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?

Idea in a Picture

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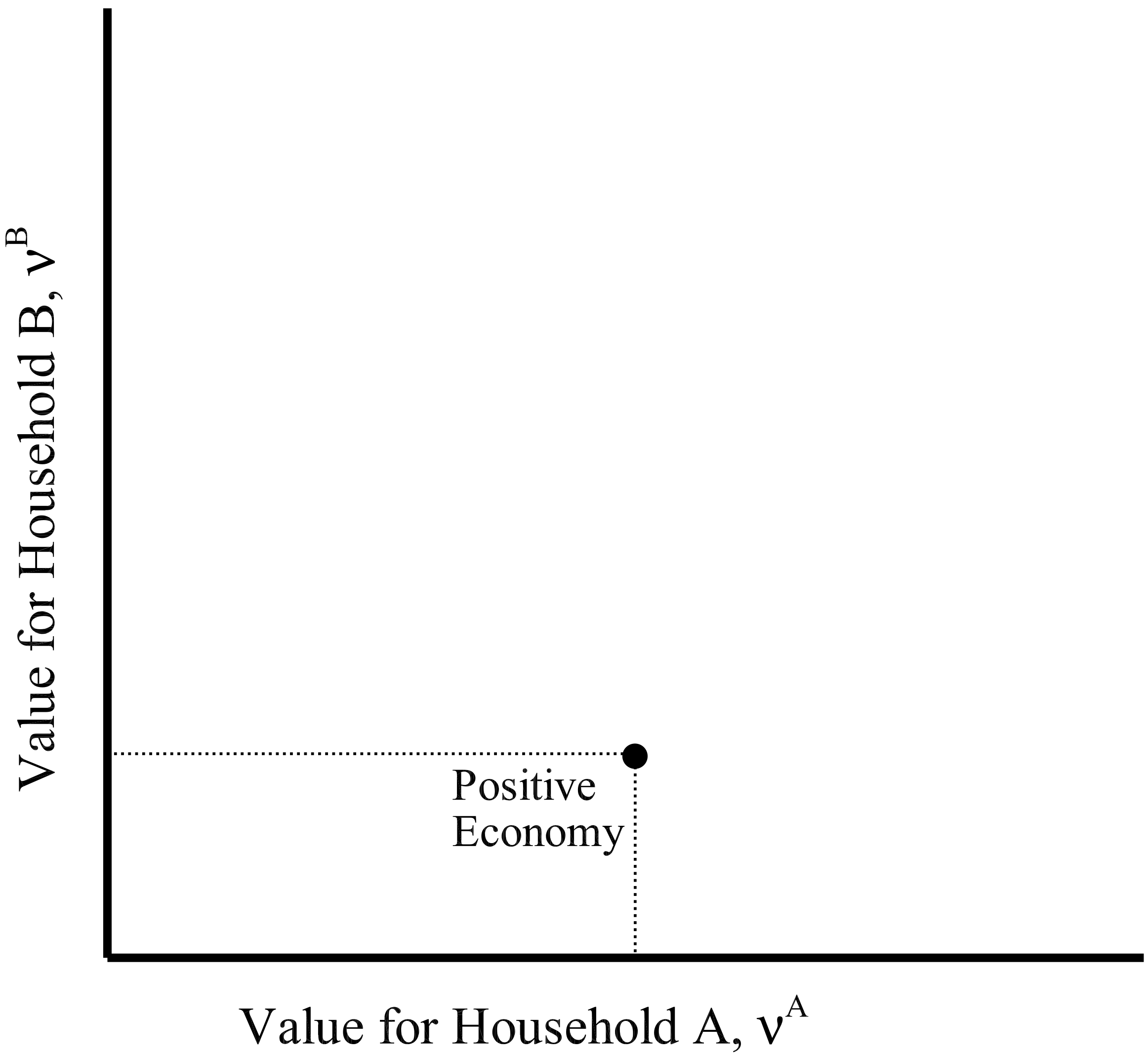

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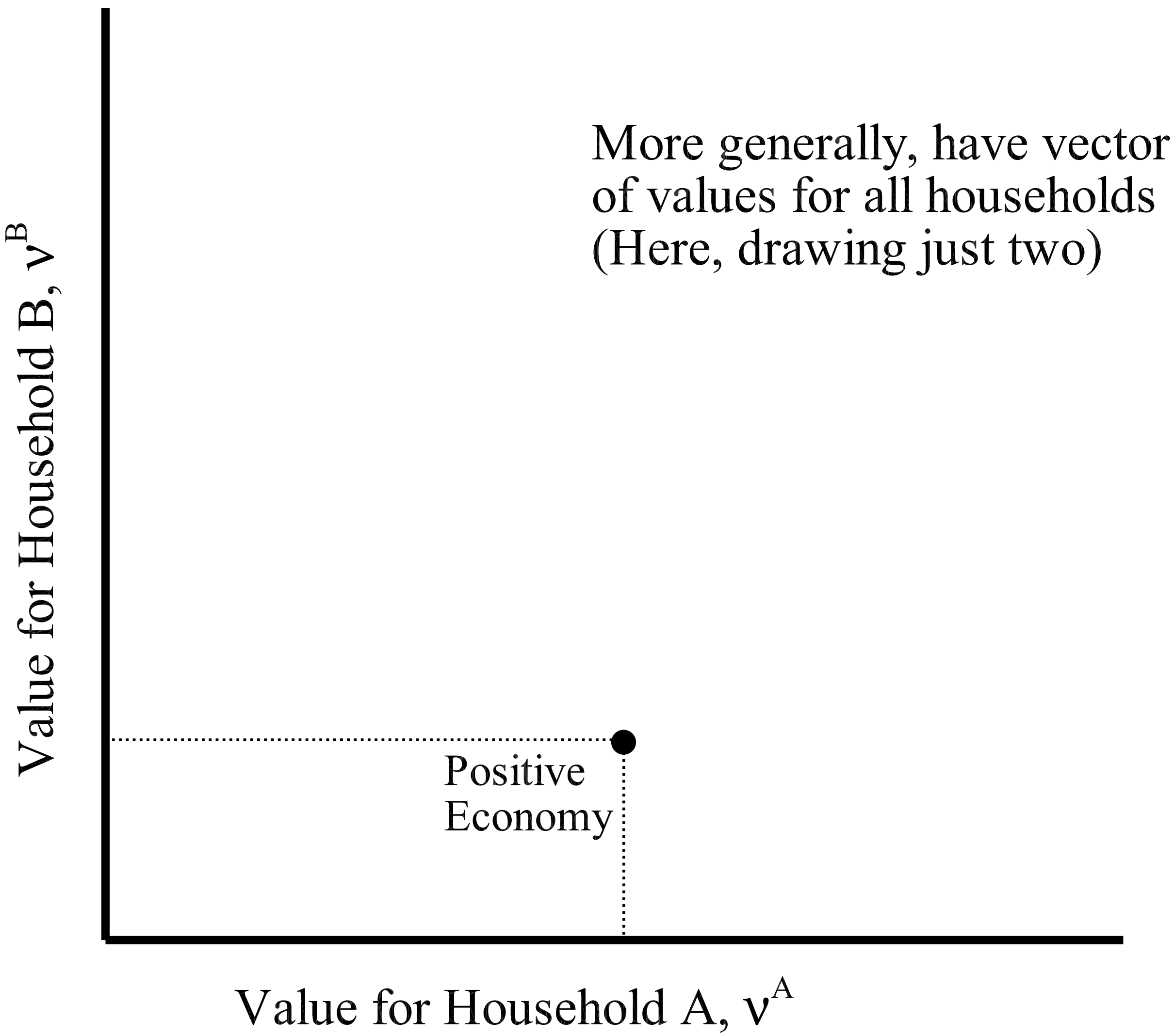

