CENTRE for ECONOMIC PERFORMANCE

Centre for Economic Performance Lionel Robbins Memorial Lectures

Upward Mobility, Innovation and Economic Growth

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Improving Equality of Opportunity
New Lessons from Big Data

Lecture 3: Upward Mobility, Innovation, and Economic Growth

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Photo Credit: Florida Atlantic University

Is Increasing Social Mobility Desirable?

- Policy focus on improving equality of opportunity is typically motivated by concerns about justice and equity
- But desirability of greater equality of opportunity also depends on impacts on aggregate output (efficiency)
- Key question: does increasing opportunities for low-income children harm high-income children?
  - Has to be true mechanically in terms of relative ranks, but is an empirical question in terms of absolute dollars

Is Increasing Social Mobility Desirable?

- In general, we may face an equity-efficiency tradeoff
  - Ex: suppose ability and resources are complements and that higher-income children have higher ability on average
  - Then equalizing opportunity will reduce total output [Benabou 2000]

  → Optimal policy depends upon social welfare function

- Sufficient condition for desirability of greater equality of opportunity: increasing equality of opportunity increases efficiency/growth
  - Greater equity *and* greater total output

Equality of Opportunity and Growth

- Question: how does increasing equality of opportunity affect aggregate growth?

- Difficult to measure effects on growth directly

  - Instead, focus here on what many think is the key driver of economic growth: innovation [e.g., Aghion and Howitt 1992]

Lecture 3 Outline

1. Equality of Opportunity and Innovation

2. Policies to Increase Innovation

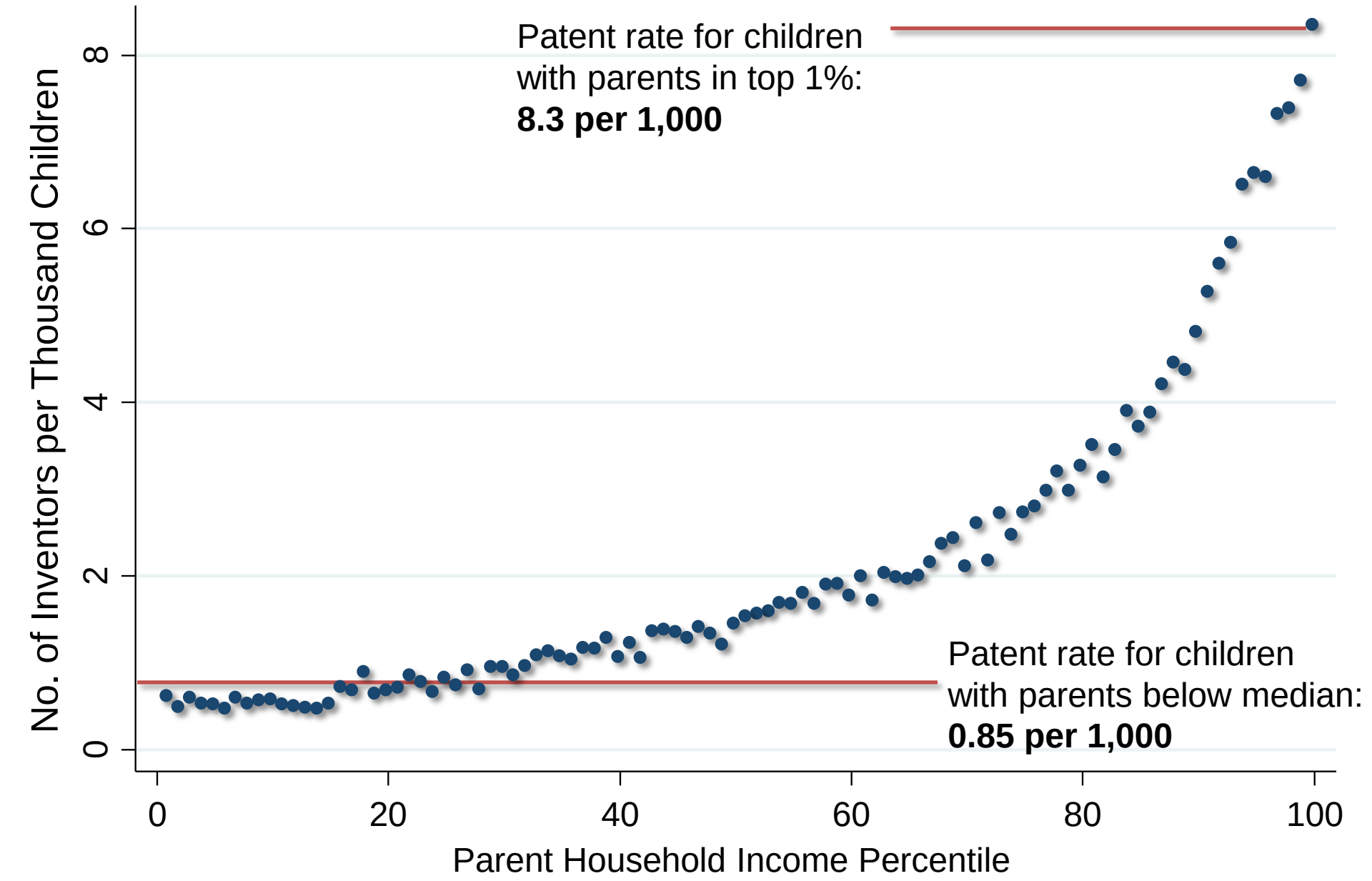
- Lecture 3 is based primarily on:
  - Bell, Chetty, Jaravel, Petkova, and van Reenen. “The Lifecycle of Inventors” wp 2016

Part 1
Equality of Opportunity and Innovation

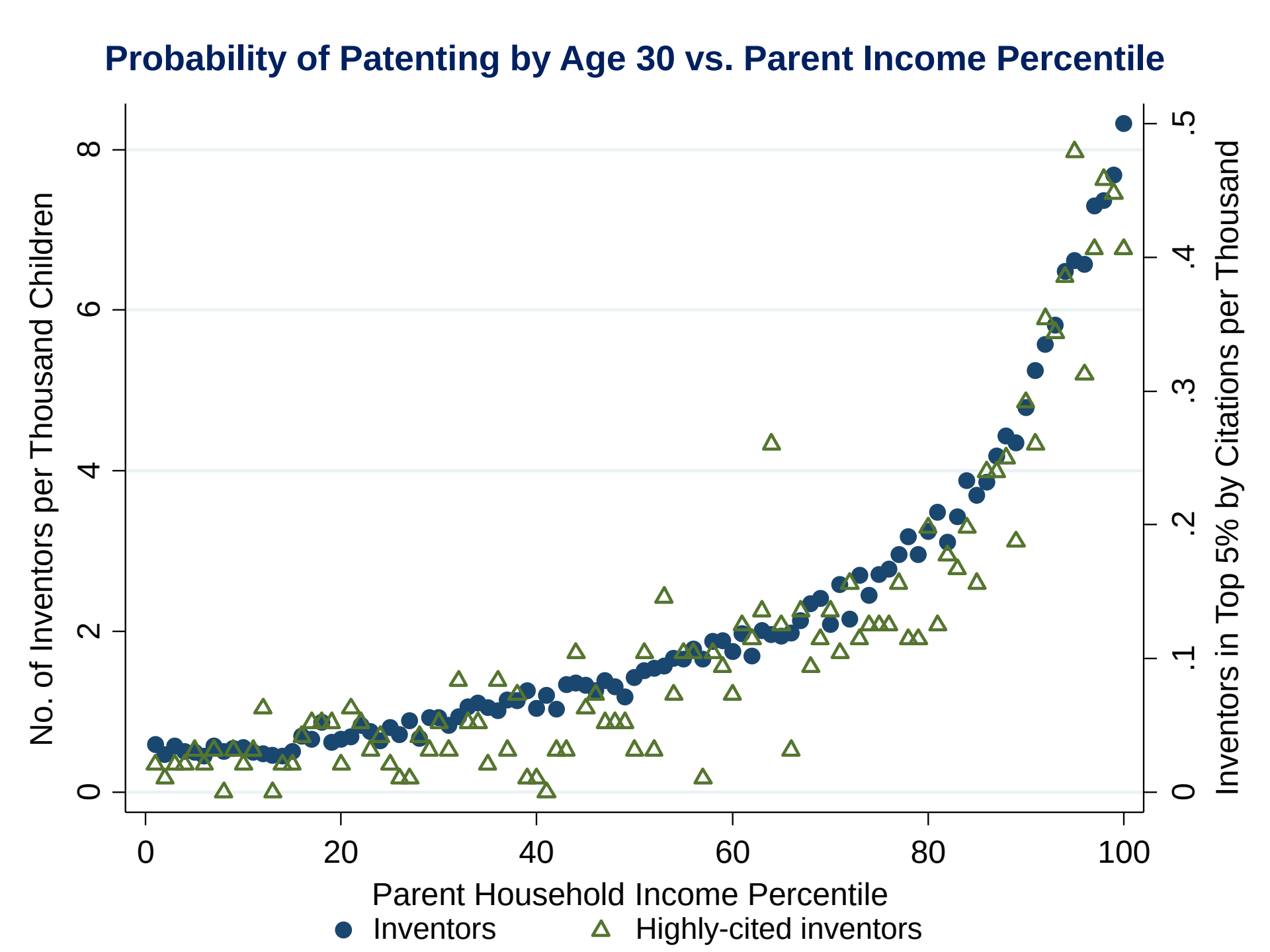
Measuring Innovation

- Measure innovation using patent data
  - Standard proxy for invention in literature, with well known pros and cons
- Link universe of patent records in the United States from 1996-2010 to tax records
  - Use linked data to study the lives of 750,000 patent holders in the U.S., from birth to adulthood

Patent Rates vs. Parent Income Percentile



Source: Bell, Chetty, Jaravel, Petkova, van Reenen 2015


Probability of Patenting by Age 30 vs. Parent Income Percentile
No. of Inventors per Thousand Children
0
2
4
6
8
Inventors in Top 5% by Citations per Thousand
0
.1
.2
.3
.4
.5
0
20
40
60
80
100
Parent Household Income Percentile
Inventors
Highly-cited inventors

Why Do Patent Rates Vary with Parent Income?

