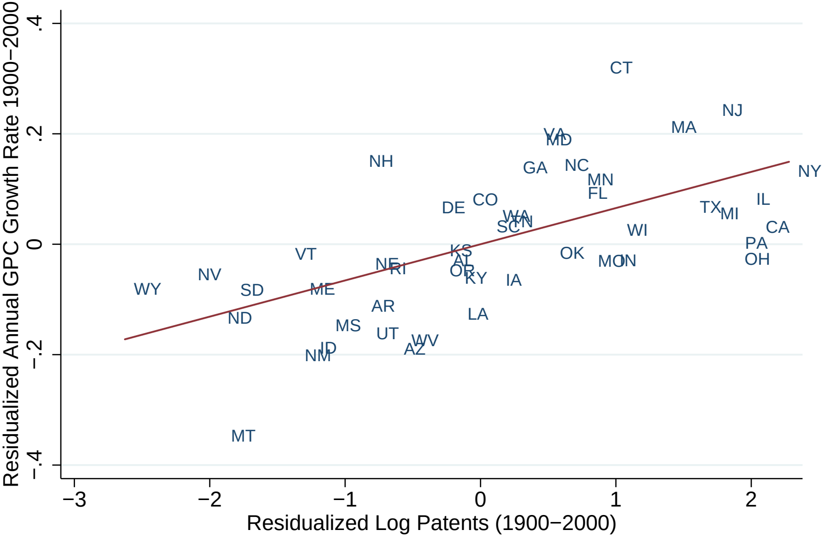
Taxation and Innovation

Stefanie Stantcheva

(Harvard University)

Innovation is One of Main Drivers of Long-Run Growth



Growth = 0.000 + 0.066 * Patents
Slope coefficient statistically significant at 1% level

In This Talk:

Two ways to study **interplay between taxation and innovation**:

1. Effects of general taxes on innovation are unwelcome byproduct that we need to consider and quantify.
2. Tax policy could be designed intentionally so as not to hurt, or even to stimulate, innovation.

1. Taxation and Innovation in the U.S. over the 20th Century.

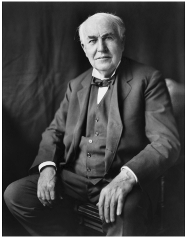
2. International effects of top-income taxation since 1975 on innovation.

3. Designing corporate tax and R&D policies to foster innovation.

Show results, but also research methods and data.

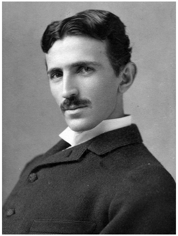
1. Taxation and Innovation in the U.S. over the 20th Century

Taxation and Innovation



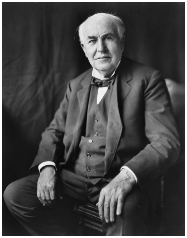
Thomas A. Edison
Light bulb.
Holds 1093 patents.

Melvin De Groote
Chocolate ice cream.
Holds 925 Patents.



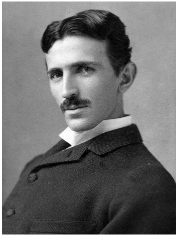
Nikola Tesla
Alternating Current.
Holds 278 Patents.

Taxation and Innovation



Thomas A. Edison
Light bulb.
Holds 1093 patents.

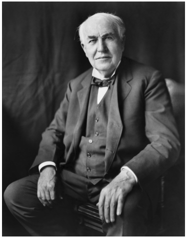
Melvin De Groote
Chocolate ice cream.
Holds 925 Patents.



Nikola Tesla
Alternating Current.
Holds 278 Patents.

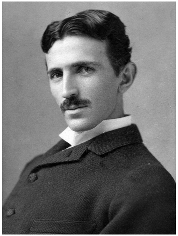
Mad geniuses? Scientific pioneers not considering net returns?

Taxation and Innovation



Thomas A. Edison
Light bulb.
Holds 1093 patents.

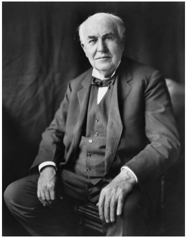
Melvin De Groote
Chocolate ice cream.
Holds 925 Patents.



Nikola Tesla
Alternating Current.
Holds 278 Patents.

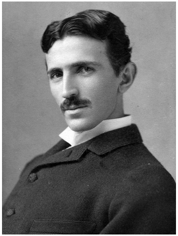
Or were these inventors affected by taxes?

Taxation and Innovation



Thomas A. Edison
Light bulb.
Holds 1093 patents.

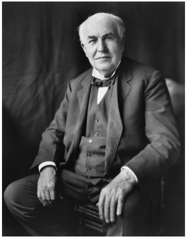
Melvin De Groote
Chocolate ice cream.
Holds 925 Patents.



Nikola Tesla
Alternating Current.
Holds 278 Patents.

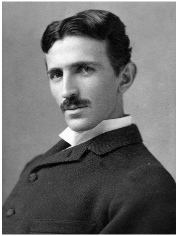
Personal taxes? Corporate taxes?

Taxation and Innovation



Thomas A. Edison
Light bulb.
Holds 1093 patents.

Melvin De Groote
Chocolate ice cream.
Holds 925 Patents.



Nikola Tesla
Alternating Current.
Holds 278 Patents.

Response margins? Patents produced? Quality of patents produced? Location choice? What firms they work for? Where they open research labs?

A Large-Scale Historical Project

- How do taxes affect innovation?

A Large-Scale Historical Project

- How do taxes affect innovation?
- Challenging question, to a large extent unanswered.

A Large-Scale Historical Project

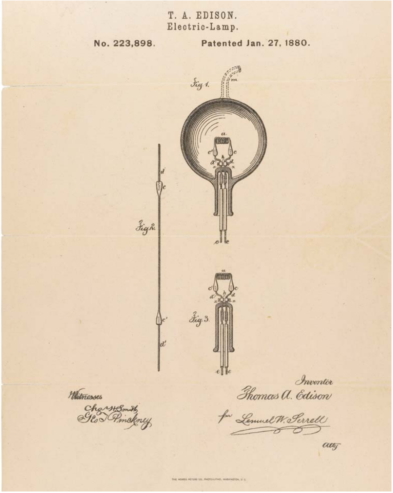
- How do taxes affect innovation?
- Challenging question, to a large extent unanswered.
- We leverage three newly constructed datasets for the U.S.:
    i) Panel of the universe of U.S. inventors since 1920 and their patents.
    ii) Panel of all R&D labs (employment, location, patents) since 1921.
    iii) Historical state-level corporate tax database.

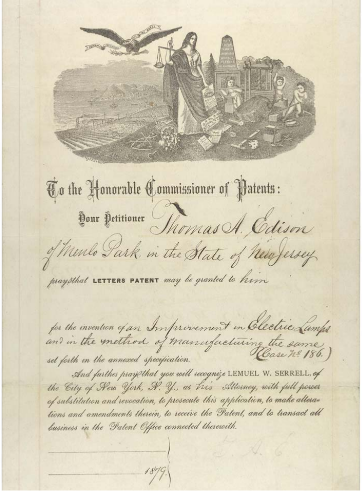
A Large-Scale Historical Project

- How do taxes affect innovation?
- Challenging question, to a large extent unanswered.
- We leverage three newly constructed datasets for the U.S.:
  i) Panel of the universe of U.S. inventors since 1920 and their patents.
  ii) Panel of all R&D labs (employment, location, patents) since 1921.
  iii) Historical state-level corporate tax database.
- Study systematically the effects of **personal and corporate income taxes** since 1920 on:
  i) Individual inventors (micro level).
  ii) Firms that do R&D (micro level).
  iii) Innovation in states (macro level).

A Large-Scale Historical Project

- How do taxes affect innovation?
- Challenging question, to a large extent unanswered.
- We leverage three newly constructed datasets for the U.S.:
  - i) Panel of the universe of U.S. inventors since 1920 and their patents.
  - ii) Panel of all R&D labs (employment, location, patents) since 1921.
  - iii) Historical state-level corporate tax database.
- Study systematically the effects of **personal and corporate income taxes** since 1920 on:
  - i) Individual inventors (micro level).
  - ii) Firms that do R&D (micro level).
  - iii) Innovation in states (macro level).
- Sheds light on taxation more generally (entrepreneurship, mobility, labor supply..)