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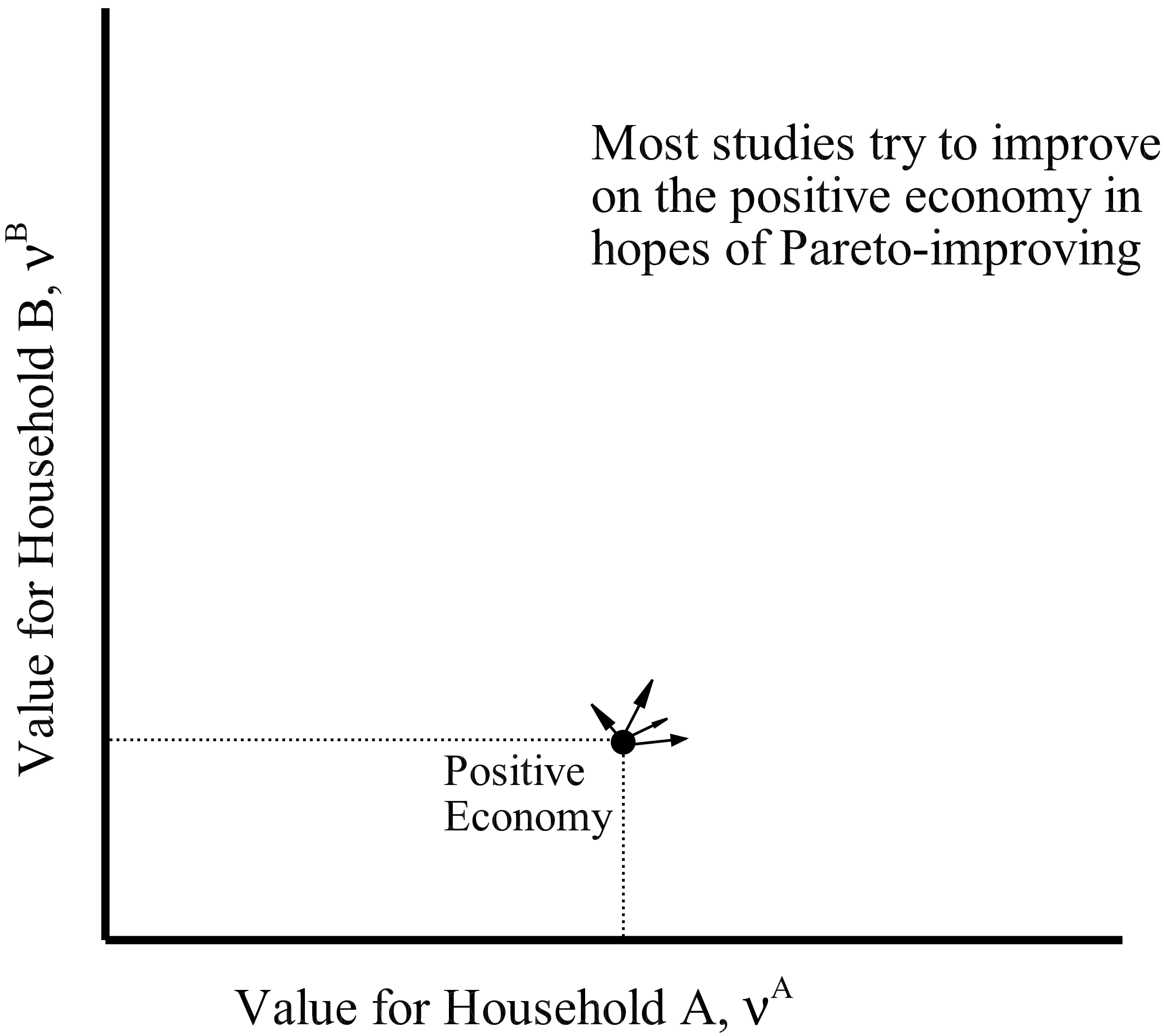

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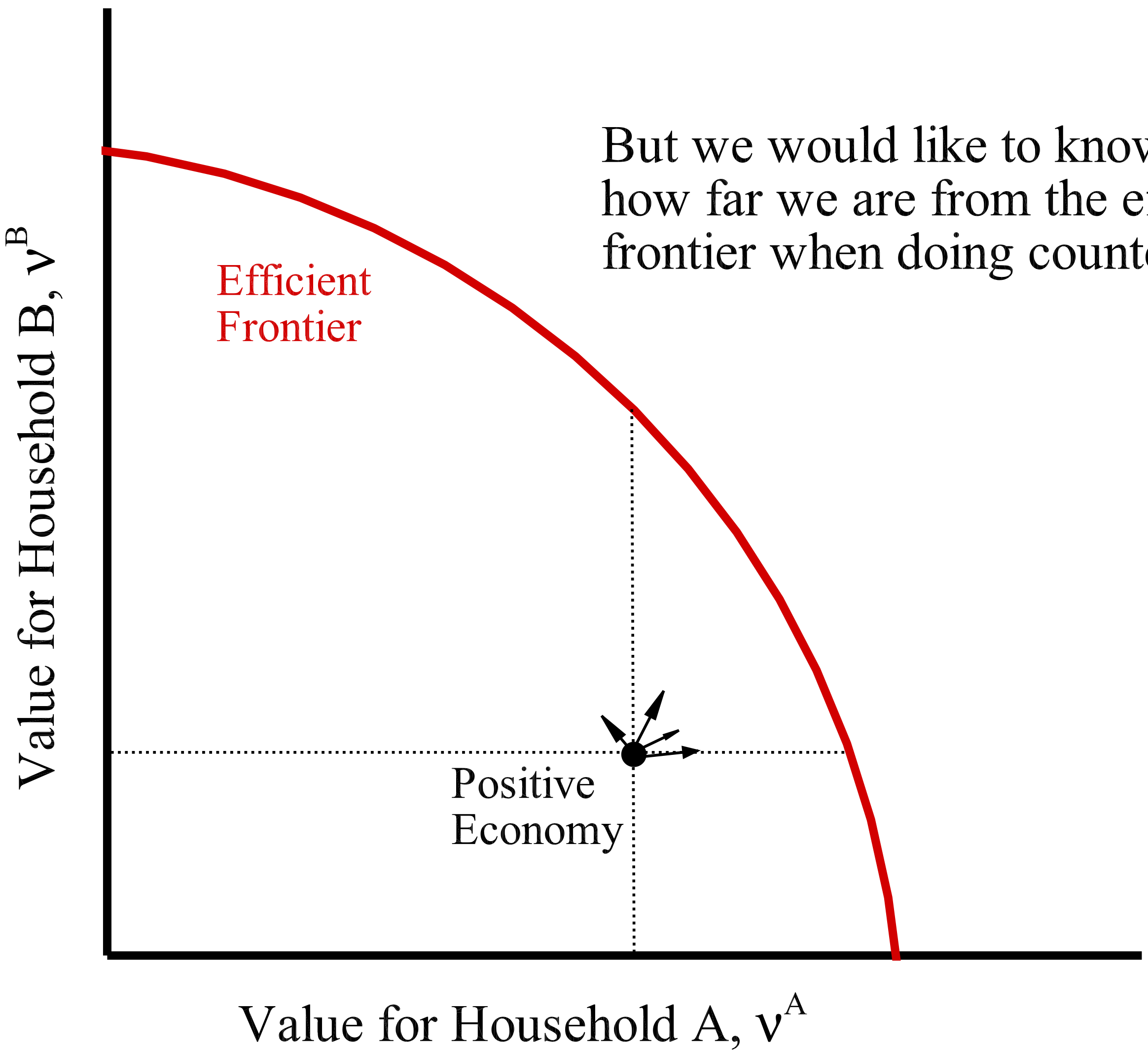
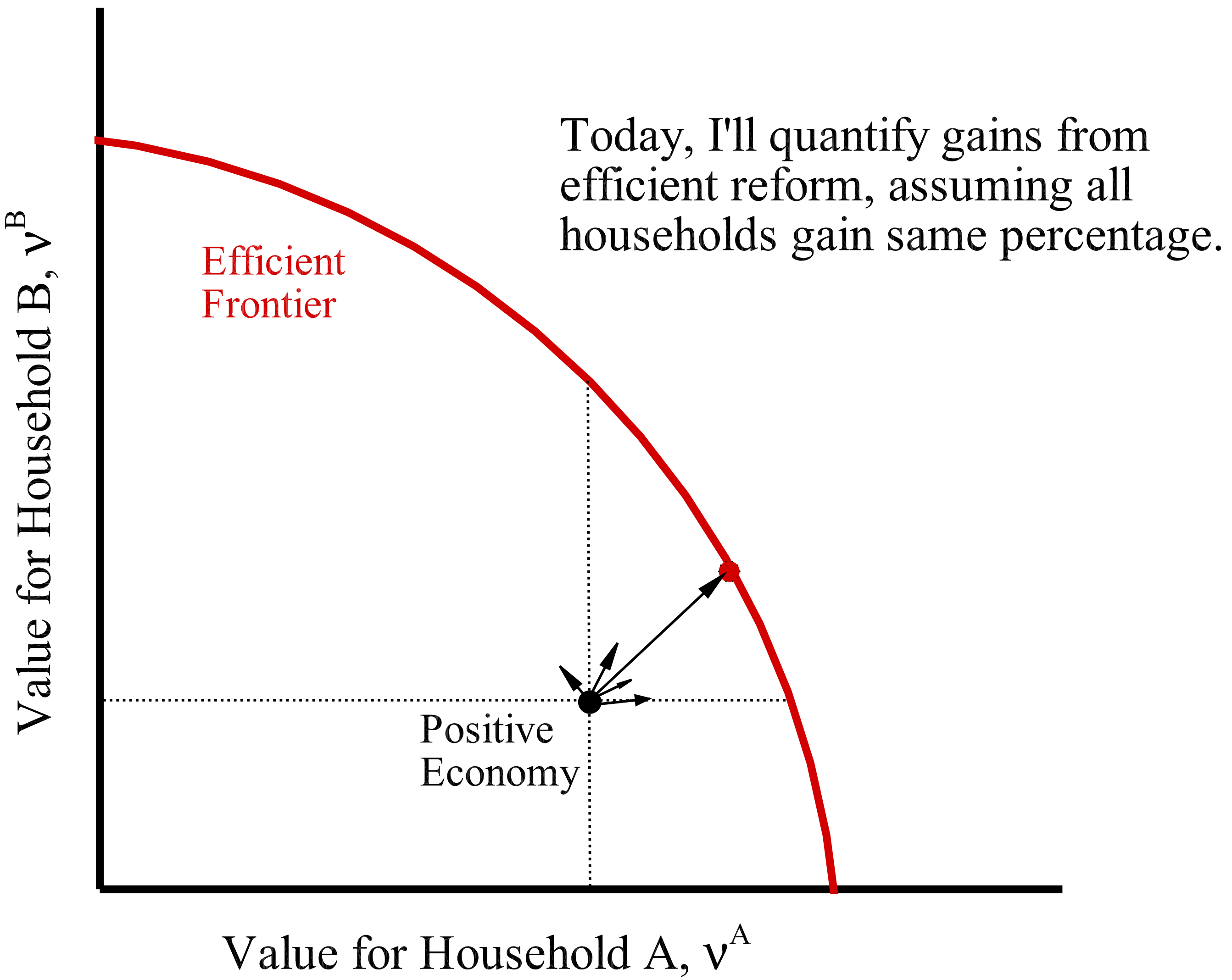


But we would like to know how how far we are from the efficient frontier when doing counterfactuals.

