Taxation and the International Mobility of Inventors

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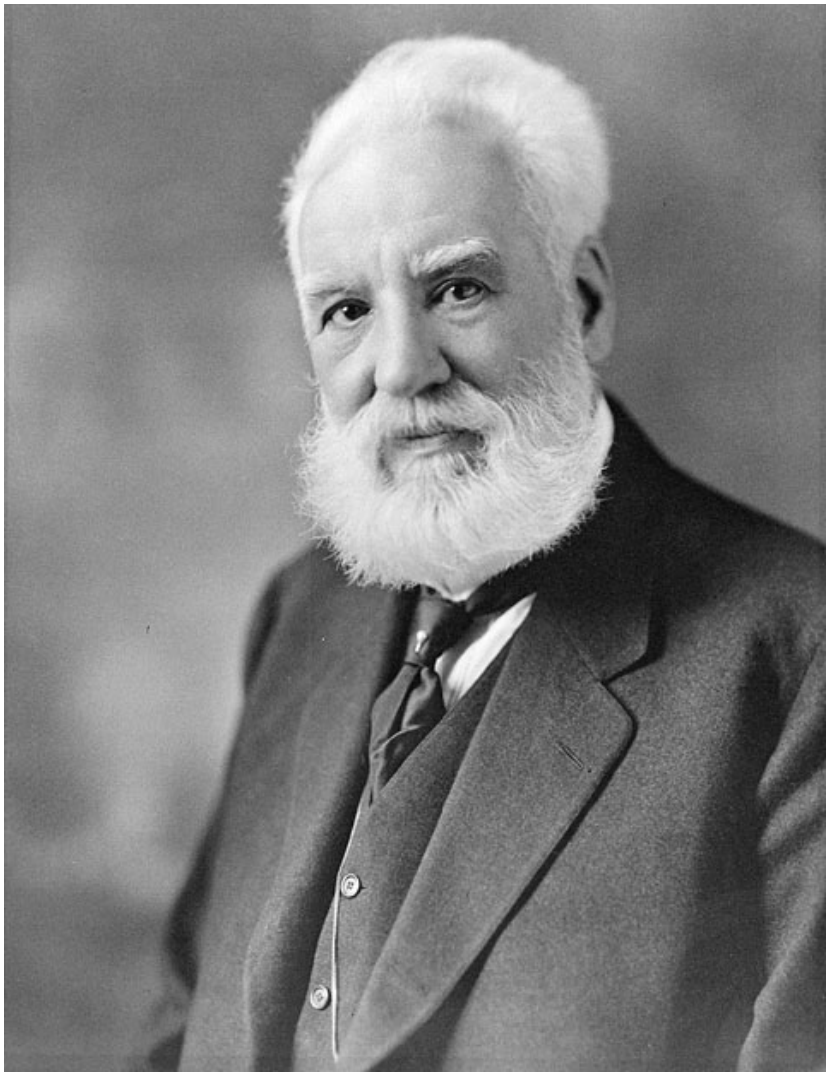
April 20, 2015

Alexander G. Bell



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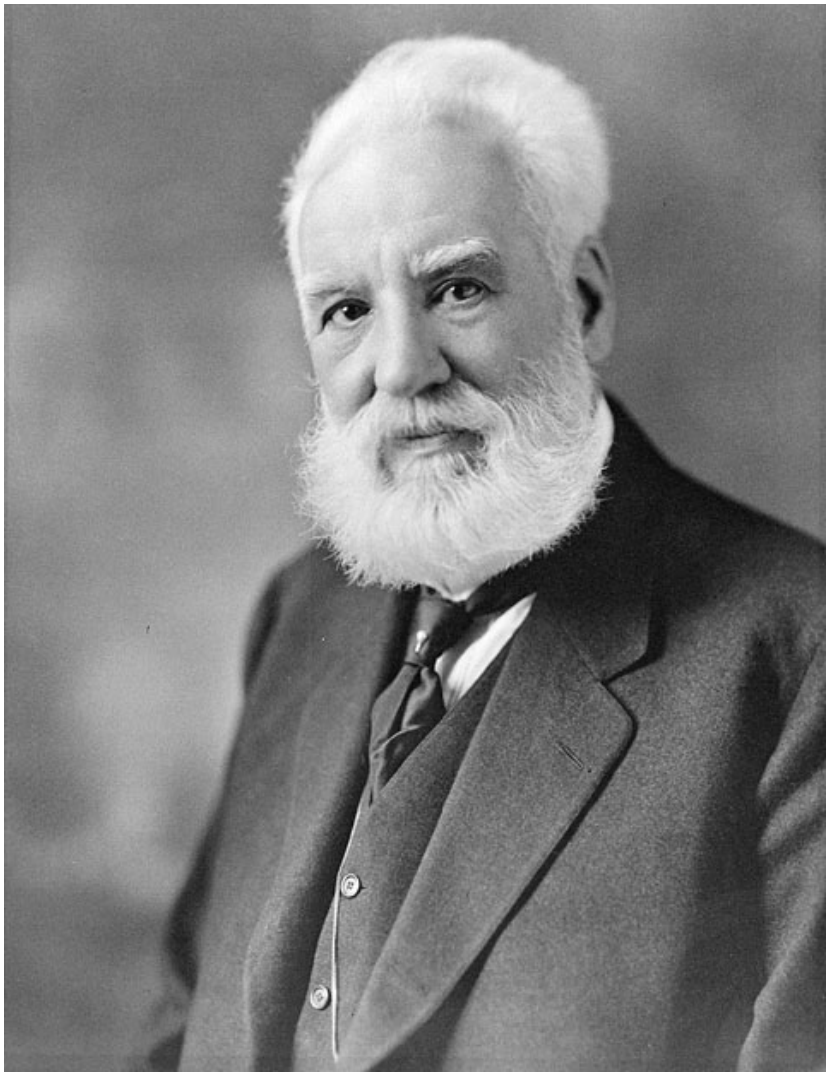

- Inventor of the telephone (1876).
- Created Bell Telephone Company (1877).
- By 1886: more than 150,000 people in U.S. own telephones.

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?

