

The Lifecycle of Inventors

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The opinions expressed in this paper are those of the authors alone and do not necessarily reflect the views of the Internal Revenue Service or the U.S. Treasury Department.

Motivation

- This paper focuses on the “Extensive Margin” – increasing quantity & quality of inventors
 - Higher **volume** of people going into innovation sector (to address market failure of “too little” R&D)
 - Better **composition**: Are we losing out on some talented kids from disadvantaged backgrounds who do not go into innovation?

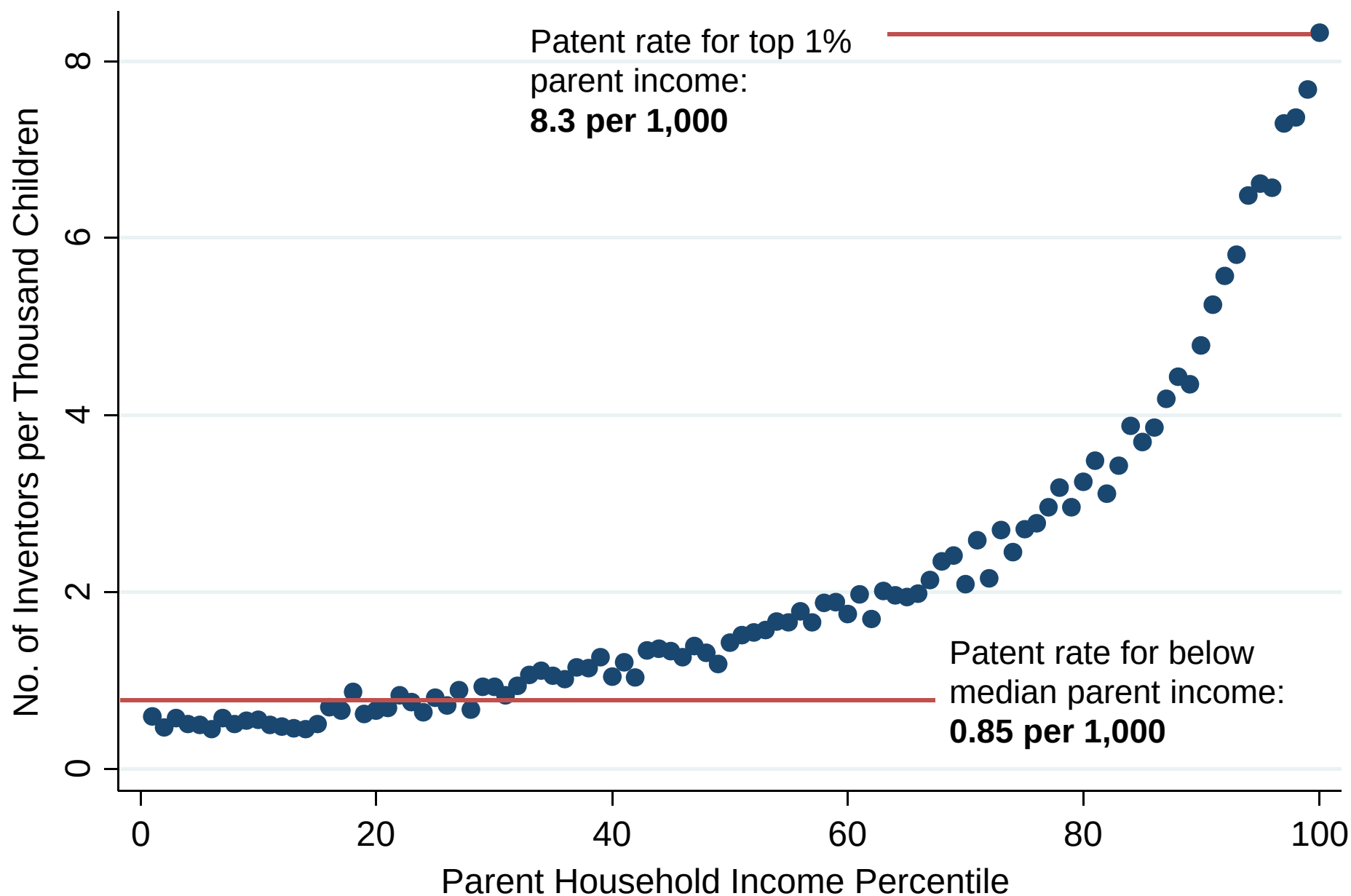
Data

- All 1.7 million patents granted between 1996-2014 from USPTO [Google XML files]; 1.6 million applications 2001-12 [Strumsky, 2014]
 - Patents well known pros & cons as measure of innovation but best measure for large-scale data analysis
- Match to Treasury tax files: panel dataset covering U.S. population (~8 billion rows)
 - Every person in U.S. appearing on any tax form 1996-2012
 - Includes non-filers through information returns (W-2's, 1099's, etc.)
- 86% match = 1,200,620 inventors (balanced on observables)

Summary of Findings

- Children from **low income backgrounds**, women & minorities much less likely to become inventors even controlling for measured early ability (e.g. 3rd grade test scores)
 - Innovation gap between rich & poor widens as kids go through school
- **Exposure** to innovation in childhood (from parents; parents' colleagues; neighborhoods) a key influence on propensity to become an inventor
 - True even in **very narrow** technology classes

