Taxes and Spatial Misallocation

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Paper

- Fajgelbaum,Pablo D; Morales, Eduardo; Suárez Serrato, Juan Carlos; Zidar, Owen; State Taxes and Spatial Misallocation. The Review of Economic Studies, 2019, 86(1), 333–376.

Main Contribution

- Study state taxes as a potential source of spatial misallocation in the United States.
  - A spatial GE framework that incorporates salient features of the U.S. state tax system, and consider the response of worker and firm location to changes in state taxes
  - A government-spending-constant elimination of spatial dispersion in state taxes would increase worker welfare by 0.6%, if government spending is held constant, and by 1.2% if government spending responds endogenously.

Outline

Background

- Regional tax heterogeneity may impact welfare by distorting the spatial allocation of resources.
- Many countries have moved towards greater regional tax harmonization in recent decades.
- No quantitative evidence on the general-equilibrium tradeoffs between centralized and decentralized tax systems exist
- The U.S. is a typical example of a country with a decentralized tax structure

The U.S. State Tax System

- Three types of Tax: personal income tax (35%), corporate income tax (5%), and sales taxes tax (47%), 4% of GDP in 2012.
- State Tax
  - Personal Income Tax
    - Including both labor and capital income;
    - average across states was 3% in 2010; highest: Oregon (6.2%), lowest: 0
    - Progressive (regressive) tax, $t_n^y = 1 - a_{n,state}^y y^{-b_{n,state}^y}$, following Heathcote et al. (2017)

The U.S. State Tax System

- State Tax
  - Corporate Income Tax
    - The tax base of C-corporations is national profits
    - Three apportionment factors: payroll, property, and sales (sales be more prevalent)
    - The national average was 6.4% in 2012; the highest: Iowa (12%); The lowest: 0.
  - Sale Tax
    - Usually paid by the consumer upon final sale
    - The national average was 5% in 2012. Highest: New Jersey (10%); Lowest:0;

Tax in Model

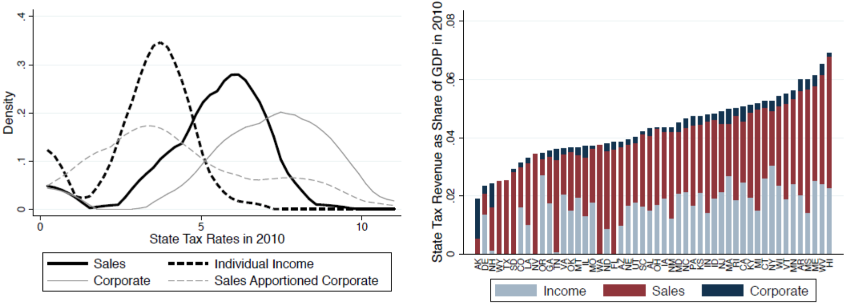
- Federal government
  - personal income taxes t_{fed}^{y}, corporate taxest_{fed}^{corp}, payroll taxest_{fed}^{w}.
- State government tax
  - personal income taxes t_{n}^{y}, corporate income taxes apportioned through salest_{n}^{x},
  - corporate income taxes through payroll and propertyt_{n}^{l} ,depends on production location
- Firm Tax burden located in n
  - (base on profits): t_{fed}^{corp}(to federal government), t_{n}^{l}, and t_{i}^{x} (to each state based on sales share)
  - (based on wages):t_{fed}^{w}
- Workers: t_{fed}^{y} and t_{n}^{y}, t_{n}^{x} (through purchasing products)
- Capital owners: t_{fed}^{y} andt_{n}^{y} (capital share, profits and endowment of fixed factors)

The U.S. State Tax System

Figure 1: Dispersion in State Taxes in 2010

(a) Distribution of Tax Rates Across States

(b) Tax Revenue as Share of GDP Across States in 2010



The U.S. State Tax System

- Transfers from the federal government amount to 6% of state GDP.
- Due to these transfers, state governments typically have balanced budgets

Model Overview

- A closed economy with N states indexed by n or i
- M firms and L workers receive idiosyncratic productivity and preference shocks. normalize M and L to 1 .
- M_n and L_n : the number of workers and firms that locate in state n.
- Each state n has an endowment H_n of fixed factors of production (land and structures), an amenity level u_n, and a productivity level z_n
- $\tau_{ni} \geqq 1$: an iceberg cost shipping from state$i$ to state n

Workers

- A continuum of workers $l \in [0, 1]$ decide in which state to work and consume.
- Each worker l observes a idiosyncratic taste draw $\varepsilon^{l}_{n}{}_{n=1}^{N}$,(i.i.d across individuals and states) and decides the state to resident.
- The worker l discovers her own productivity level z^{l}_{n} in that state, which generate a non-degenerate income distribution within each state.
- Then each worker l chooses her number of working hours h^{l}_{n}.
- So total income of l is $\omega_n h^{l}_{n} z^{l}_{n}$

Workers

- The indirect utility is $\varepsilon_n^l U_n(c_n, h_n)$,

$$U_n(c_n, h_n) = u_n(\frac{G_n}{L_n^{\chi_W}})^{\alpha_{W,n}} c_n{}^{1-\alpha_{W,n}} d_n(h_n)$$

- Define

$$\upsilon_n \equiv E_n\left[\max_h U_n(c_n(\omega_n h_n z_n), h_n)\right]$$

  - where

$$c_n(y) = \frac{1 - T_n(y)}{P_n} y$$

  - and keep-tax rate is

$$1 - T_n(y) \equiv \frac{(1 - t_{fed}^y)(1 - t_n^y)}{1 + t_n^c}$$

  - QA: why calculate the expectation of utility in indirect utility function?

