Demographics and Capital/Labor Tax Rates in OECD Countries

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Facts and Question

Facts

▶ OECD Countries differ in the capital and labor tax rates. (Mendoza, Razin, and Tesar, JME, 1994, and Carey and Tchilinguirian, 2000)
▶ The capital and labor tax rates differ in a systematic way: a country with relatively many old households has a relatively low capital tax rate and high labor tax rate.

Question

▶ WHY?
▶ HOW MUCH of the differences in tax can be explained by the differences in demographics?
Pairwise Correlation b/w Old Dependency Ratio and Tax Ratio
(Carey and Tchilinguirian Definition in 1980s Average)
## Simple Regression Analysis

<table>
<thead>
<tr>
<th></th>
<th>( Y = \tau_k/\tau_l )</th>
<th>OLS1</th>
<th>OLS2</th>
<th>Fixed1</th>
<th>Fixed2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( ODR )</td>
<td>old dep. ratio</td>
<td>-3.44</td>
<td>-42.38</td>
<td>-2.84</td>
<td>-26.59</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.05)</td>
<td>(8.90)</td>
<td>(2.39)</td>
<td>(10.25)</td>
</tr>
<tr>
<td>( ODR^2 )</td>
<td></td>
<td></td>
<td>83.24</td>
<td></td>
<td>54.44</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(18.94)</td>
<td></td>
<td>(23.01)</td>
</tr>
<tr>
<td>( ssb )</td>
<td>social security</td>
<td>0.25</td>
<td>0.24</td>
<td>0.47</td>
<td>0.46</td>
</tr>
<tr>
<td></td>
<td>replacement rate</td>
<td>(0.29)</td>
<td>(0.26)</td>
<td>(0.39)</td>
<td>(0.34)</td>
</tr>
<tr>
<td>( govc )</td>
<td>government cons. as</td>
<td>0.45</td>
<td>2.01</td>
<td>0.57</td>
<td>0.38</td>
</tr>
<tr>
<td></td>
<td>share of GDP</td>
<td>(1.55)</td>
<td>(1.29)</td>
<td>(4.10)</td>
<td>(3.58)</td>
</tr>
<tr>
<td>( size )</td>
<td>population &gt; 20 relative to world</td>
<td>1.69</td>
<td>1.63</td>
<td>31.58</td>
<td>39.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.45)</td>
<td>(0.36)</td>
<td>(22.67)</td>
<td>(19.94)</td>
</tr>
</tbody>
</table>
**Intuition and Methodology**

- Retired Households (old)
  - A larger fraction of income comes from capital income.
- Working Households (young)
  - A larger fraction of income comes from labor income.
- The old and the young disagree on the capital and labor tax policy.
- Aggregation of the preferences
  - Majority voting (one-time with commitment)
Environment: Primitives

- Infinite horizon small open economy
- Unit mass of households who maximize the expected lifetime utility.
- Incomplete market.
- No borrowing constraint.

Household Preferences (GHH Utility Function)

$$u(c, l) = \frac{1}{1 - \sigma} \left\{ c - \psi \frac{l^{1 + \frac{1}{\epsilon}}}{1 + \frac{1}{\epsilon}} \right\}^{1 - \sigma}$$

Production Function

$$f(K, L) = K^\alpha L^{1 - \alpha}$$

Capital depreciates with a rate $\delta$. 
**Environment: Demographics (Gertler, 1999)**

New born young agents with no asset

- **YOUNG**
  - Remain young with probability $\omega$

- **OLD**
  - Remain alive with probability $\gamma$

**Old Dependency Ratio (ODR)**

$$\text{ODR} = \frac{(1 - \gamma)}{(1 - \omega)}$$

**Average Life Span**

$$\text{Average Life Span} = \frac{1}{(1 - \gamma)} + \frac{1}{(1 - \omega)}$$
**Old Household’s Problem**

\[
v(a, o; \Gamma, \tau_k) = \max \{c, a'\} u(c, l) + \beta \gamma_i v(a', o; \Gamma', \tau_k')
\]

subject to

\[
c + a' = \frac{1 + r^*(1 - \tau_k)}{\gamma_i} a + b w l
\]

\[
\Gamma' = H(\Gamma, \tau_k)
\]

\[
\tau_{k'} = \Psi(\Gamma, \tau_k)
\]

where \( \bar{l} \) is the average hours worked and \( \tau_l \) is set such that the government budget constraint is balanced.
Young Household’s Problem

\[ v(a, y; \Gamma, \tau_k) = \max \{ c, a', l \} u(c, l) \]

\[ + \beta [\omega_i v(a', y; \Gamma', \tau'_k) + (1 - \omega_i) v(a', o; \Gamma', \tau'_k)] \]

subject to

\[ c + a' = (1 + r^*(1 - \tau_k))a + (1 - \tau_l)wl \quad (7) \]

\[ \Gamma' = H(\Gamma, \tau_k) \quad (8) \]

\[ \tau'_k = \Psi(\Gamma, \tau_k) \quad (9) \]

where \( \tau_l \) is set such that the government budget constraint is balanced.
Environment: Government

- Provide public goods and social security benefits through tax revenue

\[ G + bwL \frac{1 - \omega_i}{1 - \gamma_i} = \tau_k r^* A + \tau_l wL \]  

(10)

where \( r^* \) is the world real interest rate and \( A \) is the aggregate asset holding.

- Provide annuity market (Gertler, 1999)
Voting: What is $\Psi$?

