Taxation and the International Mobility of Inventors

Ufuk Akcigit Chicago

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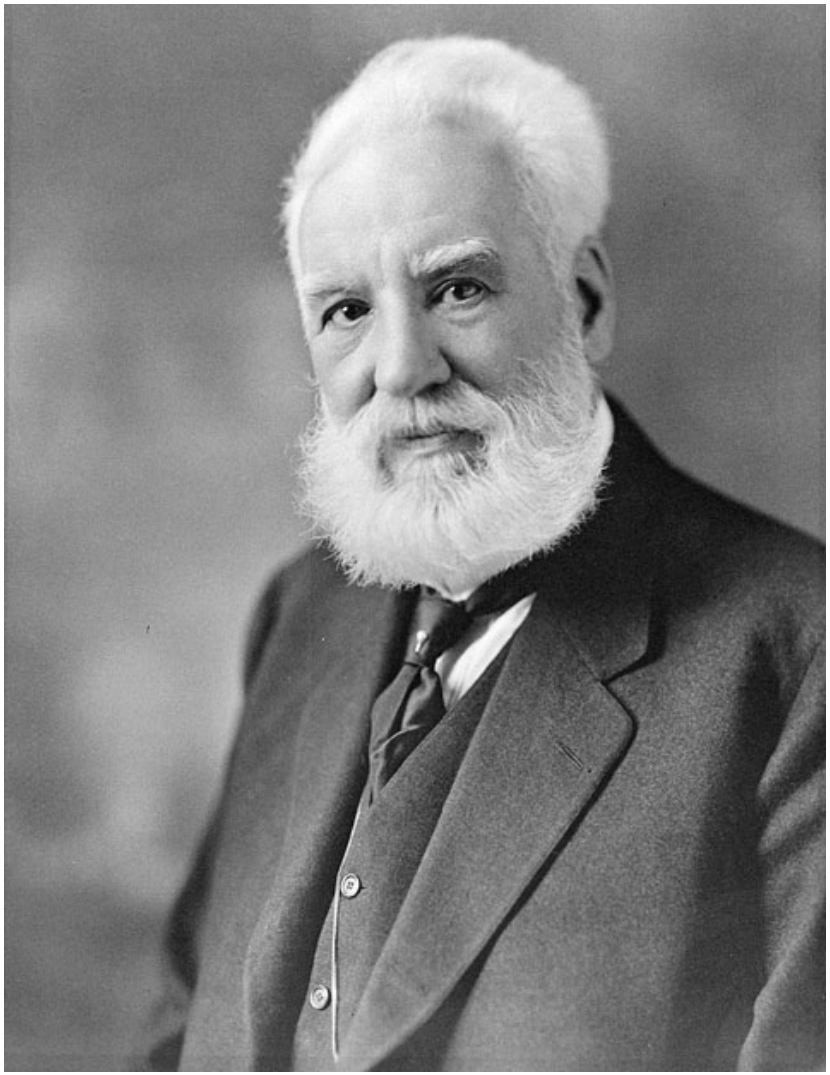
May 20, 2016

Alexander G. Bell



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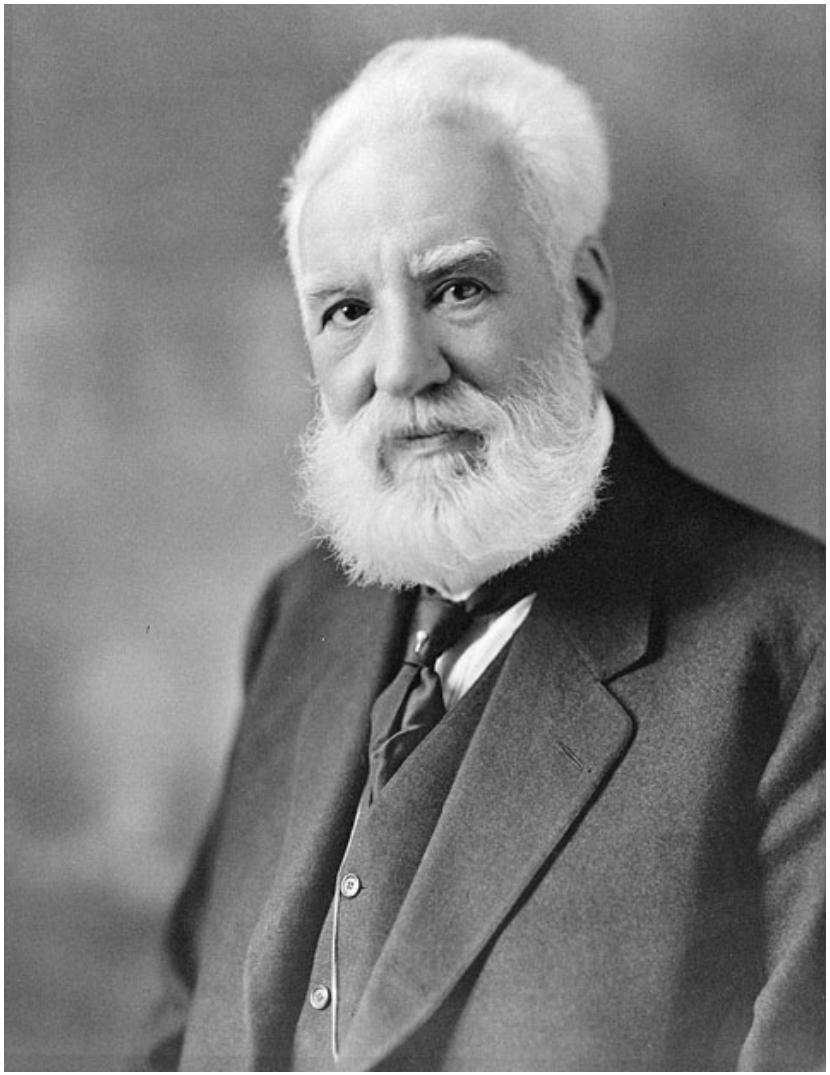

- Inventor of the telephone (1876).
- Created Bell Telephone Company (1877).
- By 1886: more than 150,000 people in U.S. own telephones.

James L. Kraft

James L. Kraft

- Invented a pasteurization technique for cheese and established his company.
- Created Kraft Foods Inc.
- His company grew into a conglomerate responsible for creating some of the United States' most popular food products and employing more than 100,000 people.

Ralph Baer


LEFT HAND PLAYER
HOR
SERVE
RIGHT HAND PLAYER
HOR
ENGLISH
SERVE

Ralph Baer

- Created TV game unit with paddle controls.
- Today, the video gaming industry is worth $66 billion.

Introduction

- ... and the list goes on.
- In addition to being very prolific inventors, these innovators had something else in common:
- They were all immigrants.
- What determines the patterns of migration of highly skilled people?

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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**.

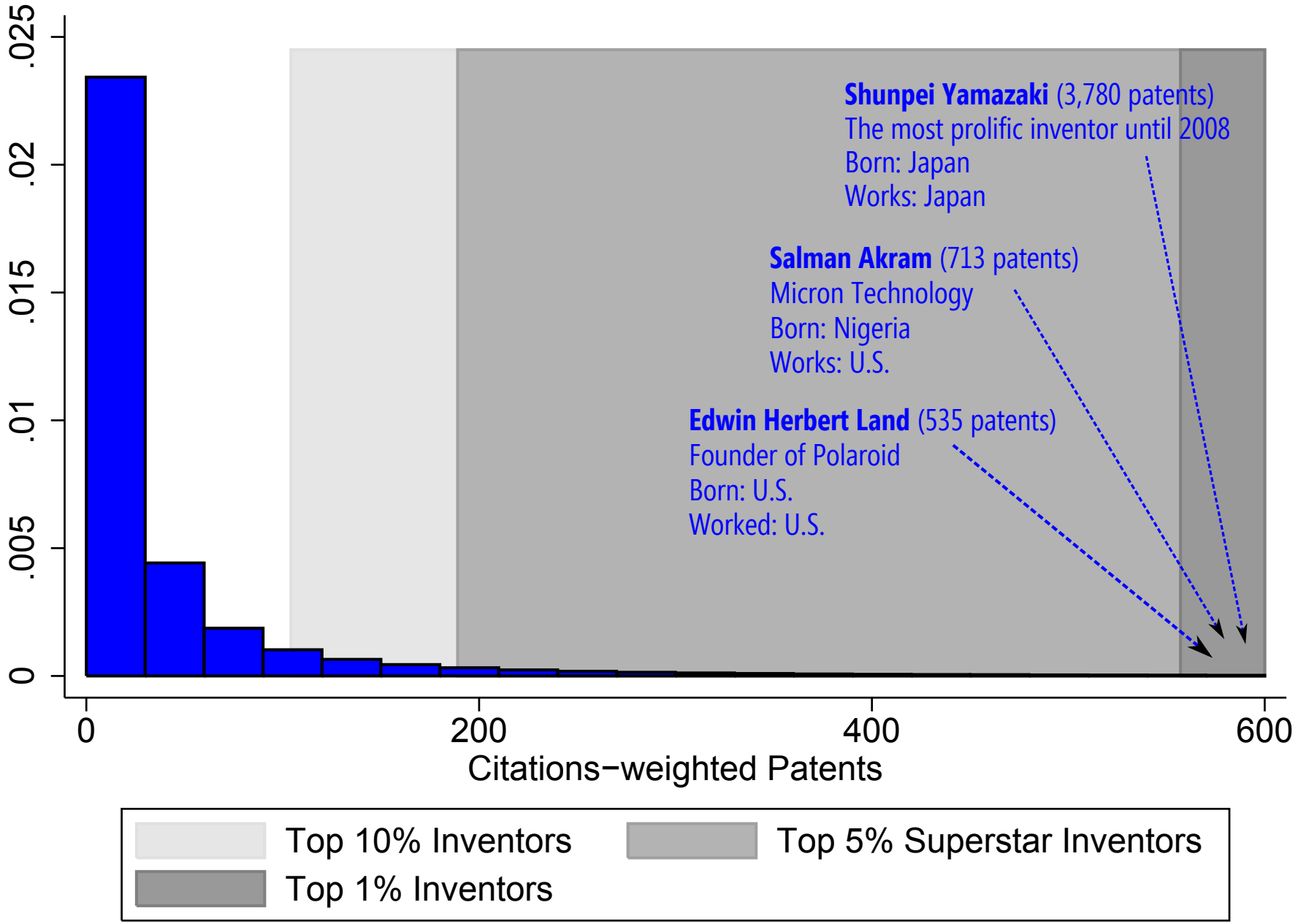
Study the Effects of Taxes on Migration using Patent Data

- 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).

Superstar Inventors in a Highly Skewed Quality Distribution



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.

Related literature

Skilled Migration: Kerr (2013), Foley and Kerr (2013), Miguelez and Moreno (2014), Miguelez (2013), Breschi, Lissoni and Tarasconi (2014).

Taxation and Migration: Kleven, Landais and Saez (2013), Kleven, Landais, Saez and Schultz (2014), Bakija and Slemrod (2004), Liebig *et al.* (2007), Moretti and Wilson (2014, 2015).

Theoretical Taxation Models with Migration: Mirrlees (1982), Wilson (1980,1982), Simula and Trannoy (2010), Lehmann, Simula and Trannoy (2014).

Outline

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Three Data sources: DID, EPO, PCT

- Inventors: employees, researchers, self-employed.
- "Assignee" is legal owner (firm or individual), can be $\neq$ from inventor. Focus on employees.

Main Data: Disambiguated Inventor Data

- USPTO: 4.2 million patent records, 3.1 million inventors in 1975-2010.
- 18% of worldwide direct patent filings (26% of all patents).
- Disambiguated names with residential addresses (Lai *et al.*, 2012).

Additional Data 1: European Patent Office (EPO) data

- Very recent disambiguation, higher representation of EU patents.

Additional Data 2: Patent Cooperation Treaty (PCT) data

▸ USPTO Stats ▸ EPO Stats ▸ Details

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Inventor Quality Measures and Ranking

Patent quality increases inventor income, directly and *indirectly*.

Quality measures
(dynamic and lagged)

1. Citations-weighted patents (benchmark)
2. Patent count
3. Average citations per patent
4. Max citations per patent
5. Patent breadth (claims-weighted patents)
6. Impact breadth (# tech classes citing patent).

▸ Correlations ▸ Patent breadth, breadth of impact

$\longrightarrow$ Dynamic, Persistent, Life-time ranking

Inventor Ranking

- Group countries by patenting intensity (robust):
  1. U.S., 2. JP, 3. EU + CA
- Assign inventors to group based on home country.

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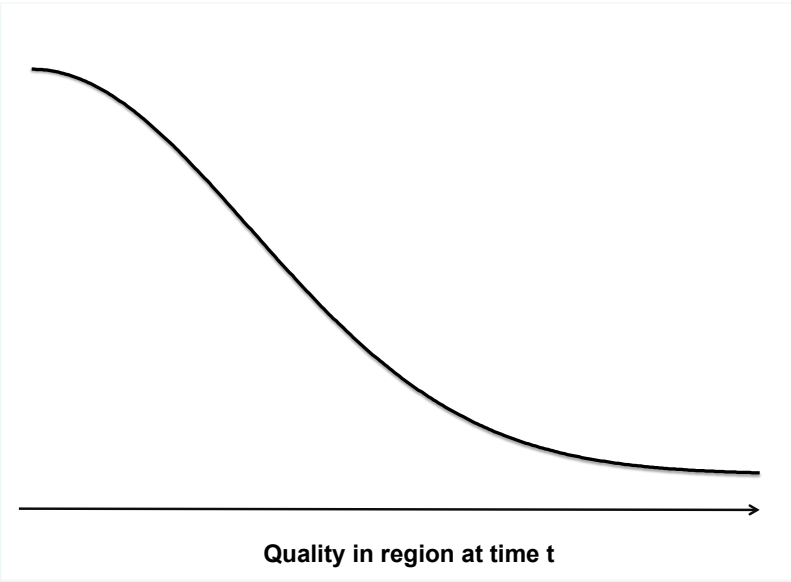

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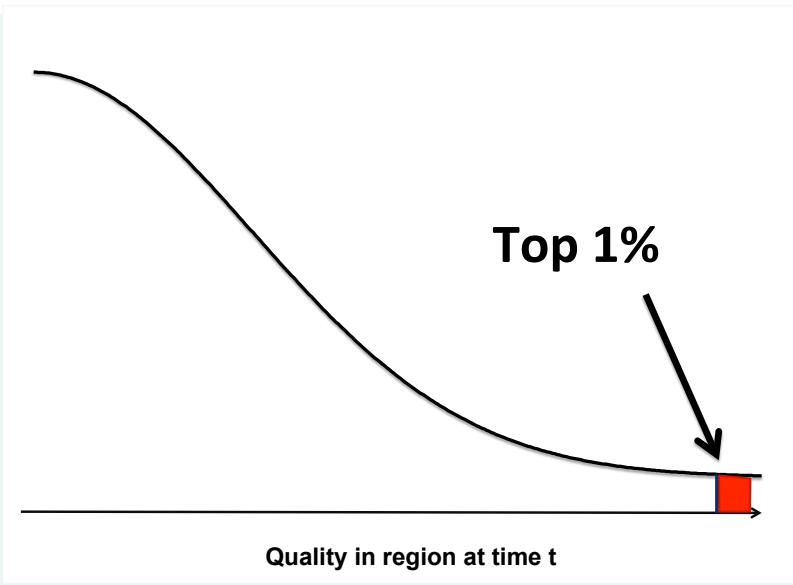

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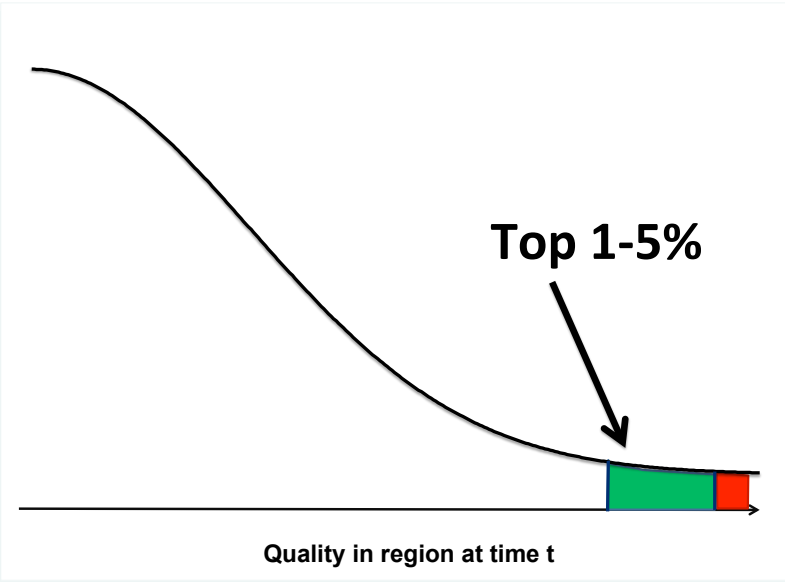

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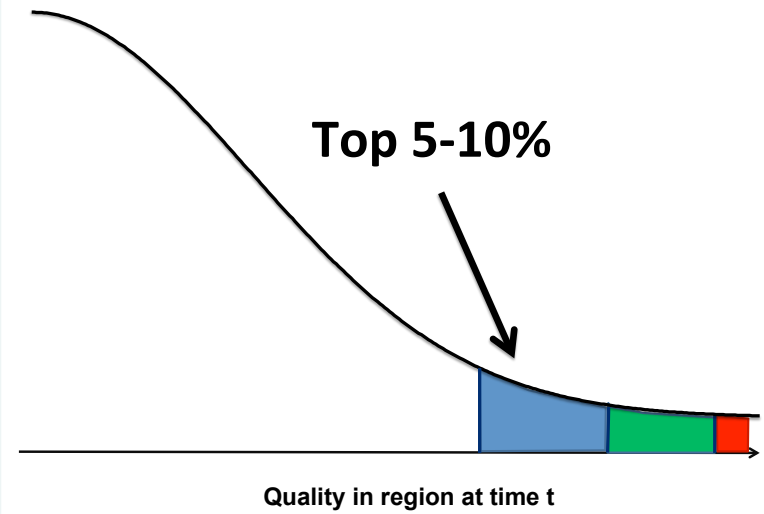

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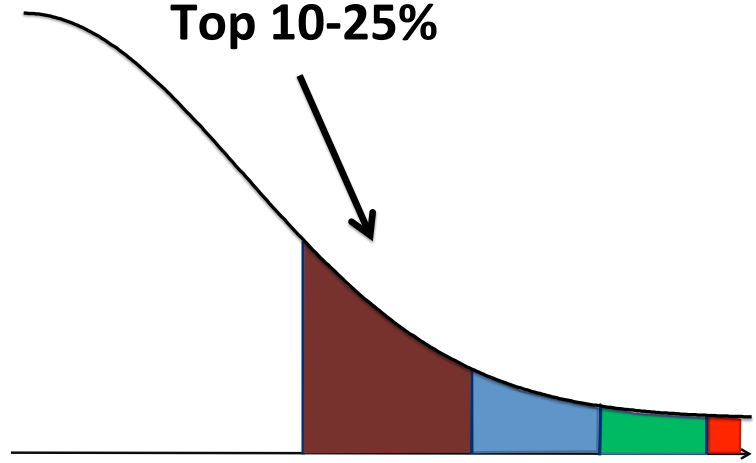

