Innovation and Human Capital Policy

NBER Innovation Boot Camp
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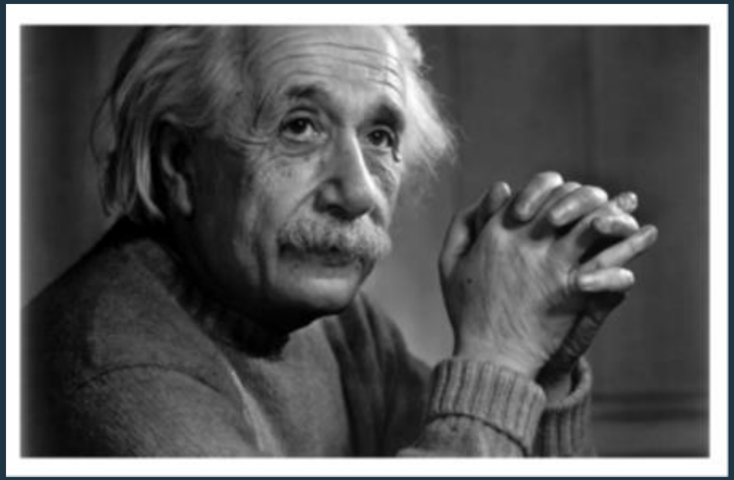
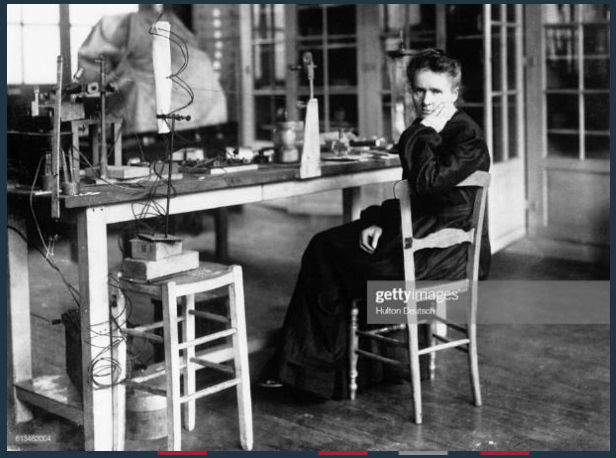
John Van Reenen

LSE and MIT



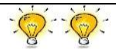
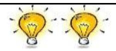
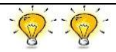
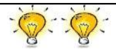


Why is human capital policy attractive to boost innovation?

- **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) Policy	(2) Quality of evidence	(3) Conclusivenes s of evidence	(4) Benefit - Cost	(5) Time frame:	(6) 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	↑
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"Demand"

"Supply"

Source: Bloom, Van Reenen and Williams (2019, JEP)

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Policy	**Quality of evidence**	**Conclusiveness of evidence**	**Benefit - Cost**	**Time frame:**	**Effect on inequality**
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Gr Inn Challenge					

“Demand”

“Supply”

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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

- Generally find positive effect on innovation of immigrants themselves and from spillovers to natives
- 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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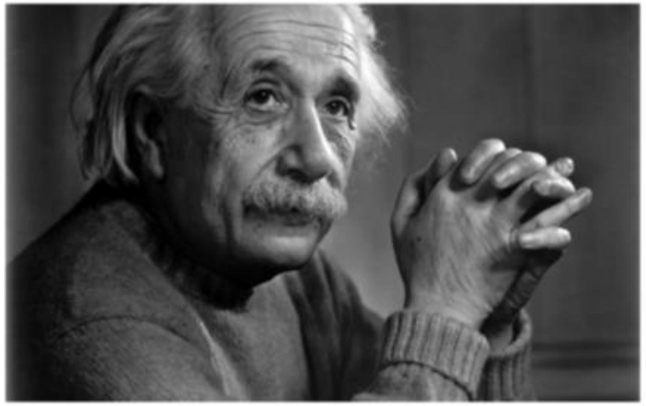
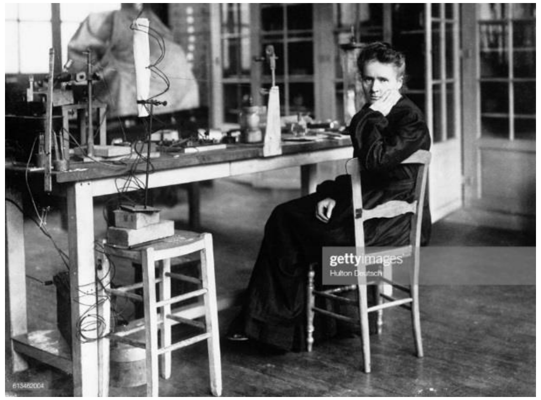
- **“Lost Einsteins”**

