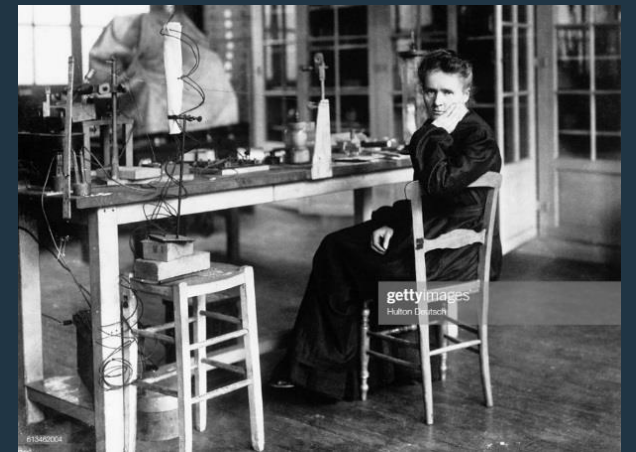
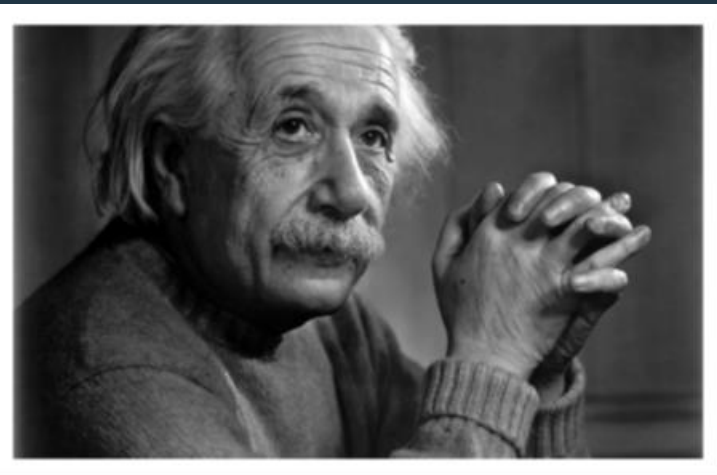


# Innovation and Human Capital Policy

NBER Innovation Boot Camp  
July 21<sup>st</sup>, 2022

John Van Reenen

LSE and MIT



# Why is human capital policy attractive to boost innovation?

- **Demand Side innovation Policies**
  - Fiscal incentives (e.g. R&D tax credits)
  - Direct subsidies to firms (e.g. SBIR)
  - Seem effective in micro studies. But if supply side inelastic, main effect is to increase R&D price rather than volume (Romer, 2001)
- **Supply side innovation policy** (survey in Van Reenen, 2022)
- Increase quantity of R&D workers - direct boost to innovation
  - Supply reduces R&D price - indirect boost via GE effect
  - But (i) leakage” concern & (ii) slower than subsidy

# Innovation Policy: The “Lightbulb” Table



| (1)                       | (2)                 | (3)                        | (4)            | (5)                 | (6)                  |
|---------------------------|---------------------|----------------------------|----------------|---------------------|----------------------|
| Policy                    | Quality of evidence | Conclusiveness of evidence | Benefit - Cost | Time frame:         | Effect on inequality |
| Direct R&D Grants         | Medium              | Medium                     | 💡💡             | Medium-Run          | ↑                    |
| R&D tax credits           | High                | High                       | 💡💡💡            | Short-Run           | ↑                    |
| Patent Box                | Medium              | Medium                     | Negative       | n/a                 | ↑                    |
| Skilled Immigration       | High                | High                       | 💡💡💡            | Short to Medium-Run | ↓                    |
| Universities: incentives  | Medium              | Low                        | 💡              | Medium-Run          | ↑                    |
| Universities: STEM Supply | Medium              | Medium                     | 💡💡             | Long-Run            | ↓                    |
| Exposure Policies         | Medium              | Low                        | 💡💡             | Long-run            | ↓                    |
| Trade and competition     | High                | Medium                     | 💡💡             | Medium-Run          | ↑                    |
| Gr: Inn Change            |                     |                            |                |                     |                      |

“Demand”

“Supply”

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“Demand”

“Supply”

# Types of Human Capital Policy

- **Increase supply of STEM qualified people**
- **Expand Universities**
  - General
  - Effect via supply of grads and postgrads
  - National Labs (Jaffe and Lerner, 1990)
  - Academic incentives (Lach & Schankerman, 2008; Hvide and Jones, 2018)
- Immigration
- “Lost Einsteins and Marie Curies”

## Universities: General Effects

- Positive impact of university entry/expansion on GDP per capita
  - Valero and Van Reenen (2019), 50 years of sub-national data across 100 countries
- Effects of universities on innovation (usually positive)
  - Jaffe (1989): US state-level spending on university research associated with more local corporate patenting
  - Acs et al (1992) using innov surveys
  - Belenzon and Schankerman (2013), Hausman (2018) on patenting

## Some Issues with university studies

- **Endogeneity** of university presence/expansion
  - Furman & MacGarvie (2007) use Morrill Acts (land grant college funds) to IV for university location looking at impact on corporate pharma R&D labs 1927-46
- Even if causal impact of universities on innovation, is the **mechanism** through graduate supply? Alternatives:
  - Faculty research/activity
  - Institution building (Valero & Van Reenen, 2019)
  - Demand (Andrews, 2018)

## Is the university impact on innovation (partially) through graduate supply? More direct evidence

- Bianchi & Giorcelli (2020)
  - Enrolment requirements changed for STEM majors in Italy
  - Subsequent innovation increased, especially in bio-medical & ICT
  - But some leakage into other sectors (like finance)
- Increase in STEM-focused colleges and long-term innovation (patenting measures)
  - Toivanen & Vaananen (2016), founding of technical schools in 1960s led to supply increase of engineers in Finland
  - Carneiro, Liu & Salvanes (2018), university expansion in Norway in 1970s led to STEM supply boost

# Types of Human Capital Policy

- Increase supply of STEM qualified people
- Expand Universities
- **Immigration**
- “Lost Einsteins”

## Immigration (“Buy rather than Make”)

- **Kerr & Kerr (2022):** Immigrants are 14% of US workforce but 25% of patents; 42% of STEM doctorates, 1/3 Nobel Prizes
- Relaxing immigration an attractive policy because:
  - Quickly increases STEM workforce
  - Foreign country pays for (at least) some of training
- Note that zero sum from a world perspective. “Brain Drain” vs. “Brain Gain” ethical issues.