Workers

- The indirect utility: $\upsilon_n^l = \upsilon_n \varepsilon_n^l$,
  - The fraction of workers located in state n is $L_n = Pr[n = argmax_{n'} \upsilon_{n'} \varepsilon_{n'}^l]$
  - The idiosyncratic taste draw ε_n^l is assumed to be i.i.d. across consumers and states, and it follows a Frechet distribution, $Pr(\varepsilon_n^l < x) = exp(-\varepsilon_W)$ *with* $\varepsilon_W > 1$
  - Then

$$L_n = (\frac{\upsilon_n}{\upsilon})^{\varepsilon w} \ with \ \upsilon \equiv (\sum_n \upsilon_n^{\varepsilon w})^{1/\varepsilon w}$$

Workers

- We assume log-linear keep-tax schedules at the state and federal levels: $1 - t_n^y = a_{n,state}^y y^{-b_{n,state}^y}$, and $1 - t_{fed}^y = a_{fed}^y y^{-b_{fed}^y}$
- These forms imply:

$$1 - T_n(y) = \frac{a_n^y y^{-b_n^y}}{1 + t_n^c}$$

- where $a_n^y \equiv a_{fed}^y \left(a_{n,state}^y\right)^{1-b_{fed}^y}$ and $b_n^y \equiv b_{n,state}^y + b_{fed}^y - b_{n,state}^y b_{fed}^y$.
- We assume disutility from hours worked of the form:

$$d_n(h_n) = exp\left(-\alpha_{h,n} \frac{h^{(1+1/\eta)}}{1+1/\eta}\right)$$

- The maximization of utility implies:

$$h_n = \left(\frac{1 - \alpha_{W,n}}{\alpha_{h,n}}(1 - b_n^y)\right)^{\frac{1}{1+1/\eta}}$$

Workers

- We assume that productivity draws across workers located in state n follow a Pareto distribution $Pr(z_n^l < Z) = 1 - (\frac{Z}{z_{L,n}})^{-\varsigma_n}$.
- These forms imply the common component of utility in state n is

$$
\begin{aligned}
\upsilon_n &= E_n \left[\max_h u_n (\frac{G_n}{L_n^{\chi_W}})^{\alpha_{W,n}} c_n{}^{1-\alpha_{W,n}} d_n(h_n) \right] \\
&= \frac{\varsigma_n u_n (\frac{G_n}{L_n^{\chi_W}})^{\alpha_{W,n}}}{\varsigma_n - (1-b_n^y)(1-\alpha_{W,n})} \left(\frac{a_n^y y^{-b_n^y}}{(1+t_n^c)P_n} \left(\omega_n z_{L,n} \left(h_n e^{-1} \right)^{\frac{1}{1+1/\eta}} \right)^{1-b_n^y} \right)^{1}
\end{aligned}
$$

- where the first term reflects wage heterogeneity within the state. If $\varsigma \to +\infty$, wage heterogeneity vanishes.
- Note $(z_n^l)^{(1-\alpha_{W,n})(1-b_n^y)}$ following $Pareto((z_{L,n})^{(1-\alpha_{W,n})(1-b_n^y)}, \frac{\varsigma_n}{(1-\alpha_{W,n})(1-b_n^y)})$

Workers

- Recall $L_n = (\frac{\upsilon_n}{\upsilon})^{\varepsilon_W}$
- Partial elasticity of share of workers in n,
  - with respect to the nominal wage per efficiency unit: $\varepsilon_W(1-\alpha_{W,n})(1-b_n^y)$.
  - with respect to g_n: $\varepsilon_W \alpha_{W,n}$.
  - The relationships are helpful to estimate ε_W and $\alpha_{W,n}$.

Capital Owners

- Immobile capital owners in state n own a fraction ω_n of a portfolio that includes all firms and fixed factors in all states.
- A larger ownership rate relative to other states results in larger trade imbalances, so calibrate ω_n to match the observed trade imbalances across states.
- Capital owners spend their income locally, pay sales taxes on consumption, and pay both federal and state income taxes on their income.

Production

- Production of variety: each variety is produced by a different firm
$$q_i^j = z_i^j [\frac{1}{\gamma_i}(\frac{h^j}{\beta_i})^{\beta_i}(\frac{l^j}{1-\beta_i})^{1-\beta_i}]^{\gamma_i}(\frac{i^j}{1-\gamma_i})^{1-\gamma_i}$$
    - where$\gamma_i$is the value-added share in production of firms in state i, and $1-\beta_i$ is the labor share in value added in state i.