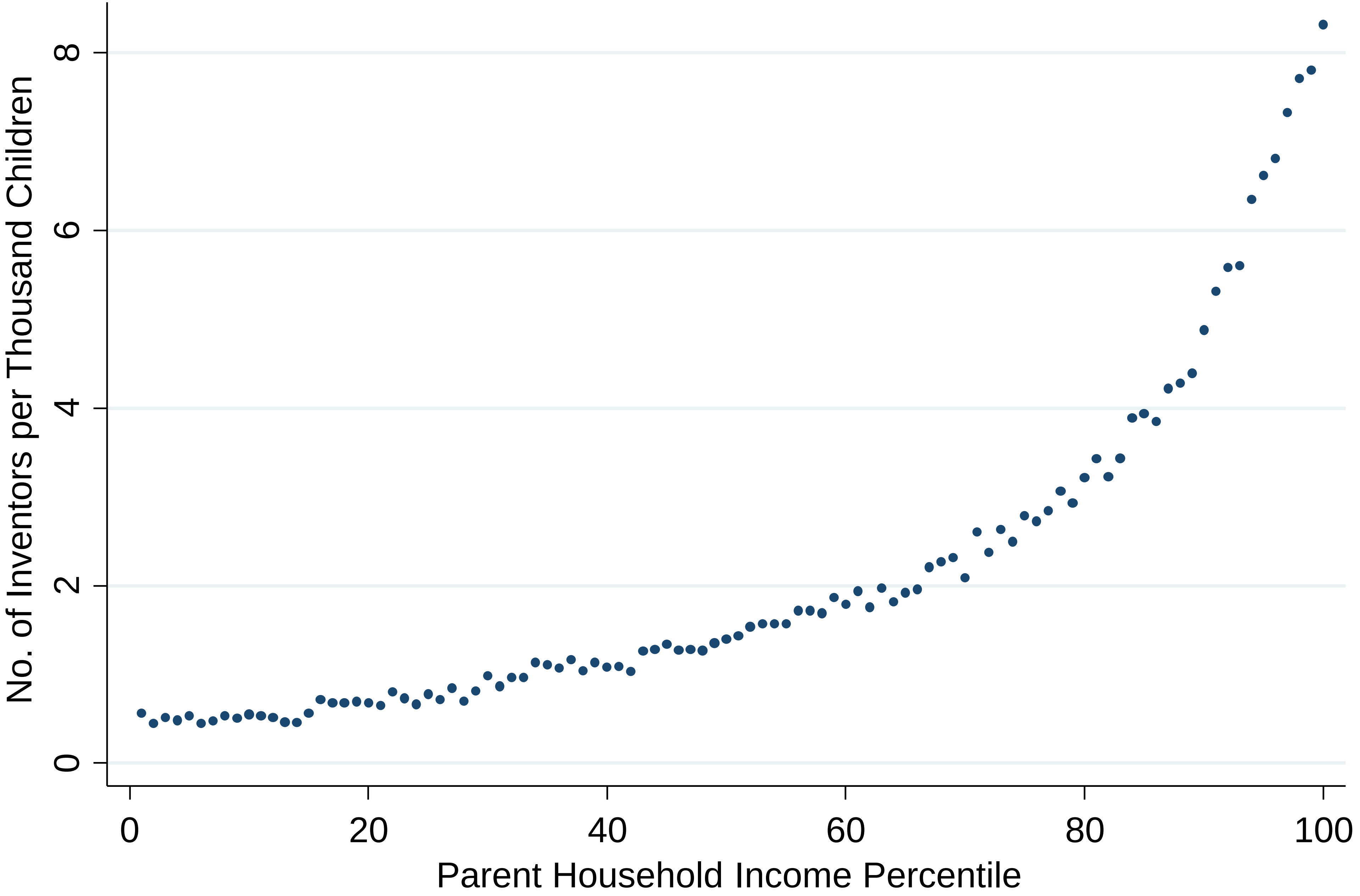
"Lost Einsteins and Marie Curies"

