State Tax Competition in the U.S.

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Motivation

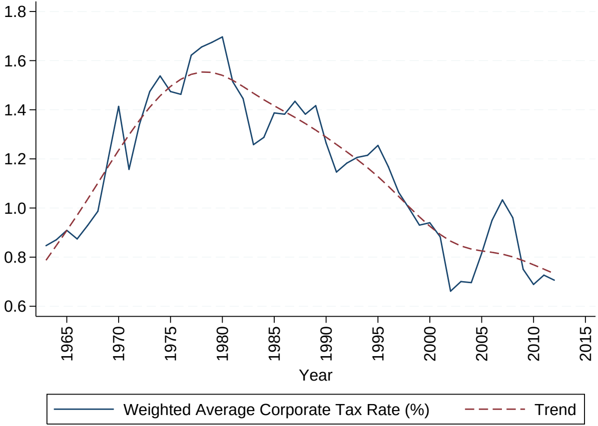
Created Panel Database at the state-level (1980-2016) in the U.S.

Patterns for tax variables

- Corporate Taxation: average tax rate, top-marginal tax rate, apportionment factors.
- Sales and labor income tax rates.
- Share of total revenue.

Average Corporate Tax Rate has declined by aprox 50%.

Figure 1: Corporate Tax Revenue by Gross Operating Surplus



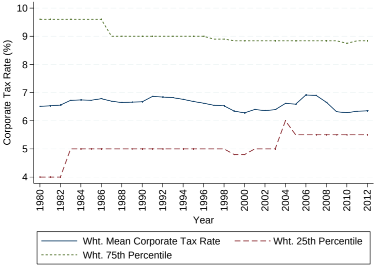
*GDP-weighted average over the 48 contiguous states. Trend: Hodrick–Prescott high-pass filter.

State's gross operating surplus is a proxy of total state business income.

Source: Bureau of Economic Analysis (Regional Accounts), Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau. By Corporate Profits

Corporate Tax Rates

- Top marginal corporate tax has remained roughly constant.
- Taxation of Multi-state Corporations: States have move towards sales-only weight.



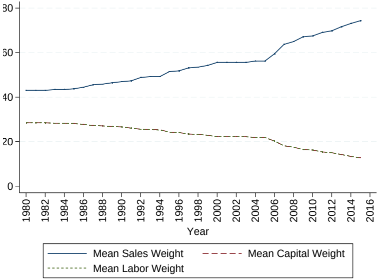
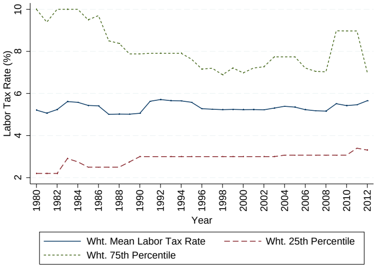


Figure 2: Corporate Taxation

Same pattern, but differences in levels across regions: By Region

Sales and Labor Tax Rates across US States

- Sales tax rate has steadily increased.
- Top marginal labor income tax has remained roughly constant.



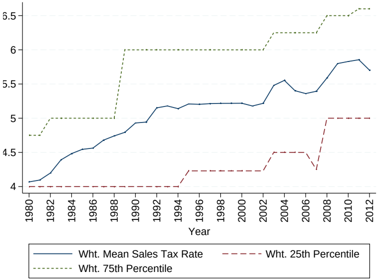


Figure 3: Statutory tax rates

Same pattern across regions: Figure

Shares of Total Tax Revenue

Sources of revenue have moved towards labor and consumption taxes.

Table 1: Tax Revenue Share

Year	Corporate Tax (%)		Labor Tax (%)		Sales Tax (%)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
1982	9.35	3.84	27.17	16.57	49.95	12.84
1992	7.79	3.60	31.09	16.13	50.57	14.66
2002	5.80	3.05	34.00	18.53	49.90	16.12
2012	5.91	3.59	34.03	19.20	49.93	18.19

* GDP-weighted average over the 48 contiguous states.
We excluded District of Columbia, Hawaii and Alaska in the computation.
Source: Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau.

