Marginal Tax Rates and Income: New Time Series Evidence

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Introduction

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- *US macro time series*; Romer and Romer (AER 2010), Barro and Redlick (QJE 2011), Mertens and Ravn (AEJ 2012, AER 2013, JME 2013), Caldara and Kamps (2013)

  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

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   - 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

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

$e_{it} = w_{it}h_{it}$, w_{it}/x_{it} (detrended) real wage, ϵ labor supply elasticity.

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

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

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

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 $S \subseteq [0,1]$,

$$\Delta \ln(e_t^s) \quad = \quad \epsilon \Delta \ln(1-\tau_t^s) + r_t^s$$

where $\tau_t^s = 1 - \int_S \left(e_{it}/\bar{e}_t^s (1 - T'(e_{it}))di \right)$ is the **AMTR for** S

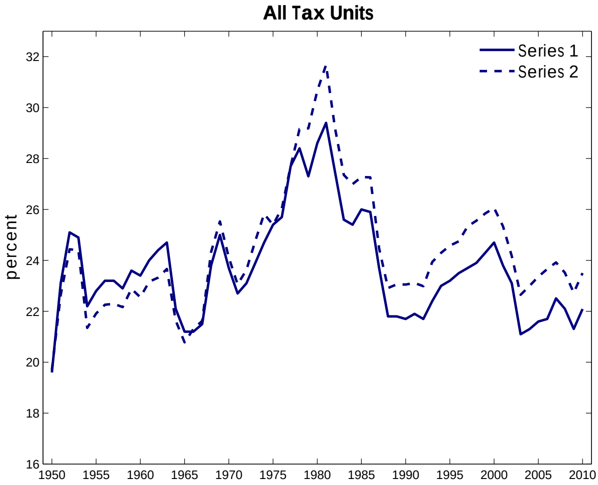
r_t^s are non-tax determinants of earnings growth.

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

Capital income, exemptions, deductions; tax avoidance/evasion

So, ϵ interpreted more broadly as the **elasticity of taxable income**.

Average Marginal Tax Rates



Federal individual income tax only. Based on Saez (2004) and Barro and Redlick (2011), extended à la Barro and Sahasakul (1983) based on SOI.

▸ details ▸ payroll and state

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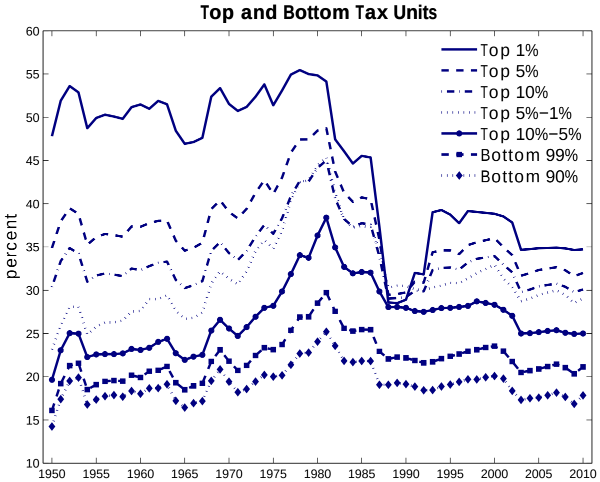

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Average Marginal Tax Rates

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

		$\tau_t \times 100$		$\Delta \ln(1-\tau_t) \times 100$										
		Mean	*St. Dev.*	*St. Dev.*	*Correlation*									
					[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]
[1]	All, Series 1	23.69	2.05	1.51	1.00								
[2]	All, Series 2	24.38	2.39	1.54	0.95	1.00							
[3]	Top 1%	44.72	8.10	4.39	0.78	0.83	1.00						
[4]	Top 5%	37.10	4.68	2.97	0.85	0.91	0.95	1.00					
[5]	Top 10%	33.74	3.85	2.45	0.88	0.94	0.92	0.99	1.00				
[6]	Top 5-1%	31.56	4.95	2.39	0.86	0.92	0.80	0.93	0.96	1.00			
[7]	Top 10-5%	26.92	3.88	1.80	0.89	0.93	0.74	0.86	0.92	0.92	1.00		
[8]	Bottom 99%	22.09	2.58	1.44	0.94	0.99	0.75	0.84	0.89	0.90	0.94	1.00	
[9]	Bottom 90%	19.19	1.98	1.33	0.92	0.96	0.69	0.76	0.81	0.81	0.87	0.98	1.00

