

# The Birth of American Ingenuity: Innovation and Inventors of the Golden Age

**Ufuk Akcigit**  
UChicago

**John Grigsby**  
UChicago

**Tom Nicholas**  
Harvard

NBER SI: Economic Growth

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# Motivation

- The premise of the 25-year old endogenous growth literature is that innovation is the engine of long-run growth (e.g., Romer 1990, Aghion and Howitt 1992).
- However little empirical work over long horizons.
- Little is known about the creators of new ideas and their backgrounds.
- Particularly important to discipline alternative growth theories on
  - agglomeration, market size, reallocation, misallocation, inequality etc.and to understand the “inclusivity” of economic growth.

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- Digitize the USPTO patents (OCR + hand entry) and merge.
- Present key facts about innovation at regional and individual levels.

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**We avoid causal interpretations**

Instead the focus is on presenting many important correlations that can shed light on various existing theories.

# DATA

# Data Sources & Summary

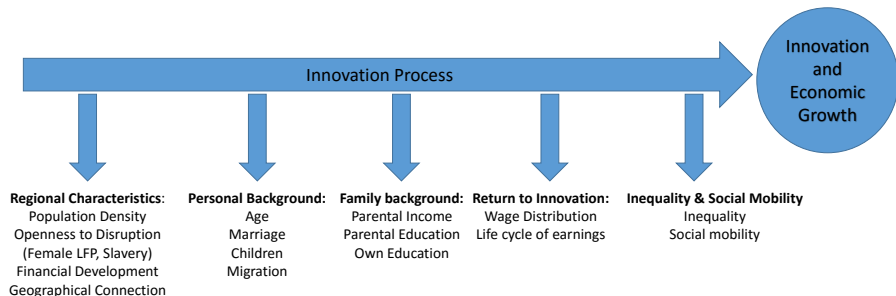
## DATA:

- 1 Complete-count data from 1880, 1900-1940 decennial U.S. Censuses
  - Name, residence, age, race, sex, marital status, occupation, birthplace
  - 1940: labor income, education, labor force status
- 2 USPTO patent documents, 1836-2004
  - Inventor names, patent class, patent filing location, grant year, assignee, citation counts (1947-2008)

## SUMMARY:

- Limit ourselves to working age population (18-65) in continental U.S.
- Over 320 million individual observations
- 63,515 inventors
- 380,338 patents.

# Roadmap





# Overview of the stylized facts

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- 5 States, which are more **geographically connected**, are more inventive.

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## FAMILY BACKGROUND:

- 8 **Father's income** is correlated with becoming an inventor
- 9 Parental income effect disappears once **child's education** is controlled for.
- 10 **Higher education** is positively correlated with inventor quality.

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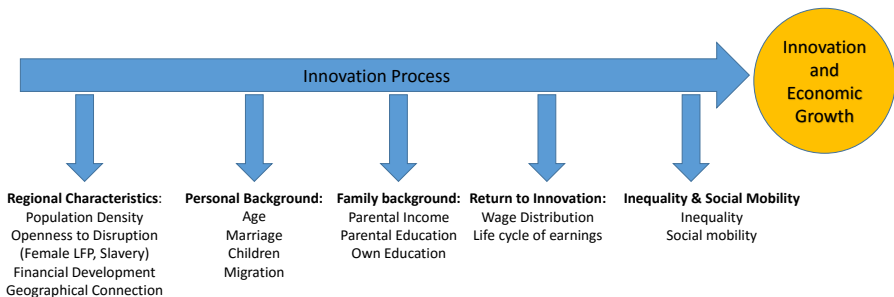
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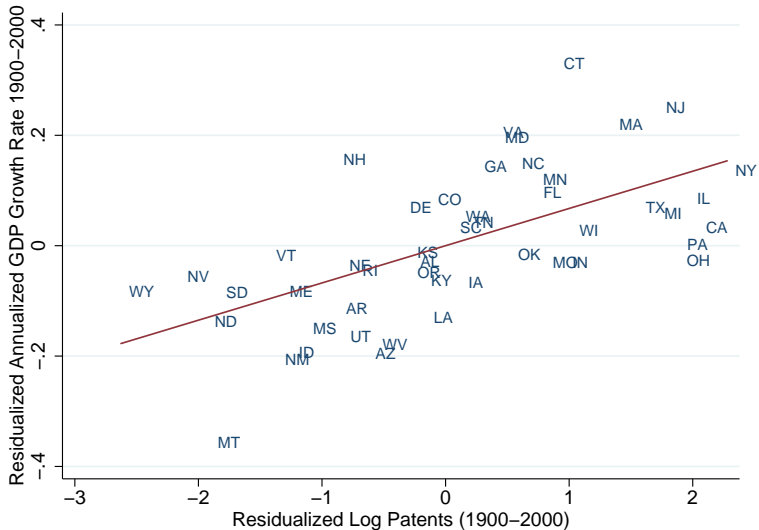
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- 15 Innovation was strongly positively correlated with **social mobility**.