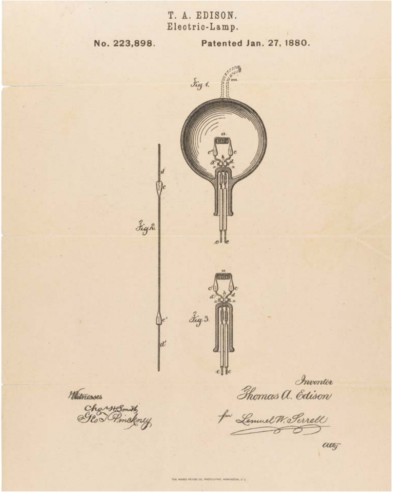

To the Honorable Commissioner of Patents:

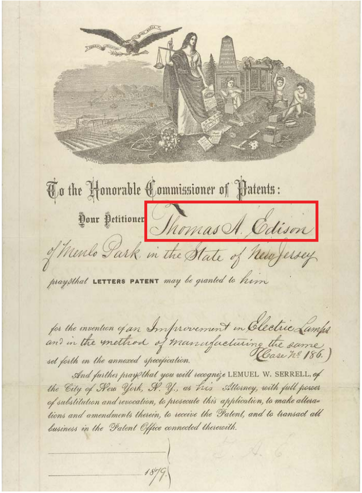
Your Petitioner Thomas A. Edison of Menlo Park in the State of New Jersey prays that LETTERS PATENT may be granted to him for the invention of an Improvement in Electric Lamps and in the method of manufacturing the same (Case No 186.) set forth in the annexed specification.

And further prays that you will recognize LEMUEL W. SERRELL, of the City of New York, N. Y., as his Attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

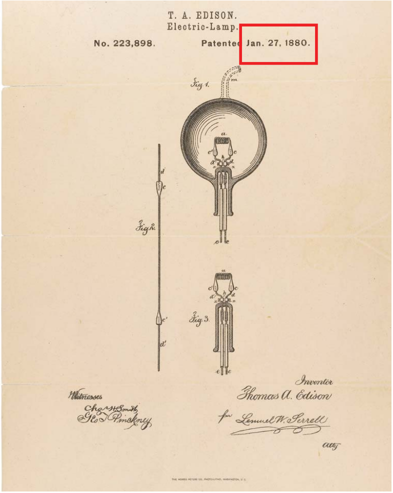
1879.

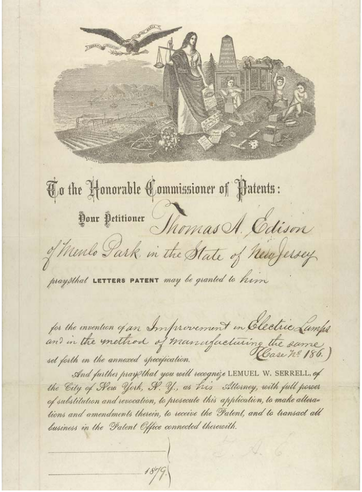
fname	sname	year	age	marital_st~s	birthplace	city
THOMAS	EDISON	1880	32	Married	OHIO	MENLO PARK
THOMAS	EDISON	1900	52	Married	OHIO	MENLO PARK
WILLIAM	WINE	1920	38	Married	VIRGINIA	TOLEDO WARD 4
ADIEL	DODGE	1940	48	Married	MISSOURI	ROCKFORD





fname	sname	year	age	marital_st~s	birthplace	city
THOMAS	EDISON	1880	32	Married	OHIO	MENLO PARK
THOMAS	EDISON	1900	52	Married	OHIO	MENLO PARK
WILLIAM	WINE	1920	38	Married	VIRGINIA	TOLEDO WARD 4
ADIEL	DODGE	1940	48	Married	MISSOURI	ROCKFORD




To the Honorable Commissioner of Patents:

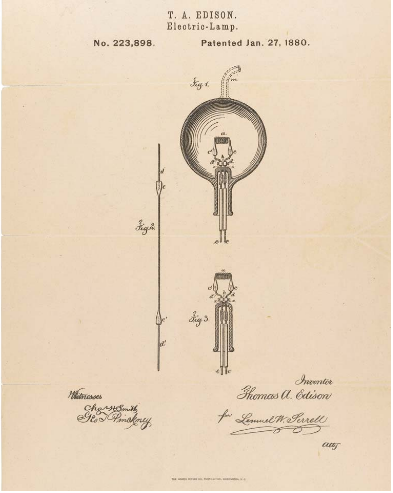
Your Petitioner Thomas A. Edison of Menlo Park in the State of New Jersey prays that LETTERS PATENT may be granted to him

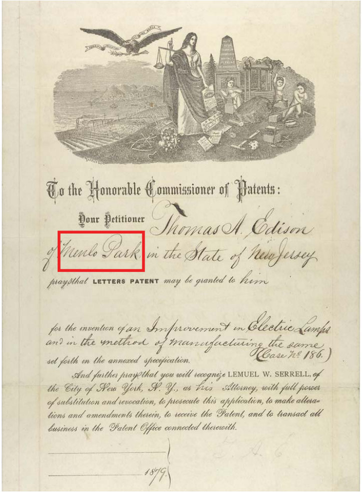
for the invention of an Improvement in Electric Lamps and in the method of manufacturing the same set forth in the annexed specification. (Case No 186.)

And further prays that you will recognize LEMUEL W. SERRELL, of the City of New York, N. Y., as his Attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

1879.

fname	sname	year	age	marital_st~s	birthplace	city
THOMAS	EDISON	1880	32	Married	OHIO	MENLO PARK
THOMAS	EDISON	1900	52	Married	OHIO	MENLO PARK
WILLIAM	WINE	1920	38	Married	VIRGINIA	TOLEDO WARD 4
ADIEL	DODGE	1940	48	Married	MISSOURI	ROCKFORD




To the Honorable Commissioner of Patents:

Your Petitioner Thomas A. Edison of Menlo Park in the State of New Jersey prays that LETTERS PATENT may be granted to him

for the invention of an Improvement in Electric Lamps and in the method of manufacturing the same (Case No 186.) set forth in the annexed specification.

And further prays that you will recognize LEMUEL W. SERRELL, of the City of New York, N. Y., as his Attorney, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to receive the Patent, and to transact all business in the Patent Office connected therewith.

1879.

fname	sname	year	age	marital_st~s	birthplace	city
THOMAS	EDISON	1880	32	Married	OHIO	MENLO PARK
THOMAS	EDISON	1900	52	Married	OHIO	MENLO PARK
WILLIAM	WINE	1920	38	Married	VIRGINIA	TOLEDO WARD 4
ADIEL	DODGE	1940	48	Married	MISSOURI	ROCKFORD

R&D Labs Data

Compiled from National Research Council (NRC) Surveys of *Industrial Research Laboratories of the United States* (IRLUS)

The NRC sent firms questionnaires – the IRLUS volumes contain the firm-level summary data responses.

- Data were hand entered from the 1921, 1927, 1931, 1933, 1938, 1940, 1946, 1950, 1956, 1960, 1965 and 1970 editions of IRLUS

Sample NRC Survey of IRLUS: Polaroid

3004. Polaroid Corp., 730 Main St., Cambridge 39, Mass. (C*p*)

Research staff: Edwin H. Land, President and Director of Research; Robert M. Palmer, Manager, College Personnel Relations; 50 chemists, 5 engineers, 1 mathematician, 9 physicists, 90 technicians, 18 auxiliaries.

Research on: One-step, three-dimensional, and color photography; color vision; chemistry of photographic processes; polarized light; polymers; absorption of light; organic chemistry; physics and crystallography, especially as related to phenomena involving radiation; spectroscopy; electronics.

How can we measure innovation?