Idea in a Picture



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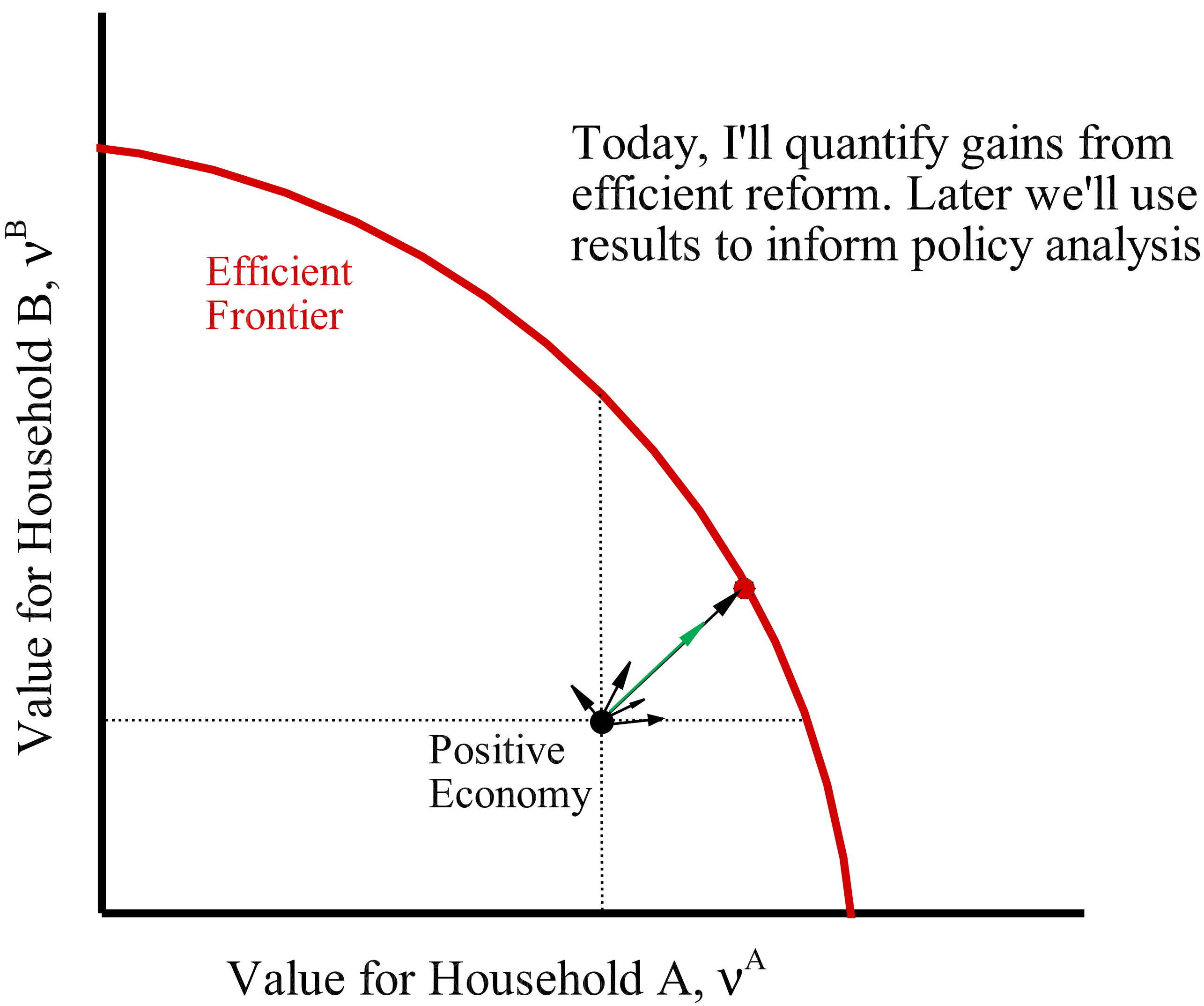


Approach

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

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 (•)

- Take 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:
  - 17% for baseline parameterization
  - 14-19% varying key parameters
- Comparing allocations:
  - Consumption: level $\uparrow$ and variance $\downarrow$ for all groups
  - Leisure: level $\downarrow$ and variance $\uparrow$ for all groups

Related Literature

- Theory and application of income tax design

  Vast body of work

- Theory behind dynamic taxation and redistribution

  Kapicka (2013), Farhi-Werning (2013), Golosov et al. (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:

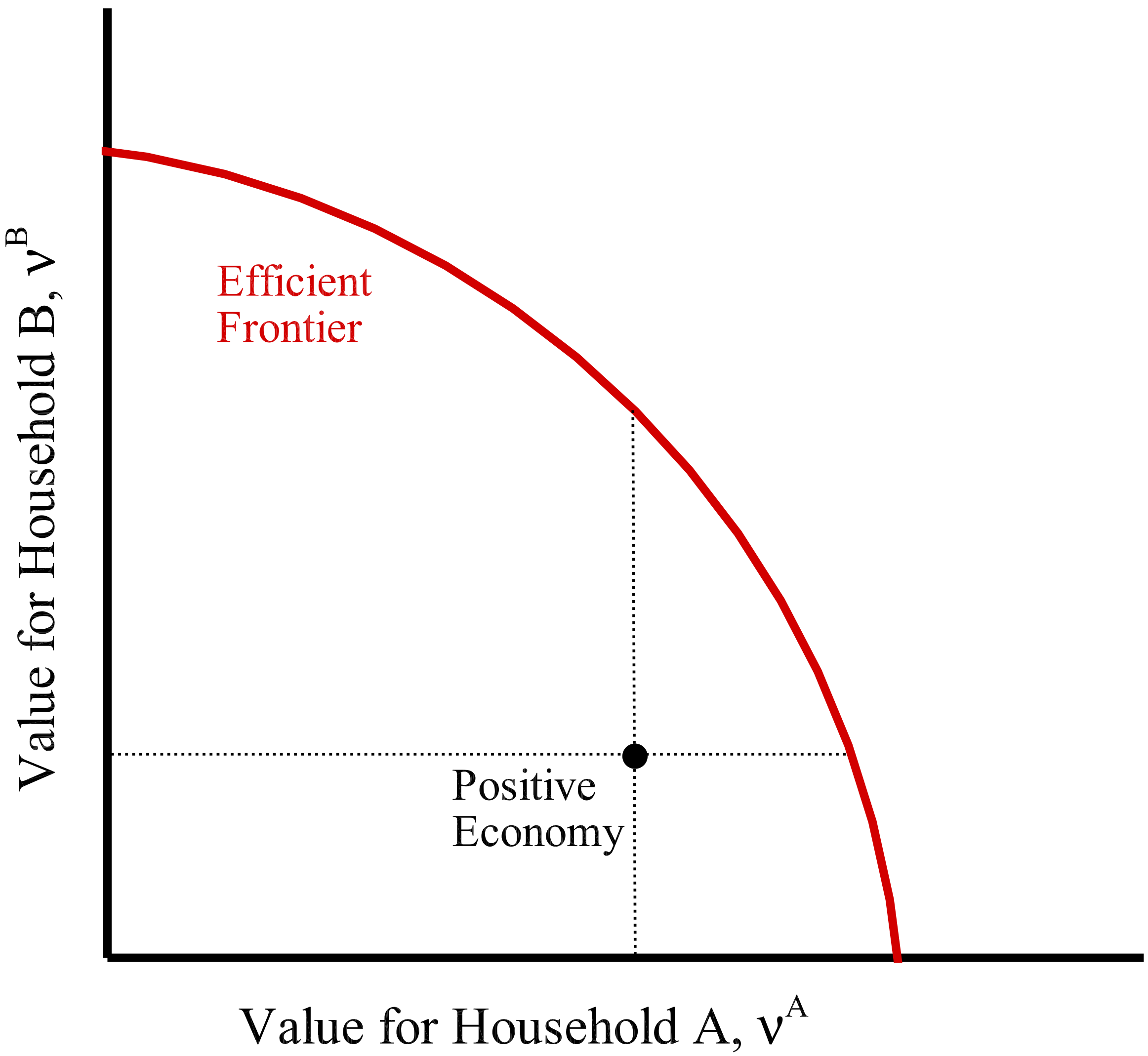
$$\vartheta(\epsilon^{j-1}) \equiv E[v_j(a, \epsilon; \Omega)|\epsilon_-]$$