# Inventive states rise up over long run: 1900-2000



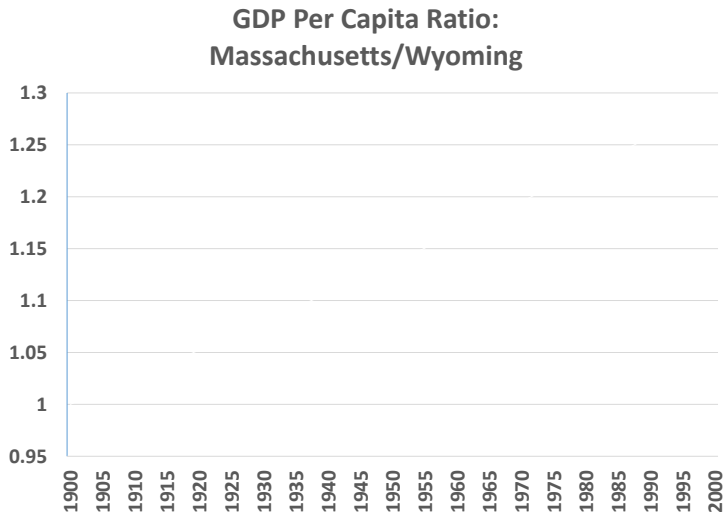


## 100-year Growth and Innovation: 1900-2000

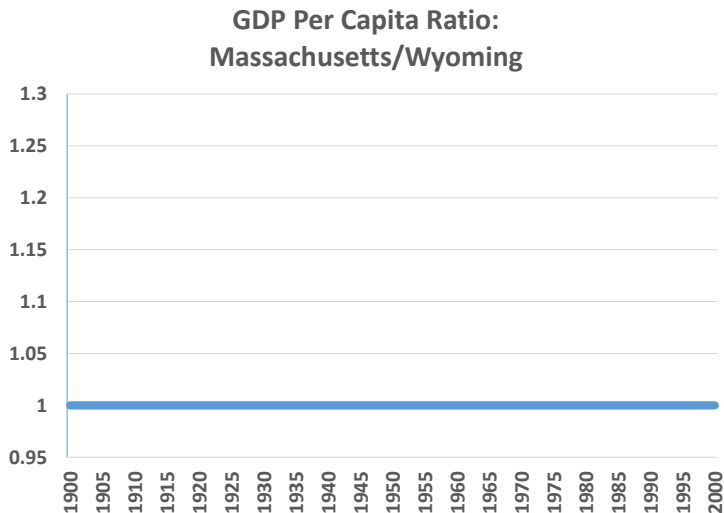
	Innovation measure: Log Patents			
	Annualized Growth Rate		DHS Growth Rate	
	(1)	(2)	(3)	(4)
Log Patents	0.067*** (0.013)	0.056*** (0.013)	0.002*** (0.001)	0.002*** (0.001)
Initial GDP per Capita	-0.902*** (0.037)	-0.917*** (0.037)	-0.023*** (0.002)	-0.023*** (0.002)
Population Density		1.179* (0.605)		0.040* (0.023)
Observations	48	48	48	48
Mean Growth	5.150	5.150	1.972	1.972
Std. Dev. of Growth	0.429	0.429	0.012	0.012

Notes: Cross-sectional regression. Data from BEA. Years 1900-2000.

