Welfare Gains

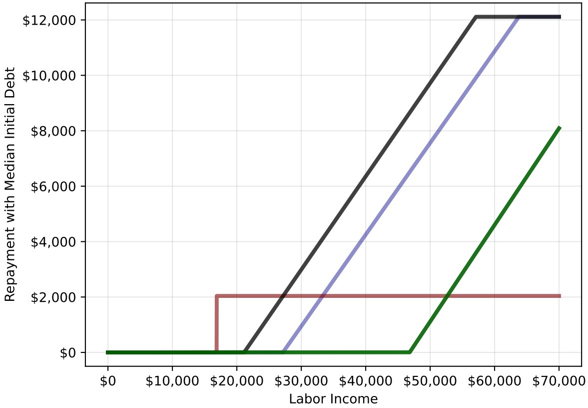




- **Costs** of forgiveness: transfer repayments to young and finite repayment horizon

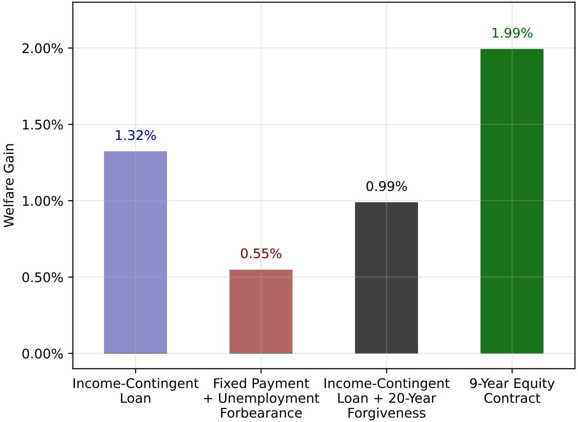
Equity Contract Gives Larger Gains

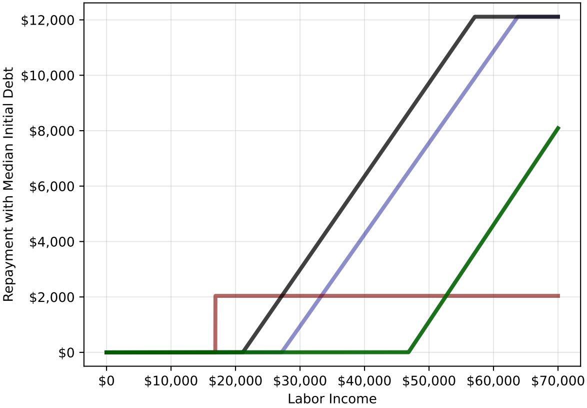




- **Benefit** of equity: uncapped payments from high-income ⇒ 70% higher threshold

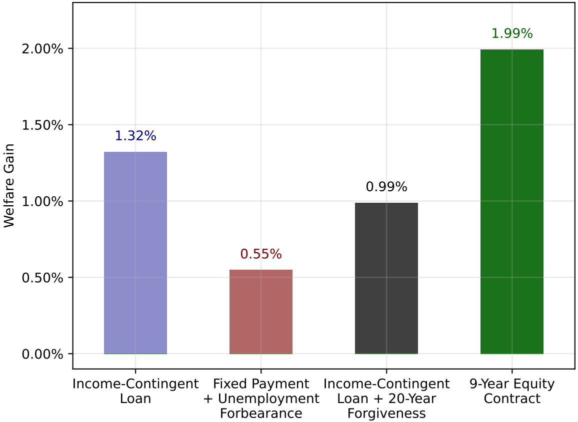
Equity Contract Gives Larger Gains, But More **Dispersed**

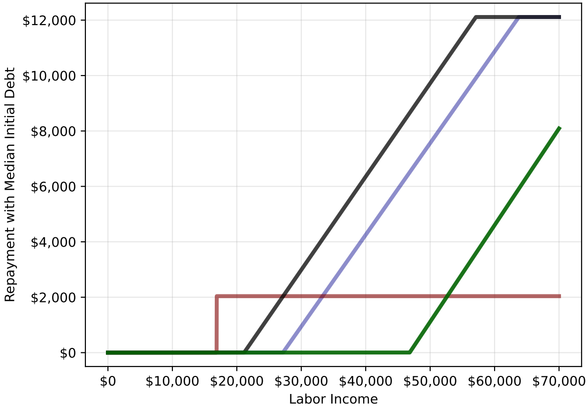




- **Cost** of equity: more likely to cause losses from **ex-ante** responses and **selection**

Equity Contract Gives Larger Gains, But More **Dispersed**





- **Cost** of equity: more likely to cause losses from **ex-ante** responses and **selection**

Heterogeneity
Additional Results

Outline

The Big Picture

- 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 are relatively 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: government-provided shared-appreciation mortgages (UK, Canada)
  - Firms: revenue-based financing

Thank You!

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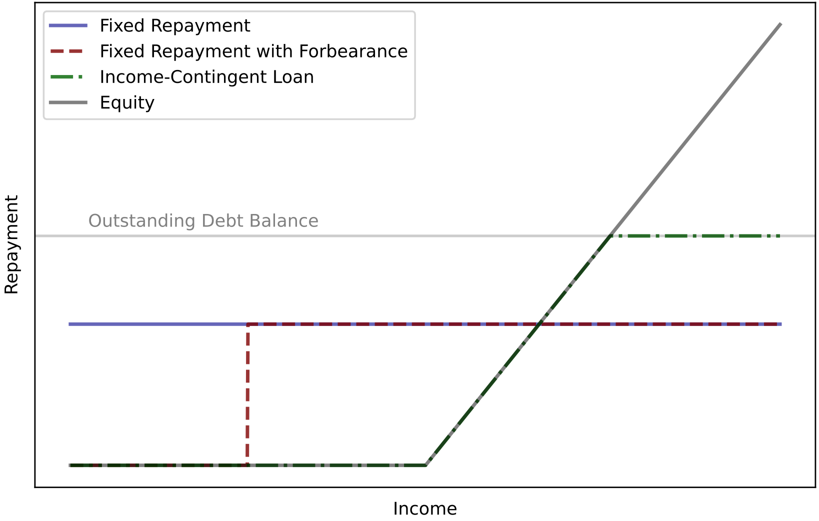
APPENDIX

START OF APPENDIX

Illustration of Different Repayment Contracts



Back: Introduction
Back: This Paper
Back: Main Results

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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   - Income-contingent loans $\Rightarrow \downarrow$ delinquencies Herbst 2023, $\downarrow$ defaults Mueller-Yannelis 2019

Contributions:

1. Empirical evidence of moral hazard from income-contingent repayment Britton-Gruber 2020, Herbst et al. 2023
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, ...

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

Data

1. Universe of individual tax returns from Australian Tax Office ($\sim$ US Form 1040)
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4. Administrative retirement savings data: superannuation balances
5. HILDA: survey data on hours worked and asset holdings

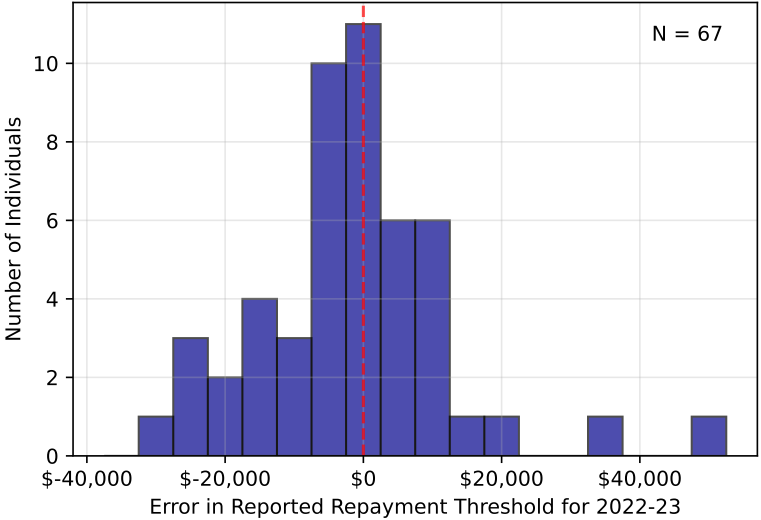
Sample: $\sim$ 4 million unique debtholders between ages 20-64 from 1991-2018

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

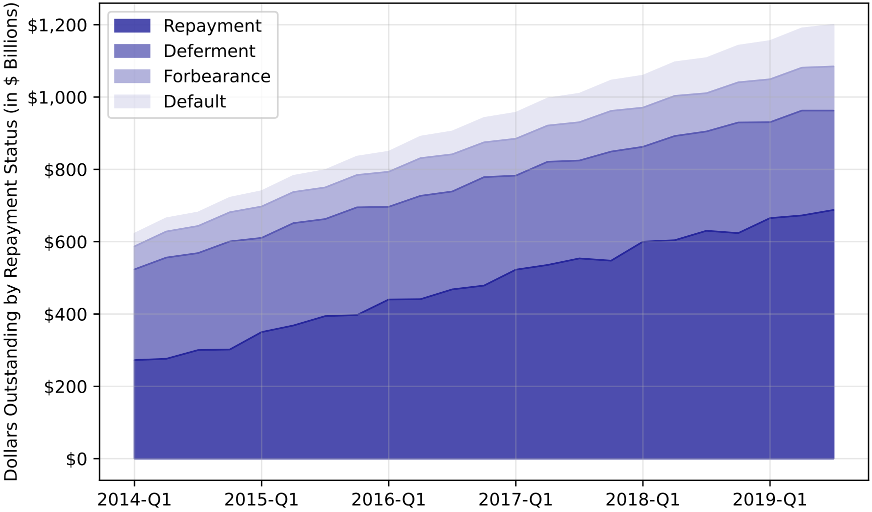
Limitation: no information about borrowing (e.g., degree, institution)

▸ Summary Stats ▸ Debt by Age ▸ Debt Repay

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 $\Rightarrow$ 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