Income data from Piketty and Saez (2007)
OLS regression

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

	All Tax Units Series 1	All Tax Units Series 2	Top 1%	Top 5%	Top 10%	Top 5-1%	Top 10-5%	Btm. 99%	Btm. 90%
					A. 1951-2010				
Wage Inc.	-0.57^{*}	-0.63^{**}	0.45	0.13	-0.01	-0.15	-0.32	-0.75^{**}	-0.97^{***}
	$(-1.18, 0.03)$	$(-1.19, -0.07)$	$(-0.10, 0.99)$	$(-0.32, 0.59)$	$(-0.43, 0.42)$	$(-0.40, 0.11)$	$(-0.86, 0.22)$	$(-1.33, -0.16)$	$(-1.66, -0.28)$
Total Inc.	-0.33	-0.42	0.58^{*}	0.28	0.14	-0.14	-0.27^{*}	-0.60^{**}	-0.80^{***}
	$(-0.89, 0.23)$	$(-0.95, 0.11)$	$(-0.08, 1.25)$	$(-0.37, 0.94)$	$(-0.44, 0.72)$	$(-0.46, 0.17)$	$(-0.58, 0.04)$	$(-1.08, -0.12)$	$(-1.37, -0.23)$
					B. 1960-2000				
Wage Inc.	-0.01	-0.17	0.54^{*}	0.26	0.18	-0.03	-0.03	-0.27	-0.38
	$(-0.43, 0.41)$	$(-0.56, 0.22)$	$(-0.03, 1.11)$	$(-0.16, 0.68)$	$(-0.19, 0.54)$	$(-0.22, 0.15)$	$(-0.34, 0.29)$	$(-0.71, 0.16)$	$(-1.03, 0.28)$
Total Inc.	0.21	0.02	0.66^{*}	0.43	0.32	-0.01	-0.08	-0.16	-0.22
	$(-0.22, 0.64)$	$(-0.37, 0.42)$	$(-0.06, 1.38)$	$(-0.22, 1.09)$	$(-0.25, 0.90)$	$(-0.24, 0.24)$	$(-0.28, 0.12)$	$(-0.51, 0.19)$	$(-0.71, 0.28)$

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

   $\Rightarrow \beta^{OLS}$ not estimating ϵ, but the 'total' causal effect η

2. Tax changes are endogenous.

   $\Rightarrow$ Reverse causality means β^{OLS} has no useful interpretation.

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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:

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

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

$$\begin{aligned} u_t^\tau &= v_t^\tau + \xi_e u_t^e + \xi_x u_t^x \\ u_t^e &= \eta v_t^\tau + \zeta_e v_t^o \\ u_t^x &= \theta v_t^\tau + \zeta_x v_t^o \end{aligned}$$

v_t^τ tax shock, v_t^o all other shocks, η income elasticity w.r.t net-of-tax rate

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v_t^τ tax shock, v_t^o all other shocks, η income elasticity w.r.t net-of-tax rate

Key Assumption 2: I have a proxy m_t such that

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

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

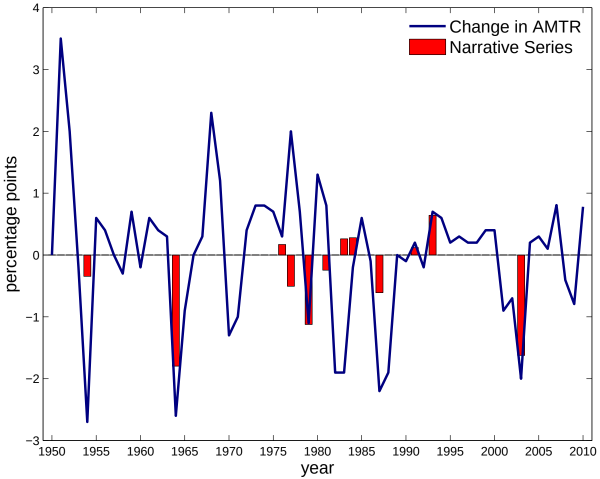
$\ln(e_t)$: average total income/average wage income reported to IRS

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.