Production

- Production of final goods

$$Q_n = (\sum_i \int_{j \in J_i} (q_{ni}^j)^{\frac{\sigma-1}{\sigma}} dj)^{\frac{\sigma}{\sigma-1}}$$

  - where J_i denotes the set of varieties produced in state i; q_{ni}^j is the quantity of variety$j$ produced in state i and used for production of the final good in state$n$.
  - The final good is non-trade, and can be used as intermediate input or final consumption

$$Q_n = C_n + I_n + G_n + G_n^{fed}$$

Production

- Price: cost of producing unit of final good in state n:

$$P_n = \left(\sum_i \int_{j \in J_i} (p^j_{ni})^{1-\sigma} dj \right)^{\frac{1}{1-\sigma}}$$

  - where p^j_{ni} is the price of variety q^j_{ni} in state n

Profit maximization given firm location

- A continuum of firms $l \in [0,1]$ decide location and how much to sell to every state. Monopolistically competitive.
- Profit Maximization given firm Location, firm j located in state i with productivity z_i^j:

$$\pi_i(z_i^j) = \max_{\{q_{ni}^j\}}(1 - \bar{t}_i^j)(\sum_{n=1}^{N} x_{ni}^j - \frac{c_i}{z_i^j}\sum_{n=1}^{N}\tau_{ni} q_{ni}^j)$$

  - $\bar{t}_i^j$:corporate tax rate of firm j in state i.$\bar{t}_i^j = t_{fed}^{corp} + t_i^l + \sum_{n=1}^{N} t_n^x s_{ni}^j$
  - s_{ni}^j is the share of sales to state n. s_{ni}^j=s_{ni}, and $\bar{t}_i^j = \bar{t}_i$.
  - $x_{ni}^j = P_n Q_n^{\frac{1}{\sigma}} (q_{ni}^j)^{1-\frac{1}{\sigma}}$: sales to state n
  - $c_i = \{[(1 + t_{fed}^w)\omega_i]^{1-\beta_i} r_i^{\beta_i}\}^{\gamma_i} P_i^{1-\gamma_i}$, cost of the cost-minimizing bundle of factors and intermediate inputs of q_i^j.

Firms' price

- The price set in n by a firm with productivity z located in state i is.
$$p^j_{ni}(z) = \frac{\sigma}{\sigma - \widetilde{t}_{ni}} \frac{\sigma}{\sigma - 1} \frac{c_i \tau_{ni}}{z^j_i}$$
  - where
$$\tilde{t}_{ni} \equiv \frac{t^x_n - \sum_{n'} t^x_{n'} s_{n'i}}{1 - \bar{t}_i}$$
  - $\tilde{t}_{ni}$ is a pricing distortion created by heterogeneity in the sales-apportioned corporate tax rates.
  - if $t^x_n = t^x$, we have $\tilde{t}_{ni}$=0.
  - Prices will be higher in states with higher sales-apportioned corporate taxes.

Firms' location choice.

- Firm productivity: $z_i^j = z_i^0 \varepsilon_i^j$.
  - where the common component of productivity

$$z_i^0 = \left(\frac{G_i}{M_i^{\chi_F}} \right)^{\alpha_F} z_i^{1-\alpha_F}$$

  - G_i: real government spending; M_i firm numbers. The first part is endogenous, and z_i is exogenous.

Firms' location choice

- Firm productivity: $z_i^j = z_i^0 \varepsilon_i^j$.
  - ε_i^j is i.i.d. across firms and states and is drawn from a Frechet distribution with shape parameter ε_F.
  - This implies$\pi_i(z_i^j) = (1-\bar{t}_i)x_i^j/\sigma = \pi_i(z_i^0)(\varepsilon_i^j)^{\sigma-1}$ are also Frechet-distributed with shape parameter $\frac{\varepsilon_F}{\sigma-1} > 1$.
  - Firm chooses the place to locate to maximize its profits, $n = argmax_h \pi_h^j\left(z_h^j\right)$.

Firms' location choice

- The fraction of firms located in state i

$$M_i = Prob(\pi_n^j \geq \pi_i^j \; for \; any \; i \neq n)$$
$$= \left(\frac{\pi_i(z_i^0)}{\bar{\pi}} \right)^{\frac{\varepsilon_F}{\sigma-1}}$$

  - where $\pi_i(z_i^0)$ is the profit of a firm with productivity z_i^0 located in i.
  - $\bar{\pi} = \left\{ \sum_{i=1}^{N} [\pi_i(z_i^0)^{\frac{\varepsilon_F}{\sigma-1}} \right\}^{\frac{\sigma-1}{\varepsilon_F}}$ is proportional to the expected profits before the drawing ε_i^j.
  - A larger value of $\frac{\varepsilon_F}{\sigma-1}$, the productivity draws are less dispersed across states, states become closer substitutes. An increase in the relative profitability of a state leads to larger response in the fraction of firms that choose to locate in it.