- **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.

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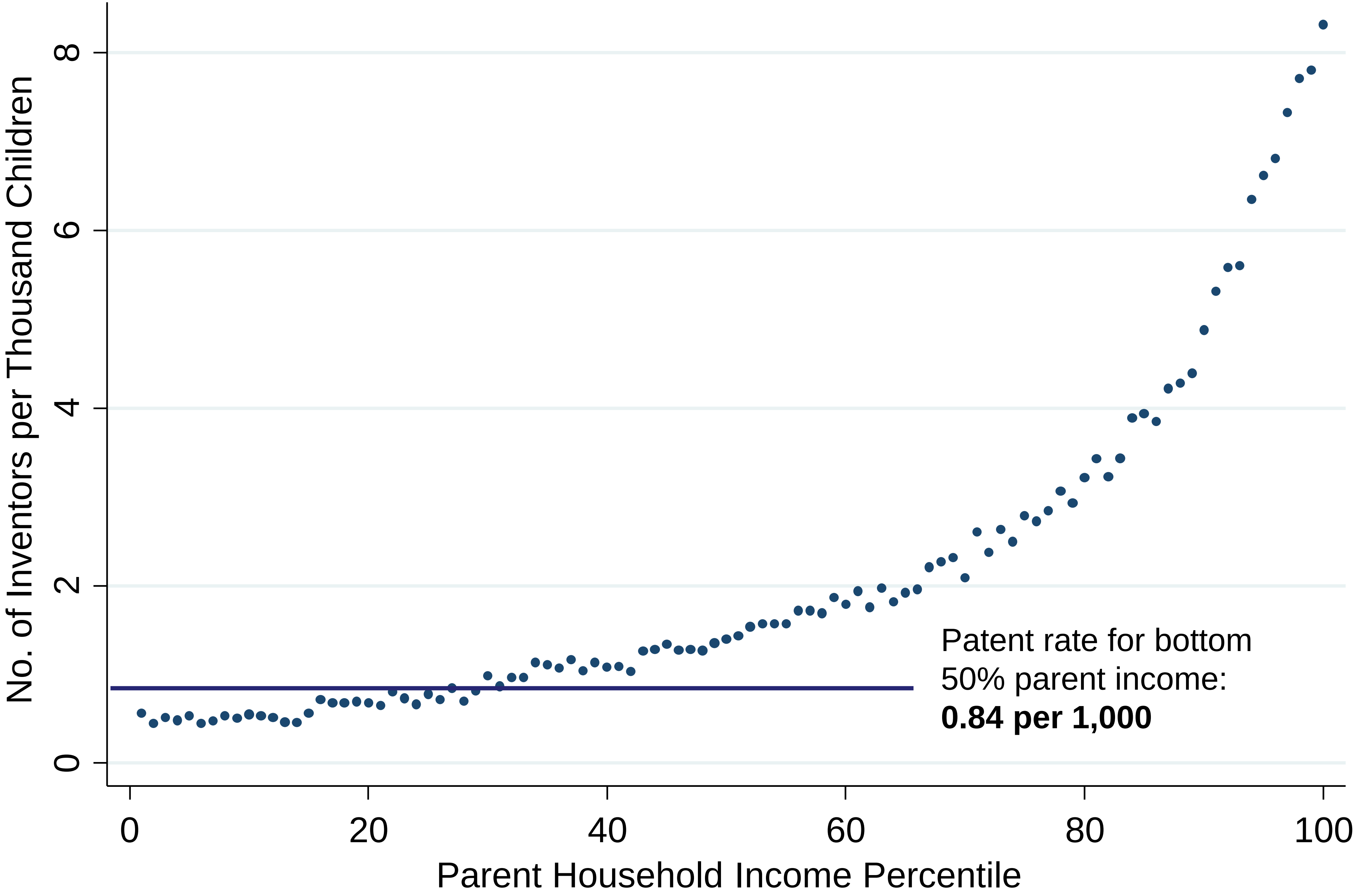