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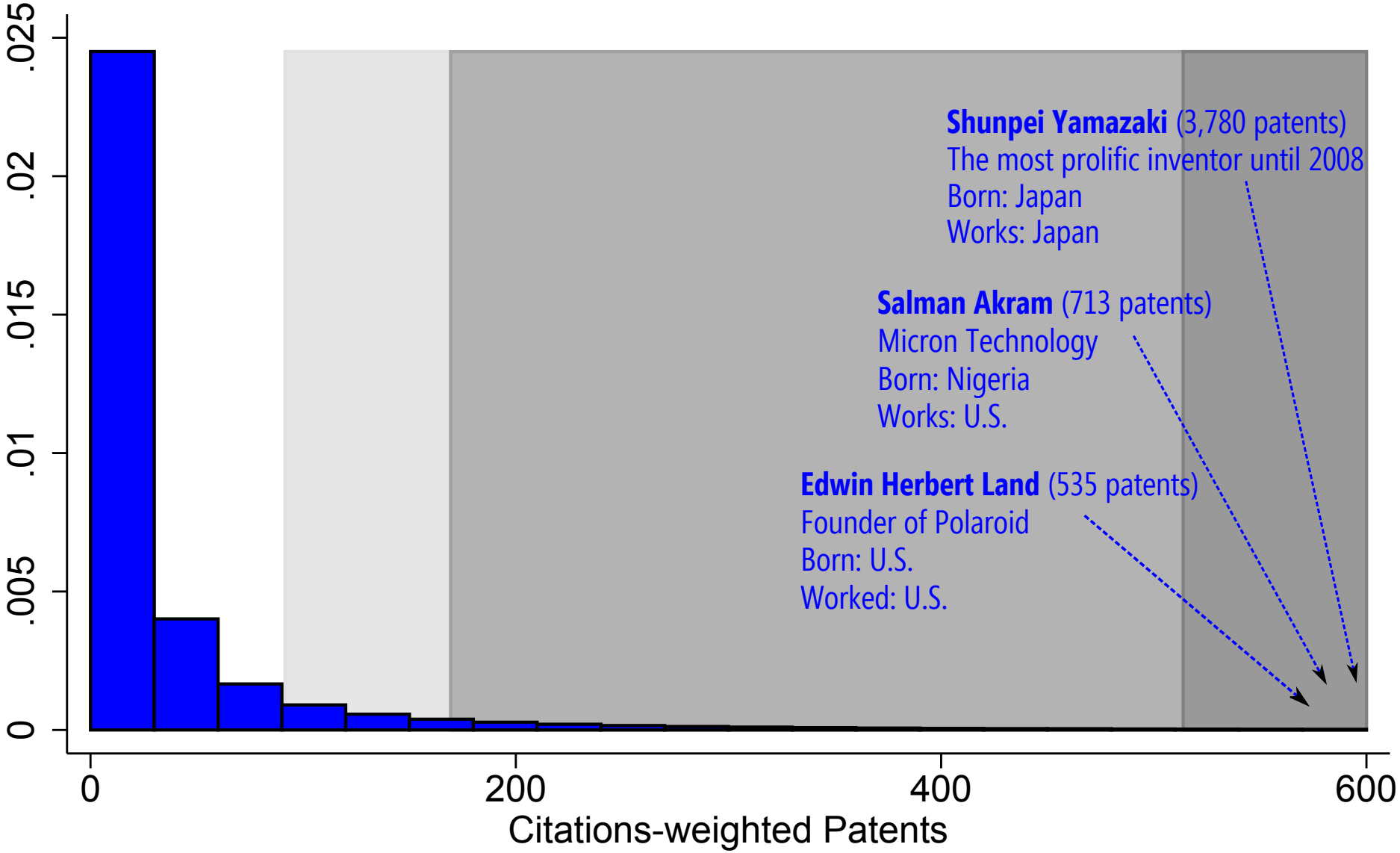
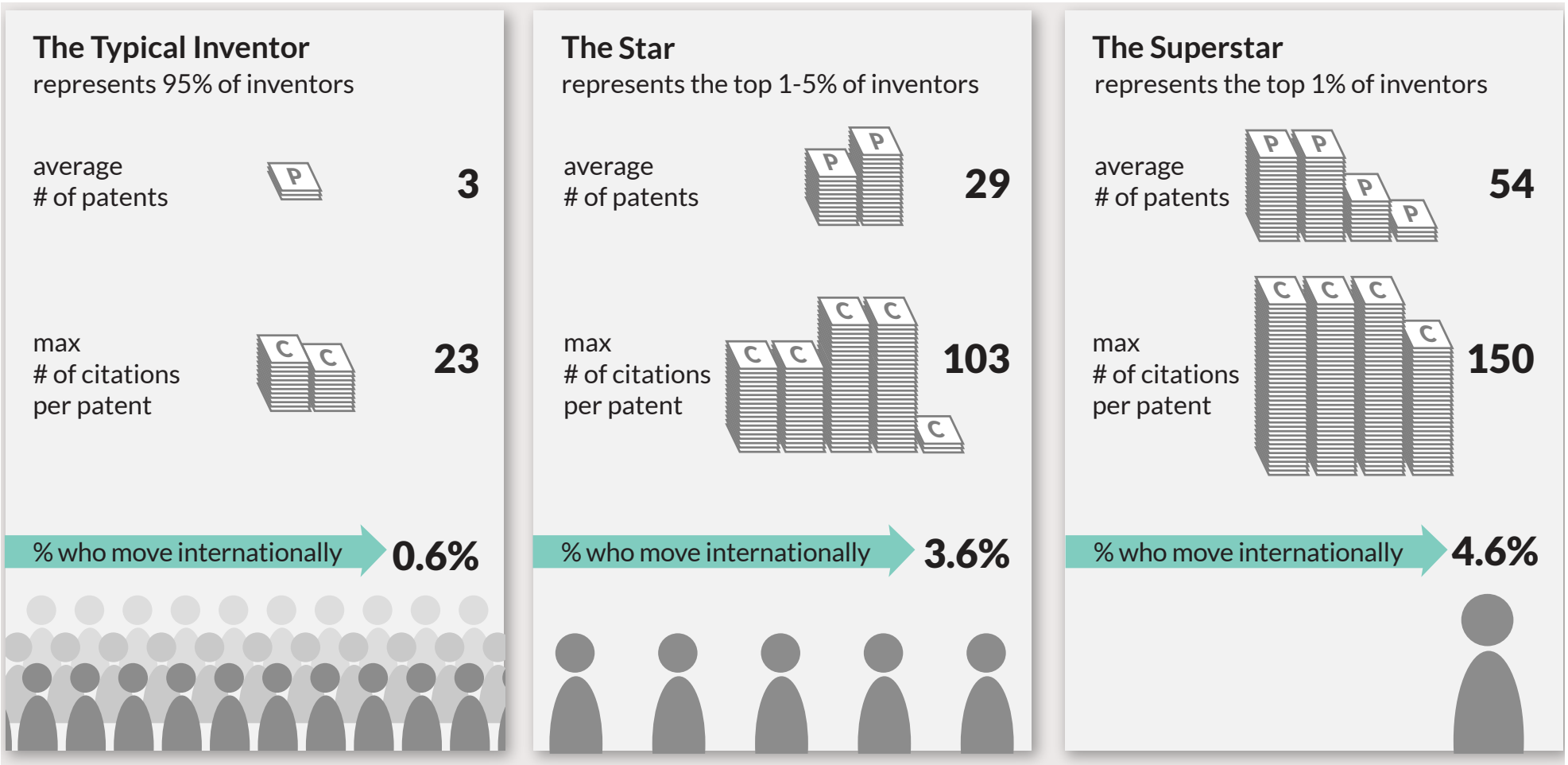
Taxes and International Migration: Anecdotes but Little Evidence

- 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."
  - Gerard Depardieu's Russian citizenship in response to taxes.
- Scarcity of rigorous evidence due to a lack of international panel data.
  - Exception: Kleven, Landais and Saez (2013) on football players.
- This paper: study the **international mobility of inventors**.
  - USPTO and EPO patent data to track inventors 1977-2003 across 8 countries (CA, CH, DE, FR, IT, JP, UK, US).
- Emphasis on **"Superstar"** inventors with most and best inventions.

Superstar Inventors in a Highly Skewed Quality Distribution



Superstar Inventors versus Typical Inventors



Our Strategy to Study Mobility Responses to Taxation

- Two challenges:

1. Counterfactual income?
   - Use detailed proxies, including patent quality measures, tech field, tech fit, etc.
2. Counterfactual (average) tax rate?
   - Focus on elasticity to top income tax rate only.
   - Surveys show: superstars are in top of income distribution.
   - Interpretable as well as the "Success tax."
   - Do not estimate "net of tax" elasticities (other taxes, firm responses, ..).

- Document stylized macro facts since 1977.
- Estimate multinomial choice location model.

Preview of Findings

- Superstar top 1% inventors' location choice significantly affected by top tax rates.
  - Elasticity: 0.04 for domestic, 1.3 for foreign.
  - 10 ppt top tax↑: 1% less domestic superstars retained
  - 38% less foreign superstars attracted.
- If have worked for multinational more sensitive to tax differentials.
- If company has localized research activity, less sensitive.
- Spillovers from superstar inventors on their peers through interactions.

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).

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

Outline

1. Setting
2. Data and Definitions
3. Reduced-form Macro Facts
4. Location Choice Model Estimation
5. Robustness and Extensions
6. Spillovers and Interactions

Inventors and Patents: Background

- Inventors are creators of innovations.
  - Employees, researchers, or self-employed.
  - Listed on the patent.
- Patents granted to assignee (e.g.: a firm or an individual).
  - Need not be one of the inventors.
- Other studies show that migration increases in skill.
- Inventors highly mobile: 2.3% of inventors and 4.6% of superstar inventors move in our sample.

A Simple Model of Inventor Migration

- C countries $c \in \{1, ..., C\}$.
- μ^i_{ct}: Non-income net utility benefit from living in country c.
- $\tau_{ch^i t}$: tax rate in c for inventor with home county h^i.
- $w^i_{c't}$: wage of inventor i in country c' at time t.
- $\tilde{w}^i_{c't}$: marginal product.
- Perfectly competitive labor market: $\tilde{w}^i_{c't} = w^i_{c't}$, $\forall c', t, i$.
- GE effects: $w^i_{c't}$ could be function of τ directly. E.g.: sorting.

A Simple Model of Inventor Migration (II)

- Utility from choosing country c at time t for inventor i is given by:

$$U^i_{ct} = u\left(w^i_{ct}\left(1 - \tau_{ch^i t}\right)\right) + \mu^i_{ct}$$

- Locate in $c = argmax_{c'} U^i_{c't}$
- Remarks
  - Preferences in μ could outweigh any tax considerations.
  - Average tax vector $(\tau_{1h^i t}, ..., \tau_{ch^i t}, ..., \tau_{Ch^i t})$ matters for migration.
  - Utility from being in c does not depend on c' (e.g.: no adjustment costs).
- Assume tax rates of other countries have small impact only.

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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).
- Different 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.
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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 ▸ Summary Statistics
- 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

Variable	Average
Patents of Superstar (Top 1%) Inventors	54
Patents of Superstar (Top 5%) Inventors	29.3
Patents of Non-superstar (Below Top 5%) Inventors	3.4
Average patents per year while in sample	1.5
Max citations per patent of Superstar (Top 1%) Inventors	149.9
Max citations per patent of Superstar (Top 5%) Inventors	102.6
Max citations per patent of Non-superstar (Below Top 5%) Inventors	23
Number of Patents (per country per year)	13,824.4
Number of Inventors (per country per year)	19,207.9
Number of immigrants (per country per year)	122.8
# of immigrants per year to the U.S.	532.8
# of immigrants per year to CA	83.9
# of immigrants per year to CH	57.3
# of immigrants per year to DE	97
# of immigrants per year to FR	48.3
# of immigrants per year to GB	99.3
# of immigrants per year to IT	15
# of immigrants per year to JP	48.5
% Superstar (Top 1%) Inventors who move over life in sample	4.6%
% Superstar (Top 5%) Inventors who move over life in sample	3.6%
% Non-superstar (Below 5%) Inventors who move over life in sample	0.6%
Average duration of stay in years conditional on move	5.17
% of inventors who are employees	73.5%
% of employees who work for multinationals	75%
Average years between first and last patent in sample	5.2

Constructing Quality Measures for Inventors

- Patent citations received: measure of economic significance (Hall *et al.*, 2001).
- p_{ijt}: truncation-adjusted forward citations of patent j of i by t.
- P^i_{t-1}: set of patents of inventor i by the end of period $t-1$.

Construct 4 measures of quality (all lagged):

1. Citations-weighted dynamic patent stock: (benchmark) $q1^i_t = \sum_{j \in P^i_{t-1}} p_{ij}$
2. Patent count: $q2^i_t = |P^i_{t-1}|$
3. Mean citations per patent: $q3^i_t = \frac{\sum_{j \in P^i_{t-1}} p_{ij}}{|P^i_{t-1}|}$
4. Max number of citations ever received on a patent: $q4^i_t = \max_{j \in P^i_{t-1}} p_{ijt}$

Constructing Quality Measures for Inventors (II)

Correlation between different 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	0.70	1		
Average citations per patents	0.32	0.05	1	
Max citations per patent	0.62	0.37	0.76	1

"Superstars:" Constructing a Ranking of Inventors

- Group countries into 3 groups based on comparable patenting intensity: 1) U.S., 2) Japan, 3) EU + Canada.
  - Results entirely robust to different region definitions or per-country ranking.
- Assign inventors to regions based on their "home" country.
- **Superstars**: Inventors in top 1% of regional quality distribution at t.
  - Dynamic ranking, changes over time.
- Define similarly top 1-5%, top 5-10%, top 10-25%.