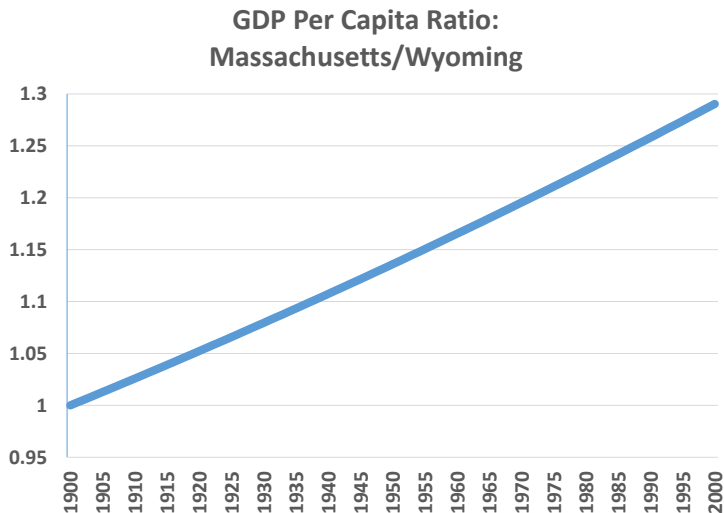
# Interpretation of the 100-year Growth Regressions



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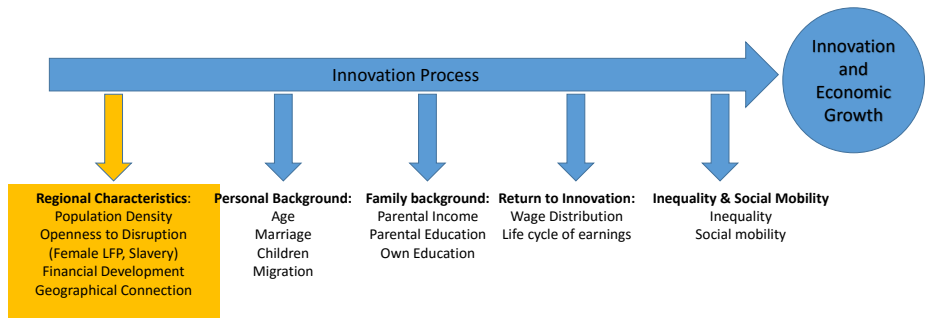
# State-level Cross-Section: Patent Counts, 1947-1987

IV using Roosevelt's wartime technology contracts between 1941-1947:  
1,717 contracts, 6 times 1940 R&D budget.

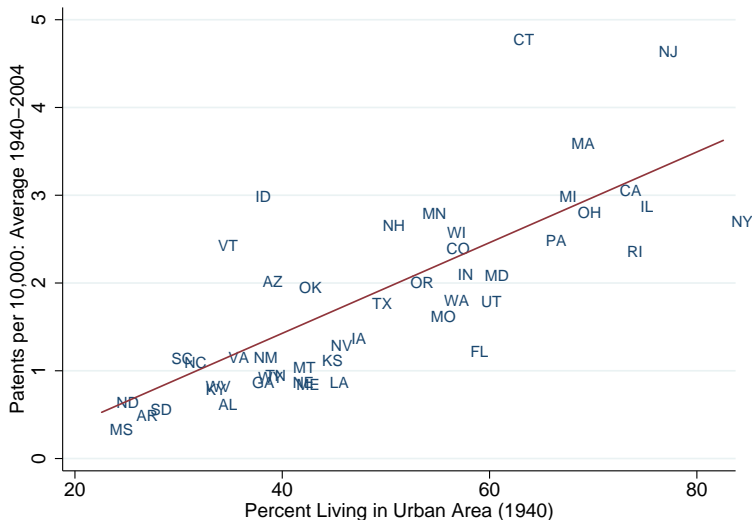
## Innovation measure: Log Patents

	Annualized Growth Rate			DHS Growth Rate		
	OLS (1)	OLS (2)	IV (3)	OLS (4)	OLS (5)	IV (6)
Log Patents	0.17*** (0.04)	0.15*** (0.04)	0.14*** (0.05)	0.06*** (0.01)	0.05*** (0.01)	0.05*** (0.02)
Initial Log GDP per Capita	-1.76*** (0.23)	-1.86*** (0.23)	-1.84*** (0.23)	-0.57*** (0.07)	-0.60*** (0.07)	-0.59*** (0.07)
Population Density		1.29** (0.54)	1.33** (0.56)		0.42** (0.17)	0.43** (0.18)
Observations	48	48	48	48	48	48
Mean Growth	2.22	2.22	2.22	0.82	0.82	0.82
Std. Dev. of Growth	0.44	0.44	0.44	0.14	0.14	0.14