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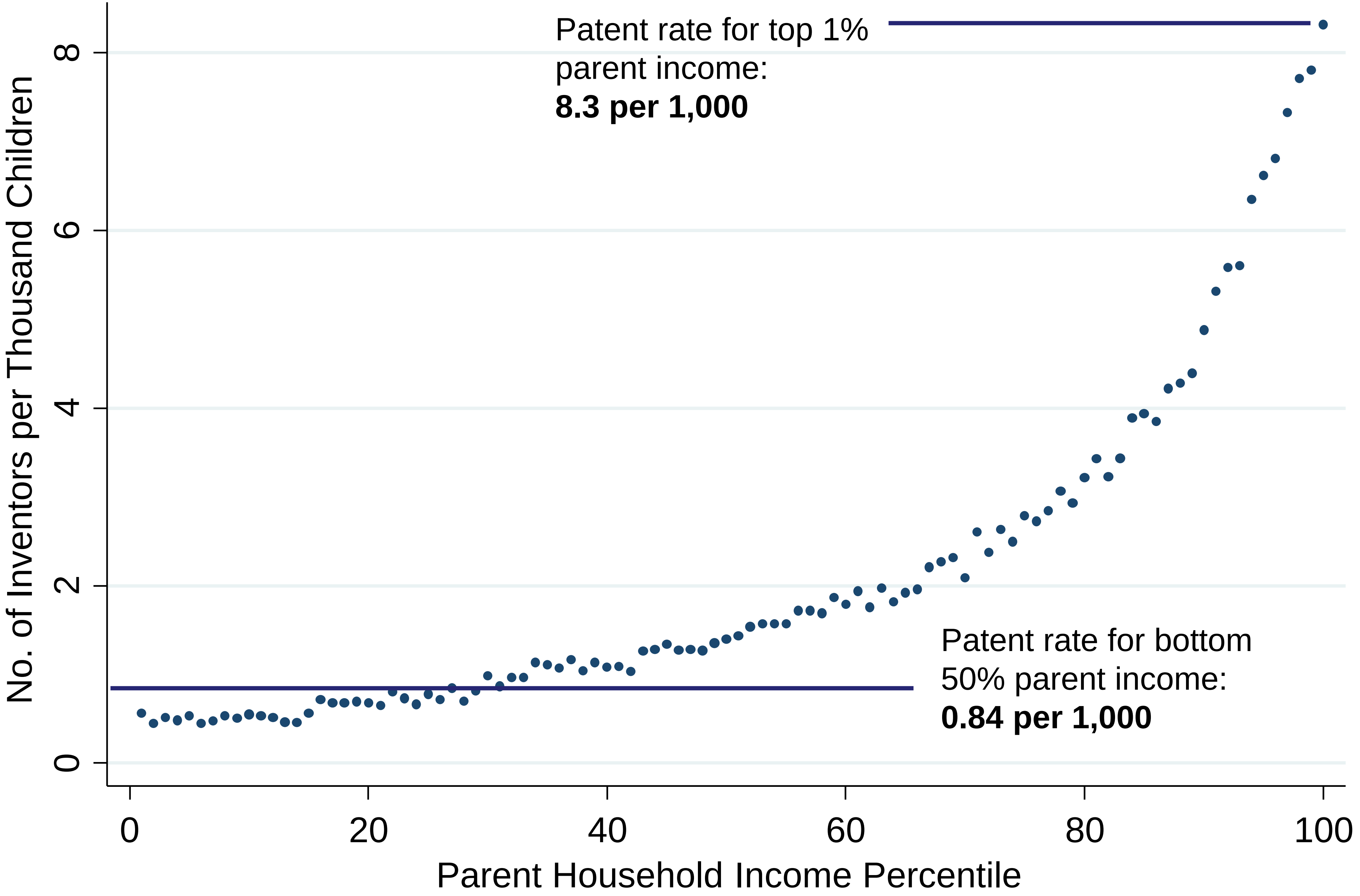

