Quantifying Efficient Tax Reform

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Question

• How large are welfare gains from efficient tax reform?

  ○ Baseline:
    – Positive economy matched to administrative data

  ○ Reform:
    – Pareto improvements on efficient frontier (full)
    – Optima given set of policy tools (restricted)
Idea in a Picture
Idea in a Picture

• Start with baseline OLG economy:
  ◦ Incomplete markets
  ◦ Heterogeneous households
  ◦ Consumption, labor supply, saving decisions
  ◦ Technology parameters and tax policies

• Compute remaining lifetime utilities \((v_j)\)
Idea in a Picture

- Start with baseline OLG economy:
  - Incomplete markets
  - Heterogeneous households
  - Consumption, labor supply, saving decisions
  - Technology parameters and tax policies

- Compute remaining lifetime utilities \((v_j)\)

- Let’s draw this for 2 households...
Idea in a Picture

Value for Household B, $v^B$

Value for Household A, $v^A$

Positive Economy
Idea in a Picture

- Typical starting point for most analyses
  - With constraints on policy instruments
  - Do counterfactuals or restricted optimal (“Ramsey”)

- Let’s draw this in the picture
Idea in a Picture

Value for Household B, $v^B$

Value for Household A, $v^A$

Positive Economy
Idea in a Picture

• Not typical starting point for studies in Mirrlees tradition
  ◦ With constraints on information sets
  ◦ Characterize efficient allocations and policy “wedges”

• Let’s draw this in the picture
This paper quantifies gains from:

- Full Pareto-improving reform a la Mirrlees
- Partial Pareto-improving reform a la Ramsey
- Adding early-life transfer informed by Mirrlees

Let’s draw this in the picture.
Idea in a Picture

Efficient Frontier

Pareto Improving

Positive Economy

Value for Household B, $v^B$

Value for Household A, $v^A$
Idea in a Picture

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Efficient Frontier

Pareto Improving

Restricted Optimal

Positive Economy
Our Approach

- Solve equilibrium 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

- Use results to inform current policy and reforms (●)
Main Findings

- Maximum consumption equivalent gains (future cohorts):
  - 21% starting at age 25
  - Comparisons made to utilitarian planner

- Decompose by comparing allocations:
  - Consumption: level ↑ and variance ↓ for all groups
  - Leisure: level ↓ and variance ↑ for all groups

Note: Currently computing transitions
Main Findings ($\bullet \rightarrow \bullet$)

- Informed by comparison of baseline ($\bullet$) and full reform ($\bullet$)
  - Most gains in lifting consumption levels for young
    $\Rightarrow$ Exploring early-life transfers: adds $\approx 2\%$ gains

*Note:* Computer is still hillclimbing
Contributions to Literature

- Theory and application of income tax design (●⇒)

  ⇒ Using administrative data from NL, go to (●)

- Pareto-improving reforms with fixed types

  Hosseini-Shourideh (2019)

  ⇒ Extend analysis to add dynamic risks

- Theory behind dynamic taxation and redistribution (●)


  ⇒ Link OLG (●) to planner (●) in full GE
Positive Economy (•)

- Open OLG economy a la Bewley
- Household heterogeneity in:
  - Age
  - Education (observed, permanent)
  - Productivity (private, stochastic)
  - Marital risk
  - Divorce risk (in progress)
  - Unemployment risk (in progress)
- Transfers and taxes on consumption, labor income, assets
Positive Economy ($\bullet$)

- Household problem

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

s.t. \[ a' = (1 + r)a - T_a(ra) + \epsilon n - T_n(j, \epsilon n) - (1 + \tau_c)c \]

where

- $j =$ age
- $a =$ financial assets
- $\epsilon =$ productivity shock
- $\Omega =$ factor prices and tax policies
- $c =$ consumption
- $n =$ labor supply ($n + \ell = 1$)
Reform Problem (●)

- Take inputs from positive economy:
  - Parameters for preferences and technologies
  - Wage profiles and shock processes
  - Values under current policy \((v_A, v_B, \ldots)\)

- Compute maximum consumption equivalent gain
Notion of Efficiency

• Our focus is Pareto-improving reforms:
  ○ There is no alternative allocation that is
    – Resource feasible
    – Incentive feasible
  ○ Making all better off and some strictly better off

• Will report gain assuming same percentage for all
Pareto-improving Reforms

Efficient Frontier

Pareto Improving

Positive Economy

Value for Household B, $v^B$

Value for Household A, $v^A$
Pareto-improving Reforms

How to construct this?