Similar patterns across regions: Figure, corporate Figure, labor and sales

Motivation

We see these patterns for tax variables as consistent with:

- *Ramsey Approach* to Optimal tax policy.

  Assumes: Rich set of instruments.
  Optimal Policy: Do not distort inter-temporal wedge.
  Use consumption and labor taxes instead of capital taxes.

- States competing over corporate taxes.

  Uniform tax system for multi-state corporations.
  Free capital mobility.

Question and Approach

Questions:

- Have States in the U.S. moved towards less distortive tax systems?
- What role has corporate tax competition played?

What we've done:

1. Document strategic interaction in states' corporate taxes.
2. Introduce multi-state corporate taxation in a Neoclassical two-country model.

   Compare two scenarios (1980) vs (2016)

   Reduction of distortions in the allocation of capital across states.

Empirical Overview

Empirical Observations:

- We estimate:

$$\tau_{it} = \theta \sum_{j \neq i} \tau_{jt} + \beta' X_{i,t-1} + \delta T_t + \gamma S_i + \varepsilon_{it}$$

X : controls.

T : time trend.

S : state fixed effect.

Empirical Evidence of Strategic Interaction

Table 2: Corporate Tax Instruments $(\tau, \alpha_k, \bar{\tau})$

	(1)	(2)	(3)
	Corp Tax	Capital AF	Average corp. tax
	τ^k	α_k	$\bar{\tau}$
Neighbors' Tax Instrument	0.715**	0.805**	0.812***
	(0.314)	(0.289)	(0.137)
Controls	Yes	Yes	Yes
Year Effects	Yes	Yes	Yes
State Fixed Effect	Yes	Yes	Yes
Instruments	Both	Both	Both
N	1591	1591	1591

Robust standard errors in parentheses. * $p<0.10$, ** $p<0.05$, *** $p<0.01$. Note: All regressions are IV regressions estimated by two-stage least squares. Instruments: lagged neighbors unemployment rate and neighbors debt to GDP ratio.

Model: Environment

Two-country GE Neoclassical growth model.

One commodity: $\{c_{it}, g_{it}, x_{it}\}$.

Resource constraint of the economy:

$$c_{at} + c_{bt} + x_{at} + x_{bt} + g_{at} + g_{bt} \leq F(k_{it}, n_{it}) + F(k_{it}, n_{it})$$

F is constant returns to scale.

Law of motion of capital

$$x_{it} = k_{it+1} - (1 - \delta)k_{it}$$

$\delta \in (0, 1)$: depreciation rate

Households

Households's problem:

$$\max_{c_{it}, n_{it}} \sum_{t=0}^{\infty} \beta^t u^i(c_{it}, 1 - n_{it}), \qquad \beta \in (0, 1)$$

flow of funds constraint,

$$\begin{aligned}(1 + \tau_i^c)c_{it} + V_t e_{it+1} + b_{it+1} &= (1 - \tau_i^n)w_{it} n_{it} + (V_t + d_t)e_{it} + \frac{q_{it-1}}{q_{it}} b_{it} \\ \lim_{T \to \infty} Q_T b_{iT} &\geq 0\end{aligned}$$

where $\frac{q_{it-1}}{q_{it}}$, are country specific.

- pay taxes on consumption and labor income
- own shares (equity) of the firm, and domestic bond,.

Government and Taxation of Multi-State corporations

Government finance $\{g_{it}, b_{i0}\}$ with:

- time-invariant taxes: $\{\tau_i^c, \tau_i^n, \tau_i\}$
- FA principle for taxation: $(\alpha_k, \alpha_l, \alpha_s)$,

Government: Flow of funds

$$\tau_i^c c_{it} + \tau_i^n w_{it} n_{it} + \Pi_t \hat{\tau}_{it} - g_{it} \quad = \quad b_{it} \qquad \forall t, \ \forall i = a, b$$

Formula Apportionment

Unified system adopted by all states in the US since the 60's to apportion the profit of multi-state corporations.