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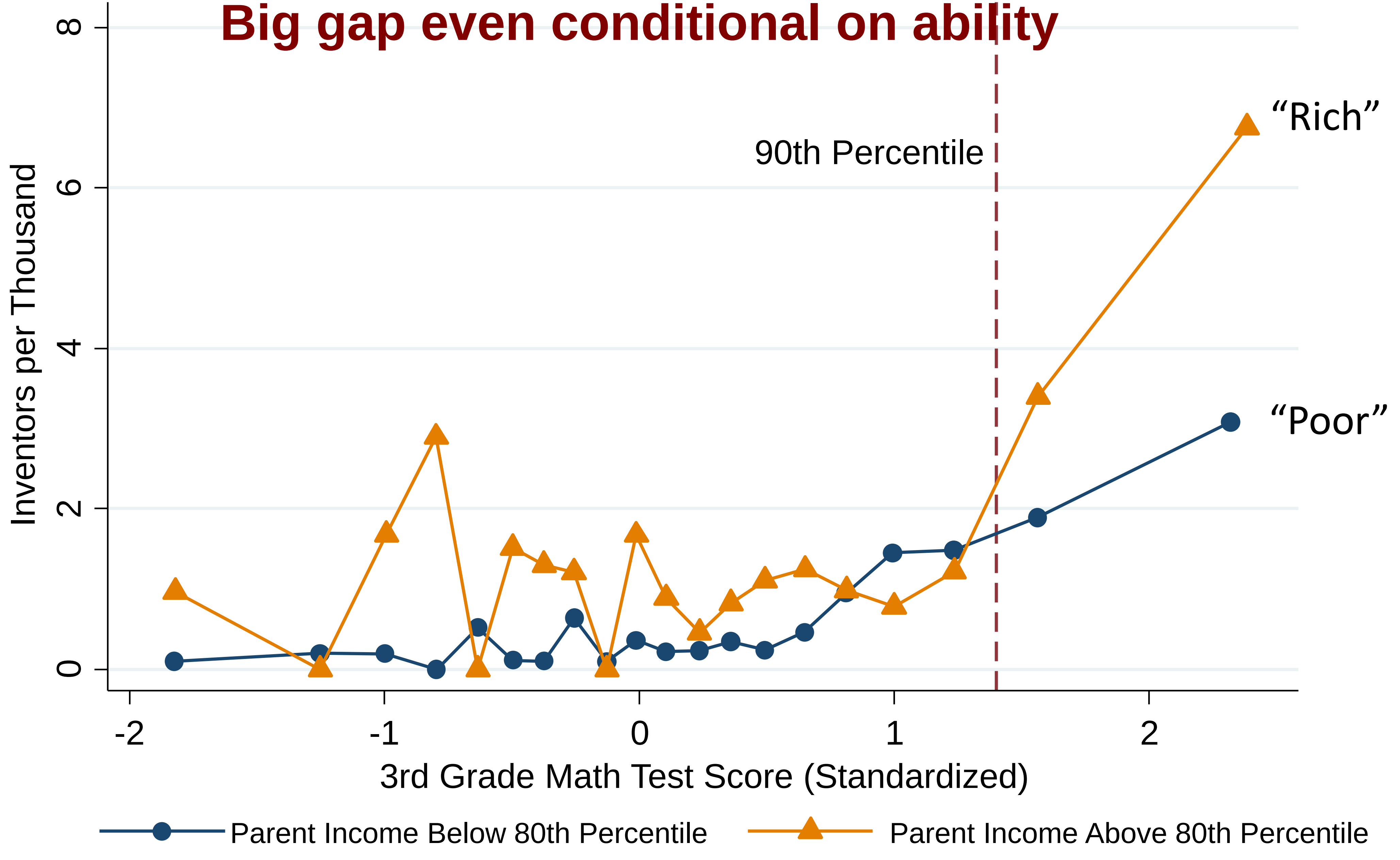