Firms' distribution

- Denote $F_n(y) \triangleq Prob(z_n^j \leqslant y)$ as the distribution of firm's productivity in state n after the firms choose its location:

$$F_n(y) = \frac{Prob(z_n^j \leq y, and\, \pi_n^j \geq \pi_i^j\ for\ any\ i \neq n)}{Prob(\pi_n^j \geq \pi_i^j\ for\ any\ i \neq n)}$$

$$= exp\left(-M_i^{-1} y^{-\varepsilon_F}\right)$$

Firms' distribution

- Aggregate sale:

$$
\begin{aligned}
X_n = \sum_{i=1}^{N} \int_j x_{in}^j dj &= (1-\bar{t}_n)\sigma\bar{\pi}_n \int_j \left(z_n^j\right)^{\sigma-1} dj \\
&= (1-\bar{t}_n)\sigma\bar{\pi}_n \int_{z_n^j} M_n \left(z_n^j\right)^{\sigma-1} dF_n(z_n^j) \\
&= M_n(1-\bar{t}_n)\sigma\bar{\pi}_n(\tilde{z}_n)^{\sigma-1}
\end{aligned}
$$

where $\tilde{z}_n = [\int_j \left(z_n^j\right)^{\sigma-1} dj]^{\frac{1}{\sigma-1}} = z_n^0(M_n)^{-\frac{1}{\varepsilon_F}}[\Gamma(1-\frac{\sigma-1}{\varepsilon_F})]^{\frac{1}{\sigma-1}}$ is the average productivity of firms located in n, and $\Gamma(.)$ is the gamma function. We have $\pi_n(\tilde{z}_n) = \bar{\pi}_n\Gamma(1-\frac{\sigma-1}{\varepsilon_F})$.

Expenditure share

- Expenditure share:

$$\lambda_{in} = \frac{x_{ni}}{\sum_{h=1}^{N} x_{nh}} = \frac{s_{ni} X_n}{\sum_{h=1}^{N} s_{nh} X_h}$$
$$= M_i^{1+\frac{1-\sigma}{\varepsilon_F}} \left(\frac{\sigma}{\sigma - \tilde{t}_{ni}} \frac{\sigma}{\sigma - 1} \frac{\tau_{ni} c_i}{z_i^0 P_n} \right)^{1-\sigma}$$

Aggregate variables

- Labor demand in state n: $\omega_n L_n^E = (1-\beta_n)\gamma_n \frac{\sigma-1}{\sigma} X_n$, where $L_n^E = L_n h_n E_n[z]$ is total efficiency units of labor.
- Return to fixed factor: $r_n H_n = \beta_n \gamma_n \frac{\sigma-1}{\sigma} X_n$
- Payment to intermediate inputs: $P_n I_n = (1-\gamma_n)\frac{\sigma-1}{\sigma} X_n$
- GDP in state n: $GDP_n = \frac{\omega_n L_n^E}{1+t_{fed}^W} + r_n H_n + \frac{X_n}{\sigma} = \{1+\gamma_n(\sigma-1)[1-(1-\beta_n)t_{fed}^W/(1+t_{fed}^W)]\}\frac{X_n}{\sigma}$.

State Government

- The budget constraint of state n is

$$P_n G_n = R_n + T_n^{fed \to st}$$

- Tax revenue collected by state n is

$$\begin{aligned} R_n &= R_n^{corp} + R_n^y + R_n^c \\ &= \left\{ \sum_h t_n^x \frac{s_{nh} X_h}{\sigma} + t_n^l \frac{X_h}{\sigma} \right\} + \{ E[t_n^y(\omega_n h_n z)] L_n + \bar{t}_n^y b_n (\Pi + R) \} \\ &+ \{ t_n^c P_n C_n \} \end{aligned}$$

  - Π is national sum of profits. R is the national sum of returns to fixed factors.

- Assume $T_n^{fed \to st} = R_n \psi_n$,the federal government therefore subsidizes a fraction $\frac{\psi_n}{1+\psi_n}$ of spending in state n.

Federal Governments

- The budget constraint of federal government:

$$\sum_n T_n^{fed \to st} = \sum_n \left\{ t_{fed}^{w} \omega_n L_n^E + E[t_{fed}^{y}(\omega_n h_n z)] L_n \right\} + \sum_n \left\{ b_n \bar{t}_{fed}^{y} (\Pi + R) + b_n t_{fed}^{corp} \sum_h \frac{X_h}{\sigma} \right\}$$

where the items are federal payroll tax, federal personal income tax of worker and capital owner, and federal cooperative tax according to profits.

General Equilibrium

The general equilibrium solve $\{M_n, L_n, P_n, Q_n, C_n, I_n, G_n, G_n^{fed}, \omega_n, r_n\}$, such that:

- Final-goods producers optimize $Q_n = \left(\sum_i \int_{j\in J_i} (Q_{ni}^j)^{1-\sigma} dj\right)^{\frac{1}{1-\sigma}}$
- Workers make consumption and location decisions optimally.
- Firms make production, sales, and location decisions optimally
- Government budget constraints hold $P_n G_n = R_n + T_n^{fed\to st}$
- Goods markets clear in every location $Q_n = C_n + I_n + G_n + G_n^{fed}$
  - $C_n = E[\frac{(1-T_n^y)\omega_n h_n z}{P_n}]L_n + \frac{\Pi+R-T-(\bar{t}_n^y+\bar{t}_{n,fed}^y)(1-\bar{t}_n^y))(\Pi+R)}{P_n(1+t_n^c)} b_n$, consumption of worker and capital owner, where $\bar{t}_n^y$ and $\bar{t}_{n,fed}^y$ are the top average state and federal personal income tax rates.