- Correlation between parent income and children growing up to be inventors could be driven by three mechanisms:

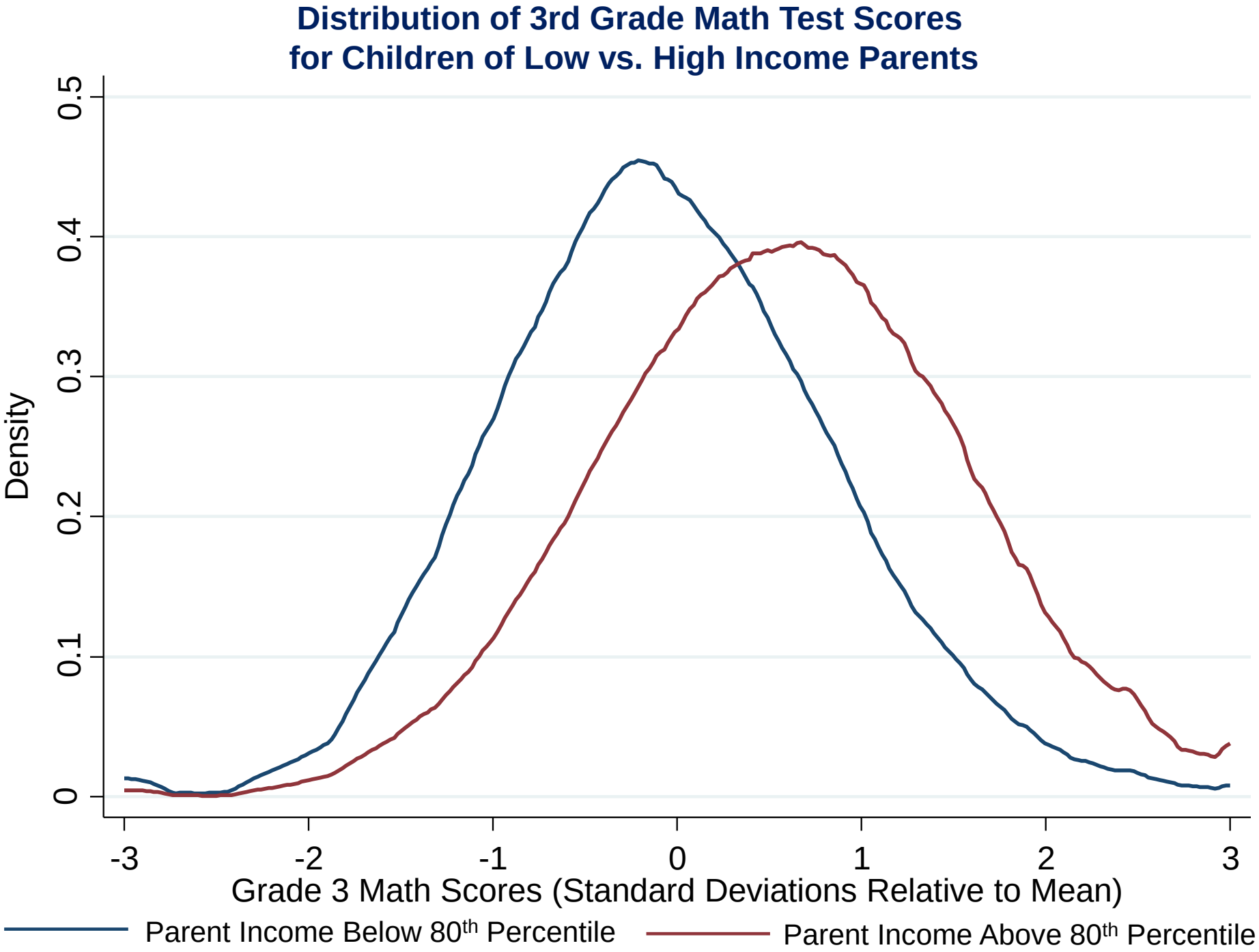
1. Endowments: Children from high-income families may have higher innate ability

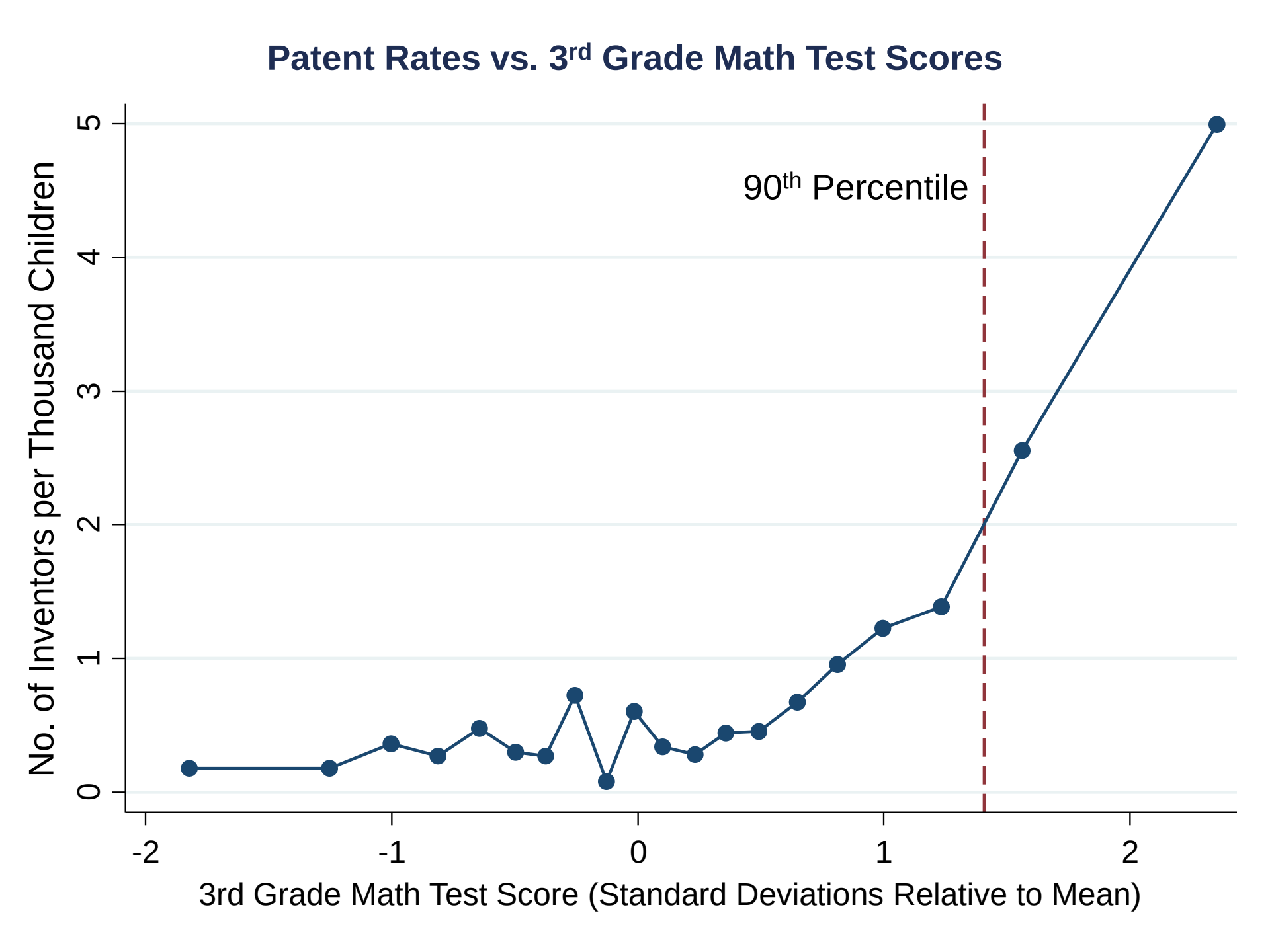
2. Preferences: lower income children may prefer other occupations