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

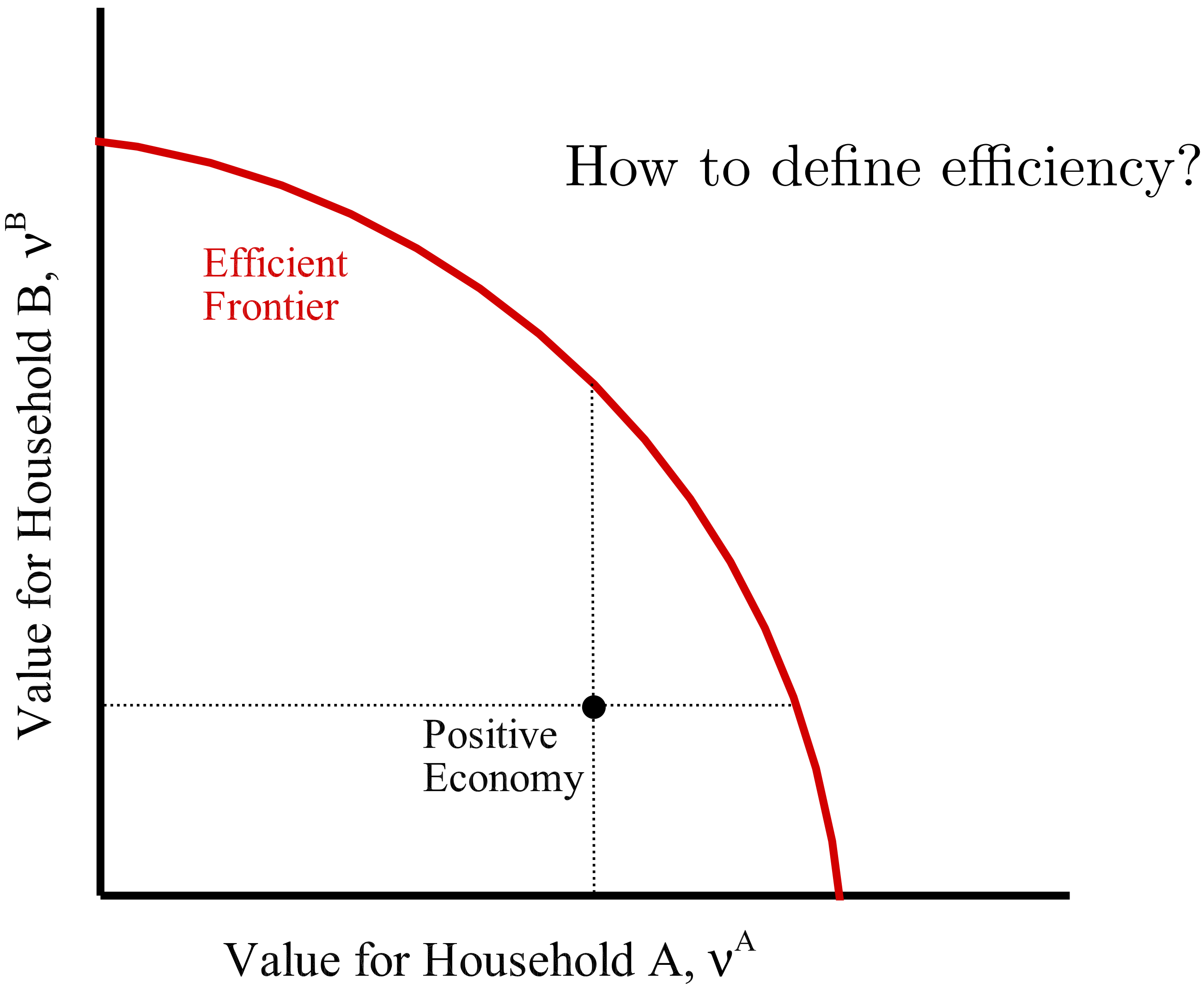
Solving Planner Problem

- First need:
  - Notion of efficiency
  - Clarification about which reform(s) to consider