## Empirical Findings on immigration and innovation

- Generally, studies find positive effect on innovation of immigrants themselves and from spillovers to natives
  - Hunt & Gauthier-Loiselle (2010) state panel 1940-2000; Kerr & Lincoln (2010) on H1(B) policy changes
  - Bernstein, Diamond, McQuade & Pousada (2021):
    - Infutor data/USPTO to get SSN based measure of immigrant status
    - Immigrants 10% of pop, 16% of inventors & ~30% of ag. innovation
    - Use premature inventor deaths to identify spillovers (30% of ag. innov immigrants)
  - Moser and San (2019); Doran and Yoon (2018) 1920s quota IV
  - Moser, Voena & Waldinger (2014): Jewish scientists fleeing Nazis

## Empirical Findings on immigration and innovation

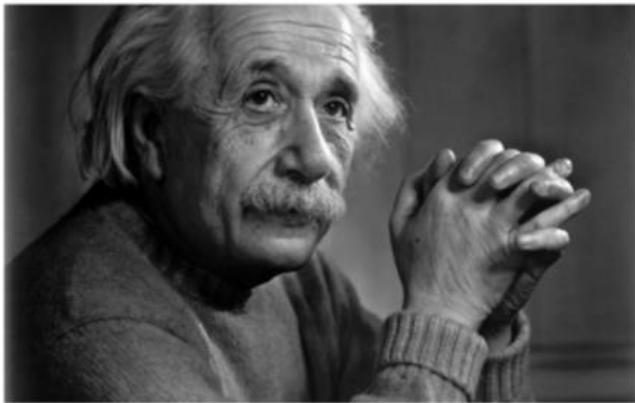
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- Exceptions: Doran et al (2015) on H1(B) lotteries (zero effect); Borjas & Doran (2015) on US mathematicians after fall of Communism
- Problem with pro-immigration policy is socio-political (Tabellini, 2020)

# Types of Human Capital Policy

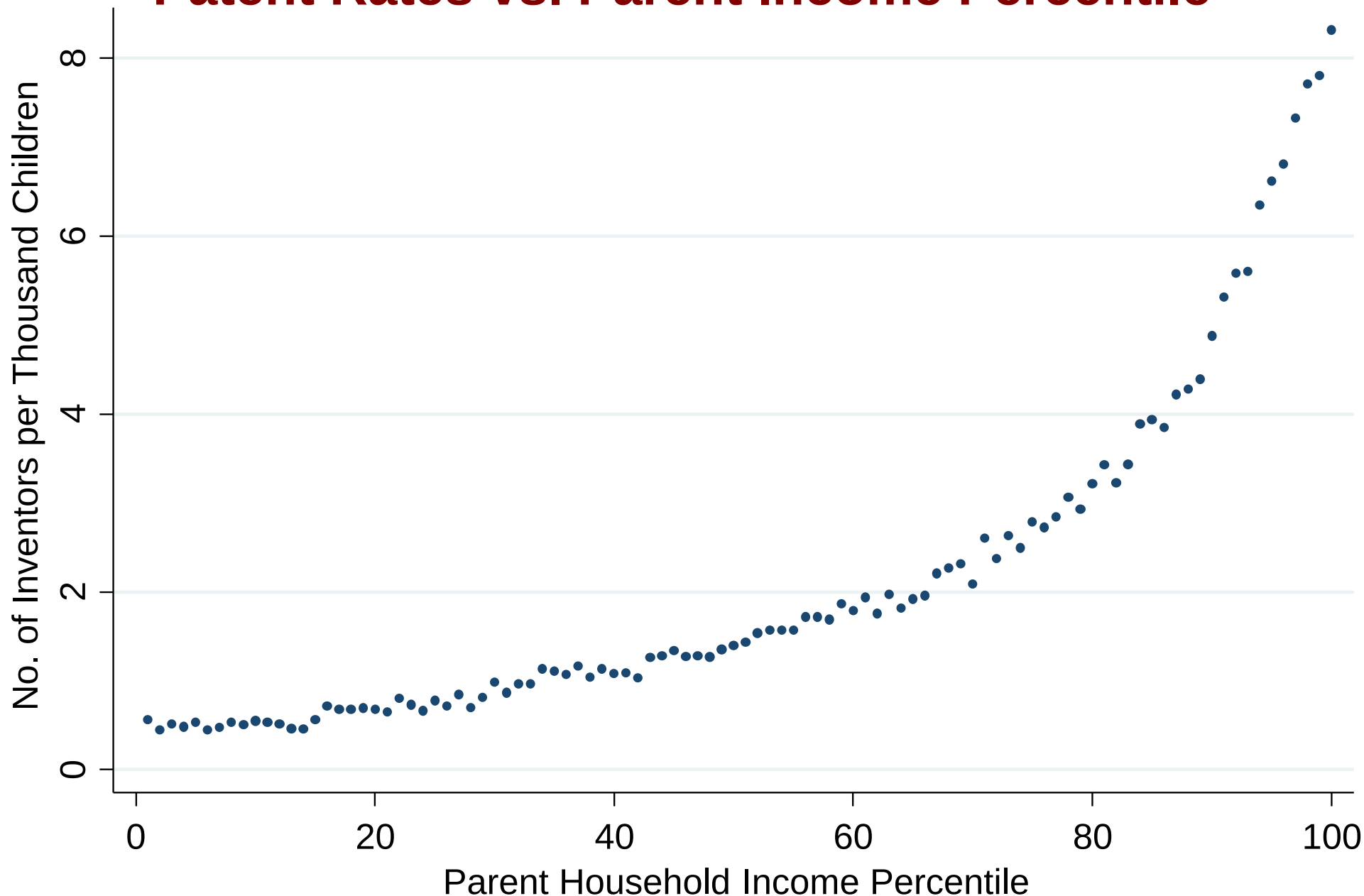
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- Immigration
- **“Lost Einsteins”**

