Marginal Tax Rates and Income: New Time Series Evidence

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Introduction

Do marginal tax rates matter for decisions to work and invest?

Stabilization and growth, austerity, income inequality, optimal taxation, ...
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Empirical effects on income (short run):

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- *IRS tax returns data*; Saez, Slemrod and Giertz (JEL 2012)

  **Modest effects**, concentrated at the top of the income distribution,


  **Large effects** on real GDP, investment, employment, hours,...

+ International evidence: UK (Cloyne, AER 2013), Germany (Hayo and Uhl, OEB 2013), OECD (Guajardo et al., JEEA fc)
This paper

Application of SVARs and the narrative approach to IRS tax returns data.

*Improvements:* Addressing endogeneity and dynamics.
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Improvements: Addressing endogeneity and dynamics.

Key Findings:

1. Aggregate changes in marginal income tax rates:
   - Large income responses on impact, hump-shaped
   - Similar elasticities across income percentile brackets.
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*Key Findings:*

1. Aggregate changes in marginal income tax rates:
   - Large income responses on impact, hump-shaped
   - Similar elasticities across income percentile brackets.

2. Changes in top marginal tax rates:
   - Top incomes and real GDP respond positively
   - Positive spillovers on other incomes, but greater inequality.
Motivating Framework

Agent $i \in [0, 1]$ has labor supply

$$h_{it} = h((1 - T'(e_{it}))w_{it}/x_{it})^\epsilon$$

e_{it} = w_{it}h_{it}, \ w_{it}/x_{it} \text{ (detrended) real wage, } \epsilon \text{ labor supply elasticity.}

Tax schedule $T(\cdot)$ as in Heathcoate, Storesletten and Violante (2011):

$$T(e_{it}) = e_{it} - (1 - \tau_t)(e_{it}/\bar{e}_t)^{1-\gamma} \bar{e}_t, \ 0 \leq \gamma < 1$$

where $\bar{e}_t = \left(\int_0^1 e_{it}^{1-\gamma} di\right)^{1/(1-\gamma)}$, tax progressivity $\gamma$

Economy-wide **average marginal tax rate** (AMTR):

$$\tau_t = 1 - \int_0^1 (e_{it}/\bar{e}_t)(1 - T'(e_{it}))di$$
For any subset $S \subseteq [0, 1]$, 

$$\Delta \ln(e^s_t) = \epsilon \Delta \ln(1 - \tau^s_t) + r^s_t$$

where $\tau^s_t = 1 - \int_S (e_{it}/\bar{e}^s_t(1 - T'(e_{it}))di)$ is the AMTR for $S$.

$r^s_t$ are non-tax determinants of earnings growth.

In reality, tax liability is based on reported taxable income.

Capital income, exemptions, deductions; tax avoidance/evasion

So, $\epsilon$ interpreted more broadly as the elasticity of taxable income.
Federal individual income tax only. Based on Saez (2004) and Barro and Redlick (2011), extended à la Barro and Sahasakul (1983) based on SOI.
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Average Marginal Tax Rates

Table 1 Average Marginal Tax Rates 1950-2010: Descriptive Statistics

<table>
<thead>
<tr>
<th></th>
<th>( \tau_t \times 100 )</th>
<th>( \Delta \ln(1 - \tau_t) \times 100 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>All, Series 1</td>
<td>23.69</td>
<td>2.05</td>
</tr>
<tr>
<td>All, Series 2</td>
<td>24.38</td>
<td>2.39</td>
</tr>
<tr>
<td>Top 1%</td>
<td>44.72</td>
<td>8.10</td>
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<tr>
<td>Top 5%</td>
<td>37.10</td>
<td>4.68</td>
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<tr>
<td>Top 10%</td>
<td>33.74</td>
<td>3.85</td>
</tr>
<tr>
<td>Top 5-1%</td>
<td>31.56</td>
<td>4.95</td>
</tr>
<tr>
<td>Top 10-5%</td>
<td>26.92</td>
<td>3.88</td>
</tr>
<tr>
<td>Bottom 99%</td>
<td>22.09</td>
<td>2.58</td>
</tr>
<tr>
<td>Bottom 90%</td>
<td>19.19</td>
<td>1.98</td>
</tr>
</tbody>
</table>
Income data from Piketty and Saez (2007)