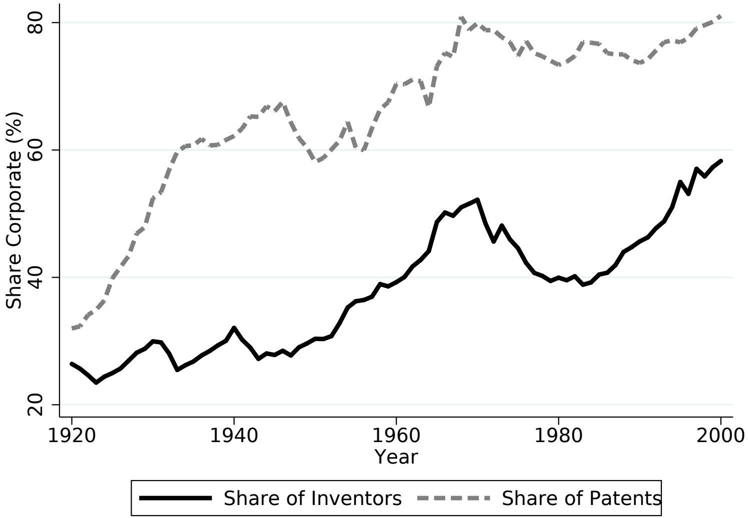
At the macro state-level:

- Number of inventors
- Number of patents
- Number of citations
- Share of corporate patents.

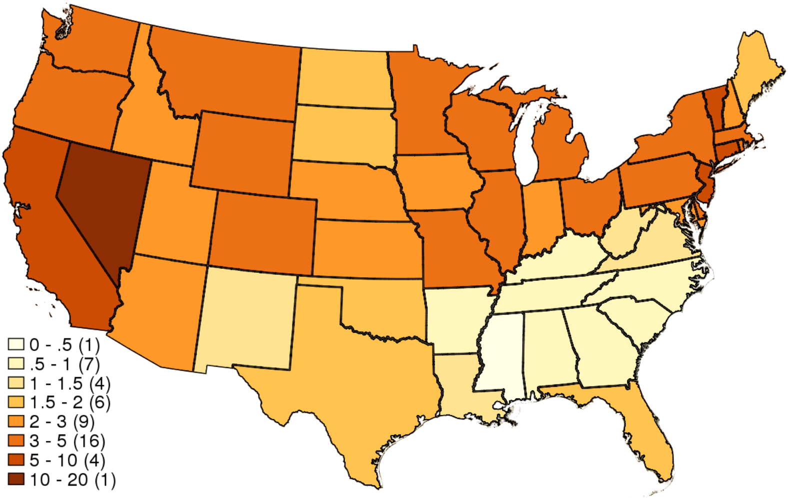
At the individual inventor and firm level:

- Do you patent at all? How many patents over the next years?
- How many citations? Home-run patent?
- Where do you locate?
- How many researchers do you hire (firms)?
- Do you work in corporate sector (inventors)?

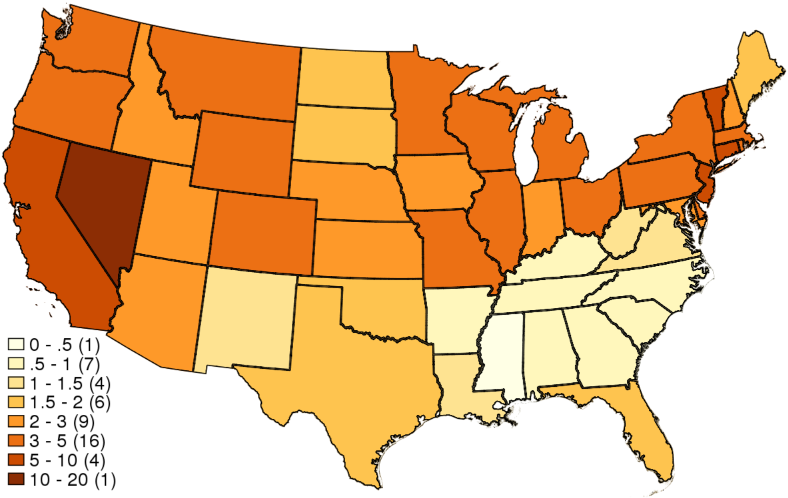
Why should we worry about both personal and corporate taxes?



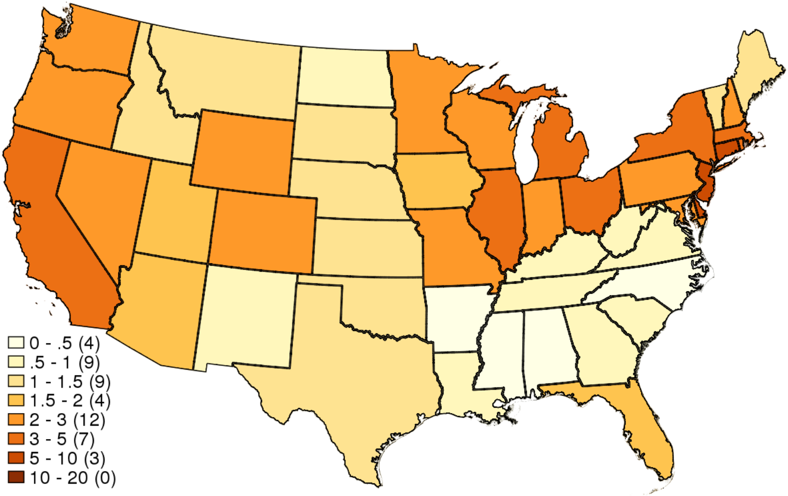
Geography of innovation. Inventors per 10,000: 1920



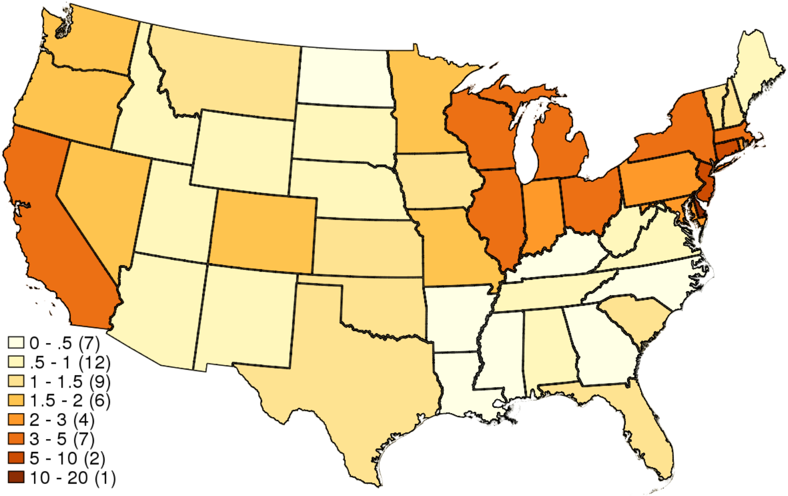
Geography of innovation. Inventors per 10,000: 1920-1930



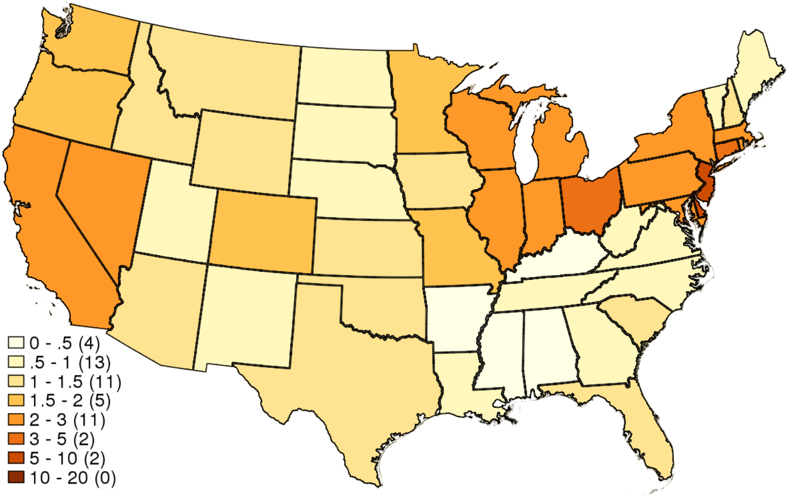
Geography of innovation. Inventors per 10,000: 1930-1940