General Equilibrium

AND:

- The labor market clears in every state $\omega_i L_i = (1-\beta_i) r_i \frac{\sigma-1}{\sigma} X_i$
- The fixed factor market clears in every location $r_i H_i = \beta_i r_i \frac{\sigma-1}{\sigma} X_i$
- The national labor market clears $\sum_n L_n = 1$

Adjusted Fundamentals and Implementation of Counterfactual

- State taxes affect these outcomes through their impact on the adjusted fundamentals $\{\tau_{ni}, z_n, u_n\}$,

$$z_n^A = (1 - \bar{t_n})^{\frac{1}{\sigma-1} - (\frac{1}{\varepsilon F} + \alpha_F \chi_F)} (\frac{P_n G_n}{GDP_n})^{\alpha_F} z_n^{1-\alpha_F}$$

$$\tau_{in}^A = \frac{\sigma}{\sigma - \tilde{t}_{in}} \tau_{in}$$

$$u_n^A = (1 - T_n)^{1-\alpha_w} (\frac{P_n G_n}{GDP_n})^{\alpha_w} u_n$$

  - Implementing counterfactual with respect to the tax distribution is equivalent to implementing a specific set of changes in amenities, productivity, bilateral trade costs, and trade imbalances in a standard model.

Agglomeration and congestion force

- Agglomeration force:
  - home market effects,
  - public service, if $\chi_W < 1$or $\chi_F < 1$.
- Congestion force:
  - immobile fixed factors
  - selection of heterogeneous firms: firm number increase lead to lower average firm productivity ($\tilde{z}_n \propto z_n^0 (M_n)^{-\frac{1}{\varepsilon_F}}$).
  - immobile capital owners, who consume where they are located.

Impact of Tax Dispersion in Simple Frameworks

Assume No trade frictions, No workers' intensive margin of labor supply, No heterogeneity in firms and workers, public good is non-rival. State sales and income taxes are the only non-zero taxes (only T_n).

- Suppose there were no differences in public spending per capita or amenities across states, spatial dispersion is inefficient;
  - Spatial efficiency (welfare maximization) requires $MPL_n = MPL_{n'}$
  - In spatial equilibrium, the consumption of a worker in each state are the same, $c_n^L = c_{n'}^L$, which implies $(1 - T_n)\omega_n = (1 - T_{n'})\omega_{n'}$.
  - Spatial dispersion in sales or income tax rates entering in T_n would result in spatial dispersion in marginal product of labor, which is inefficient.

Impact of Tax Dispersion in Simple Frameworks

- Suppose public spending per capita or amenities differ across states, spatial efficiency requires $MPL_n - c_n^L = MPL_{n'} - c_{n'}^L$, i.e., $\omega_n - c_n^L = \omega_{n'} - c_{n'}^L$, i.e., $T_n \omega_n = T_{n'} \omega_{n'}$
  - In spatial equilibrium, $c_n^L \neq c_{n'}^L$,
  - two direct outcomes when a person move: output gains (changes in MPL); final consumption cost (changes in real consumption).
  - spatial efficiency: $MPL_n - c_n^L$ are equalized across states.

Impact of Tax Dispersion in Simple Frameworks

Corollary

Assume No trade frictions, perfect substitutability across varieties ($\sigma \to \infty$), homogeneous firms ($\varepsilon_F \to \infty$), homogeneous workers with constant labor supply ($\varepsilon_w \to \infty$, $\varsigma_n \to \infty$, and constant h_n), and non-rival public goods ($\chi_W = 0$). Assume no cross-state dispersion in preferences for government spending. Then eliminating the dispersion in $\{T_n\}$ while keeping constant both its mean and the government spending in every state:

- *increases worker welfare if $corr(Z_n^{1/\beta}, (1-T_n)^{1/\beta})$ is low enough, and decreases it if it is large enough, where $Z_n \equiv (\frac{z_n^0}{\gamma})^{\frac{1}{\gamma}} (H_n)^{\beta} (u_n G_n^{\alpha w})^{\frac{1}{1-\alpha w}}$*
- *may increase or decrease the aggregate real income depending on the joint distribution of T_n, u_n and G_n.*
  - *Maximize real income: MPL is equalized across regions.*
  - *If eliminating dispersion in worker keep tax rates increase the dispersion in MPL, it will decrease the real income; Vice visa.*

Estimation independent to the model

- From the survey data:
  $P_n G_n$, L_n, M_n, $P_n I_n$, h_n, $P_n\ \omega_n$, γ_n, X_n, s_{ni}, λ_{ni}, and tax rate
- From literature: $1-\sigma = 4$; (trade elasticity)
- $(z_{L,n}, \varsigma_n)$ to match the distribution of hourly wages across individuals within each states, two moments
  - hourly wage: $w_n^h(l) = z_n^l w_n$. According Pareto distribution: $E(w_n^h(l)) = z_n^L w_n \frac{\varsigma_n}{\varsigma_n - 1}$.
  - Variance:
  - Estimating shape parameter ς_n using the average and variance of distribution of hourly wages.

$$cv = [\varsigma_n(\varsigma_n - 2)]^{-1/2}$$

$E(w_n^h(l))$ is obtained from real data.