OLS regression

\[ \Delta \ln(e_t^s) = \beta \Delta \ln(1 - \tau_t^s) + u_t \]

<table>
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<th></th>
<th>All Tax Units</th>
<th>Top 1%</th>
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A. 1951-2010

B. 1960-2000

In parentheses are Newey-West 95% intervals with 8 lags. Asterisks denote 10%, 5% or 1% significance.

**Total income:** gross income excluding government transfers and capital gains.

Additional controls, instrumenting with statutory rates yields similar results, see Saez (2004), Romer and Romer (2012),...
Endogeneity

1. GE Effects: Tax changes affect other determinants of labor supply/income

   \[ \Rightarrow \beta^{OLS} \text{ not estimating } \epsilon, \text{ but the ‘total’ causal effect } \eta \]

2. Tax changes are endogenous.

   \[ \Rightarrow \text{Reverse causality means } \beta^{OLS} \text{ has no useful interpretation.} \]
Endogeneity

1. GE Effects: Tax changes affect other determinants of labor supply/income

⇒ $\beta^{OLS}$ not estimating $\epsilon$, but the ‘total’ causal effect $\eta$

2. Tax changes are endogenous.

⇒ Reverse causality means $\beta^{OLS}$ has no useful interpretation.

In the paper, I derive the asymptotic bias due to

- Policy responses (to govt spending and output): downward bias
- Bracket creep (income and inflation): downward bias
- Anticipation effects: upward bias (probably larger for top incomes)
- Endogenous income distribution: downward bias for top incomes
- Other reasons: Overdifferencing (ambiguous), measurement error (downward bias), time aggregation (downward bias)

Bias generally decreasing in the variance of tax rates, and hence in income.
Structural Vector Autoregressive Models

**Key Assumption 1:** I have $X_t$ such that there exists a representation:

\[
\begin{bmatrix}
\ln(1 - \tau_t) \\
\ln(e_t) \\
X_t
\end{bmatrix}
= dt + B(L)
\begin{bmatrix}
\ln(1 - \tau_{t-1}) \\
\ln(e_{t-1}) \\
X_{t-1}
\end{bmatrix}
+ \begin{bmatrix}
u_t^\tau \\
u_t^e \\
u_t^x
\end{bmatrix},
\]

$d_t$: deterministic terms, $B(L)$: a finite order lag polynomial, and

\[
\begin{align*}
u_t^\tau &= \nu_t^\tau + \xi_e u_t^e + \xi_x u_t^x \\
u_t^e &= \eta \nu_t^\tau + \zeta_e \nu_t^o \\
u_t^x &= \theta \nu_t^\tau + \zeta_x \nu_t^o
\end{align*}
\]

$v_t^\tau$ tax shock, $v_t^o$ all other shocks, $\eta$ income elasticity w.r.t net-of-tax rate
Structural Vector Autoregressive Models

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\begin{bmatrix}
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\ln(e_t) \\
X_t
\end{bmatrix} = d_t + B(L) \begin{bmatrix}
\ln(1 - \tau_{t-1}) \\
\ln(e_{t-1}) \\
X_{t-1}
\end{bmatrix} + \begin{bmatrix}
u_t^T \\
u_t^e \\
u_t^x
\end{bmatrix},
\]

$d_t$: deterministic terms, $B(L)$: a finite order lag polynomial, and

\[
\begin{align*}
u_t^T &= \nu_t^T + \xi_v u_t^e + \xi_x u_t^x \\
u_t^e &= \eta v_t^T + \xi_v v_t^o \\
u_t^x &= \theta v_t^T + \xi_x v_t^o
\end{align*}
\]

$v_t^T$ tax shock, $v_t^o$ all other shocks, $\eta$ income elasticity w.r.t net-of-tax rate