Value for Household B, $v^B$

Value for Household A, $v^A$

Efficient Frontier

Positive Economy

Pareto Improving
Planner Problem in Words

- Maximize present value of aggregate resources
- subject to
  - Incentive constraints for every household and history
  - Value delivered exceeds that of positive economy
Planner Problem in Practice

- Exploit separability to solve household by household
- Include only local downward incentive constraints
  - Verify numerically that constraints are satisfied
- Solve recursively by introducing additional states
  - Promised value for truth telling
  - Threat value for local lie
Planner Problem in Practice

- Exploit separability to solve household by household

- Include only local downward incentive constraints (IC)
  - Verify numerically that all ICs satisfied

- Solve recursively by introducing additional states
  - Promised value for truth telling ($V$)
  - Threat value for local lie ($\tilde{V}$)
Planner Problem for a Household
Planner Problem for a Household

Max present value of resources
Planner Problem for a Household

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \right] + \text{future value} \]

As in positive economy,

\[ 1. \] j = age
\[ 2. \] \epsilon = productivity shock
\[ 3. \] c = consumption
\[ 4. \] n = labor supply
Planner Problem for a Household

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) [w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \\
+ \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i) / R] \]

Additionally, planner chooses

- \( V_j = \) promise value
- \( \tilde{V}_j = \) threat value
Planner Problem for a Household

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i|\epsilon) \left[ w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R \right] \]

s.t. Local downward incentive constraints
Planer Problem for a Household

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \right. \\
\left. + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i) / R \right] \]

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), \quad 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

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \right. \]

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

Deliver at least the promised value
Planner Problem for a Household

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i|\epsilon) \left[ w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \right. \\
\left. \quad + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i) / R \right] \]

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

\[ V \leq \sum_{\epsilon_i} \pi_j(\epsilon_i|\epsilon) \left[ U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right] \]
Planner Problem for a Household

\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon} \pi_j(\epsilon_i|\epsilon) \left[w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \right. \\
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\quad \quad \quad \geq U(c_j(\epsilon_{i-1}), \ell_{j+}^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \quad i \geq 2

\[ V \leq \sum_{\epsilon} \pi_j(\epsilon_i|\epsilon) \left[U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right] \]

Deliver no more than the threat value
\[ \Pi_j(V, \tilde{V}, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) \right. \\
\left. + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i) / R \right] \]

s.t. \[ U(c_j(\epsilon_i), l_j(\epsilon_i)) + \beta V_j(\epsilon_i) \]

\[ \geq U(c_j(\epsilon_{i-1}), l_j^+(\epsilon_{i-1})) + \beta \tilde{V}_j(\epsilon_i), \ i \geq 2 \]

\[ V \leq \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ U(c_j(\epsilon_i), l_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right] \]

\[ \tilde{V} \geq \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon^+) \left[ U(c_j(\epsilon_i), l_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right] \]
Planner Problem for Future Generation ($j = 1$)

$$
\Pi_j(V, -, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ w\epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i)/R \right]
$$

s.t.  \hspace{1cm} U(c_j(\epsilon_i), l_j(\epsilon_i)) + \beta V_j(\epsilon_i)

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

$$V \leq \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ U(c_j(\epsilon_i), l_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right]$$

No threat value
Planner Problem for Future Generation \((j = 1)\)

\[
\Pi_j(V, -, \epsilon) \equiv \max \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ w \epsilon_i n_j(\epsilon_i) - c_j(\epsilon_i) + \Pi_{j+1}(V_j(\epsilon_i), \tilde{V}_j(\epsilon_{i+1}), \epsilon_i) / R \right]
\]

s.t. \( U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \)

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

\[
V \leq \sum_{\epsilon_i} \pi_j(\epsilon_i | \epsilon) \left[ U(c_j(\epsilon_i), \ell_j(\epsilon_i)) + \beta V_j(\epsilon_i) \right]
\]

Replace arbitrary \( V \) with \( \vartheta(\epsilon_0) + \vartheta_\Delta \)
General Equilibrium

- Solve planner problem for positive economy values

- Evaluate resource constraints

\[ C_t + I_t + G_t + B_{t+1} = F(K_t, N_t) + RB_t \]

\[ \lim_{T \to \infty} \frac{1}{R^{T-1}}(B_T + K_T) \geq 0 \]

- Increase \( \vartheta_\Delta \) until resources exhausted
Pareto-improving Reforms

Value for Household A, $v^A$

Value for Household B, $v^B$

Efficient Frontier

Pareto Improving

Positive Economy
Pareto-improving Reforms

Value for Household A, $v^A$

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Efficient Frontier

Pareto Improving

Positive Economy
Quantitative Steps

1. Data

2. Quantify efficient reform (●→●)

3. Use answer to inform restricted reform (●→●)
Netherlands

• Merged administrative data, 2006-2014
  - Earnings from tax authority
  - Hours from employer provided data
  - Education from population survey