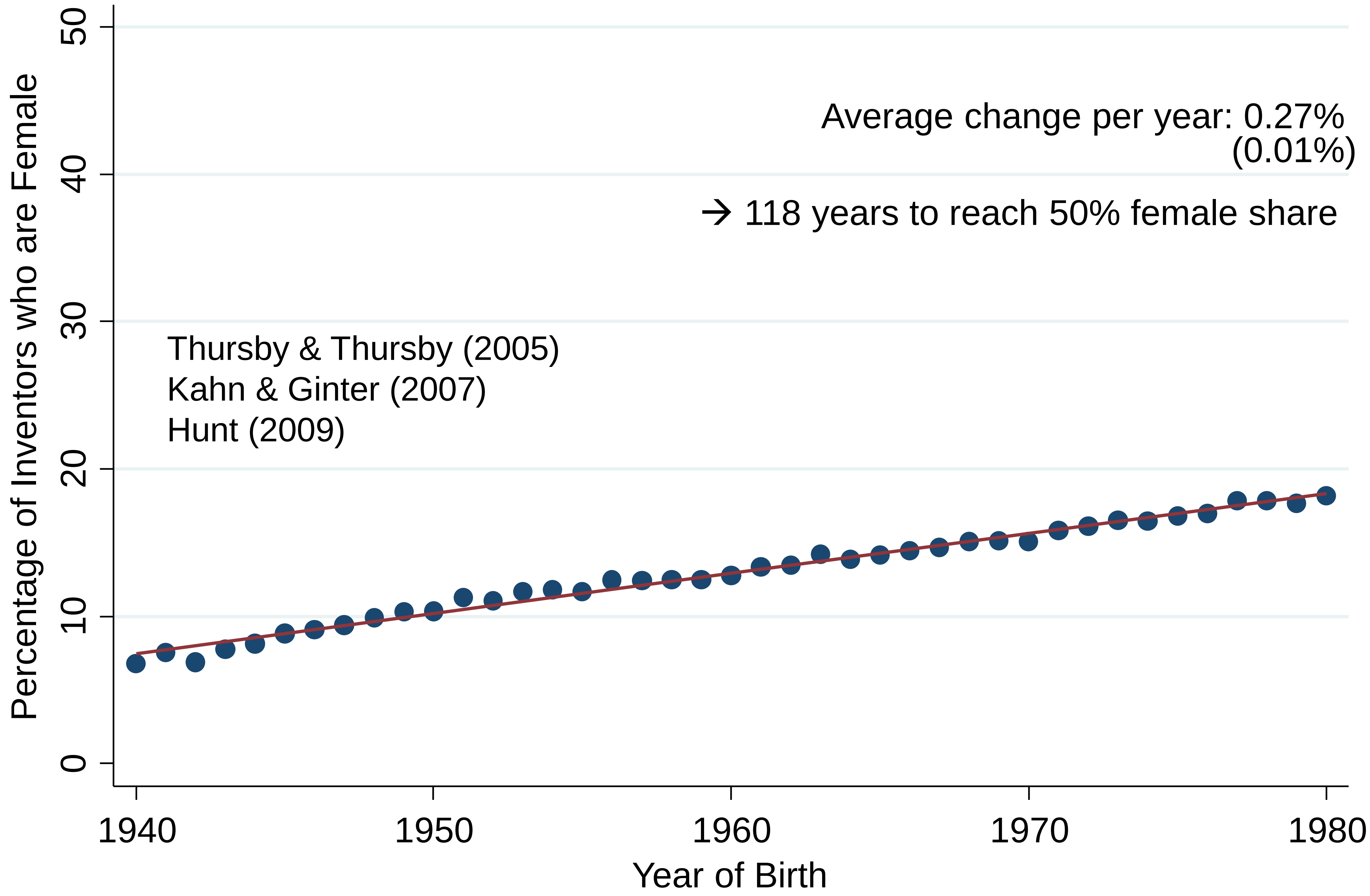
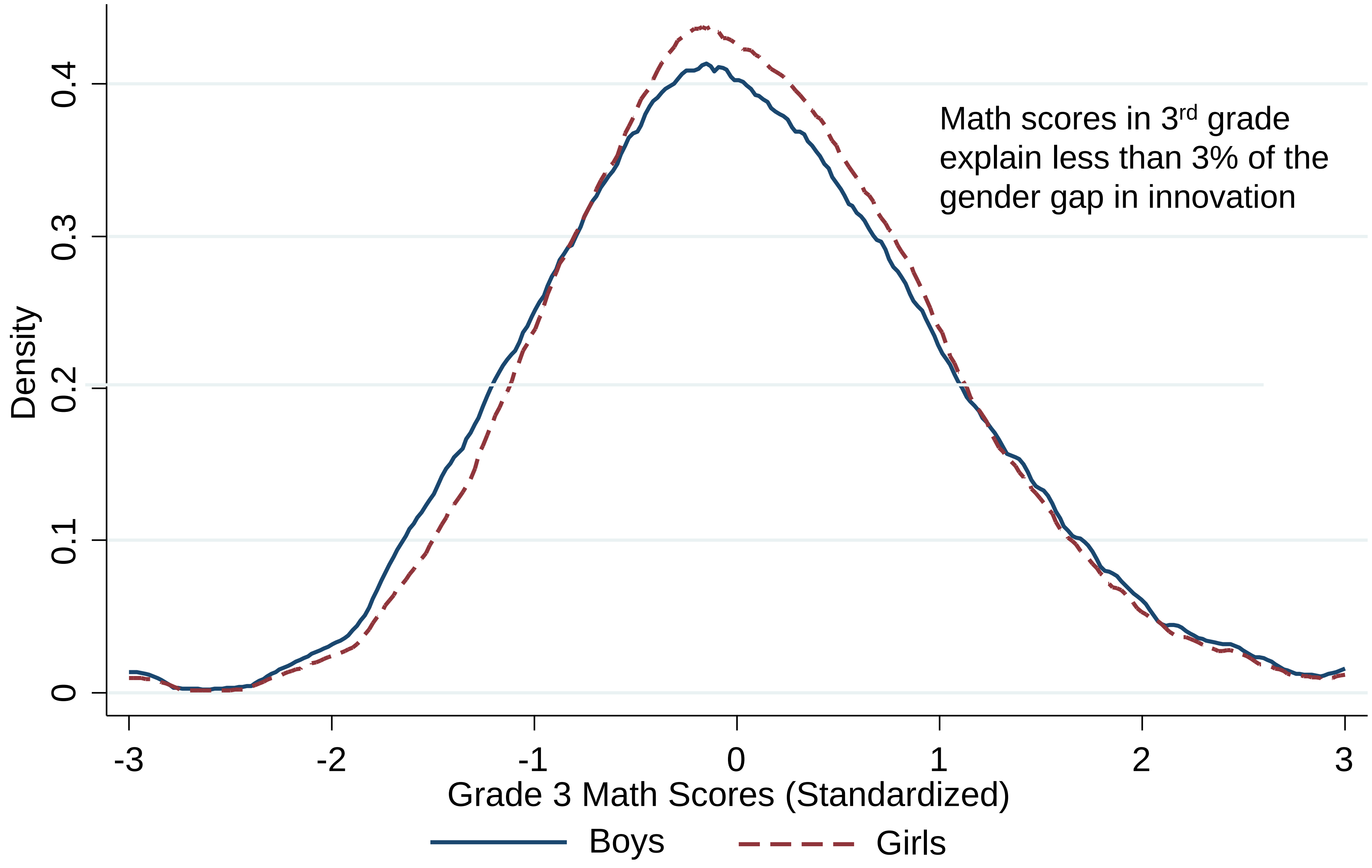
Patent Rates vs. 3rd Grade Math Test Scores by Parental Income: Big gap even conditional on ability