Estimation

- Calibrated Parameters:
  - r_n, $1-\beta_n$: simple calculation (VA share, labor income share)
  - $\sigma = 4$, $\eta = 2.84$ from literature.
  - a_n^y, b_n^y, estimated by using tax data
  - H_n, z_n, u_n, τ_{in}: estimate A_{in}, the fundamental for their effects
  - ϖ_n : backed out from observed data on trade imbalances. (capital ownership)
  - $\chi_w = 1$; $\chi_F = 1$
  - $\varepsilon_w, \varepsilon_F, \alpha_{w,n}, \alpha_F$,: by using structure form regression (dispersion of work preferences, firm productivity; worker preference on public goods, share of public goods in firm productivity)
    - Expression for share of labor in each state to estimate $\alpha_{w,n}$, ε_w
    - Expression for shares of firms in each state to estimate α_F, ε_F

Workers' location preferences and value of public goods

Combining the definition of the state appeal in (4), the labour supply equation in (7), the expression for hours worked in (13), and the government budget constraint in (28), we obtain the following expression for the share of workers living in state n:

$$\ln L_{nt} = a_{0,n} \ln \tilde{y}_{nt} + a_{1,n} \ln \tilde{R}_{nt} + a_{2,n} \ln A_{nt} + \psi_t^L + \xi_n^L + v_{nt}^L, \tag{33}$$

where the coefficients $a_{0,n} \equiv \varepsilon_W (1 - \alpha_{W,n})/(1 + \chi_W \varepsilon_W \alpha_{W,n})$, $a_{1,n} \equiv \varepsilon_W \alpha_{W,n}/(1 + \chi_W \varepsilon_W \alpha_{W,n})$ and $a_{2,n} \equiv \varepsilon_W/(1 + \chi_W \varepsilon_W \alpha_{W,n})$ are functions of structural parameters. The variables $\tilde{y}_{nt}$ and $\tilde{R}_{nt}$ are measures of after-tax real labour earnings and real government spending, respectively, and A_{nt} is a measure of within-state wage dispersion. Specifically:

$$\tilde{y}_{nt} \equiv \frac{a_{nt}^y}{1 + t_{nt}^c} \frac{\left(h_{nt} z_n^L w_{nt}\right)^{1 - b_{nt}^y}}{P_{nt}}, \tag{34}$$

$$\tilde{R}_{nt} \equiv \frac{R_{nt}}{P_{nt}}, \tag{35}$$

$$A_{nt} \equiv \frac{\zeta_n}{\zeta_n - \left(1 - b_{nt}^y\right)\left(1 - \alpha_{W,n}\right)}. \tag{36}$$

Finally, the term $\psi_t^L + \xi_n^L + v_{nt}^L \equiv (\varepsilon_W/(1 + \chi_W \varepsilon_W \alpha_{W,n})) \ln u_{nt}/v_t$ accounts for year and state fixed effects and deviations from these state and year fixed effects in states' amenities, u_{nt}.

Get $\alpha_{w,n}$, but cannot separately identify ε_w, χ_w.

Workers' location preferences and value of public goods

- Endogeneity: state amenities are not fully captured by the year-fixed effect and state-fixed effect, so error term will be correlated with the regressors $\tilde{y}_{nt}$ and $\tilde{R}_{nt}$;
  - amenity shock $\uparrow$, worker $\uparrow$,wage $\downarrow$, after-tax income $\downarrow$, causing downward bias in $a_{0,n}$ in OLS.
  - amenity shock $\uparrow$, worker $\uparrow$,tax revenue $\uparrow$, real government spending $\uparrow$, causing upward bias in $a_{1,n}$ in OLS.

Workers' location preferences and value of public goods IV

- External state tax rates: inverse-distance weighted-average of tax rates in states other than n.
  - tax rise cause workers to move to other states, affecting earnings and tax revenue in other states.
    - Assume tax changes in neighbor are independent on n's residual amenity levle.
  - Bartik-type IV

$$\mathrm{BtkP}_{nt} = \sum_k \frac{L_{kn,1974}}{L_{n,1974}} \frac{PAY_{kt} - PAY_{k,t-10}}{PAY_{k,t-10}}, \quad \mathrm{BtkTR}_{nt} = \sum_{\tau=\{c,y,x\}} \frac{REV_{\tau,n,1974}}{REV_{n,1974}} \frac{REV_{\tau,t} - REV_{\tau,t-10}}{REV_{\tau,t-10}} \tag{38}$$

    - where k indexes one-digit SIC industries, PAY denotes real annual payroll, τ indexes different types of taxes (i.e., personal income taxes, corporate income taxes, and sales taxes), and REV denotes tax revenue. The instrument BtkP_{nt} uses variation in each state's exposure to national industry shocks.
    - if a state is very dependent on a particular industry k and this industry experiences relative growth at the national level, then after-tax real earnings in state n are likely to grow.
    - $BtkTR_{nt}$ uses variation in each state's exposure to revenue-source national shocks.
    - Suppose a state relies mostly on sales taxes for tax revenue, then national sales booms will cause especially high tax revenues for that state, and high government spending.