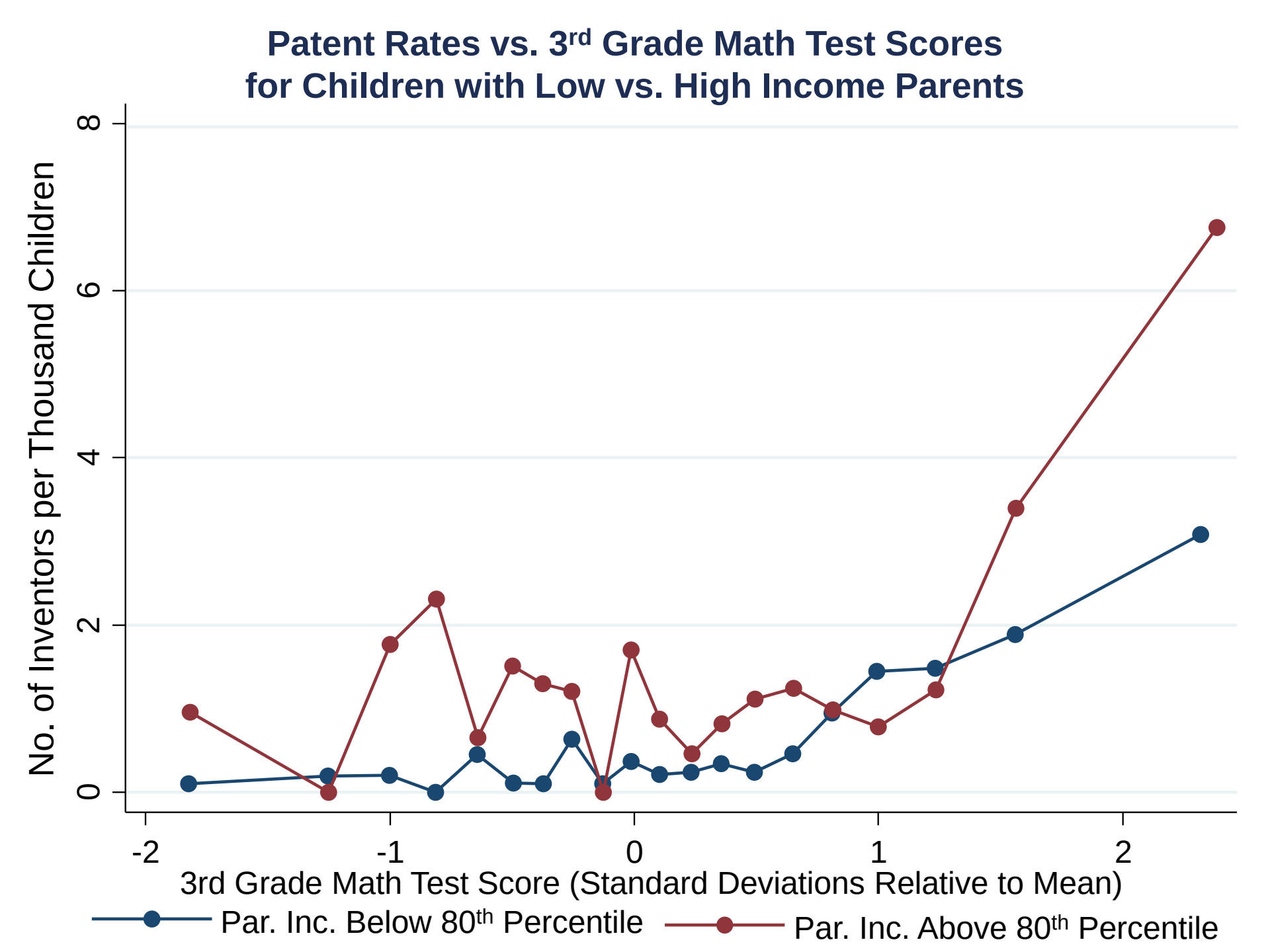
3. Constraints: lower income children may face greater barriers to entry (poorer environment, liquidity constraints)

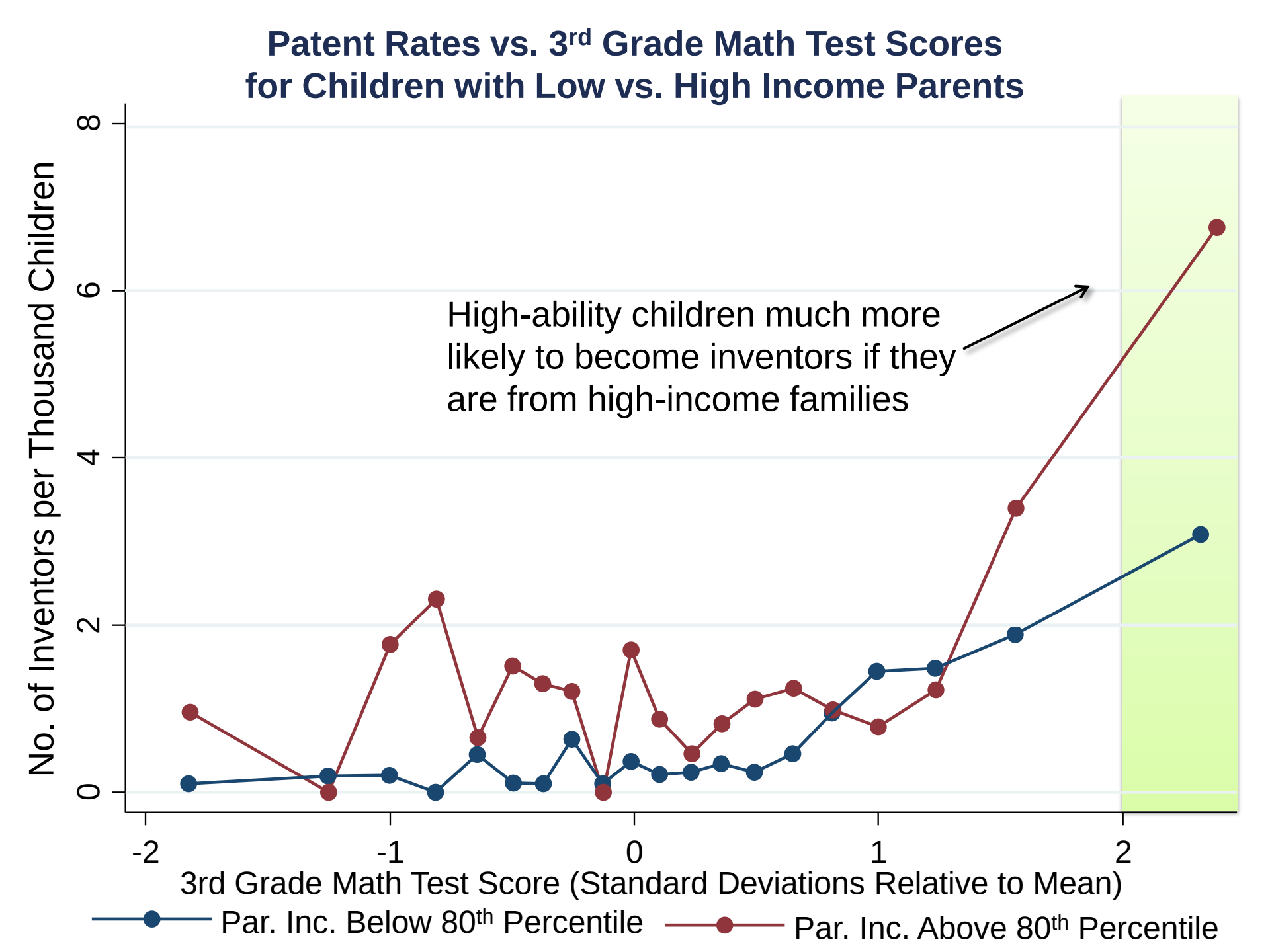
Do Differences in Ability Explain the Innovation Gap?

- Measure ability using test score data for children in NYC public schools [Chetty, Friedman, Rockoff 2014]
  - Math and English scores from grades 3-8 on standardized tests for 430,000 children born between 1979-84


Distribution of 3rd Grade Math Test Scores
for Children of Low vs. High Income Parents
Density
0
0.1
0.2
0.3
0.4
0.5
-3
-2
-1
0
1
2
3
Grade 3 Math Scores (Standard Deviations Relative to Mean)
Parent Income Below 80th Percentile
Parent Income Above 80th Percentile


Patent Rates vs. 3rd Grade Math Test Scores
90th Percentile
No. of Inventors per Thousand Children
0
1
2
3
4
5
-2
-1
0
1
2
3rd Grade Math Test Score (Standard Deviations Relative to Mean)

