Quantifying Efficient Tax Reform

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Questions

- How large are welfare gains from efficient tax reform?
  - Baseline: positive economy matched to data
  - Reform: Pareto improvements on efficient frontier
- How sensitive is the answer to modeling choices?

Approach

- Solve equilibria for positive economy
  - Inputs: fiscal policy and wage processes
  - Outputs: values under current policy
- Solve planner problem next
  - Inputs: values under current policy
  - Outputs: labor and savings wedges and welfare gains
- Ultimate goal: use results to inform policy reform

Positive Economy

- Small open economy
- Overlapping generations
- Household heterogeneity in:
  - Age
  - Education (permanent type)
  - Productivity (private, stochastic)
- Taxes on consumption, labor income, assets
- Estimated with administrative data for the Netherlands

Reform Problem

- Key inputs from positive economy
  - Parameters of preferences and technologies
  - Wage profiles and shock processes
  - Values under current policy
- Compute maximum consumption equivalent gain

Main Findings

- Maximum consumption equivalent gains:
  - 20% for all education groups in baseline
  - 18-23% varying key parameters
- Decomposition:
  - Consumption: level $\uparrow$ and dispersion $\downarrow$ for all groups
  - Leisure: level $\downarrow$ and dispersion $\uparrow$ for all groups

Related Literature

- Theory and application of income tax design
  Vast body of work
- Theory behind dynamic taxation and redistribution
  Farhi-Werning (2013), Golosov-Troshkin-Tsyvinski (2016)
- Pareto-improving reforms with fixed types
  Hosseini-Shourideh (2019)
- What's new?
  - GE analysis linking positive economy to planner
  - Analysis of Pareto reforms with stochastic types
  - Application with administrative data for NL

Outline

- Theory
- Estimation
- Results

Theory

Positive Economy: HH maximization

$$v_j(a, \epsilon; \Omega) = \max_{c,n,a'} \{u(c, \ell) + \beta E[v_{j+1}(a', \epsilon'; \Omega)|\epsilon]\}$$

$$\text{s.t.} \quad a' = (1+r)a - T_a(ra) + w\epsilon n - T_n(j, w\epsilon n) - (1+\tau_c)c$$

where

j= age

a= financial assets

ϵ= productivity shock

Ω= prices and government policies

c= consumption

n= labor supply ($n + \ell = 1$)

Positive Economy Values

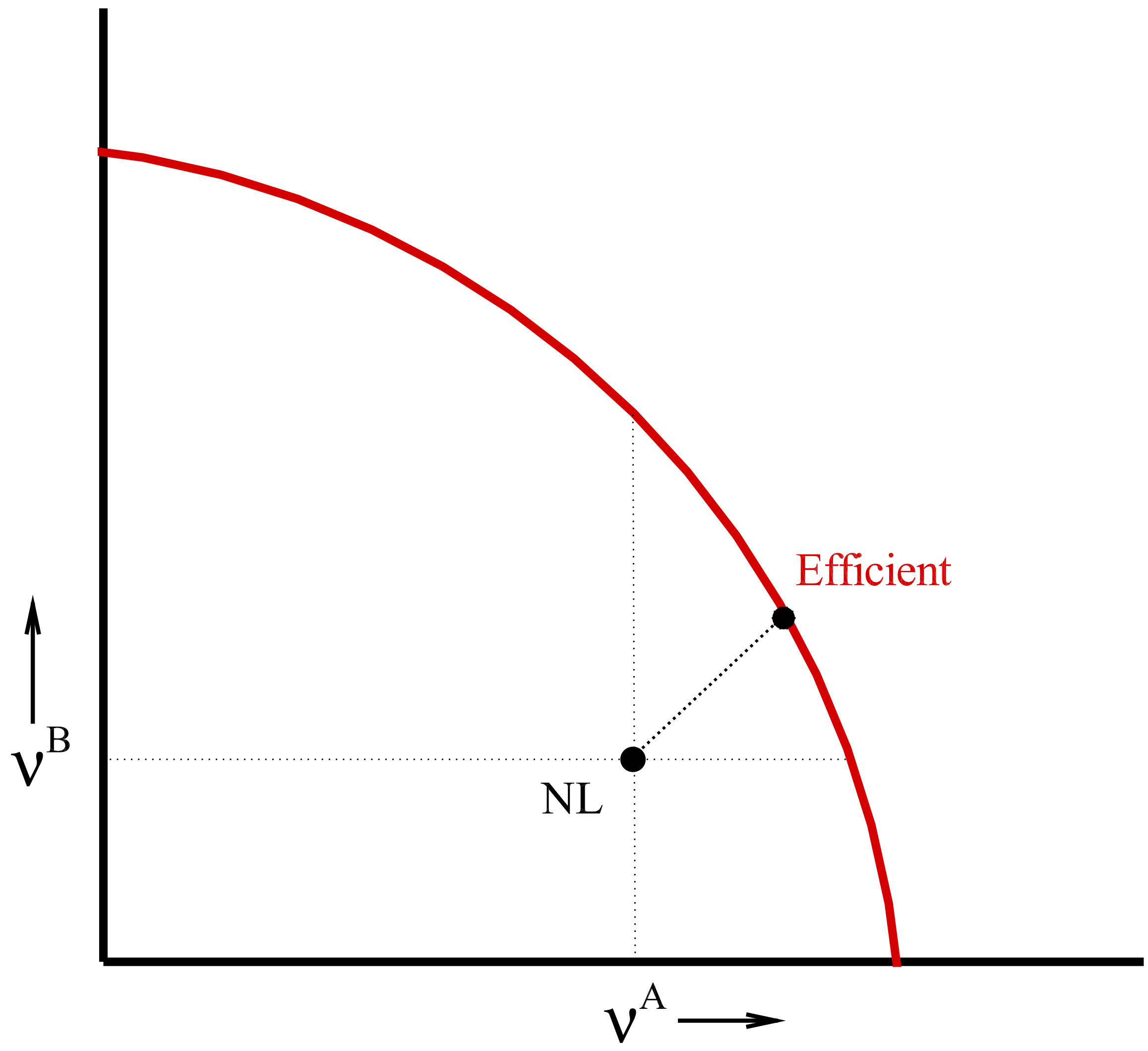
- For simplicity, assume:
  - Small open economy with constant prices, policies
  - No initial assets

- Then, inputs to planner problem:

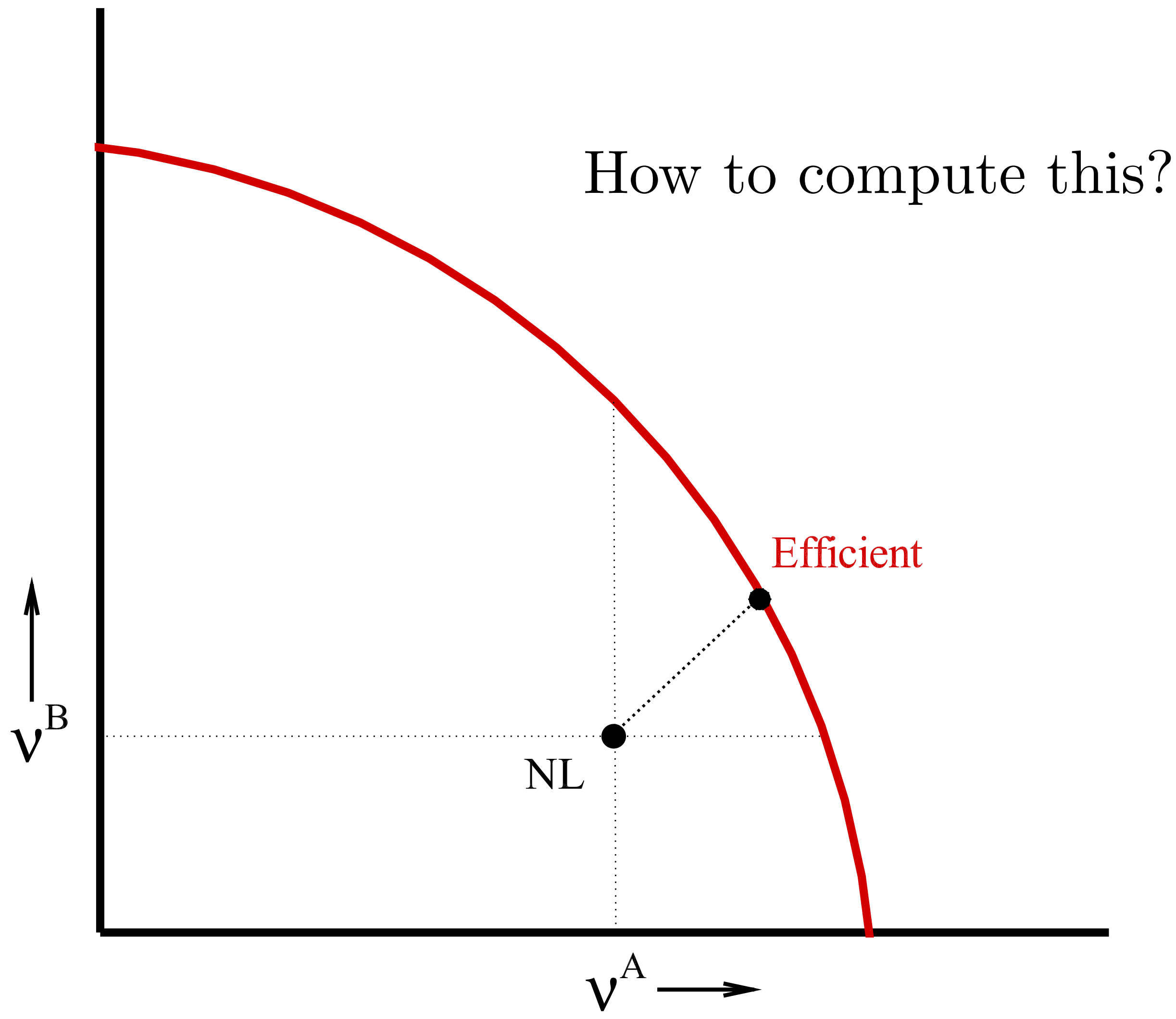
$$\vartheta(\epsilon^{j-1}) \equiv E[v_j(a,\epsilon;\Omega)|\epsilon_-]$$

including future generations $\vartheta(\epsilon_0) \equiv E[v_1(0,\epsilon;\Omega)|\epsilon_0]$

Pareto Reforms



Pareto Reforms



Planner Problem in Words

- Maximize present value of aggregate resources
- subject to
  - Incentive constraints for every household and history
  - Value delivered exceeds $\vartheta(\epsilon^{j-1})$

Planner Problem in Practice

- Exploit separability to solve household by household
- Include only local downward incentive constraints
  - Verify numerically that all ICs satisfied
- Solve recursively by introducing additional states:
  - V = promised value for truth telling
  - $\tilde{V}$ = threat value for local lie

Planner Problem for a Household

Planner Problem for a Household

Max present value of household resources

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-)\Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i)$$
$$+\Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R\Big]$$

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-)\Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i)$$
$$+\Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R\Big]$$

s.t. Local downward incentive constraints

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i | \epsilon_-) \Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R \Big]$$

$$\text{s.t.} \quad U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \geq U(c_j(\epsilon_{i-1}), \ell_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \;\; i \geq 2$$

$$\text{where } \ell_j^+(\epsilon_{i-1}) = 1 - n_j(\epsilon_{i-1})\epsilon_{i-1}/\epsilon_i$$

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i | \epsilon_-) \Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i)$$

$$+ \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R \Big]$$

$$\text{s.t.} \quad U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)$$

$$\geq U(c_j(\epsilon_{i-1}), \ell_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \;\; i \geq 2$$

Deliver at least the promised value

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-)\Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i)$$
$$+\Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R\Big]$$

$$\text{s.t.} \quad U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)$$

$$\geq U(c_j(\epsilon_{i-1}), \ell_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \;\; i \geq 2$$

$$V_- \leq \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-) \left[U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)\right]$$

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i | \epsilon_-) \Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R \Big]$$

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Deliver no more than the threat value

Planner Problem for a Household

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-) \Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R \Big]$$

$$\text{s.t.} \quad U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)$$

$$\geq U(c_j(\epsilon_{i-1}), \ell_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \;\; i \geq 2$$

$$V_- \leq \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-) \left[U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right]$$

$$\tilde{V}_- \geq \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-^+) \left[U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right]$$

Planner Problem for Future Generation ($j = 1$)

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-)\Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i)$$
$$+\Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R\Big]$$

$$\text{s.t.} \quad U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)$$

$$\geq U(c_j(\epsilon_{i-1}), \ell_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \;\; i \geq 2$$

$$V_- \leq \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-) \left[U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)\right]$$

No threat value

Planner Problem for Future Generation ($j = 1$)

$$\Pi_j(V_-, \tilde{V}_-, \epsilon_-) \equiv \max \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-)\Big[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R\Big]$$

s.t.

$$U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \geq U(c_j(\epsilon_{i-1}), \ell_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \;\; i \geq 2$$

$$V_- \leq \sum_{\epsilon_i \in \mathcal{E}} \pi_j(\epsilon_i|\epsilon_-)\left[U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i)\right]$$