## “Lost Einsteins and Marie Curies”

- **Quality** of inventor pool could be improved as well as quantity
- Bell, Chetty, Jaravel, Petkova & Van Reenen (2019, QJE) match US patent applicants & grants 1996-2014 to de-identified tax records
- Kids from low income families, minorities and women under-represented in the inventor pool
- Vast majority of this is not due to lower ability, but rather lack of opportunity/exposure to innovation

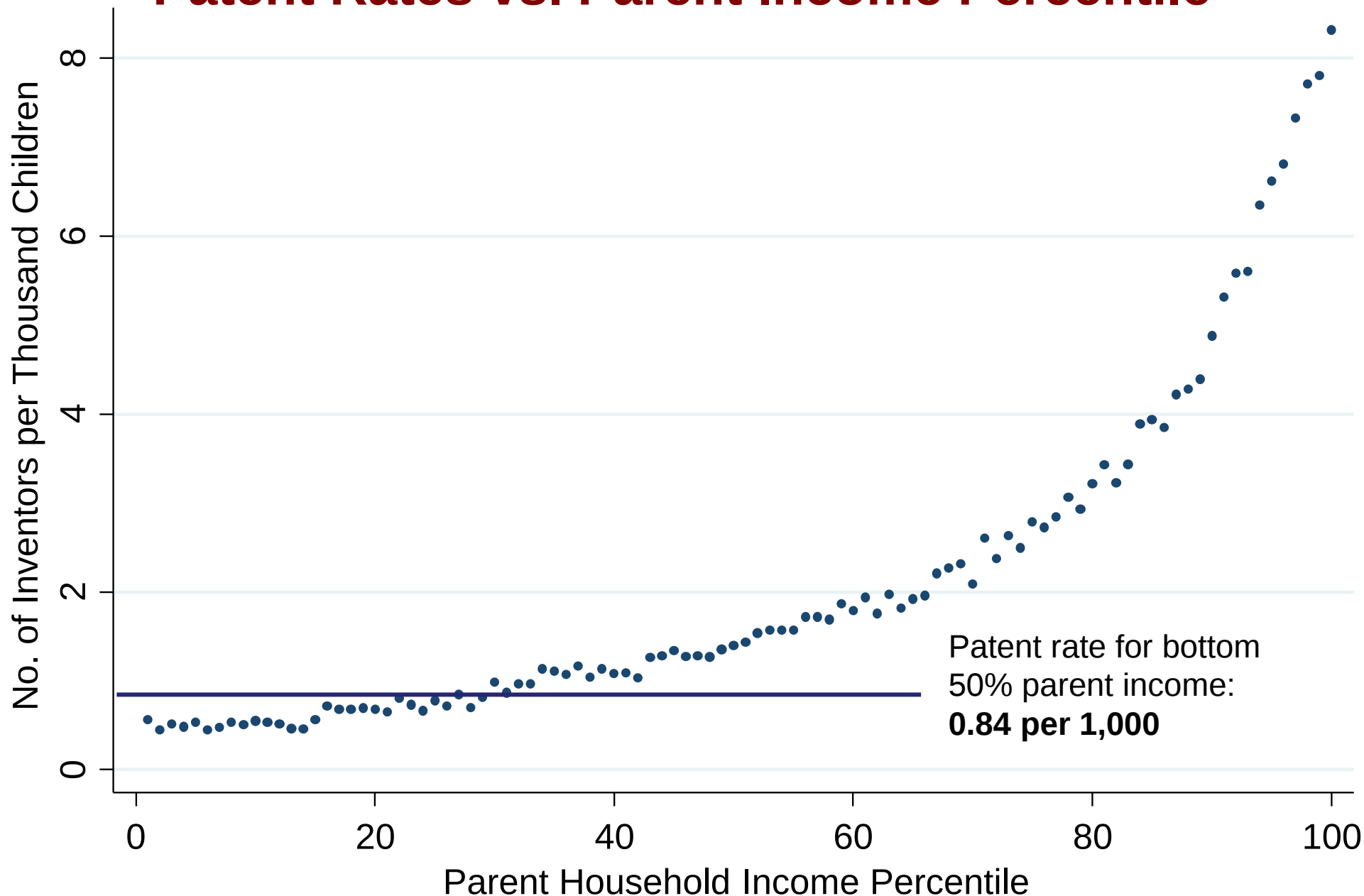


# Patent Rates vs. Parent Income Percentile



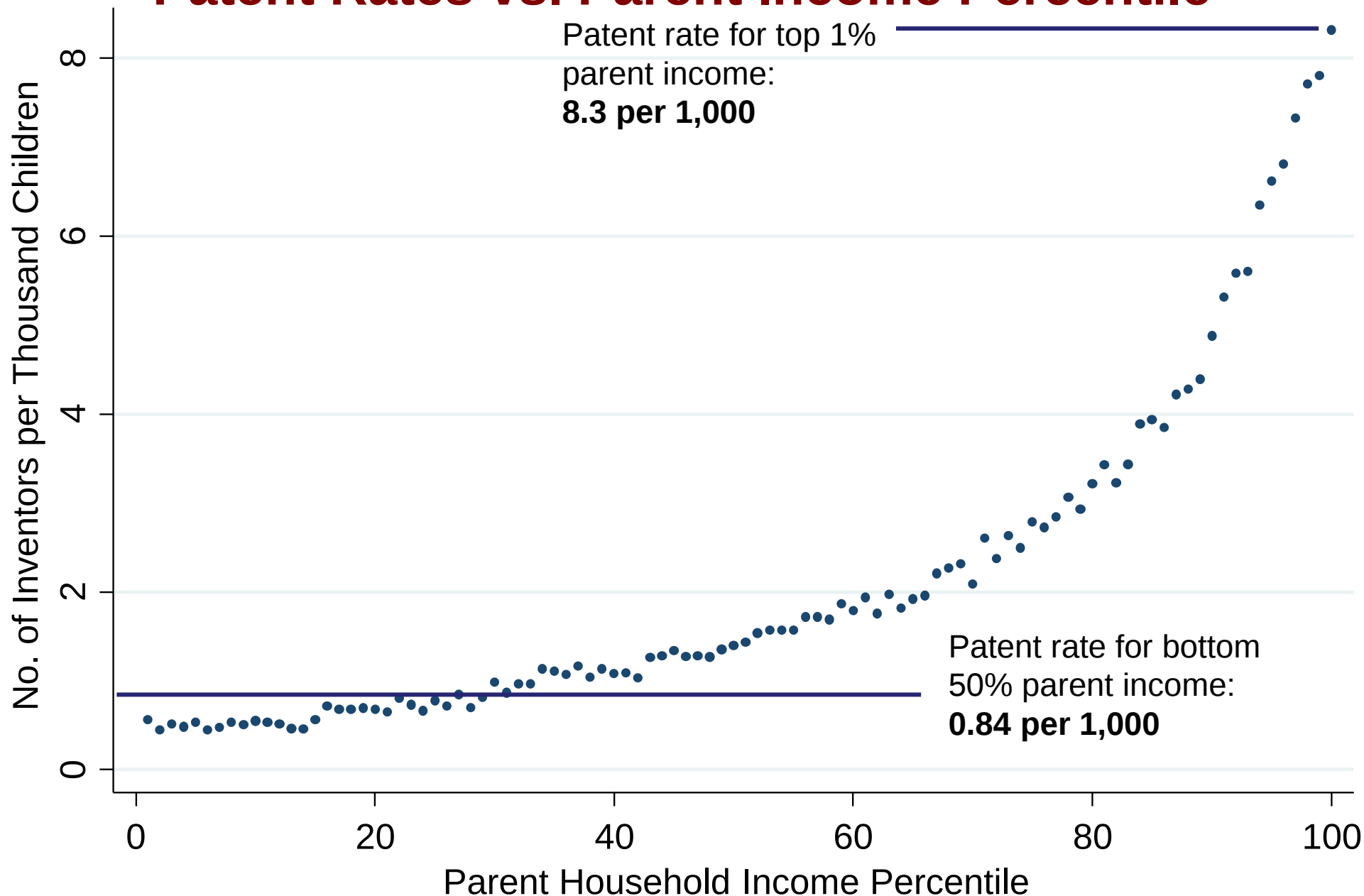
Notes: Sample of children is 1980-84 birth cohorts. Parent Income is mean household income from 1996-2000.