Strategy for Using Patent Data to Study Tax Responses of Migration

- Location of inventors recorded at each patent filing (residence?).
- Typically: income taxed where you live (some exceptions: the US).
  - Unavoidable complications: tax treaties and choices.
- Two big hurdles to overcome in the data:
  1. **Counterfactual wage** in each potential location at each time?
  2. **Counterfactual tax rate** inventor would pay in each potential location at each time?

Using Inventor Quality to Proxy for Income

- Patent quality: composite statistic of inventor's past achievements.
- Income increase linked to patent quality of an inventor:
  1. **Direct effect**: rewards, bonuses, "fair share agreements."
  2. **Indirect effect**: Employer promotes star inventors, tries to retain them.
     - ★ Chesborough: *"R&D managers often use the number of patents generated (..) as a metric to judge the productivity of (...) [a] person or organization."*
     - ★ Importance of star inventors (Zucker and Darby, 2014).
- Other detailed controls for counterfactual income: age, tech class, goodness of fit with destination, firm type, etc..

Evidence on the Link Between Patent Quality and Inventor Income

- Distribution of monetary rewards highly skewed towards high quality patents.
- Toivanen and Vaananen (2012): In Finnish administrative data matched to patents, premium of 30% for highly cited patents, persists over time.
- Harhoff and Hoisl (2007): Top 5% get 20-50% salary increase per invention, Top inventors' salaries can be multiplied by 5.
- Bell *et al.* (2015): IRS data, earnings rise sharply immediately after patent applications, particularly for highly cited patents.

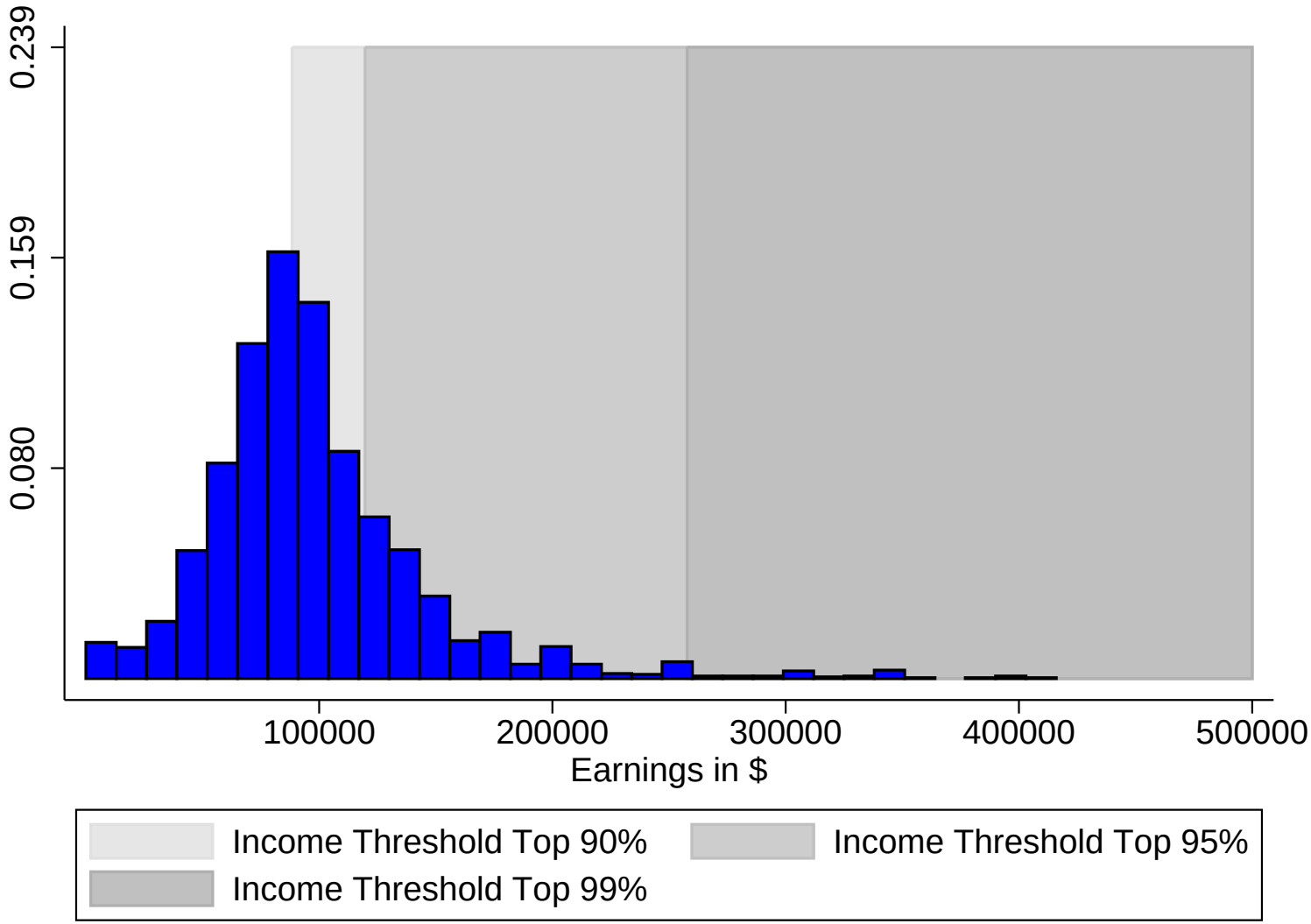
Using the Effective Top Marginal Tax Rate as Tax Measure

- Answers "How much does a country's stock of domestic and foreign inventors of various qualities change for a small change in marginal top tax rates, all else equal?"
- Not necessarily interpretable as "the migration elasticities to net-of-tax income."
  - Combines firm and worker responses.
  - Is a function of institutional features (e.g.: visas).
  - Other taxes? But limit sample to employees, where ordinary personal income likely to be main form of compensation.
- Top tax also a measure of the "success tax."
  - Could have important motivation effects even if not direct incidence.

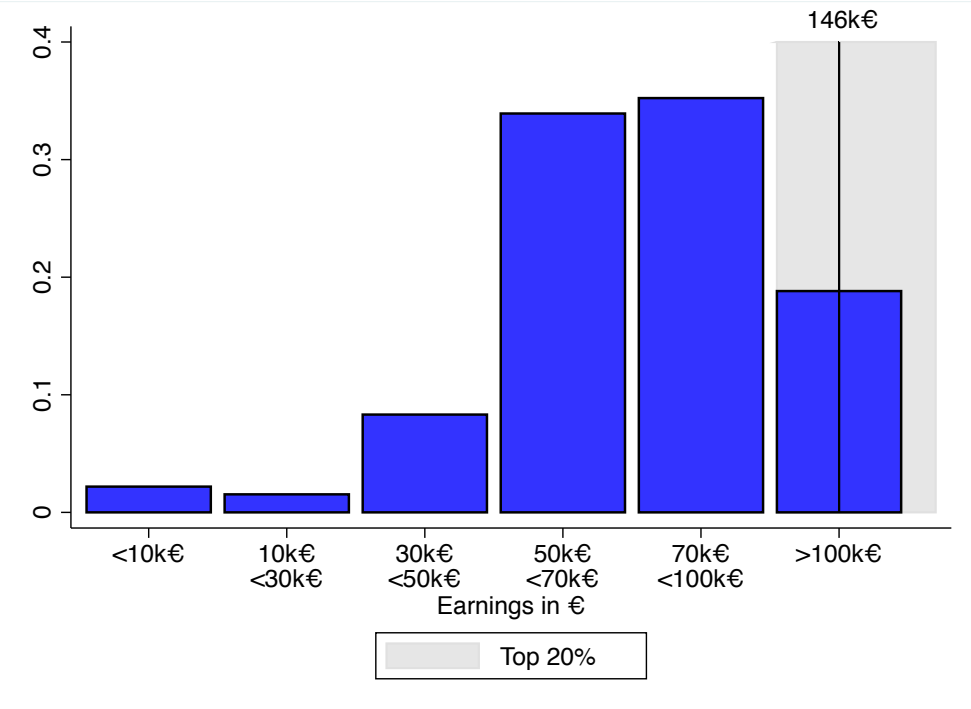
Identification and Differential Effects of Top Taxes

- Interact top tax rate measure with ranking dummies (top 1%, top 1-5%, ...)
- Marginal tax rate is good approximation to average tax for high earners; exogenous to earnings (conditional on being in top bracket).
- But should not *directly* affect people below top bracket.
  - Potential incentive effect on lower groups if "success tax."
  - But unclear if should move before actually being in top tax bracket?
- "Fuzzy RD" design: lower quality groups are controls for superstar group.
  - Fuzzy because tax brackets different in different countries...
  - and because we don't know actual or counterfactual income.
  - Indirect motivation effects.