	Country A	Country B	Total
Capital	25	10	35
Labor	5	5	10
Sales	5	15	20
Profits	70	30	100

$$\begin{aligned}\text{Rev}_i &= \Pi\ \hat{\tau}_i \\ &= \Pi\ \tau_i \left(\alpha_i^K \frac{k_i}{k_a + k_b} + \alpha_i^L \frac{n_i}{n_a + n_b} + \alpha_i^S \frac{s_i}{s_a + s_b} \right)\end{aligned}$$

where $\alpha_i^K + \alpha_i^L + \alpha_i^S = 1$, and $\alpha_i \in [0, 1]$.

Formula Apportionment

Assuming for both countries: $(\alpha^K, \alpha^L, \alpha^S) = (1/3, 1/3, 1/3)$

	Country A	Country B	Total
Marginal Tax (τ_i)	10%	6%	
Corp Rev: $\Pi\hat{\tau}_i$	4.9	3.1	8.0
Average tax rate		8.0%	

$$
\begin{aligned}
\text{Rev}_a &= \Pi\ \hat{\tau}_a \\
&= \Pi\ \tau_a \left(\alpha_a^K \frac{k_a}{k_a + k_b} + \alpha_i^L \frac{n_a}{n_a + n_b} + \alpha_a^S \frac{s_a}{s_a + s_b} \right) \\
&= 100(0.1) \left(0.33 \frac{k_a}{k_a + k_b} + 0.33 \frac{n_a}{n_a + n_b} + 0.33 \frac{s_a}{s_a + s_b} \right) \\
&= 4.9
\end{aligned}
$$

Model: Firm

One representative firm: centrally decides on investment and labor.

$$\max_{\{x_{it}, n_{it}\}} \sum_{t=0}^{\infty} Q_t d_t$$

Q_t is the intertemporal price of the common numeraire.
dividends:

$$\begin{aligned} d_t &= F(k_{at}, n_{at}) - w_{at} n_{at} - [k_{at+1} - (1 - \delta k_{at})] - \hat{\tau}_a \Pi \\ &\quad + F(k_{bt}, n_{bt}) - w_{bt} n_{bt} - [k_{bt+1} - (1 - \delta k_{bt})] - \hat{\tau}_b \Pi \end{aligned}$$

Π: consolidated profits,

$$\Pi_t = [F(k_{at}, n_{at}) - w_{at} n_{at} - \delta k_{at}] + [F(k_{bt}, n_{bt}) - w_{bt} n_{bt} - \delta k_{bt}]$$

Model: Firm

$$\max_{\{x_{it}, n_{it}\}} \sum_{t=0}^{\infty} Q_t d_t$$

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dividends:

$$\begin{aligned} d_t \quad = \quad & F(k_{at}, n_{at}) - w_{at} n_{at} - [k_{at+1} - (1 - \delta k_{at})] \\ & + F(k_{bt}, n_{bt}) - w_{bt} n_{bt} - [k_{bt+1} - (1 - \delta k_{bt})] \\ & - \bar{\tau}_t \Pi \end{aligned}$$

$\bar{\tau}_t = \hat{\tau}_{at} + \hat{\tau}_{bt}$: average corporate tax rate.
Π: consolidated profits,

Corporate Tax according to Formula Apportionment

$$\begin{aligned}
\bar{\tau}_t &= \hat{\tau}_{at} + \hat{\tau}_{bt} \\
&= \tau_a \left(\alpha_a^K \frac{k_{at}}{K_t} + \alpha_a^L \frac{n_{at}}{N_t} + \alpha_a^S \frac{s_{at}}{Y_t} \right) + \tau_b \left(\alpha_b^K \frac{k_{bt}}{K_t} + \alpha_b^L \frac{n_{bt}}{N_t} + \alpha_b^S \frac{s_{bt}}{Y_t} \right) \\
Y_t &= y_{at} + y_{bt} \\
&= s_{at} + s_{bt} \qquad \forall t
\end{aligned}$$

where $\alpha_i^K + \alpha_i^L + \alpha_i^S = 1, \quad \alpha_i \in [0, 1]$

Main assumption:

- Sales can be different than output in each country, $s_{it} \neq y_{it}$.