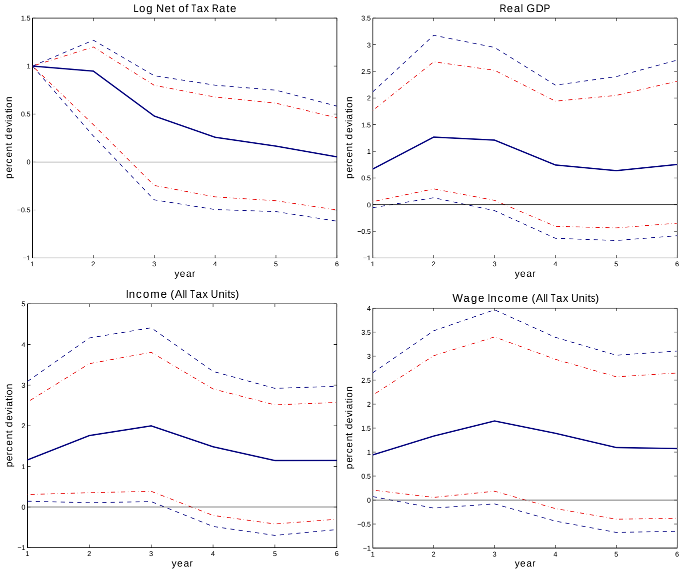
Change in AMTR
Narrative Series
percentage points
year
4
3
2
1
0
−1
−2
−3
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

scatter

Implementation

$$\begin{aligned} u_t^{\tau} &= v_t^{\tau} + \xi_e u_t^e + \xi_x u_t^x \\ u_t^e &= \eta v_t^{\tau} + \zeta_e v_t^o \\ u_t^x &= \theta v_t^{\tau} + \zeta_x v_t^o \end{aligned}$$

1. Regress u_t^e and u_t^x on u_t^{τ} using m_t as instruments. Define the residuals in these regressions n_t^e and n_t^x.
2. Regress u_t^{τ} on u_t^x and u_t^e using n_t^e and n_t^x as instruments, which yields unbiased estimates of ξ_e and ξ_x. The residual is v_t^{τ}.
3. Regress u_t^e and u_t^x on v_t^{τ} to obtain unbiased estimates of η and θ.



95% and 90% bootstrapped confidence bands

$\eta = 1.16$ (total income), 0.94 (wage income) Alternative AMTR Corporate

AMTRs are not exogenous

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

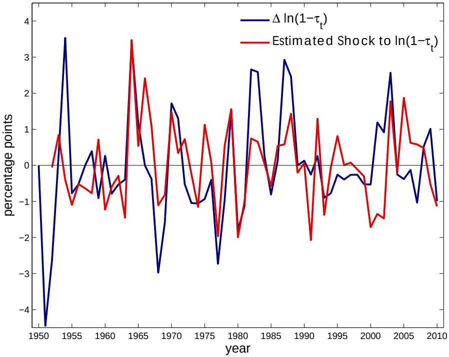
Table 3 Contemporaneous Endogeneity of Tax Rates (Estimates of ξ_x and ξ_e)

GDP	Infl.	FF rate	Govt. Sp.	Δ Debt	Cap. Gains	Total Inc.	Joint Test Wald p-value
-0.17	-0.31	-0.09	-0.20	-0.09	-0.02^*	-0.11	< 0.01
$(-0.75, 0.38)$	$(-1.22, 0.36)$	$(-0.75, 0.61)$	$(-0.46, 0.05)$	$(-0.38, 0.13)$	$(-0.05, 0.01)$	$(-0.70, 0.30)$	

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^τ as instrument in the OLS regressions.