Efficient Frontier



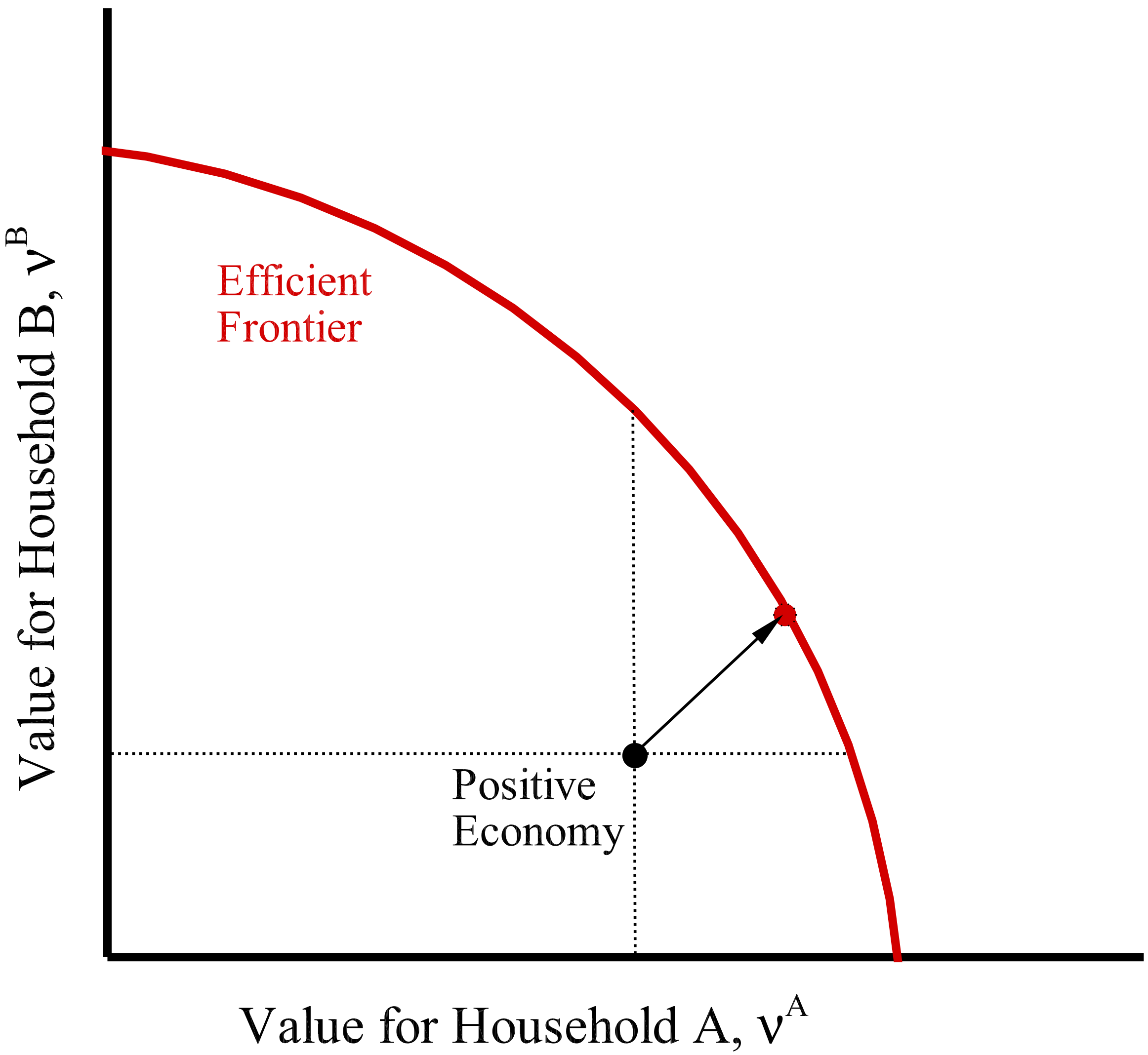
Efficient Frontier



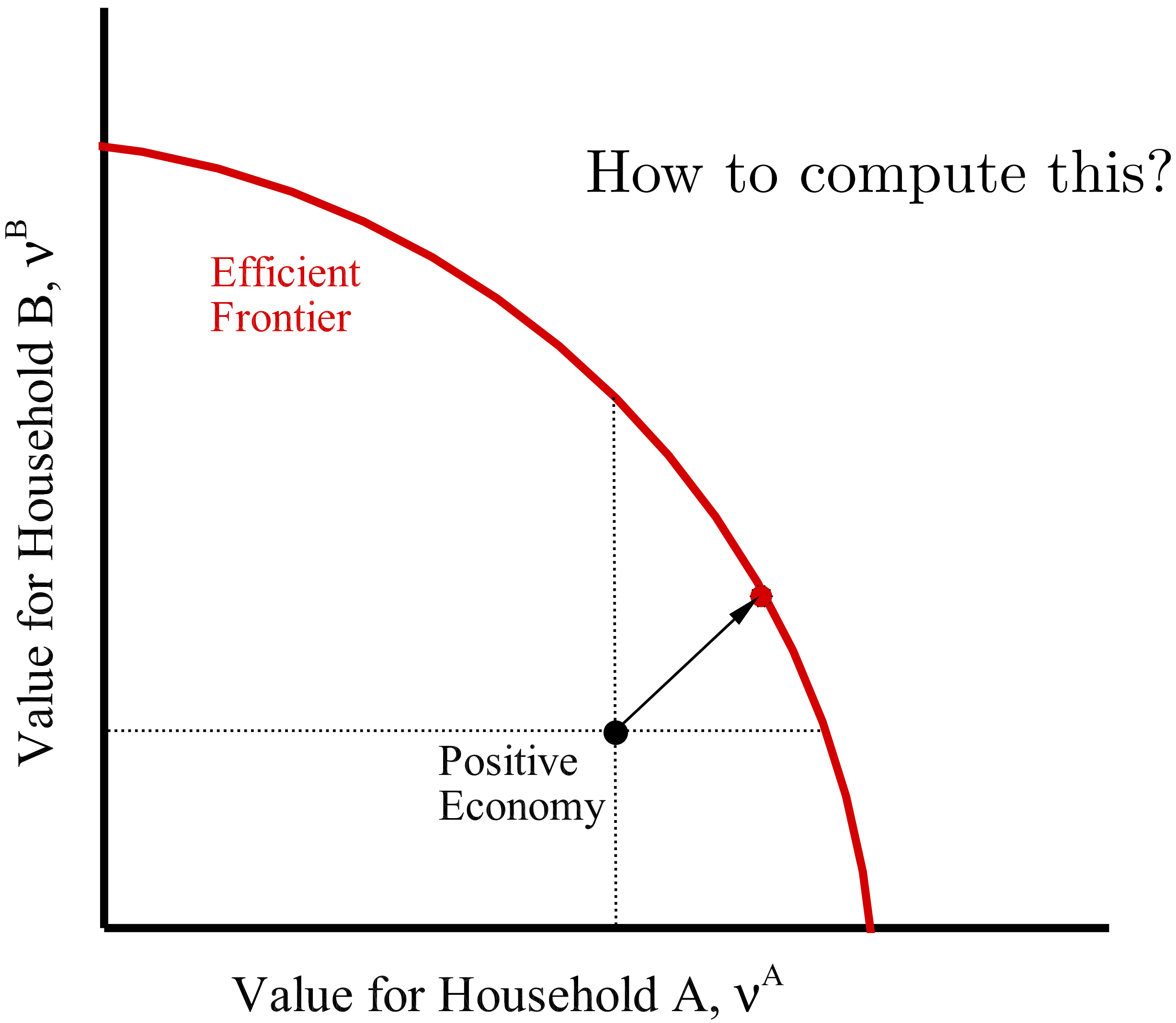
Notion of Efficiency

- Our focus is Pareto-improving reforms:
  - There is no alternative allocation that is
    - Resource feasible (only so much to go around)
    - Incentive feasible (induces truthful reports)
  - making all better off and some strictly better off
- Will assume all HHs gain by same percentage

Pareto-improving Reforms



Pareto-improving 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

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

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

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

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

Planner Problem for a Household

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Deliver at least the promised value

Planner Problem for a Household

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

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Deliver no more than the threat value

Planner Problem for a Household

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

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

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

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

No threat value

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

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

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:

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

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

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

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

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- Savings wedge:

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

$\Rightarrow$ 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):

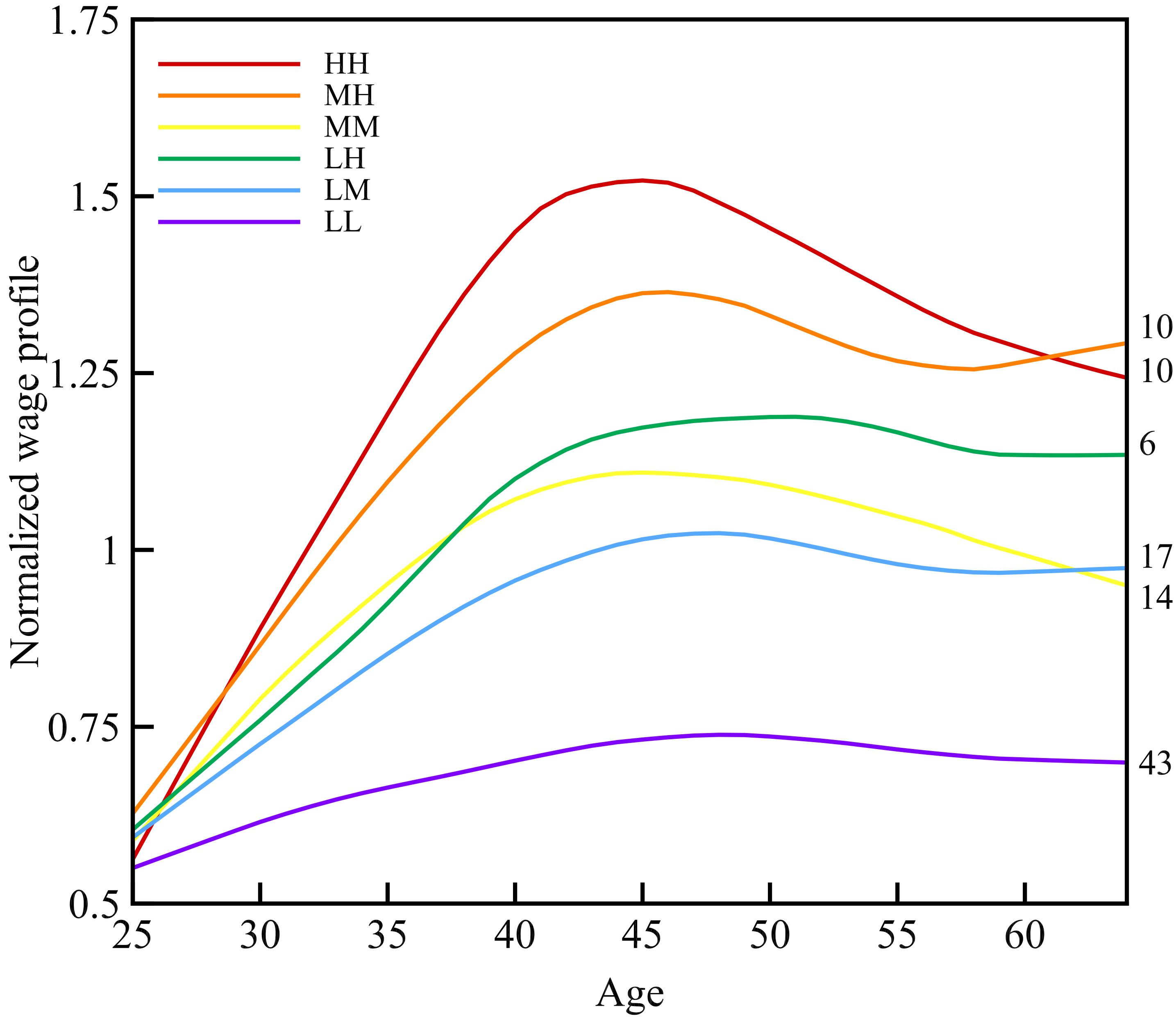
$$\omega_{ij} = \epsilon_{ij} + \eta_{ij}$$
$$\epsilon_{ij} = \rho\epsilon_{ij-1} + u_{ij}$$
$$\eta_{ij} \sim \mathcal{N}(0, \sigma_\eta^2)$$
$$u_{ij} \sim \mathcal{N}(0, \sigma_u^2)$$
$$\epsilon_{i0} \sim \mathcal{N}(0, \sigma_{\epsilon_0}^2)$$

- 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



An Aside

- Government:
    - Can *ex-post* infer type from choices
    - Can't *ex-ante* observe type
- But, can design policy to *induce* truthful reporting of type