Key Assumption 2: I have a proxy $m_t$ such that

\[
E[m_t v_t^T] \neq 0 \quad \text{and} \quad E[m_t v_t^o] = 0.
\]

See Mertens and Ravn (AER 2013, JME 2013) and Stock and Watson (NBER 2008, BPEA 2012)
Data & Specification

Sample: 1950-2010, two lags, constant term

\( \ln(1 - \tau_t) \): AMTR for all tax units, Series 1
\( \ln(e_t) \): average total income/average wage income reported to IRS

\( X_t \): macro controls

- Log real GDP per capita
- Inflation (CPI-U-RS)
- Federal Funds Rate
- Log real government spending per capita (Purchases + Net Transfers)
- Log change of real federal government debt per capita (held by the public)
- Log of average realized capital gains on tax returns

Proxy \( m_t \): projected impact on tax liabilities of 12 legislative changes affecting individual statutory rates

‘Exogenous’ according to Romer and Romer (2009)
Legislated and effective within one year
Scaled by lagged total income and demeaned.
Implementation

\[
\begin{align*}
  u_t^\tau &= v_t^\tau + \xi_e u_t^e + \xi_x u_t^x \\
  u_t^e &= \eta v_t^\tau + \zeta_e v_t^o \\
  u_t^x &= \theta v_t^\tau + \zeta_x v_t^o
\end{align*}
\]

1. Regress \(u_t^e\) and \(u_t^x\) on \(u_t^\tau\) using \(m_t\) as instruments. Define the residuals in these regressions \(n_t^e\) and \(n_t^x\).

2. Regress \(u_t^\tau\) on \(u_t^x\) and \(u_t^e\) using \(n_t^e\) and \(n_t^x\) as instruments, which yields unbiased estimates of \(\xi_e\) and \(\xi_x\). The residual is \(v_t^\tau\).

3. Regress \(u_t^e\) and \(u_t^x\) on \(v_t^\tau\) to obtain unbiased estimates of \(\eta\) and \(\theta\).
95% and 90% bootstrapped confidence bands

$\eta = 1.16$ (total income), $0.94$ (wage income)
AMTRs are not exogenous

- Granger non-causality strongly rejected
- Contemporaneous exogeneity strongly rejected

Table 3 Contemporaneous Endogeneity of Tax Rates (Estimates of $\xi_x$ and $\xi_e$)

<table>
<thead>
<tr>
<th></th>
<th>GDP</th>
<th>Infl.</th>
<th>FF rate</th>
<th>Govt. Sp.</th>
<th>Δ Debt</th>
<th>Cap. Gains</th>
<th>Total Inc.</th>
<th>Joint Test</th>
<th>Wald p-value</th>
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<tbody>
<tr>
<td>Estimates</td>
<td>$-0.17$</td>
<td>$-0.31$</td>
<td>$-0.09$</td>
<td>$-0.20$</td>
<td>$-0.09$</td>
<td>$-0.02^*$</td>
<td>$-0.11$</td>
<td>$&lt; 0.01$</td>
<td></td>
</tr>
<tr>
<td>Bootstrapped 95% percentiles</td>
<td>$(-0.75,0.38)$</td>
<td>$(-1.22,0.36)$</td>
<td>$(-0.75,0.61)$</td>
<td>$(-0.46,0.05)$</td>
<td>$(-0.38,0.13)$</td>
<td>$(-0.05,0.01)$</td>
<td>$(-0.70,0.30)$</td>
<td></td>
<td></td>
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</table>

Values in parenthesis are bootstrapped 95% percentiles.
Response at Different Income Levels

Short run income elasticities w.r.t. net-of-tax rates can be estimated by using estimated SVAR shock $v_t^\tau$ as instrument in the OLS regressions.
Recall the OLS estimates