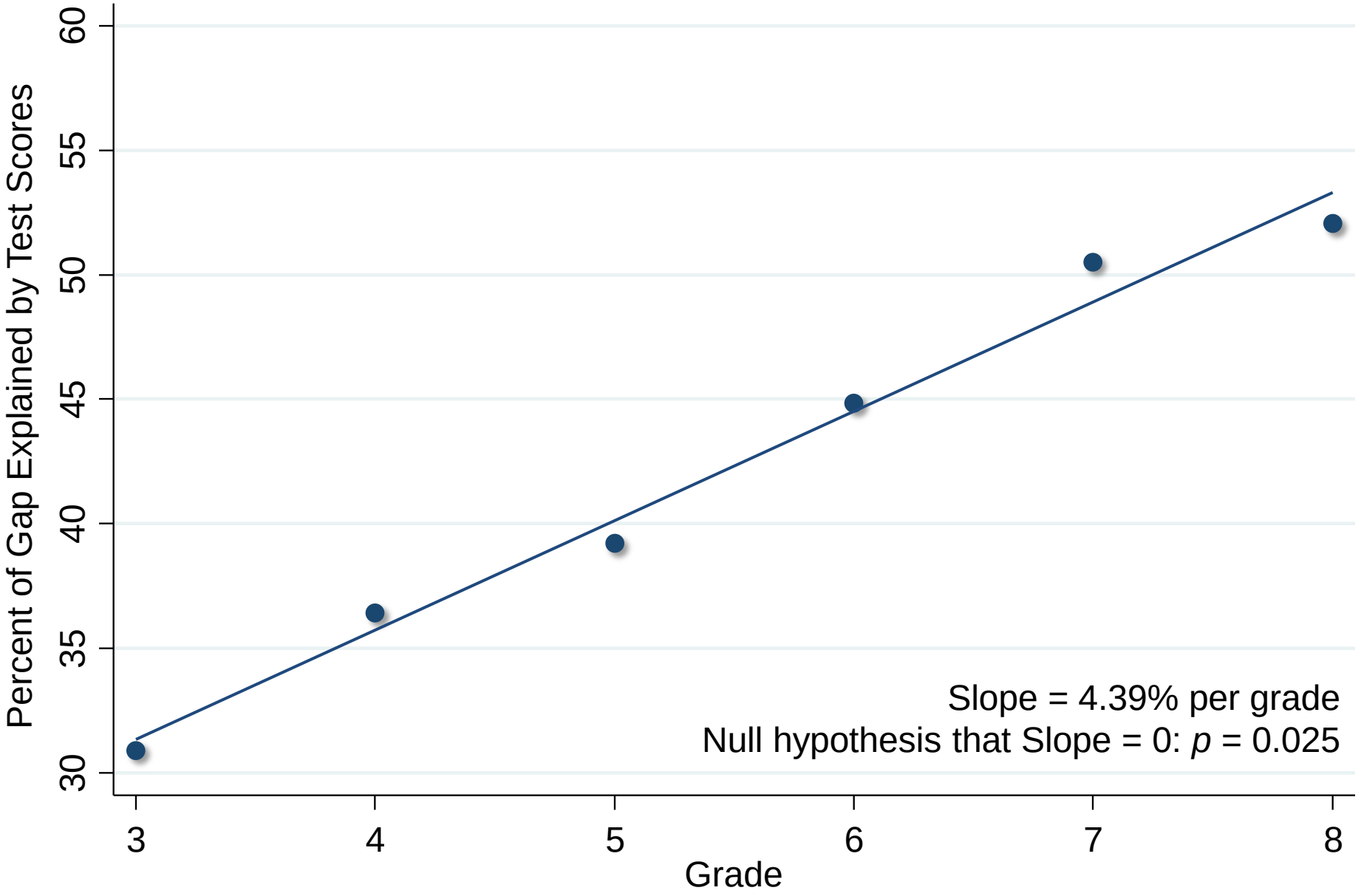

Patent Rates vs. 3rd Grade Math Test Scores
for Children with Low vs. High Income Parents
No. of Inventors per Thousand Children
0
2
4
6
8
-2
-1
0
1
2
3rd Grade Math Test Score (Standard Deviations Relative to Mean)
Par. Inc. Below 80th Percentile
Par. Inc. Above 80th Percentile

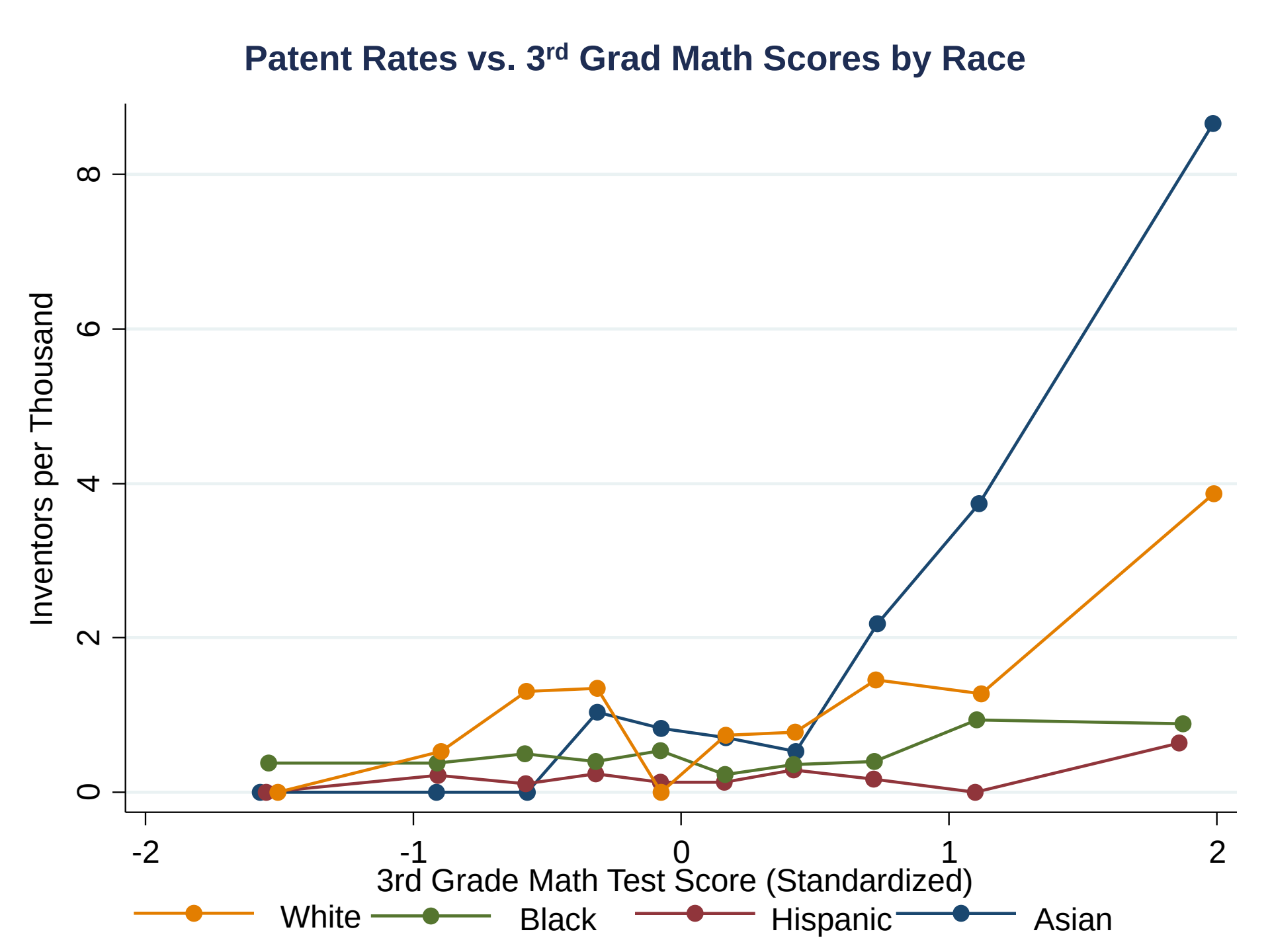

Patent Rates vs. 3rd Grade Math Test Scores
for Children with Low vs. High Income Parents
No. of Inventors per Thousand Children
0
2
4
6
8
High-ability children much more
likely to become inventors if they
are from high-income families
-2
-1
0
1
2
3rd Grade Math Test Score (Standard Deviations Relative to Mean)
Par. Inc. Below 80th Percentile
Par. Inc. Above 80th Percentile