Tax Distorted Competitive Equilibrium

Given policies $\{\tau_i^c, \tau_i^n, \tau_i, \overrightarrow{\alpha_i}\}$ a *Competitive Equilibrium* for this two-country economy consist of a set of allocations $\{c_{it}, n_{it}, e_{it}, k_{it+1}, x_{it}, b_{it}\}$, prices $\{Q_t, w_{it}, V_0, q_{it}\}$, and given $\{k_0, e_{i0}, Q_{-1}b_{i0}\}$ such that:

- households solve their problem,
- firms maximize value,
- government budget constraint holds,
- markets clears

Optimality Conditions

Intra-temporal condition:

$$\frac{u^i_{ct}}{u^i_{nt}} = \frac{(1+\tau^c_i)}{(1-\tau^n_i)} \frac{1}{F^i_{nt} - \frac{\Pi_t}{1-\bar{\tau}_t} \frac{\partial \bar{\tau}_t}{\partial n_{it}}}$$

Inter-temporal condition:

$$\frac{u^i_{ct}}{\beta u^i_{ct+1}} = 1 + (1-\bar{\tau}_{t+1})(F^i_{kt+1} - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}}$$

Production Efficiency:

$$(1-\bar{\tau}_{t+1})(F^a_{kt+1} - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{at+1}} = (1-\bar{\tau}_{t+1})(F^b_{kt+1} - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{bt+1}}$$

FOC-hhs FOC-firm

Corporate Taxation: 1980 vs 2016

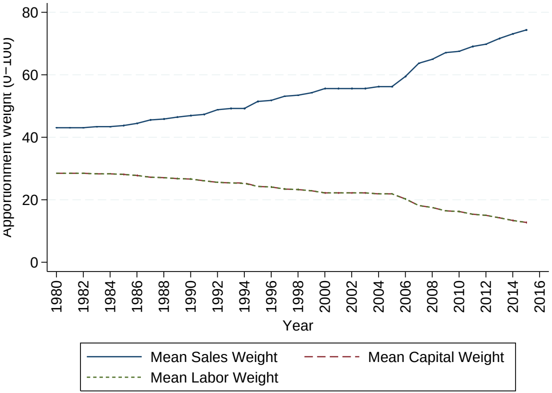

Figure 4: Apportionment weights

Compare two steady states:

- Apportionment weights: $(\frac{1}{3}, \frac{1}{3}, \frac{1}{3})_{1980}$ vs $(0, 0, 1)_{2016}$

1980 Corporate Tax policy

$(\alpha_i^K, \alpha_i^L, \alpha_i^S) = (\frac{1}{3}, \frac{1}{3}, \frac{1}{3})$

$$\begin{aligned}
\frac{\partial \bar{\tau}_t}{\partial n_{it}} &= \frac{n_{jt}}{N_t^2}(\tau_i \alpha_i^L - \tau_j \alpha_j^L) - F_{nt}^i \Phi_t \\
\frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} &= \frac{k_{jt+1}}{K_t^2}(\tau_i \alpha_i^K - \tau_j \alpha_j^K) - F_{kt+1}^i \Phi_t
\end{aligned}$$

where $\Phi_t = \frac{\sum \tau_{it} \alpha_{it} s_{it}}{(y_{at} + y_{bt})^2}$

Optimality conditions as shown before.