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<td>(−0.86, 0.22)</td>
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</tr>
<tr>
<td>Series 2</td>
<td>−0.33</td>
<td>−0.42</td>
<td>0.58*</td>
<td>0.28</td>
<td>0.14</td>
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<tr>
<td>Series 1</td>
<td>−0.01</td>
<td>−0.17</td>
<td>0.54*</td>
<td>0.26</td>
<td>0.18</td>
<td>−0.03</td>
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<td></td>
<td>(−0.43, 0.41)</td>
<td>(−0.56, 0.22)</td>
<td>(−0.03, 1.11)</td>
<td>(−0.16, 0.68)</td>
<td>(−0.19, 0.54)</td>
<td>(−0.22, 0.15)</td>
<td>(−0.34, 0.29)</td>
<td>(−0.71, 0.16)</td>
</tr>
<tr>
<td>Series 2</td>
<td>0.21</td>
<td>0.02</td>
<td>0.66*</td>
<td>0.43</td>
<td>0.32</td>
<td>−0.01</td>
<td>−0.08</td>
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<td>(−0.24, 0.24)</td>
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<td>(−0.51, 0.19)</td>
</tr>
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In parentheses are Newey-West 95% intervals with 8 lags. Asterisks denote 10%, 5% or 1% significance.
## IV estimates

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<td>A. 1952-2010</td>
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<tr>
<td></td>
<td>1st Stage F</td>
<td>15.31</td>
<td>8.96</td>
<td>8.61</td>
<td>8.27</td>
<td>8.71</td>
<td>6.92</td>
<td>6.57</td>
</tr>
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<td><strong>Total Inc.</strong></td>
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<td>7.13</td>
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<td>B. 1960-2000</td>
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<td>(0.14, 1.78)</td>
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In parentheses are Newey-West 95% intervals with 8 lags. Asterisks denote 10%, 5% or 1% significance.
Dynamic Estimates of Tax Elasticities

The graphs illustrate the percent deviation in income over six years for different income groups: Top 1%, Top 5%, Top 10%, Top 5%–1%, Top 10%–5%, and Bottom 99%, Bottom 90%.

The left graph shows income trends, while the right graph displays wage income trends. Each line represents a different income category, with clear distinctions in the percent deviation over time.
Changes in Top Marginal Rates

Why look at changes in top rates only?
- Many postwar reforms have made large changes to top marginal tax rates.
- Top rates correlate with income inequality, Piketty et al. Evidence.
- 'Smaller' general equilibrium effects (cfr. Romer and Romer 2012)

Larger VAR with AMTRs and income for top 1% and bottom 99%.

\[
\bar{\nu}_t^\tau = [v_t^{\tau,1}, v_t^{\tau,99}]' \text{ with } E[\bar{\nu}_t^\tau \bar{\nu}_t^{\tau'}] = \Sigma_{\tau} \text{ not necessarily diagonal}
\]

Two proxies \( \tilde{m}_t \) and assume

\[
E[\tilde{m}_t \bar{\nu}_t^{\tau'}] = \Phi, \quad E[\tilde{m}_t v_t^{\sigma'}] = 0.
\]

where \( \Phi \) is an unknown nonsingular \( 2 \times 2 \) matrix.

This permits identification of the response to \( \lambda \bar{\nu}_t^\tau = [1, 0]' \), see Mertens and Ravn (AER 2013)
Additional proxy is the change in top marginal rate associated with previously selected tax reforms.
Implementation

\[
\begin{align*}
\bar{u}_t^\tau &= \bar{v}_t^\tau + \xi_e \bar{u}_t^e + \xi_x u_t^x \\
\bar{u}_t^e &= \eta \bar{v}_t^\tau + \zeta_e v_t^o \\
u_t^x &= \theta \bar{v}_t^\tau + \zeta_x v_t^o.
\end{align*}
\]

1. Regress \( \bar{u}_t^e \) and \( u_t^x \) on \( \bar{u}_t^\tau \) using \( m_t \) as instruments. Define the residuals in these regressions \( \bar{n}_t^e \) and \( n_t^x \).