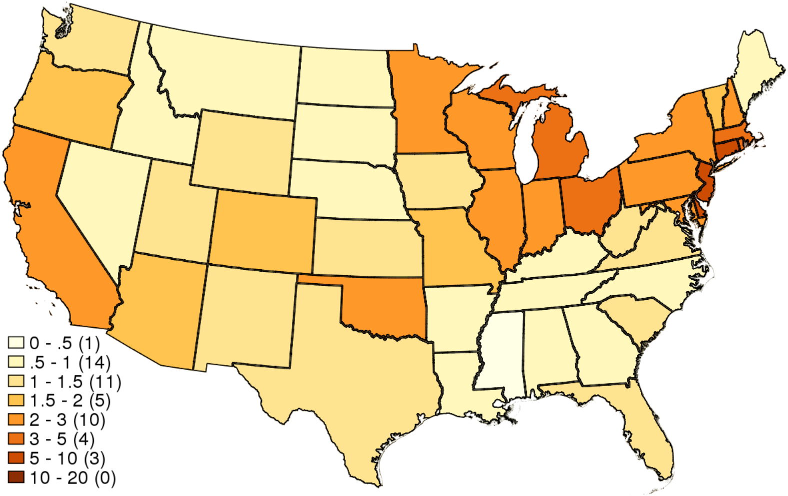
Geography of innovation. Inventors per 10,000: 1940-1950



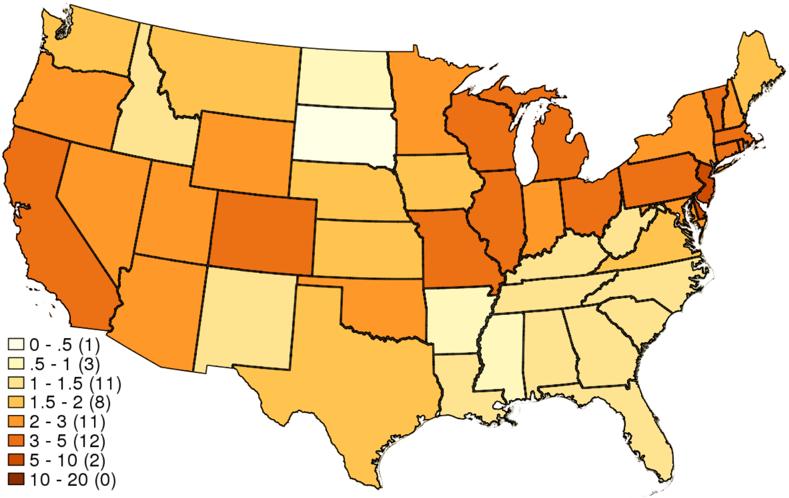
Geography of innovation. Inventors per 10,000: 1950-1960



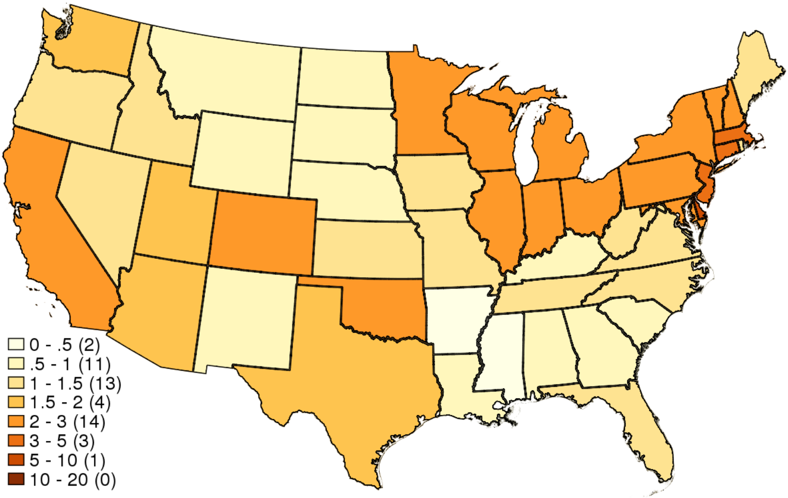
Geography of innovation. Inventors per 10,000: 1960-1970



Geography of innovation. Inventors per 10,000: 1970-1980

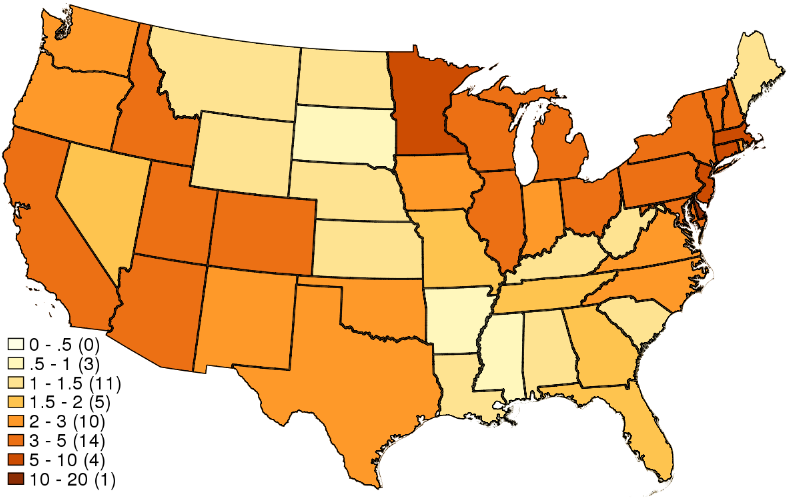


Geography of innovation. Inventors per 10,000: 1980-1990

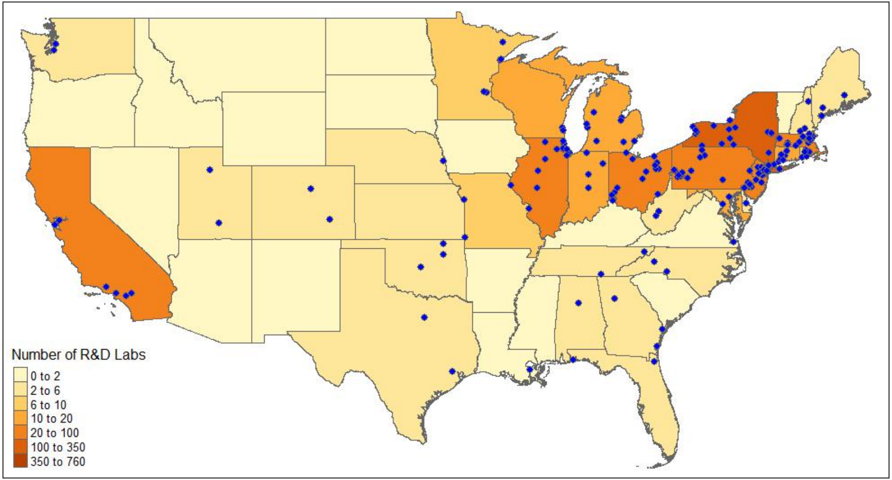


Geography of innovation. Inventors per 10,000: 1990-2000

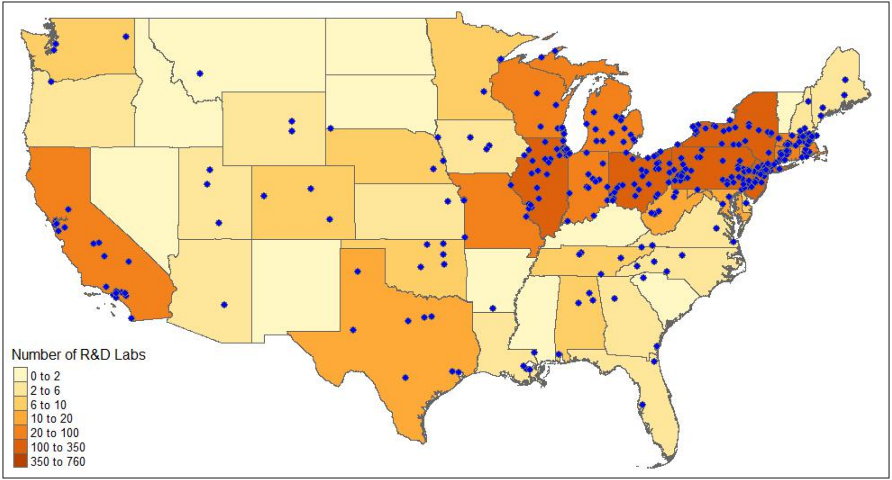
▸ Pat.