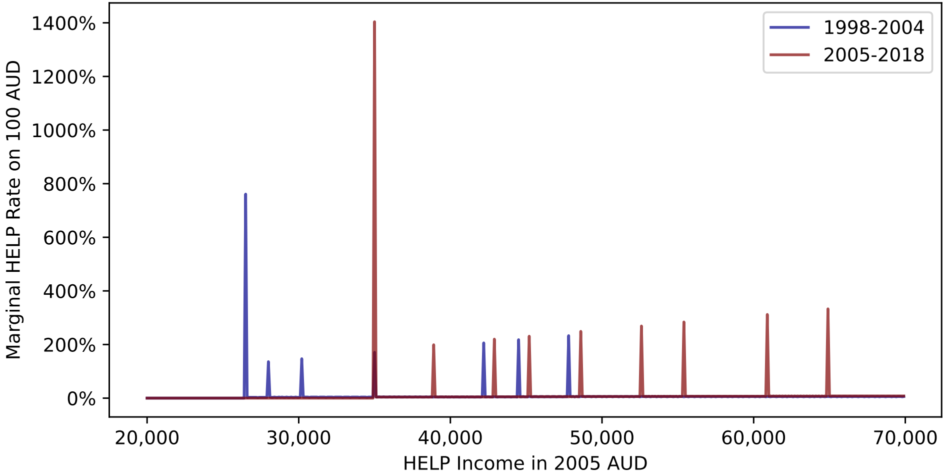
Statistics Back

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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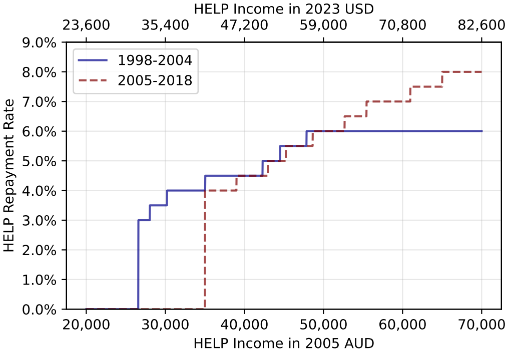
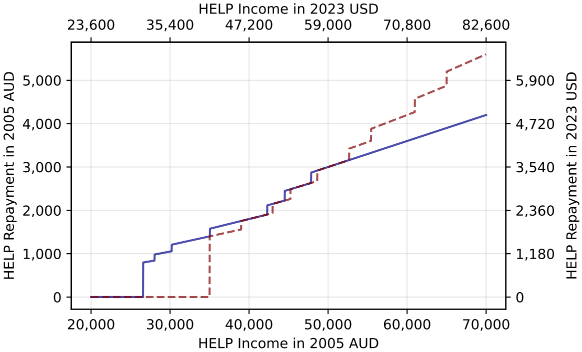
HELP Repayment Rates and Repayments





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News Article: Policy Change

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Politics

Print article

Ease HECS burden on students, say universities

Kate Marshall

Jan 9, 2003 – 11.00am

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

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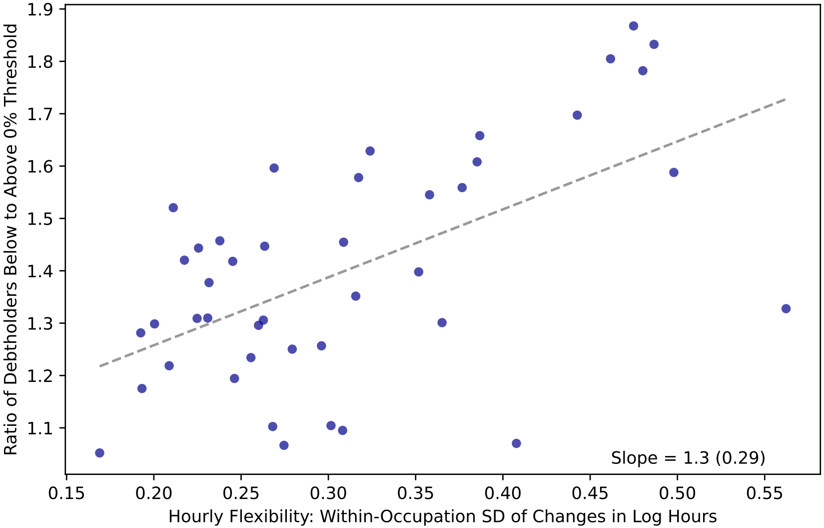
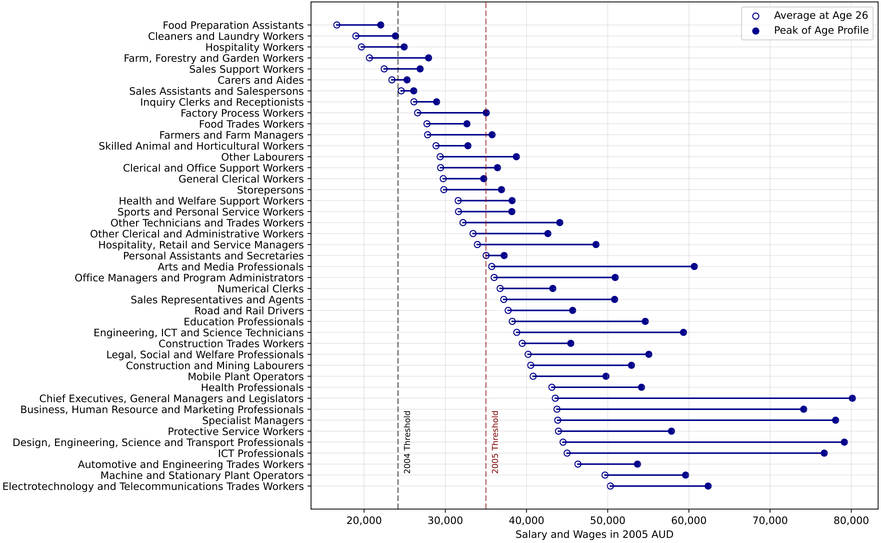
More Bunching in Occupations with Greater Hourly Flexibility



Sample: all wage-earners between 2005-2018

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

Occcupation-Specific Income Profiles Relative to Thresholds



Back: Policy Back: Hours Back: Table

Summary Statistics

	Non-Debtholders (1)	Debtholders (2)
Demographics		
Age	41.1	29.5
Female	0.46	0.60
Wage-Earner	0.85	0.91
Income Totals (in 2005 AUD)		
Taxable Income	37,695	27,796
HELP Income	38,756	28,586
Income Components (in 2005 AUD)		
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
HELP Variables		
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

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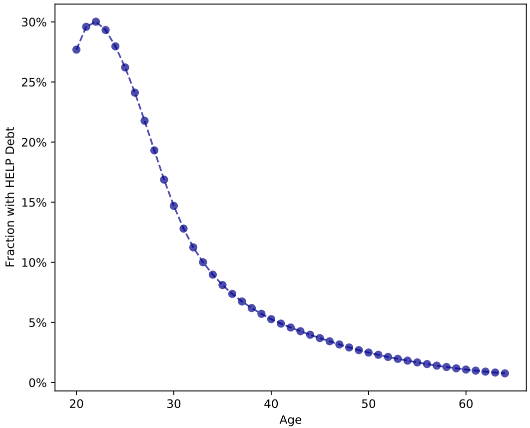
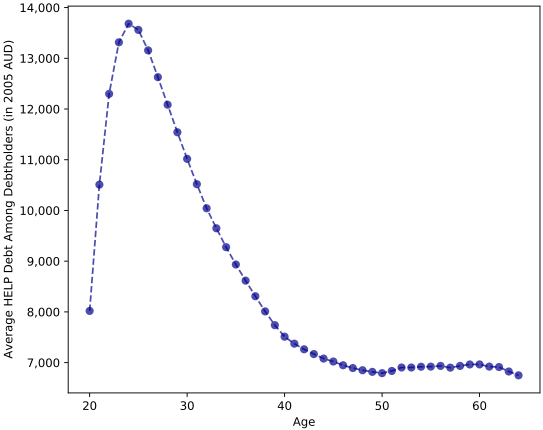
Debt Balances by Age





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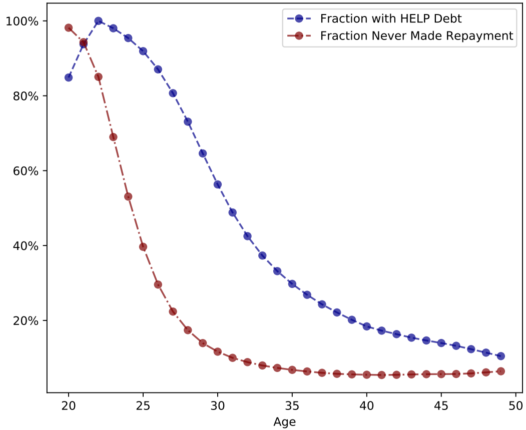
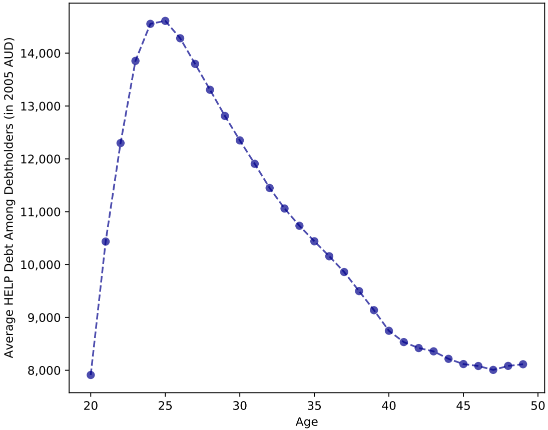
Debt Balances by Age: Individuals with Positive Debt at Age 22





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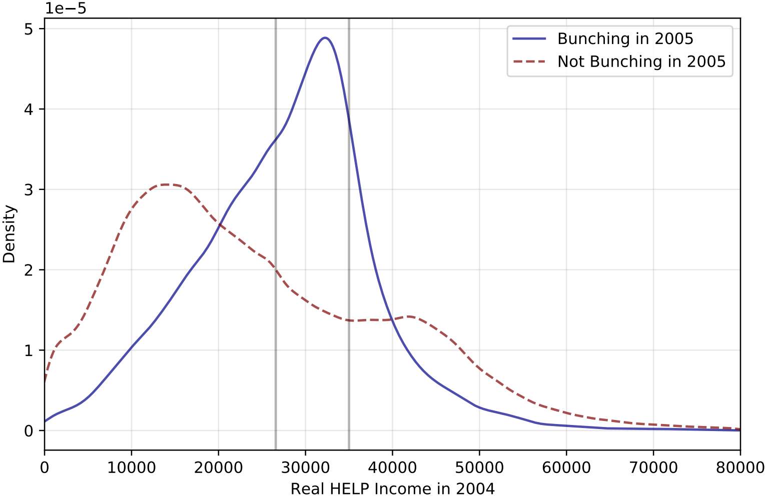
New Bunching Comes from Between Old and New Thresholds



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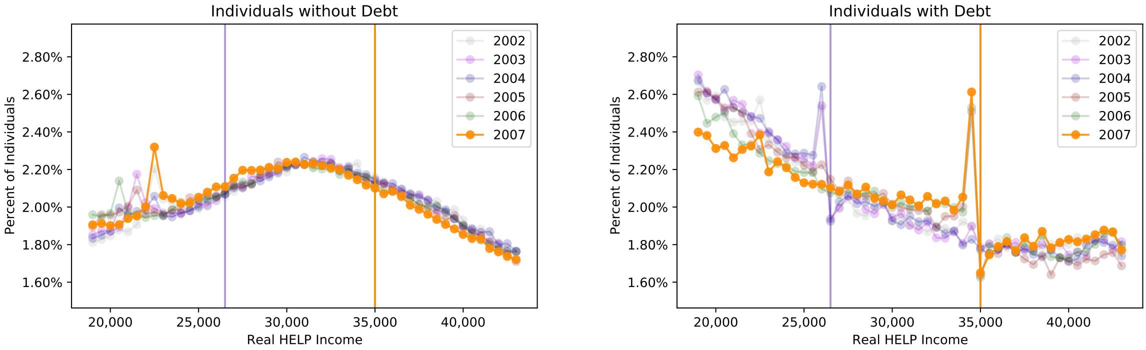
No Bunching at Repayment Threshold for Non-Debtholders