2. Regress \( \bar{u}_t^\tau \) on \( u_t^x \) and \( \bar{u}_t^e \) using \( \bar{n}_t^e \) and \( n_t^x \) as instruments. Define the residuals in these regressions \( \bar{n}_t^\tau \). The covariance of \( \bar{n}_t^\tau \) is an estimate of \( \Sigma_\tau \).

3. Let \( C \) be the upper triangular Choleski decomposition of \( \Sigma_\tau \). Regress \( \bar{u}_t^\tau \), \( \bar{u}_t^e \) and \( u_t^x \) on \( C^{-1} \bar{n}_t^\tau \). The coefficients associated with the first element of \( C^{-1} \bar{n}_t^\tau \) is the impact of the orthogonalized tax shock.
Implications

*Stabilization and austerity:*

- Across-the-board cuts can provide successful stimulus, not necessarily leading to greater income concentration at the top.
- Raising marginal tax rates on income is costly austerity measure.
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- Top marginal rate cuts increase income inequality
- Positive spillovers and real GDP response requires explanations beyond tax avoidance and bargaining.
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*Income inequality and top marginal tax rates:*

- Top marginal rate cuts increase income inequality
- Positive spillovers and real GDP response requires explanations beyond tax avoidance and bargaining.

*Optimal Taxation:*

- Large income responses signal large distortionary effects.
- Dynamics (investment) and general equilibrium effects.
Summary

Application of SVARs and the narrative approach to IRS tax returns data.

Improvements: Addressing endogeneity and dynamics.

Key Findings:

1. Aggregate changes in marginal income tax rates:
   - Large income responses on impact, hump-shaped
   - Similar elasticities across income percentile brackets.

2. Changes in top marginal tax rates:
   - Top incomes and real GDP respond positively
   - Positive spillovers on other incomes, but greater inequality.

Implications: Stabilization, inequality and optimal taxation.
I fit a probability distribution function $D(y)$ for AGI per return $y$,

$$D(y) = \sum_{i=1}^{n} w(i) \int_{b(i)}^{\min\{y, b(i+1)\}} f_i(x) dx,$$

$$f_i(x) = \begin{cases} 
\text{Beta}(a(i), 1) & \text{if } m(i) \geq \frac{(b(i) + b(i+1))}{2} \text{ and } i < n \\
\text{Beta}(1, a(i)) & \text{if } \frac{(b(i) + b(i+1))}{2+c} \leq m(i) < \frac{(b(i) + b(i+1))}{2} \text{ and } i < n \\
\text{BoundPar}(a(i)) & \text{if } m(i) < \frac{(b(i) + b(i+1))}{2+c} \text{ or } i = n 
\end{cases}$$

where $n$ is the total number of brackets, $b(i)$ is the bracket floor and $b(n+1) = \infty$, $w(i)$ is the fraction of returns in bracket $i$ and $m(i)$ is the mean AGI within bracket $i$.

**Method 1:** uses data for each filing status on total AGI and number of returns for which a given statutory rate is the highest marginal rate. The distributions $D(y)$ are used to interpolate for each filing status the total AGI taxed at each statutory rate applicable to returns exceeding the percentile floor.

**Method 2:** uses the data on taxable income in combination with the statutory tax rates and brackets, including surcharges and reductions, to calculate the marginal rate for each AGI level and filing status. Numerical integration based on $D(y)$.

Nonfilers and untaxed returns carry a zero marginal rate.

Weighting based on AGI
$R^2 = 0.54$
Policy Responses to Y and G

I Suppose

\[
\Delta \ln(y_t) = \Delta \ln(e_t) = \eta v_t^\tau + \nu_t \quad E[v_t^\tau, \nu_t] = 0
\]

\[
\ln(1 - \tau_t) = \ln(1 - \tau) + \phi_y \Delta \ln(y_t) + v_t^\tau, \quad v_t^\tau \sim N(0, \sigma_{\tau}^2)
\]

then

\[
\beta_{OLS} = \eta + \frac{\phi_y}{1 - \phi_y \eta} \frac{\text{Var}(\nu_t)}{\text{Var}(\Delta \ln(1 - \tau_t))}
\]

Procyclical tax rates \(\phi_y < 0\) leads to downward bias.