Workers' location preferences

- variability in $\alpha_{W,n}$ across states.
  - Impose the assumption that $\alpha_{W,n} = \alpha_W$ for every state n, and public goods enjoyed by workers are rival ($\chi_W = 1$),
  - Assume that $\alpha_{W,n} = R_n / GDP_n$, the average ratio of tax revenue to GDP during the sample period; Assume $\chi_W = 1$.
  - Assume $\alpha_{W,n} = \alpha_W$ for each n and calibrate the value of α_W to equal the cross-state mean value of the states' tax revenue to GDP ratio.
  - Impose the extreme assumption that public services have no impact on workers' utility ($\alpha_{W,n} = 0$ for each n).

firms' location preferences and value of public goods

Combining the pricing equation in (23), the definition of productivity in (25), the firm-location equation in (26), and the definition of profits in (A.10), our model yields the following expression for the share of firms in state n:

$$\ln M_{nt} = b_0 \ln\left((1-\bar{t}_n) MP_{nt}\right) + b_1 \ln c_{nt} + b_2 \ln \tilde{R}_{nt} + \psi_t^M + \xi_n^M + \nu_{nt}^M, \tag{40}$$

where $b_0 \equiv (\varepsilon_F/(\sigma-1))/(1+\chi_F\alpha_F\varepsilon_F)$, $b_1 \equiv -\varepsilon_F/(1+\chi_F\alpha_F\varepsilon_F)$, and $b_2 \equiv -\alpha_F b_1$; ψ_t^M is a time effect, and $\xi_n^M + \nu_{nt}^M$ accounts for state effects and deviations from state and year effects in log productivity, $\ln z_{nt}$. Unit costs are $c_{nt} = (w_{nt}^{1-\beta} r_{nt}^{\beta})^{\gamma} P_{nt}^{1-\gamma}$.[26] MP_{nt} is the market potential of state n in year t,

$$MP_{nt} = \sum_{n'} E_{n't} \left(\frac{\tau_{n'nt}}{P_{n't}} \frac{\sigma}{\sigma - \tilde{t}_{n'nt}} \frac{\sigma}{\sigma-1} \right)^{1-\sigma}, \tag{41}$$

where $E_{n't} \equiv P_{n't} Q_{n't}$ denotes aggregate expenditures in state n'. The market potential of state n is a measure of the market size for a firm located in state n, once trade costs with other states are taken into account.

firms' location preferences and value of public goods

- Endogeneity: unobserved productivity shocks may be positively correlated with local wages, and therefore with c_{nt}.
  - Firms are likely to locate in more productive places, leading to an upward bias in b_1.
  - IV: similar IV used to estimate the worker location equation; (however, use $BtkW_{nt}$ instead of $BtkP_{nt,}$ since endogenous variable now is unit costs, which depend on hourly wages rather than total earnings)

Estimation

Table 1: GMM Estimates of Worker Parameters

Instruments	Restrictions on $\alpha_{W,n}$	ε_W		α_W	
		$\chi_W = 0$	$\chi_W = 1$	$\chi_W = 0$	$\chi_W = 1$
Z^T_{nt}	$\alpha_{W,n} = \alpha_W$	1.42***	2.1***	.23***	.23***
		(.36)	(.8)	(.07)	(.07)
Z^B_{nt}	$\alpha_{W,n} = \alpha_W$	1.79***	2.25**	.11*	.11*
		(.63)	(.93)	(.06)	(.06)
Z^T_{nt}, Z^B_{nt}	$\alpha_{W,n} = \alpha_W$	1.36***	1.73***	.16***	.16***
		(.3)	(.52)	(.06)	(.06)
Z^T_{nt}, Z^B_{nt}	$\alpha_{W,n} = \frac{R_n}{GDP_n}$	.75***	1.48***		
		(.23)	(.33)		
Z^T_{nt}, Z^B_{nt}	$\alpha_{W,n} = 0.04 = \text{Mean}\frac{R_n}{GDP_n}$	1.19***	1.25***		
		(.32)	(.35)		
Z^T_{nt}, Z^B_{nt}	$\alpha_{W,n} = 0$	1.04***	1.04***		
		(.3)	(.3)		

Table 2: GMM Estimates of Firm Parameters

Instruments	Restrictions on α_F	ε_F		α_F	
		$\chi_F = 0$	$\chi_F = 1$	$\chi_F = 0$	$\chi_F = 1$
Z^T_{nt}	None	2.45***	2.84***	.06	.06
		(.27)	(.62)	(.07)	(.07)
Z^B_{nt}	None	2.81***	2.46***	-.05	-.05
		(.36)	(.46)	(.08)	(.08)
Z^T_{nt}, Z^B_{nt}	None	2.44***	2.63***	.03	.03
		(.27)	(.46)	(.06)	(.06)
Z^T_{nt}, Z^B_{nt}	$\alpha_F = 0.04 = \text{Mean}\frac{R_n}{GDP_n}$	2.43***	2.7***		
		(.26)	(.32)		
Z^T_{nt}, Z^B_{nt}	$\alpha_F = 0$	2.45***	2.45***		
		(.26)	(.26)		

Model validation

- the share of each state in national GDP against the data in 2007.
- the model's share of firms in each state against the actual share in 2007
- the share of government revenue in state GDP.
- for each type of tax, the model-implied and the observed share of revenue from this tax in total state tax revenue

Counterfactuals

Single-State Tax Changes

- A 1 percentage point reduction in the income tax rate of each state, one state at a time, while keeping government spending constant in every state

Table 3: Lowering Income Tax in One State

Change in	Own	Rest of U.S.
Keep Rate $(1 - T_n)$	1.12%	0%
Employment	0.84%	-0.02%
(Pre-tax) Nominal Wage	-0.43%	0.01%
Firms	0.41%	-0.01%
Real GDP	0.52%	-0.01%
State Effect (v_n)	0.44%	0.01%

Counterfactuals

- Replacing original distribution of state taxes in 2007 by new alternative distribution $(t_n^j)' = a^j + b * t_{n,2007}^j$

1. Tax-harmonization counterfactual: all states have the same tax rates (b = 0)
2. Same ranking of U.S. states by their original tax rates, but the dispersion can change

General Equilibrium Impact of the North Carolina Income Tax Cuts

In 2007, North Carolina had a progressive tax schedule with a top rate of 8.25%. The individual income tax rate in 2016 was a flat rate of 5.5%.