$$\begin{aligned}
\frac{u_{ct}^i}{u_{nt}^i} &= \frac{(1+\tau_i^c)}{(1-\tau_i^n)} \frac{1}{F_{nt}^i - \frac{\Pi_t}{1-\bar{\tau}_t} \frac{\partial \bar{\tau}_t}{\partial n_{it}}} \\
\frac{u_{ct}^i}{\beta u_{ct+1}^i} &= 1 + (1-\bar{\tau}_{t+1})(F_{kt+1}^i - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} \\
(1-\bar{\tau}_{t+1})(F_{kt+1}^a - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{at+1}} &= (1-\bar{\tau}_{t+1})(F_{kt+1}^b - \delta) - \Pi_{t+1} \frac{\partial \bar{\tau}_{t+1}}{\partial k_{bt+1}}
\end{aligned}$$

2016 Corporate Tax policy
$(\alpha_i^K, \alpha_i^L, \alpha_i^S) = (0, 0, 1)$

$$
\begin{aligned}
\frac{\partial \bar{\tau}_t}{\partial n_{it}} &= -F_{nt}^i \frac{\sum \tau_{it} s_{it}}{{Y_{t+1}}^2} \\
\frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} &= -F_{kt+1}^i \frac{\sum \tau_{it+1} s_{it+1}}{{Y_{t+1}}^2}
\end{aligned}
$$

Average tax rate becomes:

$$
\bar{\tau}_t = \tau_a \left(\frac{s_{at}}{s_{at} + s_{bt}} \right) + \tau_b \left(\frac{s_{bt}}{s_{at} + s_{bt}} \right)
$$

Optimality conditions

$$
\begin{aligned}
\frac{u_{ct}^i}{u_{nt}^i} &= \frac{(1+\tau_i^c)}{(1-\tau_i^n)} \frac{1}{(1 + \frac{\Pi_t}{1-\bar{\tau}_t} \Phi_t) F_{nt}^i} \\
\frac{u_{ct}^i}{\beta u_{ct+1}^i} &= 1 + (1 - \bar{\tau}_{t+1})(F_{kt+1}^i - \delta) + \Pi_{t+1} F_{kt+1}^i \Phi_{t+1} \\
F_{kt+1}^a &= F_{kt+1}^b
\end{aligned}
$$

Tax Competition Framework

Governments from each country meet once to play a game in which they choose α weights

Payoffs: welfare gains or losses at the CE supported by the choice of α_i and τ_i^c needed to satisfy the intertemporal government budget constraints.

$V(\overrightarrow{\alpha}_i | \overrightarrow{\alpha}_j)$ is *the payoff function* for country i strategic choice of FA weights given country's j choice.

A strategic decision rule $\overrightarrow{\boldsymbol{\alpha}}_{\boldsymbol{i}}(\overrightarrow{\alpha}_j)$: each government in each country chooses its FA weights, given the others, in order to maximize the payoff to the residents in its country:

$$\overrightarrow{\boldsymbol{\alpha}}_{\boldsymbol{i}} = \arg \max_{\overrightarrow{\alpha}_i \in \mathcal{A}_i} V(\overrightarrow{\alpha}_i | \overrightarrow{\alpha}_j) \qquad i = a, b, \; i \neq j$$

$\mathcal{A}_i$ is the space of admissible FA weights.

Tax Competition Framework

A *Nash Equilibrium* for the Formula Apportionment competition game is defined by a pair of FA weight vectors $(\overrightarrow{\alpha}_a, \overrightarrow{\alpha}_b)$ and the associated payoffs $V(\overrightarrow{\alpha}_a|\overrightarrow{\alpha}_b)$, and $V(\overrightarrow{\alpha}_b|\overrightarrow{\alpha}_a)$ such that:

1. $\overrightarrow{\alpha}_a$ maximizes $V(\overrightarrow{\alpha}_a|\overrightarrow{\alpha}_b)$ given $\overrightarrow{\alpha}_b$,
2. $\overrightarrow{\alpha}_b$ maximizes $V(\overrightarrow{\alpha}_b|\overrightarrow{\alpha}_a)$ given $\overrightarrow{\alpha}_a$,
3. the payoff functions are consistent with the competitive equilibrium prices and allocations corresponding to $(\overrightarrow{\alpha}_a, \overrightarrow{\alpha}_b)$,
4. the fiscal solvency rules of both $i = a, b$ countries are satisfied.