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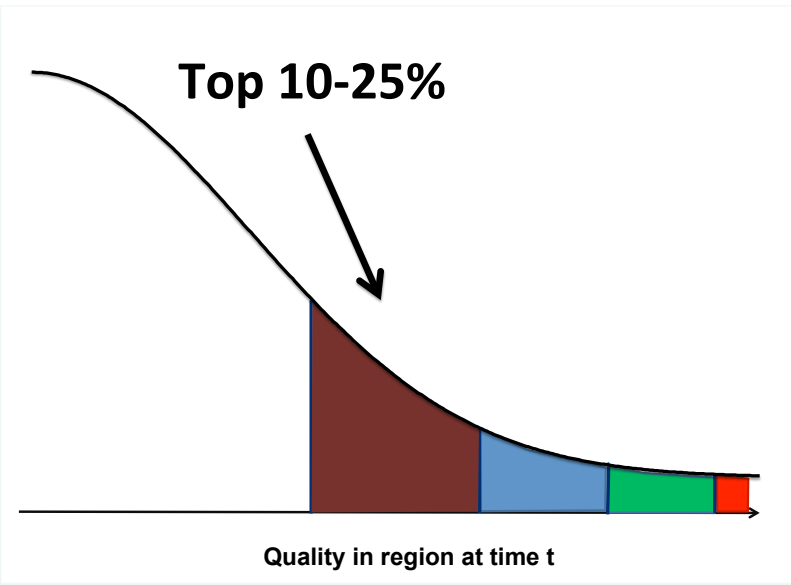
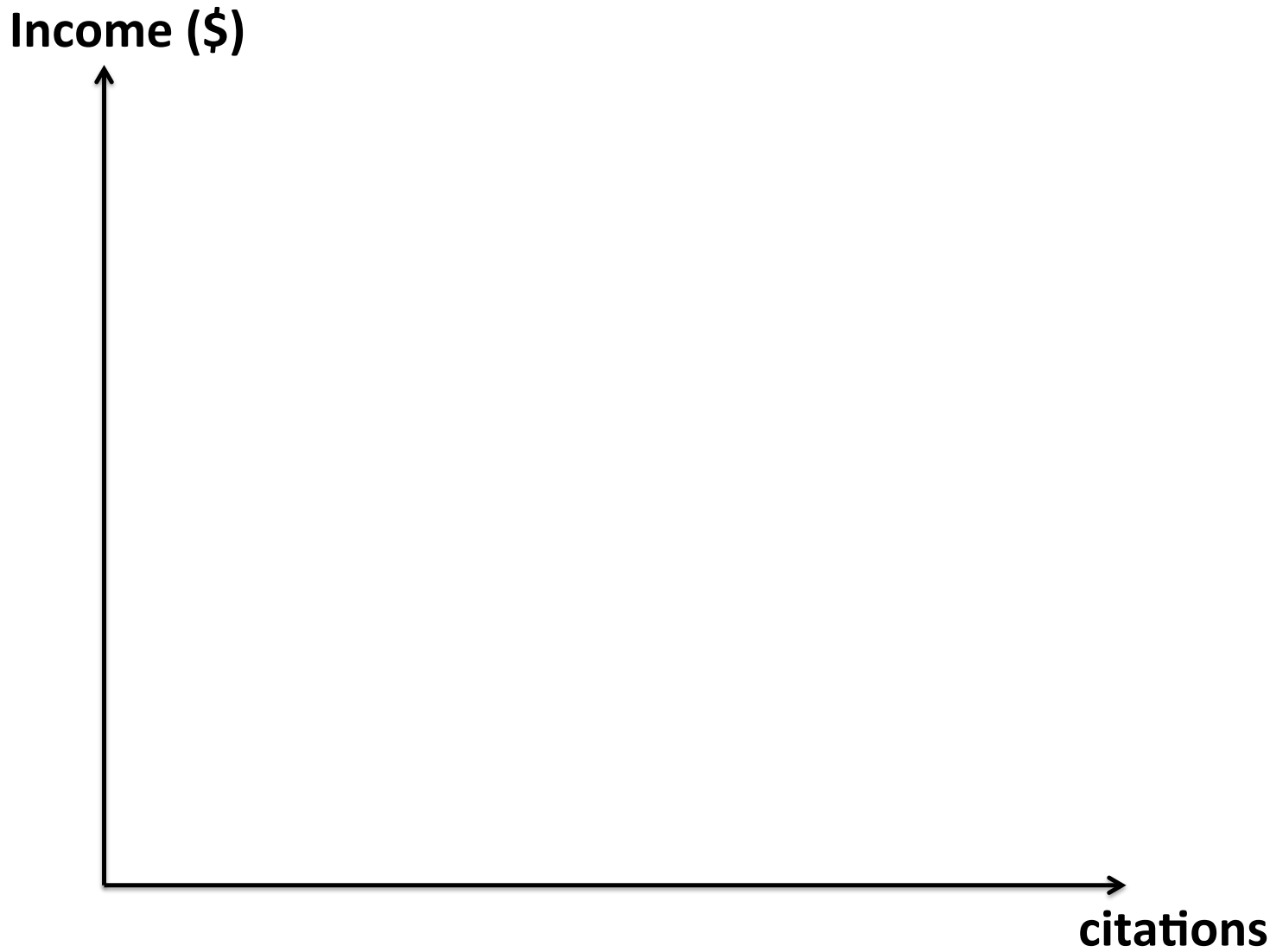


Link between Inventor Quality and Income in IRS data



Source: Bell *et al.* (2015).

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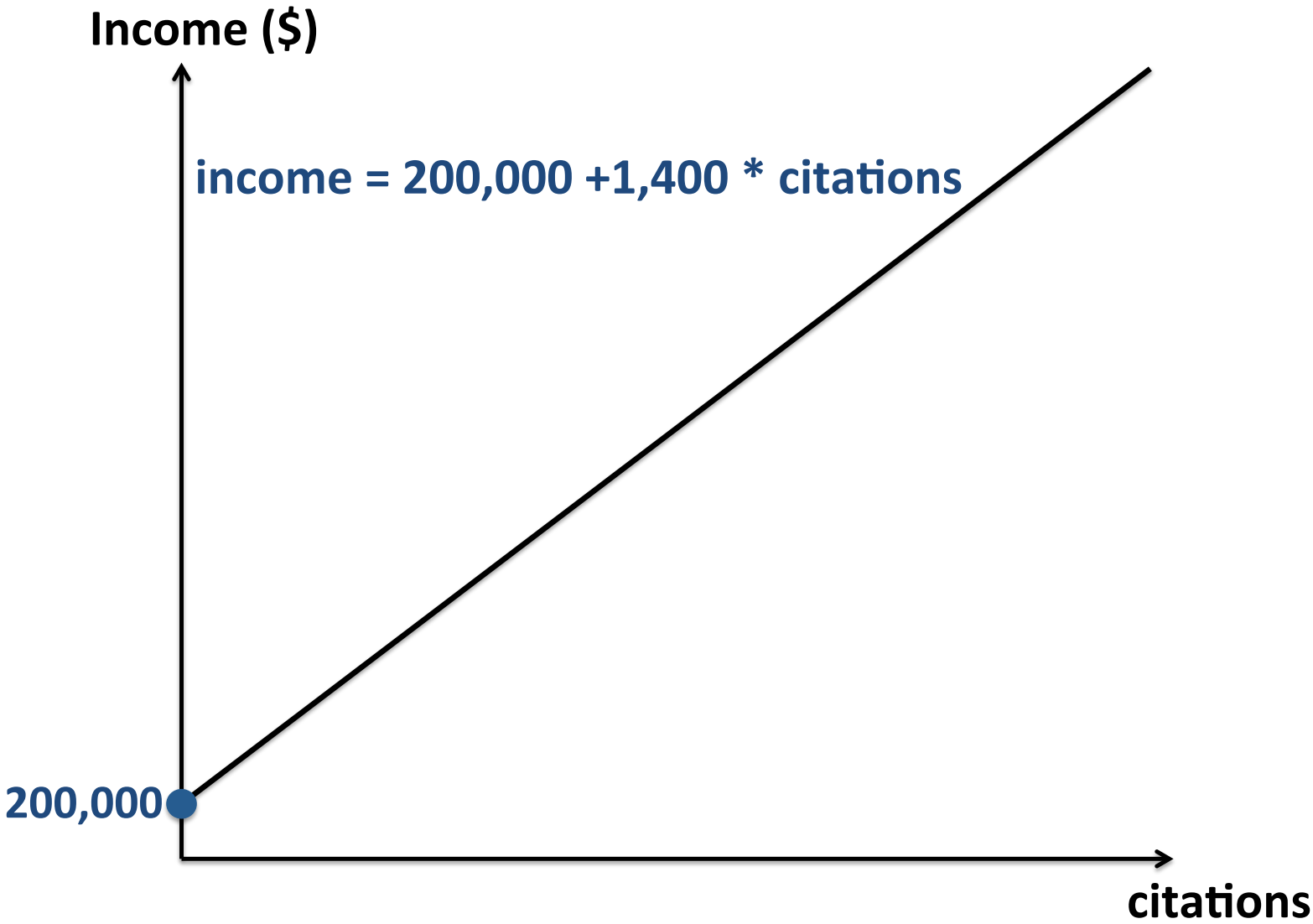

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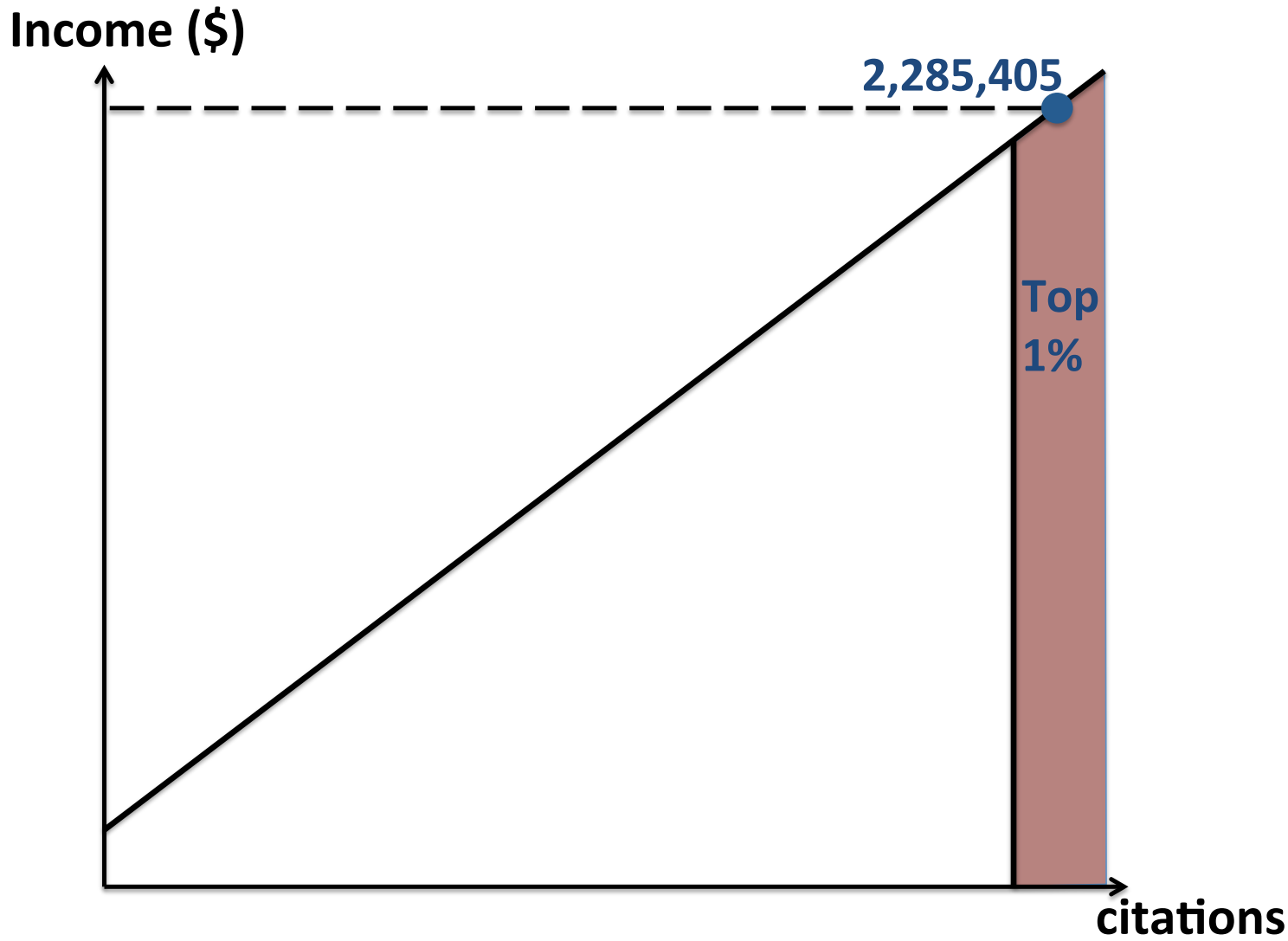

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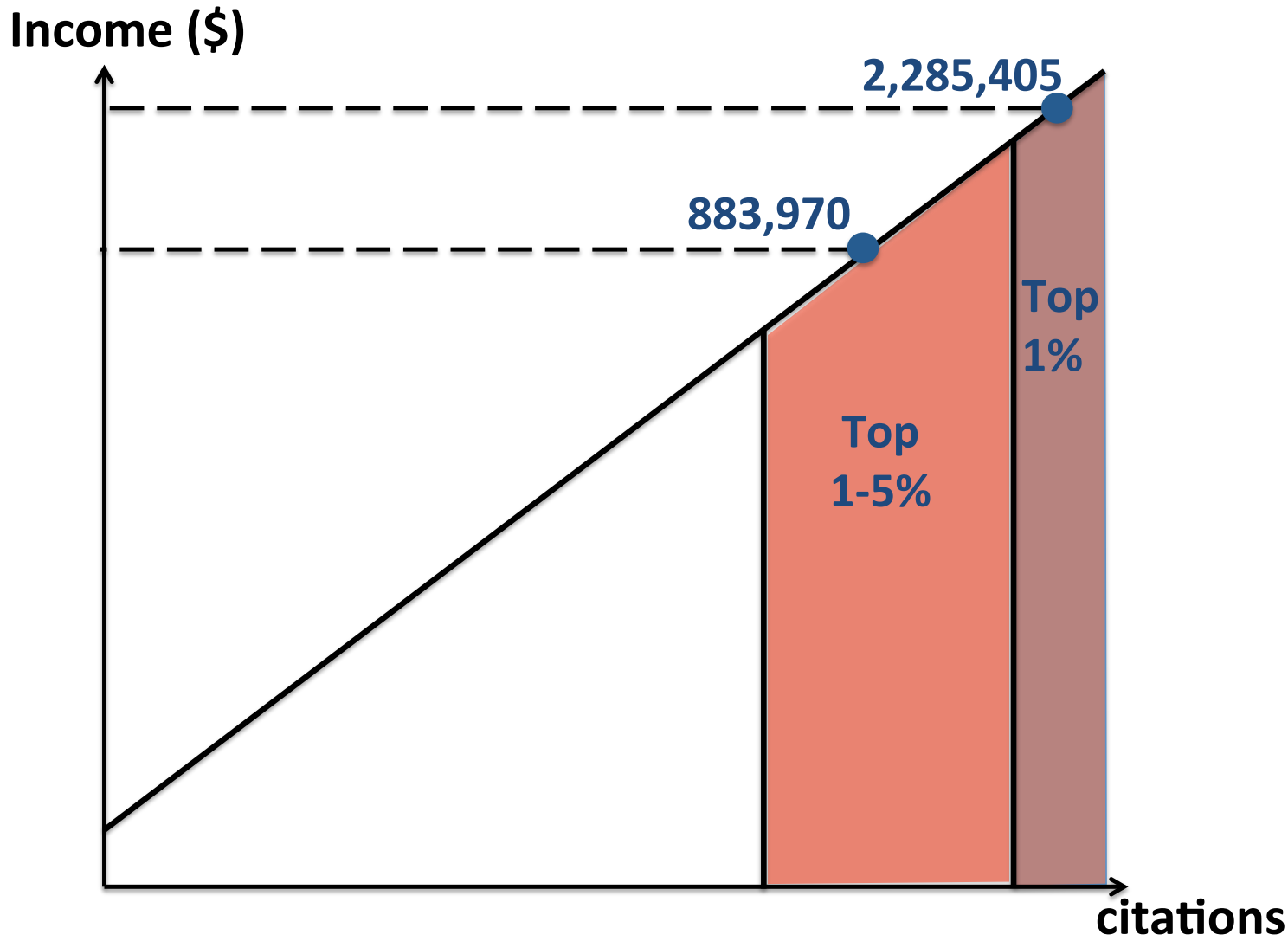

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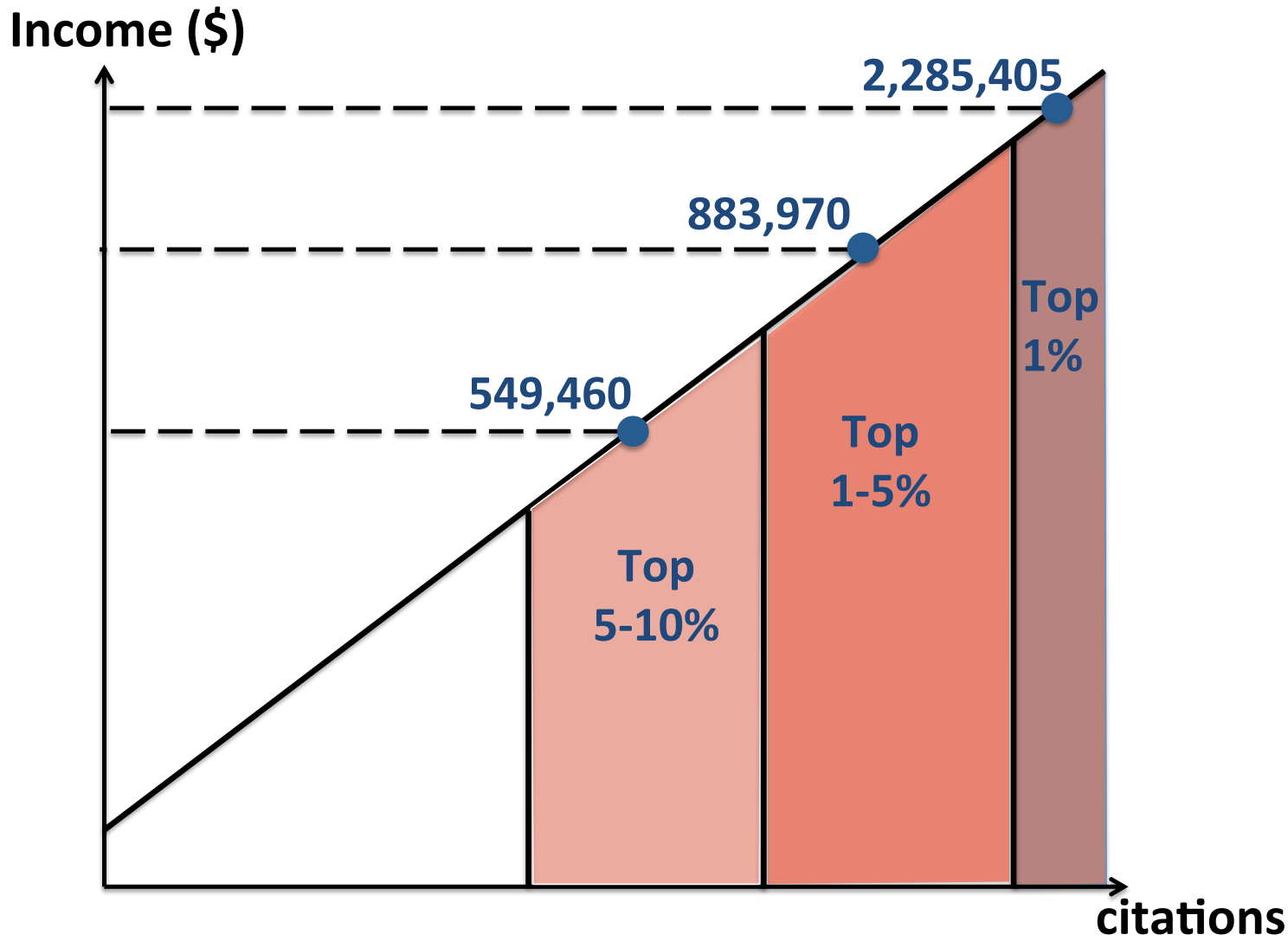