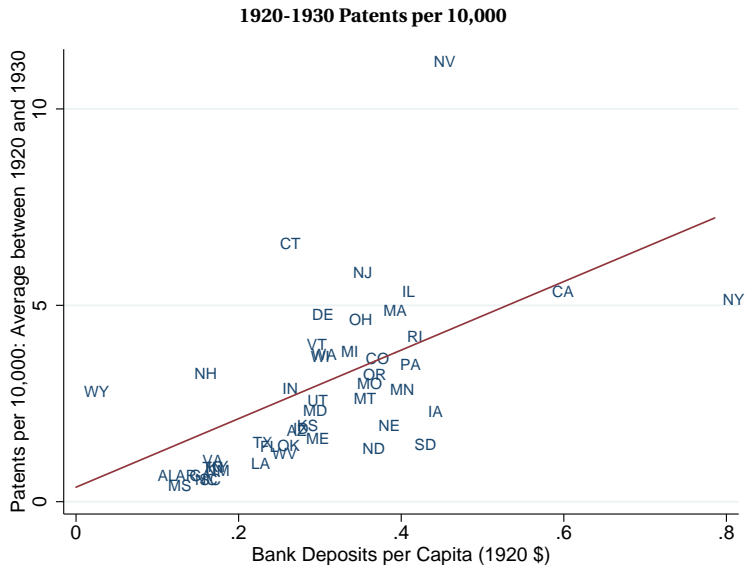
# Roadmap



# More urban states in 1940 continue to be innovative today

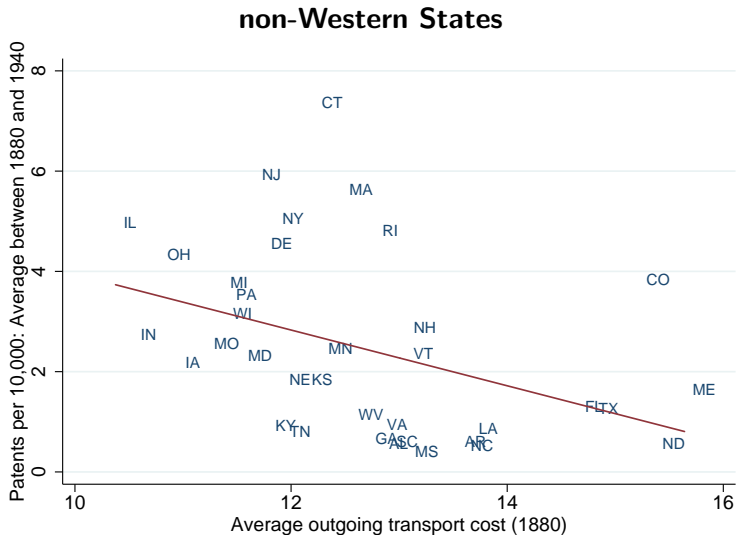


## Banking



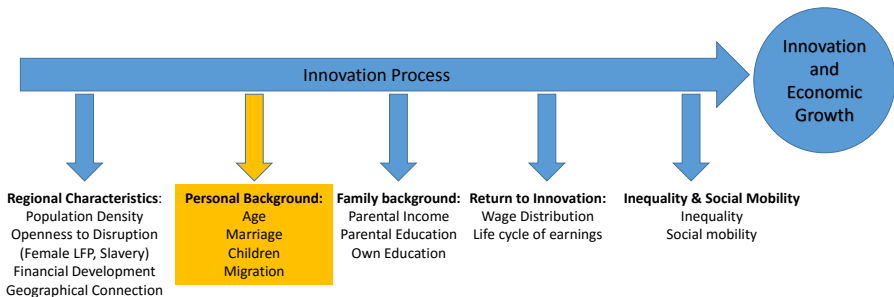


# Transportation

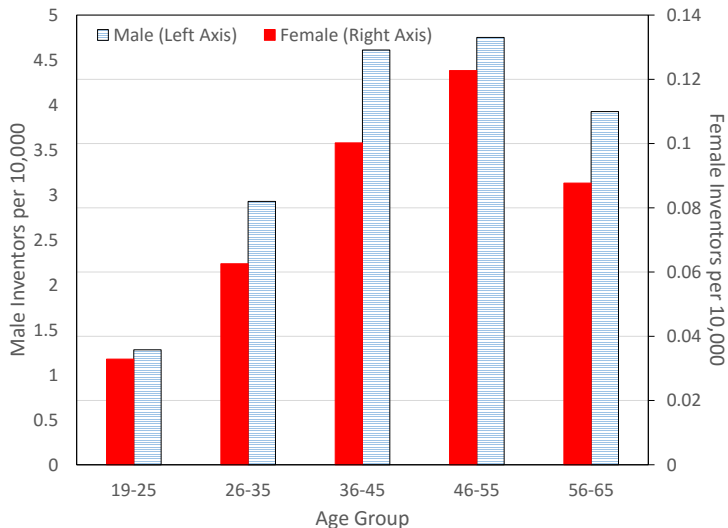


Patents per capita =  $9.503 - 0.556 * \text{Transport Cost}$   
 Slope coefficient statistically significant at 1% level