Fig. 1: Probability of Patenting by Age 30 vs. Parent Income Percentile

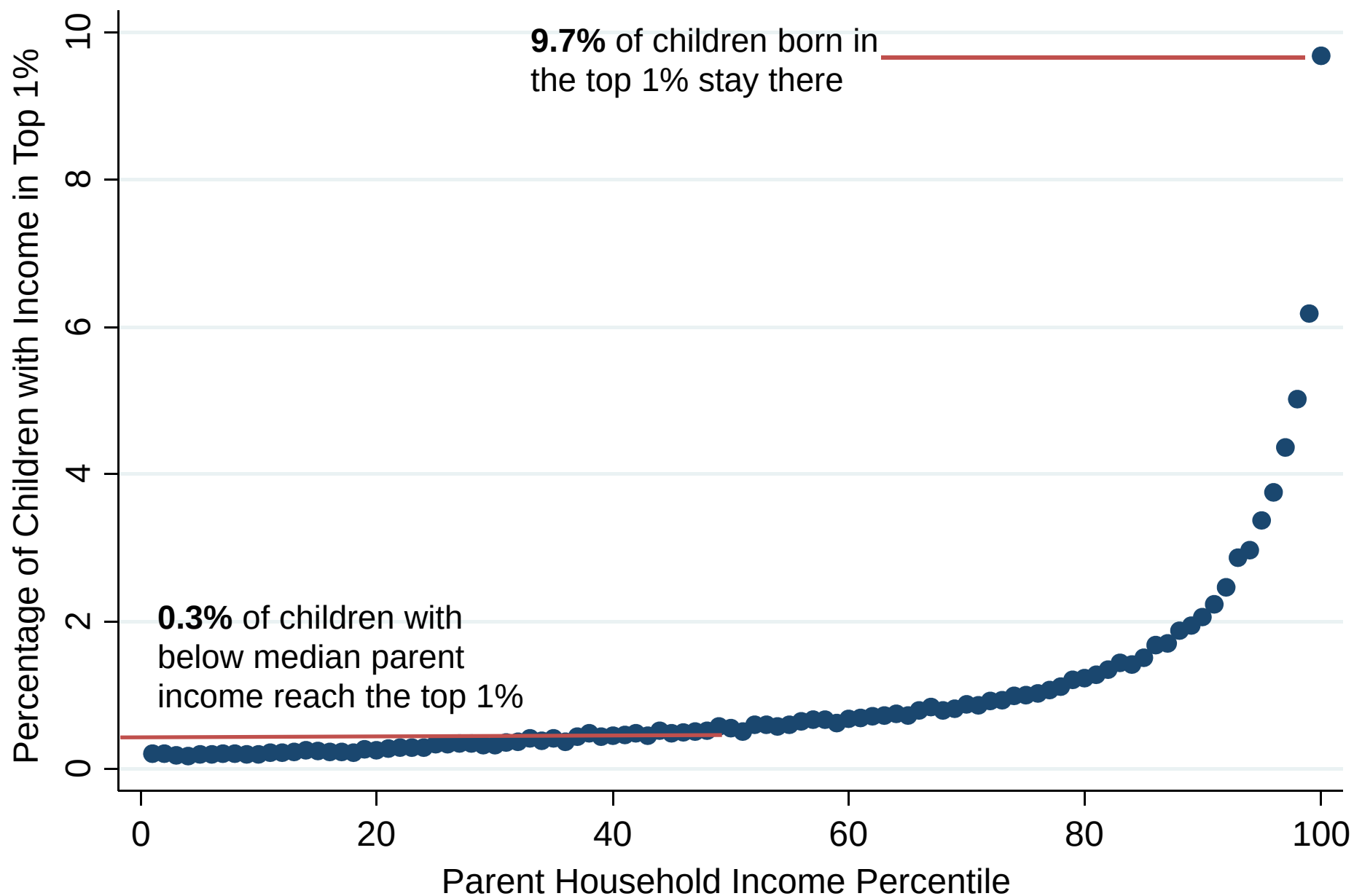


Notes: Sample of children is 1980-82 birth cohorts. Parent Income is mean from 1996-2000.

Upper-Tail Outcomes

- Probability of patenting is an increasing, convex function of parent income percentile
- Same is true of other upper tail outcomes, e.g. probability of having income in top 1% of distribution

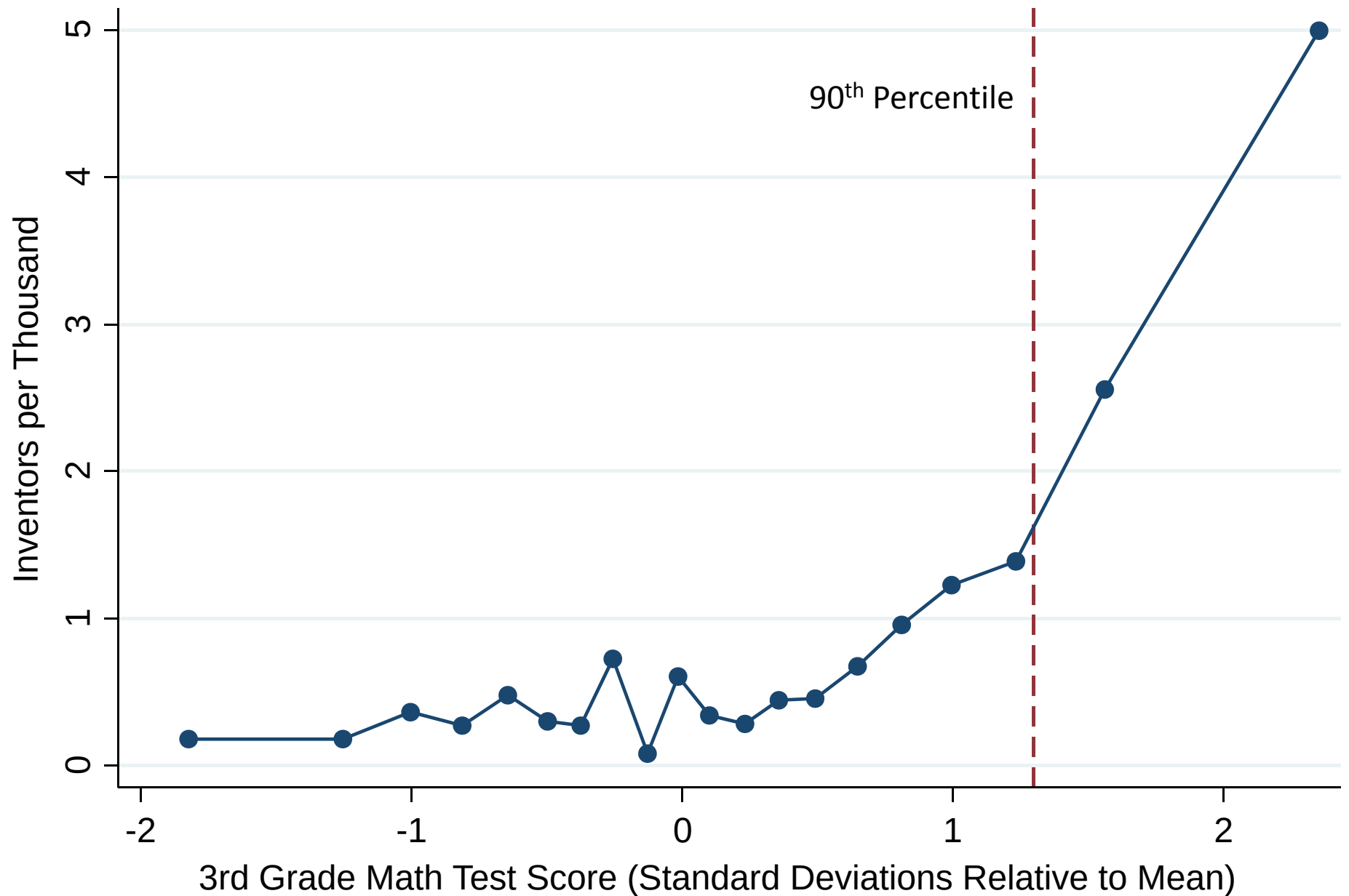
Percentage of Children in Top 1% of Cohort's Income Distribution