Next Steps

- Is model suitable for Quantitative exercise?
  - Competition among states: Non-cooperative Nash
- Explore the decline on average corporate tax rate.
  - Distribution of sales across states: establishment-level data (LBD).
  - Tax credits and deductions.

Corporate Tax rates by US regions

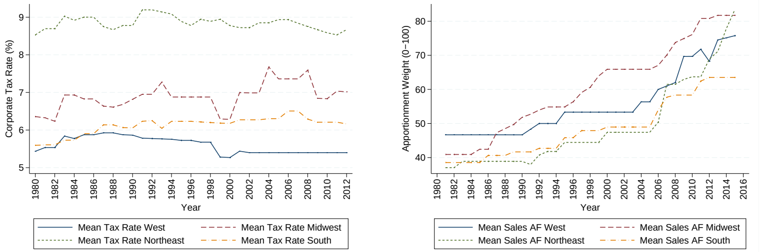

Figure 5: Corporate Taxation

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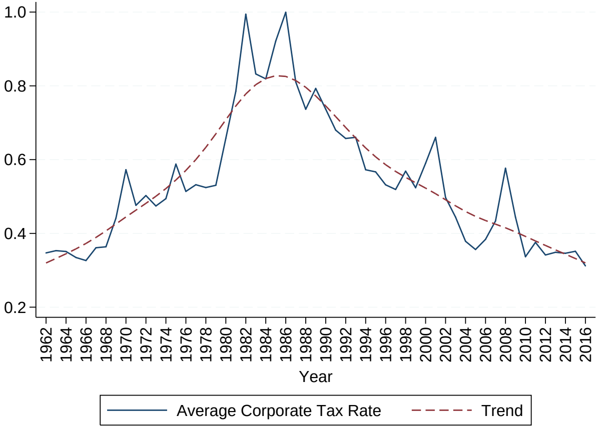
Average Corporate Tax Rate across US States

Figure 6: Corporate Tax Revenue by U.S. Corporate Profits



Source: Bureau of Economic Analysis (Regional Accounts), Annual Survey of State Government Tax Collections (STC)–U.S. Census Bureau. back

Labor and Sales tax rates by US regions

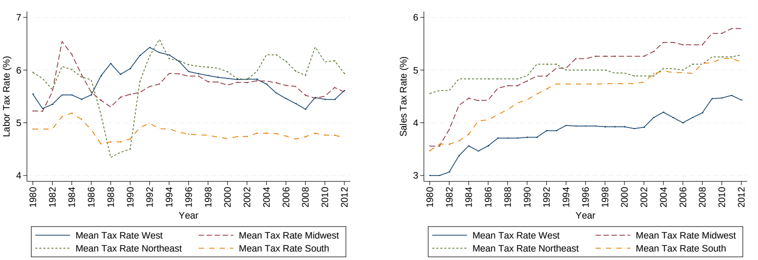


Figure 7: Statutory tax rates

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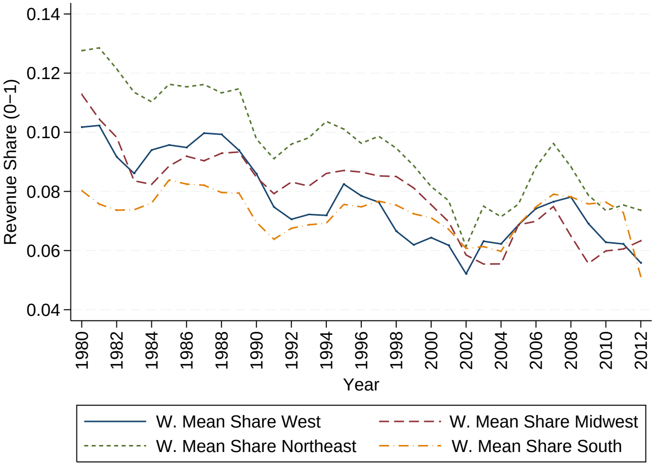
Corporate Tax share of Total Revenues