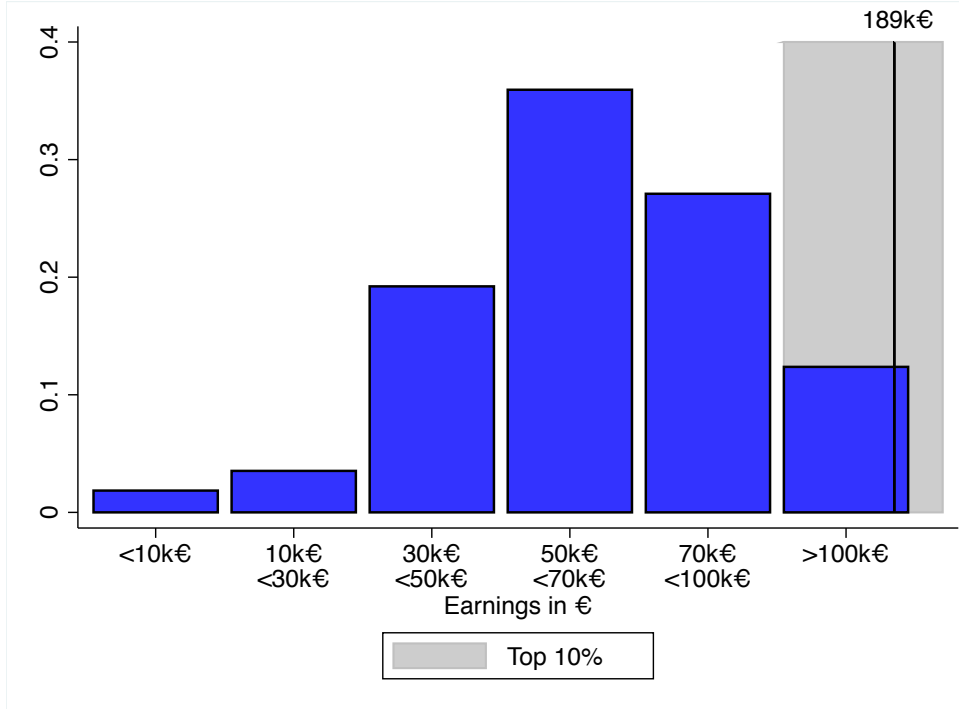
U.S. Inventors' earnings distribution from NSF NSCG, 2003