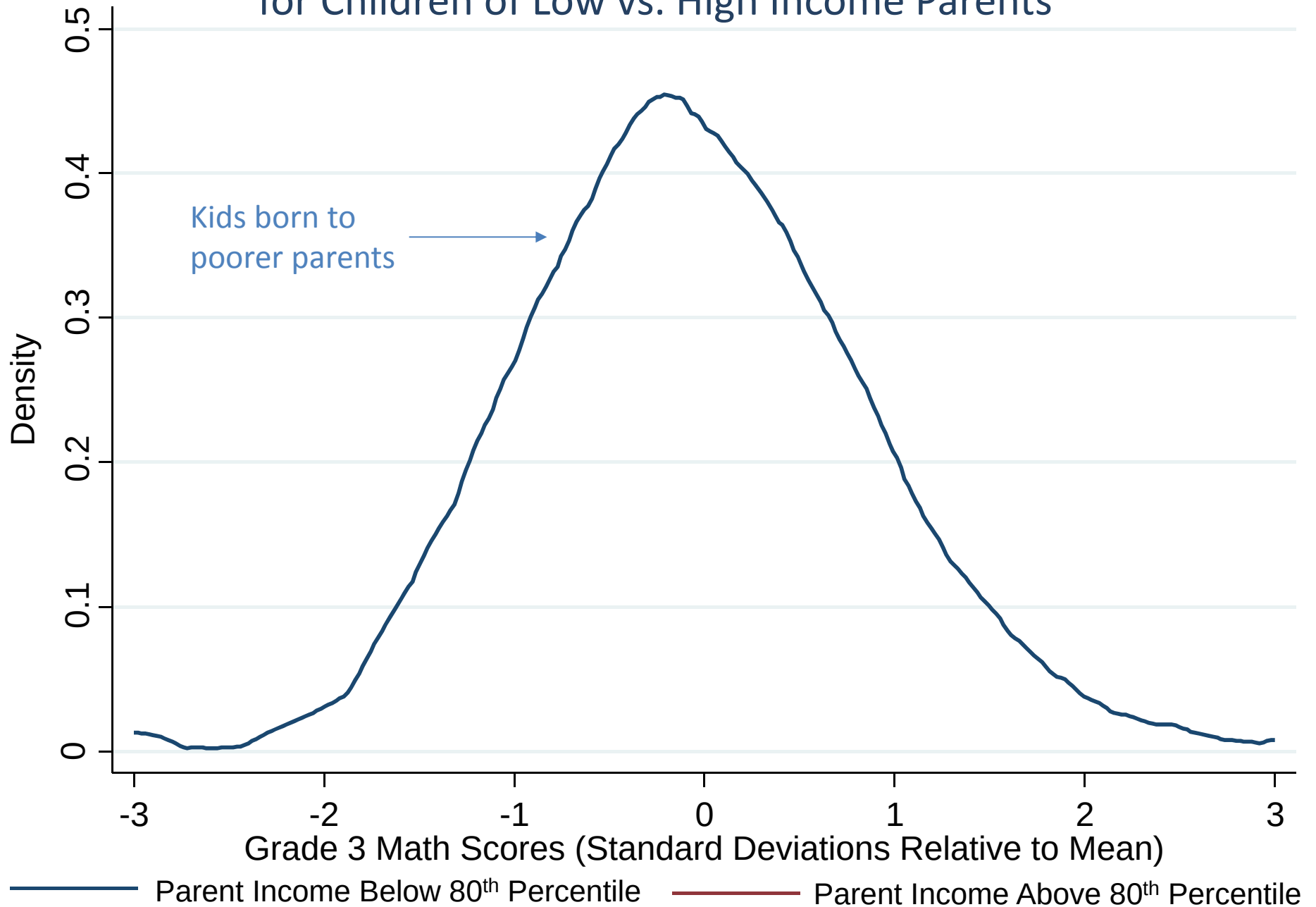
Why Do Patent Rates Vary with Parent Income?