Replace arbitrary V_- with $\vartheta(\epsilon_0) + \vartheta_\Delta$

Planner Problem Deliverables

- Welfare gains
  - Total consumption equivalent
  - Decomposition
- Wedges
  - Labor
  - Savings

Welfare Gain Decomposition

- If $U(c,\ell) = \gamma \log c + (1-\gamma)\log \ell$
- Consumption equivalent gain Δ:

$$\log(1+\Delta) = \log((1+\Delta_c^L)(1+\Delta_c^D)) + (1-\gamma)\log((1+\Delta_\ell^L)(1+\Delta_\ell^D))/\gamma$$

$$1+\Delta_x^L = \frac{\sum \pi(\epsilon^j)\hat{x}(\epsilon^j)}{\sum \pi(\epsilon^j)x(\epsilon^j)}, \quad \hat{x}\text{: planner, } x\text{: positive}$$

$$1+\Delta_x^D = \sum \beta^j \pi(\epsilon^j)\log\left(\frac{\hat{x}(\epsilon^j)}{\sum \pi(\epsilon^j)\hat{x}(\epsilon^j)}\right) - \sum \beta^j \pi(\epsilon^j)\log\left(\frac{x(\epsilon^j)}{\sum \pi(\epsilon^j)x(\epsilon^j)}\right)$$

Wedges

- Labor wedge:

$$\tau_n(\epsilon^j) = 1 - \frac{1}{w}\frac{U_\ell(c(\epsilon^j),\ell(\epsilon^j))}{U_c(c(\epsilon^j),\ell(\epsilon^j))}$$

- Savings wedge:

$$\tau_a(\epsilon^j) = 1 - \frac{U_c(c(\epsilon^j),\ell(\epsilon^j))}{\beta R E[U_c(c(\epsilon^{j+1}),\ell(\epsilon^{j+1}))|\epsilon_j]}$$

Wedges

- Labor wedge:

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$$\tau_a(\epsilon^j) = 1 - \frac{U_c(c(\epsilon^j),\ell(\epsilon^j))}{\beta R E[U_c(c(\epsilon^{j+1}),\ell(\epsilon^{j+1}))|\epsilon_j]}$$

$\Rightarrow$ Hopefully informative for reforming current policy

Data

Netherlands

- Merged administrative data, 2006-2014
  - Earnings from tax authority
  - Hours from employer provided data
  - Education from population survey
- National accounts
- Tax schedules

Advantages over US Data

- Administrative data:

  NL:

  Individual earnings linked across HH members

  Individual hours linked across HH members

  Individual education linked across HH members

  US:

  Individual earnings *not* linked across HH members

- Survey data:

  US:

  Years of schooling linked across HH members

  Hours and wages linked across HH members

Estimation of Shock Processes

- Construct hourly wages W_{ijt} (j=age, t=time)
- Classify degrees:
  - High school or practical (Low)
  - University of applied sciences (Medium)
  - University (High)
- Bin households into 6 groups
  - Assign singles to LL, MM, or HH
  - Use average wage rates for couples
- Construct residual wages ω_{ijt}:

$$\log W_{ijt} = A_t + X_{ijt} + \omega_{ijt}$$

Estimation of Shock Processes

- Pool data across cohorts
- Estimate (for each education group):

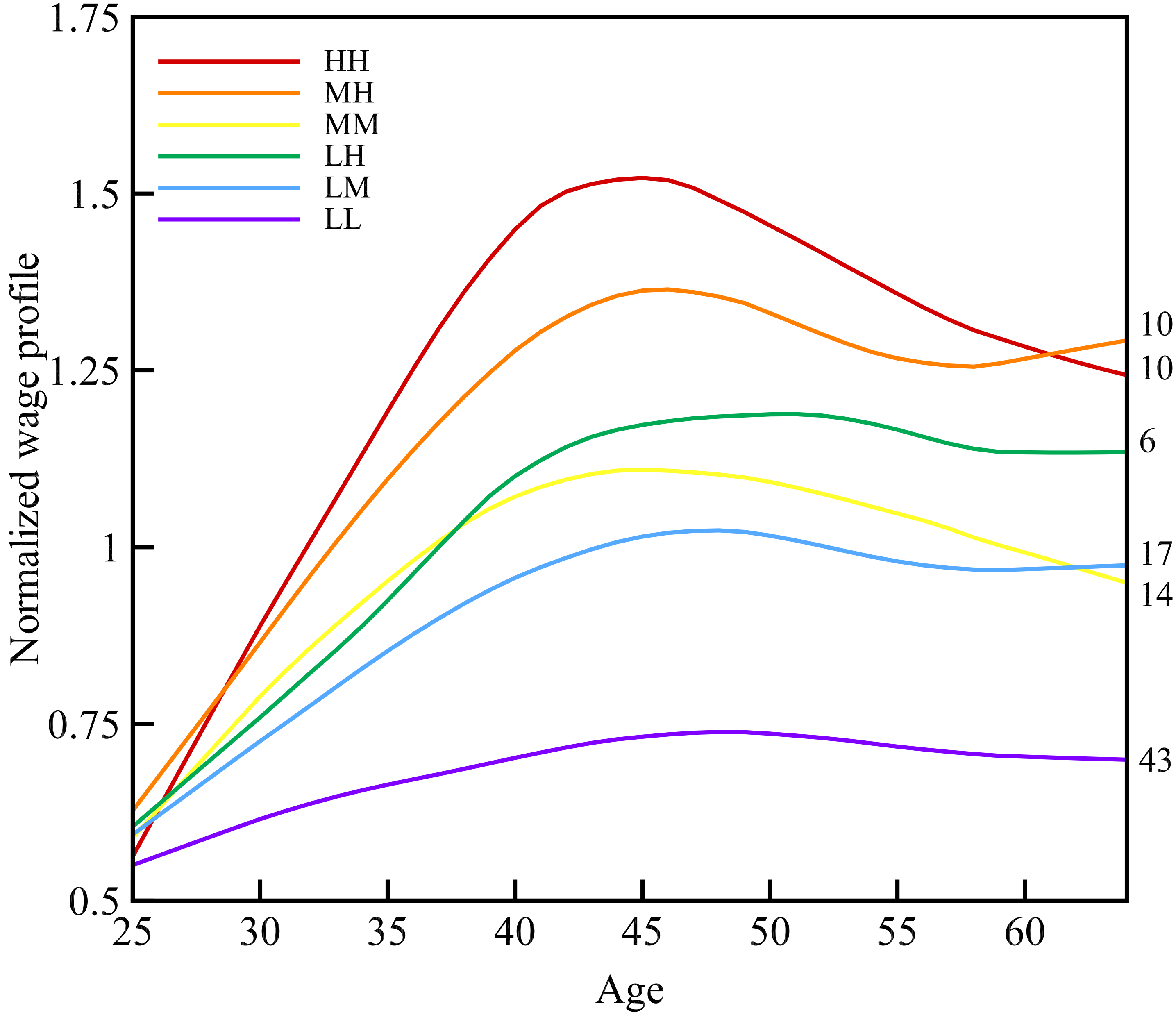
$$\omega_{ij} = \epsilon_{ij} + \eta_{ij}$$
$$\epsilon_{ij} = \rho\epsilon_{ij-1} + u_{ij}$$
$$\eta_{ij} \sim \mathcal{N}(0, \sigma_\eta^2)$$
$$u_{ij} \sim \mathcal{N}(0, \sigma_u^2)$$
$$\epsilon_{i0} \sim \mathcal{N}(0, \sigma_{\epsilon_0}^2)$$