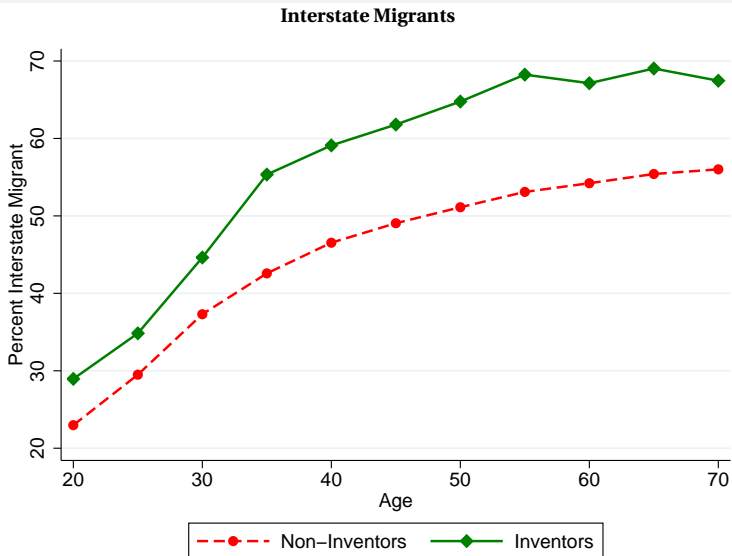
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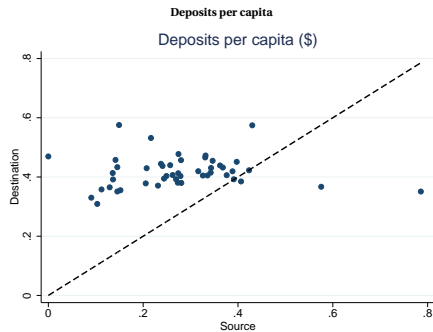
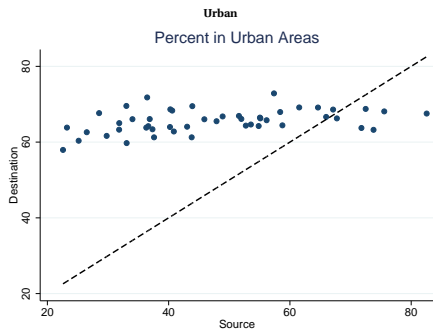
# Inventors more likely to be middle aged



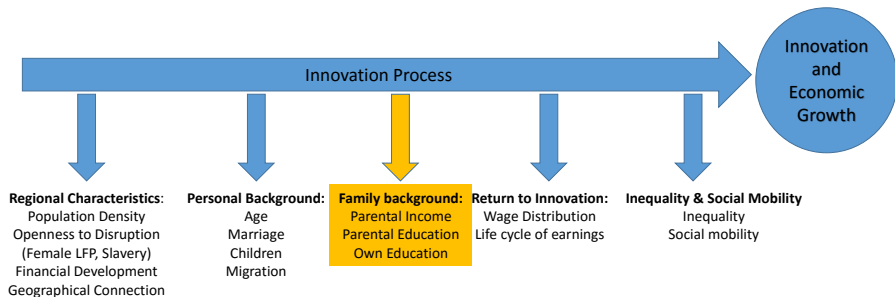
# Interstate Migration



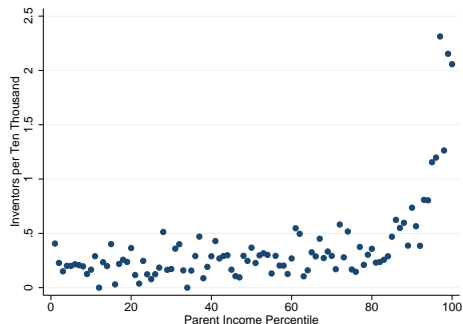
# Where Do the Inventors Move?