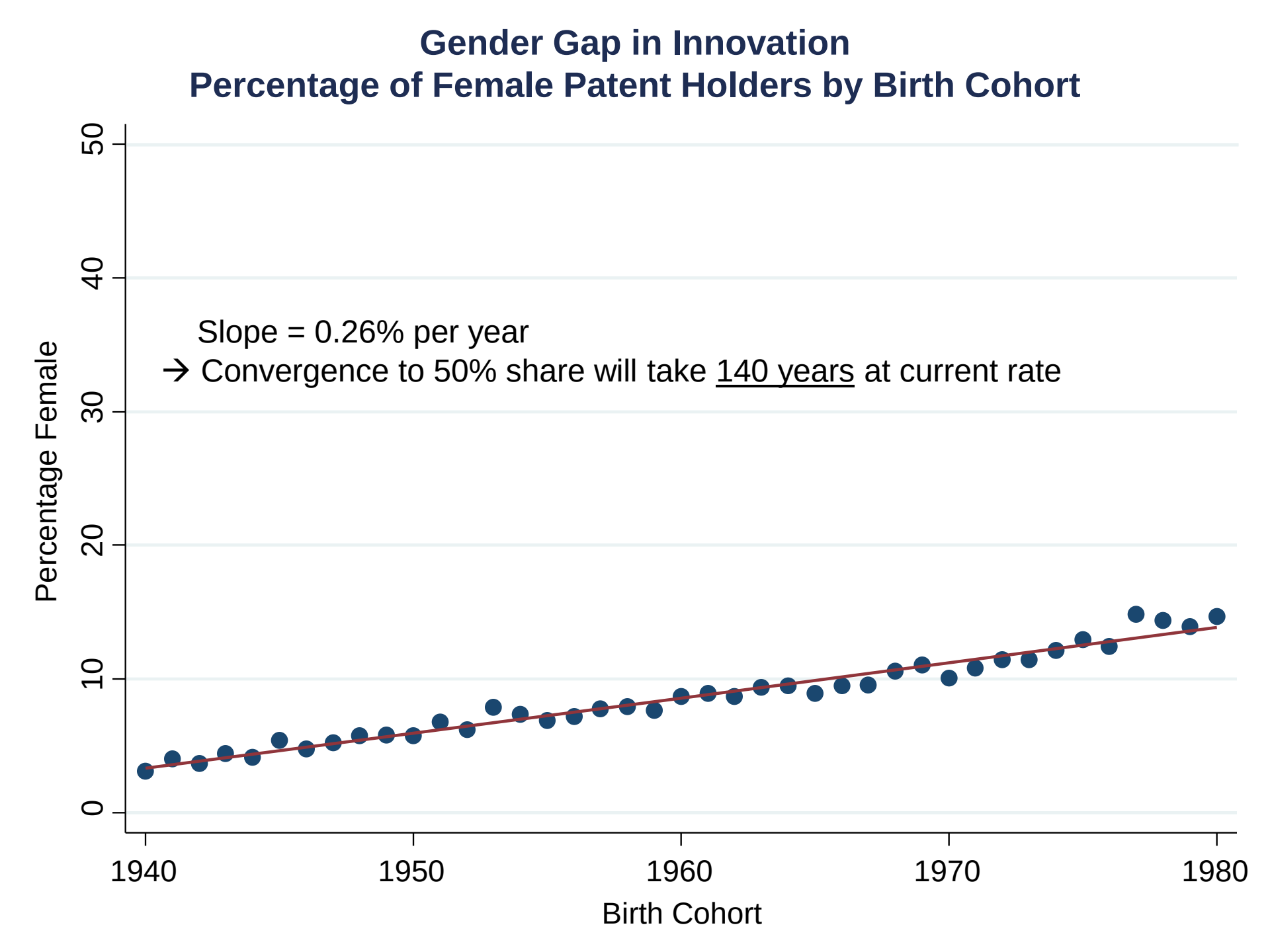
Innovation Gap Explained by Test Scores

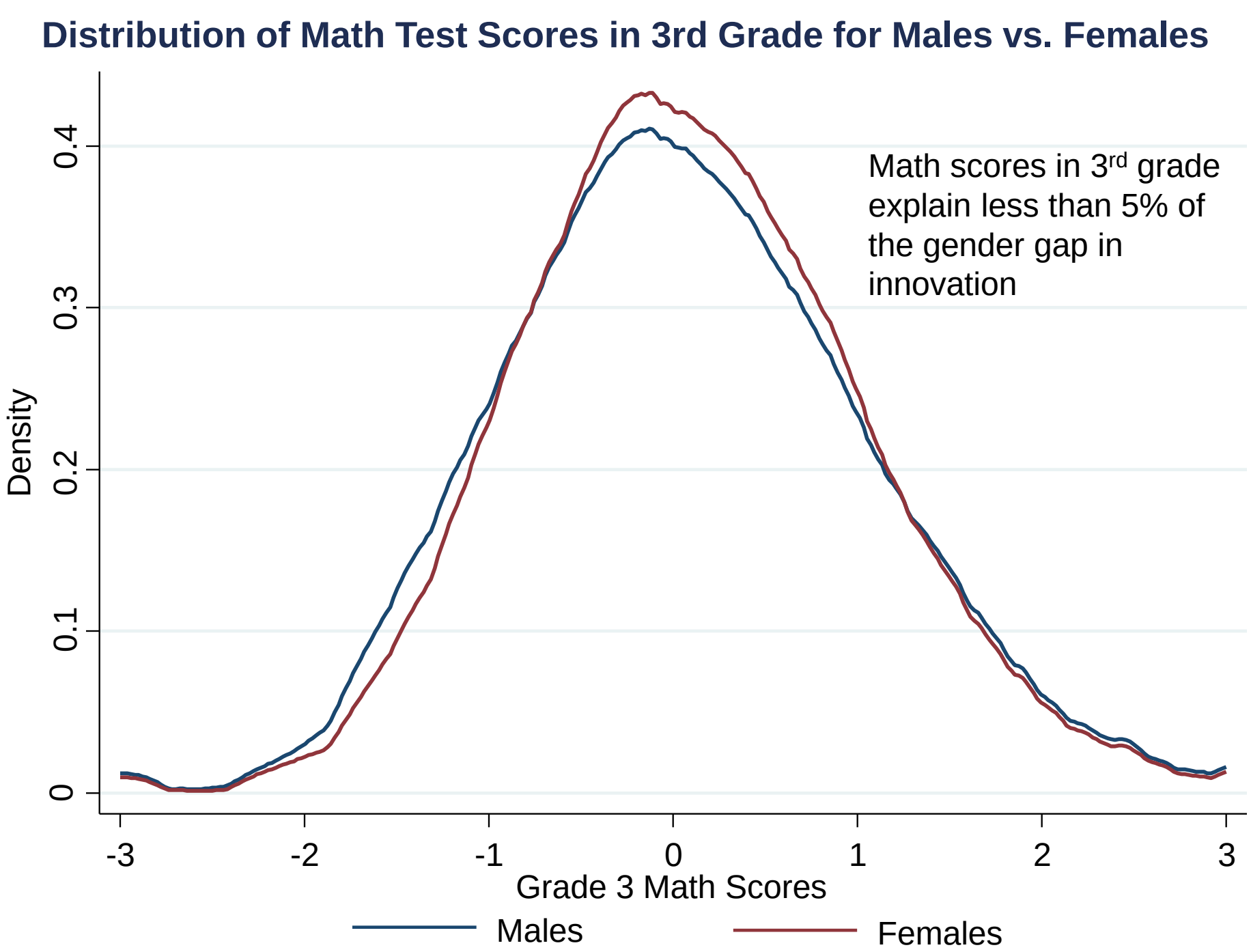
- Differences in 3rd grade test scores account for **31%** of the income gap in innovation
  - If low-income children had same test score distribution as high-income children, gap in innovation would be 31% smaller
- Does this change if we use test scores in later grades?

Percentage of Innovation Gap Explained by Test Scores in Grades 3-8




Patent Rates vs. 3rd Grad Math Scores by Race
Inventors per Thousand
0
2
4
6
8
-2
-1
0
1
2
3rd Grade Math Test Score (Standardized)
White
Black
Hispanic
Asian


Gender Gap in Innovation
Percentage of Female Patent Holders by Birth Cohort
Slope = 0.26% per year
→ Convergence to 50% share will take 140 years at current rate
Percentage Female
0
10
20
30
40
50
1940
1950
1960
1970
1980
Birth Cohort