Recall the OLS estimates

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	$(-1.18, 0.03)$	$(-1.19, -0.07)$	$(-0.10, 0.99)$	$(-0.32, 0.59)$	$(-0.43, 0.42)$	$(-0.40, 0.11)$	$(-0.86, 0.22)$	$(-1.33, -0.16)$	$(-1.66, -0.28)$
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IV estimates

	All Tax Units Series 1	All Tax Units Series 2	Top 1%	Top 5%	Top 10%	Top 5-1%	Top 10-5%	Btm. 99%	Btm. 90%
					A. *1952-2010*				
Wage Inc.	0.94**	1.12*	1.27***	0.82**	0.96**	0.34	1.31*	0.98	1.08
	(0.09, 1.80)	(−0.06, 2.30)	(0.43, 2.11)	(0.01, 1.63)	(0.13, 1.79)	(−0.29, 0.98)	(−0.13, 2.74)	(−0.31, 2.27)	(−0.69, 2.85)
1st Stage F	*15.31*	*8.96*	*8.61*	*8.27*	*8.71*	*6.92*	*6.57*	*5.99*	*6.36*
Total Inc.	1.16**	1.37**	1.27***	1.12**	1.11**	0.65*	0.83*	1.13*	1.33*
	(0.25, 2.08)	(0.12, 2.61)	(0.41, 2.12)	(0.18, 2.07)	(0.13, 2.09)	(−0.12, 1.42)	(−0.14, 1.80)	(−0.03, 2.29)	(−0.01 − 2.67)
1st Stage F	*16.39*	*10.01*	*10.57*	*9.79*	*10.04*	*7.13*	*6.85*	*6.21*	*7.28*
					B. *1960-2000*				
Wage Inc.	0.53*	0.59	1.01**	0.62	0.71**	0.25	0.95*	0.44	0.33
	(−0.06, 1.11)	(−0.12, 1.30)	(0.18, 1.84)	(−0.13, 1.37)	(0.05, 1.38)	(−0.29, 0.79)	(−0.04, 1.94)	(−0.37, 1.24)	(−0.91, 1.57)
1st Stage F	*33.59*	*19.31*	*9.14*	*10.28*	*11.32*	*11.21*	*8.45*	*19.91*	*18.08*
Total Inc.	0.84**	0.94**	0.96**	0.81**	0.79**	0.47*	0.61	0.82**	0.96**
	(0.14, 1.54)	(0.10, 1.79)	(0.14, 1.78)	(0.02, 1.59)	(0.01, 1.57)	(−0.07, 1.01)	(−0.13, 1.36)	(0.03, 1.60)	(0.06, 1.87)
1st Stage F	*36.91*	*22.02*	*11.46*	*13.00*	*13.98*	*11.46*	*8.26*	*18.11*	*16.18*

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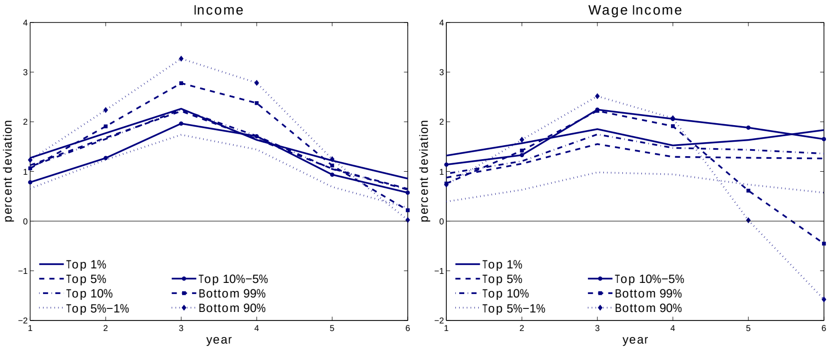
Dynamic Estimates of Tax Elasticities



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%.