# Patent Rates vs. Parent Income Percentile



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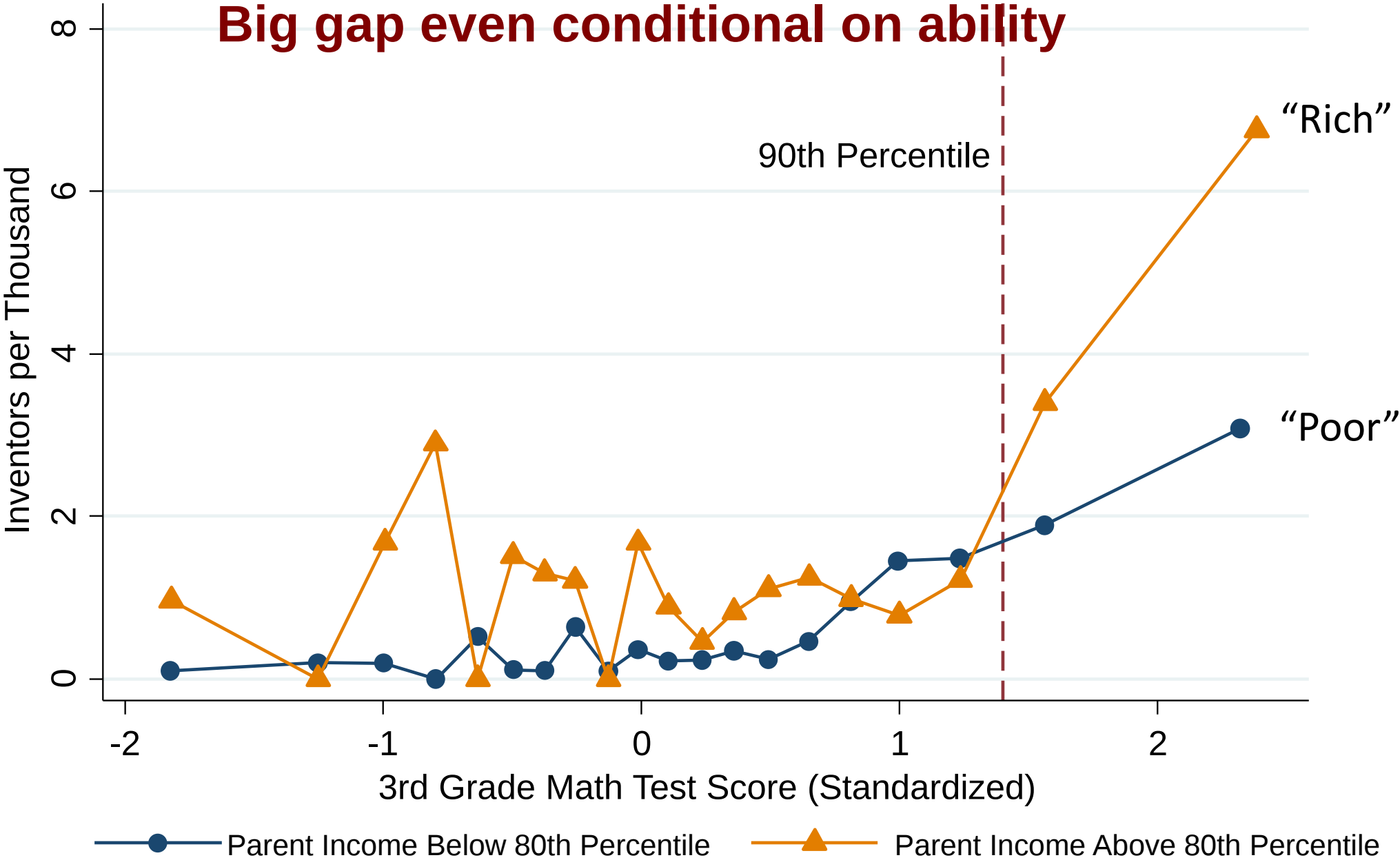
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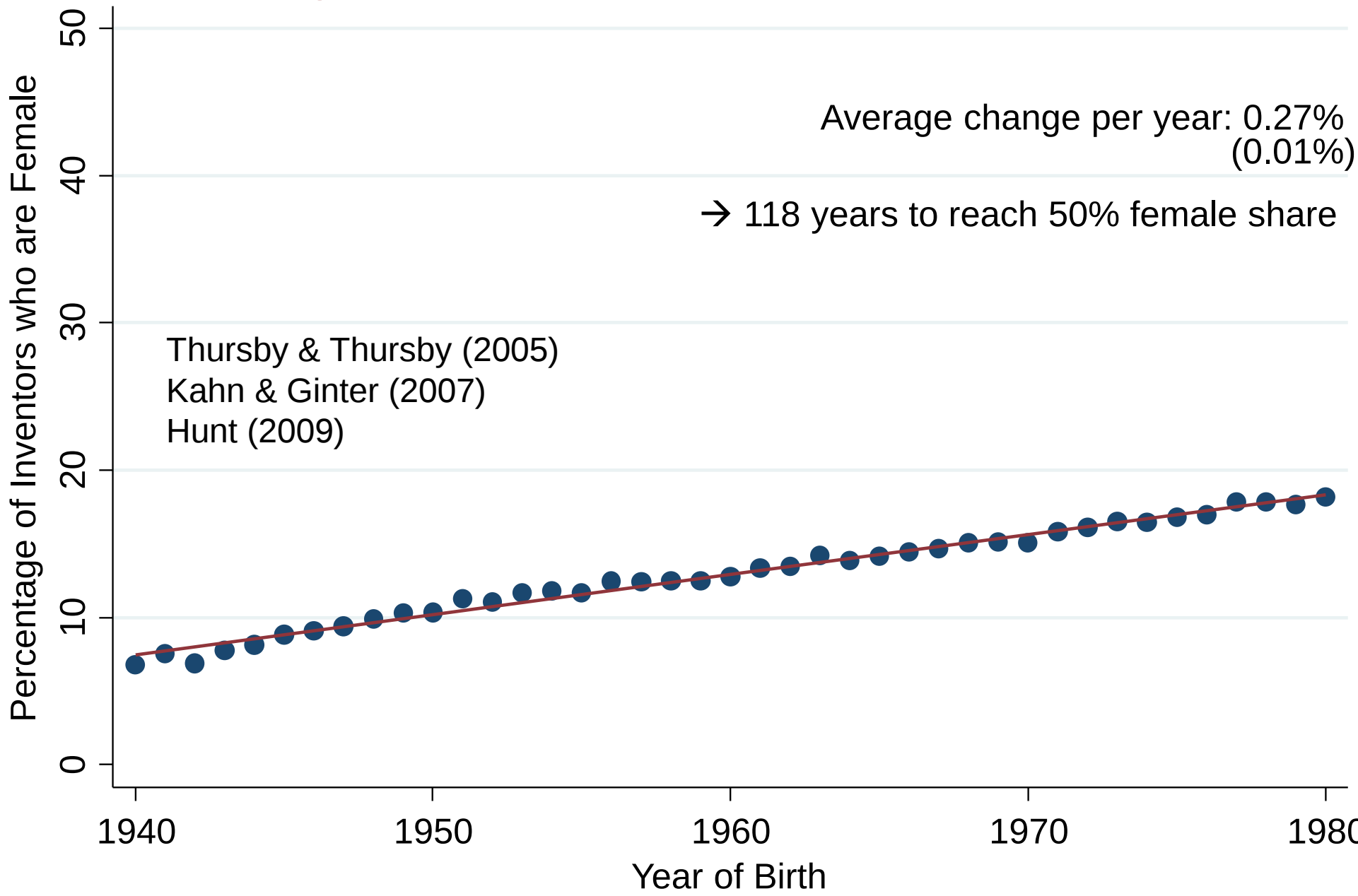
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# Patent Rates vs. 3rd Grade Math Test Scores by Parental Income:

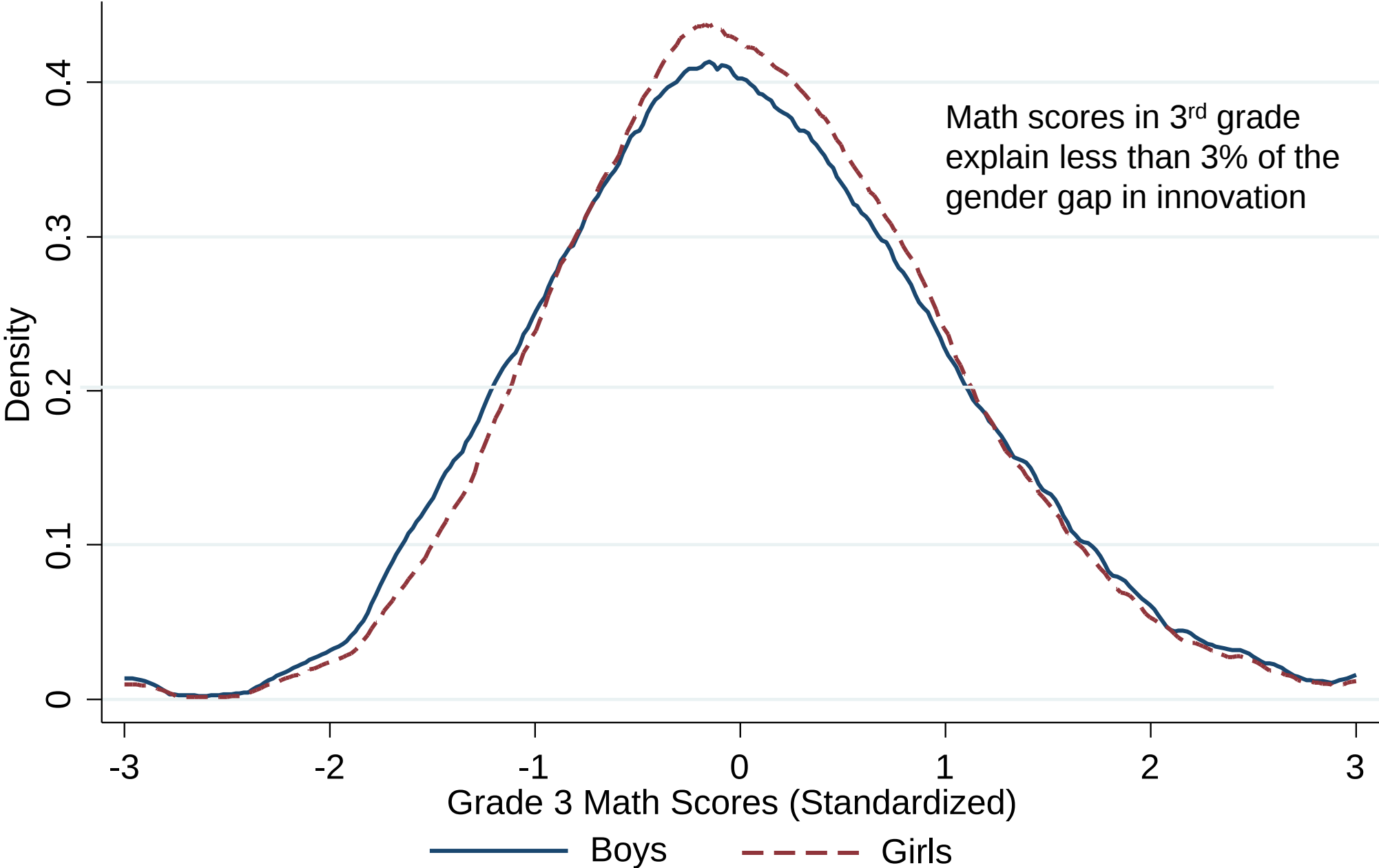
Big gap even conditional on ability



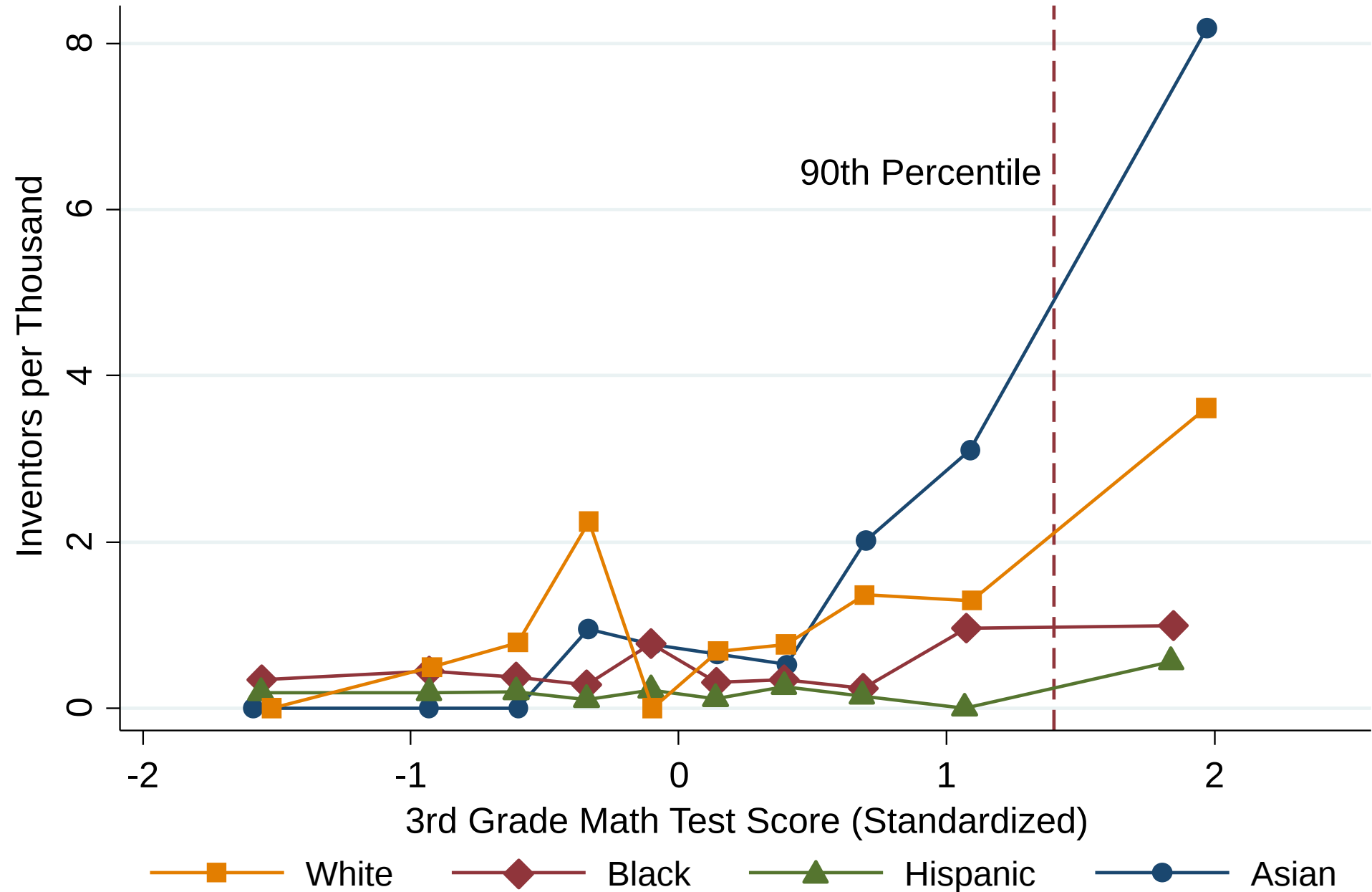
# Gender: Percentage of Female Inventors by Birth Cohort