- Apply method of simulated moments:
  - Moments: variance, autocovariances of ω_{ij}
  - Parameters: ρ, σ_u, σ_η, σ_{ϵ_0}

Wage Process Estimates

Group	$\hat{\rho}$	$\hat{\sigma}_u^2$
Low, Low	.9542	.0096
Low, Medium	.9660	.0087
Low, High	.9673	.0162
Medium, Medium	.9570	.0099
Medium, High	.9616	.0109
High, High	.9564	.0172

Wage Profiles



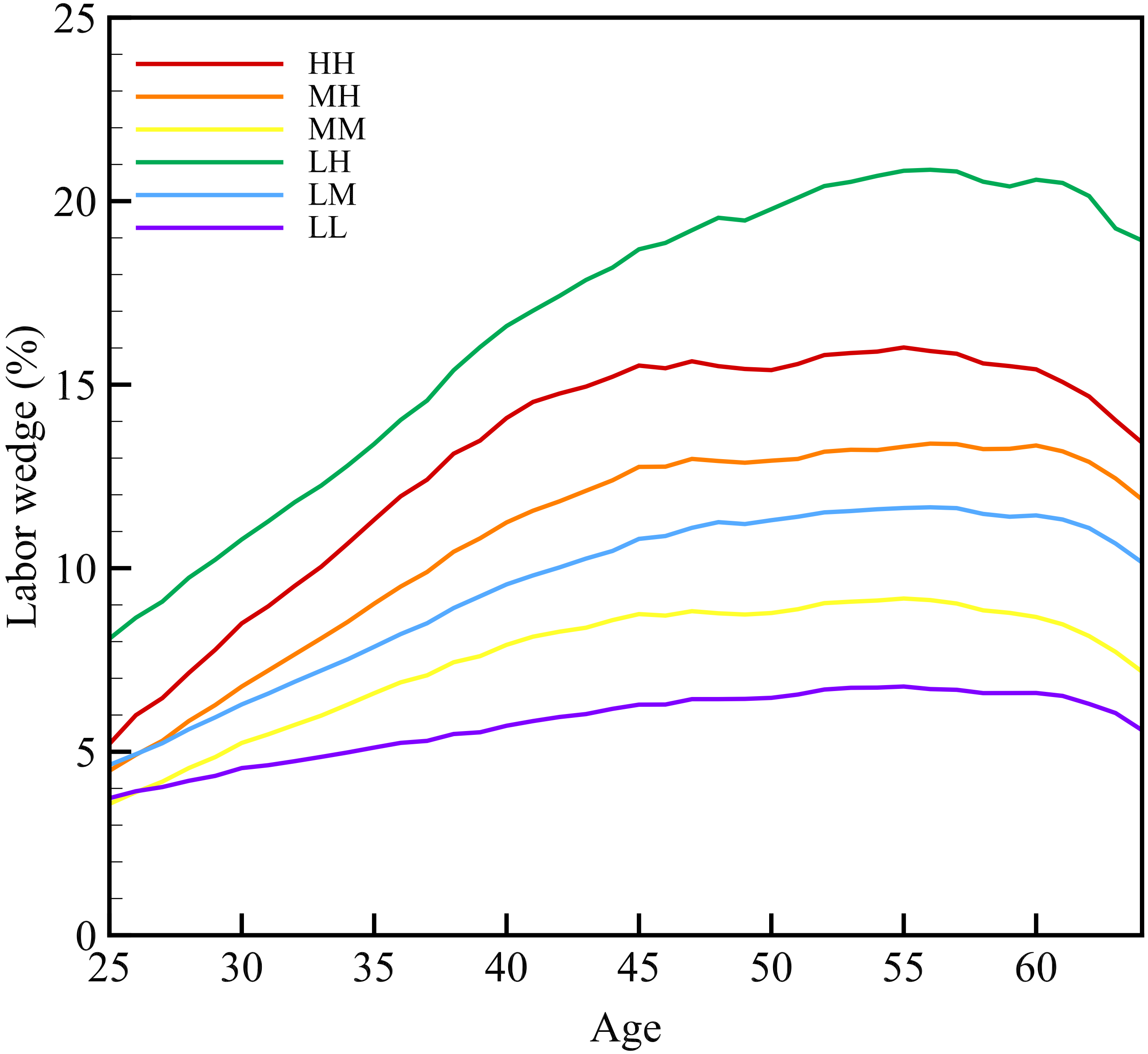
Other Key Parameters

- Number of types $\epsilon_i \in \mathcal{E}$
- Preferences
- Status quo policy

Baseline: 20 types, log preferences, NL wages & policy

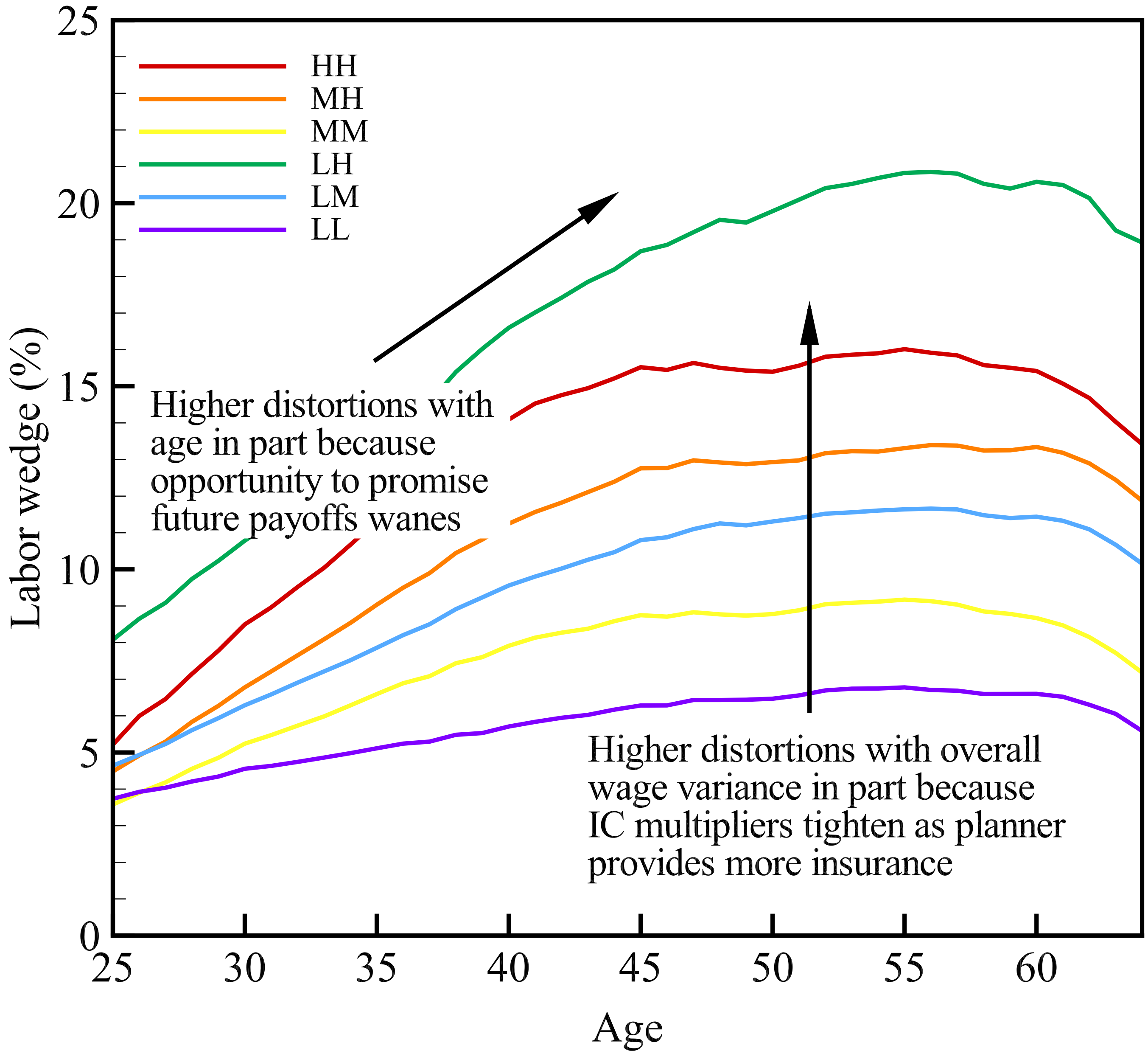
Baseline Results

Labor Wedge



HH
MH
MM
LH
LM
LL
Labor wedge (%)
Age
0
5
10
15
20
25
25
30
35
40
45
50
55
60

Labor Wedge


Labor wedge (%)
Age
25
20
15
10
5
0
25
30
35
40
45
50
55
60
HH
MH
MM
LH
LM
LL
Higher distortions with age in part because opportunity to promise future payoffs wanes
Higher distortions with overall wage variance in part because IC multipliers tighten as planner provides more insurance

Welfare

- Consumption equivalent gain of 20%
- Welfare decomposition:
    - Consumption: level $\uparrow$ and dispersion $\downarrow$ for all groups
    - Leisure: level $\downarrow$ and dispersion $\uparrow$ for all groups

Welfare Contributions ($\Delta = 20\%$)

	Consumption		Leisure	
Education group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
Low, Low	27	2	−8	−2
Low, Medium	25	4	−9	−1
Low, High	20	11	−8	−2
Medium, Medium	27	4	−10	−1
Medium, High	25	7	−11	−1
High, High	21	17	−14	−5

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Low, High	20	11	-8	-2
Medium, Medium	27	4	-10	-1
Medium, High	25	7	-11	-1
High, High	21	17	-14	-5

Find significant gains for level increase in consumption

Intuition using Static Problem

- No insurance:

$$\max \ \gamma \log c + (1-\gamma)\log \ell$$

$$\text{s.t. } c = (1-\tau(\epsilon))w\epsilon(1-\ell)$$

Intuition using Static Problem

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$$\max \ \gamma \log c + (1-\gamma)\log \ell$$

$$\text{s.t. } c = (1-\tau(\epsilon))w\epsilon(1-\ell)$$

$\Rightarrow$ variation in consumption, constant leisure

Intuition using Static Problem

- No insurance:

$$\max \ \gamma \log c + (1-\gamma)\log \ell$$

$$\text{s.t. } c = (1-\tau(\epsilon))w\epsilon(1-\ell)$$

$$\Rightarrow \ c(\epsilon) = \gamma w(1-\tau(\epsilon))\epsilon, \ \ell(\epsilon) = 1-\gamma$$

Intuition using Static Problem

- No insurance:

$$\max \ \gamma \log c + (1-\gamma) \log \ell$$

$$\text{s.t. } c = (1-\tau(\epsilon)) w\epsilon(1-\ell)$$

$$\Rightarrow \ c(\epsilon) = \gamma w(1-\tau(\epsilon))\epsilon, \ \ell(\epsilon) = 1-\gamma$$

- Full insurance:

$$\max \ \int [\gamma \log c(\epsilon) + (1-\gamma) \log \ell(\epsilon)] dF(\epsilon)$$

$$\text{s.t. } \int [c(\epsilon) - (1-\tau(\epsilon)) w\epsilon(1-\ell(\epsilon))] dF(\epsilon) \leq 0$$

Intuition using Static Problem

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$$\max \ \gamma \log c + (1-\gamma)\log \ell$$

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- Full insurance:

$$\max \ \int [\gamma \log c(\epsilon) + (1-\gamma)\log \ell(\epsilon)]dF(\epsilon)$$

$$\text{s.t. } \int [c(\epsilon) - (1-\tau(\epsilon))w\epsilon(1-\ell(\epsilon))]dF(\epsilon) \leq 0$$

$\Rightarrow$ constant consumption, variation in leisure

Intuition using Static Problem

- No insurance:

$$\max \ \gamma \log c + (1-\gamma)\log \ell$$

$$\text{s.t. } c = (1-\tau(\epsilon))w\epsilon(1-\ell)$$

$$\Rightarrow \ c(\epsilon) = \gamma w(1-\tau(\epsilon))\epsilon, \ \ell(\epsilon) = 1-\gamma$$