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Tax Revenue Shares by region

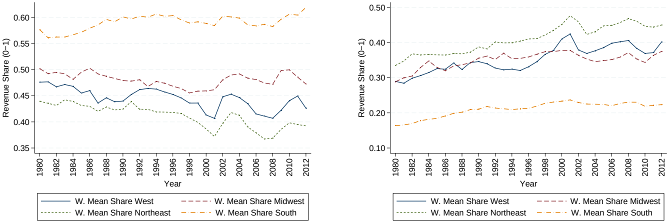

Figure 8: Shares of Total Revenue

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Effects of Formula Apportionment

Irrelevant if $\bar{\tau} = \tau_a = \tau_b$.

Interesting case: $\tau_a \neq \tau_b$,

$$\begin{aligned}
\frac{\partial \bar{\tau}_t}{\partial n_{it}} &= \frac{n_{jt}}{N_t^2}(\tau_i \alpha_i^L - \tau_j \alpha_j^L) - F_{nt}^i \Phi_t \\
\frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} &= \frac{k_{jt+1}}{K_t^2}(\tau_i \alpha_i^K - \tau_j \alpha_j^K) - F_{kt+1}^i \Phi_t
\end{aligned}$$

where $\Phi_t = \frac{\sum \tau_{it} \alpha_{it} s_{it}}{(y_{at} + y_{bt})^2}$

Consider $\tau_a > \tau_b$, $\alpha_a^L > \alpha_b^L$, and $\alpha_a^K > \alpha_b^K$, then

$$\frac{\partial \bar{\tau}_{t+1}}{\partial k_{bt+1}} < \frac{\partial \bar{\tau}_{t+1}}{\partial k_{at+1}}$$

- allocating one unit of capital to the subsidiary in country b will reduce the average tax rate the firm faces.

Household's FOC

F.O.Cs with respect to $\{c_{it}, n_{it}, e_{it+1}, b_{it+1}\}$:

$$\begin{aligned}
\frac{u^i_{ct}(1-\tau^n_i)}{u^i_{nt}(1+\tau^c_i)} &= \frac{1}{w_{it}} \\
\frac{u^i_{ct}}{(1+\tau^c_{it})} &= \frac{V_{t+1}+d_{t+1}}{V_t}\frac{\beta u^i_{ct+1}}{(1+\tau^c_{it+1})} \\
\frac{q_{it-1}}{q_{it}} &= \frac{V_{t+1}+d_{t+1}}{V_t}
\end{aligned}$$

Define the change in equity value in units of the numeraire between period t and period $t+1$ to be:

$$\frac{Q_t}{Q_{t+1}} = \frac{V_{t+1}+d_{t+1}}{V_t} \tag{1}$$

back

Firm's FOC

The F.O.C for the parent firm are:

$$
\begin{aligned}
F^i_{nt} &= w_{it} + \frac{\Pi_t}{1-\bar{\tau}_t}\frac{\partial \bar{\tau}_t}{\partial n_{it}} && i = a, b \qquad (2) \\
\frac{Q_t}{Q_{t+1}} &= 1 + (1-\bar{\tau}_{t+1})(F^i_{kt+1} - \delta) - \Pi_{t+1}\frac{\partial \bar{\tau}_{t+1}}{\partial k_{it+1}} && i = a, b (3)
\end{aligned}
$$

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