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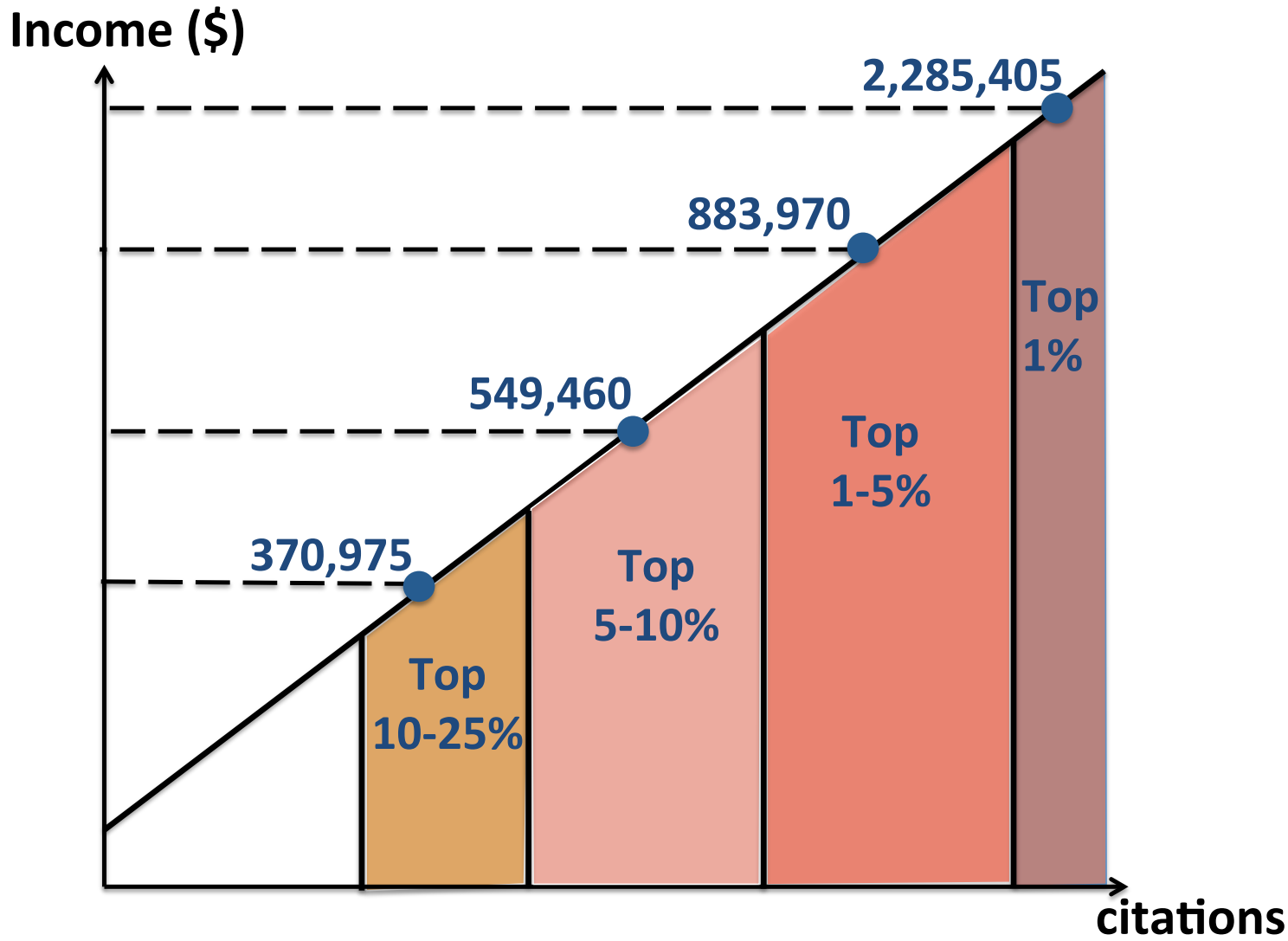

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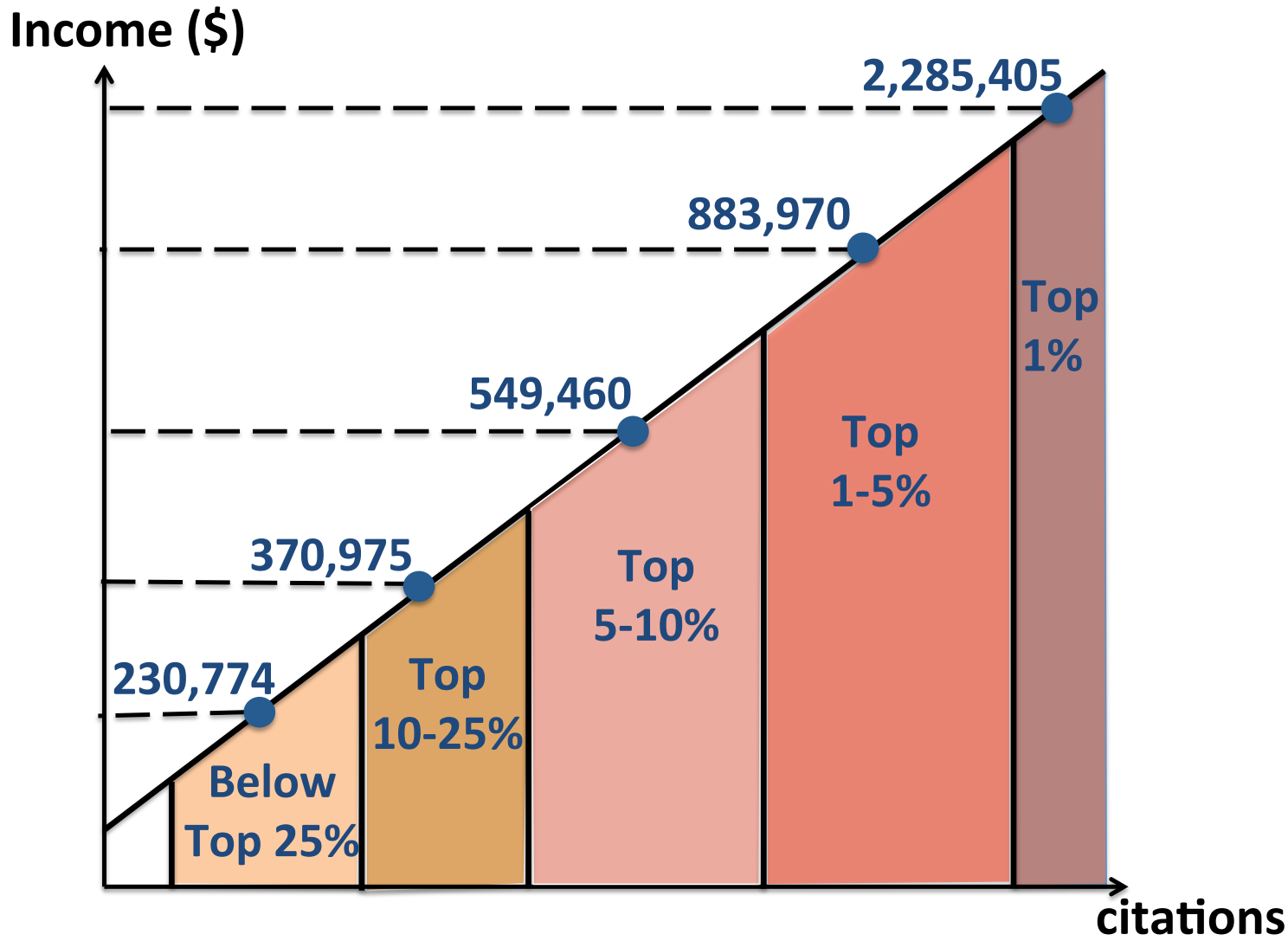
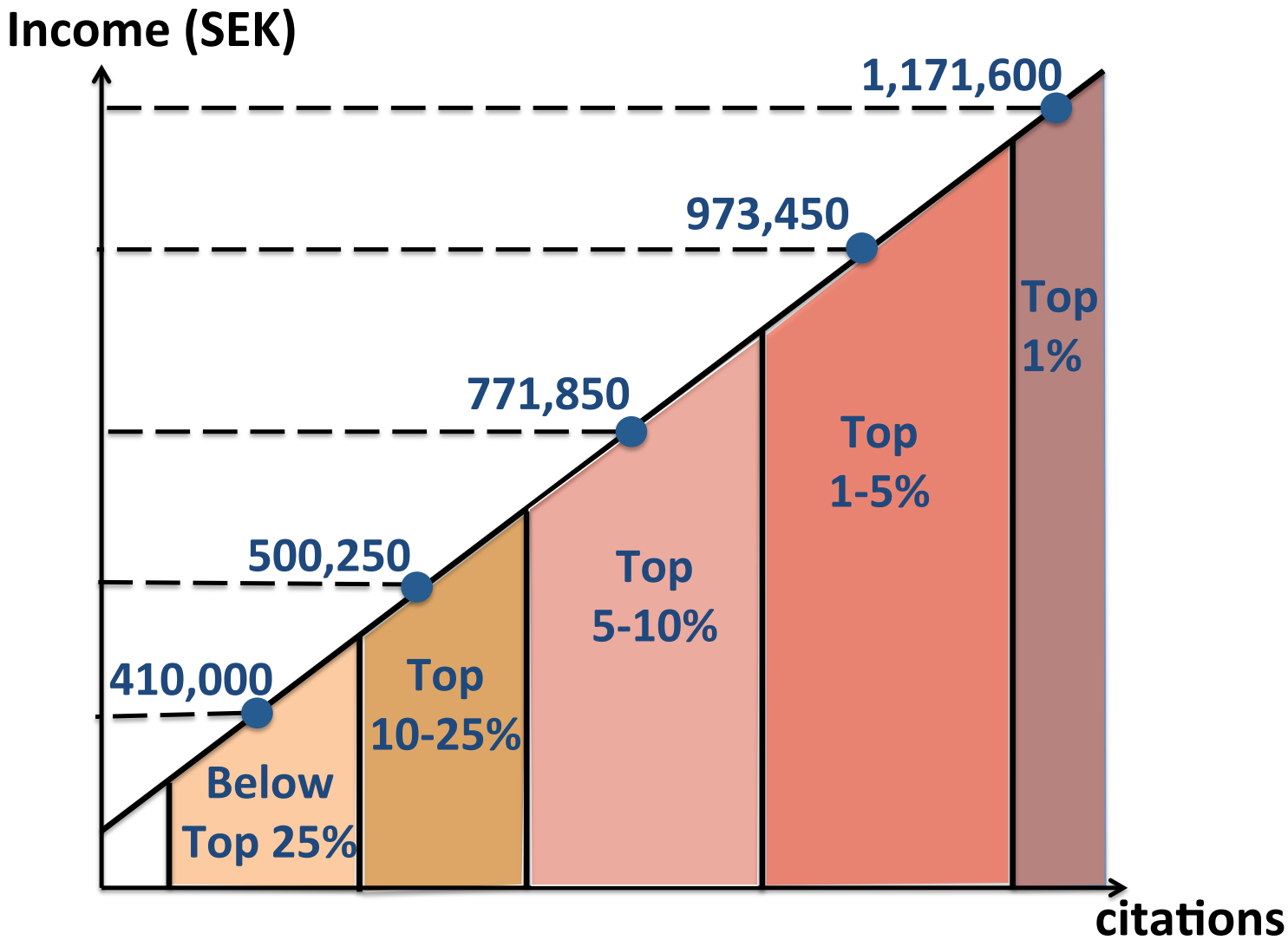


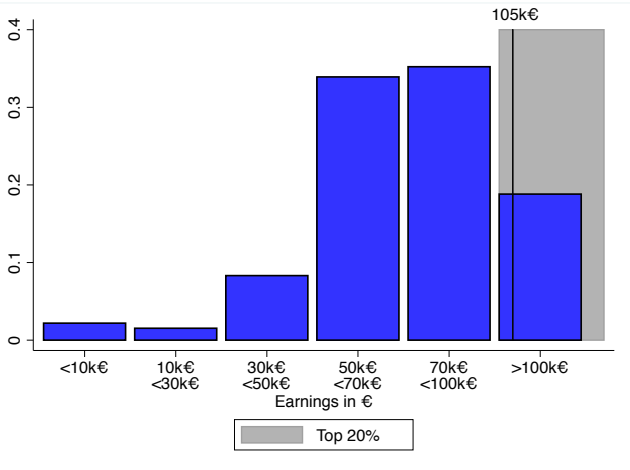
Source: Bell *et al.* (2015).

Link between Inventor Quality and Income in Swedish and Finnish Admin data

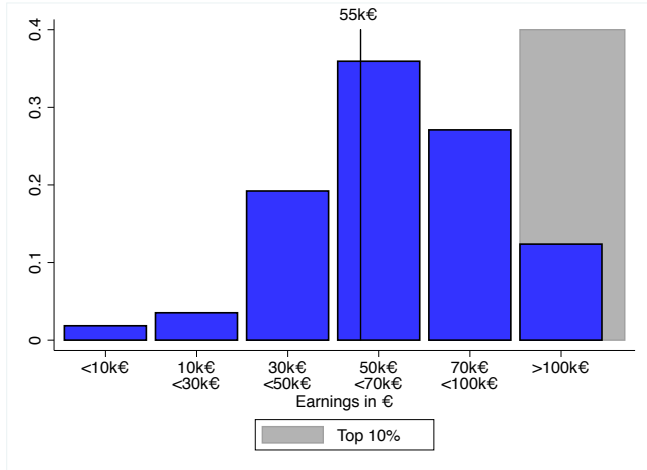


Source: Olof Ejermo and Otto Toivaannen.

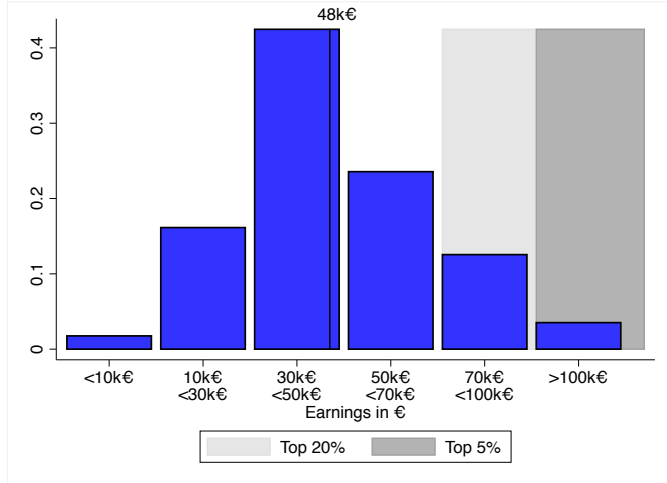
Survey Income Distributions + Link Quality-Income