II Suppose \(g_t\) affects labor supply positively (e.g. income effects) and

\[
\ln(1 - \tau_t) = \ln(1 - \tau) + \phi_g \ln \left( \frac{1 - g_t / y_t}{1 - s_g} \right) + v_t^\tau, \quad v_t^\tau \sim N(0, \sigma_{\tau}^2)
\]

then

\[
\beta_{OLS} = \eta \left( 1 - \phi_g \frac{\text{Var}(\Delta \ln(1 - g_t / y_t))}{\text{Var}(\Delta \ln(1 - \tau_t))} \right)
\]

Higher tax rates when \(g\) rises (\(\phi_g > 0\)) leads to downward bias.
Bracket Creep

Suppose agent i’s nominal tax liabilities are

\[ T(E_{it}) = E_{it} - (1 - \tilde{\tau}_t) \frac{(E_{it}/\bar{E}_{t-1})^{1-\gamma}}{1-\gamma} \bar{E}_{t-1} \]

where \( \ln(1 - \tilde{\tau}_t) = \ln(1 - \tau) + v_t \), \( \tilde{\tau}_t \) is exogenous, \( E_{it} \) nominal wage income of agent i, \( \bar{E}_t \equiv \left( \int_0^1 E_{it}^{1-\gamma} \, di \right)^{1/(1-\gamma)}. \)

The economy-wide AMTR is now determined by

\[ \tau_t = 1 - (1 - \tilde{\tau}_t) \left( \frac{\bar{e}_t}{\bar{e}_{t-1}}(1 + \pi_t) \right)^{-\gamma}. \]

Suppose, \( \bar{e}_t = e_t = \alpha y_t \) then

\[ \ln(1 - \tau_t) = \ln(1 - \tau) - \gamma \Delta \ln(y_t) - \gamma \pi_t + v_t \]

▶ back
Anticipation Effects

In dynamic settings, timing matters. Suppose all tax changes are permanent,

$$\Delta \ln(1 - \tau_t) = \nu_t^\tau + \nu_{t-1}^a, \quad \nu_t^\tau \sim N(0, \sigma^2_{\tau}), \quad \nu_t^a \sim N(0, \sigma^2_a).$$

If some tax changes are unanticipated by agents ($\nu_t^\tau$) whereas others are known one year in advance ($\nu_t^a$), then

$$\beta^{OLS} = \eta + (\chi - \eta) \frac{\sigma^2_a}{\sigma^2_{\tau} + \sigma^2_a}$$

where $\eta$ is the true effect, $\chi$ is income growth at the time that a tax change occurs that was preannounced in the year before.

Sign generally ambiguous, but results in Mertens and Ravn (AEJ 2012) and Leeper, Walker, Yang (ECMTA 2013) suggests $\chi > \eta$.

Upward bias may be larger for higher incomes.


Endogenous Income Distribution

Note that
\[
\ln(1 - \tau_t^s) = \ln(1 - \tau_t) - \gamma \ln(\bar{e}_t^s / \bar{e}_t) .
\]

Suppose
\[
\Delta \ln e_t^s = \eta \Delta \ln(1 - \tau_t^s) + \rho^s \nu_t
\]
Then,
\[
\beta_{s}^{OLS} \approx \eta + (1 - \rho^s) \frac{\gamma \rho^s}{1 + \eta \gamma} \frac{\text{Var}(\nu_t)}{\text{Var}(\Delta \ln(1 - \tau_t^s))} . \tag{1}
\]

No bias in the aggregate, but downward bias for bracket S if income share of S is procyclical ($\rho^s > 1$, top incomes).
95% and 90% bootstrapped confidence bands

\[ \eta = 1.33 \text{ (total income)}, \ 1.07 \text{ (wage income)} \]
A. Using AMTR Series 1

B. Using AMTR Series 2
A. Top 1% Income Shares and Top MTR

B. Top 1% and Bottom 99% Income Growth

Elasticity = .47 (.11)