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

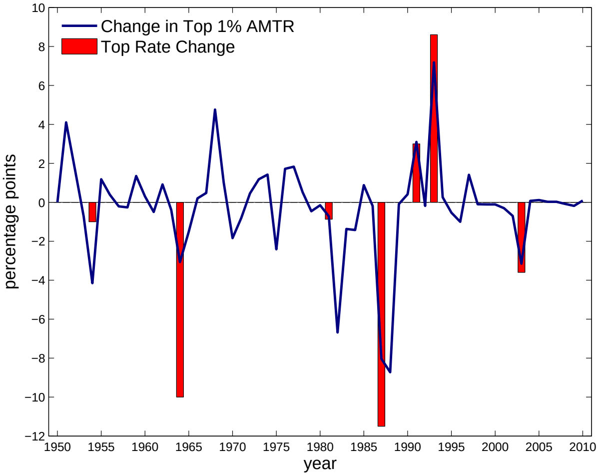
Two proxies $\bar{m}_t$ and assume

$$E[\bar{m}_t \bar{v}_t^{\tau\prime}] = \Phi \quad , \quad E[\bar{m}_t v_t^{o\prime}] = 0 \ .$$

where Φ is an unknown nonsingular 2×2 matrix.

This permits identification of the response to $\lambda \bar{v}_t^{\tau} = [1 \ , \ 0]'$,
see Mertens and Ravn (AER 2013)

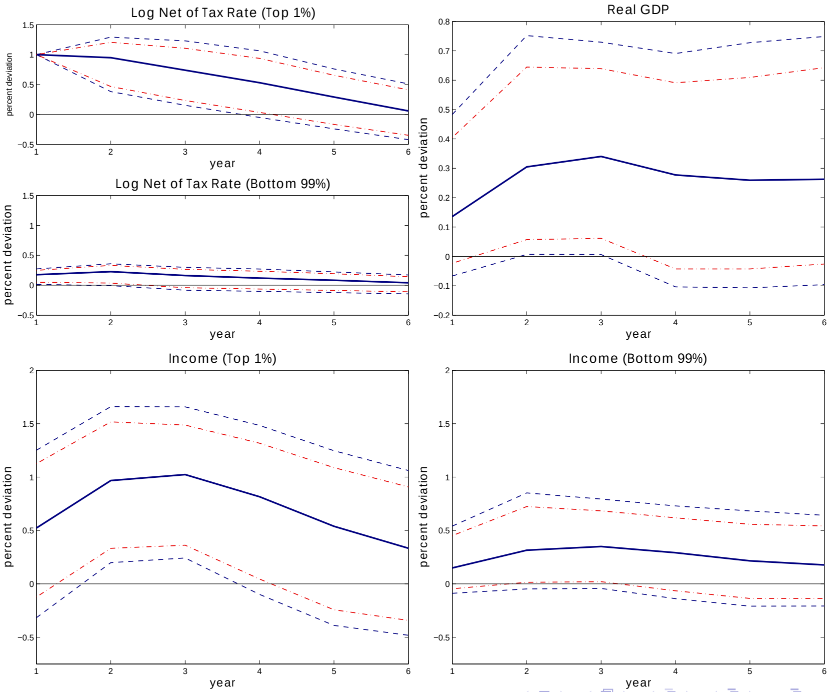
Additional proxy is the change in top marginal rate associated with previously selected tax reforms.



Implementation

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

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


Log Net of Tax Rate (Top 1%)
percent deviation
year
Log Net of Tax Rate (Bottom 99%)
percent deviation
year
Real GDP
percent deviation
year
Income (Top 1%)
percent deviation
year
Income (Bottom 99%)
percent deviation
year

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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- Positive spillovers and real GDP response requires explanations beyond tax avoidance and bargaining.