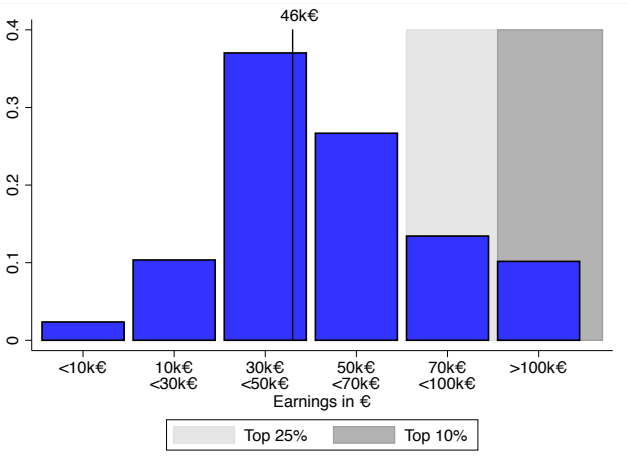
(a) Switzerland



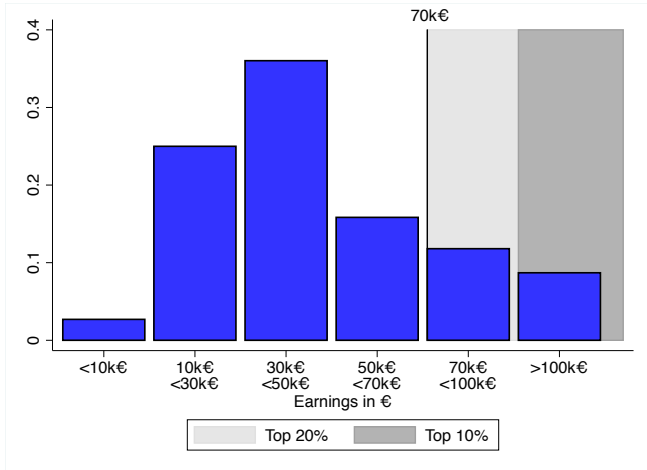
(b) Germany



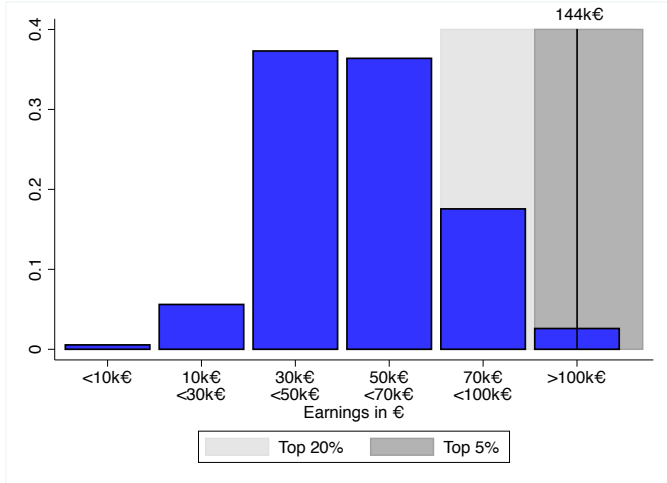
(c) France



(d) Great Britain

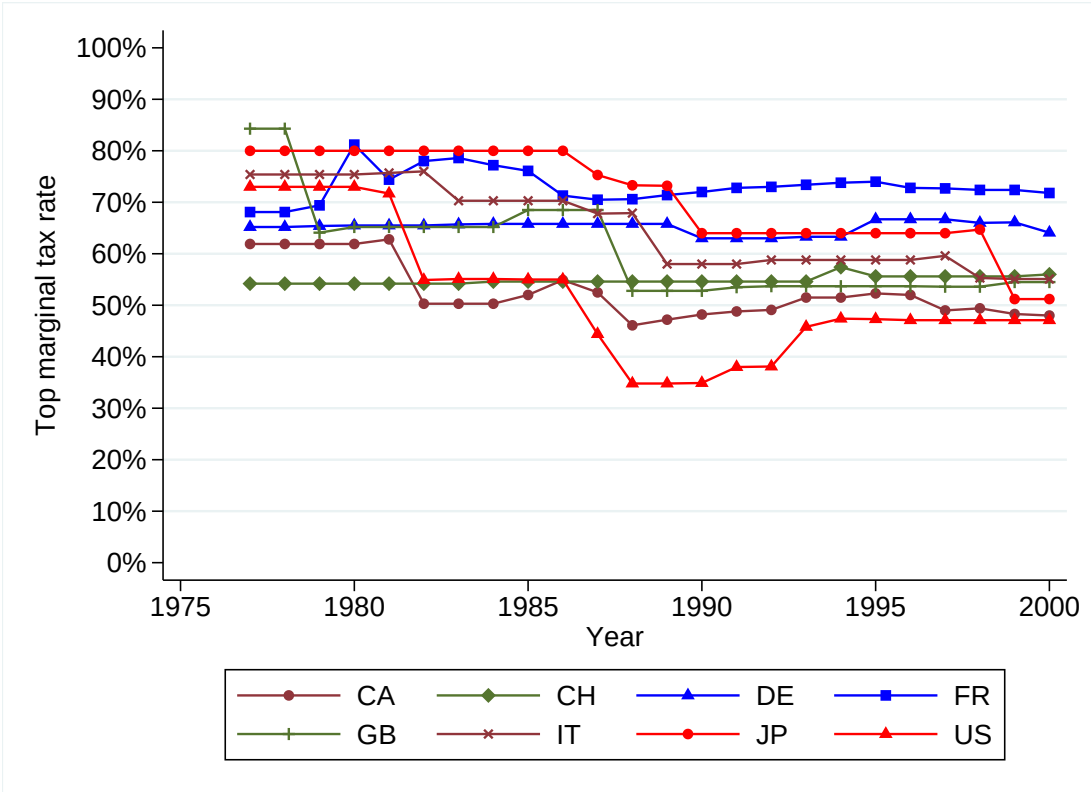


(e) Italy



(f) Japan

Migration Elasticities to Top Marginal Tax Rates

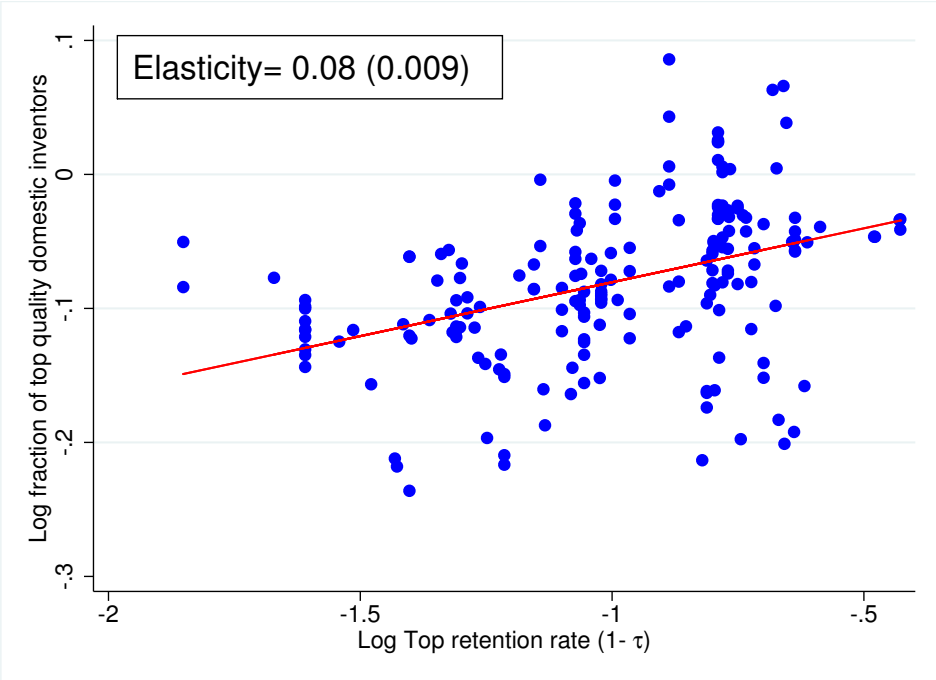


Effective top MTRs from *Piketty, Saez, and Stantcheva (2014)* (90 top MTR changes).

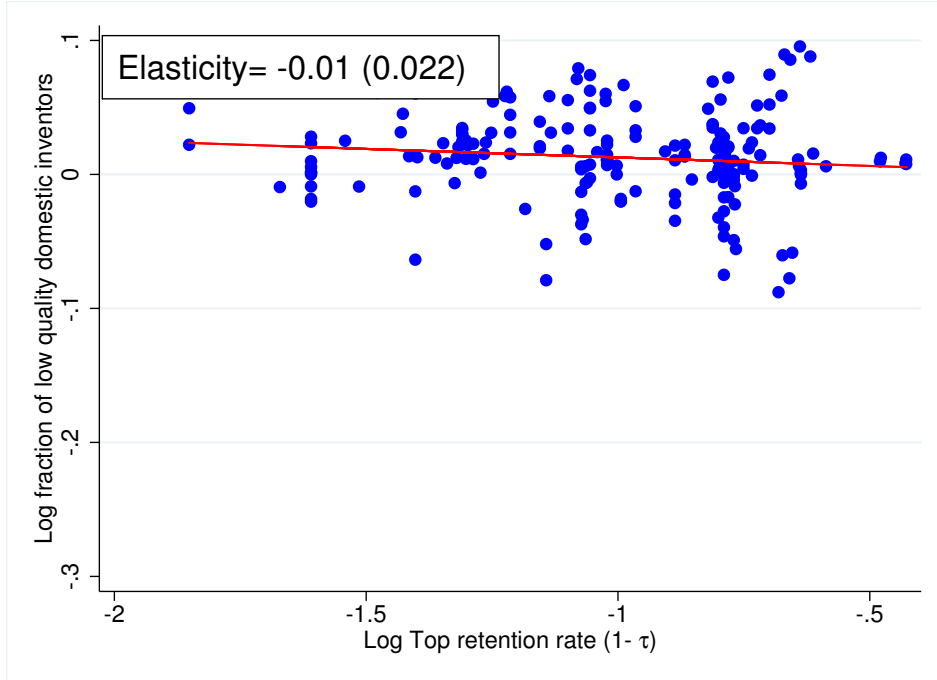
- "Success tax," focal policy tool.
- "Reduced-form" elasticity: MTR $\approx$ instrument for ATR. Exogenous to income.
- Firm and worker responses, institutional features (e.g.: visas).
- Other taxes? 1) sample of employees only, 2) check corporate & capital gains tax, 3) lower bound.

Outline

Top $(1-\tau)$ and % of Domestic Inventors in Home Country



(a) Top quality inventors



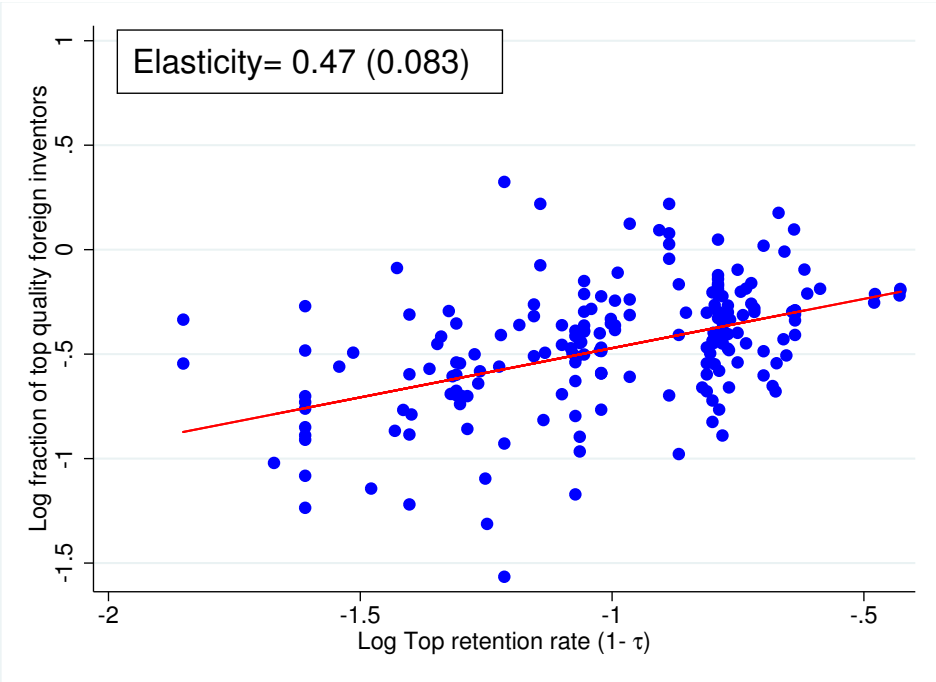
(b) Low quality inventors

Additional macro level results in the paper:

- Domestic and Foreign inventors.
- For different quality levels, in different datasets.
- With leads and lags.

▸ Tax lead ▸ Event Study

Top $(1-\tau)$ and % of Foreign Inventors



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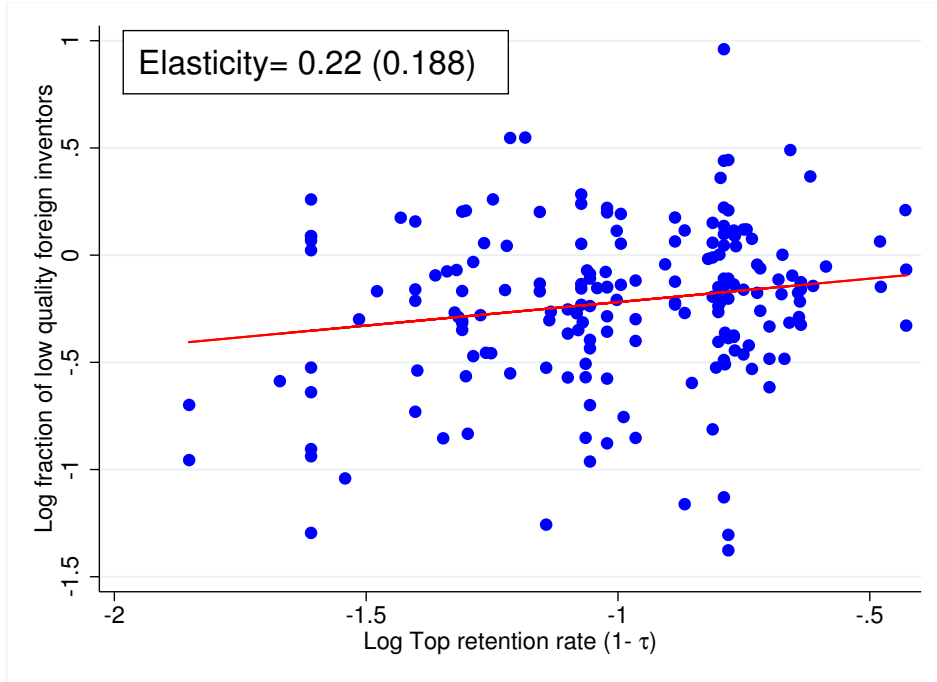


(b) Low quality inventors

Log outcomes at the country-year level. Partial residual plots controlling for country's patent stock, GDP per capita, country fixed effects, year fixed effects. Elasticities reported (standard errors clustered at the country level).

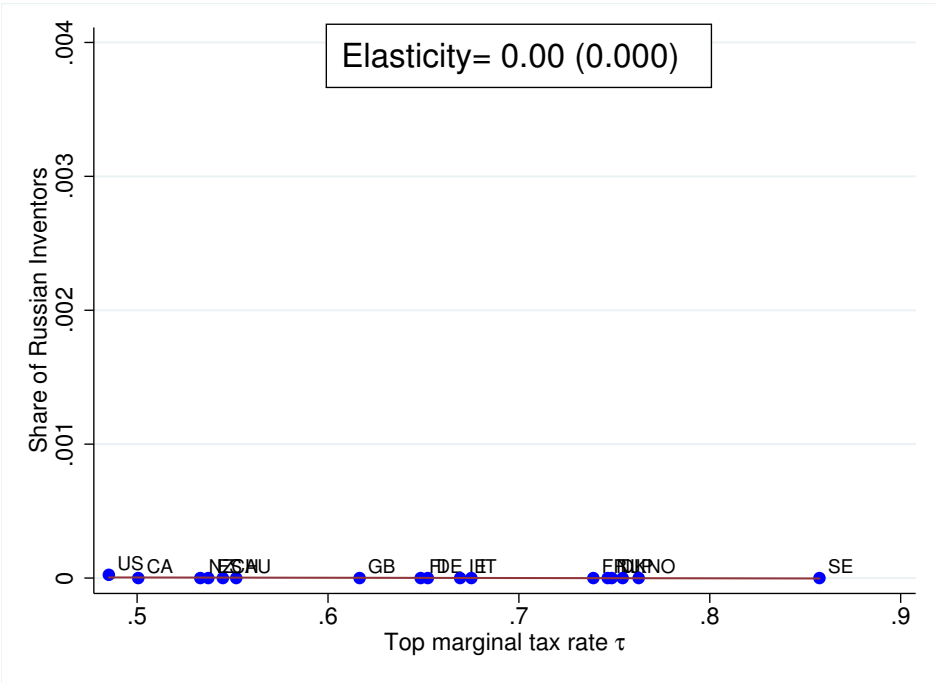
Cross-country Summary:
Top $(1-\tau)$ and % of domestic and foreign inventors

	Benchmark DID		PCT
	Top quality inventors	Low quality inventors	All inventors
	(1)	(2)	(3)
Domestic Elasticity	0.080***	-0.013	0.074*
	(0.009)	(0.022)	(0.038)
Foreign Elasticity	0.471***	0.219	0.985*
	(0.083)	(0.188)	(0.483)
(Domestic) Observations	192	192	244
(Foreign) Observations	191	188	238

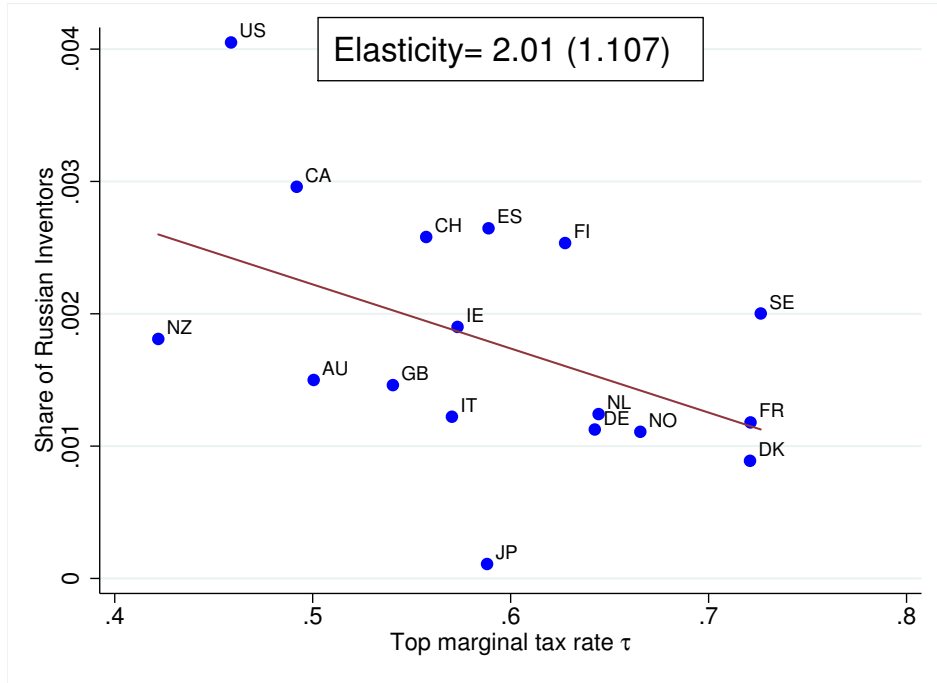
Regressions control for country fixed effects, year fixed effects, log GDP per capita and log number of patents in the country in that year.