- 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 talent
 2. **Preferences:** lower income children prefer other occupations
 3. **Constraints:** lower income children have comparable talent but face higher barriers to entry or lack exposure to inventors in early life

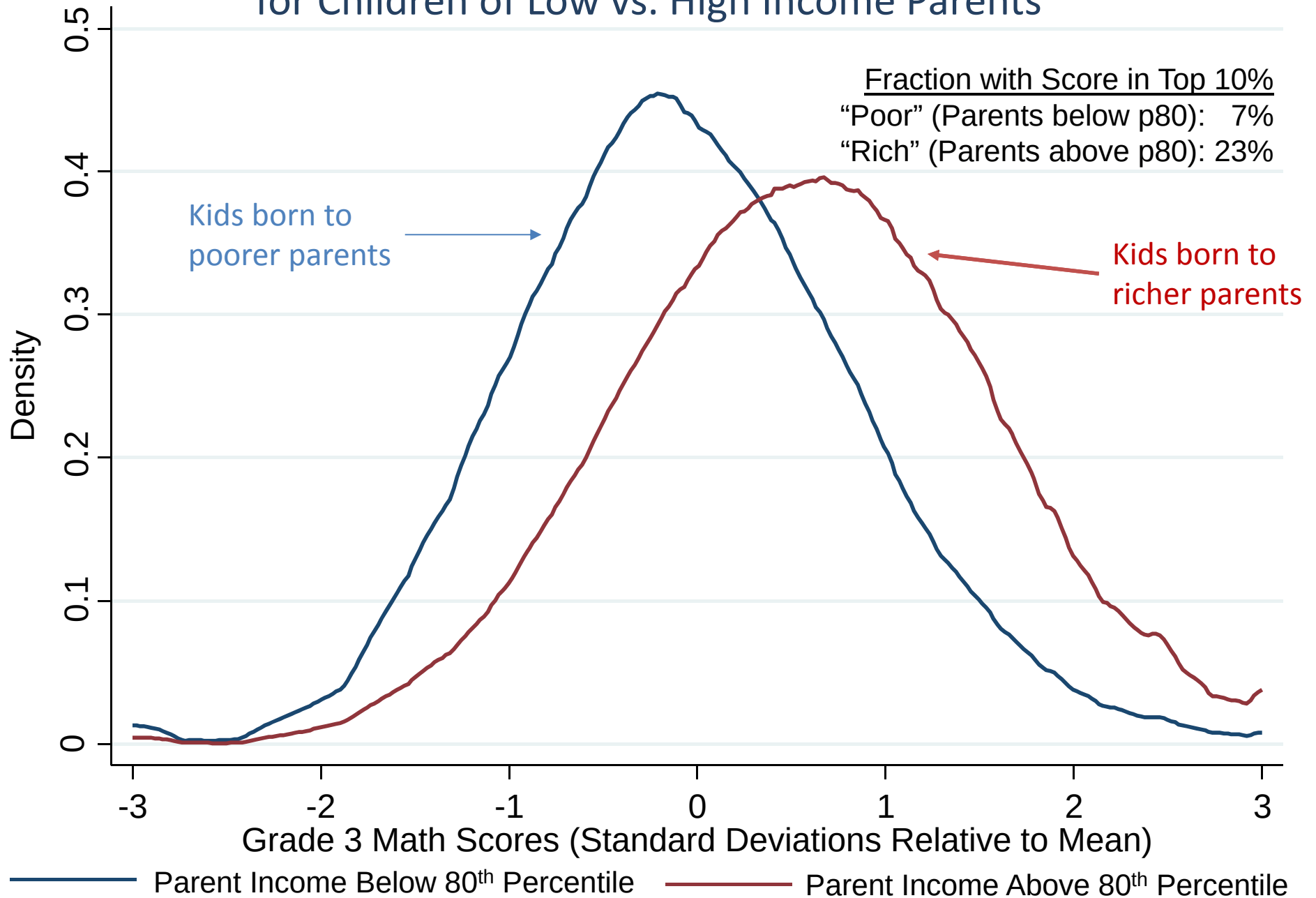
Patent Rates vs. 3rd Grade Math Test Scores in NYC Public Schools



Distribution of Math Test Scores in 3rd Grade for Children of Low vs. High Income Parents



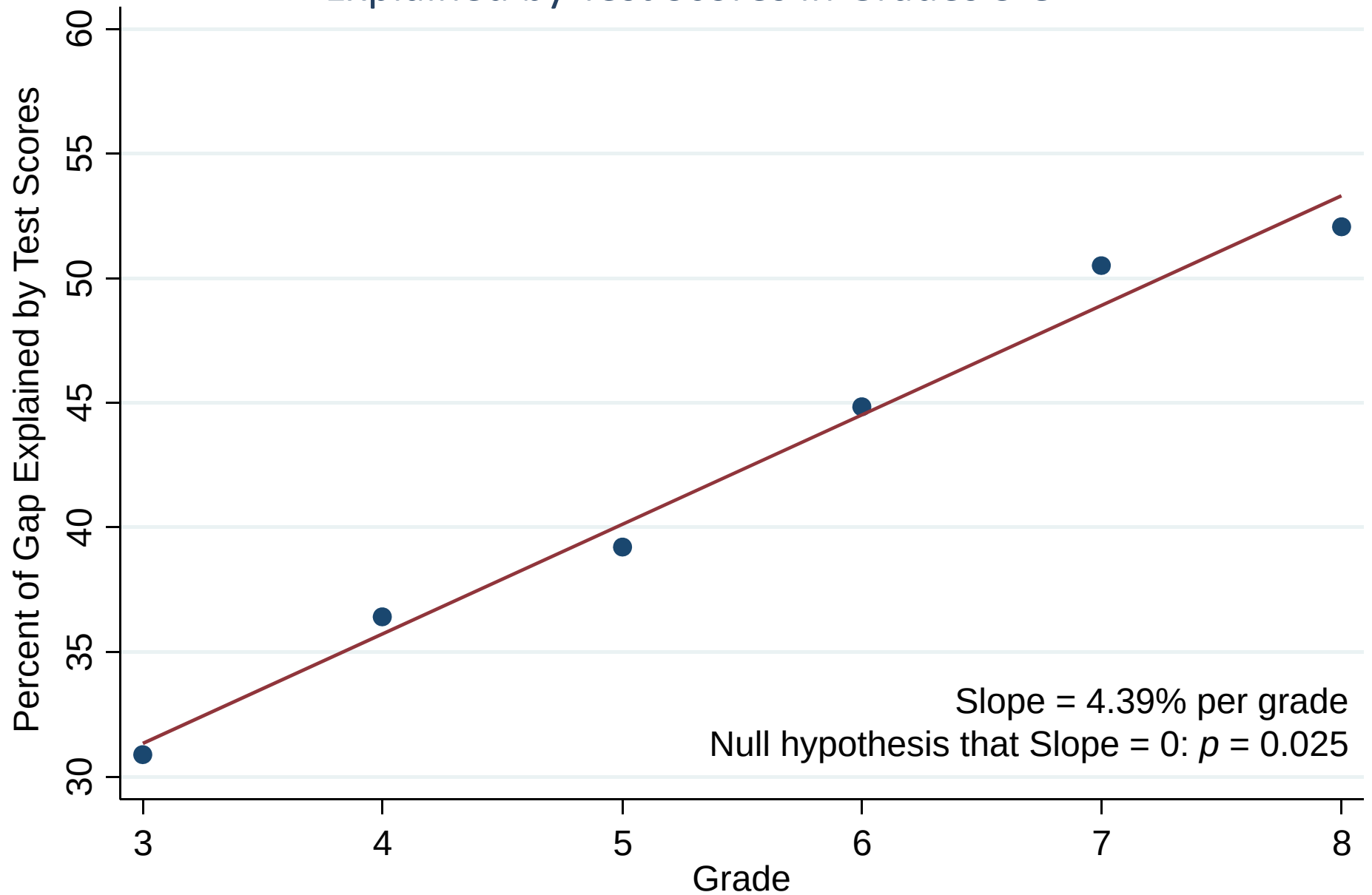
Distribution of Math Test Scores in 3rd Grade for Children of Low vs. High Income Parents