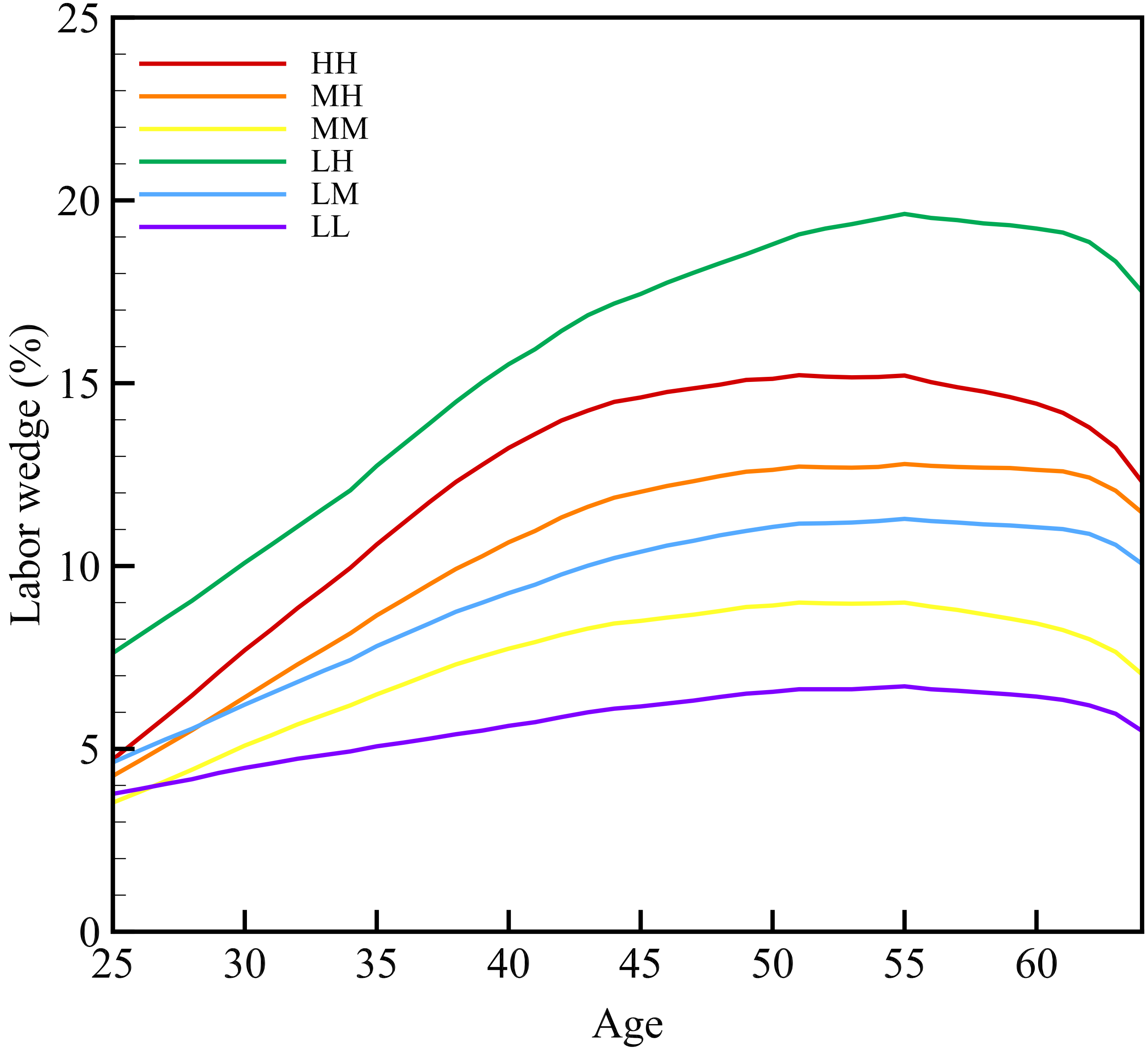
Other Key Parameters

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

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

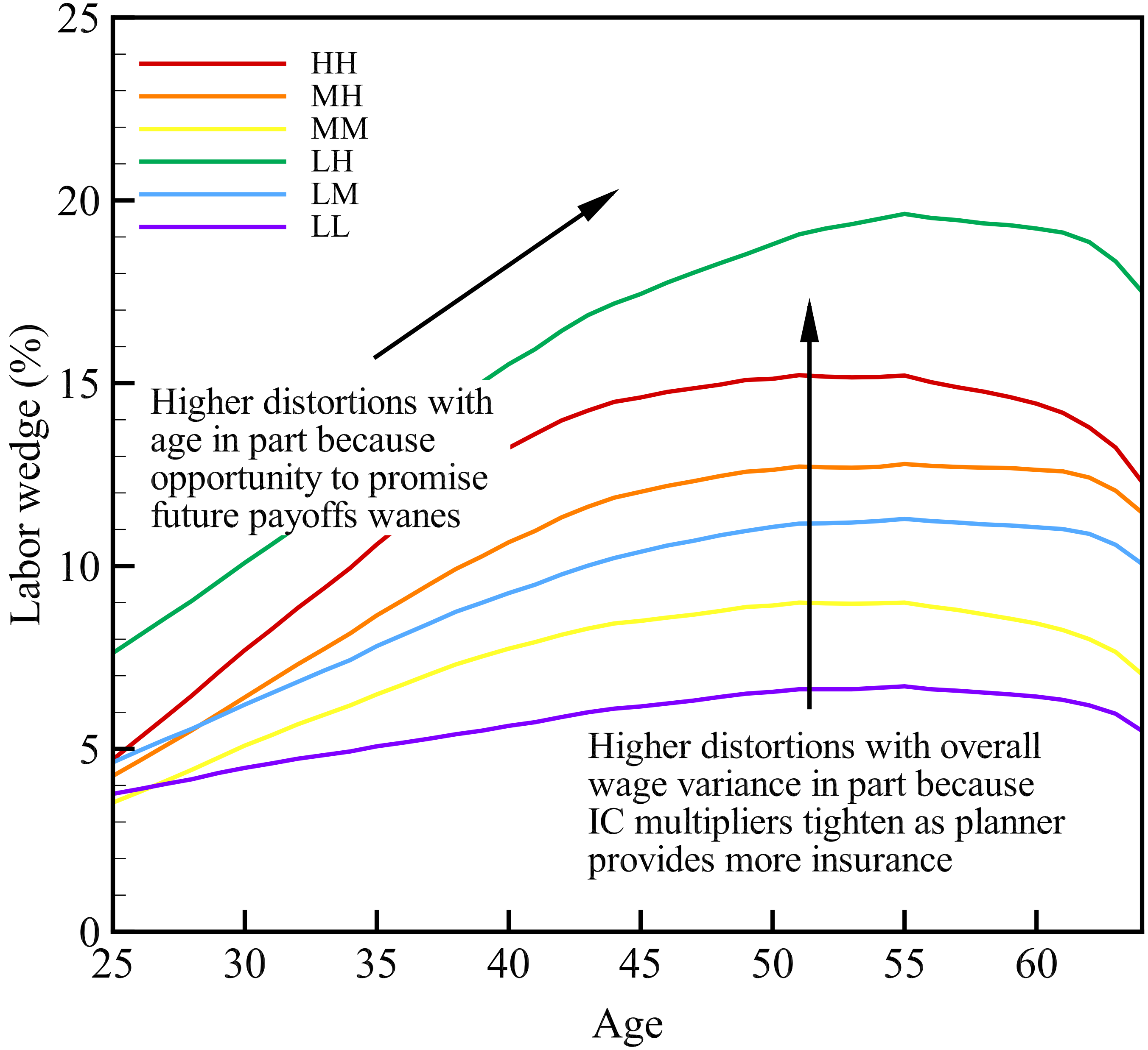
Baseline Results

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



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
Labor wedge (%)
Age
0
5
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60

Welfare

- Consumption equivalent gain of 17%
- Comparing allocations:
  - Consumption: level $\uparrow$ and variance $\downarrow$ for all groups
  - Leisure: level $\downarrow$ and variance $\uparrow$ for all groups

Welfare

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- Comparing allocations:
  - Consumption: level $\uparrow$ and variance $\downarrow$ for all groups
  - Leisure: level $\downarrow$ and variance $\uparrow$ for all groups
- Next, consider welfare decomposition...

Welfare Decomposition ($\Delta = 17\%$)

	Consumption		Leisure	
Education group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
Low, Low	22	2	-11	4
Low, Medium	21	3	-12	5
Low, High	16	5	-10	6
Medium, Medium	21	3	-13	5
Medium, High	19	5	-14	6
High, High	17	8	-15	7

Welfare Decomposition ($\Delta = 17\%$)

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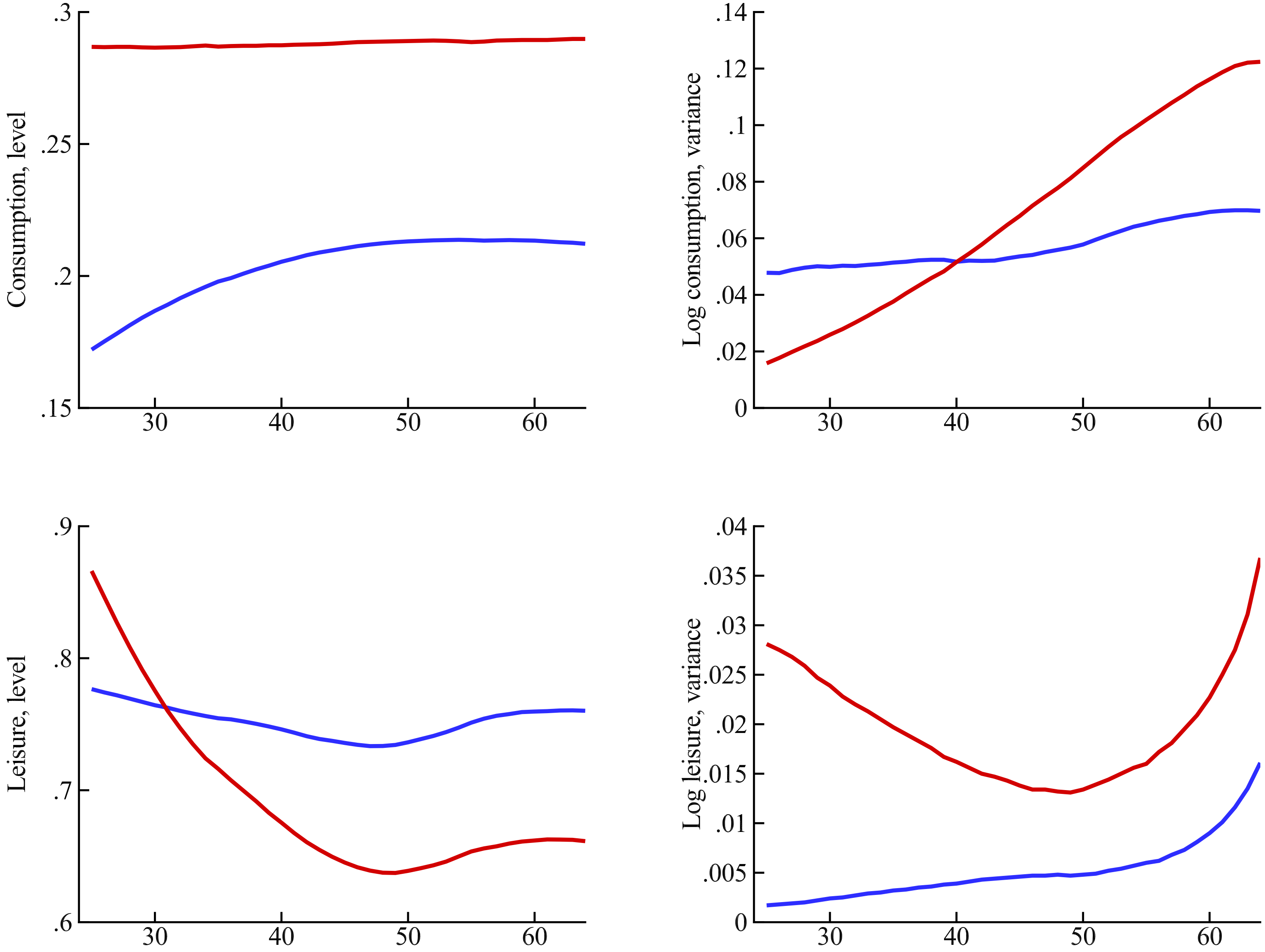
Find significant gains for level increase in consumption