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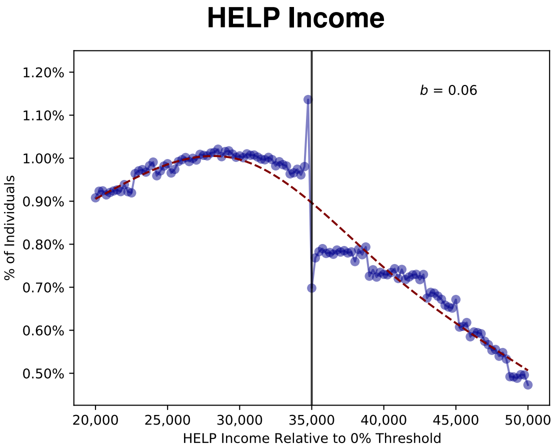
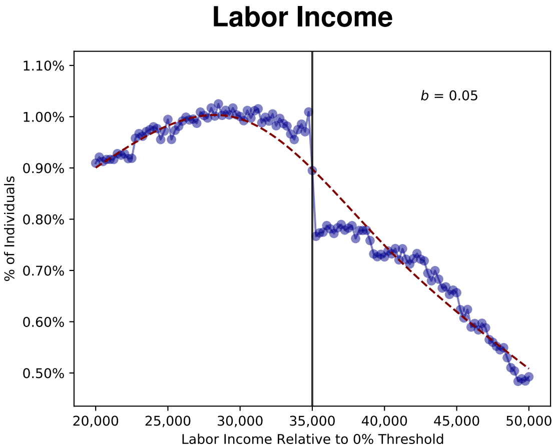
Bunching in Labor Income = 83% of Bunching in HELP Income





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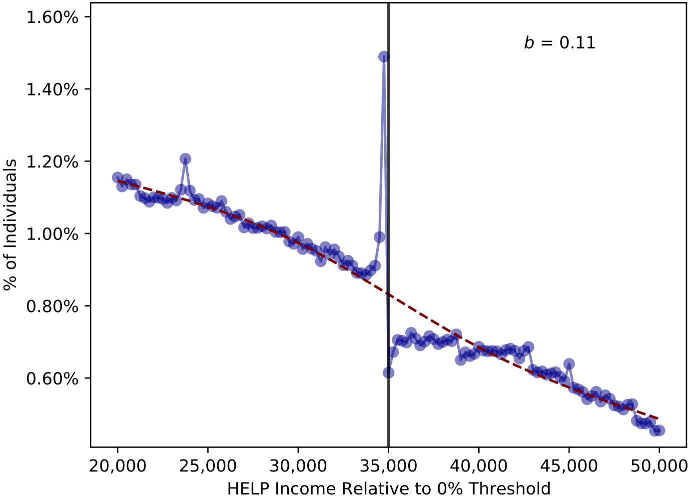
Bunching at Threshold is Larger than at Tax Kink: 2016



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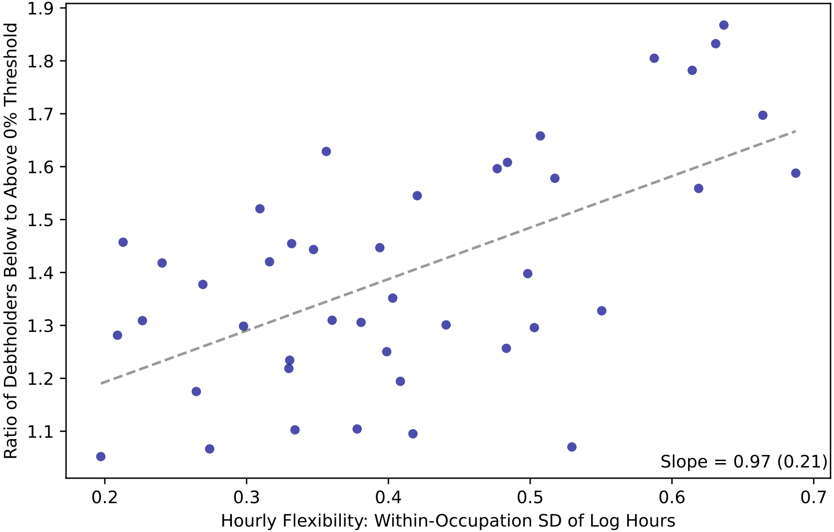
Alternative Measure of Hourly Flexibility



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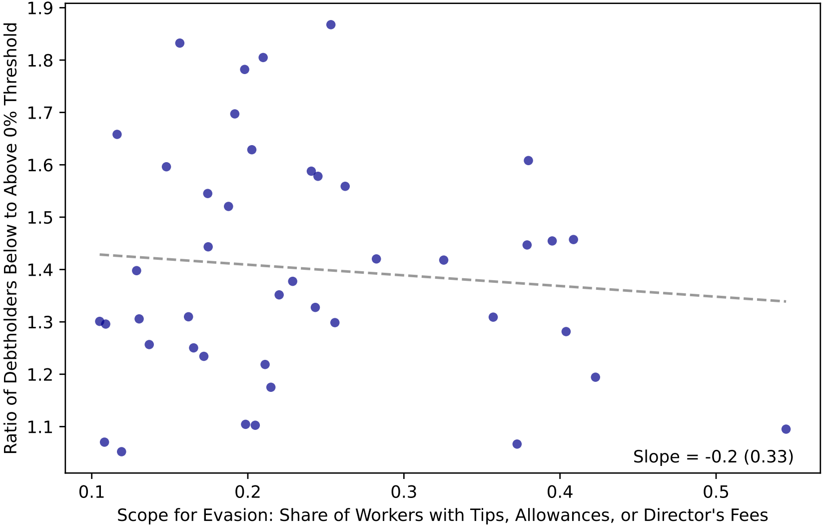
Bunching Uncorrelated with Measure of Evasion



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

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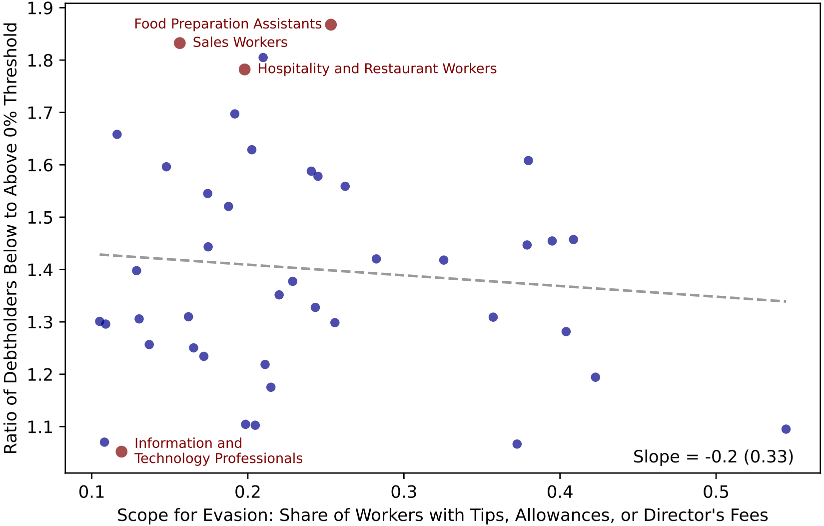
Bunching Uncorrelated with Measure of Evasion



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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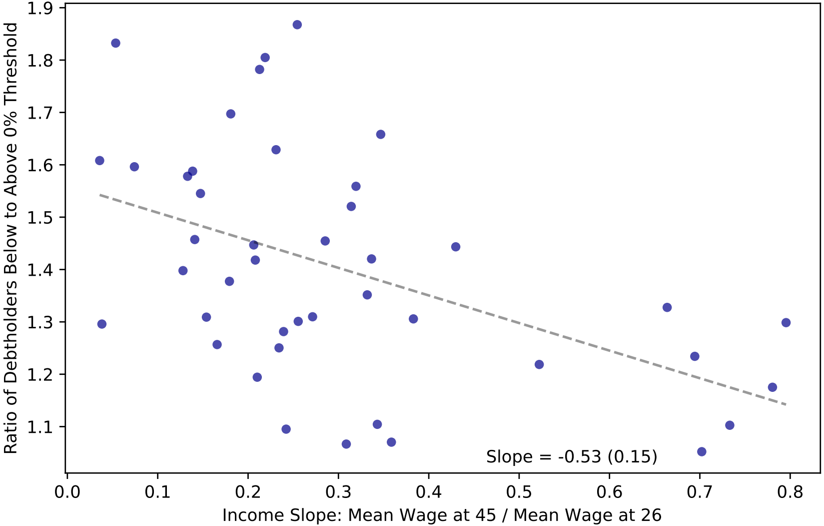
Bunching Decreases with Expected Wage Growth



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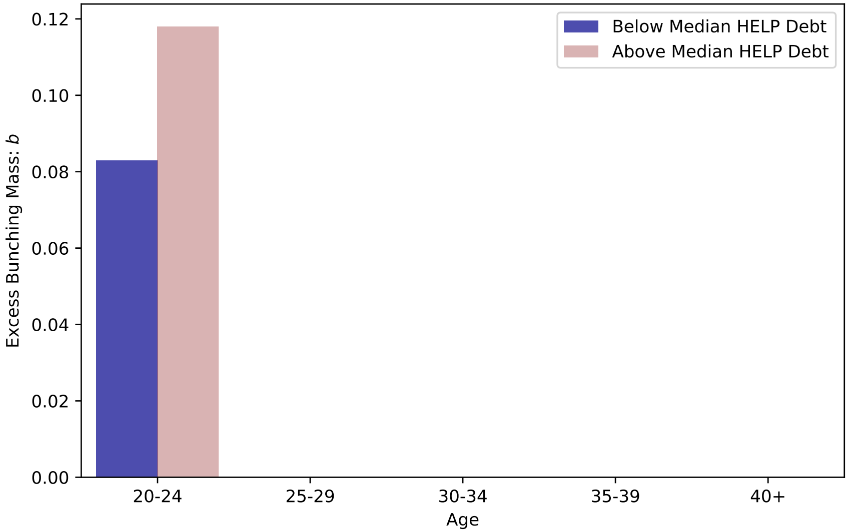
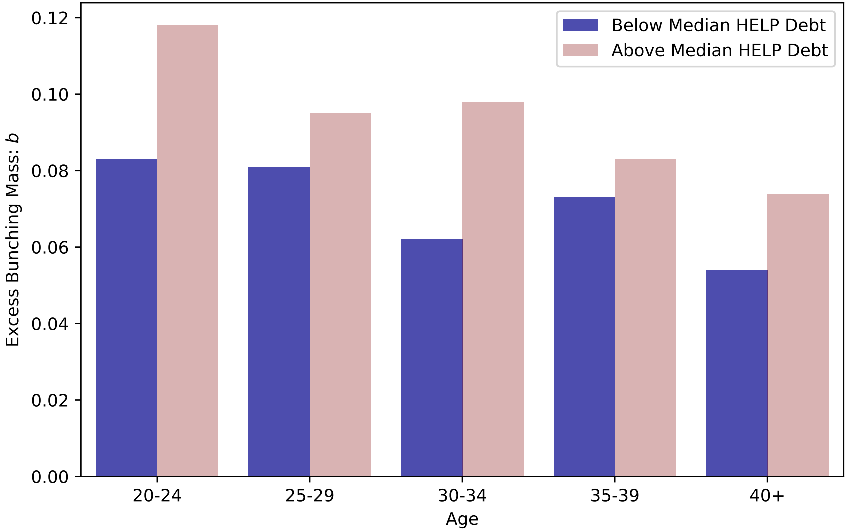
Bunching Increases with Debt Balances