Inventors' earnings distribution in CH and DE

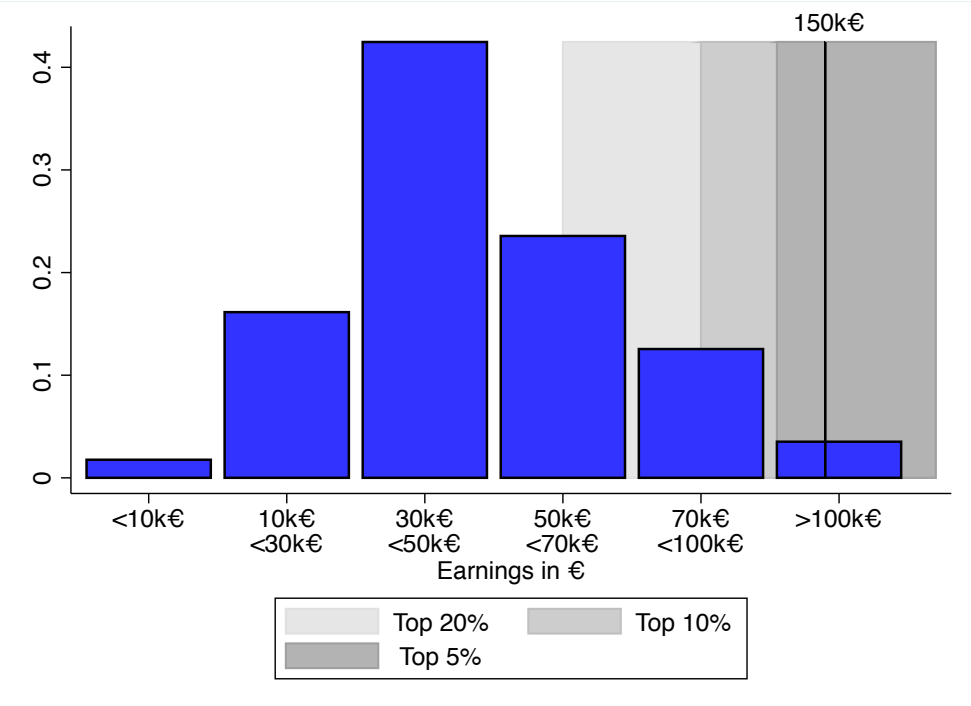


(a) Switzerland

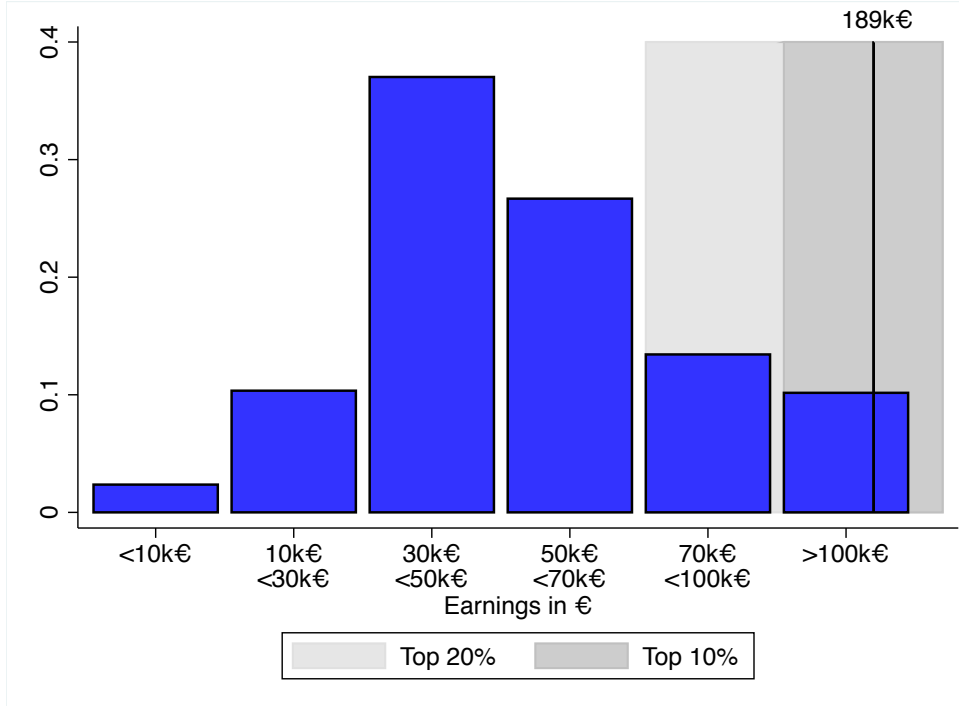


(b) Germany

Inventors' earnings distribution in FR and GB

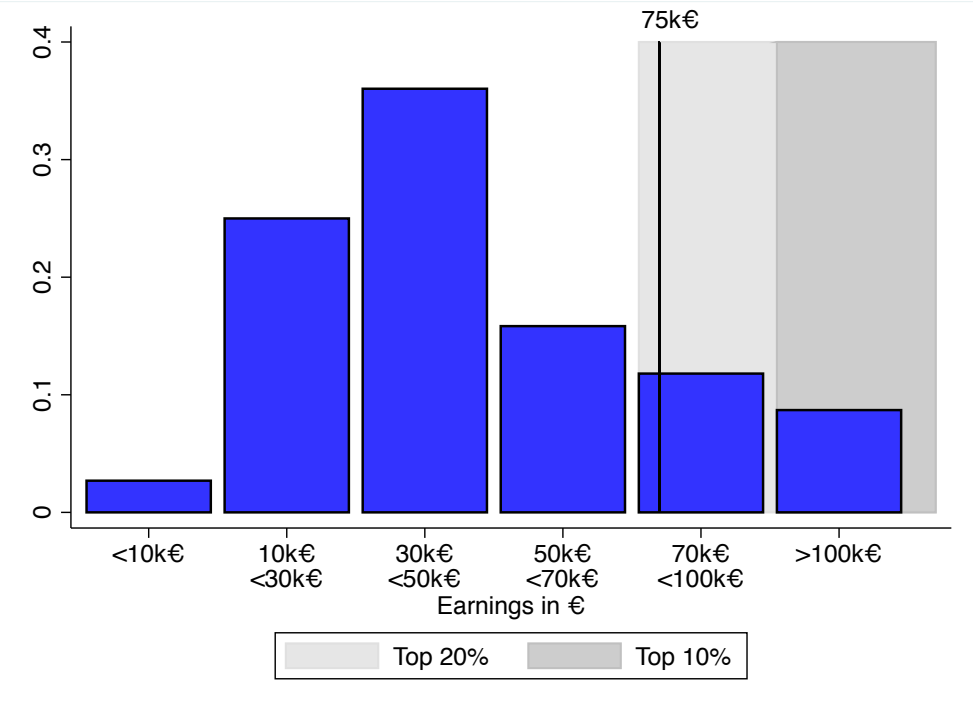


(c) France

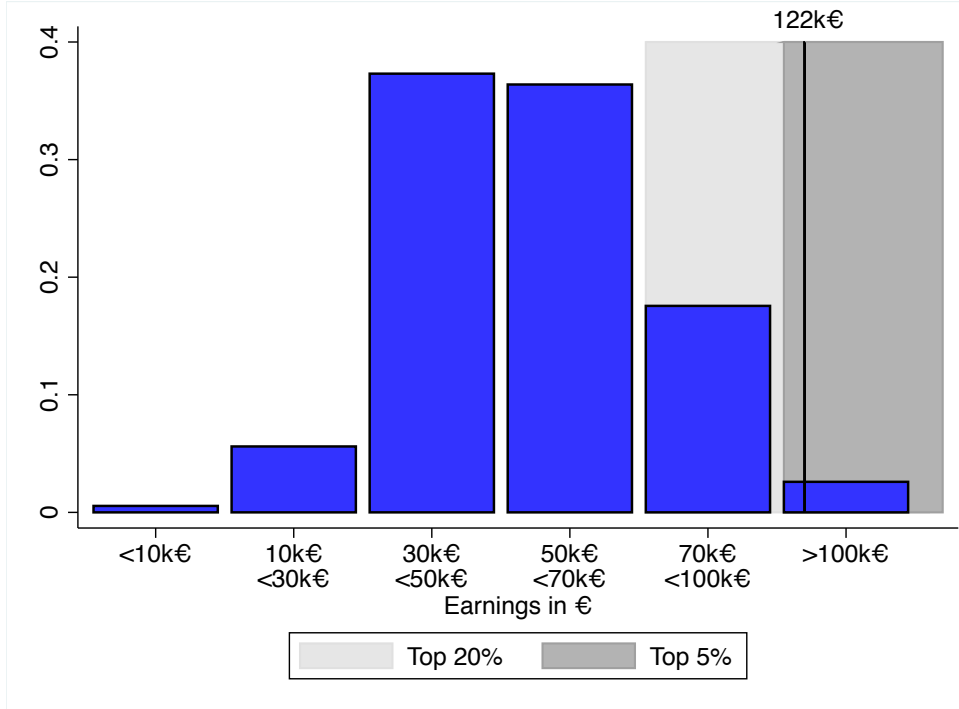


(d) Great Britain

Inventors' earnings distribution in IT and JP



(e) Italy



(f) Japan

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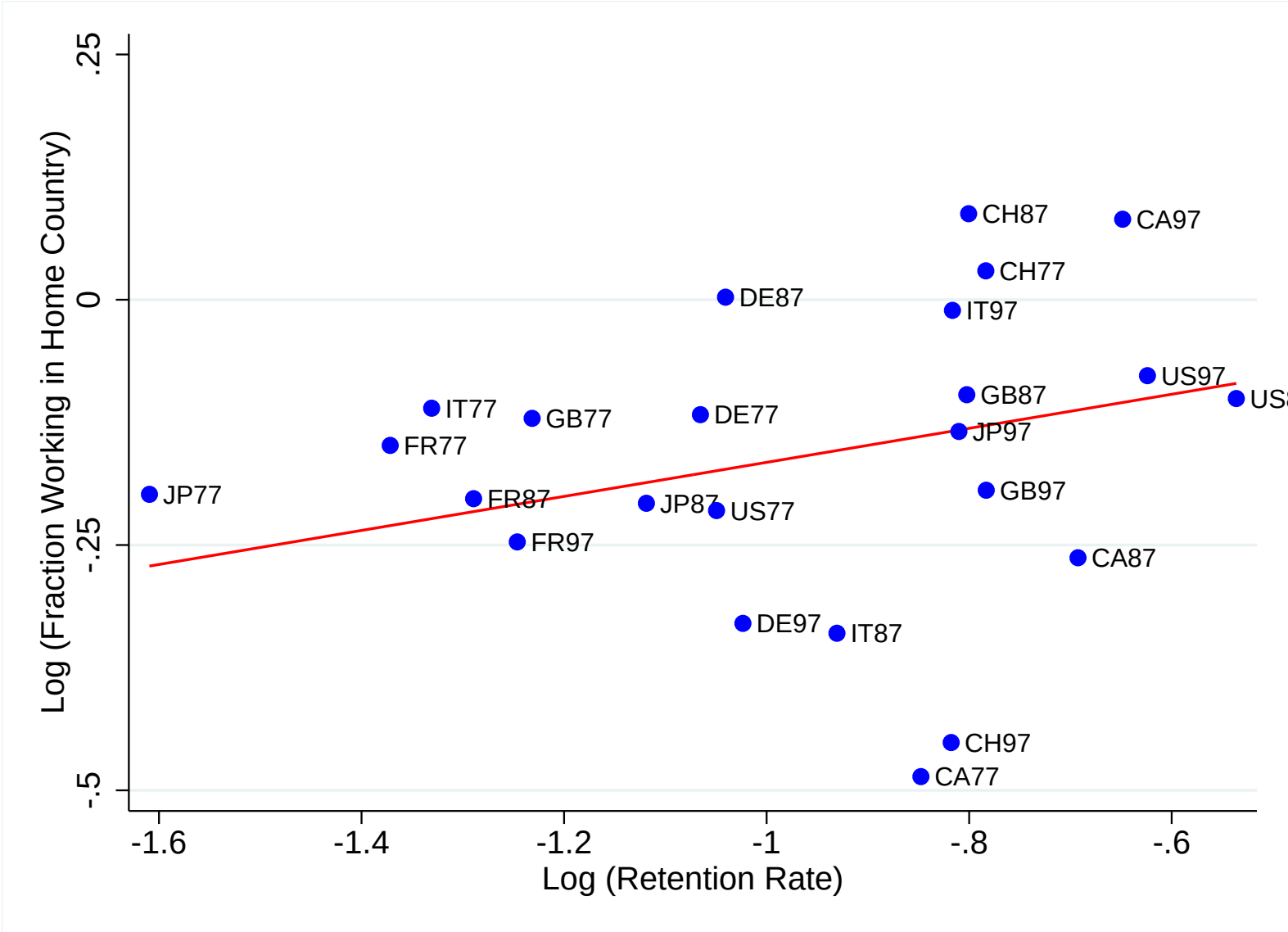
Superstar Top 1% Inventors

Top $(1-\tau)$ and % of inventors working in home country



Non-Superstar Inventors

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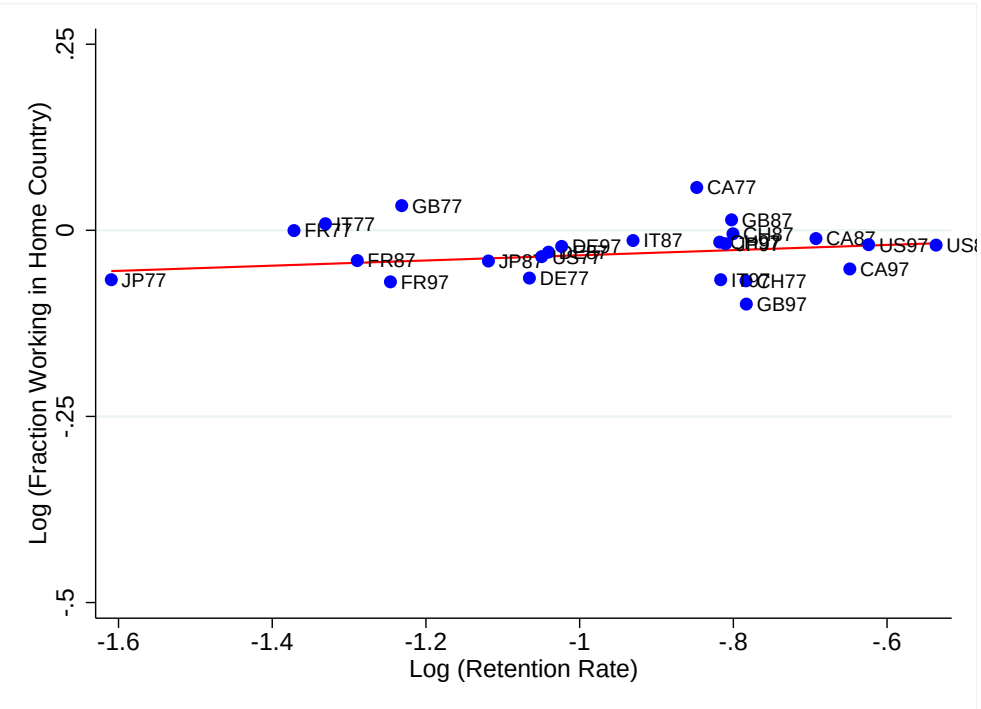
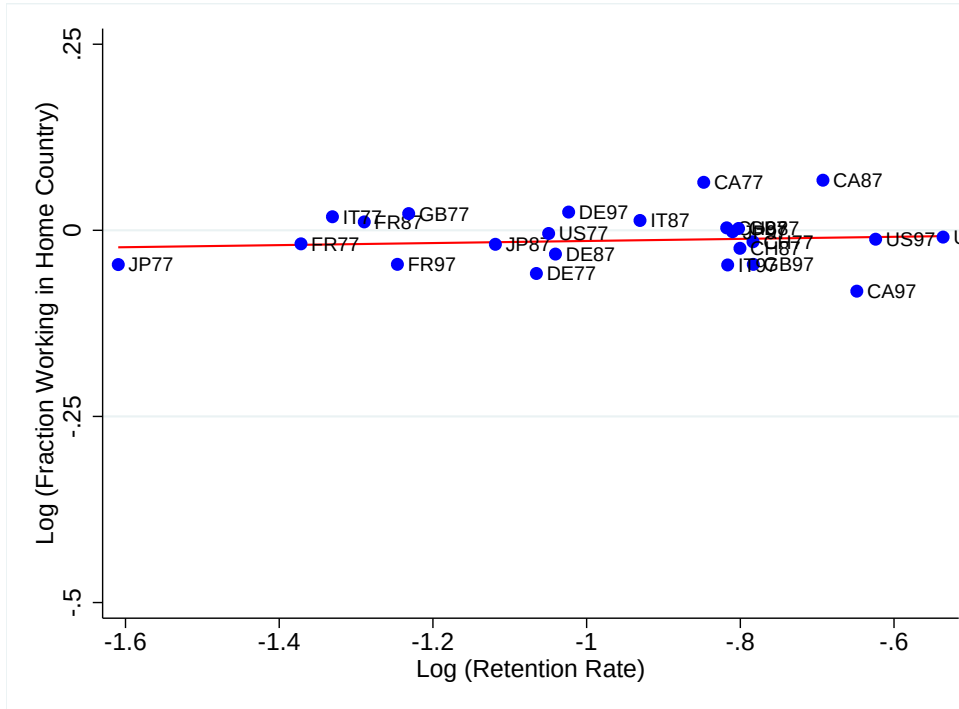