Outline

Russian Inventors' Migration and Top Tax Rates Pre and Post Soviet Union Collapse

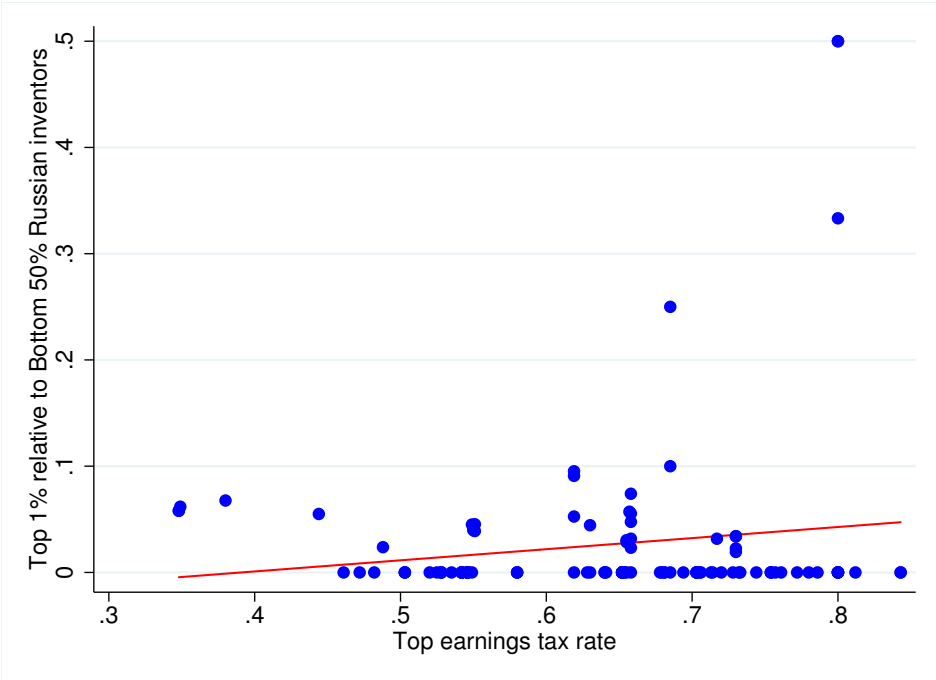


(a) Pre Soviet Union Collapse: No possible migration

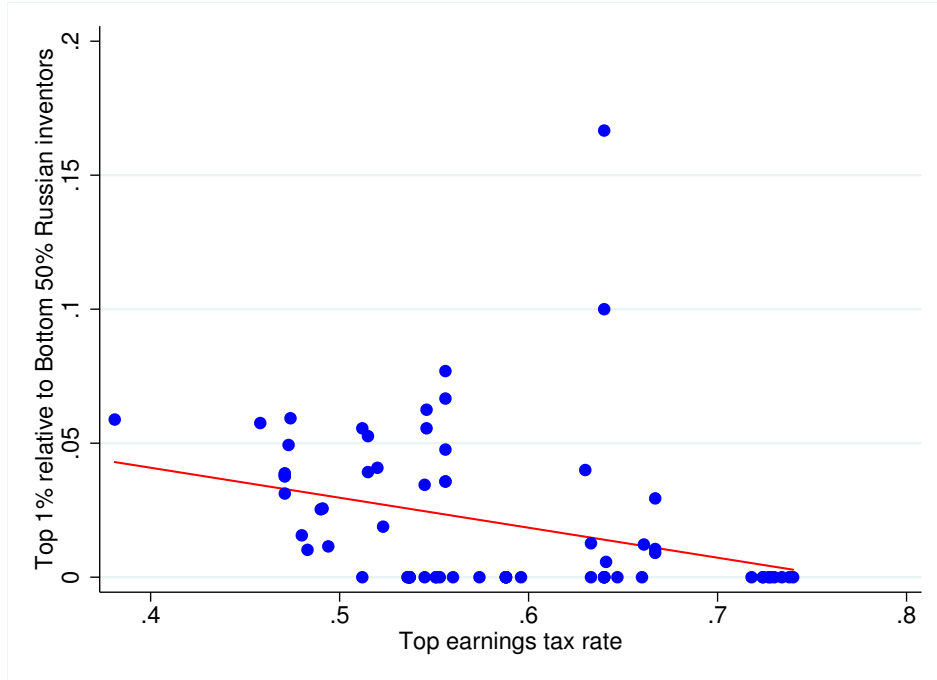


(b) Post Soviet Union Collapse: Migration negatively correlated with top τ.

Top Quality versus Low Quality Russian Inventors' Migration



(a) Pre Soviet Union collapse

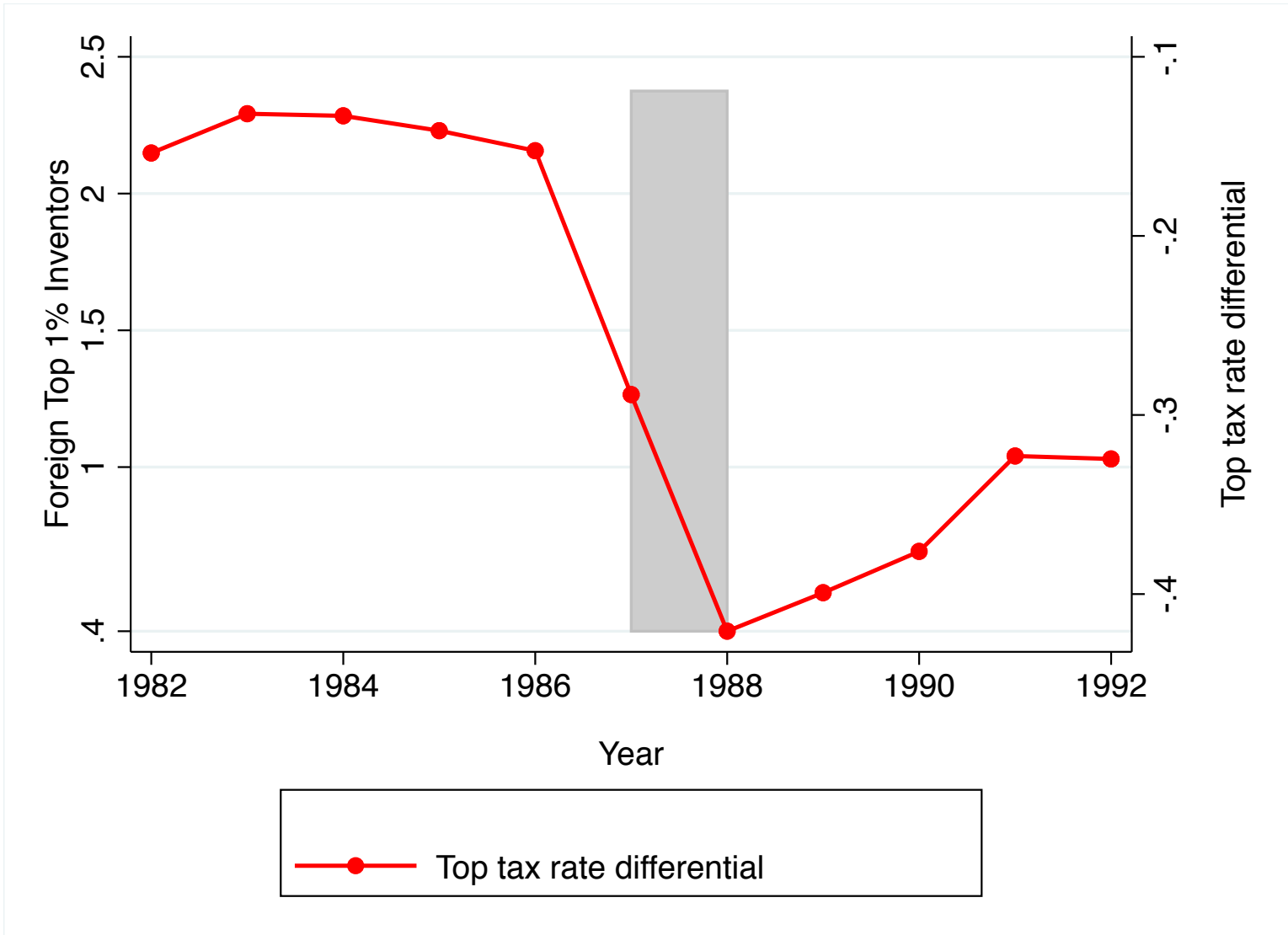


(b) Post Soviet Union collapse: $-0.11^{***}(0.028)$

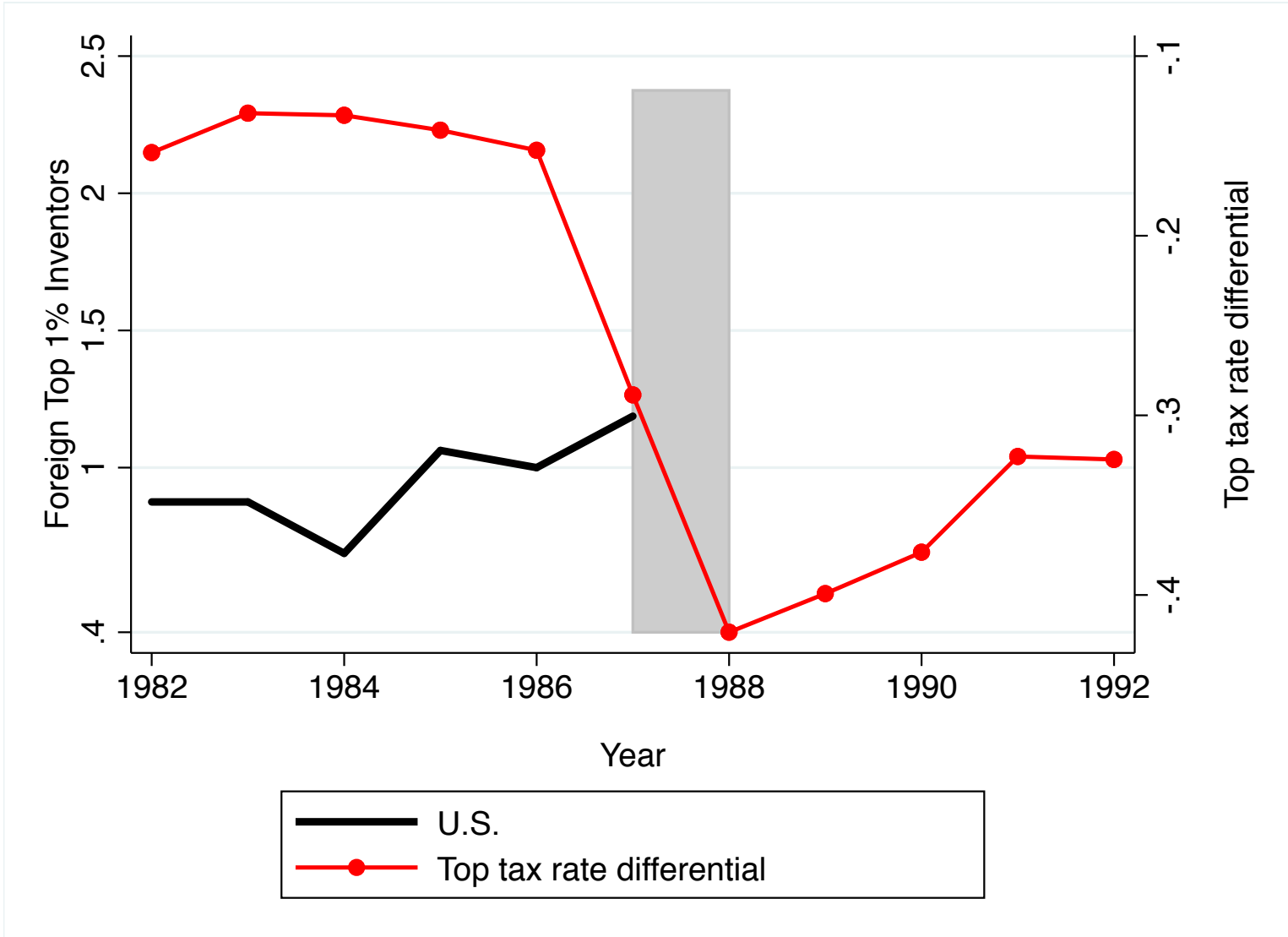
Elasticities:

	(1) Top 1%	(2) Top 1-50%
Pre Soviet Union collapse	0.0878	0.0779
	(0.193)	(0.131)
Post Soviet Union collapse	1.154***	0.398**
	(0.263)	(0.191)
Observations	192	192