Note: confidence intervals omitted due to small size

▸ b Details ◂ Back

Bunching Increases with Debt Balances



Note: confidence intervals omitted due to small size

b Details
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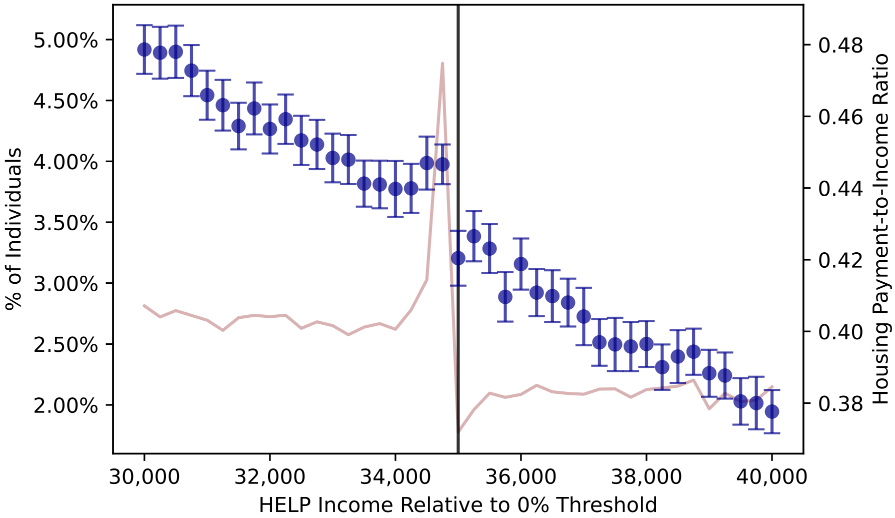
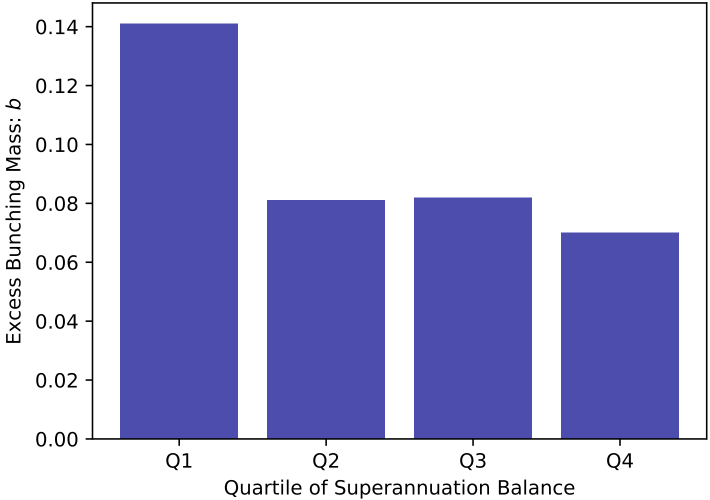
Bunching Increases with Proxies for Liquidity Constraints



▸ Retirement Savings ▸ House Prices ◂ Back

Bunching Decreases with Superannuation Balances



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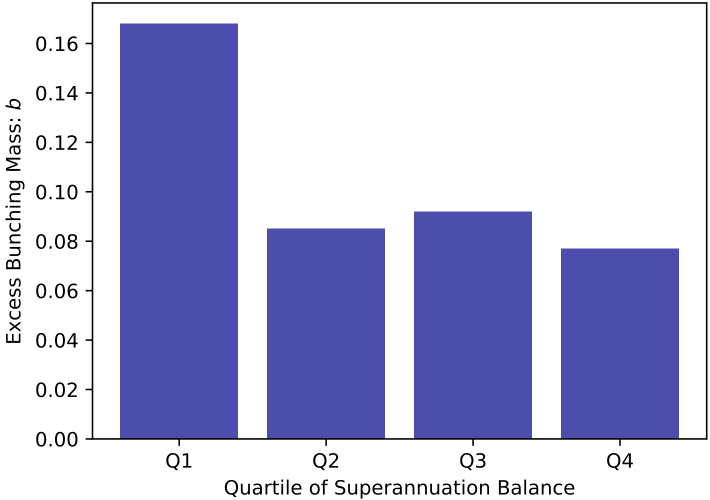
Bunching Heterogeneity by Super Wealth: Ages 20-29



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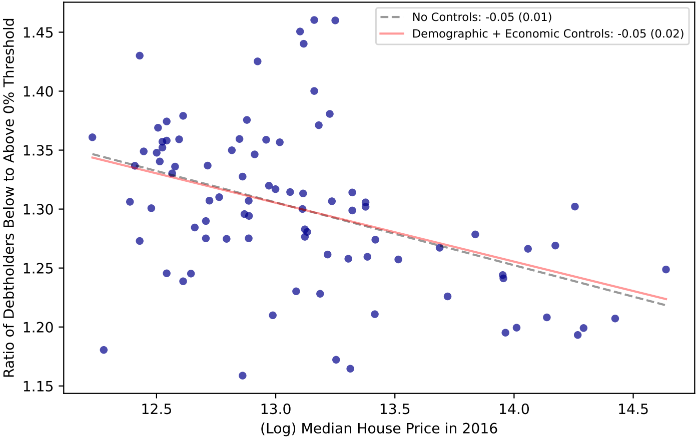
Less Bunching in Regions with More Housing Wealth



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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

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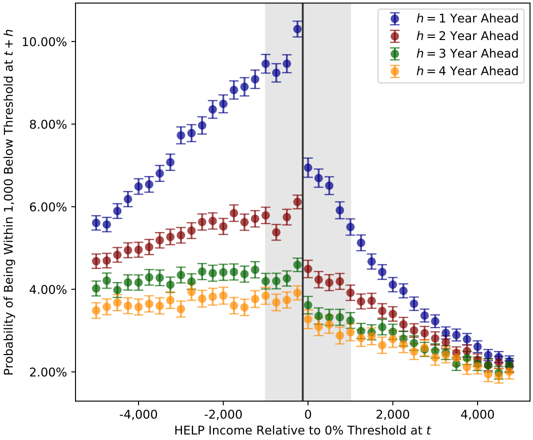
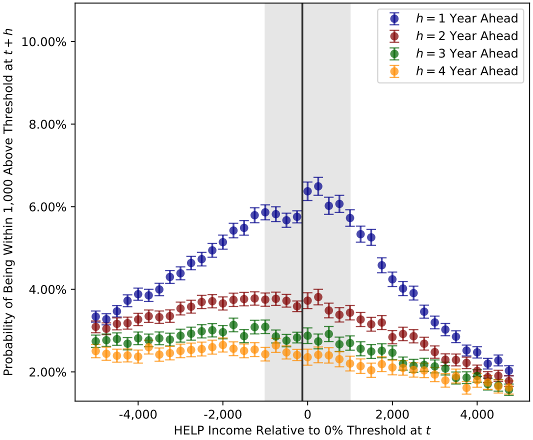
Persistence of Bunching Lasts around Three Years





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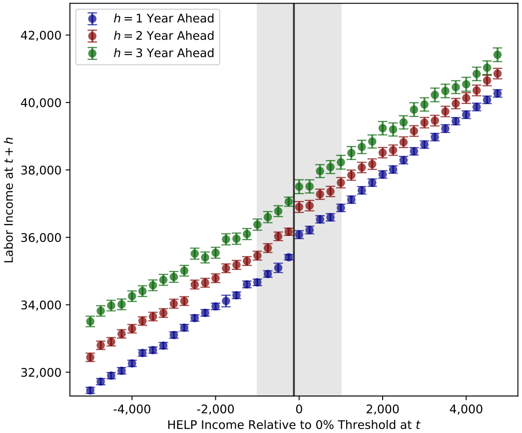
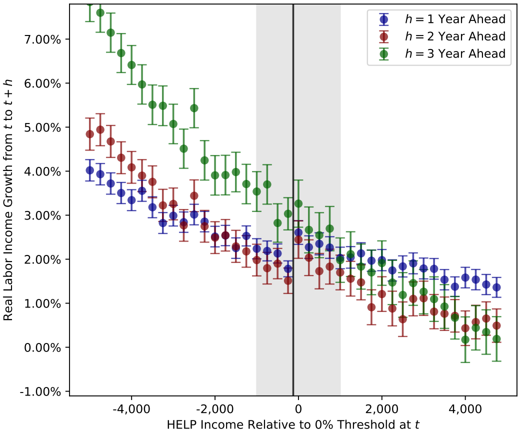
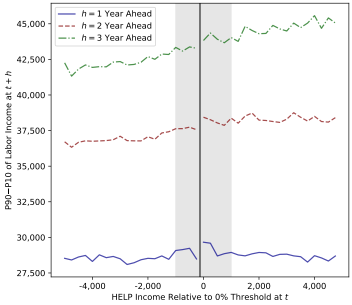
Limited Evidence of Dynamic Cost to Bunching

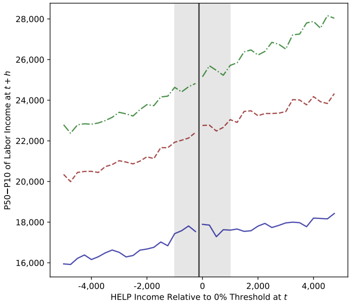


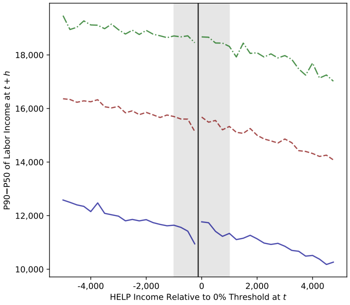


▸ Distribution ◂ Back

Little Difference in Distribution of Future Income







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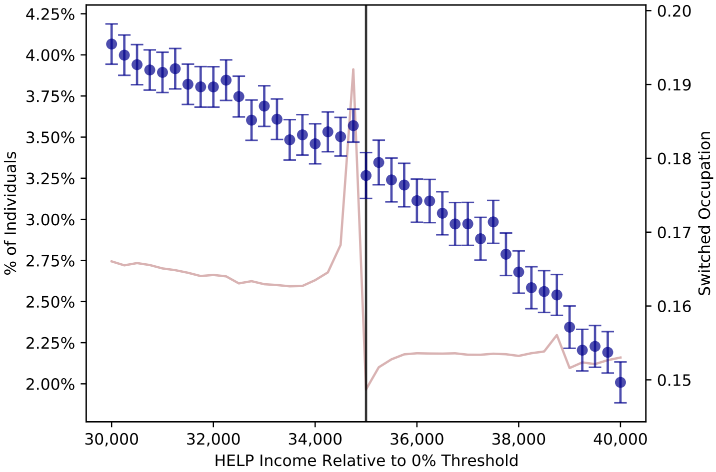
No Discontinuity in the Probability of Switching Occupations