- Full insurance:

$$\max \ \int [\gamma \log c(\epsilon) + (1-\gamma)\log \ell(\epsilon)] dF(\epsilon)$$

$$\text{s.t. } \int [c(\epsilon) - (1-\tau(\epsilon))w\epsilon(1-\ell(\epsilon))] dF(\epsilon) \leq 0$$

$$\Rightarrow \ c(\epsilon) = \gamma w \int (1-\tau(\epsilon))\epsilon dF(\epsilon)$$

$$\ell(\epsilon) = (1-\gamma)\int (1-\tau(\epsilon))\epsilon dF(\epsilon)/((1-\tau(\epsilon)\epsilon)$$

Intuition using Static Problem

- No insurance:

$$\max \ \gamma \log c + (1-\gamma)\log \ell$$

$$\text{s.t. } c = (1-\tau(\epsilon))w\epsilon(1-\ell)$$

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- Full insurance:

$$\max \ \int[\gamma \log c(\epsilon) + (1-\gamma)\log \ell(\epsilon)]dF(\epsilon)$$

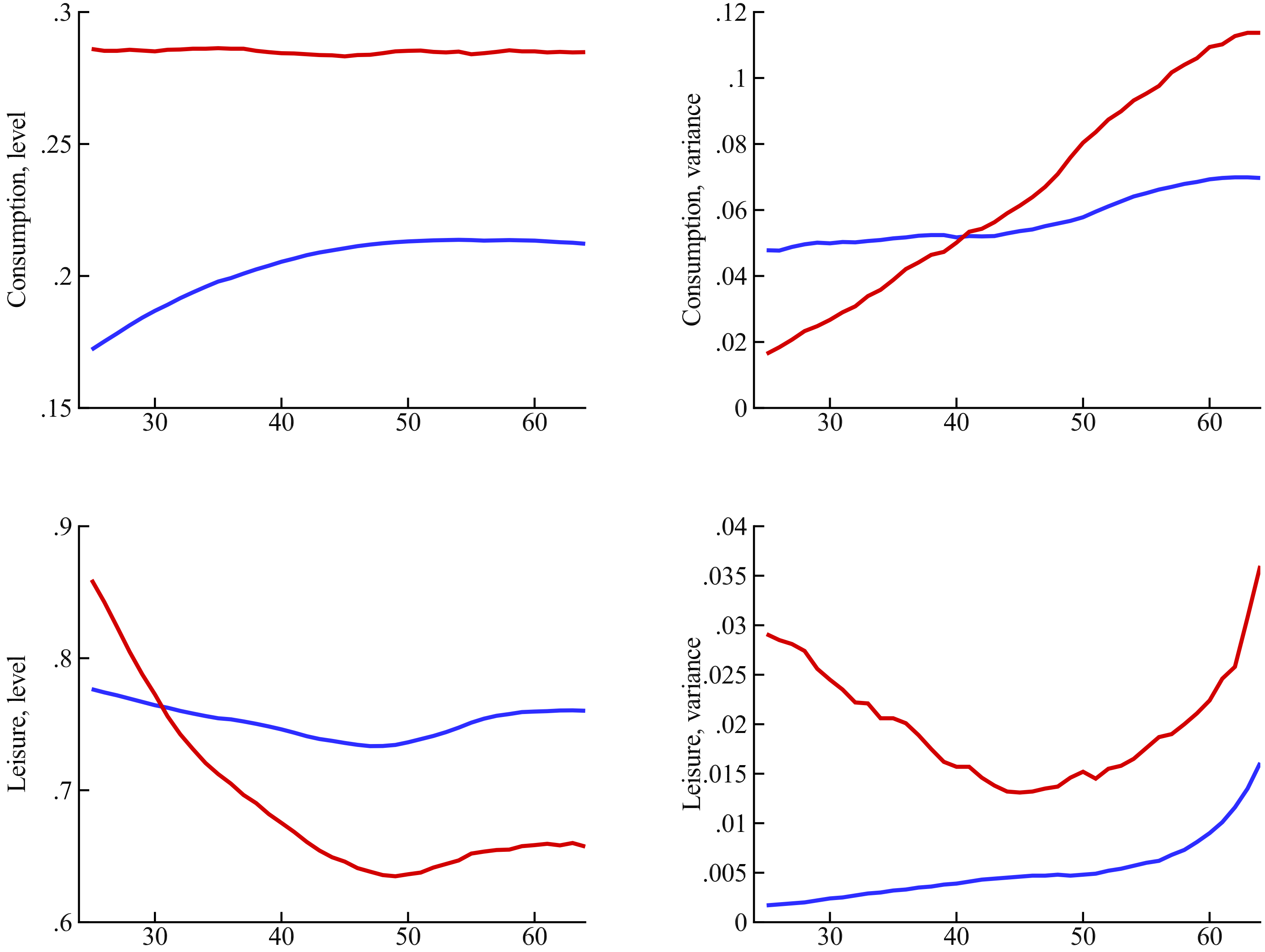
$$\text{s.t. } \int[c(\epsilon) - (1-\tau(\epsilon))w\epsilon(1-\ell(\epsilon))]dF(\epsilon) \leq 0$$

$$\Rightarrow \ c(\epsilon) = \gamma w \int (1-\tau(\epsilon))\epsilon dF(\epsilon)$$

$$\ell(\epsilon) = (1-\gamma)\int(1-\tau(\epsilon))\epsilon dF(\epsilon)/((1-\tau(\epsilon)\epsilon)$$

$\Rightarrow$ c level $\uparrow$ & dispersion $\downarrow$, ℓ level $\downarrow$ & dispersion $\uparrow$