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- 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
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2. Changes in top marginal tax rates:
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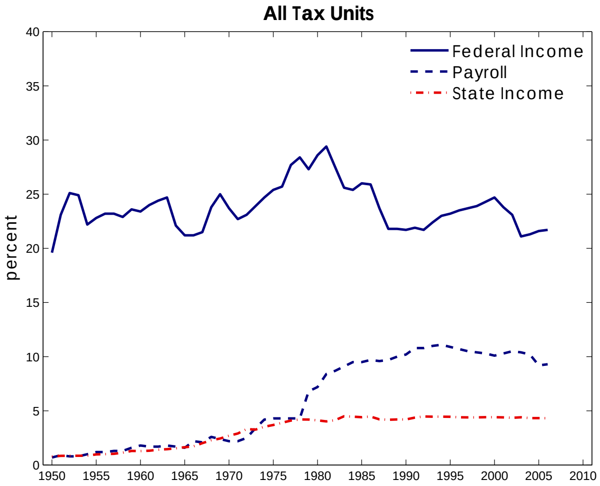
Implications: Stabilization, inequality and optimal taxation.


All Tax Units
percent
Federal Income
Payroll
State Income
0
5
10
15
20
25
30
35
40
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010

back

I fit a probability distribution function $D(y)$ for AGI per return y,

$$
\begin{aligned}
D(y) &= \sum_{i=1}^{n} w(i) \int_{b(i)}^{\min\{y, b(i+1)\}} f_i(x) dx \quad , \\
f_i(x) &= \begin{cases} \text{Beta}(a(i), 1) & \text{if } \; m(i) \geq (b(i) + b(i+1))/2 \text{ and } i < n \\ \text{Beta}(1, a(i)) & \text{if } \; (b(i) + b(i+1))/(2 + c) \leq m(i) < (b(i) + b(i+1))/2 \text{ and } i < n \\ \text{BoundPar}(a(i)) & \text{if } \; m(i) < (b(i) + b(i+1))/(2 + c) \text{ or } i = n \end{cases}
\end{aligned}
$$

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.

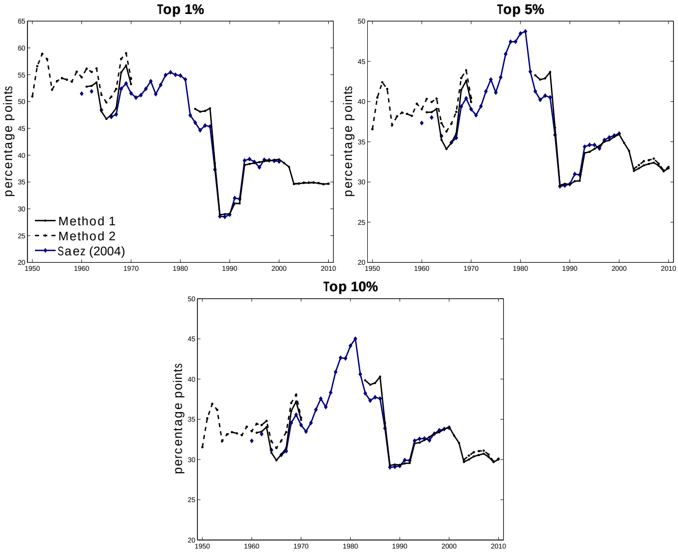
Method 1: uses data for each filing status on total AGI and number of returns for which a given statutory rate is the highest marginal rate. The distributions $D(y)$ are used to interpolate for each filing status the total AGI taxed at each statutory rate applicable to returns exceeding the percentile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

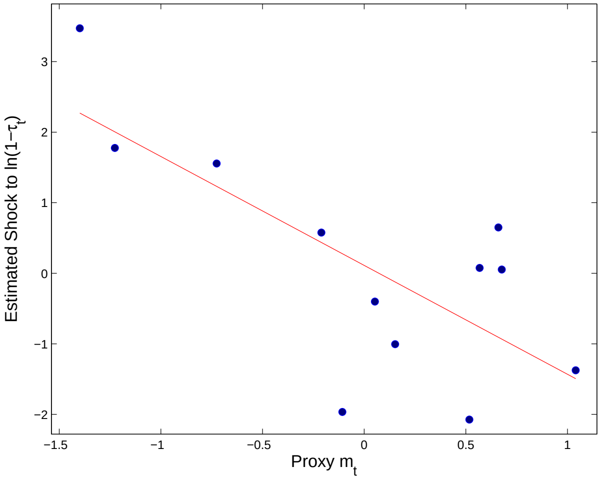
Nonfilers and untaxed returns carry a zero marginal rate.