Patenting Gap Explained by Test Scores?

- What fraction of the gap in patenting by parent income is accounted for by test scores?
- Calculate this non-parametrically using a simple reweighting approach [Dinardo, Fortin, Lemieux 1996]
 - Estimate patent rate for low-income kids if they were to have the same distribution of 3rd grade math scores as high income kids
 - 30.9% (s.e. 8.5) of patenting gap accounted for by 3rd grade test scores

% of Gap in Patent Rates for Low vs. High-Income Students Explained by Test Scores in Grades 3-8



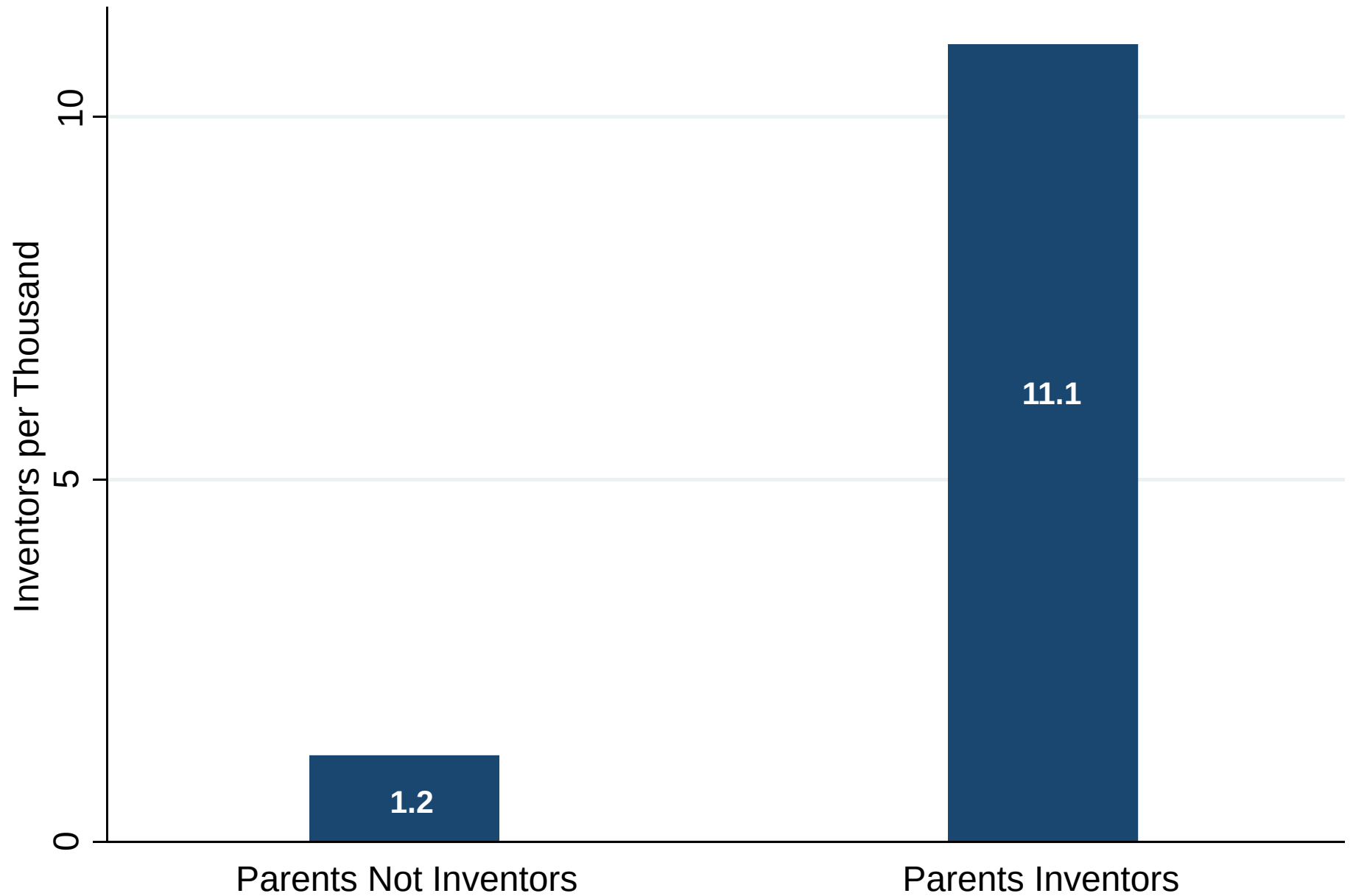
Expanding Gaps over Childhood

- Gap in innovation explained by test scores grows over time, consistent with low SES children falling behind over time [Fryer and Levitt 2006]
- Suggests that innovation may be driven by differences in childhood environment
- However, not conclusive because latent genetic ability may be better manifested in tests at later ages
- To evaluate whether environment matters, document importance of **exposure to innovation** directly