A Look Under the Hood: Group LL



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

- No insurance:

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

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

$\Rightarrow$ variation in consumption, constant leisure

Intuition using Static Problem

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

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- Full insurance:

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

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

Intuition using Static Problem

- No insurance:

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

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

$\Rightarrow$ constant consumption, variation in leisure

Intuition using Static Problem

- No insurance:

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

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

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

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

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

Intuition using Static Problem

- No insurance:

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

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

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

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

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

Sensitivity

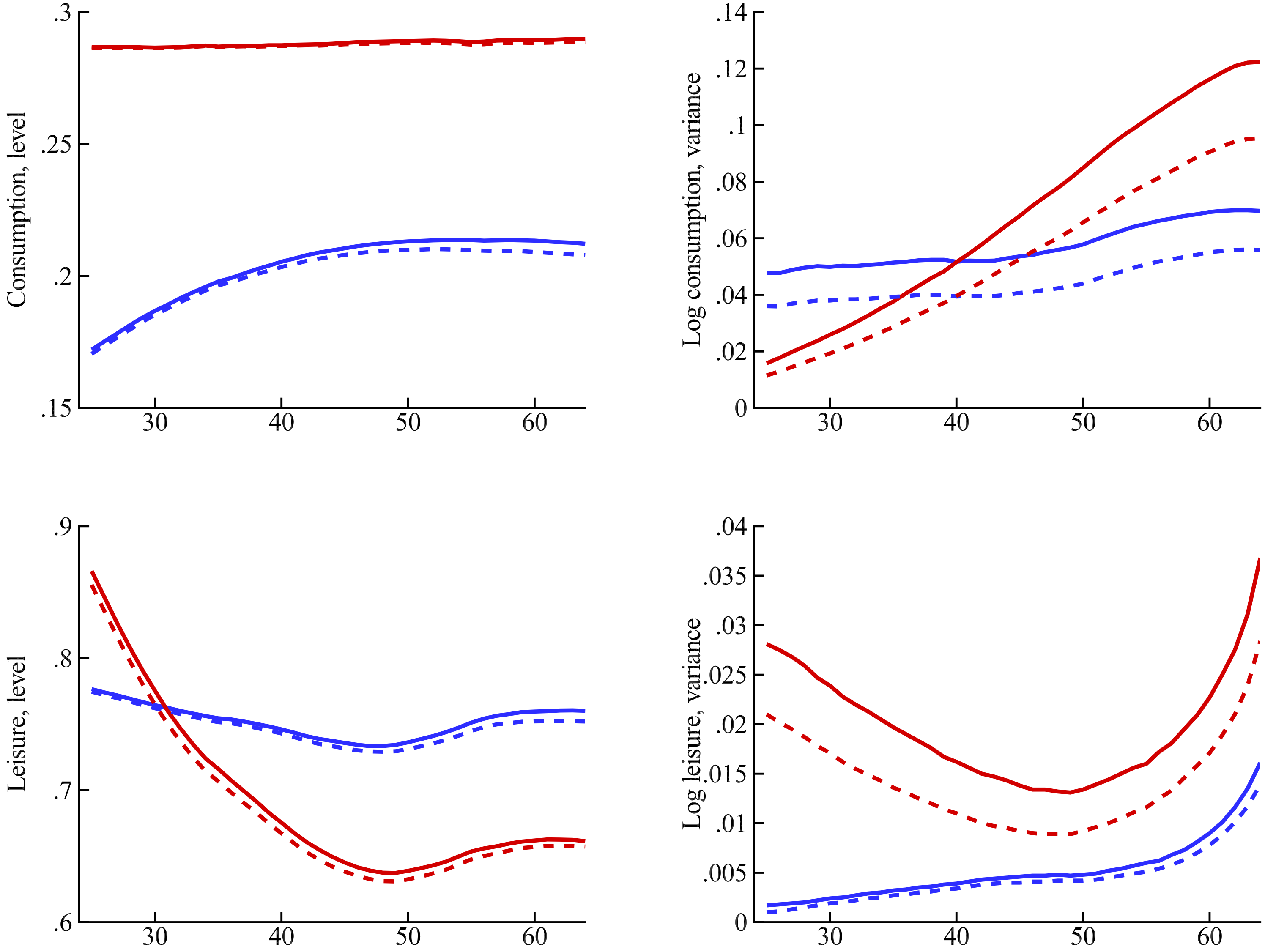
- How do results change with
  - Number of types: $\epsilon_i \in \mathcal{E}$
  - Wage profile: varying or constant over lifecycle
  - Preferences: varying elasticity in $v(\ell)$
  - Wage process: choices of ρ, σ_u^2
- Compare welfare gains and allocations to baseline

Double Number of Types

- Little change in total gain: 16%
- Hardly any change in decomposition:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	$22/22$	$2/1$	$-11/-11$	$4/4$
LM	$21/21$	$3/3$	$-12/-12$	$5/6$
LH	$16/17$	$5/5$	$-10/-13$	$6/7$
MM	$21/21$	$3/3$	$-13/-13$	$5/5$
MH	$19/20$	$5/5$	$-14/-15$	$6/7$
HH	$17/17$	$8/6$	$-15/-15$	$7/7$

Double Number of Types: A Look at LL



Changing Preferences

- Consider alternative preferences:

$$U(c, \ell) = \gamma \log c - \kappa \frac{(1-\ell)^\alpha}{\alpha}$$

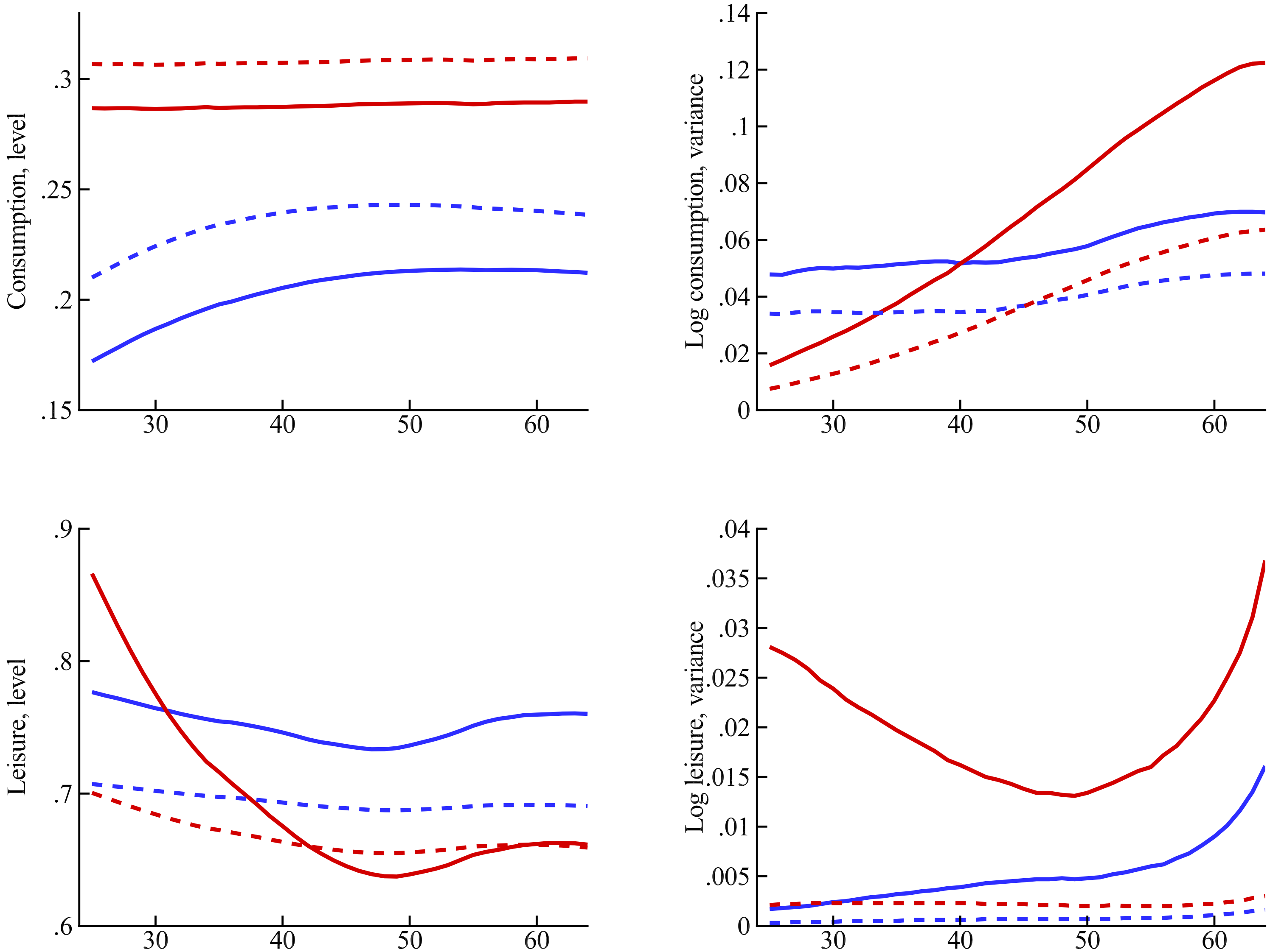
- Set $\alpha = 3 \Rightarrow$ lower labor elasticity of $1/2$