Weighting based on AGI

back


Top 1%
percentage points
Method 1
Method 2
Saez (2004)
Top 5%
percentage points
Top 10%
percentage points

back



$R^2 = 0.54$ back

Policy Responses to Y and G

I Suppose

$$\begin{aligned} \Delta \ln(y_t) = \Delta \ln(e_t) &= \eta v_t^{\tau} + \upsilon_t \quad E[v_t^{\tau}, \upsilon_t] = 0 \\ \ln(1-\tau_t) &= \ln(1-\tau) + \phi_y \Delta \ln(y_t) + v_t^{\tau} \quad , \quad v_t^{\tau} \sim N(0, \sigma_{\tau}^2) \end{aligned}$$

then

$$\beta^{OLS} = \eta + \frac{\phi_y}{1-\phi_y \eta} \frac{Var(\upsilon_t)}{Var(\Delta \ln(1-\tau_t))}$$

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

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

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

then

$$\beta^{OLS} = \eta \left(1 - \phi_g \frac{Var\left(\Delta \ln(1-g_t/y_t)\right)}{Var(\Delta \ln(1-\tau_t))}\right)$$

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

back

Bracket Creep

Suppose agent i's nominal tax liabilities are

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

where $\ln(1-\tilde{\tau}_t) = \ln(1-\tau) + v_t^{\tau}$, $\tilde{\tau}_t$ 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

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

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

$$\ln(1-\tau_t) \quad = \quad \ln(1-\tau) - \gamma\Delta\ln(y_t) - \gamma\pi_t + v_t^{\tau} \quad .$$

▸ back

Anticipation Effects

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

$$\Delta \ln(1-\tau_t) \quad = \quad v_t^{\tau} + v_{t-1}^{a} \;\; , \;\; v_t^{\tau} \sim N(0, \sigma_{\tau}^2) \; , \; v_t^{a} \sim N(0, \sigma_a^2) \;\; .$$

If some tax changes are unanticipated by agents (v_t^{τ}) whereas others are known one year in advance (v_t^{a}), then

$$\beta^{OLS} \quad = \quad \eta + (\chi - \eta)\, \frac{\sigma_a^2}{\sigma_{\tau}^2 + \sigma_a^2}$$

where η is the true effect, χ 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

▸ back

Endogenous Income Distribution

Note that

$$\ln(1-\tau_t^s) \quad = \quad \ln(1-\tau_t) - \gamma \ln\left(\bar{e}_t^s/\bar{e}_t\right) \ .$$

Suppose

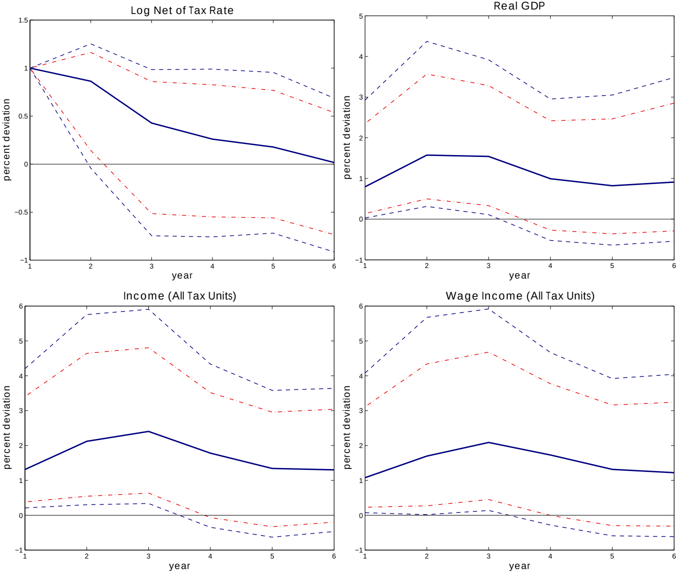
$$\Delta \ln e_t^s = \eta \Delta \ln(1-\tau_t^s) + \rho^s \upsilon_t$$