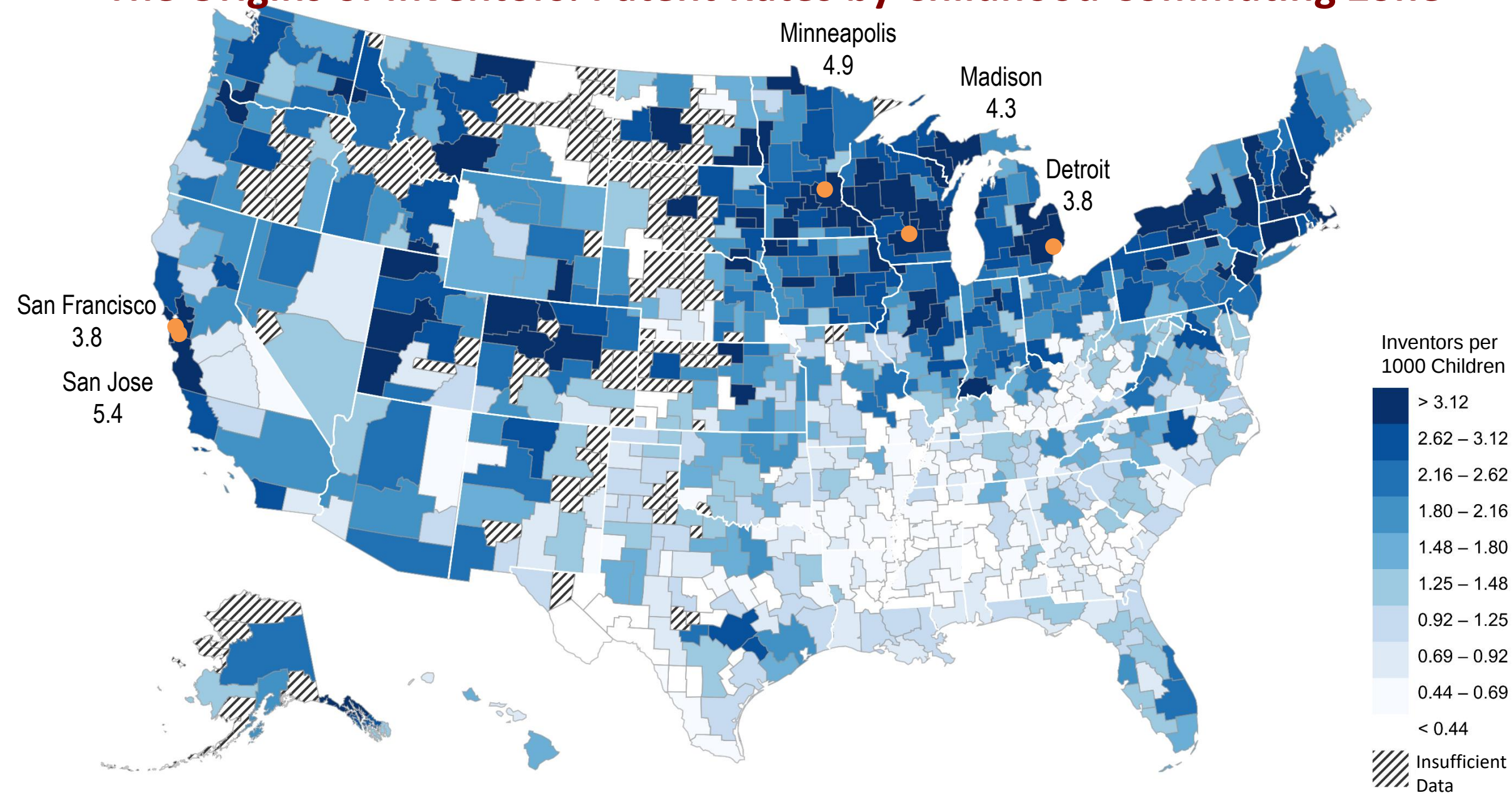
# Distribution of Math Test Scores in 3rd Grade for Boys vs. Girls