A Look Under the Hood: Group LL



Sensitivity

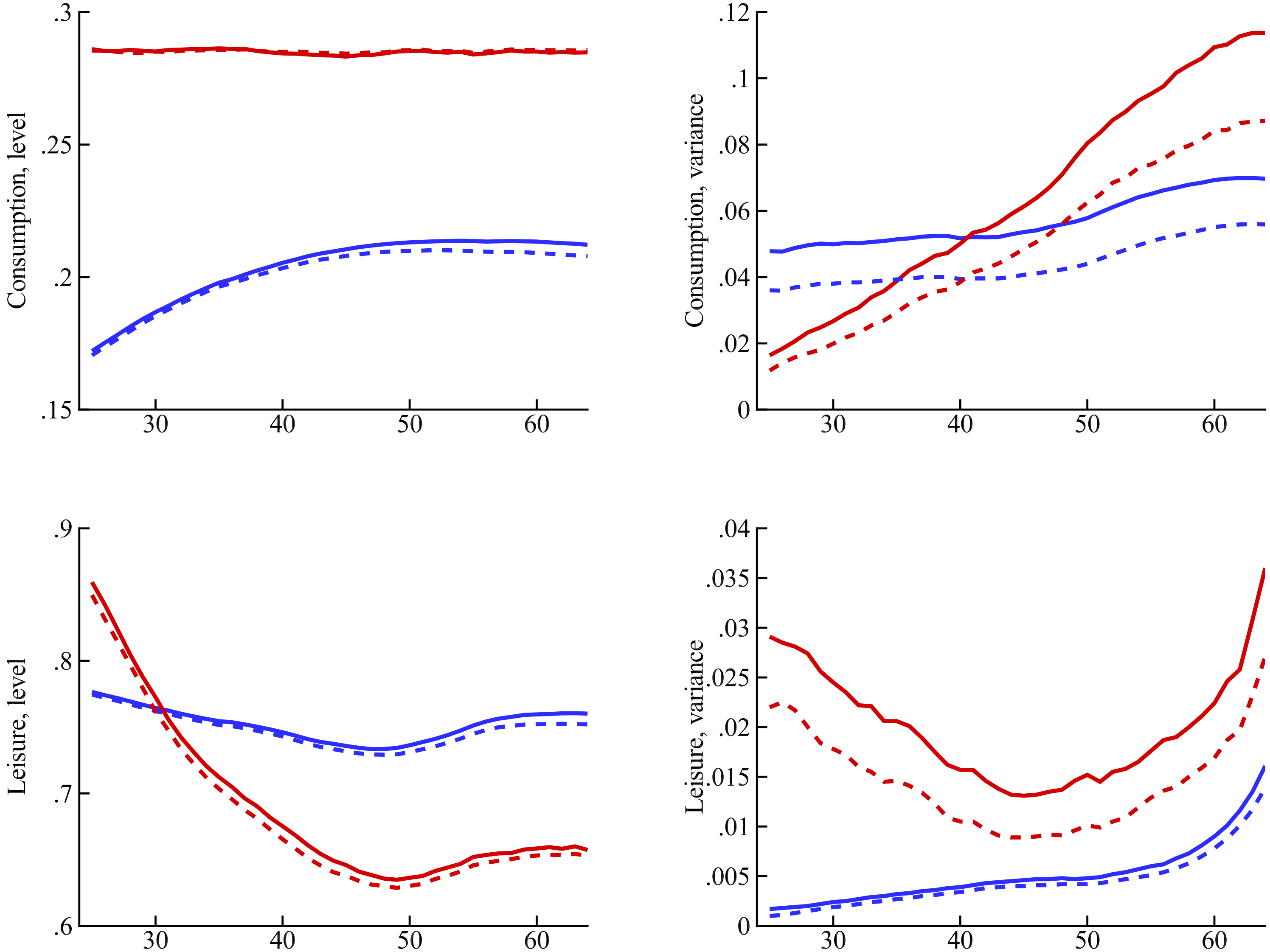
- How do results change with
  - Number of types: $\epsilon_i \in \mathcal{E}$
  - Wage profile: varying or constant over lifecycle
  - Wage process: choices of ρ, σ_u^2
  - Preferences: μ in $\log c + \psi[\ell^{1-\mu} - 1]/(1-\mu)$
- Compare welfare gains and allocations to baseline

Double Number of Types

- No change in total gain: 20%
- Small changes in decomposition for most groups:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	27/28	2/1	−8/−8	−2/−2
LM	25/28	4/4	−9/−11	−1/−1
LH	20/28	11/10	−8/−16	−2/−2
MM	27/29	4/4	−10/−11	−1/−2
MH	25/29	7/7	−11/−14	−1/−2
HH	21/33	17/14	−14/−22	−5/−5