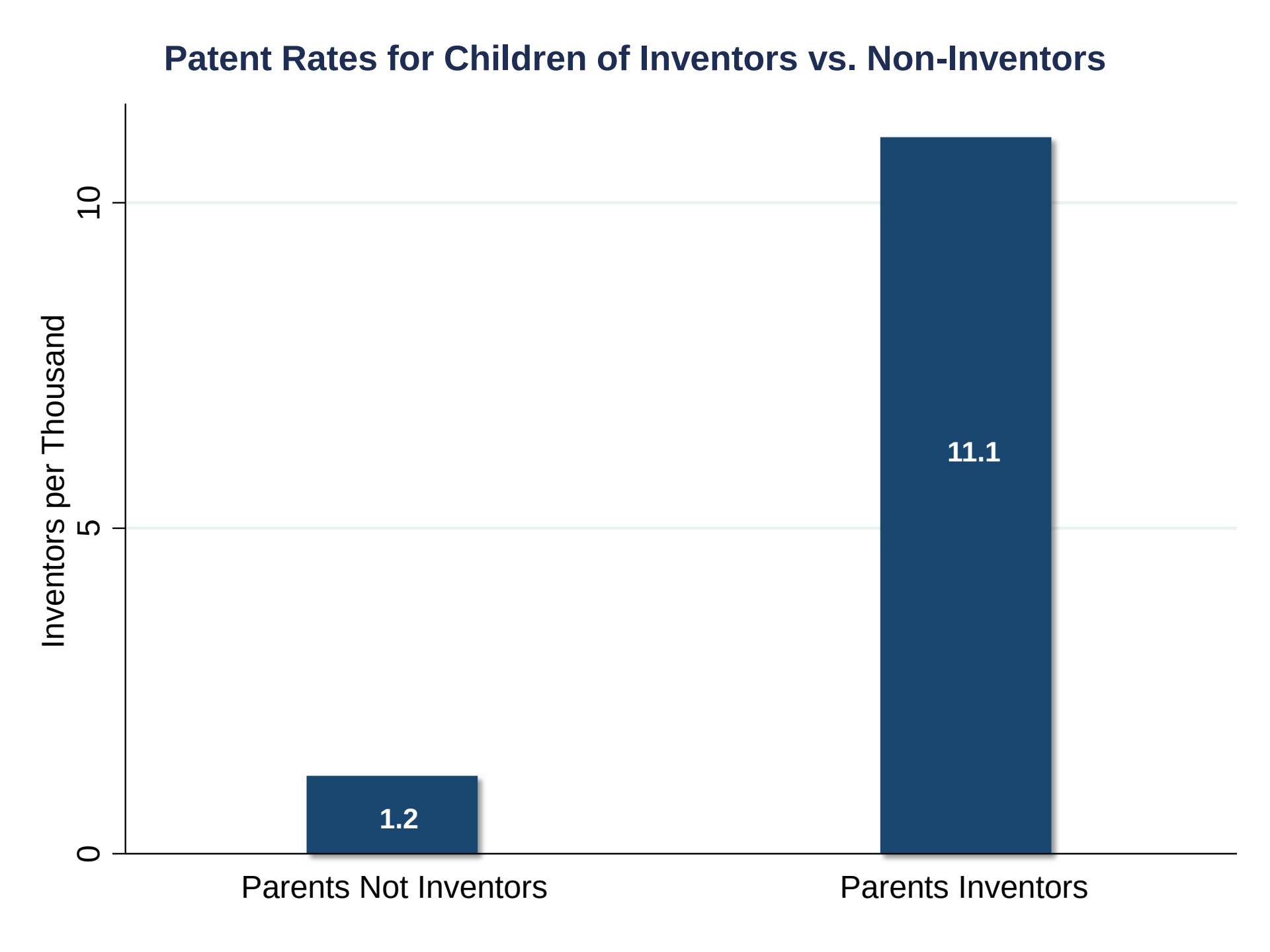

Distribution of Math Test Scores in 3rd Grade for Males vs. Females
Math scores in 3rd grade explain less than 5% of the gender gap in innovation
Density
0
0.1
0.2
0.3
0.4
-3
-2
-1
0
1
2
3
Grade 3 Math Scores
Males
Females

Differences in Ability and the Innovation Gap

- Test score data suggest that most of the innovation gap across income, race, and gender is not due to ability diffs.
  - But not conclusive because tests are imperfect measures of ability
  - Moreover, latent genetic ability may be better manifested in tests at later ages

Differences in Environment and the Innovation Gap

- Study role of environment by returning to idea of childhood exposure effects
  - Do differences in exposure to innovation during childhood explain innovation gap?
- Begin by analyzing relationship between children's and parents' innovation rates


Patent Rates for Children of Inventors vs. Non-Inventors
Inventors per Thousand
0
5
10
1.2
11.1
Parents Not Inventors
Parents Inventors

Exposure vs. Genetics

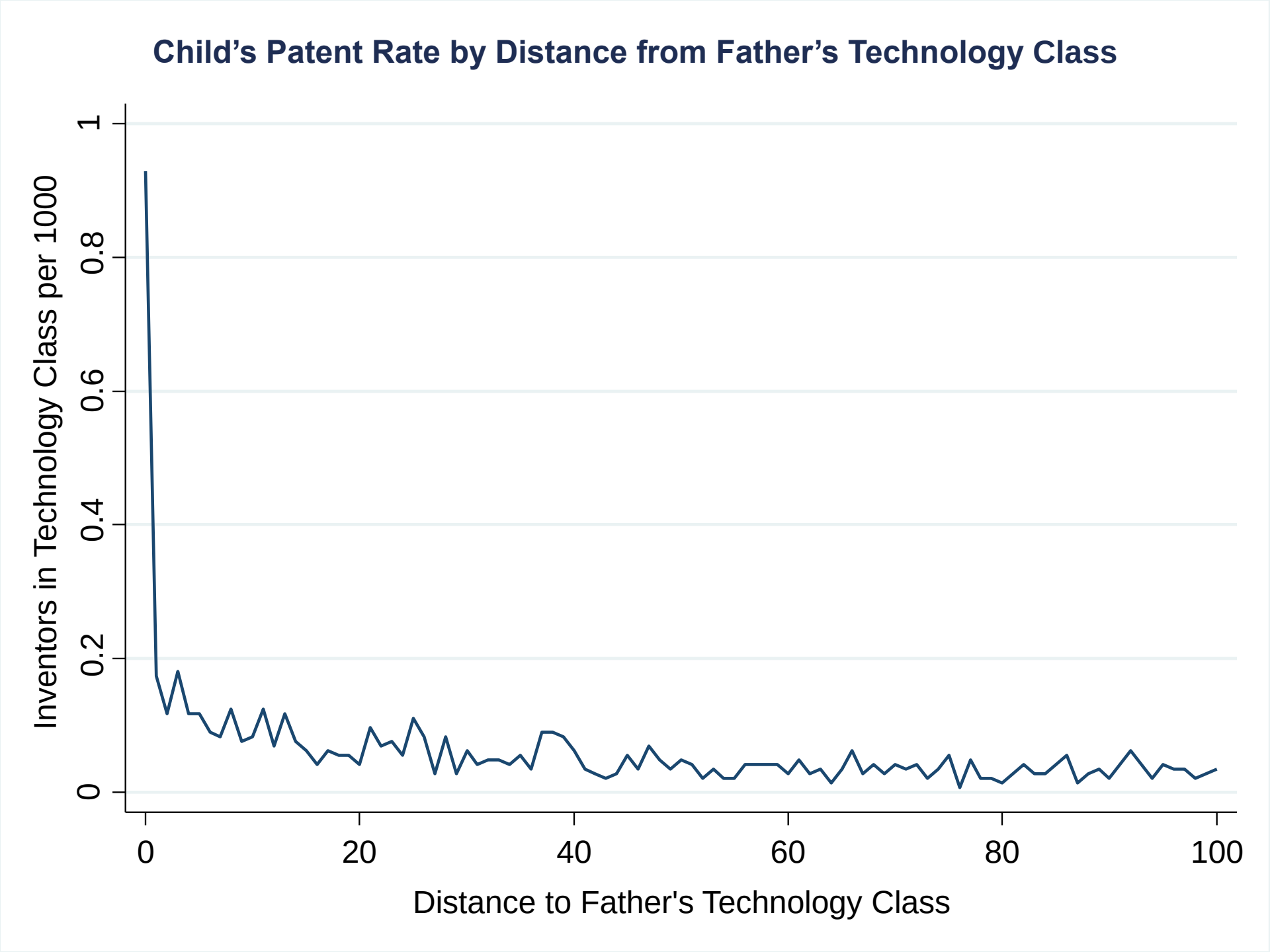
- Correlation between child and parent's propensity to patent could be driven by genetics or by environment
- To distinguish these two explanations, analyze propensity to patent by narrow technology class

Illustration of Technology Classes and Distance

Category*: Computers + Communications*

Sub-category*: Communications*

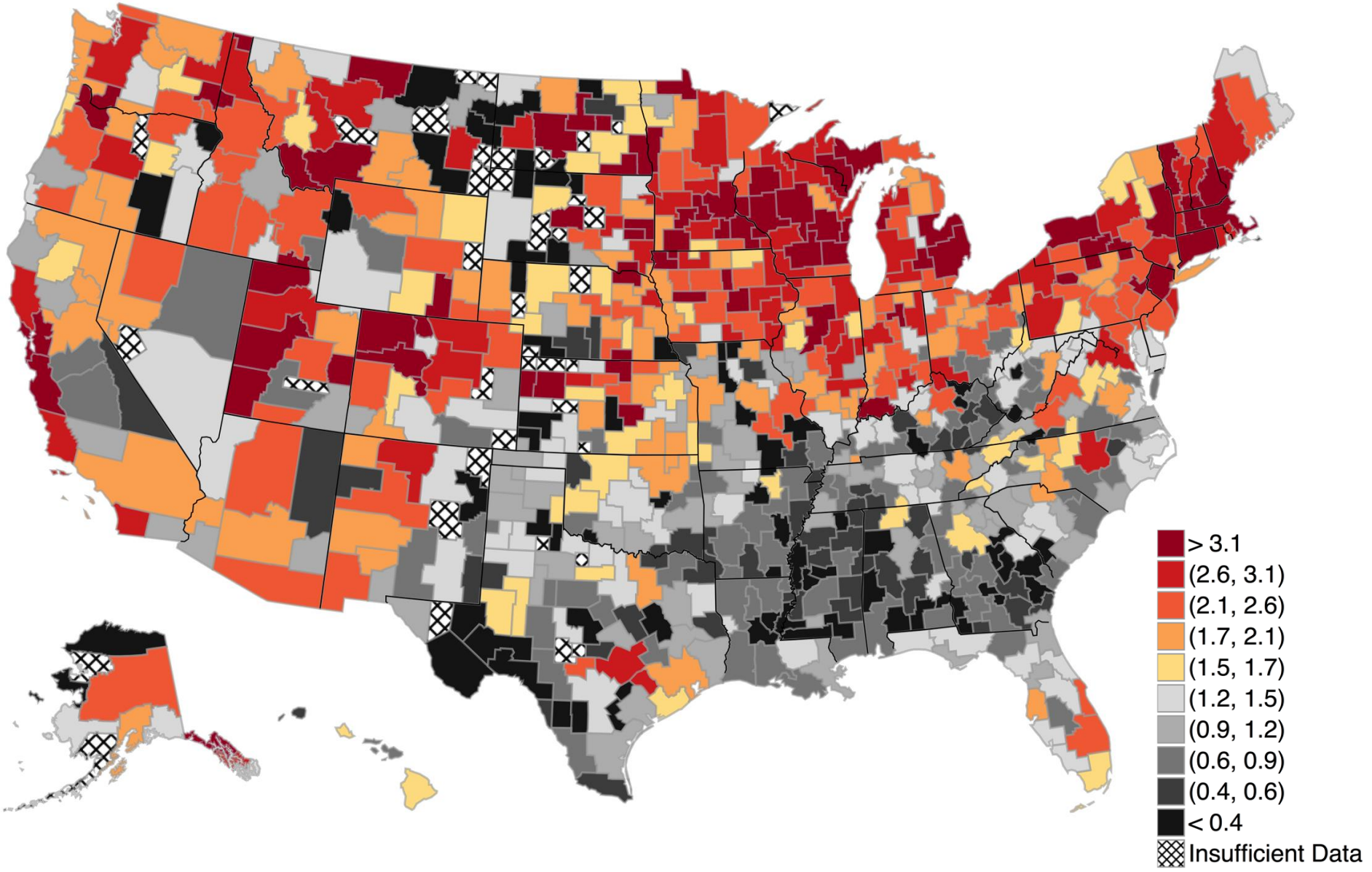
Technology Class	Distance Rank
Pulse or digital communications	0
Demodulators	1
Modulators	2
Coded data generation or conversion	3
Electrical computers: arithmetic processing and calculating	4
Oscillators	5
Multiplex communications	6
Telecommunications	7
Amplifiers	8
Motion video signal processing for recording or reproducing	9
Directive radio wave systems and devices (e.g., radar, radio navigation)	10