• National accounts

• Tax schedules

*Note*: Big data advantage for estimating elasticities & shocks
Estimation of Wage Processes

• Construct hourly wages $W_{ijt}$ ($j=$age, $t=$time)

• Classify degrees:
  ◦ High school or practical (Low)
  ◦ University of applied sciences (Medium)
  ◦ University (High)

• Construct residual wages $\omega_{ijt}$:
  ◦ $\log W_{ijt} = A_t + X_{ijt} + \omega_{ijt}$
  ◦ Estimate AR(1) process for idiosyncratic risk
Marriage and Household Structure

• In period 0, individuals are single
  ○ Different by education (L,M,H)

• After that, individuals either
  ○ Form a couple (LL,LM,LH,MM,MH,HH) or
  ○ Remain single (included with LL,MM,HH)

Note: Working on adding divorce risk
## Wage Process Estimates

<table>
<thead>
<tr>
<th>Group</th>
<th>$\hat{\rho}$</th>
<th>$\hat{\sigma}^2_u$</th>
</tr>
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<tbody>
<tr>
<td>Low, Low</td>
<td>.9542</td>
<td>.0096</td>
</tr>
<tr>
<td>Low, Medium</td>
<td>.9660</td>
<td>.0087</td>
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<tr>
<td>Low, High</td>
<td>.9673</td>
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<td>Medium, Medium</td>
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<td>.0109</td>
</tr>
<tr>
<td>High, High</td>
<td>.9564</td>
<td>.0172</td>
</tr>
</tbody>
</table>
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 productivity types
- Preferences
- Status quo policy

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

- Welfare gains
  - Total consumption equivalent ($\vartheta_\Delta$)
  - Decomposition

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

⇒ Hopefully informative for reforming current policy
Labor Wedges

Increasing with age since the opportunity to promise future payoffs decreases.

Increasing with wage variance as planner trades off increasing distortions with more insurance.
Welfare, (●) vs (●)

• Consumption equivalent gain of 21% for future cohorts

• Large but maybe not surprising given:
  ◦ Tax rates in NL over 40%
  ◦ Tax wedges of planner in 4% to 20% range
Welfare, (●) vs (●)

• Consumption equivalent gain of 21% for future cohorts

• Large but maybe not surprising given:
  ○ Tax rates in NL over 40%
  ○ Tax wedges of planner in 4% to 20% range

• What are the implied Pareto weights?
Implied Pareto Weights

• Could also have solved:
  
  ◦ $\max \sum_i \omega_i V^i$
  
  ◦ subject to resource and incentive constraints

• What are the implied $\omega_i$’s for L, M, H?
## Pareto Weights and Welfare Gains

| Education | Equal Gains | | Equal Weights | |
|-----------|-------------|------------------|
|           | $\omega_i$  | $\Delta_i$       | $\omega_i$  | $\Delta_i$ |}
| Low       | 0.8         | 21               |             |             |
| Medium    | 1.0         | 21               |             |             |
| High      | 1.2         | 21               |             |             |
# Pareto Weights and Welfare Gains

<table>
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<th>Equal Weights(^\dagger)</th>
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\(^\dagger\) Utilitarian planner with \(V^H \geq V^M \geq V^L\)
Comparing Allocations, (∗) vs (•)

• Consumption: level ↑ and variance ↓ for all groups

• Leisure: level ↓ and variance ↑ for all groups

• Intuition from simple static model:
  ◦ No insurance: \( c \) varies, \( \ell \) constant
  ◦ Full insurance: \( c \) constant, \( \ell \) varies

• What about magnitudes?
A Look Under the Hood: Group LL

Levels of Consumption

Levels of Leisure

Variances of Log Consumption

Variances of Log Leisure
A Look Under the Hood: Group LL

![Graphs showing consumption, leisure, and log consumption/leisure variance for Planner and Positive cases.](image-url)
Informing Counterfactuals (●)

- Efficient Frontier
- Pareto Improving
- Restricted Optimal
- Positive Economy

Value for Household B, $v^B$

Value for Household A, $v^A$
Informing Counterfactuals (●)

• Results of planner problem suggest large gains to
  ○ Lower average marginal tax rates
  ○ Early life transfers

Note: our results on restricted gains still tentative
Summary

• Ultimate deliverables of project:
  ○ Estimates of gains for efficient reform
  ○ Identification of sources of gains
  ○ Ideas for new policy instruments
  ○ Prototype for future analyses

• Stay tuned...