# Roadmap



# Who Becomes an Inventor? Father's Income vs Education



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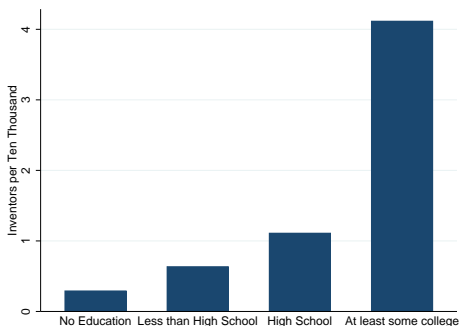
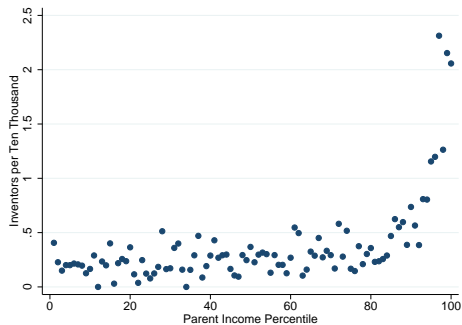




Table: WHO BECOMES AN INVENTOR?

	(1)	(2)	(3)	(4)	(5)
Father Inventor	0.161** (0.075)		0.159** (0.076)	0.157** (0.075)	0.155** (0.075)
Father Income 90p-95p		0.003** (0.001)	0.003** (0.001)	0.002* (0.001)	-0.000 (0.001)
Father Income 95p+		0.008*** (0.002)	0.008*** (0.002)	0.006*** (0.002)	0.001 (0.002)
Father: High School				0.004** (0.001)	-0.001 (0.001)
Father: At least College				0.007*** (0.001)	-0.002* (0.001)
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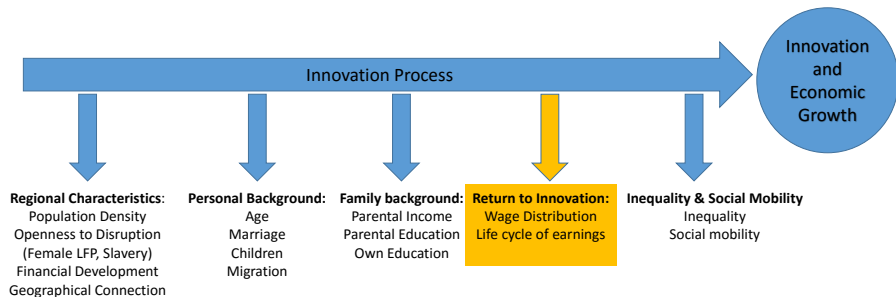
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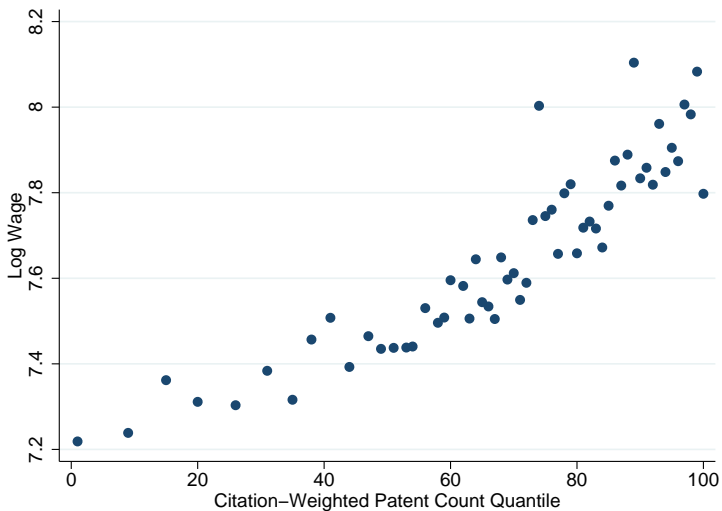
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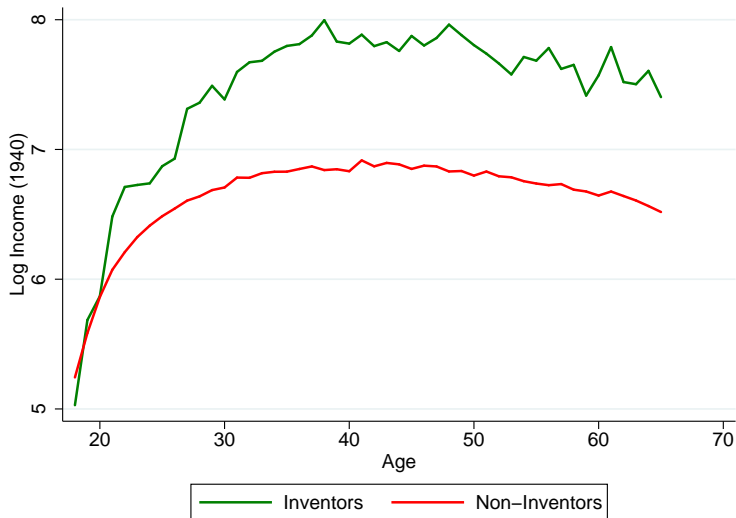
# Roadmap