Measuring *Exposure* to innovation in Childhood Environment

- Measures of Exposure for future inventors. We ask:
 1. Were parents disproportionately inventors? **YES**
 2. Do parents work in innovative industries? **YES**
 3. Did children grow up in innovative areas? **YES**
- In all of these results not just innovation *per se*, but also type of innovation (e.g. narrow technology class)
 - E.g. synthetic rubber vs. non-synthetic rubber

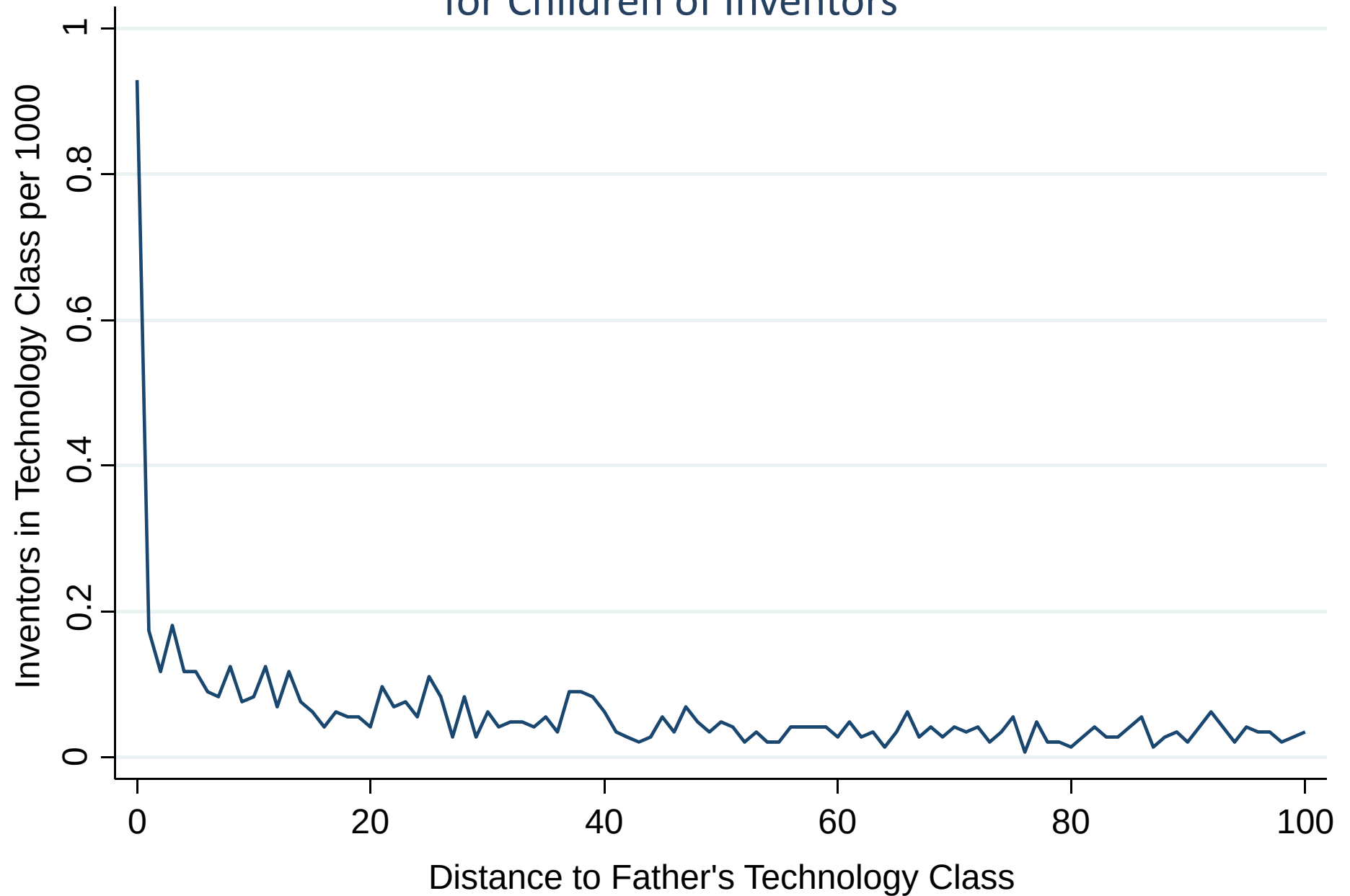
Patent Rates for Children of Inventors vs. Non-Inventors



Exposure vs. Endowments

- Correlation between child and parent's propensity to patent could be driven by endowment (e.g. genes) or environment
- To distinguish the two, analyze propensity to patent by narrow technology class (~450 fields)
 - *Intuition:* genetic ability to innovate is unlikely to vary significantly across similar technology classes
- Define “similarity” of two technology classes based on the fraction of inventors who hold patents in both classes
 - This measure of distance is simple to calculate in linked patent-tax data; other measures yield similar results
 - Other distance metrics give similar results [Bloom et al, 2013]