Double Number of Types: A Look at LL

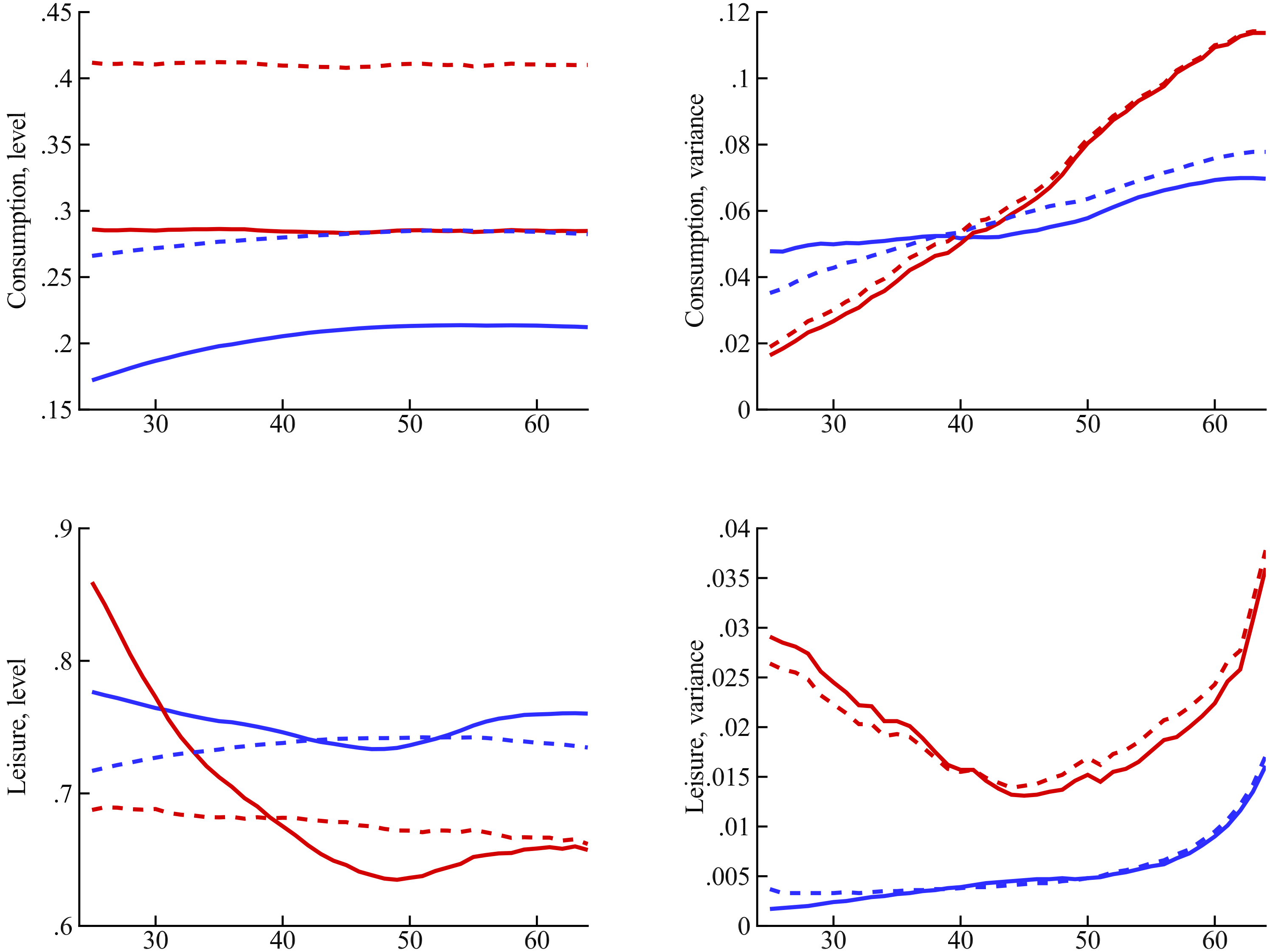


No Wage Growth

- Slightly lower total gain: 18%
- No gain from smoothing consumption:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	27/28	2/0	−8/−7	−2/−4
LM	25/27	4/0	−9/−6	−1/−3
LH	20/25	11/0	−8/−5	−2/−2
MM	27/28	4/0	−10/−6	−1/−4
MH	25/27	7/0	−11/−6	−1/−3
HH	21/25	17/1	−14/−6	−5/−3

No Wage Growth: A Look at LL

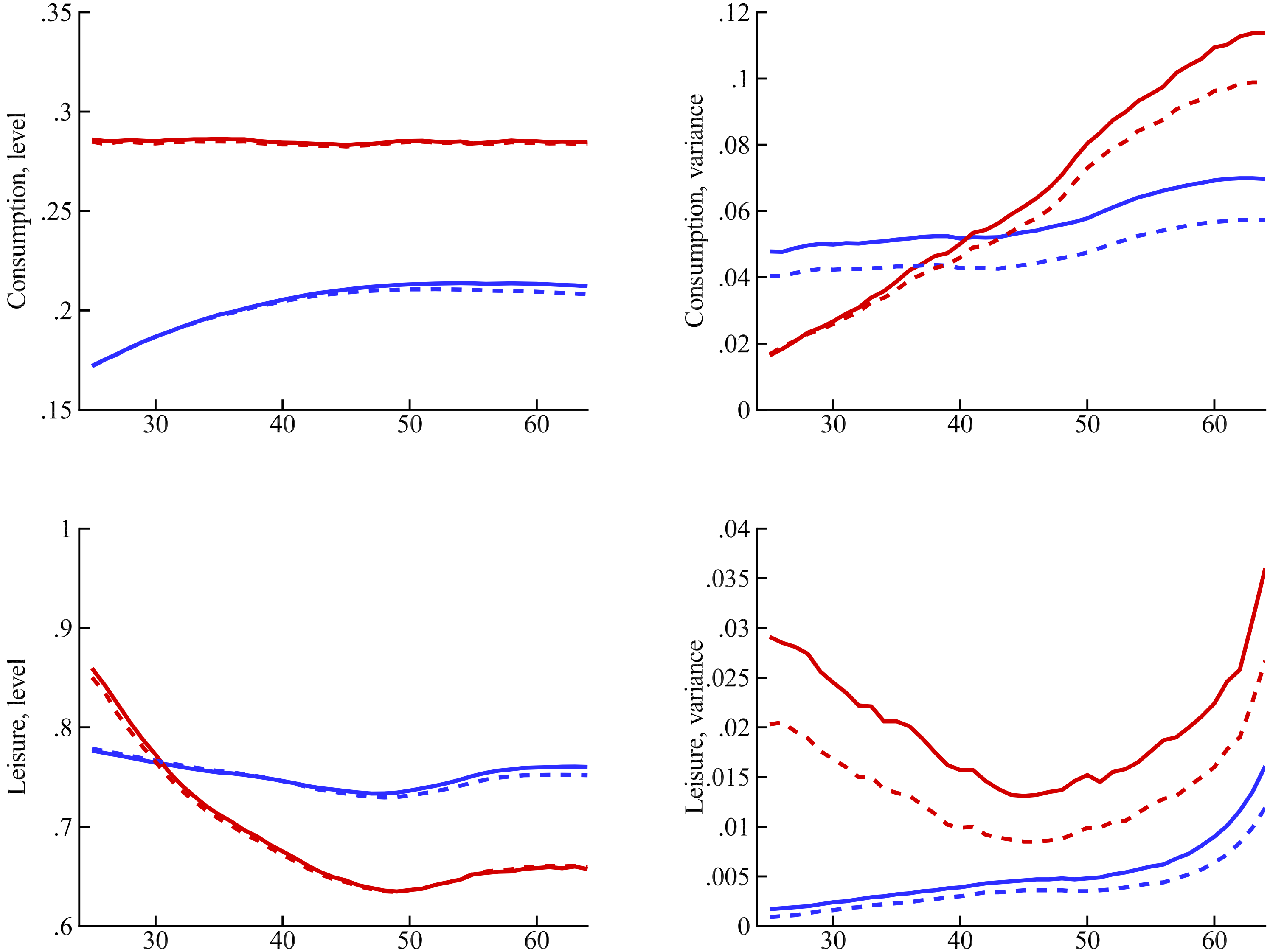


Decrease Overall Variance by 2/3

- Slightly lower total gain: 18%
- Smaller gain from smoothing consumption:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	27/25	2/1	−8/−7	−2/−2
LM	25/25	4/3	−9/−9	−1/−1
LH	20/24	11/7	−8/−12	−2/−1
MM	27/25	4/3	−10/−8	−1/−1
MH	25/24	7/5	−11/−10	−1/−1
HH	21/23	17/10	−14/−12	−5/−2

Decrease σ_u^2: A Look at LL



Changing Labor Supply Elasticities

- Work in progress

- Recall $U(c, \ell) = \log c + \psi[\ell^{1-\mu} - 1]/(1-\mu)$
  - μ large implies very steep slope near 0
  - Challenge: planner evaluates wide range of ℓ

- Comparison of gains for perturbations:
  - 23%, $\mu = 0.8$
  - 20%, $\mu = 1.0$
  - 19%, $\mu = 1.1$

Summary

- How large are gains from efficient tax reform? 20%
- How sensitive is answer to modeling choices?
  - Found large gains across all trials
  - Found decomposition sensitive to key parameters
  - But more work needed
- Next step: Using results to inform policy reform