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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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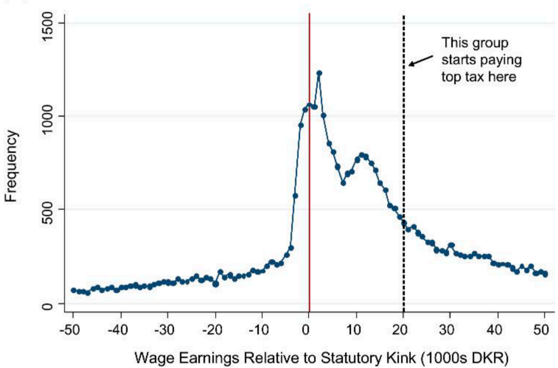
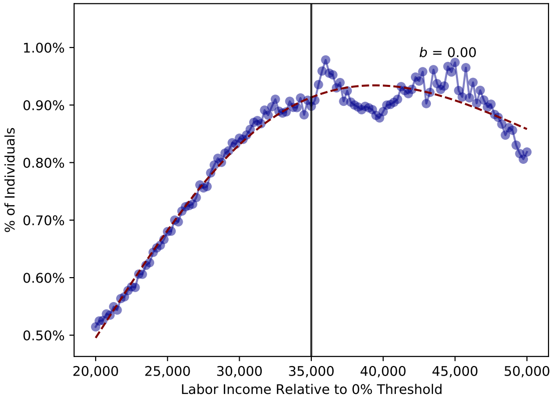
Chetty et al: Teacher Wages



Borrower Labor Income



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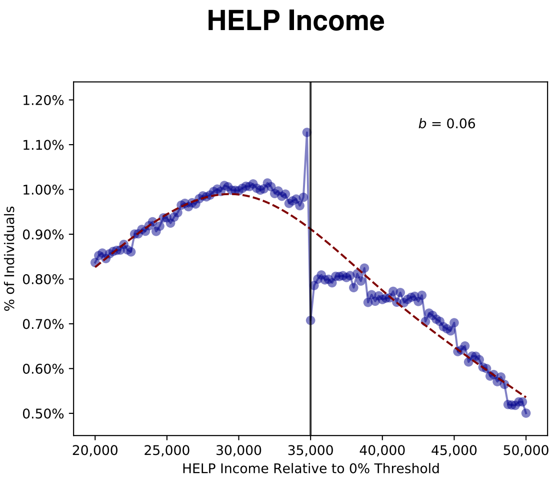
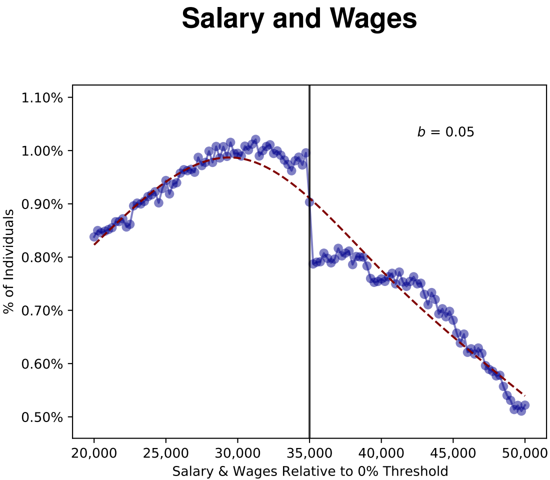
Bunching in Distribution of Salary and Wages





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First-Stage Calibration

- **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 and EIS**: $\gamma = \frac{1}{\sigma}$ = 2.23 (Choukhmane-de Silva 2023)
  - Welfare analysis: consider alternative values $+$ preference for early resolution

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- **Learning-by-doing extension**: $\alpha = 0.24$ (median value from Best-Kleven 2013)
-

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Elasticity of Moments with Respect to Parameters

	ϕ	f	λ
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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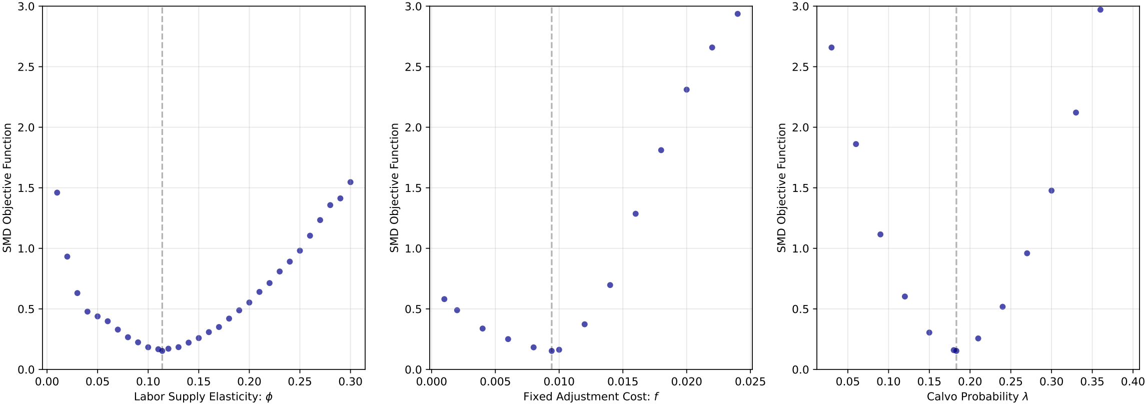
SMM Objective is Smooth in Labor Supply Parameters



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Simulated Minimum Distance: Other Moments

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

- 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 $\Rightarrow$ β
- Average labor supply $\Rightarrow$ κ

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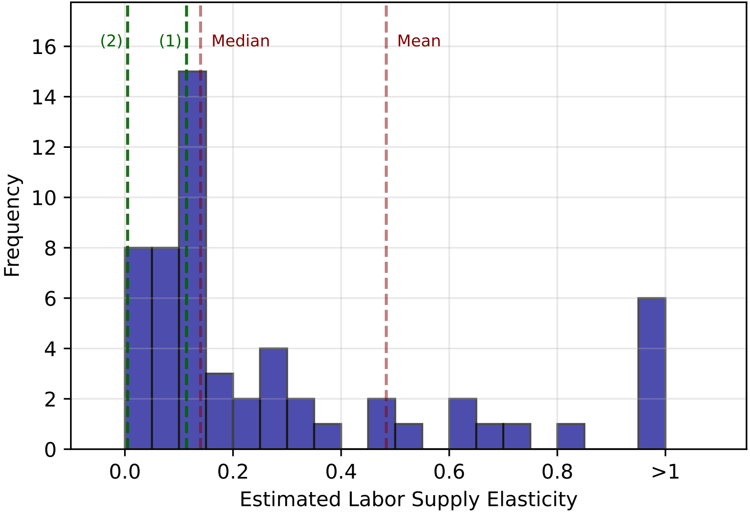
Comparison with Existing Literature on Labor Supply (1/2)



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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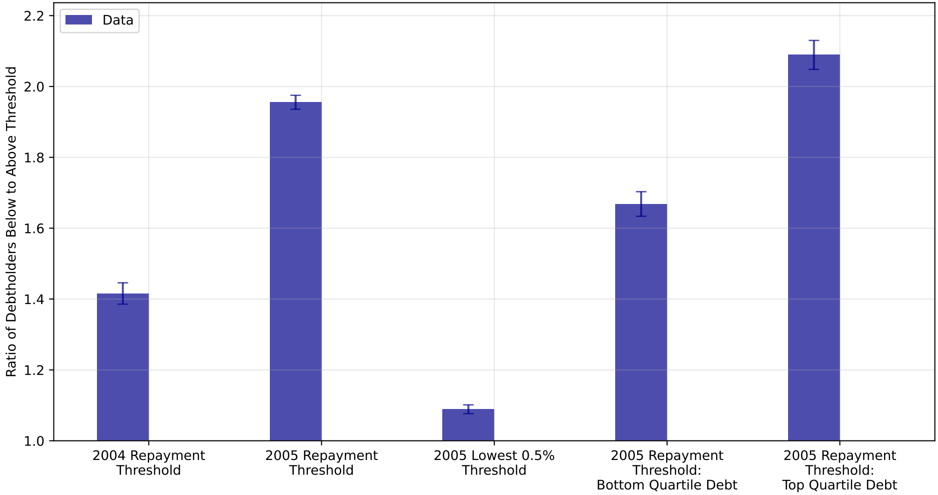
Full Estimation Results

Parameter		Estimation (1)	(2)	(3)	(4)	(5)	(6)	(7)
Labor supply elasticity	ϕ	0.114	0.005	0.188	0.053	0.082	0.111	0.067
		(.004)	(.000)	(.003)	(.002)	(.002)	(.004)	(.002)
Adjustment cost	f	\$377	\$0	\$2278	\$0	\$762	\$513	\$848
		(\$13)	.	(\$21)	.	(\$10)	(\$19)	(\$11)
Calvo probability	λ	0.183	1	1	0.147	0.346	0.191	0.266
		(.003)	.	.	(.002)	(.009)	(.003)	(.005)
Scaling parameter	κ	0.560	0.030	0.059	0.510	1.242	0.593	0.448
		(.007)	(.003)	(.014)	(.012)	(.116)	(.001)	(.001)
Time discount factor	β	0.973	0.996	0.972	0.944	0.951	0.951	0.946
		(.001)	(.000)	(.001)	(.001)	(.001)	(.001)	(.001)
Wage profile parameters	δ_0	8.922	9.862	8.680	9.389	9.197	9.143	9.211
		(.009)	(.002)	(.006)	(.007)	(.007)	(.008)	(.008)
	δ_1	0.073	0.111	0.073	0.063	0.070	0.075	0.074
		(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
	δ_2	−0.001	−0.002	−0.001	−0.001	−0.001	−0.001	−0.001
		(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
	δ_0^E	−0.487	−0.294	−0.450	−0.530	−0.480	−0.478	−0.505
		(.002)	(.000)	(.001)	(.002)	(.002)	(.002)	(.002)
	δ_1^E	0.020	0.032	0.018	0.021	0.018	0.020	0.021
		(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Persistence of permanent shock	ρ	0.930	0.914	0.943	0.922	0.889	0.907	0.931
		(.000)	(.000)	(.000)	(.000)	(.000)	(.001)	(.001)
Std. deviation of permanent shock	σ_ν	0.236	0.076	0.196	0.268	0.288	0.275	0.246
		(.000)	(.000)	(.000)	(.000)	(.000)	(.001)	(.001)
Std. deviation of transitory shock	σ_ϵ	0.130	0.504	0.168	0.077	0.064	0.080	0.116
		(.000)	(.000)	(.000)	(.002)	(.002)	(.002)	(.001)
Std. deviation of individual FE	σ_i	0.599	0.101	0.541	0.654	0.625	0.612	0.632
		(.003)	(.001)	(.003)	(.003)	(.003)	(.003)	(.003)
Learning-by-doing parameter	α	0	0	0	0	0.24	0	0
Adjustment cost function		Fixed	Fixed	Fixed	Fixed	Fixed	Linear	Fixed
Misperception of debt payoff		No	No	No	No	No	No	Yes