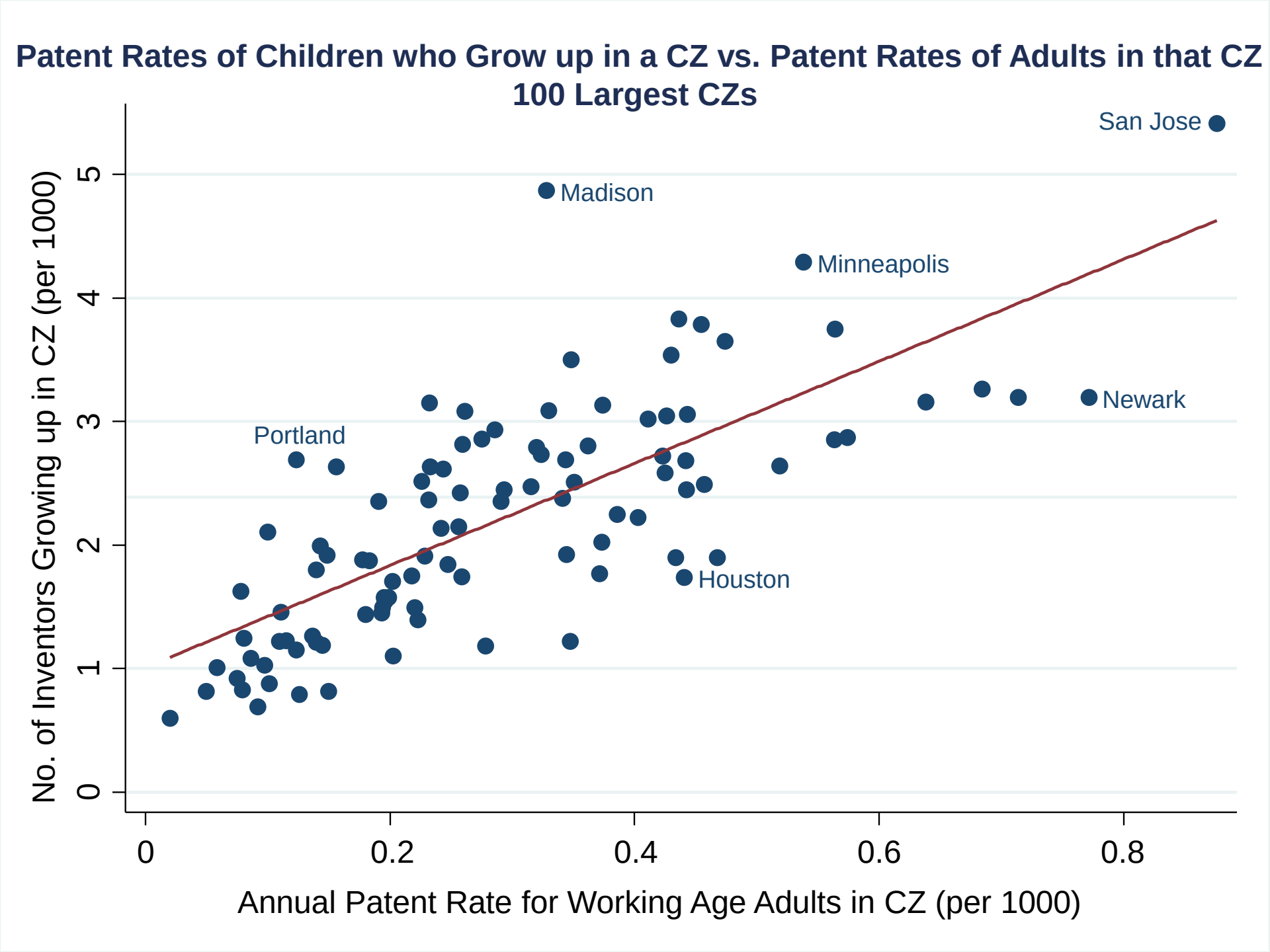

Child's Patent Rate by Distance from Father's Technology Class
Inventors in Technology Class per 1000
0
0.2
0.4
0.6
0.8
1
0
20
40
60
80
100
Distance to Father's Technology Class

Neighborhood Exposure Effects and Innovation

- Parents are only one potential source of exposure
- To capture broader sources of exposure, analyze variation across neighborhoods where child *grew up*

The Origins of Inventors
Patent Rates per 1000 Children by CZ where Child Grew Up




Patent Rates of Children who Grow up in a CZ vs. Patent Rates of Adults in that CZ
100 Largest CZs
San Jose
Madison
Minneapolis
Newark
Portland
Houston
No. of Inventors Growing up in CZ (per 1000)
0
1
2
3
4
5
0
0.2
0.4
0.6
0.8
Annual Patent Rate for Working Age Adults in CZ (per 1000)

Neighborhood Exposure Effects and Innovation

- Children raised in areas with more inventors are more likely to be inventors themselves
- Could again be driven by genetics or exposure effects
- Once again, study patterns *within* technological class to distinguish the two explanations
  - Exact technology class in which a child innovates is strongly related to where he grew up, conditional on location in adulthood

Summary: Inequality and Innovation

- Key lesson: there are substantial gaps in innovation by family background, driven primarily by differences in exposure

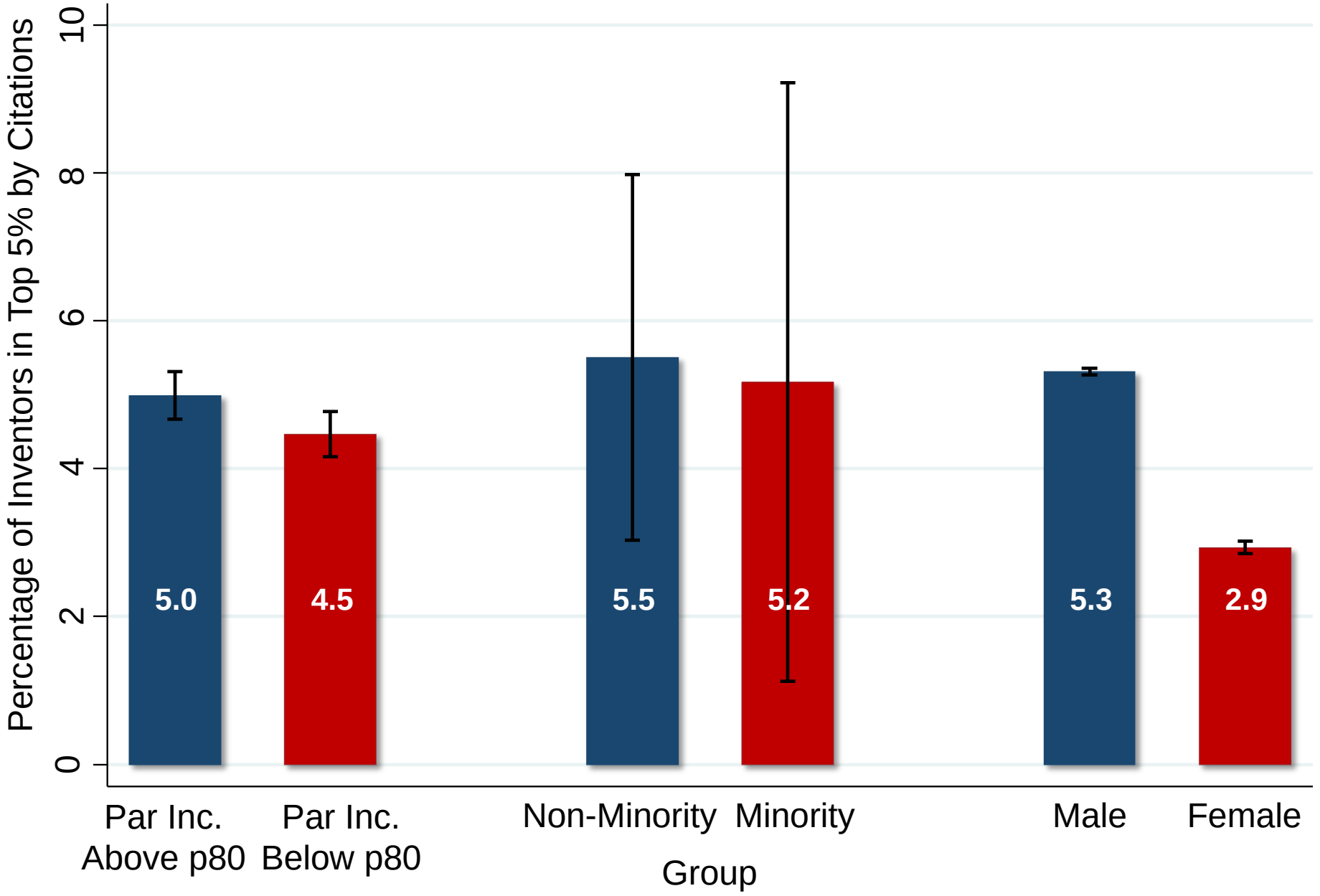
- Implies that increasing equality of opportunity could *increase* efficiency and GDP growth