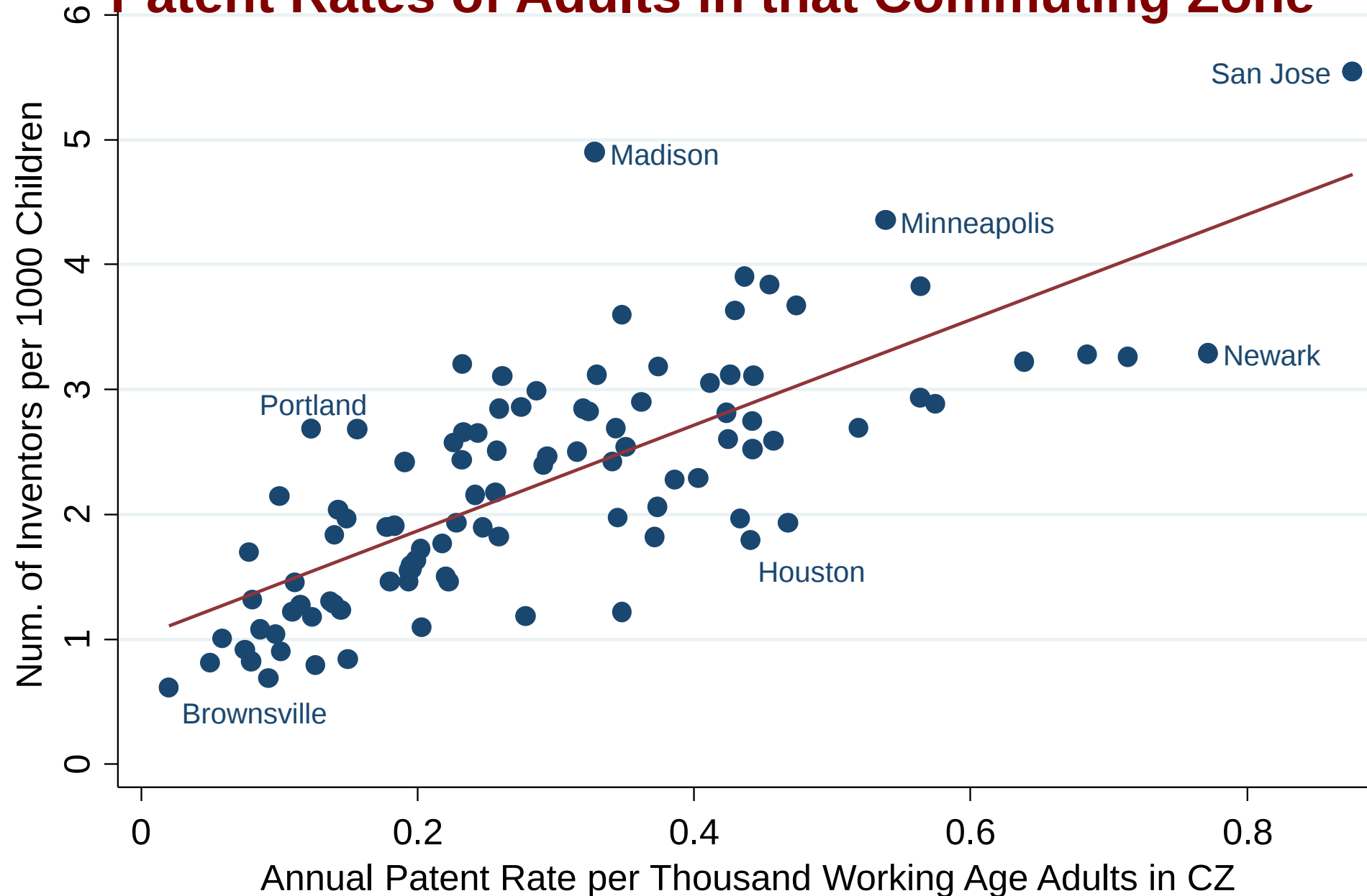
# Patent Rates vs. 3rd Grade Math Test Scores by Race and Ethnicity



# The Origins of Inventors: Patent Rates by Childhood Commuting Zone



# Patent Rates of Children who Grow up in a Commuting Zone vs. Patent Rates of Adults in that Commuting Zone



## Identification of the causal impact of place-based exposure

- **Timing and Fixed effects:** Regress adult outcomes on childhood exposure, including current destination place effects
- Use the sharp discontinuity by **technology class**.
  - Idea is that growing up in area that specializes in software (vs. medical devices) relatively more likely to innovate in software (vs. medical devices)
- **Movers design:** compare families where kids moved at early vs. later age

# Lost Einstein Policies

- Education policies
- Mentorship/internships
- Tackling Discrimination

## Within School tracking for Gifted and Talented (“G&T”)

- **Card and Giuliana (2016)** study large urban US School District with in-school tracking program
- 4<sup>th</sup> and 5<sup>th</sup> graders. If a G&T pupil, school has to have a separate “Gifted/High Achievers” class. But, since few G&T most seats are simply high achievers
- Since lots of between school segregation many high achievers are Black & Hispanics
- Rank RD Design shows large positive effects on Math & English for minorities (0.5sd). Persist until at least 6<sup>th</sup> grade
- Diff-In-Diffs on cohort shows no negative effects on kids who don’t get selected into GHA class
- Not better teachers or quality peers, but teacher expectations

## Within School tracking

- **Cohodes (2010)** looks at similar in-school tracking in Boston Public School System
- 3<sup>rd</sup> graders in Advanced Work Class. Half are minorities
- Fuzzy RDD finds college enrolment 15 pp higher, with gains mainly from minority students (65% increase in college enrolment on 4 year course)

## **Summary on examples of exposure programs in Card & Giuliano (2016) and Cohodes (2020)**

- Not simply a G&T programs (where low income and minority kids often don't qualify). These ambiguous (e.g. Bui et al, 2014)
- Rather, both papers a broader within (not between) school tracking policy to create exposure

## Conclusions on Human Capital Policies for innovation

- Human capital policy acts on supply side, so more attractive than “demand side” tax/subsidy policies
  - Lower risk of increasing equilibrium costs (and inequality)
  - And some evidence of successful interventions
- But some limitations:
  - Less of an empirical literature than demand side policies
  - Policies will take longer to have an effect
  - Leakage issues (although less of a problem for US than for other countries)