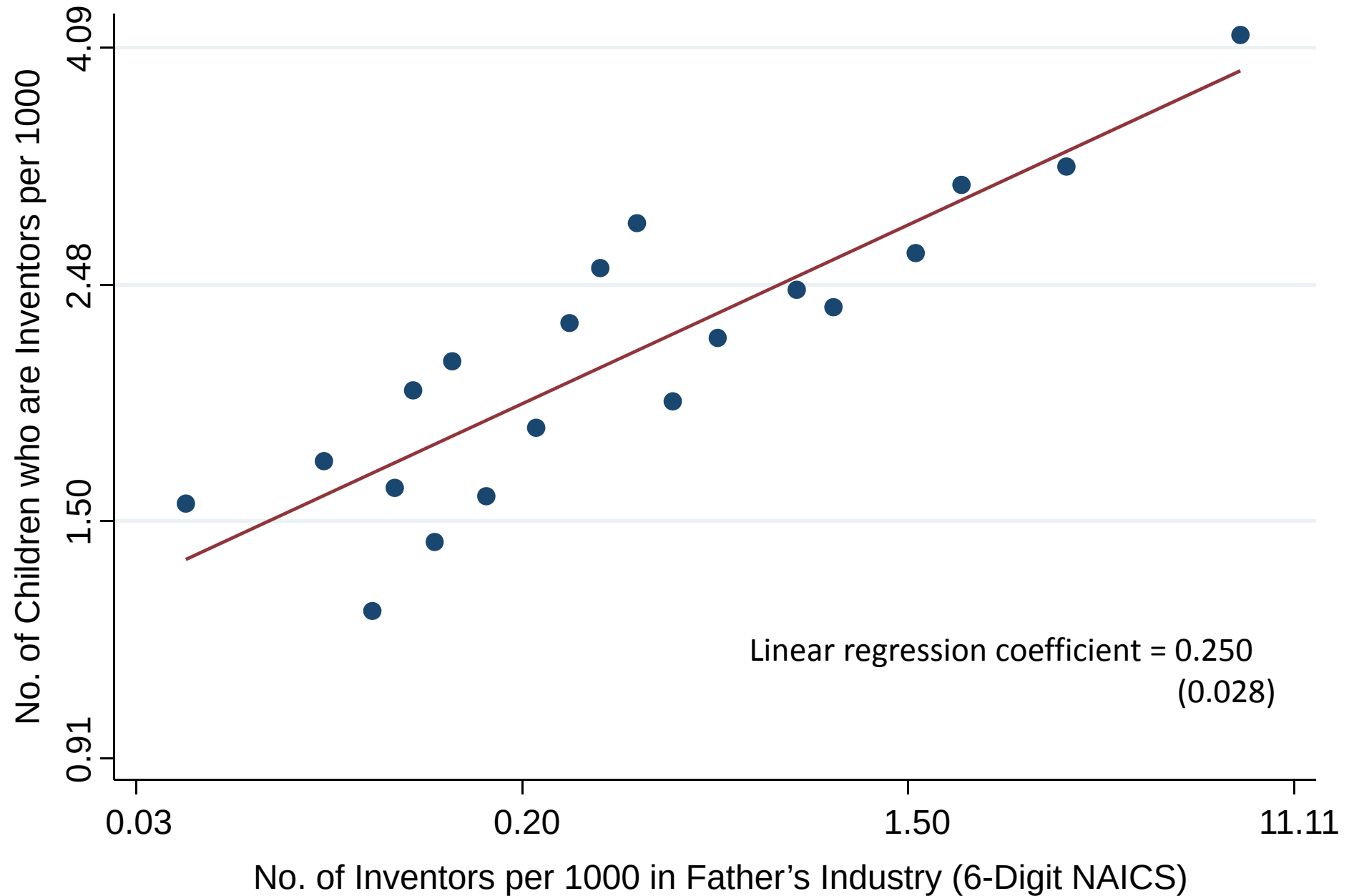
Class-Level Patent Rates by Distance from Father's Technology Class for Children of Inventors



“Mentors”: Industry

- Now turn to a broader source of exposure: parents’ “colleagues”
- Do children whose parents work in more innovative industries have higher patent rates?
 - Focus on children whose parents are *not* inventors themselves to eliminate direct effect of parent inventing