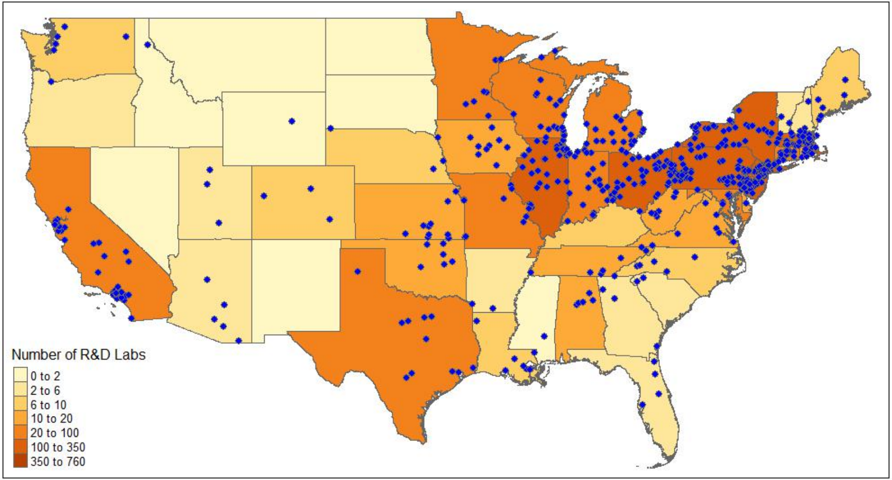
Location of R&D Labs - 1921



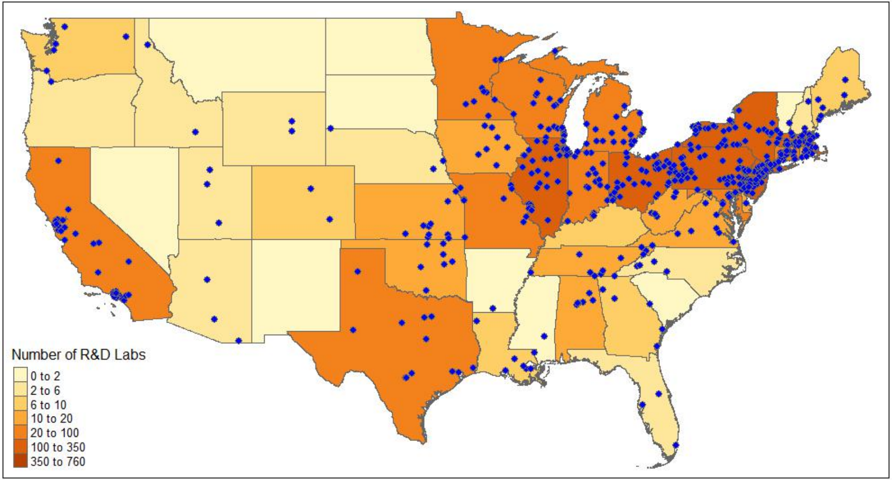
Location of R&D Labs - 1927



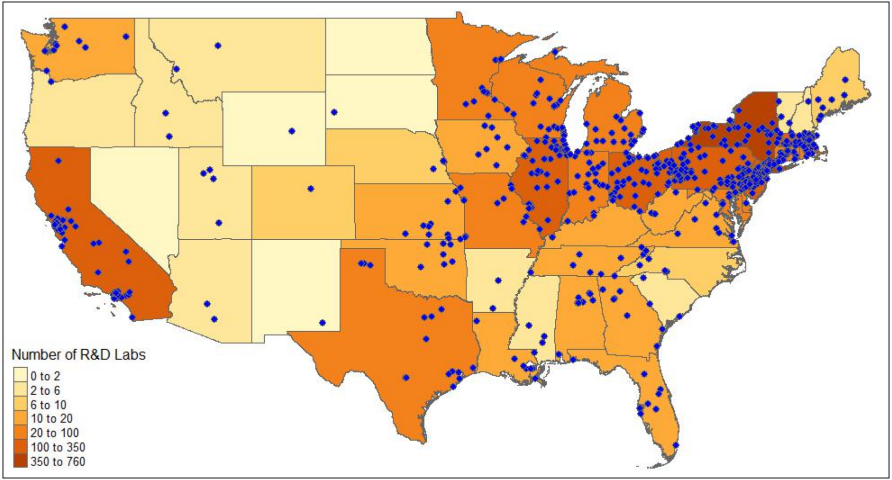
Location of R&D Labs - 1931



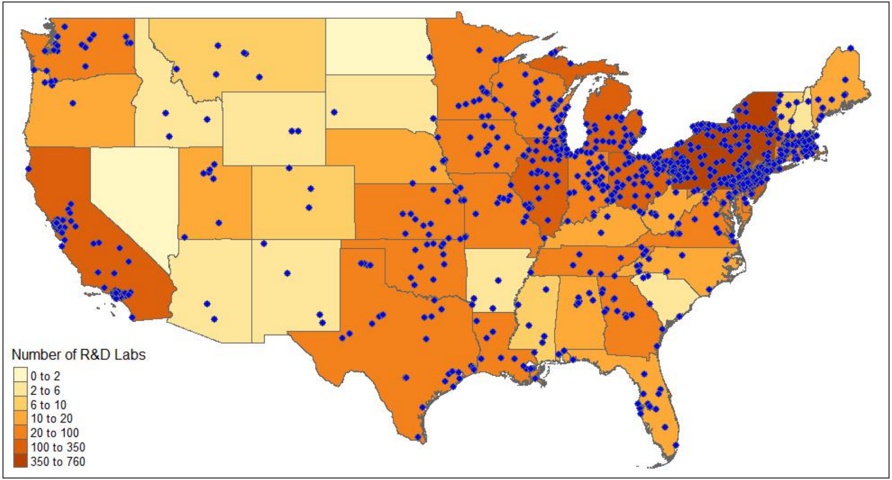
Location of R&D Labs - 1933



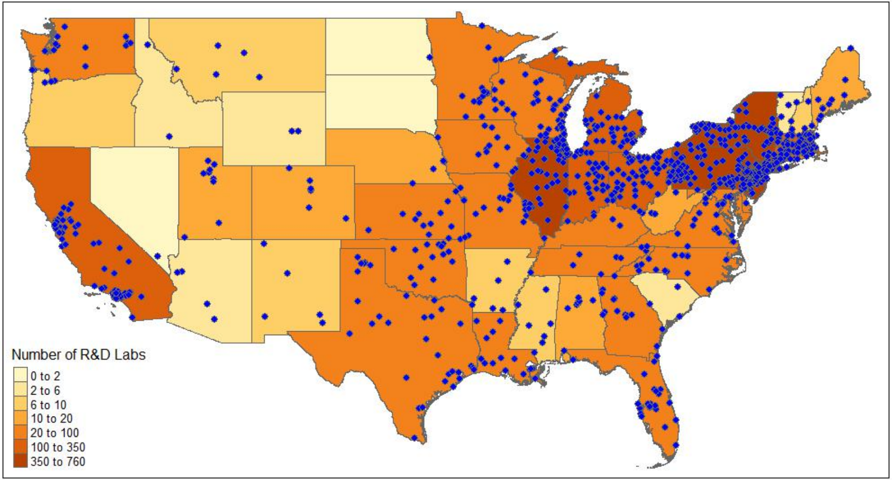
Location of R&D Labs - 1938



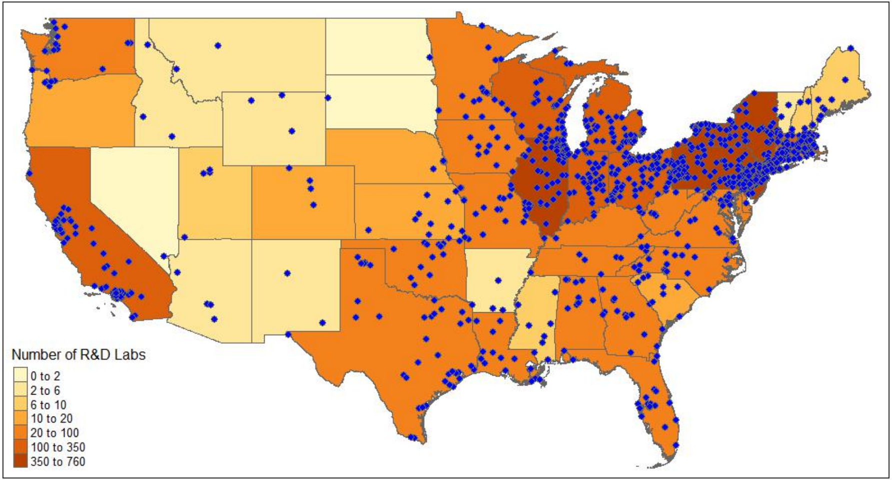
Location of R&D Labs - 1940



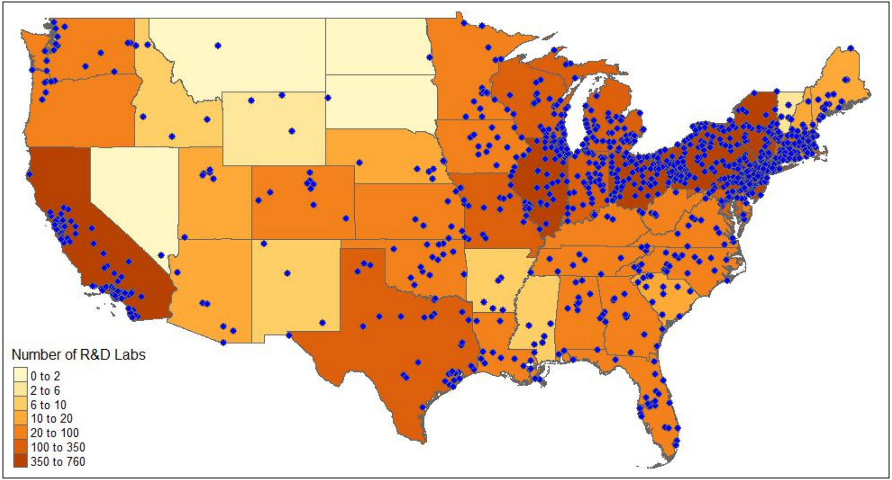
Location of R&D Labs - 1946



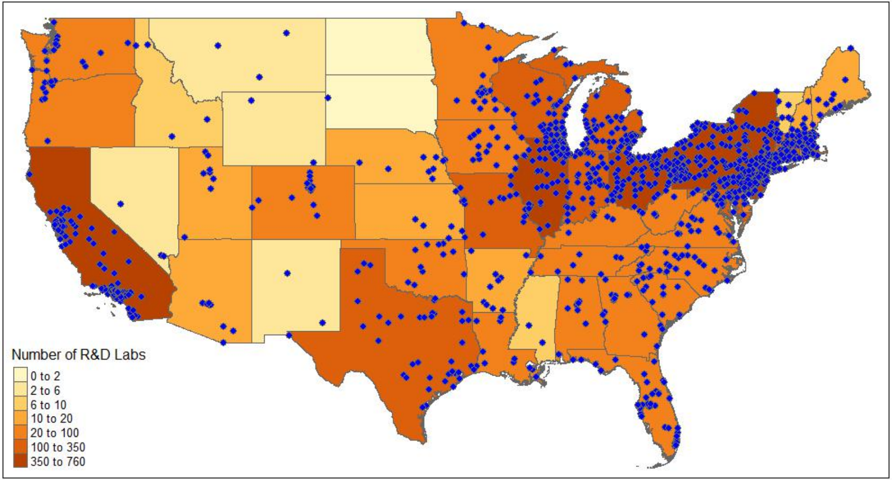
Location of R&D Labs - 1950



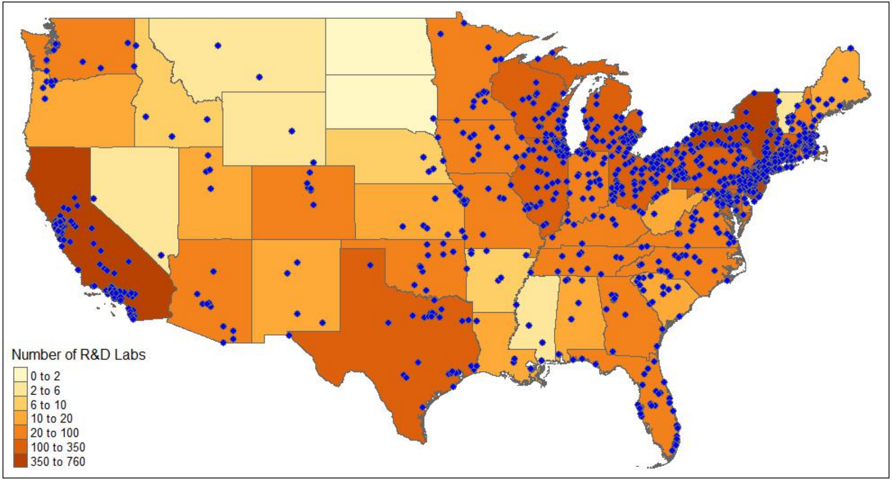
Location of R&D Labs - 1956



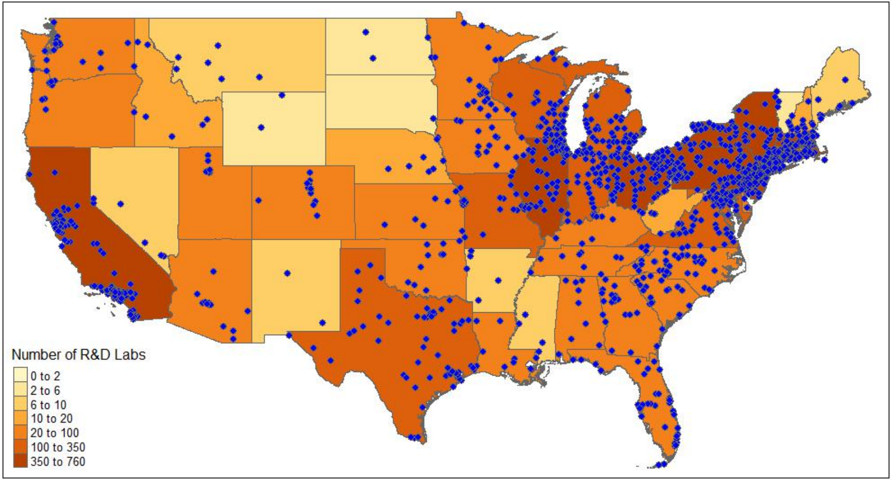
Location of R&D Labs - 1960



Location of R&D Labs - 1965



Location of R&D Labs - 1970



How can we study the effects of taxes on innovation?

$$\text{Innovation Outcome} = \beta_1 \times \text{Income tax} + \beta_2 \times \text{Corporate tax} + \text{Controls}.$$

Macro level (state) and micro level (individual inventor and firm).

Many confounding factors: Taxes changed jointly with other policies or in response to local econ conditions!

Need a proper empirical strategy.

- "Fixed effects:" filter out characteristics constant within year & states.
- "Instrumental variables:" use only changes in total tax burdens driven by federal-level changes.
- Compare border counties in neighboring states.
- Event studies: look before and after sharp tax changes.