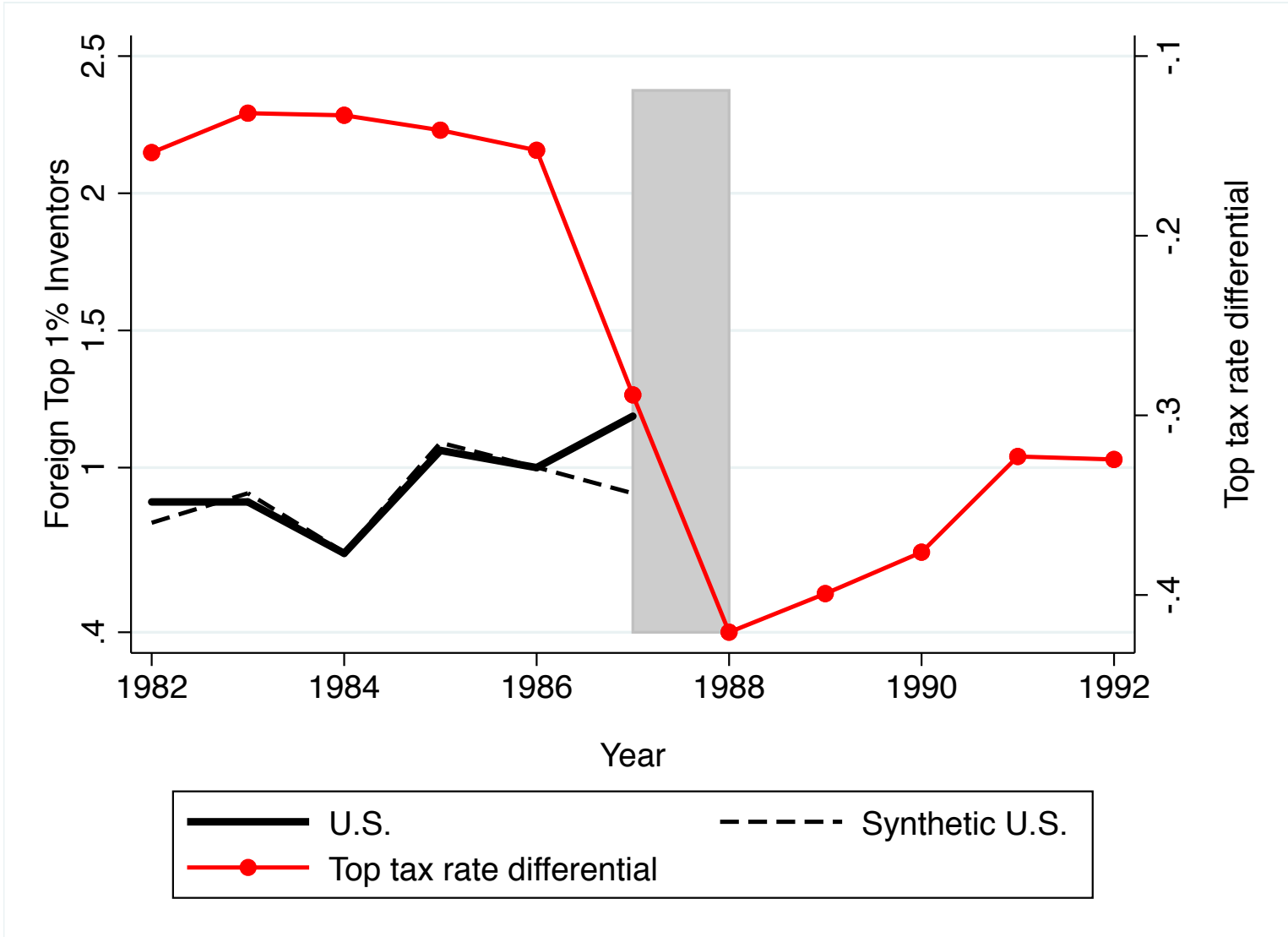
Case Study: U.S. TRA 1986



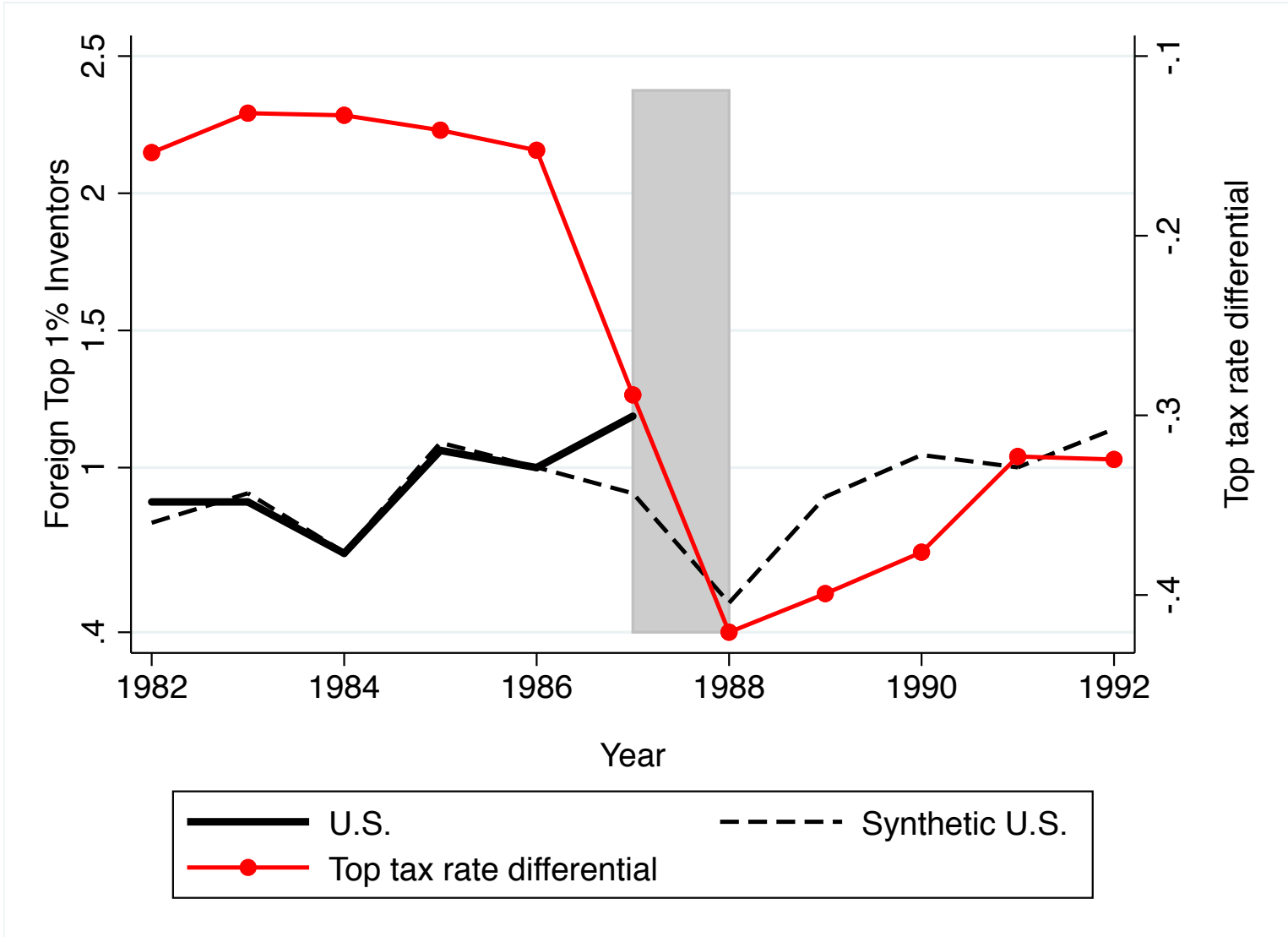
Case Study: U.S. TRA 1986



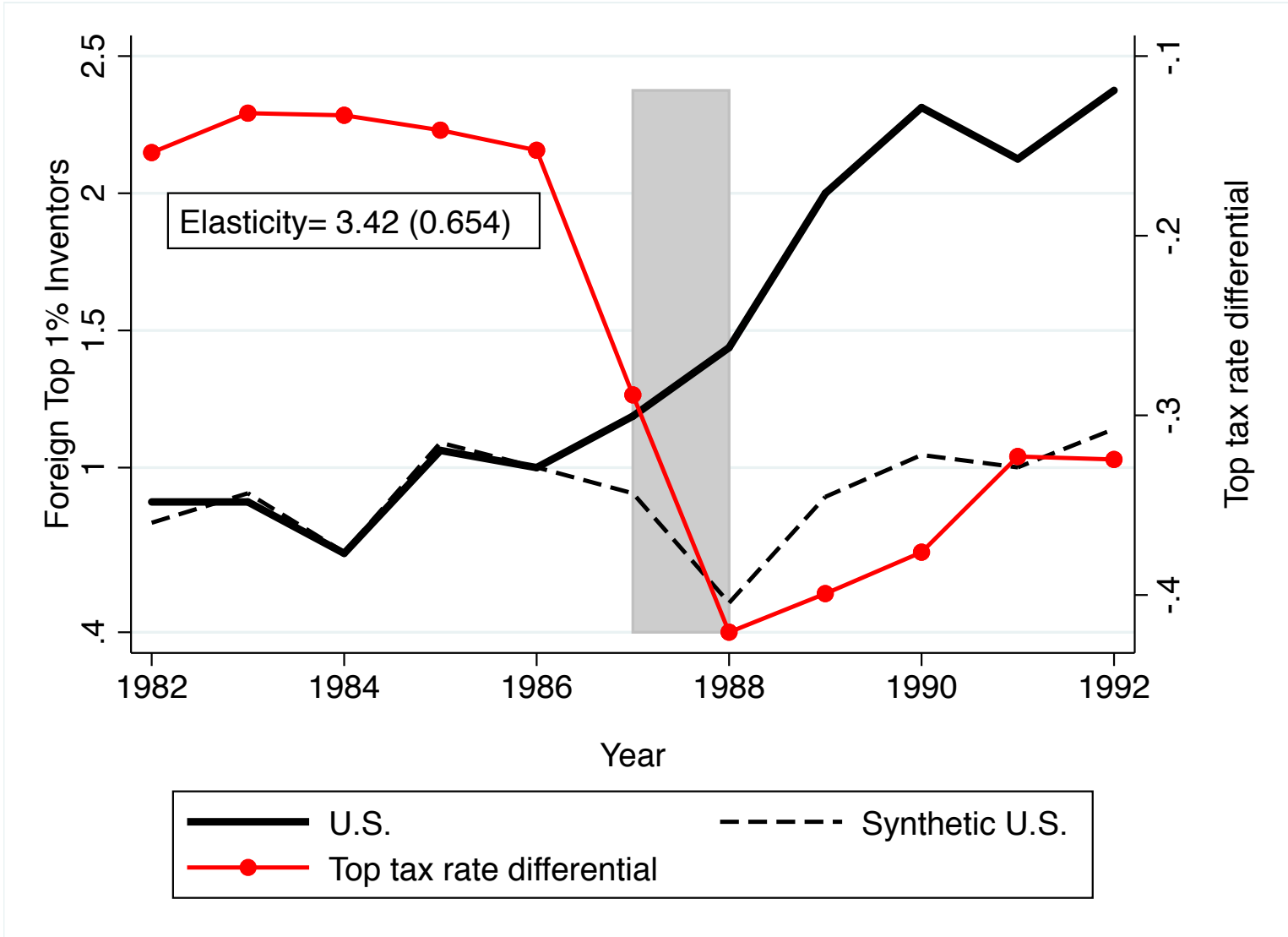
Case Study: U.S. TRA 1986



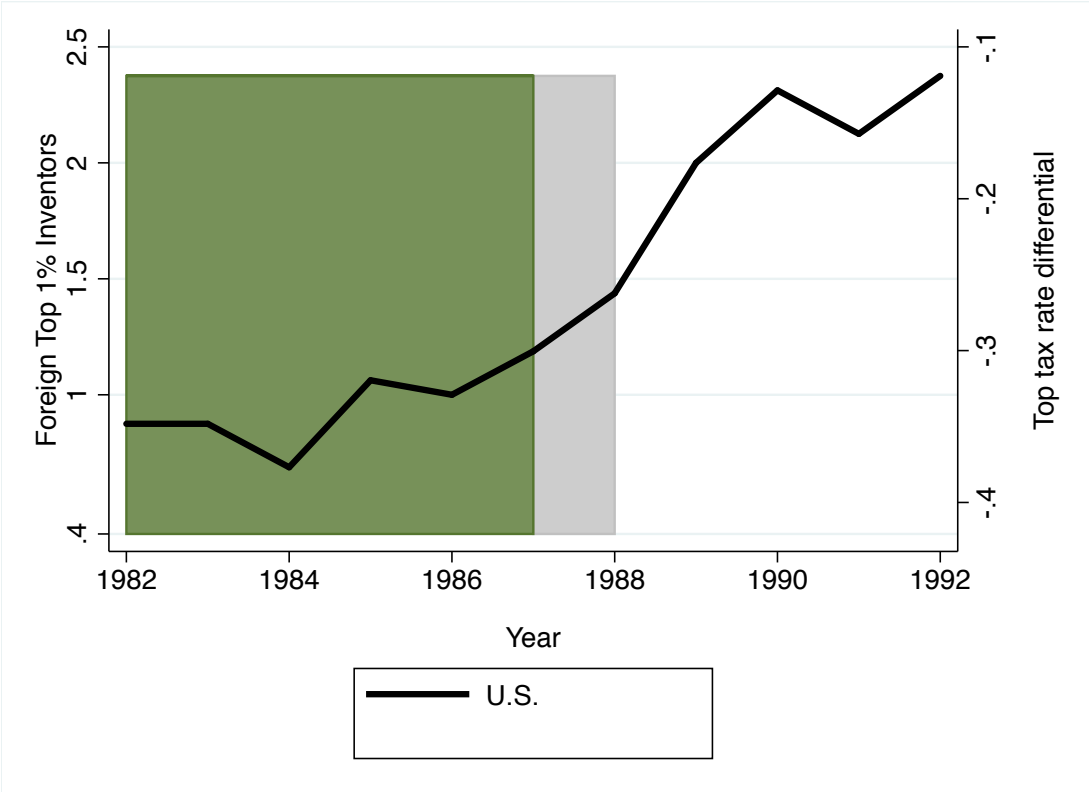
Case Study: U.S. TRA 1986



Case Study: U.S. TRA 1986



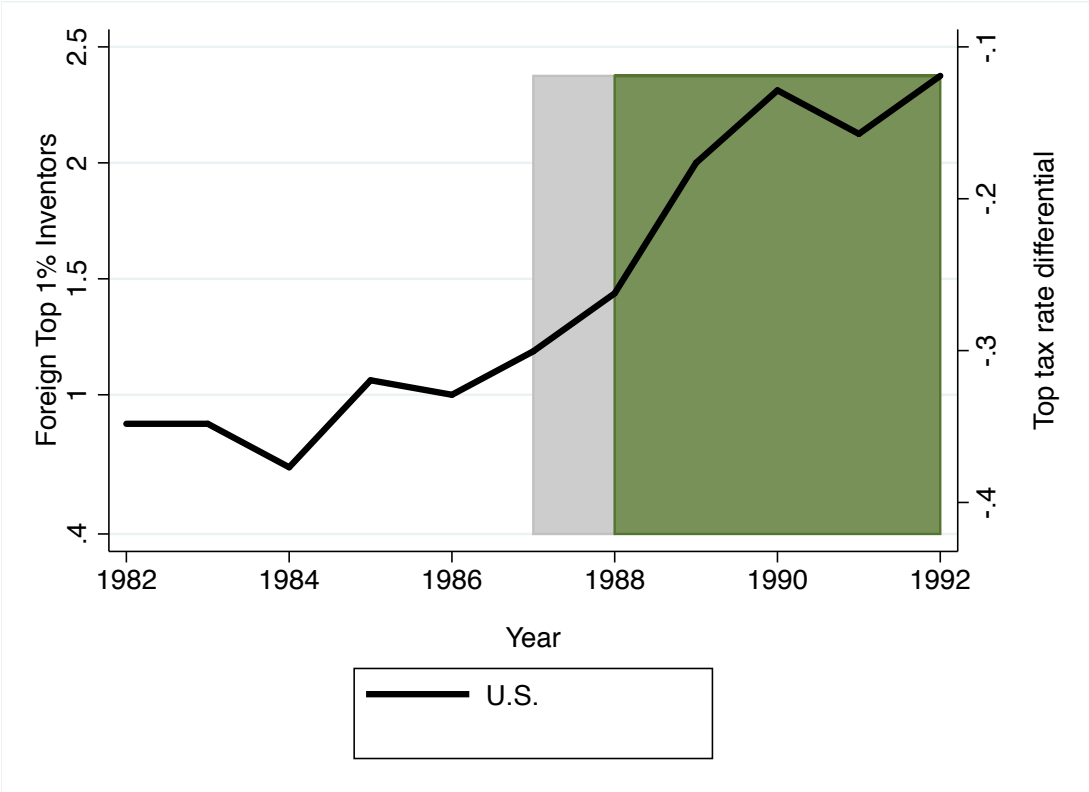
Case Study: U.S. TRA 1986



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



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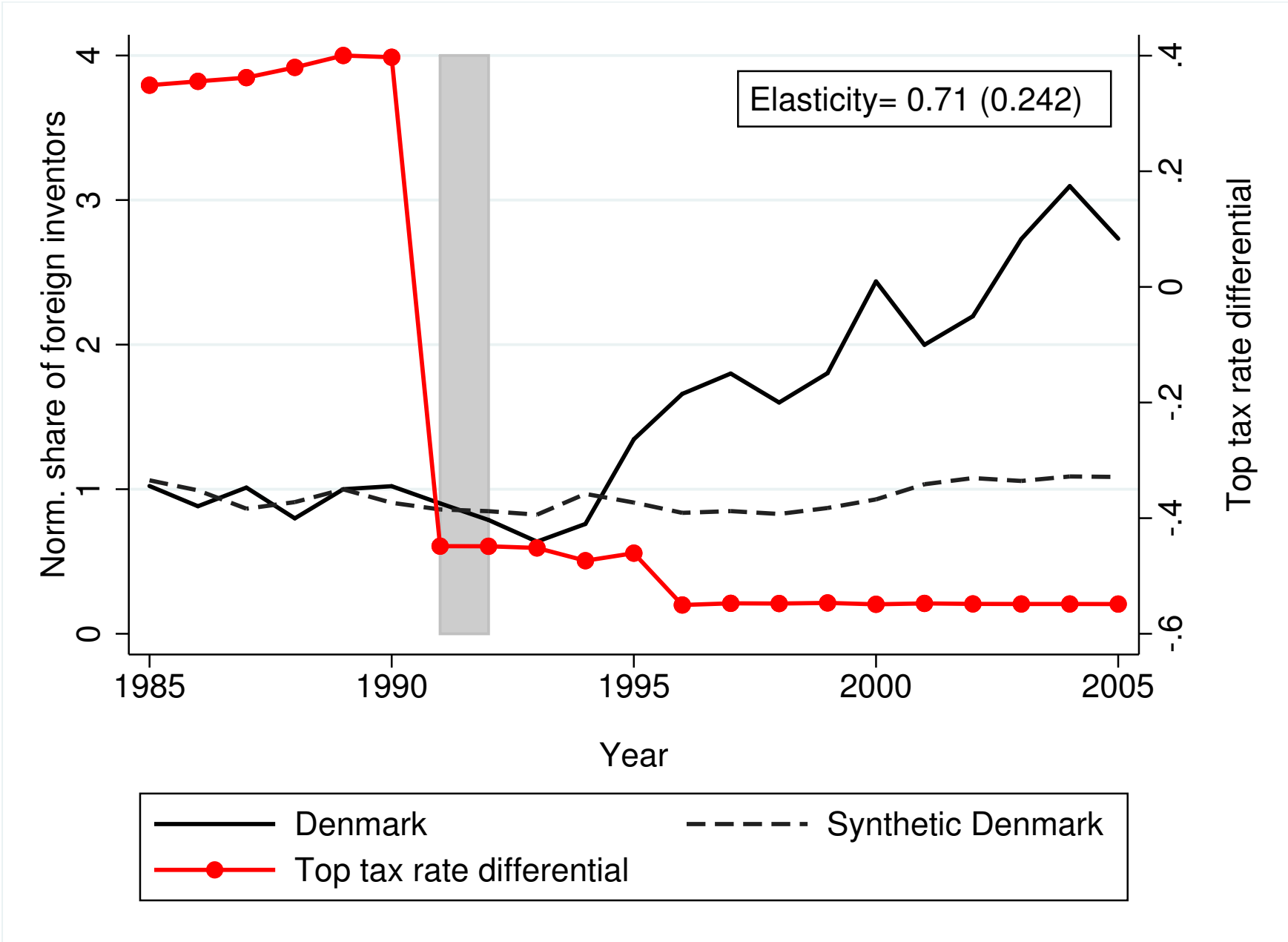
Top 10-25%	13%	11.4%

Case Study: Denmark's 1992 Preferential Tax Reform



Outline

$$Pr(y_{it} = c) = f(\alpha_{r_{it}} \log\left(1 - \text{top MTR}^{i}_{ct}\right) + \beta_c \mathbf{x}_{ti} + \eta \mathbf{x}_{cti} + \zeta \mathbf{x}_{ct})$$

x_{ti}: individual covariates ($\times$ country FE), control for *counterfactual* earnings. Age, tech field, works for multinational, ranking
+ quality $\times$ country FE
+ quality $\times$ country FE $\times$ trend
+ quality $\times$ country FE $\times$ trend $\times$ tech field.

x_{cti}: individual-country pair covariates: home dummy, patent stock in inventor's tech field, distance, common language.

- x_{ct}: country covariates.

$$Pr(y_{it} = c) = f(\alpha_{r_{it}} \log\left(1 - \text{top MTR}^{i}_{ct}\right) + \beta_c \mathbf{x}_{ti} + \eta \mathbf{x}_{cti} + \zeta \mathbf{x}_{ct})$$

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+ quality $\times$ country FE $\times$ trend $\times$ tech field.

x_{cti}: individual-country pair covariates: home dummy, patent stock in inventor's tech field, distance, common language.

- x_{ct}: country covariates.
- **Country-by-year variation**: patent stock, GDP per capita, country FEs, year FEs, country-specific time trends.
  - Contemporaneous country-specific policies?
  - Loads general equilibrium effects and sorting on coefficient of top tax (e.g.: inflow of higher ability inventors could displace low ability inventors if rigid demand).

$$Pr(y_{it} = c) = f(\alpha_{r_{it}} \log\left(1 - \text{top MTR}^{i}_{ct}\right) + \beta_c \mathbf{x}_{ti} + \eta \mathbf{x}_{cti} + \zeta \mathbf{x}_{ct})$$

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- x_{ct}: country covariates.
- **Superstars vs. Non-superstars**: include country $\times$ year FE.
  - Logic: Top 1% and slightly lower quality inventors very comparable.
  - Only inventors actually in top tax bracket are directly affected by top tax.
  - Higher quality $\rightarrow$ Higher income $\rightarrow$ higher propensity to be treated by top MTR (MTR $\approx$ ATR).

$$Pr(y_{it} = c) = f(\alpha_{r_{it}} \log\left(1 - \text{top MTR}^{i}_{ct}\right) + \beta_c \mathbf{x}_{ti} + \eta \mathbf{x}_{cti} + \zeta \mathbf{x}_{ct})$$

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+ quality $\times$ country FE $\times$ trend
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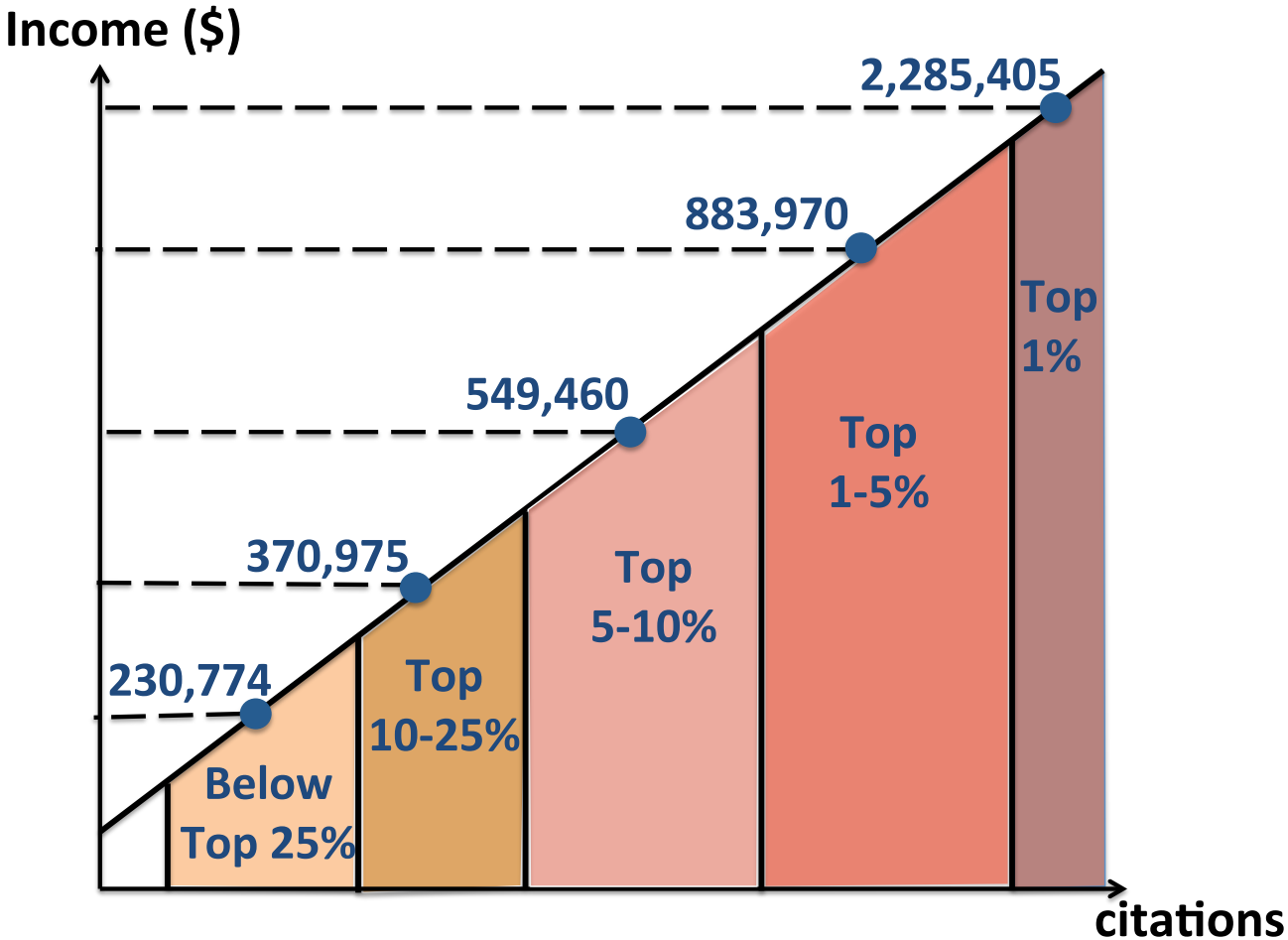
Choice of the Control Group?