Back: Estimation
Back: Additional

Model Fit: Bunching Heterogeneity



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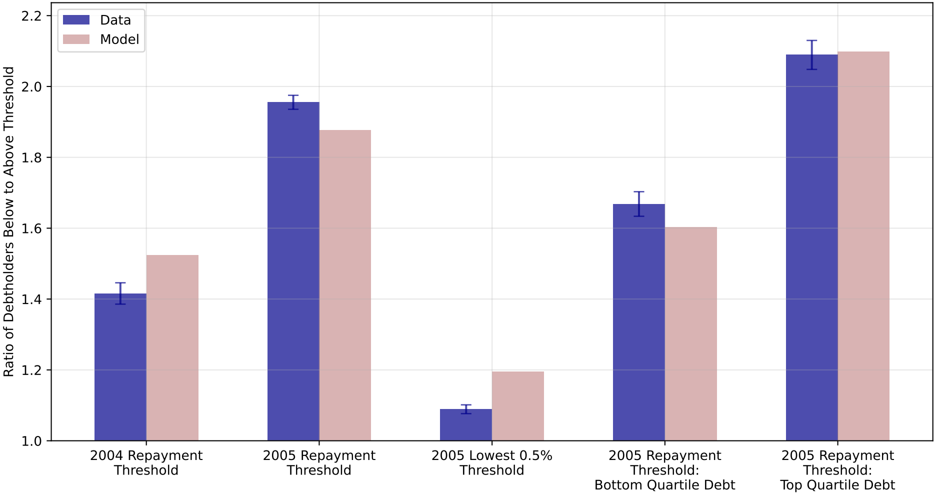
Model Fit: Bunching Heterogeneity



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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**: $\widehat{\phi} = 0.111$ 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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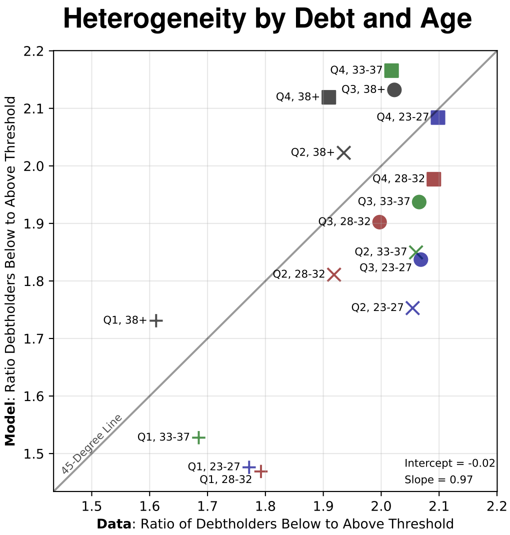
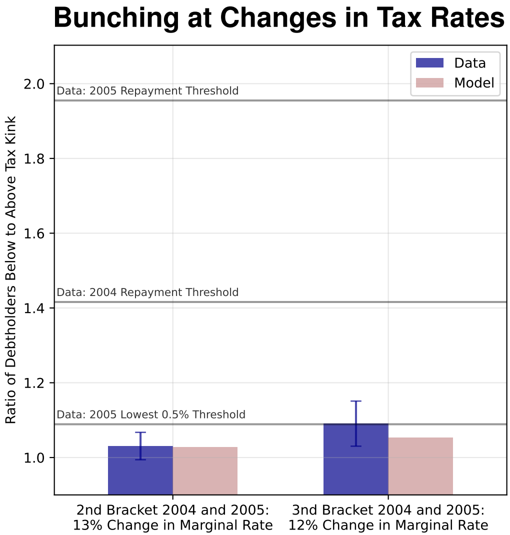
Validation of Baseline Model on Nontargeted Bunching





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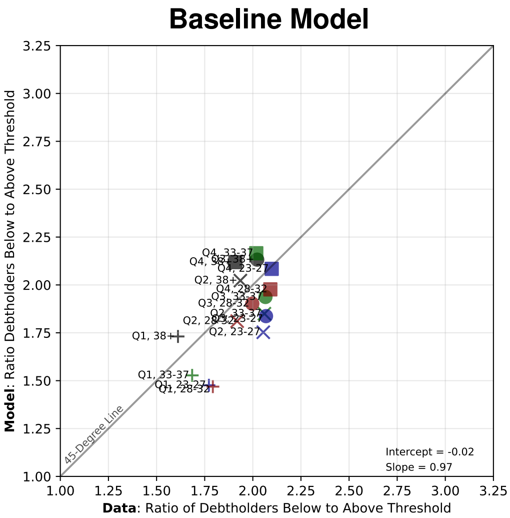
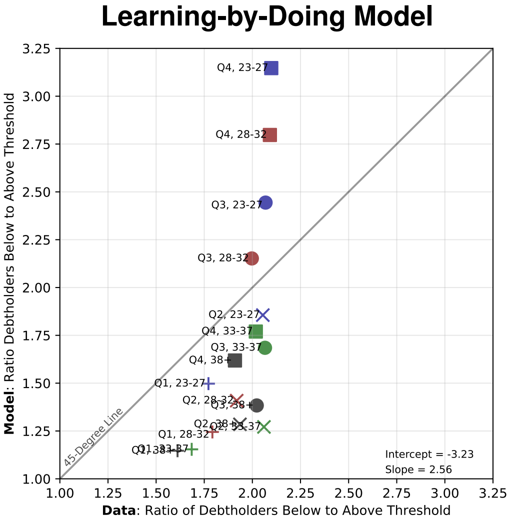
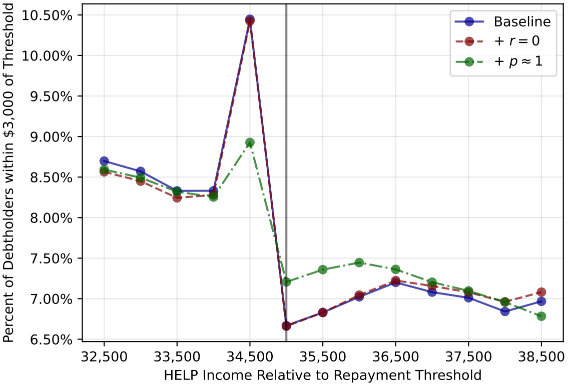
Learning-by-Doing Model Fits Worse than Baseline Model

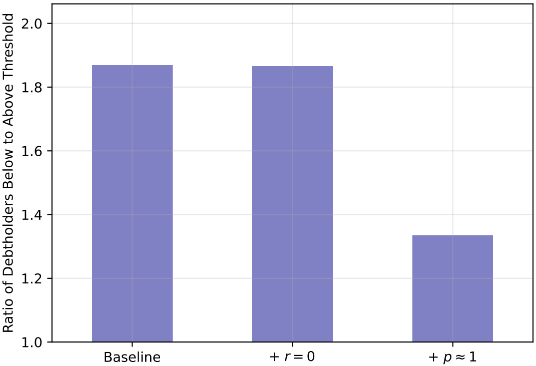




◂ Back

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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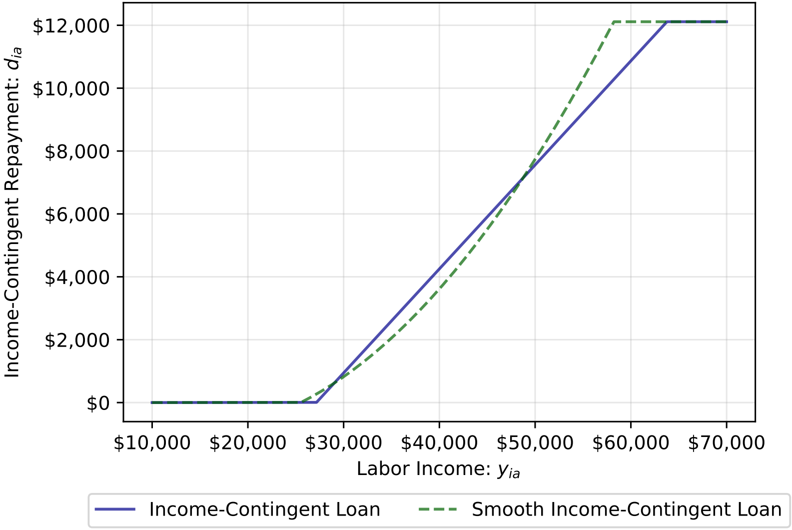
Solution to Constrained-Planner's Problem: Quadratic



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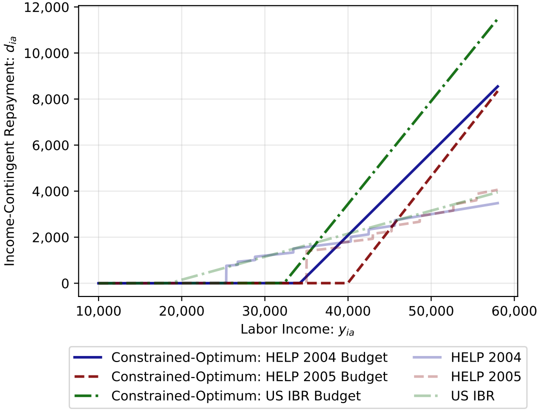
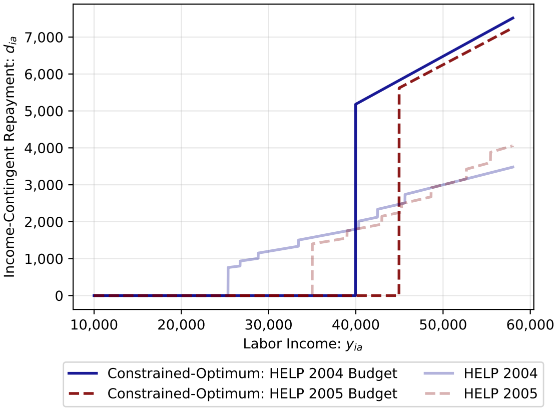
Change in Marginal Rate



Change in Average Rate



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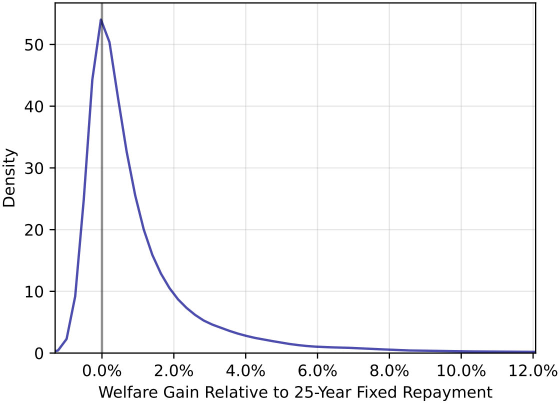
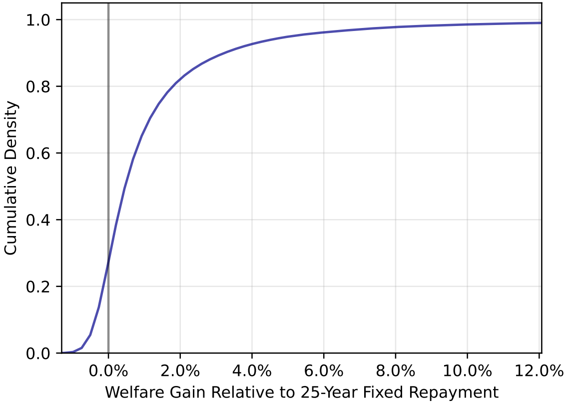
Distribution of Initial Welfare Gains: ICL