Main Results

Personal income and corporate income taxes– negatively influence:

1. Quantity of innovation,
2. Quality of innovation,
3. Location of innovation.

At the macro level, cross-state spillovers and business-stealing are important, but not the full story.

Corporate inventors more reactive to personal, but especially to corporate taxes (to net returns in general?).

Could be differential exposure or different motives.

Agglomeration appears to matter: inventors are less sensitive to taxation where there is already more innovation in their own field.

2. International effects of Top Income Taxation since 1975.

Taxes and International Migration: Anecdotes but Little Evidence

- Is the "brain drain" in response to taxes real? Lots of anecdotes:
  - NYT, 2013: 'The Myth of the Rich Who Flee From Taxes"
  - Forbes, 2 days later: "Sorry New York Times, Tax Flight of the Rich Is Not a Myth."
  - Famous people migrating for tax reasons? Rolling Stones to France (!), David Bowie to Switzerland, Rod Stewart to California, Sting to Ireland, Gerard Depardieu's Russian citizenship, Edoardo Saverin (facebook co-founder) to Singapore, ...
- Scarcity of rigorous evidence due to a lack of **international panel data**.
  - Exceptions: Kleven, Landais and Saez (2013) on football players.
- This paper: study the effect of taxes on the **international mobility of inventors**.

Study the Effects of Taxes on Migration using Patent Data

- Use a **unique international panel data** to overcome challenges:
  - **Patent data** from the USPTO and EPO, 1977-2000.
  - Track inventors in 8 big patenting countries: CA, CH, DE, FR, IT, JP, UK, US through residential addresses.
- Study effects of **top tax rates** on **"superstar"** inventors' locations.
- Patent data gives direct measures of inventor quality.
- Detailed controls for ***counterfactual*** earnings in each potential location.

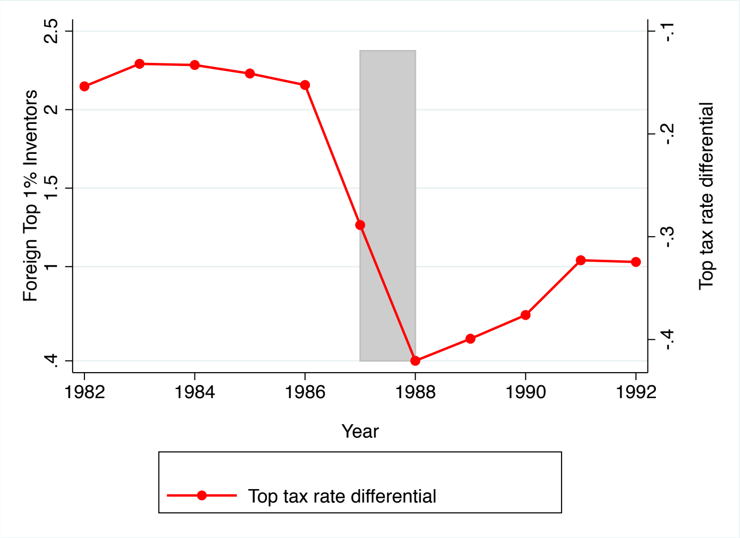
Three levels of analysis:

1. Macro country-year level migration flows (country-by-year variation).
2. Country case studies (quasi-experimental variation from reforms).
3. Micro inventor level location choice model (differential impact of top MTR within country-year. Inventor quality $\rightarrow \uparrow$ propensity to be treated).

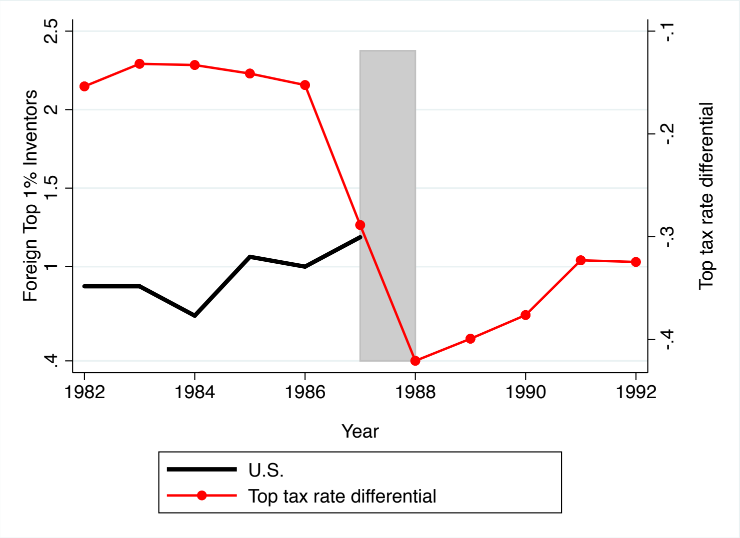
Preview of Findings

- Superstar top 1% inventors' location choice significantly affected by top tax rates.
- If have worked for multinationals more sensitive to tax differentials.
- If company has localized research activity, less sensitive.