(a) Top 25-50% inventors



(b) Bottom 50% inventors

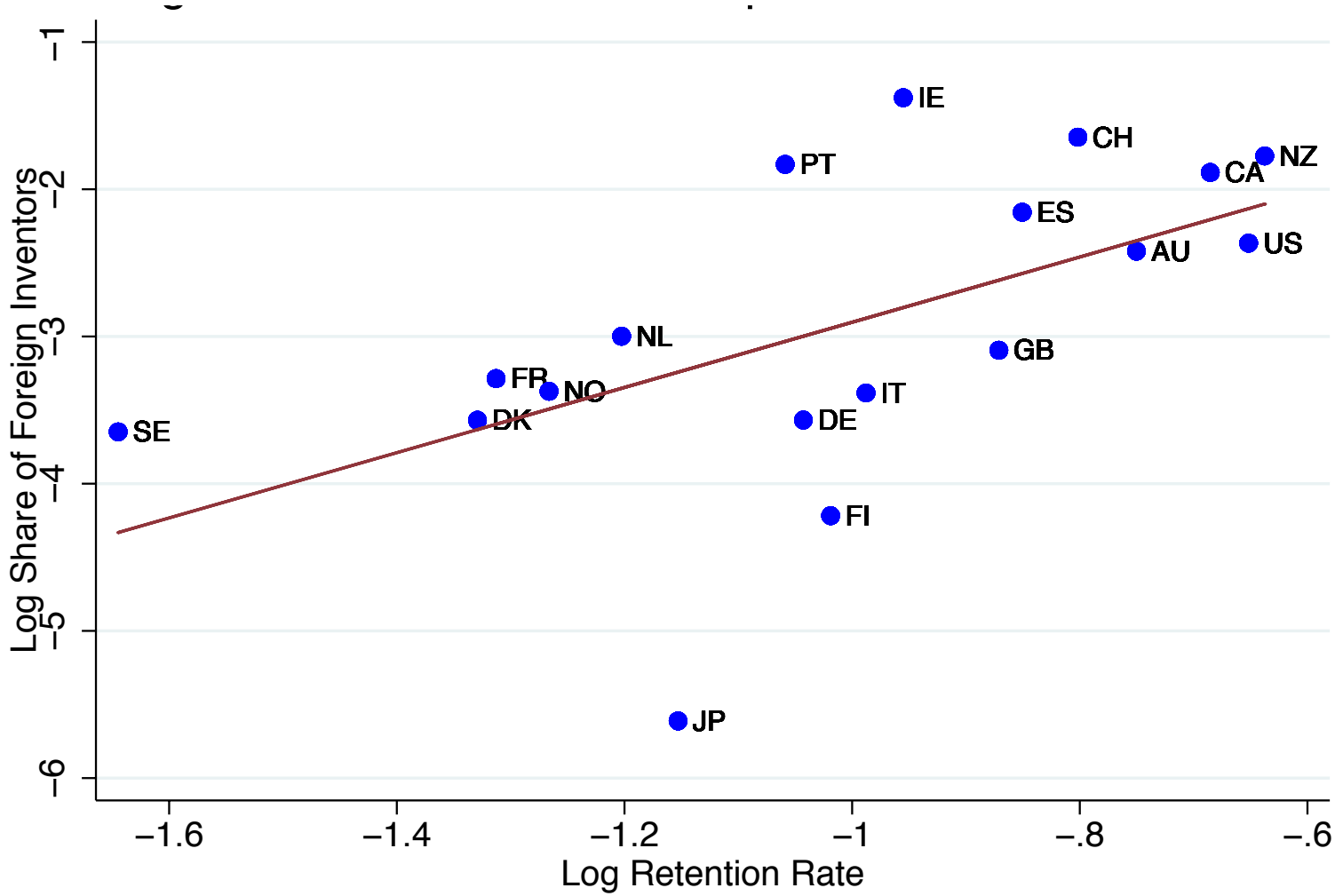
Reduced Form Regressions

Top $(1-\tau)$ and % of inventors working in home country

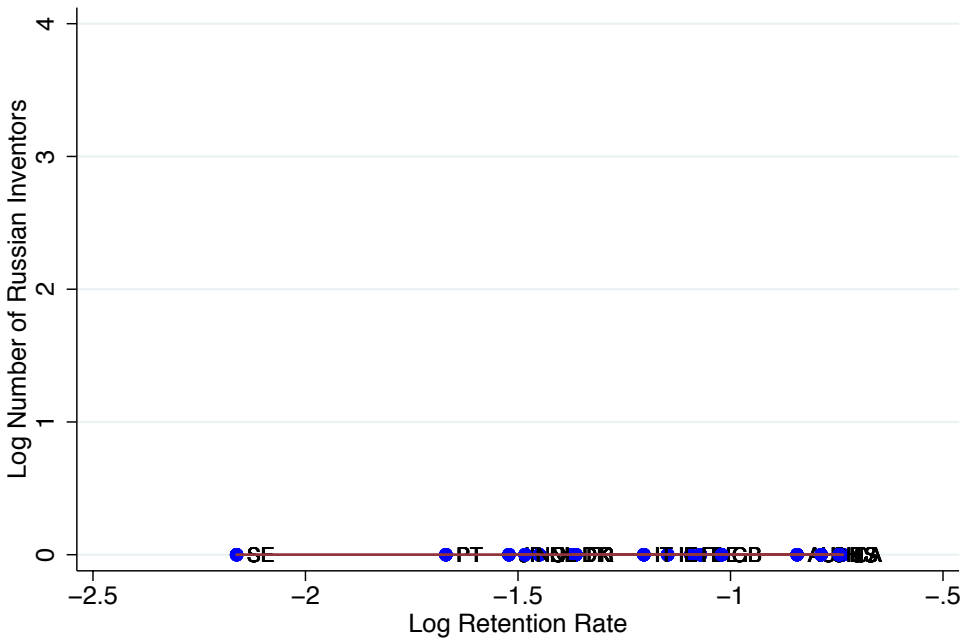
$$log(\text{Fraction Staying Home}_{ct}) = \alpha + \beta log(1-\tau)_{ct} + log(patents)_{ct} + log(GDP\ pc)_{ct} + Year\ FE + Country\ FE$$

	(1) Top 1%	(2) Top 1-5%	(3) Top 5-10%	(4) Top 10-25%	(5) Top 25-50%	(6) Bottom 50%
Elasticity to $1-\tau$	0.165**	0.147**	0.0876***	0.0565***	0.0332	0.0143
	(0.0627)	(0.0577)	(0.0186)	(0.00978)	(0.0255)	(0.0304)
Observations	216	216	216	216	216	216

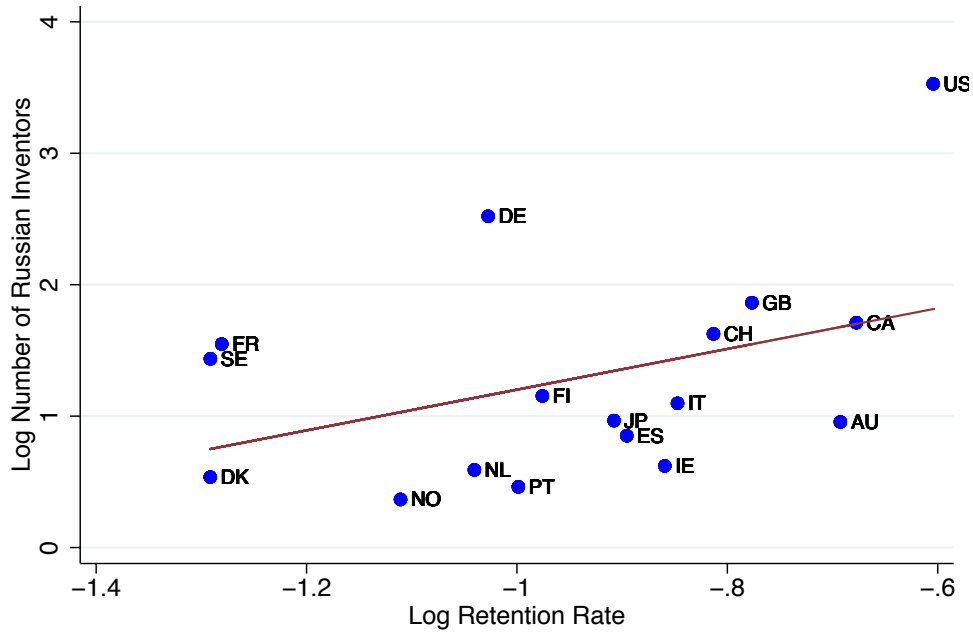
All Inventors in the PCT Data, 1980-2004



Russian Inventors Pre and Post 1990 and Top Tax Rates



(c) Pre 1990: No possible migration



(d) Post 1990: Migration positively (significantly) correlated with top retention rates.

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Micro-level Analysis: Empirical Location Choice Model

- Inventor i in country c at time t obtains utility

$$U_{ct}^{i} = u\left(\left(1 - \tau_{ch^{i}t}\right) w_{ct}^{i}\right) + \mu_{ct}^{i}$$

- If assume log-utility and model μ_{ct}^{i} explicitly:

$$U_{ct}^{i} = \alpha \log\left(1 - \tau_{ch^{i}t}\right) + \alpha \log\left(w_{ct}^{i}\right) + h_{c}^{i} + \mathbf{x}_{t}^{i}\beta_{c} + \zeta \mathbf{x}_{ct} + \eta \mathbf{x}_{ct}^{i} + \\ + \gamma_{c} + \gamma_{t} + \gamma_{ct} + v_{ct}^{i}$$

- x_{t}^{i}: individual covariates with country-specific effect: age, quality, tech field, works for multinational, ranking (all interacted with country FE).
- x_{ct}: country covariates: patent stock, GDP per capita, country-year FE.
- x_{ct}^{i}: individual-country pair covariates: home dummy, patent stock in inventor's tech field, distance, common language.
- v_{ct}^{i}: idiosyncratic shock (type I extreme value).

