Taxation and Innovation

Stefanie Stantcheva

(Harvard University)

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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.
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.
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Taxation and Innovation

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Mad geniuses? Scientific pioneers not considering net returns?
Taxation and Innovation

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Or were these inventors affected by taxes?
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Personal taxes? Corporate taxes?
Taxation and Innovation

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A Large-Scale Historical Project

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- 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.
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- Study systematically the effects of **personal and corporate income taxes** since 1920 on:
  1. Individual inventors (micro level).
  2. Firms that do R&D (micro level).
  3. Innovation in states (macro level).
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  2. Firms that do R&D (micro level).
  3. Innovation in states (macro level).
- Sheds light on taxation more generally (entrepreneurship, mobility, labor supply..)
T. A. EDISON.
Electric-Lamp.

Inventor
Thomas A. Edison
f

To the Honorable Commissioner of Patents:

Petitioner
Thomas A. Edison

of Menlo Park, in the State of New Jersey,

petition that LETTERS PATENT may be granted to learn

for the invention of an Improvement in Electric Lamps and in the method of manufacturing the same,

set forth in the annexed specification.

And further pray that you will recognize Lemuel W. Serrell, of the City of New York, N. Y., as my Attorney, with full power of substitution and execution, to prosecute this application, to make alterations and amendments therein, to secure the Patent, and to transact all business in the Patent Office connected therewith.

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
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<td>William</td>
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<td>38</td>
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<td>48</td>
<td>Married</td>
<td>Missouri</td>
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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.  (Cp)

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?
Barebones Conceptual Framework: Taxes and Innovation

Innovation quantity/quality require inputs: effort/labor & material resources.


Corporate & personal taxes can affect firms & inventors: surplus sharing rule, tax base choice.

Tax elasticities depend on behavioral & technological elasticities, empirical question, ≠ for quality vs. quantity; Newton under the tree?

Corporate vs non-corporate inventors: different exposures to taxes, motives for innovation.

At macro level: extra cross-state spillovers and business stealing.

Dynamic effects: Lag to innovation? Forward-looking behavior.
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

[Map showing the distribution of inventors per 10,000 population across the United States, with different shades indicating varying ranges of inventors per 10,000.]

- 0 - .5: 4 states
- .5 - 1: 9 states
- 1 - 1.5: 9 states
- 1.5 - 2: 4 states
- 2 - 3: 12 states
- 3 - 5: 7 states
- 5 - 10: 3 states
- 10 - 20: 0 states
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: 1980-1990
Geography of innovation. Inventors per 10,000: 1990-2000

Map showing the distribution of inventors per 10,000 population across the United States from 1990 to 2000. The colors represent different ranges of inventors, with darker shades indicating higher numbers.

Legend:
- 0 - .5 (0)
- .5 - 1 (3)
- 1 - 1.5 (11)
- 1.5 - 2 (5)
- 2 - 3 (10)
- 3 - 5 (14)
- 5 - 10 (4)
- 10 - 20 (1)
Location of R&D Labs - 1921
Location of R&D Labs - 1931

Number of R&D Labs
- 0 to 2
- 2 to 6
- 6 to 10
- 10 to 20
- 20 to 100
- 100 to 350
- 350 to 760
Location of R&D Labs - 1933
Location of R&D Labs - 1940
Location of R&D Labs - 1946
Location of R&D Labs - 1950
Location of R&D Labs - 1970

Number of R&D Labs
- 0 to 2
- 2 to 6
- 6 to 10
- 10 to 20
- 20 to 100
- 100 to 350
- 350 to 760
Empirical Strategies and Identification

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).

**Fixed effects: 1) within-state tax changes:** state + year FE + inventor FE + time-varying controls specification.

2) **within-state-year tax differences:** state $\times$ year FE using different personal income tax brackets within state-year.

**IV strategy:** at macro and micro levels: exploit only federal level tax changes in personal and corporate income taxes.

**Border Counties strategy:** Neighboring counties in different states.

**Event Studies and Case Studies:** Episodes with sharp tax changes.
States Have Changed their Tax Rates a Lot over Time

1940

- MTR (Median)
- MTR (90th)
- ATR (Median)
- ATR (90th)
States Have Changed their Tax Rates a Lot over Time

1940

- **MTR (Median)**
- **MTR (90th)**
- **ATR (Median)**
- **ATR (90th)**
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.
Taxes and International Migration: Anecdotes but Little Evidence

- Is the “brain drain” in response to taxes real? Lots of anecdotes:
  - 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:
  - 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 →↑ propensity to be treated).
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.
Link between Inventor Quality and Income in IRS data

Source: Bell et al. (2015).
Link between Inventor Quality and Income in IRS data

Income ($)

\[\text{income} = 200,000 + 1,400 \times \text{citations}\]

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Case Study: U.S. TRA 1986

The diagram illustrates the change in the top tax rate differential and the foreign top 1% inventors over the years 1982 to 1992. The top tax rate differential shows a sharp decrease around 1988, which aligns with the implementation of the Tax Reform Act of 1986 (TRA 1986). This decrease is followed by an increase in the differential, indicating a change in tax policy and its impact on foreign inventors.
Case Study: U.S. TRA 1986

The graph shows the change in foreign top 1% inventors and the top tax rate differential in the U.S. from 1982 to 1992. The top tax rate differential is highlighted in 1986, indicating a significant change in the tax rate structure that affected foreign inventors. The graph illustrates how changes in tax policy can impact foreign investment and innovation.
Case Study: U.S. TRA 1986

The graph illustrates the changes in foreign top 1% inventors and the top tax rate differential in the U.S. from 1982 to 1992. The top tax rate differential decreased significantly in 1988, correlating with a decline in foreign top 1% inventors. The synthetic U.S. data shows a similar trend, indicating that the tax rate changes may have influenced the foreign inventors' behavior.
Case Study: U.S. TRA 1986

The graph illustrates the impact of the U.S. Tax Reform Act of 1986 (TRA 1986) on top tax rate differentials and foreign top 1% inventors. The red line represents the top tax rate differential, showing a significant drop around 1988, indicating the tax reforms' effect. The black line represents the U.S. Synthetic, and the dashed black line represents the Synthetic U.S., highlighting the trend before and after the TRA 1986.
Case Study: U.S. TRA 1986

Elasticity = 3.42 (0.654)
Case Study: U.S. TRA 1986

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

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Case Study: Denmark’s 1992 Preferential Tax Reform

Elasticity = 0.71 (0.242)
Taking Stock: So.. should we slash taxes?

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

\[
\tau^* = \frac{1 - \bar{g}}{1 - \bar{g} + \bar{e}} + \bar{C}
\]

The desired level of taxes crucially depends on your “social preferences” and wish for redistribution.
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?
Profit and R&D wedges

(a) Profit wedge

(b) R&D wedges
(c) Profit wedge

(d) R&D wedges
Approximating the Optimal Policies

![Graph showing the relationship between Relative Welfare and Externality (ζ). Different lines represent various policies: Linear, Linear + Cross, HSV, HSV + Cross, and HSV + Cross + Time. The graph shows how the Relative Welfare decreases as the Externality (ζ) increases.](image-url)
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 (profits, captures past performance); iii) current investment level.