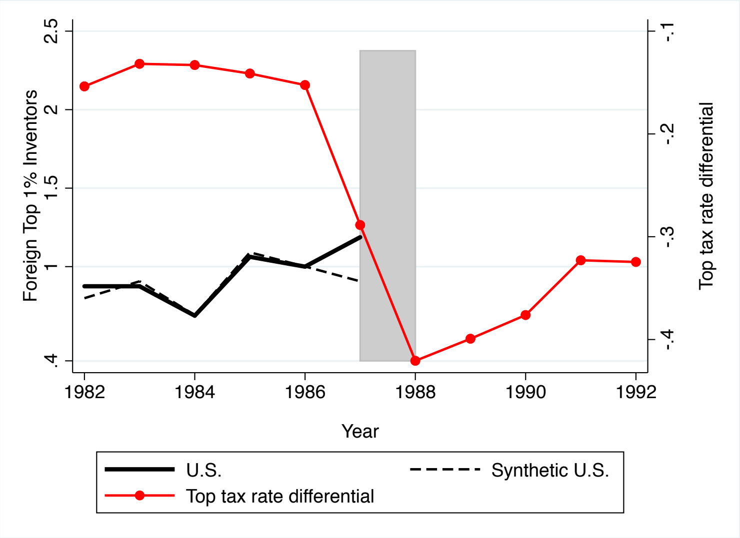
Case Study: U.S. TRA 1986



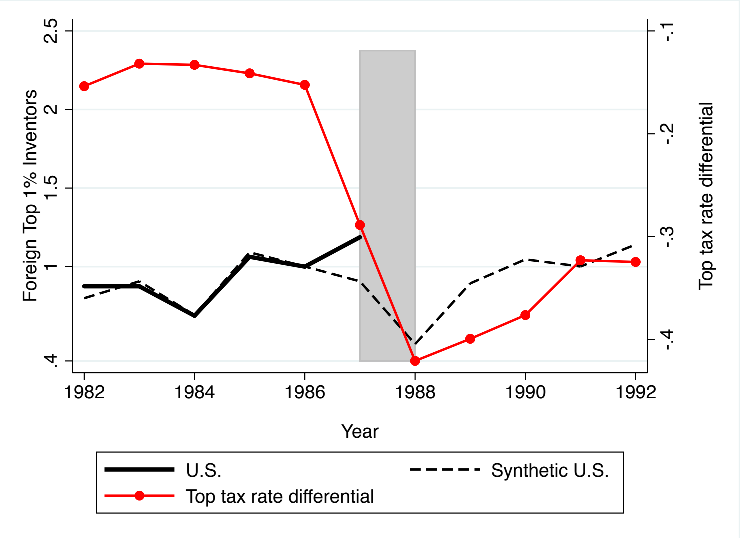
Case Study: U.S. TRA 1986



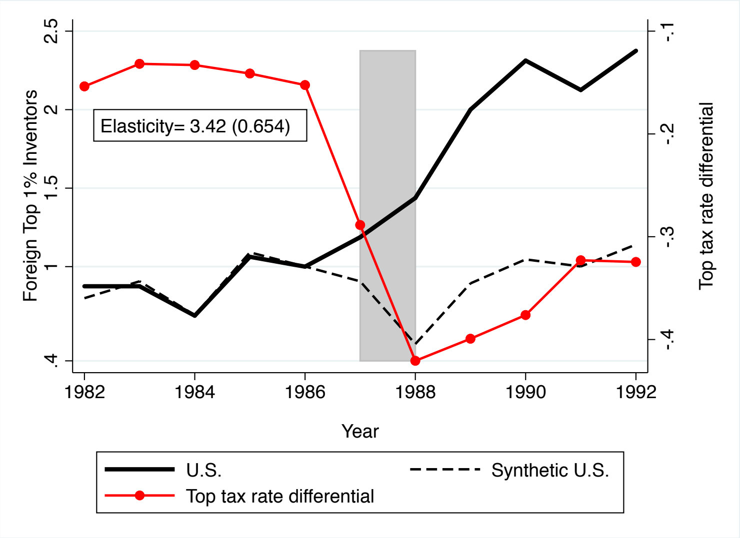
Case Study: U.S. TRA 1986



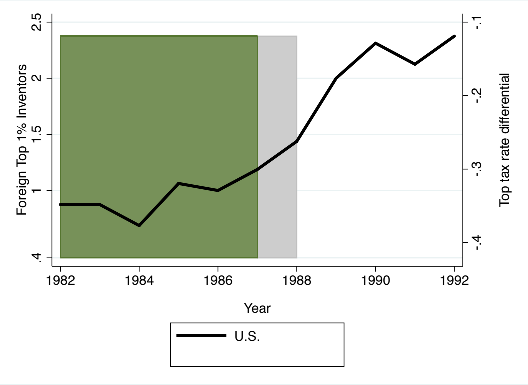
Case Study: U.S. TRA 1986



Case Study: U.S. TRA 1986



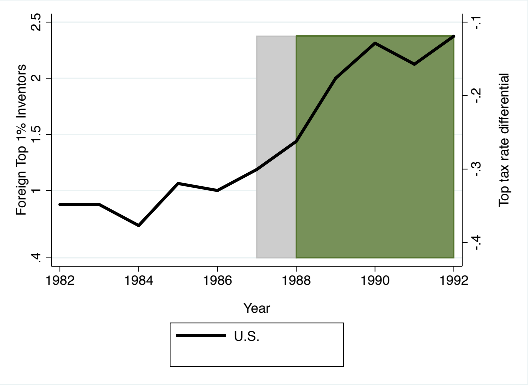
Case Study: U.S. TRA 1986



Structural break in growth of foreign top 1% relative to lower quality inventors.

Inventor quality	Pre T.R.A 1986	Post T.R.A 1986
Top 1%	6.8%	16.4%
Top 10-25%	13%	11.4%

Case Study: U.S. TRA 1986



Structural break in growth of foreign top 1% relative to lower quality inventors.

Inventor quality	Pre T.R.A 1986	Post T.R.A 1986
Top 1%	6.8%	16.4%
Top 10-25%	13%	11.4%

3. Designing Corporate Tax and R&D Policies

Motivation I: Widespread and Diverse R&D Policies

"The need to foster greater innovation and productivity growth is one of the most important economic challenges we face, and tax policy is one of several important levers that policymakers can use", J. Furman, former chairman of CEA

Businesses spend a lot of resources on R&D... and the government already intervenes heavily.

Large **variety** of policies target **innovation and R&D**

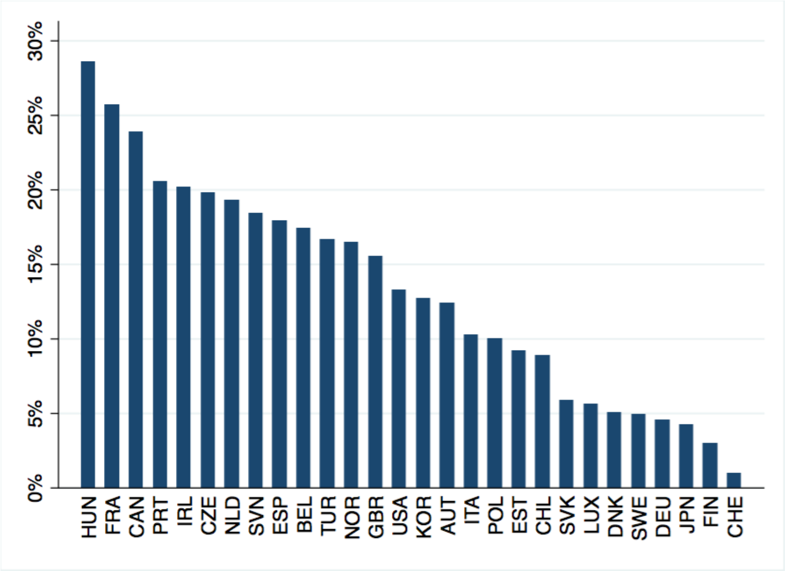
Tax credits, deductions, grants, contracts, direct funding in FFRDCs, Universities, Firms, small business, start-ups..

Large variety of policies across countries as well.

R&D policies are widespread, not fully understood, & very costly:

- "Intramural" R&D cost $35 billion (2014).
- "Extramural" R&D: tax credit $11 bil in 2012, contracting with non FFRDCs 50,6 billion, NSF-NIH $40 billion (econ grant: 0.0025%)

Share of Government Funding in Business R&D



Is the amount spent by government correlated with better productivity?

Motivation II: Private Information is an Important Constraint

- Take young firms at start of their lifecycle. How much of the variation in subsequent innovation quantity & quality can we explain based on observables?
  - Observables: age, assets, past investments, sales, state FE, year FE, sector FE (+ all interactions), and even past innovations:
  - R^2 not above 0.3, improves with age (as info revealed).
  - Conditional on these observables, many "outlier" firms.
- Two ways of possibly addressing asymmetric info problem:
  - **Direct screening**: what the NSF and VCs try to do. Done by the government with public procurement. Hard to do and very costly on a large scale.
  - **Indirect screening**: Design a menu of options (implemented by taxes and subsidies), let firms self-select! "Easy" to decentralize and scalable.

What are Key Ingredients to consider?

Firms have **different** productivities that evolve over time, somewhat unpredictably.

> Productivity: efficiency of converting R&D inputs into innovation output.

Some inputs are **observable** (R&D Investments) and can be subsidized; others are **unobservable** (R&D effort).

Uncertainty about R&D returns at the time investments are made.

Spillovers between firms: one firm's innovations affect other firms (+ society).

Innovation not appropriable unless IPR.

Firm productivity is **private information**.

What should the government/regulator do? How can it pick winners and not subsidize losers?

How to Approach this Question?

1) "Mechanism design approach:" what is the best we can do under this info constraint?

2) Quantitative Investigation using Patent data + Longitudinal Business Database (LBD) data.

> Can see the observable inputs to innovation and outputs (patents & citations).

3) Can now simulate effects of any policies! What simpler policy reforms can help?

Main Findings

Relative to current policies, a lot can be gained by better “targeting” and screening of R&D subsidies/credits to firms.

Key parameters and trade-off: How complementary are the (observable) subsidized R&D investments to firm productivity vs. to the (unobservable) not-subsidized inputs.

- If very complementary to firm productivity, very costly to subsidize as good firms extract very high rents (paid for by general tax $!)

Reforms that can save a lot of revenues while still fostering innovation:

- Condition corporate tax and R&D subsidies for innovative firms on i) age; ii) size; iii) past performance.

Conclusion: So.. should we slash taxes?

This is just one part of the (literal) equation – namely part of the efficiency cost.

$$\tau^* = \frac{1 - \overbrace{\bar{g}}^{\text{Social preferences}} + \overbrace{C}^{\text{Externalities}}}{1 - \bar{g} + \underbrace{e}_{\text{Efficiency effects}}}$$

The desired level of taxes crucially depends on your "social preferences" and wish for redistribution.

This is not something the data can tell us..