Controlling for the counterfactual wage

Four specifications, adding more and more detailed controls.

1. Only previously listed controls.
2. + Ability $\times$Country FE.
3. + Year $\times$ Ability $\times$ Country FE.
4. + Technological Class FE $\times$ Year $\times$ Ability $\times$ Country FE.

Benchmark Sample

- Benchmark sample: Top 25% inventors, unbalanced panel, 1977-2003.
- At each period, inventor faces a choice between 8 countries (US, CA, DE, GB, FR, JP, IT, CH).
- $P^i_{ct} \equiv Prob(U^i_{ct} > U^i_{c't}, \forall c')$ the probability of inventor i to locate in country c at time t.
- If v^i_{ct} type I extreme value distribution, can be estimated as multinomial logit.

Benchmark Results

	(1)	(2)	(3)	(4)
Log Retention Rate × Top 1	1.543***	1.641***	1.642***	1.606***
	(3.71)	(3.93)	(3.87)	(3.81)
Log Retention Rate × Top 1-5	1.043**	1.148**	1.142**	1.097**
	(2.73)	(2.99)	(2.93)	(2.84)
Log Retention Rate × Top 5-10	0.737	0.847*	0.839*	0.790*
	(1.94)	(2.23)	(2.17)	(2.06)
Log Retention Rate × Top 10-25	0.432	0.551	0.545	0.497
	(1.16)	(1.48)	(1.44)	(1.33)
Log Retention Rate × Below Top 25	0.187	0.336	0.323	0.290
	(0.50)	(0.89)	(0.84)	(0.76)
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	.037	.039	.038	.038
s.e	(.0098)	(.0098)	(.0101)	(.0098)
Foreign elasticity	1.293	1.381	1.377	1.345
s.e	(.348)	(.351)	(.356)	(.353)
Observations	9274992	9246912	9246912	9246912

Implied Migration Elasticities across Countries

Country	Domestic elasticity	Foreign elasticity	% change in domestic inventors	% change in foreign inventors
United States	0.004	1.25	0.1%	23.7%
Great Britain	0.48	1.60	10.6%	35.1%
Canada	0.41	1.59	7.9%	30.6%
Denmark	0.07	1.57	1.9%	43.8%
France	0.17	1.59	6.1%	56.4%
Italy	0.18	1.59	4.0%	35.5%
Japan	0.02	1.59	0.3%	32.6%
Switzerland	0.24	1.59	5.5%	36.1%

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

Implied Economic Gains across Countries (in million USD)

Country	Small Patent Value		Large Patent Value	
	5% points tax change	10% points tax change	5% points tax change	10% points tax change
United States	84	168	2,796	5,593
Great Britain	24	48	795	1591
Canada	26	51	852	1,704
Germany	26	52	871	1,742
France	16	33	546	1,091
Italy	4	9	145	289
Japan	12	25	416	832
Switzerland	8	16	267	535

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

- Small Patent Value: 3 mln USD; Large Patent Value: 100 mln USD.
- Spillovers?

The Role of Companies

	(1)	(2)
Log Retention Rate × Top 1	1.417***	1.767***
	(0.316)	(0.488)
Log Retention Rate × Top 1-5	0.827**	1.312**
	(0.276)	(0.427)
Log Retention Rate × Top 5-10	0.463	1.077*
	(0.272)	(0.424)
Log Retention Rate × Top 10-25	0.0946	0.833*
	(0.264)	(0.412)
Log Retention Rate × Below Top 25	-0.308	0.705
	(0.273)	(0.419)
Log Retention Rate × Not multinational	-0.239*	
	(0.124)	
Log Retention Rate × Activity abroad		-0.545***
		(0.133)
Quality× Country FE	YES	YES
Quality × Country FE × Year	YES	YES
Quality×Country FE×Year×Field FE	YES	YES
Domestic elasticity	.035	.529
s.e	(.0077)	(.1464)
Foreign elasticity	1.206	1.743
s.e	(.267)	(.481)
Observations	7669176	8015760

General Equilibrium and Sorting Effects

Replace country × year FE controls with country FE × linear time trend:

	(1)	(2)	(3)	(4)
Log Retention Rate × Top 1	0.963***	0.964***	1.032***	1.021***
	(4.83)	(4.78)	(5.03)	(4.95)
Log Retention Rate × Top 1-5	0.460***	0.468***	0.531***	0.512***
	(3.59)	(3.62)	(4.10)	(3.94)
Log Retention Rate × Top 5-10	0.153	0.167	0.230*	0.207
	(1.38)	(1.50)	(2.12)	(1.90)
Log Retention Rate × Top 10-25	-0.153	-0.131	-0.0633	-0.0851
	(-1.69)	(-1.45)	(-0.74)	(-0.99)
Log Retention Rate × Below Top 25	-0.401***	-0.350**	-0.281*	-0.290*
	(-3.63)	(-3.03)	(-2.44)	(-2.50)
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	.024	.024	.025	.025
s.e	(.0046)	(.0045)	(.0048)	(.0049)
Foreign elasticity	.808	.808	.865	.856
s.e	(.166)	(.169)	(.172)	(.174)
Observations	9274992	9246912	9246912	9246912

Outline

1. Setting
2. Data and Definitions
3. Reduced-form Macro Facts
4. Location Choice Model Estimation
5. Robustness and Extensions
6. Spillovers and Interactions

Robustness checks and Extensions

- Alternative quality measures: static and other dynamic measures.
- Unbalanced nature of the data: selection based on patenting?
  - Use raw number of patents as quality measure – does not work well.
  - Imputing data for missing years.
  - Heckman selection model on U.S.-Canada.
  - Omit Japan.
- Long term vs. Short term mobility.
- Alternative dataset from the European Patent Office.

Alternative Quality Measures and Imputing Data

	Alternative quality Measures				Imputing location
	Static	Patent counts	Mean cits per patent	Max cits per patent	
Log Retention Rate × Top 1-5	1.283**	0.737*	1.679***	1.442***	1.166***
	(3.29)	(2.33)	(3.82)	(3.75)	(3.69)
Log Retention Rate × Top 5-10	0.786*	0.593	1.127**	0.896*	0.923**
	(1.99)	(1.93)	(2.61)	(2.35)	(2.98)
Log Retention Rate × Top 10-25	0.518	0.586	0.512	0.509	0.733*
	(1.35)	(1.95)	(1.20)	(1.37)	(2.44)
Log Retention Rate × Below Top 25	0.355	1.165***	-0.193	0.385	0.820**
	(0.75)	(3.79)	(-0.45)	(1.02)	(2.71)
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
Domestic elasticity	.035	.009	.021	.04	.041
s.e	(.0097)	(.006)	(.005)	(.0095)	(.0091)
Foreign elasticity	1.276	.561	2.002	1.563	1.353
s.e	(.342)	(.361)	(.459)	(.363)	(.302)
Observations	9246912	11563176	9032456	8644176	18395768

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.
  - On average the patent grant period is less than 3 years, so effective increase in patent protection length.
  - First stage: increases probability of patenting.

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

	(1) Probit	(2) Selection	(3) Probit	(4) Selection	(5) Probit	(6) Selection	(7) Probit	(8) Selection
US log retention rate × Top 1	1.184***	1.182***	1.225***	1.224***	1.274***	1.276***	1.265***	1.265***
	(4.23)	(4.22)	(4.36)	(4.35)	(4.52)	(4.52)	(4.49)	(4.49)
US log retention rate × Top 1 - 5	0.215	0.215	0.242	0.241	0.307	0.310	0.275	0.276
	(1.08)	(1.08)	(1.21)	(1.21)	(1.54)	(1.56)	(1.39)	(1.39)
US log retention rate × Top 5 - 10	0.119	0.121	0.142	0.139	0.212	0.212	0.184	0.183
	(0.77)	(0.78)	(0.92)	(0.90)	(1.36)	(1.37)	(1.18)	(1.18)
US log retention rate × Top 10 - 25	0.115	0.118	0.128	0.125	0.211*	0.212*	0.172	0.172
	(0.94)	(0.96)	(1.04)	(1.02)	(1.71)	(1.72)	(1.40)	(1.39)
US log retention rate × Below top 25	-0.0266	-0.0255	-0.0168	-0.0191	0.0822	0.0857	0.0496	0.0504
	(-0.22)	(-0.21)	(-0.14)	(-0.16)	(0.63)	(0.66)	(0.38)	(0.38)
US log retention rate × Top 1		0.388***		0.112		0.799***		0.528***
		(5.87)		(1.60)		(10.11)		(6.66)
US log retention rate × Top 1 - 5		0.214***		-0.0198		0.678***		0.378***
		(4.15)		(-0.36)		(10.21)		(5.77)
US log retention rate × Top 5 - 10		0.0858*		-0.121**		0.574***		0.250***
		(1.71)		(-2.24)		(8.92)		(3.98)
US log retention rate × Top 10 - 25		0.0371		-0.114**		0.574***		0.225***
		(0.77)		(-2.20)		(9.31)		(3.75)
US log retention rate × Below top 25		0.111**		-0.00660		0.763***		0.408***
		(2.31)		(-0.13)		(12.63)		(6.94)
Quality× Country FE	NO	NO	YES	YES	YES	YES	YES	YES
Quality × Country FE × Year	NO	NO	NO	NO	YES	YES	YES	YES
Quality×Country FE×Year×Field FE	NO	NO	NO	NO	NO	NO	YES	YES
Observations	612966	1247867	612966	1247867	610853	1245754	610853	1245754