Then,

$$\beta_s^{OLS} \quad \approx \quad \eta + (1-\rho^s)\frac{\gamma\rho^s}{1+\eta\gamma}\frac{Var(\upsilon_t)}{Var(\Delta \ln(1-\tau_t^s))} \ . \qquad (1)$$

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

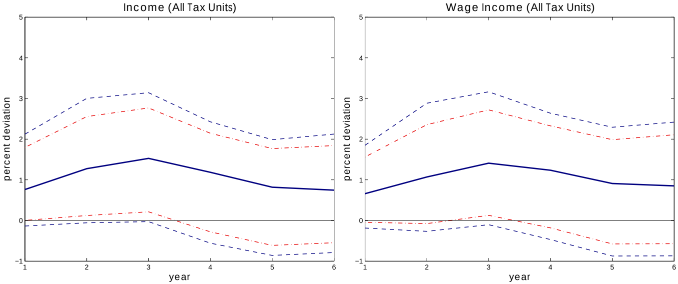
back



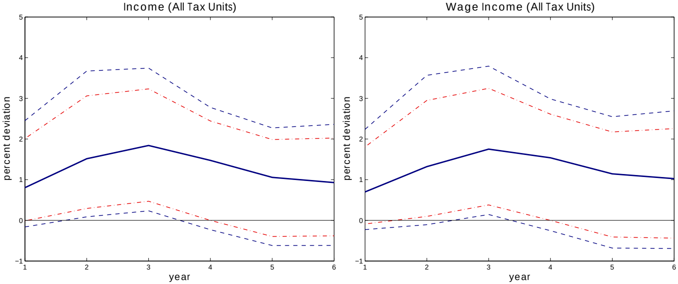
95% and 90% bootstrapped confidence bands

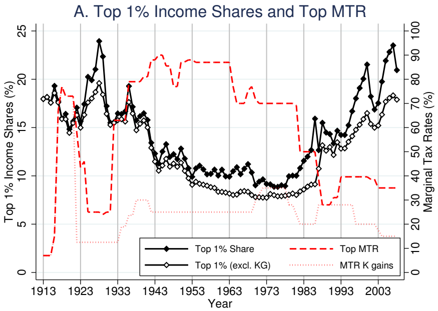
$\eta = 1.33$ (total income), 1.07 (wage income) back

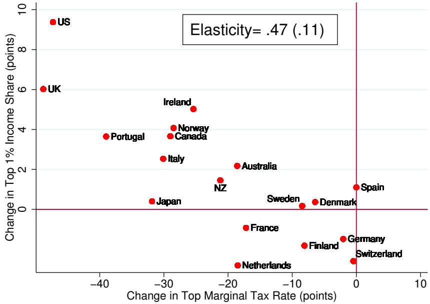
A. Using AMTR Series 1



B. Using AMTR Series 2




A. Top 1% Income Shares and Top MTR
Top 1% Income Shares (%)
Marginal Tax Rates (%)
Year
Top 1% Share
Top 1% (excl. KG)
Top MTR
MTR K gains
1913
1923
1933
1943
1953
1963
1973
1983
1993
2003


Elasticity= .47 (.11)
Change in Top 1% Income Share (points)
Change in Top Marginal Tax Rate (points)
US
UK
Ireland
Norway
Canada
Portugal
Italy
Australia
NZ
Japan
Sweden
Denmark
Spain
France
Germany
Finland
Switzerland
Netherlands

back