# The Rewards to Innovation

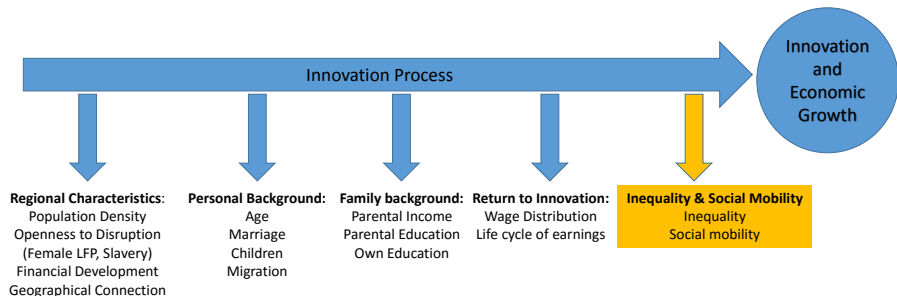


# Inventors have steeper life cycle earnings profile



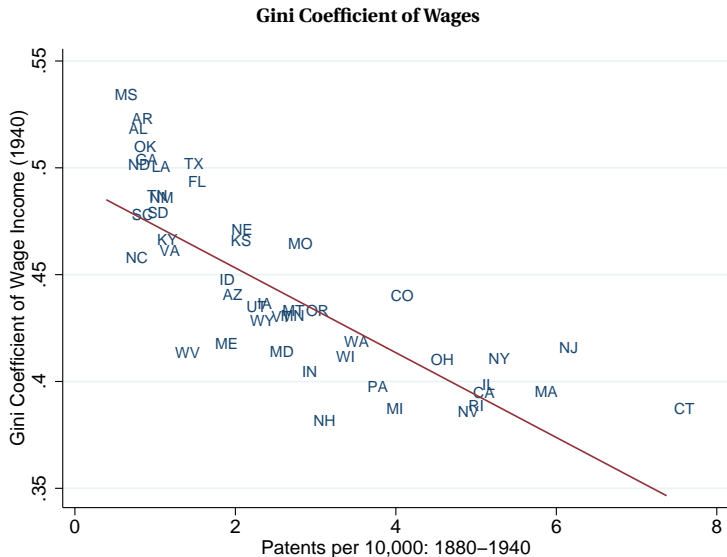


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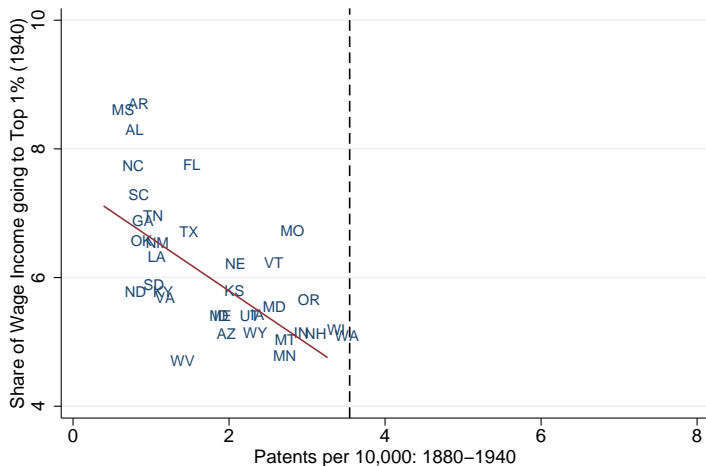