Long-term Mobility: Moving Abroad without Moving Back

	(1)	(2)	(3)
Log Retention Rate × Top 1	2.065**	1.600***	1.945**
	(0.649)	(0.471)	(0.747)
Log Retention Rate × Top 1-5	1.625**	1.134**	1.562*
	(0.597)	(0.410)	(0.622)
Log Retention Rate × Top 5-10	1.133	0.568	1.115
	(0.585)	(0.400)	(0.608)
Log Retention Rate × Top 10-25	0.901	0.267	0.938
	(0.577)	(0.391)	(0.597)
Log Retention Rate × Below Top 25	0.723	-0.117	0.808
	(0.584)	(0.402)	(0.608)
Log Retention Rate × Not multinational		-0.219	
		(0.171)	
Log Retention Rate × Activity abroad			-0.265
			(0.199)
Quality× Country FE	YES	YES	YES
Quality × Country FE × Year	YES	YES	YES
Quality×Country FE×Year×Field FE	YES	YES	YES
Domestic elasticity	.026	.02	.415
s.e	(.008)	(.0058)	(.1591)
Foreign elasticity	1.713	1.345	1.931
s.e	(.537)	(.394)	(.743)
Observations	8972248	7428552	7773552

Location Choice Estimates with EPO Data

	(1)	(2)	(3)	(4)
Log Retention Rate × Top 1	3.214***	2.828***	4.177***	3.248***
	(9.20)	(10.07)	(10.11)	(8.58)
Log Retention Rate × Top 1-5	3.033***	2.788***	3.668***	2.823***
	(10.43)	(13.87)	(15.33)	(13.53)
Log Retention Rate × Top 5-10	2.841***	2.622***	3.391***	2.555***
	(10.49)	(15.17)	(17.43)	(14.57)
Log Retention Rate × Top 10-25	2.338***	2.130***	2.840***	1.989***
	(8.91)	(13.27)	(16.54)	(11.79)
Log Retention Rate × Below Top 25	1.981***	1.773***	2.442***	1.573***
	(6.54)	(8.08)	(10.95)	(6.84)
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	.058	.051	.078	.058
s.e	(.0065)	(.0051)	(.0078)	(.0069)
Foreign elasticity	3.142	2.746	4.047	3.123
s.e	(.34)	(.273)	(.4)	(.364)
Observations	7538603	7532627	7532627	7532627

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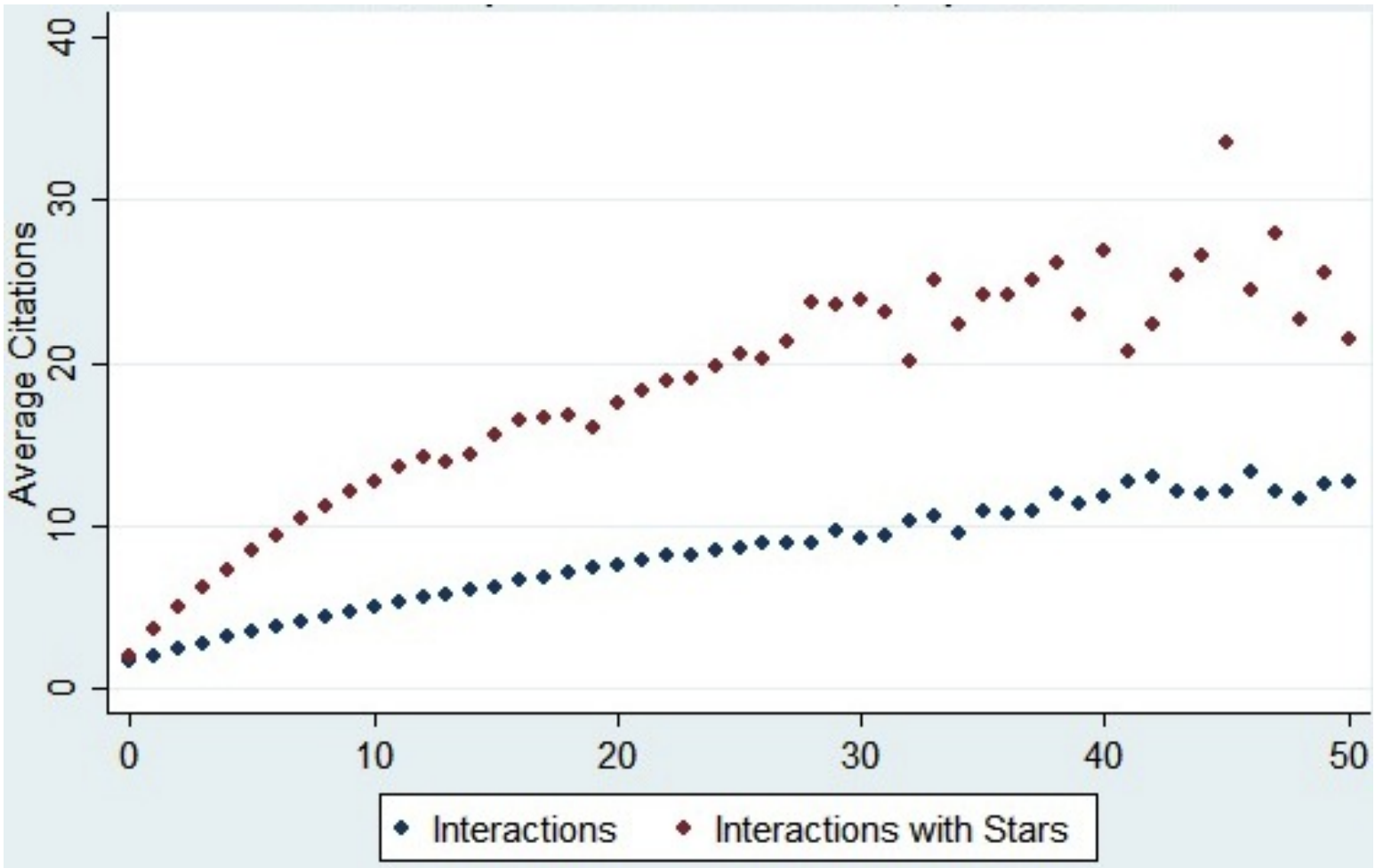
Productivity Spillovers from Interactions

- Part of project "**Dancing with the Stars: Interactions and Human Capital Accumulation**", joint with Ufuk Akcigit, Ernest Miguelez, and Valerio Sterzi.
- How do interactions with other inventors foster human capital acquisition and productivity?
- How about interactions with superstars?
- One example of spillovers and benefits from retaining inventors nationally.

Interactions and Productivity: A Positive Correlation

Total citations received within 3 years



Controls for age effects

OLS Results: Interactions and Productivity Gains

	All Interactions	Interactions with Superstars
Interactions	0.0595***	
	(0.00207)	
Interactions with superstars		0.407***
		(0.00471)
Year FE	YES	YES
Country FE	YES	YES
Sector FE	YES	YES
Individual FE	YES	YES
Observations	876,112	876,112

Endogeneity and Empirical Strategy

- Better latent quality inventors $\rightarrow$ more interactions and more realized quality?
- Use **Employment Protection Legislation (EPL)** index at the country-year level: cost of dismissal, from OECD.
- Interact with "Propensity to adjust labor force" at sector year level from the U.S.
  - "Rajan-Zingales" type instrument, where U.S. is the benchmark of a flexible labor market.
  - Low propensity to adjust sectors serve as "control" group for high propensity to adjust sectors.
  - More labor market flexibility fosters interactions.

IV Results: Interactions and Productivity Gains

	All Interactions		Interactions with Superstars	
	1^{st} stage	2^{nd} stage	1^{st} stage	2^{nd} stage
Interactions		0.0291*		
		(0.015)		
Interactions with superstars				0.233***
				(0.072)
EPL × US Mobility	0.643***		0.109***	
	(0.007)		(0.002)	
Year FE	YES	YES	YES	YES
Country FE	YES	YES	YES	YES
Sector FE	YES	YES	YES	YES
Individual FE	YES	YES	YES	YES
Observations	876,112	876,112	876,112	876,112

Conclusion

- Superstar inventors react to top tax rates – elasticities are small, but significant.
- Those who worked for multinationals most sensitive.
- Career concerns of course strongly matter.
- Open Questions:
  - What are the economic costs from taxation when including the migration margin and potentially spillovers from inventors?
  - What about capital taxes and corporate taxes? (Work in progress).

Appendix

EPO Data Summary Statistics

Variable	Average
Patents of Superstar (Top 1%) Inventors	47.7
Patents of Superstar (Top 5%) Inventors	23.9
Patents of Non-superstar (Below Top 5%) Inventors	2.3
Average patents per year while in sample	1.5
Max citations per patent of Superstar (Top 1%) Inventors	308
Max citations per patent of Superstar (Top 5%) Inventors	308
Max citations per patent of Non-superstar (Below Top 5%) Inventors	97
Number of Patents (per country per year)	5513.9
Number of Inventors (per country per year)	8648.7
Number of immigrants (per country per year)	32.1
# of immigrants per year to the U.S.	157.9
# of immigrants per year to CA	14.9
# of immigrants per year to CH	39.5
# of immigrants per year to DE	62.1
# of immigrants per year to FR	35.0
# of immigrants per year to GB	41.5
# of immigrants per year to IT	13.2
# of immigrants per year to JP	19.4
% Superstar (Top 1%) Inventors who move over life in sample	4.7%
% Superstar (Top 5%) Inventors who move over life in sample	3.3%
% Non-superstar (Top 25%) Inventors who move over life in sample	1.5%
% Non-superstar (Below 5%) Inventors who move over life in sample	0.3%
% of inventors who are employees (all inventors)	80.4%
% of inventors (Top 25%) who are employees	86.2%
% of inventors who work for multinationals	84.9 %
% of inventors (Top 25%) who work for multinationals	91.1 %
Average years between first and last patent in sample (all inventors)	2.8
Average years between first and last patent in sample (Top 25% Inventors),	6.9
Average duration of stay in years conditional on move	4.6

Back