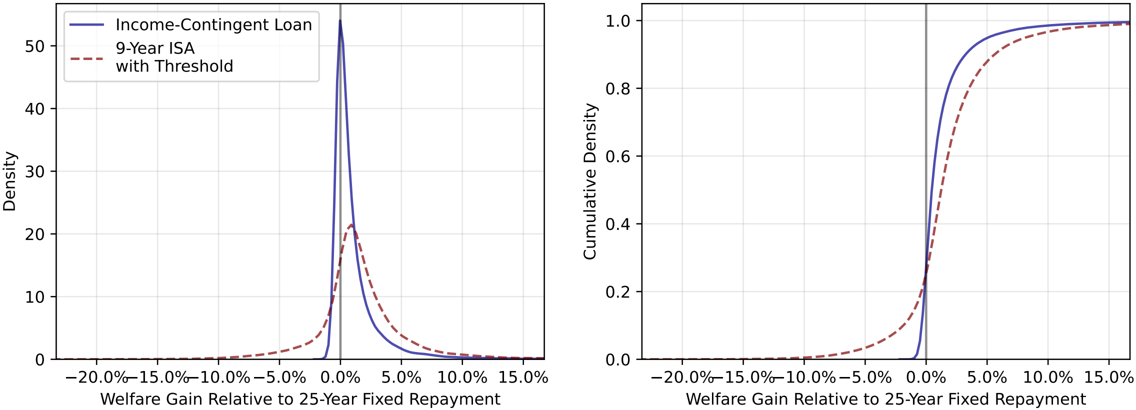




- Only **1.2%** of borrowers have welfare loss above 0.5%

▸ Heterogeneity by Initial States ▸ Losers ▸ Heterogeneity by Age ◂ Back

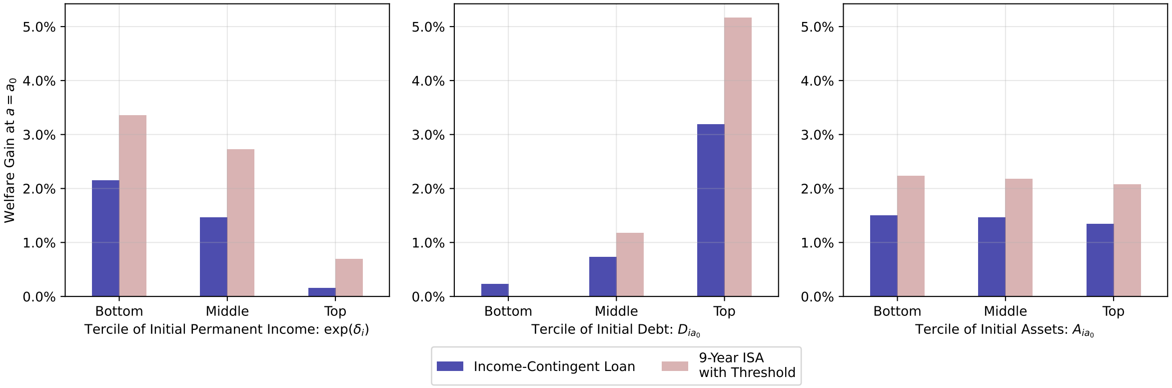
Distribution of Initial Welfare Gains: ICL vs. Equity



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

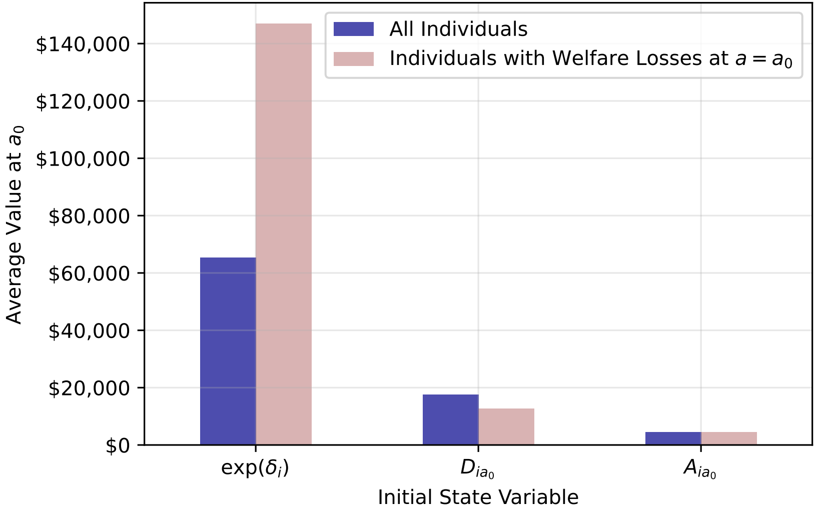
▸ Heterogeneity by Initial States ◂ Back

Heterogeneity in Welfare Gains across Initial States



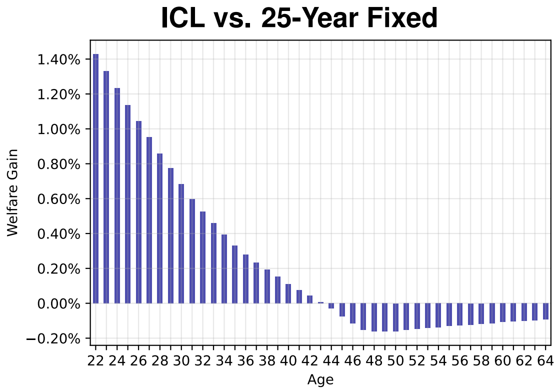
Losers under ICL | Heterogeneity by Age | Heterogeneity by Initial Debt | Back: ICL Gain | Back: Contracts

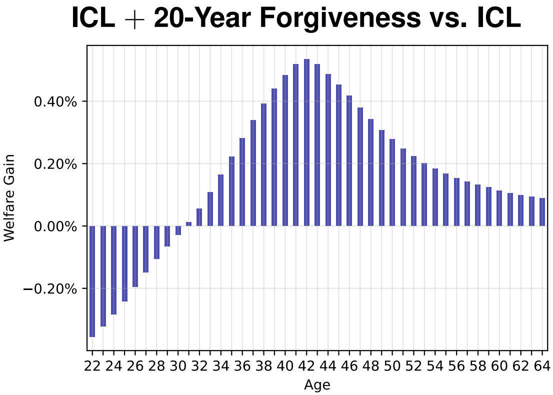
Individuals with Initial Welfare Losses: ICL