- Voting takes place at $t = 0$, once and for all (commitment).
- Given $\tau_{k,0}$ and $\Gamma(\tau_{k,0})$, rational and forward-looking households vote for a permanent future capital tax rate $\{\tau_{k,t}\}_{t=1}^\infty$ with $\tau_{k,1} = \tau_{k,2} = \ldots$.
- The future labor tax rates adjust such that the government budget constraint holds every period.
- Tax preference is single peaked.
- Median voter chooses a constant future capital tax rate.
- Stationary equilibrium such that the initial capital tax rate is equal to the capital tax rate that the median voter chooses.
Single Peakedness and Tax Preference with Different Initial Asset
Exercise

- Calibrate the model economy to each sample OECD country.
  - The only source of country heterogeneity is \( \{\omega_i, \gamma_i\} \).
- Find a stationary politico-economic equilibrium for each country.
- Plot the simulated tax ratios in stationary politico-economic equilibria against the actual data points.
# Calibration: Common Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r^*$</td>
<td>$1.04^4 - 1$</td>
<td>Mendoza (1991)</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.96$^4$</td>
<td>Discount factor</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>1</td>
<td>Coefficient of Relative Risk Aversion</td>
</tr>
<tr>
<td>$\epsilon$</td>
<td>0.3</td>
<td>Heathcote (2005)</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.33</td>
<td>Gollin (2002)</td>
</tr>
<tr>
<td>$\delta$</td>
<td>$1 - (1 - 0.06)^4$</td>
<td>Stokey and Rebelo (1995)</td>
</tr>
<tr>
<td>$\psi$</td>
<td>1.8</td>
<td>Hours Worked = 0.3 (for the US)</td>
</tr>
<tr>
<td>$b$</td>
<td>0.47</td>
<td>Sample average SS replacement rate</td>
</tr>
<tr>
<td>$g$</td>
<td>0.08</td>
<td>Sample average government consumption</td>
</tr>
</tbody>
</table>
Calibration: Country Specific Parameters

- Two moments to match
  - Country specific old dependency ratio:
    \[
    \frac{1 - \omega_i}{1 - \gamma_i}
    \]  
    (11)
  - Common average length of life (14 model periods):
    \[
    \frac{1}{1 - \omega_i} + \frac{1}{1 - \gamma_i}
    \]  
    (12)

- Summary statistics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mean</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\omega)</td>
<td>0.0873</td>
<td>0.0026</td>
</tr>
<tr>
<td>(\gamma)</td>
<td>0.4027</td>
<td>0.0560</td>
</tr>
</tbody>
</table>
Main Results

Simulated Data (Triangles) VS Actual Data (Circles)

- Capital Tax Rate / Labor Tax Rate
- Old Dependency Ratio

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SUMMARY

- The calibrated model replicates
  - The negative correlation between the old dependency ratios and the tax ratios.
  - The level of the tax ratios (slightly over-predicted)
  - The nonlinearity
EXTENSION AND FUTURE RESEARCH

- sequential voting
- endogenizing other political parameters (social security benefit)
Voting

How are taxes determined? (What is $\Psi$?)

- Voting takes place at $t = 0$, once and for all (commitment).
- Given $\tau_{k,0}$, rational and forward-looking households vote for $\{\tau_{k,t}\}_{t=1}^{\infty}$ with $\tau_{k,1} = \tau_{k,2} = \ldots$. In recursive form,

$$\tau''_k = \Psi(\Gamma', \tau'_k) = \tau'_k \quad \forall \Gamma', \tau'_k$$

- The future labor tax rate adjusts such that the government budget constraint holds.
**Finding Stationary Equilibrium**

- Given $\tau_k$ and a possible future capital tax rate, $\tau_k'$, the young households solve

$$
\tilde{v}(a, y; \Gamma, \tau_k, \tau_k') = \max\{c, a', l\} u(c, l) + \beta [\omega iv(a', y; \Gamma', \tau_k') + (1 - \omega) v(a', o; \Gamma', \tau_k')]
$$

subject to

$$
c + a' = (1 + r^* (1 - \tau_k)) a + (1 - \tau_l) w l
$$  \hspace{1cm} (14)

$$
\Gamma' = \tilde{H}(\Gamma, \tau_k, \tau_k')
$$  \hspace{1cm} (15)

$$
\tau_k'' = \Psi(\Gamma', \tau_k') = \tau_k' \forall \Gamma', \tau_k'
$$  \hspace{1cm} (16)

where $\tau_l$ is set such that the government budget constraint is balanced.

- Old households solve a similar problem.

- This determines the indirect utility of voting for $\tau_k'$, given $\tau_k$. 
Finding Stationary Equilibrium

- Tax preference is single peaked (Median Voter Theorem)
- Median voter chooses a constant future tax rate:

\[ \Psi_0(\Gamma, \tau_k) = \arg\max_{\tau_k'} \tilde{\nu}((a, s)_{median}, \Gamma, \tau_k, \tau_k'') \]

with all continuation values evaluated according to the “identity” function.

- Stationary equilibrium: \( \tau_k = \tau_k' = \tau_k'' = ... \)
- This restricts only the evolution of tax rates - the evolution of the distribution is given by \( H(\Gamma, \tau_k) \). It is still necessary to compute the entire transition (of prices) to evaluate each possible tax change.

\[
\begin{align*}
\Gamma' &= \tilde{H}(\Gamma, \tau_k, \tau_k') \\
\Gamma'' &= H\left(\tilde{H}(\Gamma, \tau_k, \tau_k'), \tau_k'\right) \\
\Gamma''' &= H\left[H\left(\tilde{H}(\Gamma, \tau_k, \tau_k'), \tau_k'\right), \tau_k'\right]
\end{align*}
\]