Children's Patent Rates vs. Patent Rates in Father's Industry

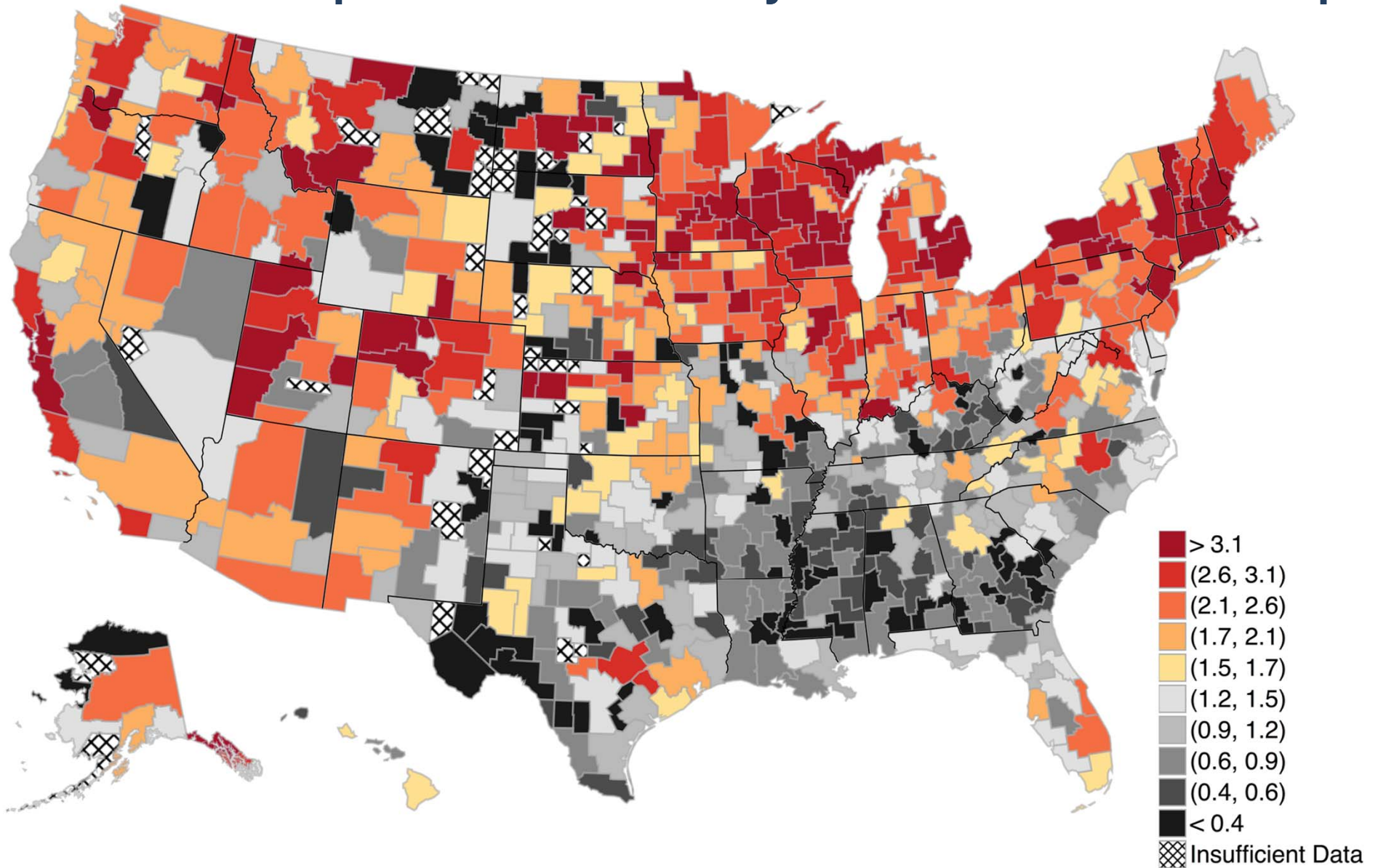


Neighborhoods

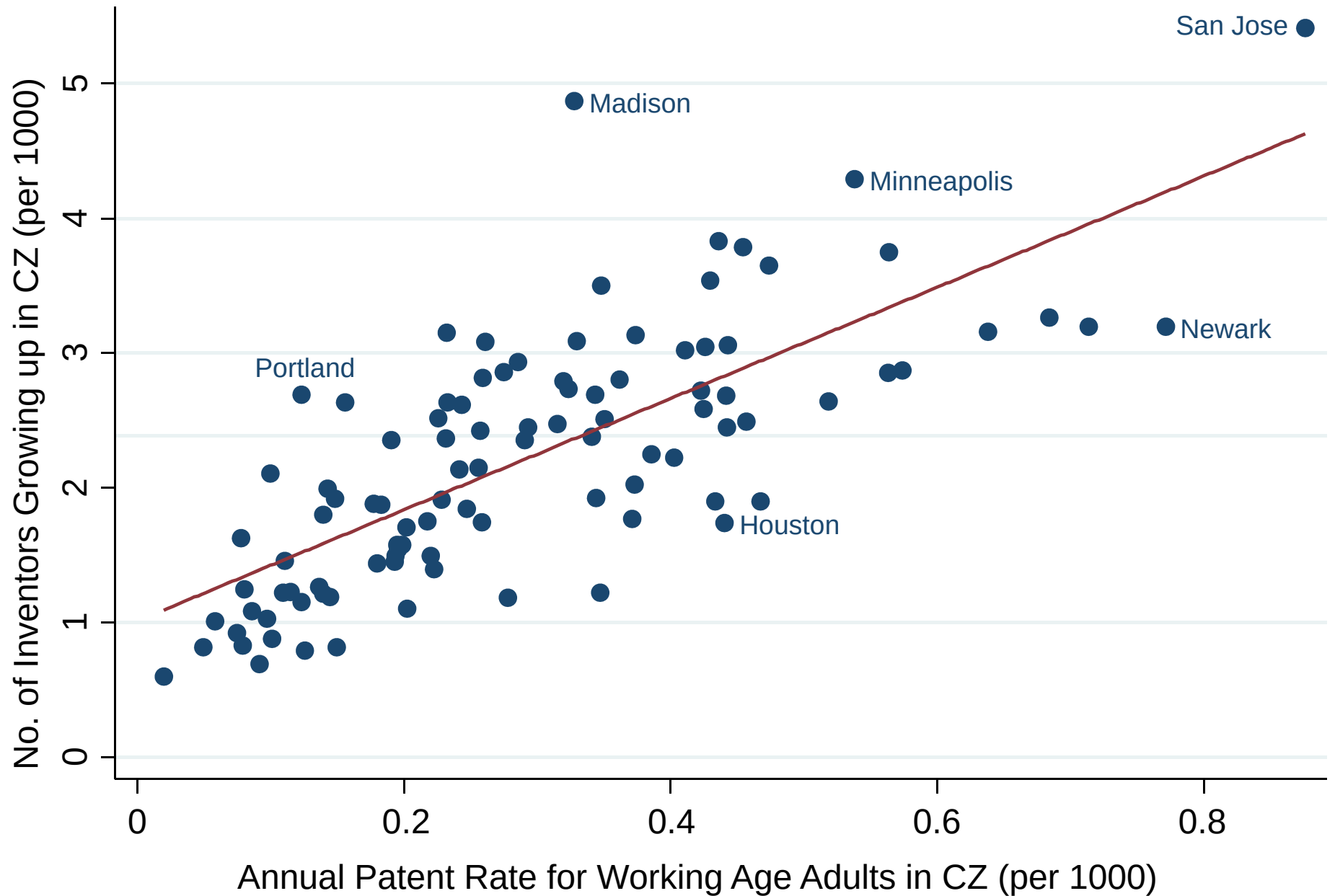
- Tabulate patent rates by commuting zone
(aggregation of counties analogous to metro area)
where child *grows up*

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



Conclusions

- 1.2m inventors from birth to growing up to labor market
- **Birth matters:** kids who are low income; female; black much less likely to grow up to be inventors
 - Even after controlling for early test scores. For low income much to do with falling behind in human capital
- Inventors are made not just born. **Exposure** to innovation during childhood matters a lot
- **Loss of talent:** large potential gains from “supply side” policies that seek to draw low-income children, women & minorities into innovation
 - **Example:** gifted/talented programs providing youth in low-income communities exposure to science/innovation at early ages