▸ Heterogeneity by Age
◂ Back: ICL Gain
◂ Back: Contracts

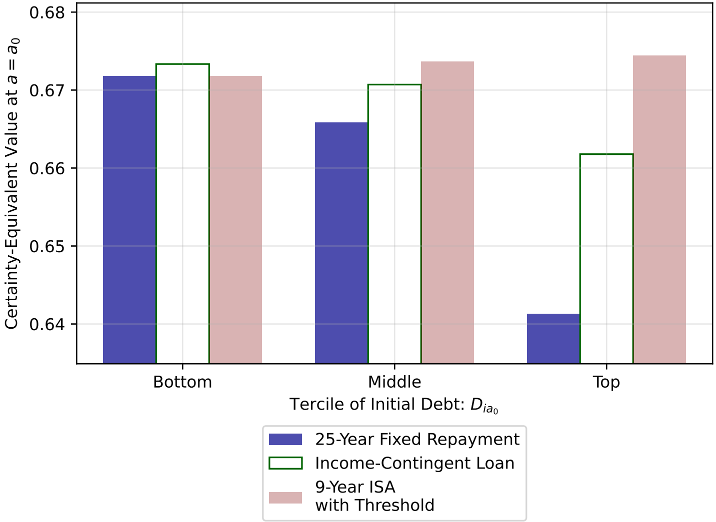
Welfare Gains by Age





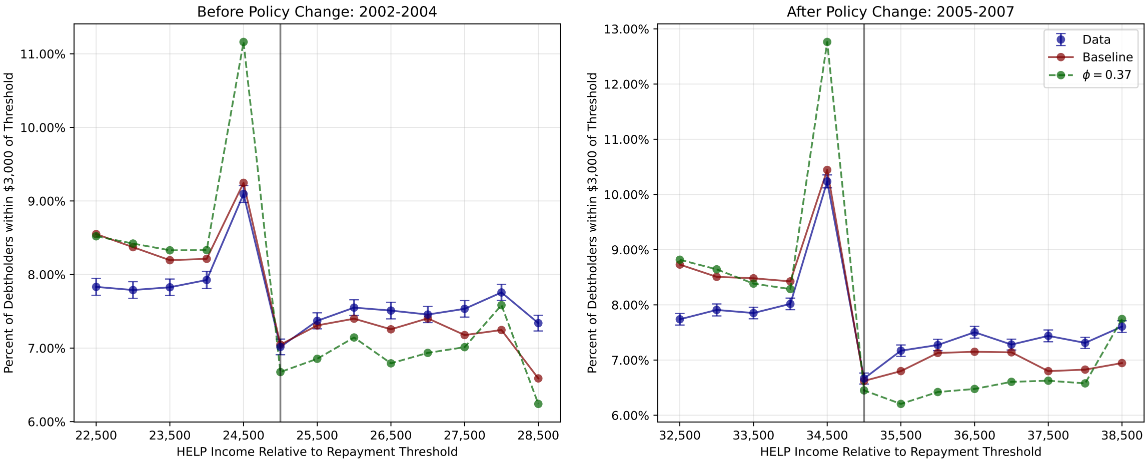
Back: ICL Gain Back: Contracts

Certainty-Equivalents across Initial Debt



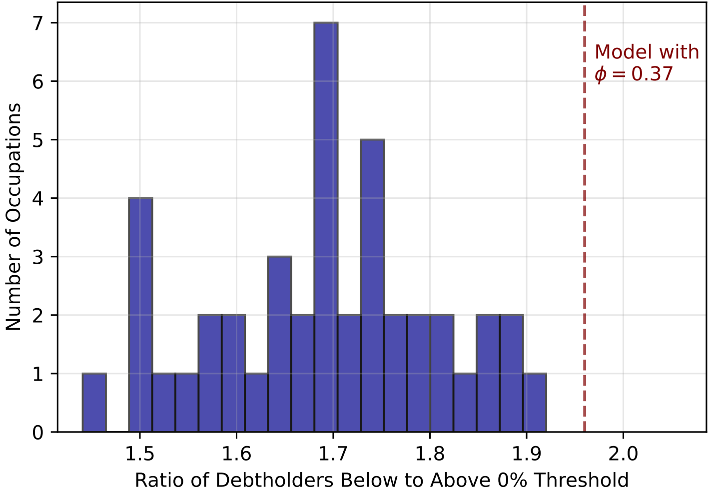
Back: ICL Gain Back: Contracts

Fit of Model in which Fixed Repayment is Optimal



▸ Occupations ◂ Back

Bunching when Fixed Repayment is Optimal vs. Occupations



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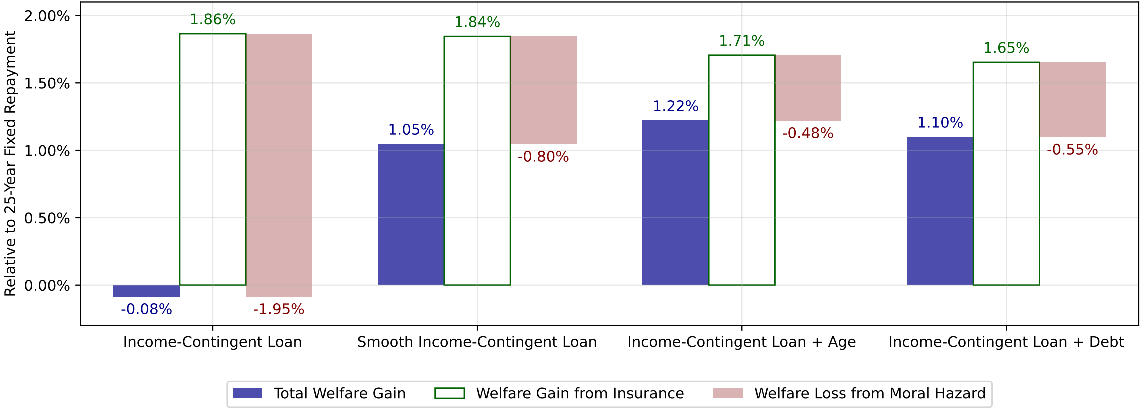
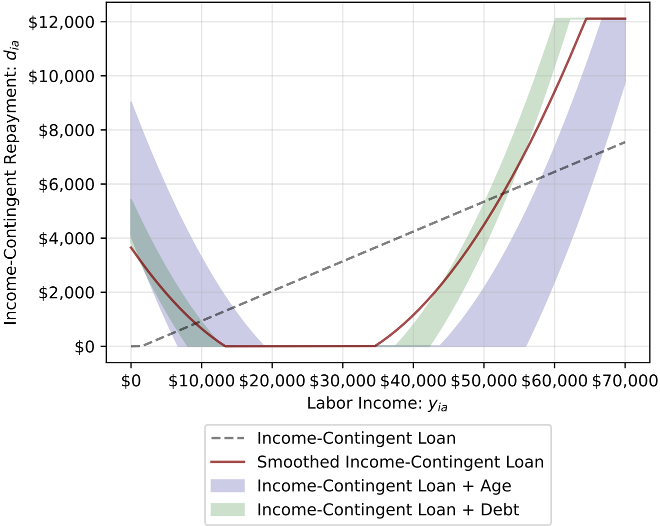
Alternative Contracts Reduce Welfare Cost of Moral Hazard



▸ Contract Structures ▸ Baseline ϕ ◂ Back

Alternative Forms of Income-Contingent Loans: $\phi = 0.37$



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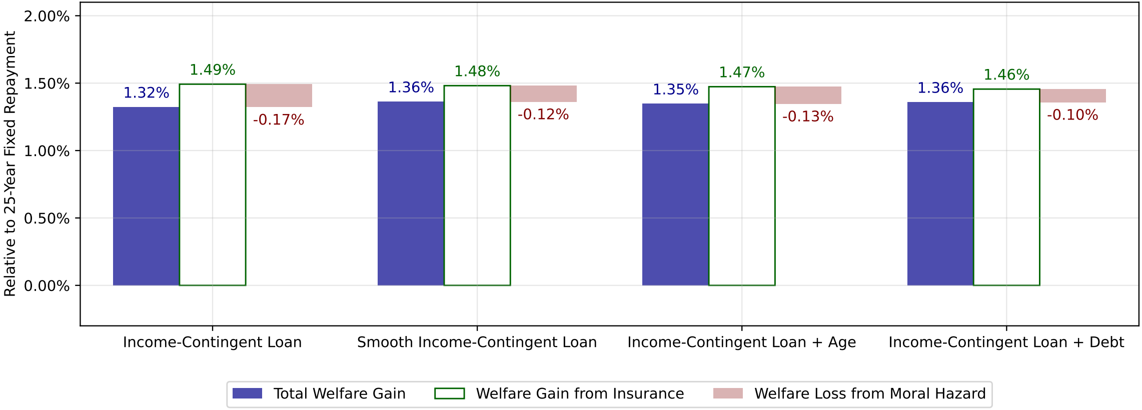
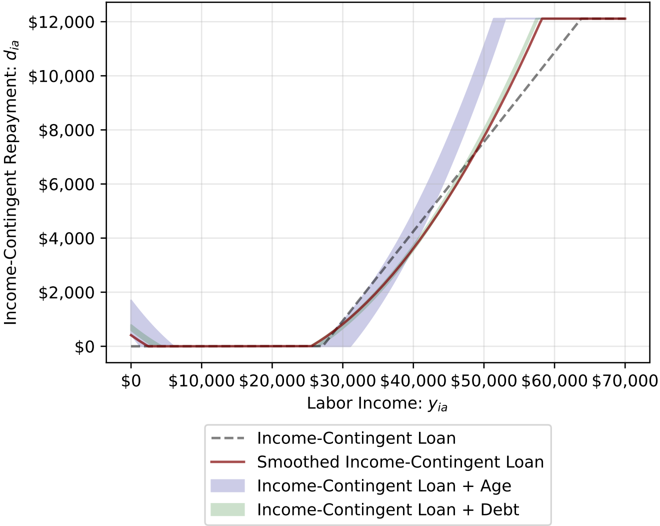
Reducing Welfare Cost of Moral Hazard: Baseline ϕ



Contract Structures Back

Alternative Forms of Income-Contingent Loans: Baseline ϕ



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Robustness to Model Misspecification

	Difference from Baseline	Welfare Gain	$=$ Insurance	$+$ Moral Hazard	ψ^*	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
	Baseline Model	**1.32%**	**1.47%**	**-0.15%**	**33%**	**\$27,147**

Back: Additional Results

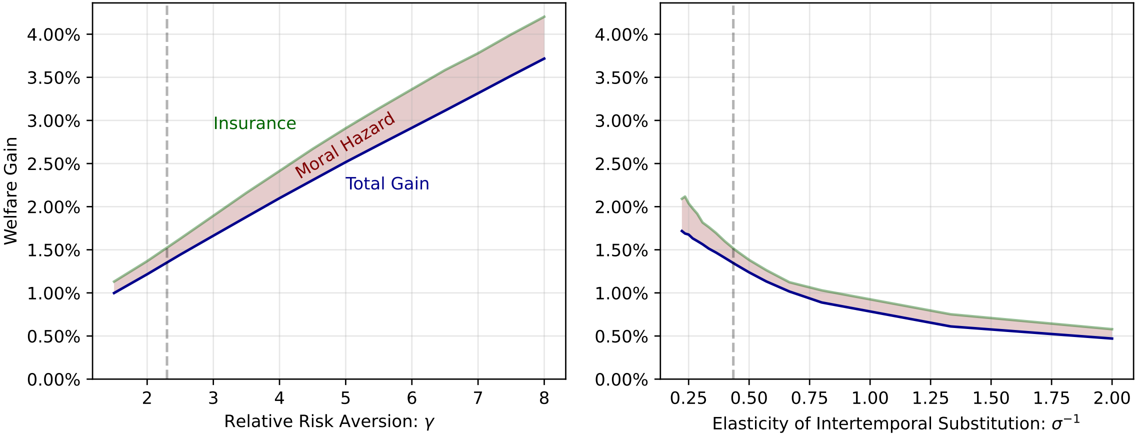
Robustness to Alternative Models of Frictions

	Difference from Baseline Model	Welfare Gain	$=$ Insurance	$+$ Moral Hazard	ψ^*	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
	Baseline Model	**1.32%**	**1.47%**	**-0.15%**	**33%**	**\$27,147**

- 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 ϕ | Back: Additional Results

Effects of Changing Risk Aversion and EIS



Back: Fixed Point ϕ
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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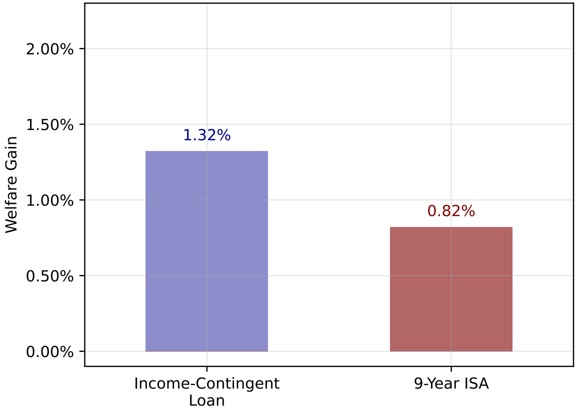
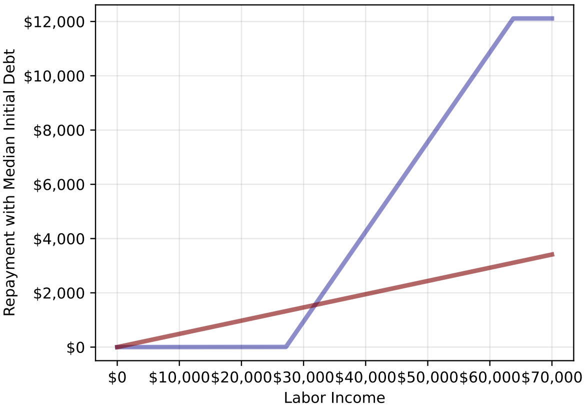
Pure Equity Does Worse than Income-Contingent Loan





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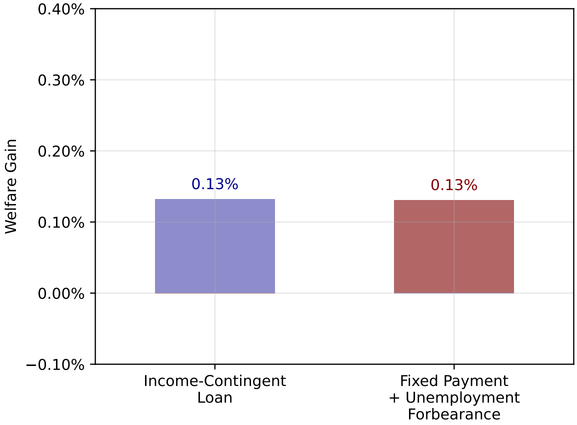
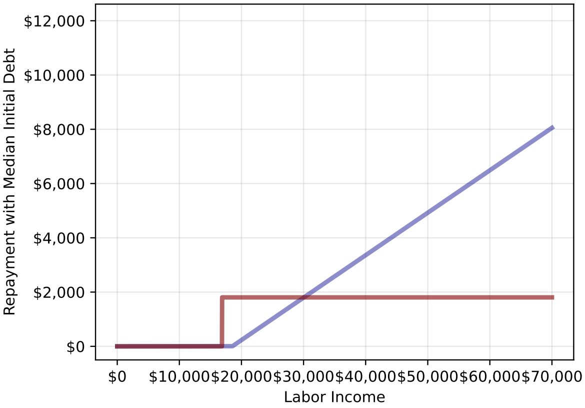
Welfare Gains with Optimal Tax Progressivity





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- Mac: Cmd + Shift + N