Part 2
Policies to Increase Innovation

Two Policy Paradigms to Increase Innovation

- First approach: “supply side” policies to draw more people into innovation [Goolsbee 1998, Romer 2000]
  - E.g. investments to increase exposure, such as gifted/talented programs, internships
- Traditional concern: marginal individual drawn into innovation might produce inventions of limited value
  - In a standard Roy-type selection model, superstar inventors (Einsteins) will come through pipeline regardless of background
  - Such models predict that average quality of inventors from under-represented groups will be *higher* on average [Hsieh et al. 2013]

Fraction of Highly-Cited Patents by Demographic Group, Conditional on Inventing



Supply-Side Policies: Lost Einsteins

- Inventors from under-represented groups do not have better inventions on average

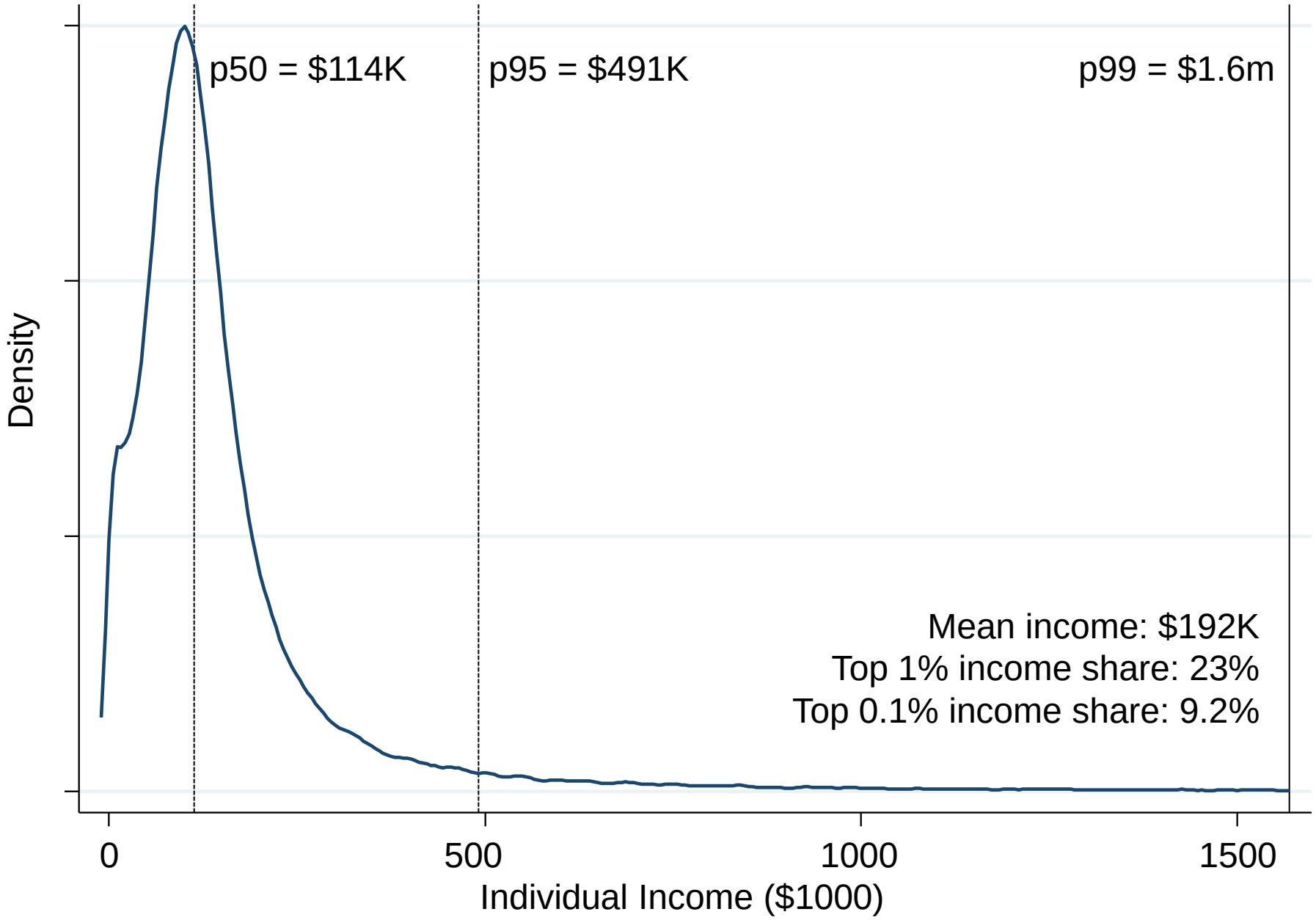
  → Many lost Einsteins: children from low-income backgrounds who would produce high-impact innovations if they became inventors

- Consistent with importance of exposure effects: children who don't become inventors are not trading off costs/benefits on the margin

- Implies that supply-side policies that increase exposure could have substantial effects on aggregate innovation

Two Policy Paradigms to Increase Innovation

- Second approach: “demand side” policies that incentivize innovation
  - Substantial policy discussion regarding cutting top income tax rates to spark innovation
- Data are less supportive of this approach
  - Changing tax rates unlikely to have substantial effects if key determinant of innovation is exposure
  - Moreover, skewness of payoffs to innovation limits scope for top tax rates to influence innovation


Distribution of Inventors' Mean Individual Income Between Ages 40-50
p50 = $114K
p95 = $491K
p99 = $1.6m
Mean income: $192K
Top 1% income share: 23%
Top 0.1% income share: 9.2%
Density
0
500
1000
1500
Individual Income ($1000)

Summary: Policies to Increase Innovation

- Supply-side policies to increase innovation have more promise than traditional approach of changing incentives
- May be desirable to increase top income tax rates to finance programs that draw more low-income children into innovation
- More broadly, policies that improve equality of opportunity could increase rate of innovation and thereby increase economic growth

Robbins Lectures: Conclusions

1. Tackle social mobility at a local, not just national level

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2. Improve childhood environment at all ages (not just earliest ages)

Robbins Lectures: Conclusions

1. Tackle social mobility at a local, not just national level

2. Improve childhood environment at all ages (not just earliest ages)

3. Harness big data to evaluate other policies scientifically and measure local progress and performance

   - Working with government agencies to create a system to monitor local trends in inequality and opportunity

   - County-level data on upward mobility publicly available at www.equality-of-opportunity.org

Download County-Level Data on Social Mobility in the U.S.

www.equality-of-opportunity.org/data

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Downloadable Data on Intergenerational Mobility

Data Description		
Preferred Mobility Measures by Commuting Zone	Stata file	Excel file
Online Data Table 1: National 100 by 100 Transition Matrix	Stata file	Excel file
Online Data Table 2: Marginal Income Distributions by Centile	Stata file	Excel file
Online Data Table 3: Intergenerational Mobility Statistics and Selected Covariates by County	Stata file	Excel file
Online Data Table 4: Intergenerational Mobility Statistics by Metropolitan Statistical Area	Stata file	Excel file
Online Data Table 5: Intergenerational Mobility Statistics by Commuting Zone	Stata file	Excel file
Online Data Table 6: Quintile-Quintile Transition Matrices by Commuting Zone	Stata file	Excel file
Online Data Table 7: Income Distributions by Commuting Zone	Stata file	Excel file
Online Data Table 8: Commuting Zone Characteristics	Stata file	Excel file
Online Data Table 9: Commuting Zone Characteristics Definitions and Data Sources		Excel file
Geographic Crosswalks (Tolbert and Sizer 1996, Autor and Dorn 2009 & 2013)	Zip file	
Replication Stata Code and Datasets	Zip file	
Downloadable Map of Absolute Upward Mobility		

Version 2.0, released January 17, 2014. For Version 1.0 (released on July 22, 2013), click here. Version 2.0 reports statistics using the 1980-82 birth cohorts (rather than 1980-81) and includes new data such as mobility statistics by county and MSA, new CZ-level covariates, and marginal income distributions for parents and children.

For more information on the data, please email info@equality-of-opportunity.org

An Opportunity and a Challenge

Metro Area	Odds of Rising from Bottom to Top Fifth
Dubuque, IA	17.9%
San Jose, CA	12.9%
U.K. Average	9.0%
U.S. Average	7.5%
Chicago, IL	6.5%
Memphis, TN	2.6%