Trade-off in the choice of the control group.

$\rightarrow$ Provide set of effects of $(1 - \text{MTR})$ on all quality groups.

$\rightarrow$ Provide elasticity of top 1% relative to several control groups $g \in \{\text{top 5-10\%, top10-25\%, below top 25\%}\}$.

Country-by-year Variation and General Equilibrium Effects

	(1)	(2)	(3)	(4)
Log Retention Rate × Top 1	0.890**	0.891**	0.965**	0.951**
	(0.365)	(0.377)	(0.384)	(0.383)
Log Retention Rate × Top 1-5	0.447**	0.456**	0.527***	0.507**
	(0.182)	(0.197)	(0.199)	(0.203)
Log Retention Rate × Top 5-10	0.141	0.155	0.227	0.202
	(0.142)	(0.148)	(0.147)	(0.148)
Log Retention Rate × Top 10-25	-0.131	-0.107	-0.0296	-0.0533
	(0.113)	(0.114)	(0.108)	(0.106)
Log Retention Rate × Below Top 25	-0.415***	-0.358**	-0.275	-0.285
	(0.150)	(0.171)	(0.176)	(0.176)
Quality× Country FE	NO	YES	YES	YES
Quality × Country FE × Year	NO	NO	YES	YES
Quality×Country FE×Year×Field FE	NO	NO	NO	YES
Domestic elasticity	0.02	0.02	0.024	0.023
s.e	(0.009)	(0.009)	(0.009)	(0.009)
Foreign elasticity	0.75	0.751	0.807	0.798
s.e	(0.305)	(0.319)	(0.324)	(0.322)
Observations	8,645,464	8,617,464	8,617,464	8,617,464

Superstars vs. Non-Superstars

		(1)	(2)	(3)	(4)
Log Retention Rate × Top 1		1.328**	1.456**	1.399**	1.352**
		(0.644)	(0.642)	(0.667)	(0.669)
Log Retention Rate × Top 1-5		0.885*	1.022**	0.961*	0.907*
		(0.514)	(0.514)	(0.532)	(0.536)
Log Retention Rate × Top 5-10		0.576	0.719	0.658	0.599
		(0.495)	(0.483)	(0.501)	(0.506)
Log Retention Rate × Top 10-25		0.303	0.456	0.398	0.341
		(0.486)	(0.466)	(0.481)	(0.484)
Log Retention Rate × Below Top 25		0.022	0.207	0.153	0.110
		(0.493)	(0.471)	(0.478)	(0.482)
Quality× Country FE		NO	YES	YES	YES
Quality × Country FE × Year		NO	NO	YES	YES
Quality× Country FE× Year× Field FE		NO	NO	NO	YES
Control: Top 5-10	Domestic elasticity	0.02	0.02	0.02	0.02
	s.e	(0.009)	(0.009)	(0.009)	(0.009)
	Foreign elasticity	0.63	0.62	0.62	0.63
	s.e	(0.314)	(0.321)	(0.318)	(0.319)
Control: Top 10-25	Domestic elasticity	0.03	0.02	0.02	0.02
	s.e	(0.009)	(0.009)	(0.009)	(0.009)
	Foreign elasticity	0.86	0.84	0.84	0.85
	s.e	(0.323)	(0.334)	(0.335)	(0.334)
Control: Below Top 25	Domestic elasticity	0.03	0.03	0.03	0.03
	s.e	(0.009)	(0.010)	(0.011)	(0.011)
	Foreign elasticity	1.09	1.05	1.04	1.04
	s.e	(0.340)	(0.376)	(0.382)	(0.381)
Observations		8,645,464	8,617,464	8,617,464	8,617,464

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Quality× Country FE		NO	YES	YES	YES
Quality × Country FE × Year		NO	NO	YES	YES
Quality× Country FE× Year× Field FE		NO	NO	NO	YES
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	s.e	(0.009)	(0.009)	(0.009)	(0.009)
	Foreign elasticity	0.63	0.62	0.62	0.63
	s.e	(0.314)	(0.321)	(0.318)	(0.319)
Control: Top 10-25	Domestic elasticity	0.03	0.02	0.02	0.02
	s.e	(0.009)	(0.009)	(0.009)	(0.009)
	Foreign elasticity	0.86	0.84	0.84	0.85
	s.e	(0.323)	(0.334)	(0.335)	(0.334)
Control: Below Top 25	Domestic elasticity	0.03	0.03	0.03	0.03
	s.e	(0.009)	(0.010)	(0.011)	(0.011)
	Foreign elasticity	1.09	1.05	1.04	1.04
	s.e	(0.340)	(0.376)	(0.382)	(0.381)
Observations		8,645,464	8,617,464	8,617,464	8,617,464

Implied Migration Elasticities across Countries

Country	Domestic elasticity	Foreign elasticity	Percentage change in domestic inventors	Percentage change in foreign inventors
United States	0.003	0.97	0.1	18.4
Great Britain	0.36	1.24	8.0	27.2
Canada	0.31	1.23	6.1	23.7
Germany	0.05	1.22	1.4	33.9
France	0.12	1.23	4.4	43.6
Italy	0.13	1.23	3.0	27.4
Japan	0.01	1.23	0.2	25.2
Switzerland	0.18	1.23	4.2	27.9

Columns 3, 4: Implied % change after 10 pp decline in top tax rates in 2000.

Implied Economic Gains across Countries (in million USD)

	Small Patent Value		Large Patent Value	
Tax Change:	5 percentage points	10 percentage points	5 percentage points	10 percentage points
Country				
United States	59.1	118.2	1,248.0	2,496.1
Great Britain	17.6	35.2	371.2	742.5
Canada	17.6	35.3	372.4	744.8
Germany	17.8	35.7	376.6	753.2
France	10.9	21.9	230.8	461.6
Italy	3.0	5.9	62.6	125.3
Japan	8.6	17.3	182.1	364.2
Switzerland	5.5	11.0	116.6	233.3

$$dV_{ct} = \frac{d(1-\tau_{ct})}{(1-\tau_{ct})} \times (\varepsilon_d^c \times N_c^d + \varepsilon_f^c \times N_c^f) \times N_p \times V_p$$

- Small Patent Value: 2.7 mln USD; Large Patent Value: 57 mln USD.
- Spillovers? Patent breadth?

The Role of Companies

		(1)	(2)
Log Retention Rate × Top 1		1.345**	1.366**
		(0.676)	(0.692)
Log Retention Rate × Top 1-5		0.819	0.649
		(0.550)	(0.593)
Log Retention Rate × Top 5-10		0.453	0.313
		(0.516)	(0.581)
Log Retention Rate × Top 10-25		0.122	0.0350
		(0.509)	(0.550)
Log Retention Rate × Below Top 25		-0.314	-0.430
		(0.524)	(0.565)
Log Retention Rate × Not Multinational		-0.219*	
		(0.124)	
Log Retention Rate × Activity abroad			-1.506***
			(0.151)
Quality× Country FE		YES	YES
Quality × Country FE × Year		YES	YES
Quality× Country FE× Year× Field FE		YES	YES
Control: Top 5-10	Domestic elasticity	0.022	0.288
	s.e	(0.009)	(0.083)
	Foreign elasticity	0.756	1.038
	s.e	(0.327)	(0.301)
Control: Top 10-25	Domestic elasticity	0.030	0.363
	s.e	(0.009)	(0.089)
	Foreign elasticity	1.038	1.313
	s.e	(0.330)	(0.322)
Control: Below Top 25	Domestic elasticity	0.041	0.492
	s.e	(0.010)	(0.095)
	Foreign elasticity	1.407	1.771
	s.e	(0.342)	(0.341)
Observations		7,060,896	6,169,624

▸ other taxes

The Role of Companies

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Log Retention Rate × Not Multinational		-0.219*	
		(0.124)	
Log Retention Rate × Activity abroad			-1.506***
			(0.151)
Quality× Country FE		YES	YES
Quality × Country FE × Year		YES	YES
Quality× Country FE× Year× Field FE		YES	YES
Control: Top 5-10	Domestic elasticity	0.022	0.288
	s.e	(0.009)	(0.083)
	Foreign elasticity	0.756	1.038
	s.e	(0.327)	(0.301)
Control: Top 10-25	Domestic elasticity	0.030	0.363
	s.e	(0.009)	(0.089)
	Foreign elasticity	1.038	1.313
	s.e	(0.330)	(0.322)
Control: Below Top 25	Domestic elasticity	0.041	0.492
	s.e	(0.010)	(0.095)
	Foreign elasticity	1.407	1.771
	s.e	(0.342)	(0.341)
Observations		7,060,896	6,169,624

▸ other taxes

Outline

Robustness checks and Extensions

- Alternative quality measures:
  - All the other 5 measures (based on citations, patent breadth, breadth of impact...)
  - "Life time" or "persistent" quality measures.
- Unbalanced nature of the data: selection based on patenting?
  - Use patent counts as quality measure $\rightarrow$ does not drive results.
  - Imputing data for missing years.
  - Heckman selection model on U.S.-Canada exploiting 1994 reform.
- Long term vs. Short term mobility.
- Repeat everything on European Patent Office data.
- Drop all inventors who ever move to U.S. from DID and EPO data.

Alternative Quality Measures and Imputing Data

		Alternative quality Measures				Imputing location
		(1)	(2)	(3)	(4)	(5)
Log Retention Rate × Top 1		1.290**	0.282	2.529***	1.665**	1.444**
		(0.633)	(0.634)	(0.720)	(0.692)	(0.621)
Log Retention Rate × Top 1-5		1.061**	0.434	2.059***	1.265**	1.097**
		(0.493)	(0.458)	(0.636)	(0.546)	(0.481)
Log Retention Rate × Top 5-10		0.578	0.415	1.354**	0.685	0.876**
		(0.507)	(0.443)	(0.655)	(0.500)	(0.433)
Log Retention Rate × Top 10-25		0.368	0.550	0.690	0.270	0.680*
		(0.513)	(0.444)	(0.653)	(0.508)	(0.408)
Log Retention Rate × Below Top 25		0.0947	1.384***	0.129	0.0705	0.745*
		(0.574)	(0.459)	(0.534)	(0.514)	(0.406)
Quality× Country FE		YES	YES	YES	YES	YES
Quality × Country FE × Year		YES	YES	YES	YES	YES
Quality× Country FE× Year× Field FE		YES	YES	YES	YES	YES
Control: Top 5-10	Domestic elasticity	0.013	0.000	0.012	0.021	0.015
	s.e	(0.007)	(0.007)	(0.004)	(0.009)	(0.010)
	Foreign elasticity	0.599	-0.119	1.132	0.863	0.486
	s.e	(0.315)	(0.429)	(0.485)	(0.377)	(0.337)
Control: Top 10-25	Domestic elasticity	0.018	-0.003	0.015	0.028	0.019
	s.e	(0.007)	(0.007)	(0.004)	(0.009)	(0.010)
	Foreign elasticity	0.773	-0.241	1.770	1.227	0.653
	s.e	(0.326)	(0.424)	(0.477)	(0.351)	(0.330)
Control: Below Top 25	Domestic elasticity	0.025	-0.018	0.021	0.034	0.017
	s.e	(0.009)	(0.009)	(0.004)	(0.010)	(0.011)
	Foreign elasticity	1.004	-0.994	2.310	1.404	0.597
	s.e	(0.397)	(0.513)	(0.474)	(0.428)	(0.351)
Observations		8,617,464	8,617,464	8,617,464	8,617,464	17,173,640

▸ more robustness

Breadth of Impact and Patent breadth

		(1)	(2)
Log Retention Rate × Top 1		1.253*	1.191*
		(0.646)	(0.693)
Log Retention Rate × Top 1-5		1.103**	0.777
		(0.508)	(0.622)
Log Retention Rate × Top 5-10		0.944*	0.506
		(0.484)	(0.593)
Log Retention Rate × Top 10-25		0.658	0.494
		(0.489)	(0.566)
Log Retention Rate × Below Top 25		0.532	0.194
		(0.537)	(0.490)
Quality× Country FE		YES	YES
Quality × Country FE × Year		YES	YES
Quality× Country FE× Year× Field FE		YES	YES
Control: Top 5-10	Domestic elasticity	0.007	0.017
	s.e	(0.008)	(0.010)
	Foreign elasticity	0.271	0.576
	s.e	(0.346)	(0.327)
Control: Top 10-25	Domestic elasticity	0.012	0.017
	s.e	(0.008)	(0.009)
	Foreign elasticity	0.523	0.586
	s.e	(0.346)	(0.322)
Control: Below Top 25	Domestic elasticity	0.014	0.025
	s.e	(0.011)	(0.011)
	Foreign elasticity	0.633	0.837
	s.e	(0.485)	(0.385)
Observations		8,617,464	8,617,464

▸ Patent breadth, breadth of impact

Heckman Selection Model

- Binary Heckman selection model on U.S.- or Canadian inventors.
  - Reason: Theoretical and practical difficulty of multinomial choice with selection.
- Dependent variable is 1 if inventor locates in the U.S.
- Selection on the extensive margin: patent or not.
- Exploit the "Patent Term and Publication Reform Act of 1994" reform: change in patent terms.
  - Patent term of 17 years counted from grant year changed to 20 years from application year.
  - In data, patent grant period is 2 years so effective increase in patent protection length.
  - First stage: increases probability of patenting.
  - Especially binding in industries with long patent lifecycle (e.g., pharma) based on patent renewal data.

Results: Heckman Selection Model on Canada-U.S.

	(1) Probit	(2) Selection
US log retention rate × Top 1	1.406***	1.404***
	(0.196)	(0.197)
US log retention rate × Top 1 - 5	0.180	0.178
	(0.199)	(0.200)
US log retention rate × Top 5 - 10	0.135	0.132
	(0.141)	(0.141)
US log retention rate × Top 10 - 25	0.109	0.107
	(0.107)	(0.107)
US log retention rate × Below top 25	-0.0320	-0.0331
	(0.107)	(0.107)
First stage		
Post reform (1994) dummy		0.101***
		(0.0382)
Observations	568,888	1,160,331

▸ long patent life cycles

Long-term Mobility: Moving Abroad without Moving Back

		(1)	(2)	(3)
Log Retention Rate × Top 1		2.350***	2.176**	2.642***
		(0.843)	(0.879)	(0.899)
Log Retention Rate × Top 1-5		1.787**	1.566**	1.828**
		(0.742)	(0.771)	(0.843)
Log Retention Rate × Top 5-10		1.447**	1.136	1.434*
		(0.704)	(0.741)	(0.812)
Log Retention Rate × Top 10-25		1.253*	0.871	1.165
		(0.700)	(0.751)	(0.797)
Log Retention Rate × Below Top 25		1.028	0.418	0.703
		(0.728)	(0.787)	(0.824)
Log Retention Rate × Not Multinational			-0.154	
			(0.160)	
Log Retention Rate × Activity abroad				-1.672***
				(0.202)
Quality× Country FE		YES	YES	YES
Quality × Country FE × Year		YES	YES	YES
Quality× Country FE× Year× Field FE		YES	YES	YES
Control: Top 5-10	Domestic elasticity	0.011	0.012	0.229
	s.e	(0.005)	(0.005)	(0.070)
	Foreign elasticity	0.761	0.892	1.196
	s.e	(0.357)	(0.364)	(0.367)
Control: Top 10-25	Domestic elasticity	0.012	0.018	0.280
	s.e	(0.005)	(0.005)	(0.072)
	Foreign elasticity	0.924	1.119	1.464
	s.e	(0.366)	(0.366)	(0.376)
Control: Below Top 25	Domestic elasticity	0.016	0.022	0.366
	s.e	(0.006)	(0.006)	(0.077)
	Foreign elasticity	1.114	1.506	1.923
	s.e	(0.417)	(0.386)	(0.405)
Observations		8,414,376	6,881,984	6,012,592

Benchmarks results with the EPO data

		Benchmark	Alternative quality measures			
		(1)	(2)	(3)	(4)	(5)
Log Retention Rate × Top 1		2.108***	2.181***	3.019***	2.722***	1.011
		(0.647)	(0.677)	(0.765)	(0.646)	(0.732)
Log Retention Rate × Top 1-5		1.952***	1.906***	2.586***	2.147***	1.075*
		(0.564)	(0.591)	(0.646)	(0.557)	(0.606)
Log Retention Rate × Top 5-10		1.600***	1.439***	2.297***	1.885***	1.350**
		(0.517)	(0.553)	(0.668)	(0.543)	(0.606)
Log Retention Rate × Top 10-25		1.142**	1.193**	1.836***	1.264**	1.585***
		(0.457)	(0.531)	(0.709)	(0.502)	(0.573)
Log Retention Rate × Below Top 25		0.839*	1.117*	0.834	0.756	2.060***
		(0.446)	(0.608)	(0.571)	(0.557)	(0.533)
Quality× Country FE		YES	YES	YES	YES	YES
Quality × Country FE × Year		YES	YES	YES	YES	YES
Quality× Country FE× Year× Field FE		YES	YES	YES	YES	YES
Control: Top 5-10	Domestic elasticity	0.008	0.010	0.003	0.013	-0.003
	s.e	(0.007)	(0.007)	(0.003)	(0.005)	(0.006)
	Foreign elasticity	0.495	0.729	0.720	0.822	-0.331
	s.e	(0.406)	(0.504)	(0.505)	(0.330)	(0.467)
Control: Top 10-25	Domestic elasticity	0.016	0.012	0.005	0.022	-0.006
	s.e	(0.007)	(0.006)	(0.003)	(0.005)	(0.006)
	Foreign elasticity	0.943	0.969	1.180	1.430	-0.562
	s.e	(0.443)	(0.488)	(0.470)	(0.315)	(0.452)
Control: Below Top 25	Domestic elasticity	0.020	0.014	0.011	0.030	-0.014
	s.e	(0.009)	(0.007)	(0.002)	(0.007)	(0.009)
	Foreign elasticity	1.240	1.045	2.176	1.929	-1.024
	s.e	(0.533)	(0.566)	(0.444)	(0.428)	(0.696)
Observations		8,449,929	8,449,929	8,449,929	8,449,929	8,449,929

▸ no movers

Conclusion

- Superstar inventors react to top tax rates – elasticities are not large.
  - Comparing superstars to non-superstars for identification.
- Those who worked for multinationals most sensitive.
- Career concerns seem to matter for location.
- Very promising data, for a wide range of other questions in PF.
- Open Question: What is the economic costs from taxation when including the migration margin and potential spillovers from inventors?