Changing Preferences

- Lower overall gain: 14%
- No gain from lower dispersion in leisure:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	$22/17$	$2/1$	$-11/-4$	$4/1$
LM	$21/15$	$3/2$	$-12/-4$	$5/1$
LH	$16/13$	$5/4$	$-10/-4$	$6/0$
MM	$21/16$	$3/2$	$-13/-5$	$5/1$
MH	$19/15$	$5/3$	$-14/-5$	$6/1$
HH	$17/13$	$8/6$	$-15/-6$	$7/1$

Changing Preferences: A Look at LL

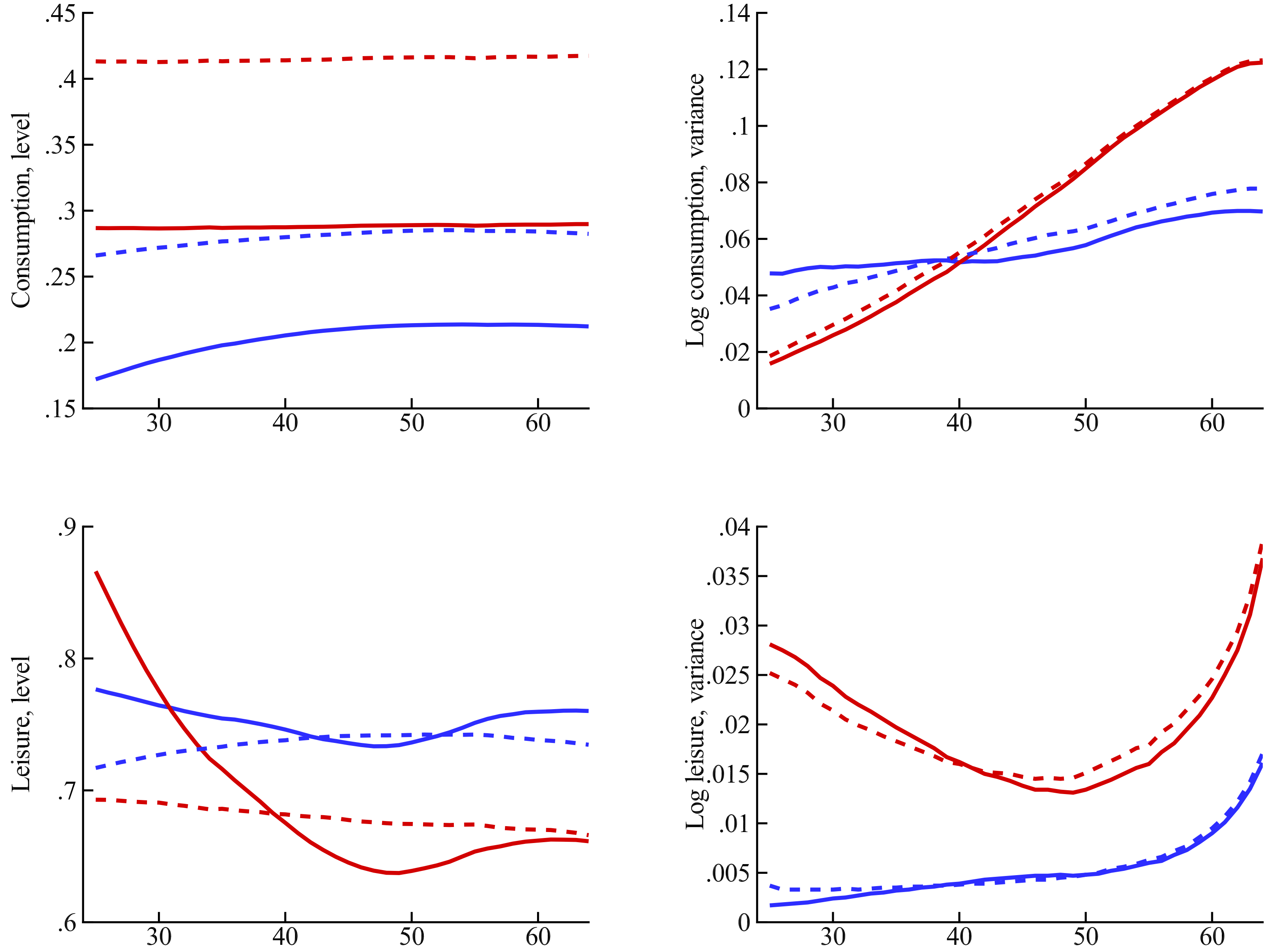


No Wage Growth

- Lower overall gain: 14%
- No gain from lower dispersion:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	22/28	2/0	−11/−9	4/1
LM	21/27	3/0	−12/−7	5/1
LH	16/25	5/0	−10/−5	6/1
MM	21/28	3/0	−13/−8	5/1
MH	19/27	5/0	−14/−7	6/1
HH	17/25	8/1	−15/−6	7/1

No Wage Growth: A Look at LL

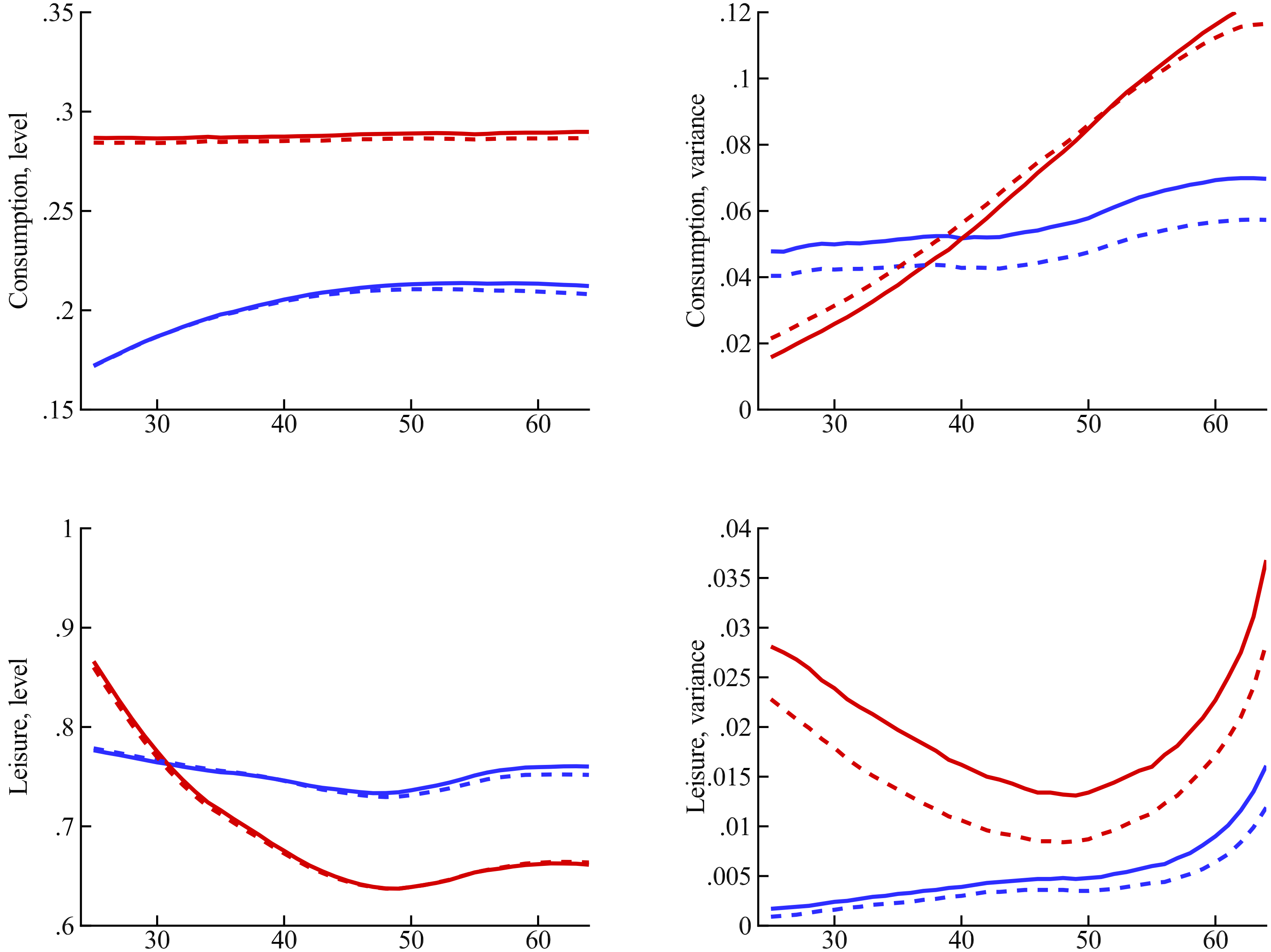


Decrease Shock Variance by 2/3

- Higher overall gain: 19%
- Shows up mostly in levels:

	Consumption		Leisure	
Group	Δ_c^L	Δ_c^D	Δ_ℓ^L	Δ_ℓ^D
LL	$22/26$	$2/1$	$-11/-12$	$4/4$
LM	$21/27$	$3/3$	$-12/-19$	$5/7$
LH	$16/25$	$5/6$	$-10/-21$	$6/8$
MM	$21/26$	$3/3$	$-13/-17$	$5/7$
MH	$19/26$	$5/6$	$-14/-21$	$6/8$
HH	$17/21$	$8/7$	$-15/-17$	$7/8$

Decrease σ_u^2: A Look at LL



Summary

- Gains from efficient tax reform are large
- 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