Table 3: The North Carolina Income Tax Cuts

Change in	Government Spending	
	Constant	Variable
Employment	0.31	0.02
(Pre-Tax) Nominal Wage	-0.17	-0.06
Firms	0.11	-0.06
Real GDP	0.13	-0.08
Real Government Spending	0.00	-1.77
Consumption of K	0.02	-0.02
Consumption of L	0.55	0.33

Tax Harmonization

All sales, corporate, and individual income tax rates are replaced by their mean values across all U.S. states, or cencus regions, are Census divisions.

Table 4: Tax Harmonization

Case	Welfare		U.S. GDP		C_K		C_L	
	G Con	G Var	G Con	G Var	G Con	G Var	G Con	G Var
Within All U.S.	0.51	0.98	0.03	-0.16	0.26	0.12	-0.05	0.62
Within Regions	0.48	0.89	0.02	-0.11	0.28	0.17	-0.07	0.49
Within Divisions	0.31	0.91	0.01	-0.02	0.20	0.19	0.05	0.45

$$d \ln v = \sum_n L_n d \ln GDP_n + \sum_n L_n \left(\frac{\alpha_W - G_n/GDP_n}{1 - G_n/GDP_n} \right) d \ln \frac{G_n}{GDP_n}.$$

Tax Harmonization

Eliminating tax dispersion in scenarios where wages, income, and trade flows across states are the same as those observed in the initial equilibrium, but state employment shares are reassigned across states

Table 5: Spending Constant Counterfactual under Alternative Distribution of Fundamentals

Case	$RankCorr(T_n, L_n) = 1$		Actual Data		$RankCorr(T_n, L_n) = -1$	
	Welfare	GDP	Welfare	GDP	Welfare	GDP
Within All U.S.	0.90	-0.09	0.51	0.03	-1.16	0.20
Within Regions	0.79	-0.07	0.48	0.02	-1.09	0.18
Within Divisions	0.78	-0.04	0.31	0.01	-0.99	0.16

Eliminating the State and Local Tax Deduction

(SALT) is one of the largest tax expenditures in the U.S. tax code.
Many tax reform plans have proposed eliminating it.
Th 2017 tax reform substantially limited it.

Table 6: Eliminating the State and Local Tax Deduction

Case	Welfare		U.S. GDP		C_K		C_L	
	G Con	G Var	G Con	G Var	G Con	G Var	G Con	G Var
Benchmark	-0.63	-0.75	-0.33	-0.37	-0.32	-0.36	-1.56	-1.60
$\alpha_{W,n} = \frac{R_n}{GDP_n}, \alpha_F = 0$	-0.81	-0.83	-0.33	-0.34	-0.33	-0.33	-1.56	-1.56
$\alpha_W = \alpha_F = .04$	-0.74	-0.81	-0.33	-0.38	-0.32	-0.37	-1.56	-1.61
Mean-constant a_n^y, b_n^y	-0.70	-0.74	-0.05	-0.07	-0.04	-0.06	-0.76	-0.78

Rolling back

How different the equilibrium in 2007 would have been if, over the 1980-2007 period, every fundamental of the economy had changed as it did, but state taxes had remained at the initial levels.

Table 7: Rolling Back Taxes

	80-07 Chg.		Welfare		U.S. GDP		C_K		C_L	
	Mean	CV	G Con	G Var	G Con	G Var	G Con	G Var	G Con	G Var
Sales	1.33	-0.04	1.23	-1.72	-0.01	-0.69	1.41	0.69	-1.35	-1.77
Income	-0.48	-0.13	-0.46	-0.25	0.01	0.04	0.03	0.06	-0.35	-0.27
Corp.	1.55	-0.04	0.05	-0.56	0.03	-0.12	0.36	0.21	0.00	-0.36
All			0.81	-2.65	0.03	-0.80	1.81	0.92	-1.69	-2.41

Robustness

- Progressive Income Taxes
- Alternative Definitions of Corporate Taxes
  - Some states grant firms reductions in their corporate tax liabilities
  - The fact that not all firms are C-corporations
- Change $\chi_w = 0$, $\chi_F = 0$
- Considering local taxes and property taxes

Summary

- Quantify the effect of dispersion in U.S. state tax rates on US aggregate real income and worker welfare
- Develop a spatial general-equilibrium framework that incorporates salient features of the U.S. state tax system
- Estimate the key model parameters using the over 350 changes in state tax rates implemented between 1980-2010 and economic activity across states.
- The U.S., tax dispersion leads to aggregate losses
- The potential losses from greater tax dispersion can be sizable