Appendix

Disambiguated Inventor Data (DID)

- USPTO: 4.2 million patent records, 3.1 million inventors in 1975-2010.
- 18% of worldwide direct patent filings (26% of all patents).
- Filing propensities: US-58%, CA-48%,GB-19%, DE-16%, IT-20%, JP-13%, FR-17%, CH-12%.
- 8 countries account for 89% of patents (US-55%, CA-2.3%,GB-3%, DE-7.6%, IT-1.2%, JP-19.6%, FR-2.9%, CH-1.3%).
- Largest migration corridors are UK-US, CA-US. Very small migration corridors but lots of patenting: JP-US, CH-US.
- Disambiguated inventors' names with residential addresses.
- Info on assignees and patent characteristics from NBER patent data.
- "Home" is country where inventor first observed. (Alternative: ethnicity data). Back

Additional Data Sources: EPO and PCT

- European Patent Office (EPO) Data.
  - Higher representation of European patents:
  - Canada 1.3%, Switzerland 3.3%, Germany 23.7%, France 7.7%, Great Britain 6.2%, Italy 3.8%, Japan 16.4%, U.S. 27.5%.
  - Very recent disambiguation
- Patents filed under Patent Cooperation Treaty (PCT).
  - 1980-2004
  - 54% of international patent applications and 8% of worldwide filings.
  - Not yet a panel data, but has nationality info.

Disambiguated Inventor Data Summary Stats

Variables	Average
Patents of Superstar (Top 1 percent) Inventors	54
Patents of Superstar (Top 5 percent) Inventors	29.3
Patents of Non-superstar (Below Top 5 percent) Inventors	3.5
Average patents per year while in sample	1.5
Max citations on any patent of Superstar (Top 1 percent) Inventors	147
Max citations on any patent of Superstar (Top 5 percent) Inventors	100
Max citations on any patent of Non-superstar (Below Top 5 percent) Inventors	24
Number of Patents (per country per year)	12,454
Number of Inventors (per country per year)	17,275
Number of Co-Inventors (per patent)	1.2
Number of immigrants (per country per year)	102
Number of immigrants per year to the U.S.	439
Number of immigrants per year to CA	71.5
Number of immigrants per year to CH	50.1
Number of immigrants per year to DE	78.6
Number of immigrants per year to FR	37.9
Number of immigrants per year to GB	87.2
Number of immigrants per year to IT	12.6
Number of immigrants per year to JP	40.0
Percentage of Superstar (Top 1) Inventors who move over life in sample	4.6
Percentage of Superstar (Top 5) Inventors who move over life in sample	3.6
Percentage of Non-superstar (Below 5) Inventors who move over life in sample	0.7
Average duration of stay in years conditional on move (benchmark sample)	5.3
Percentage of inventors who are employees	83.2
Percentage of employees who work for multinationals	75
Average years between first and last patent (benchmark sample)	12

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Constructing Quality Measures for Inventors (II)

Correlation between different quality measures:

TABLE 1: CORRELATION MATRIX FOR THE FOUR QUALITY MEASURES

	Citations-weighted patent number	Number of patents	Average citations per patent	Max citations per patent
Citations-weighted patent number	1			
Number of patents	0.67	1		
Average citations per patents	0.35	0.02	1	
Max citations on any patent	0.66	0.30	0.76	1

Notes: The correlations between different dynamic measures of the inventor's quaility are computed across inventors for the period 1977-2000. The data includes inventors in 8 countries: Canada, France, Germany, Great Britain, Italy, Japan, Switzerland, and the United States. The sample contains 3,422,865 observations with 1,439,129 unique inventors.

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Constructing Quality Measures for Inventors (III)

Patent breadth and breadth of impact measures by inventor quality:

	Breadth of impact	Patent breadth
Top 1	28.90	412.99
Top 1-5	18.44	187.82
Top 5-10	13.27	118.27
Top 10-25	9.18	72.71

▸ Back to quality measure

▸ Back to regression

EPO Data Summary Statistics

Variables	Average
Patents of Superstar (Top 1 percent) Inventors	47
Patents of Superstar (Top 5 percent) Inventors	23
Patents of Non-superstar (Below Top 5 percent) Inventors	2.2
Average patents per year while in sample	1.5
Max citations on any patent of Superstar (Top 1 percent) Inventors	34
Max citations on any patent of Superstar (Top 5 percent) Inventors	23
Max citations on any patent of Non-superstar (Below Top 5 percent) Inventors	4.5
Number of Patents (per country per year)	8,101
Number of Inventors (per country per year)	12,714
Number of immigrants (per country per year)	44
Number of immigrants per year to the U.S.	140
Number of immigrants per year to CA	16
Number of immigrants per year to CH	37
Number of immigrants per year to DE	48
Number of immigrants per year to FR	31
Number of immigrants per year to GB	37
Number of immigrants per year to IT	13
Number of immigrants per year to JP	21
Percentage of Superstar (Top 1) Inventors who move over life in sample	3.6
Percentage of Superstar (Top 5) Inventors who move over life in sample	2.5
Percentage of Non-superstar (Below 5) Inventors who move over life in sample	.24
Average duration of stay in years conditional on move in sample	4.9
Percentage of inventors who are employees in sample	94
Average years between first and last patent in sample	6.9

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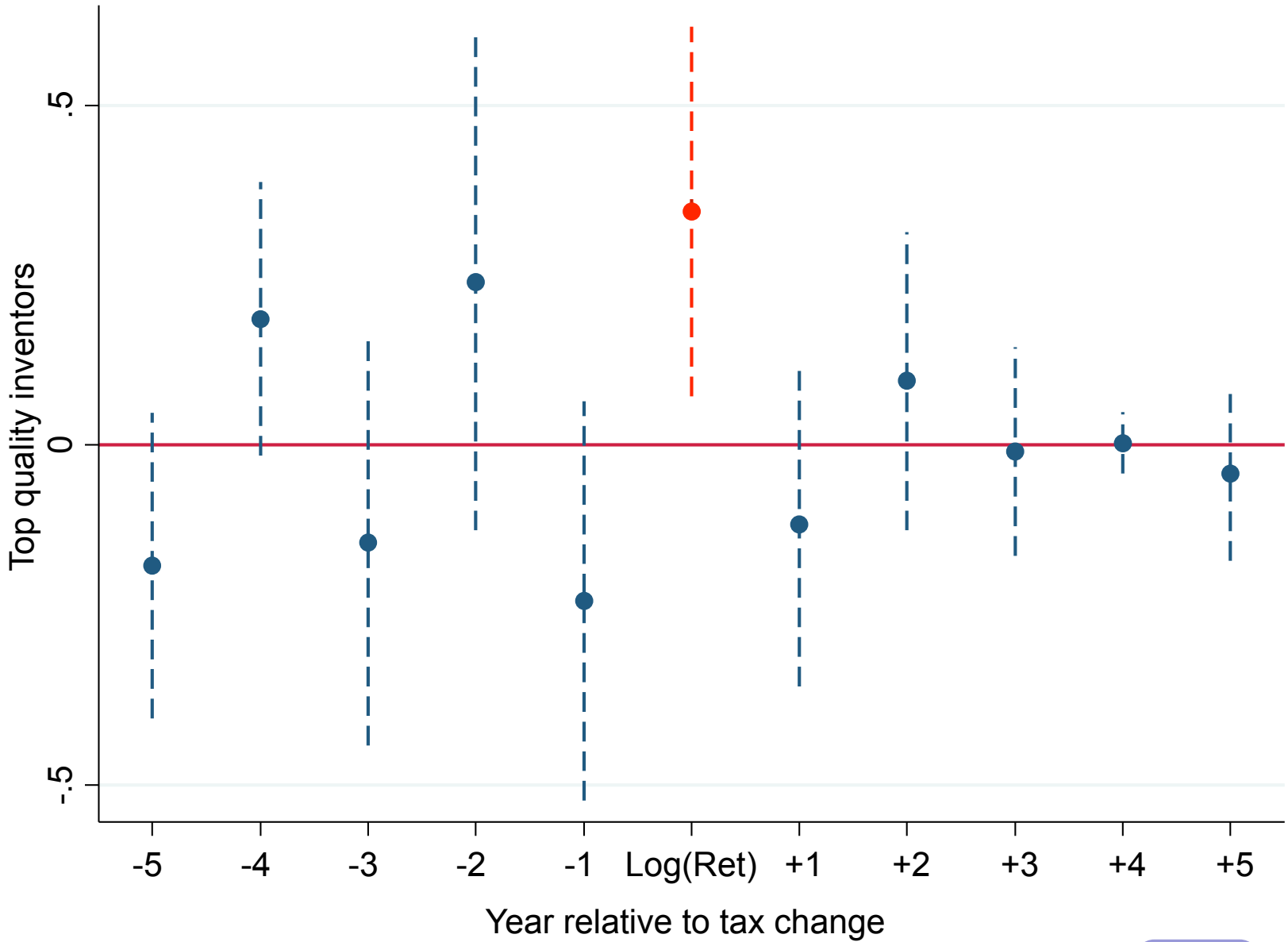
Tax leads



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Heckman Selection model on Canada-U.S, on industries with long patent life cycles

	(1) Probit	(2) Selection
US log retention rate × Top 1	1.406***	1.404***
	(0.196)	(0.197)
US log retention rate × Top 1-5	0.180	0.178
	(0.199)	(0.200)
US log retention rate × Top 5-10	0.135	0.132
	(0.141)	(0.141)
US log retention rate × Top 10-25	0.109	0.107
	(0.107)	(0.107)
US log retention rate × Below Top 25	-0.0320	-0.0331
	(0.107)	(0.107)
First stage		
Post reform (1994) dummy		0.0847**
		(0.0379)
Post reform (1994) dummy × Long lifecycle dummy		0.0464**
		(0.0190)
Observations	568,888	1,160,331

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Corporate and capital gains taxes

	(1)	(2)
Log Retention Rate × Top 1	0.950**	1.151***
	(0.375)	(0.397)
Log Retention Rate × Top 1-5	0.490**	0.700**
	(0.202)	(0.274)
Log Retention Rate × Top 5-10	0.200	0.121
	(0.147)	(0.257)
Log Retention Rate × Top 10-25	-0.0997	-0.194
	(0.112)	(0.251)
Log Retention Rate × Below Top 25	-0.353*	-0.624*
	(0.197)	(0.324)
Log Retention Rate for the corporate tax	0.167	
	(0.131)	
Log Retention Rate for the capital gains tax		0.0265
		(0.202)
Quality× Country FE	YES	YES
Quality × Country FE × Year	YES	YES
Quality×Country FE×Year×Field FE	YES	YES
Domestic elasticity	0.025	0.029
s.e	(0.009)	(0.010)
Foreign elasticity	0.801	0.979
s.e	(0.315)	(0.338)
Observations	7,982,960	5,186,872

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Dropping movers to the US

		(1)	(2)	(3)	(4)
Log Retention Rate × Top 1		2.136***	2.616***	2.794***	2.769***
		(0.825)	(0.800)	(0.819)	(0.813)
Log Retention Rate × Top 1-5		1.618**	2.019***	2.194***	2.150***
		(0.765)	(0.715)	(0.728)	(0.733)
Log Retention Rate × Top 5-10		1.498**	1.825***	1.996***	1.936***
		(0.750)	(0.697)	(0.712)	(0.719)
Log Retention Rate × Top 10-25		1.220*	1.426**	1.594**	1.531**
		(0.706)	(0.658)	(0.678)	(0.685)
Log Retention Rate × Below Top 25		0.706	0.545	0.699	0.649
		(0.744)	(0.706)	(0.729)	(0.735)
Quality× Country FE		NO	YES	YES	YES
Quality × Country FE × Year		NO	NO	YES	YES
Quality× Country FE× Year× Field FE		NO	NO	NO	YES
Control: Top 5-10	Domestic elasticity	0.003	0.004	0.004	0.004
	s.e	(0.004)	(0.004)	(0.004)	(0.004)
	Foreign elasticity	0.637	0.788	0.795	0.831
	s.e	(0.680)	(0.699)	(0.698)	(0.691)
Control: Top 10-25	Domestic elasticity	0.005	0.006	0.006	0.006
	s.e	(0.004)	(0.004)	(0.004)	(0.004)
	Foreign elasticity	0.913	1.186	1.198	1.234
	s.e	(0.660)	(0.682)	(0.681)	(0.674)
Control: Below Top 25	Domestic elasticity	0.008	0.012	0.012	0.012
	s.e	(0.004)	(0.004)	(0.004)	(0.004)
	Foreign elasticity	1.426	2.066	2.090	2.114
	s.e	(0.673)	(0.694)	(0.697)	(0.688)
Observations		8,591,640	8,563,792	8,563,792	8,563,792

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Non-employees, additional OECD countries and country ranking

		(1)	(2)	(3)
Log Retention Rate × Top 1		1.352**	1.278**	1.327**
		(0.669)	(0.588)	(0.668)
Log Retention Rate × Top 1-5		0.907*	0.858*	0.922*
		(0.536)	(0.492)	(0.535)
Log Retention Rate × Top 5-10		0.599	0.488	0.669
		(0.506)	(0.473)	(0.504)
Log Retention Rate × Top 10-25		0.341	0.271	0.335
		(0.484)	(0.453)	(0.495)
Log Retention Rate × Below Top 25		0.110	0.160	0.188
		(0.482)	(0.444)	(0.492)
Quality× Country FE		YES	YES	YES
Quality × Country FE × Year		YES	YES	YES
Quality× Country FE× Year× Field FE		YES	YES	YES
Control: Top 5-10	Domestic elasticity	0.018	0.023	0.015
	s.e	(0.009)	(0.008)	(0.008)
	Foreign elasticity	0.631	0.668	0.562
	s.e	(0.319)	(0.243)	(0.317)
Control: Top 10-25	Domestic elasticity	0.024	0.030	0.020
	s.e	(0.009)	(0.009)	(0.008)
	Foreign elasticity	0.848	0.852	0.848
	s.e	(0.334)	(0.261)	(0.328)
Control: Below Top 25	Domestic elasticity	0.029	0.032	0.025
	s.e	(0.011)	(0.010)	(0.009)
	Foreign elasticity	1.042	0.946	0.972
	s.e	(0.381)	(0.302)	(0.376)
Observations		8,617,464	15,460,745	8,617,464

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EPO, Dropping movers to the US

		(1)	(2)	(3)	(4)
Log Retention Rate × Top 1		2.724***	3.226***	3.154***	3.182***
		(0.746)	(0.794)	(0.789)	(0.782)
Log Retention Rate × Top 1-5		2.983***	3.359***	3.260***	3.244***
		(0.660)	(0.677)	(0.677)	(0.679)
Log Retention Rate × Top 5-10		2.373***	2.603***	2.482***	2.455***
		(0.644)	(0.650)	(0.653)	(0.657)
Log Retention Rate × Top 10-25		2.080***	2.045***	1.893***	1.864***
		(0.596)	(0.590)	(0.597)	(0.599)
Log Retention Rate × Below Top 25		1.511**	1.015*	0.822	0.793
		(0.625)	(0.604)	(0.612)	(0.614)
Quality× Country FE		NO	YES	YES	YES
Quality × Country FE × Year		NO	NO	YES	YES
Quality× Country FE× Year× Field FE		NO	NO	NO	YES
Control: Top 5-10	Domestic elasticity	0.001	0.003	0.004	0.004
	s.e	(0.003)	(0.003)	(0.003)	(0.003)
	Foreign elasticity	0.351	0.623	0.670	0.723
	s.e	(0.405)	(0.426)	(0.426)	(0.415)
Control: Top 10-25	Domestic elasticity	0.003	0.009	0.009	0.009
	s.e	(0.003)	(0.003)	(0.003)	(0.003)
	Foreign elasticity	0.643	1.179	1.256	1.315
	s.e	(0.410)	(0.442)	(0.442)	(0.432)
Control: Below Top 25	Domestic elasticity	0.009	0.015	0.015	0.016
	s.e	(0.004)	(0.004)	(0.004)	(0.004)
	Foreign elasticity	1.211	2.206	2.326	2.382
	s.e	(0.482)	(0.517)	(0.518)	(0.509)
Observations		8,423,817	8,423,817	8,423,817	8,423,817

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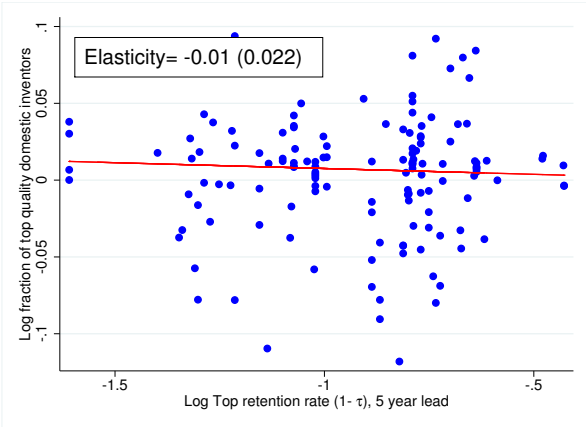
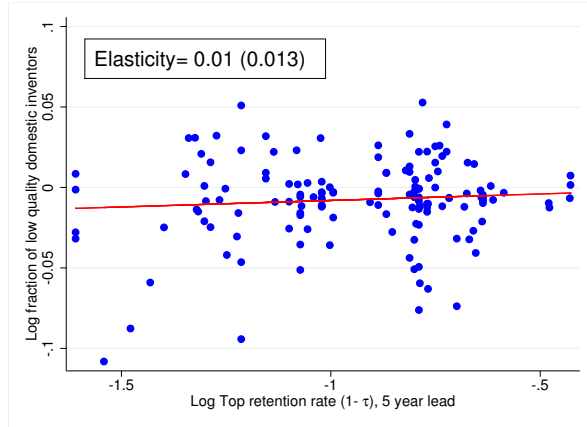
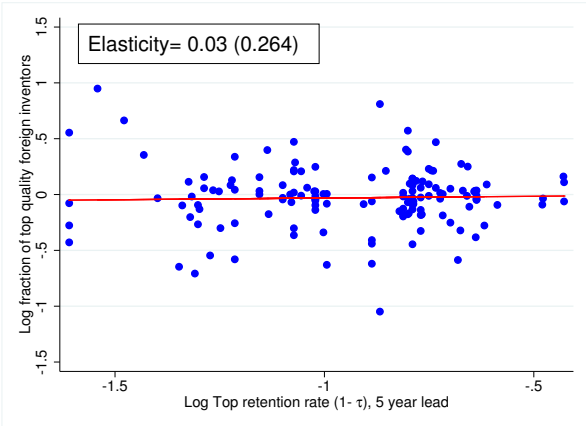
Lead top $(1-\tau)$ and % of domestic and foreign inventors 1977-2000



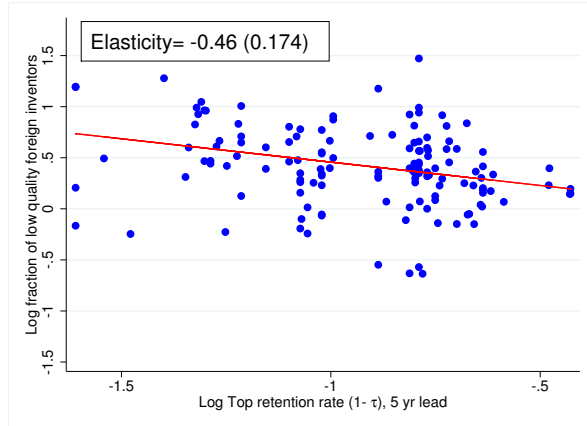
(a) Fraction of top quality inventors in home country



(b) Fraction of low quality inventors in home country



(c) Fraction of top quality foreign inventors



(d) Fraction of low quality foreign inventors

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