## Gini Coefficient

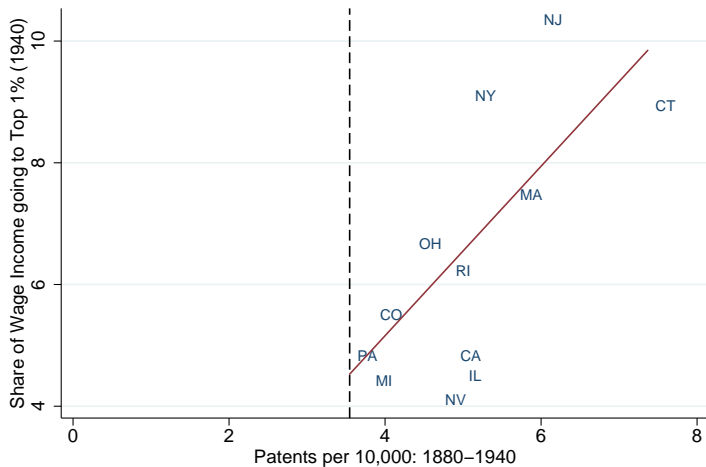


# Top-1 Share



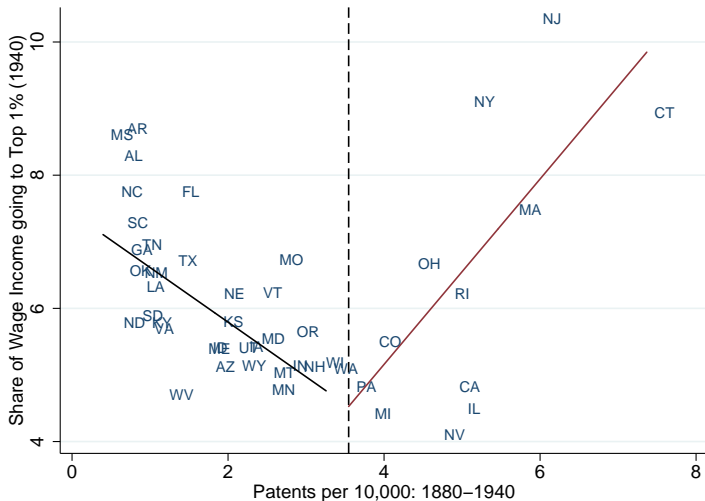
Share 1 Percent =  $7.435 - 0.821 * \text{Patents per cap}$   
 Slope coefficient statistically significant at 1% level

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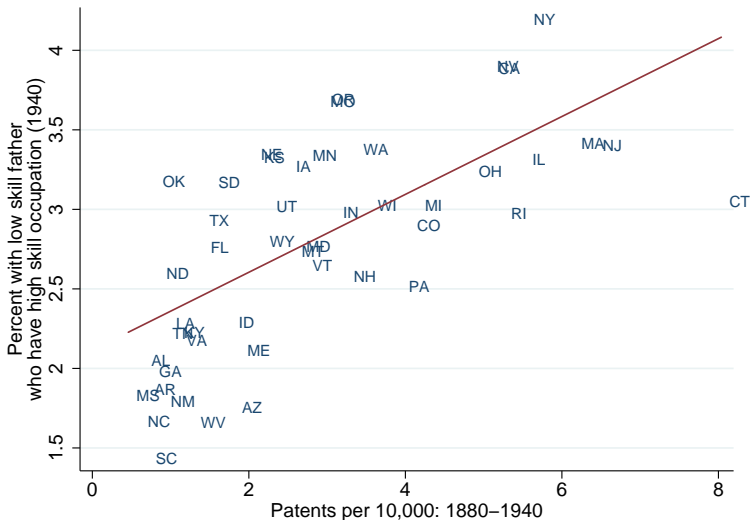


Share 1 Percent =  $-0.410 + 1.392 * \text{Patents per cap}$   
 Slope coefficient statistically significant at 1% level

# Top-1 Share



# Social mobility positively correlated with past innovation



# Conclusion

- Matched USPTO patent records to complete-count U.S. Census data
- Document:
  - ① The link between innovation and growth.
  - ② Characteristics of innovative regions in the US.
  - ③ Backgrounds of the golden-age inventors.
- However causal evidence only suggestive.
- Exciting research agenda ahead.