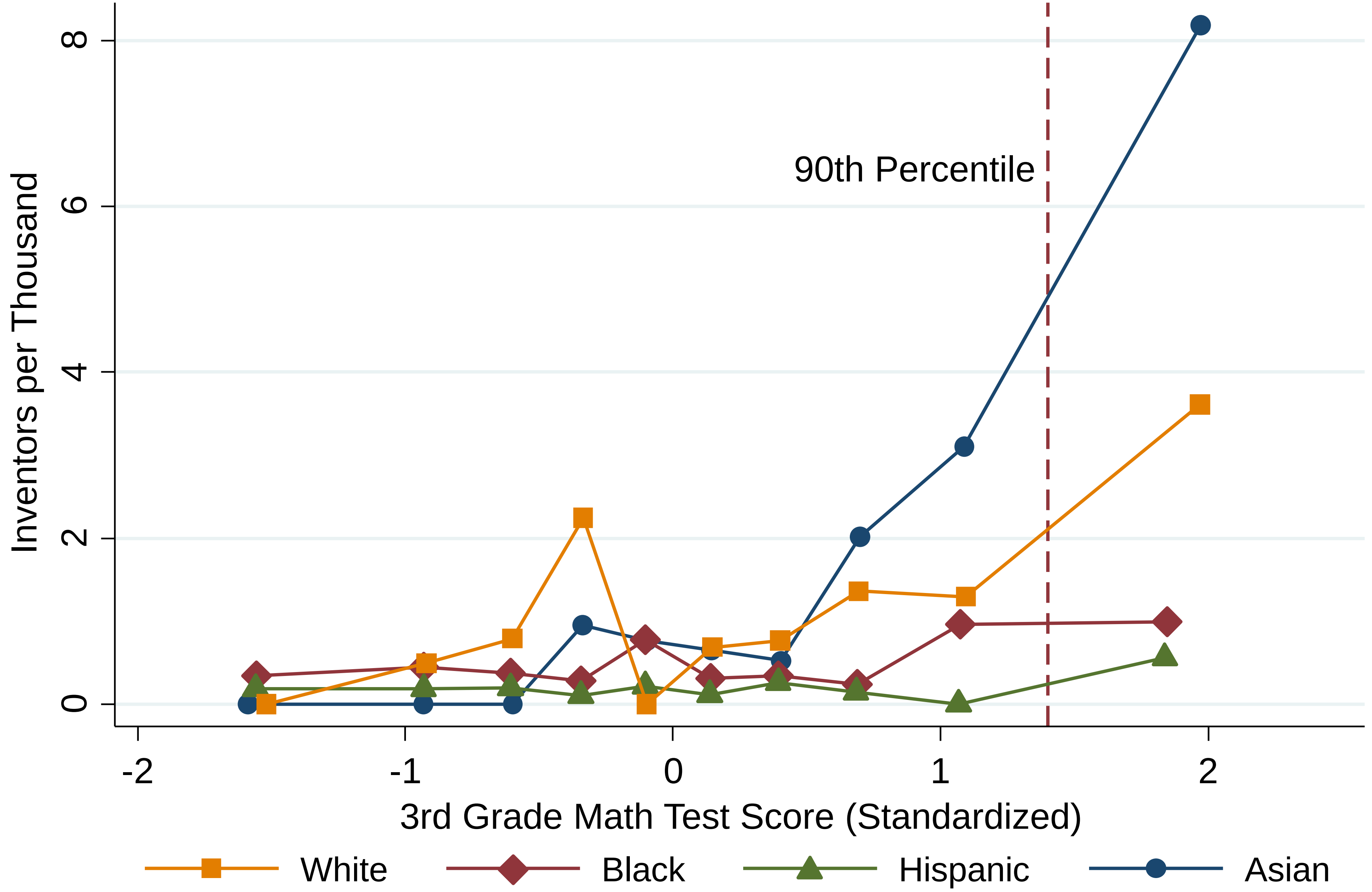
Gender: Percentage of Female Inventors by Birth Cohort



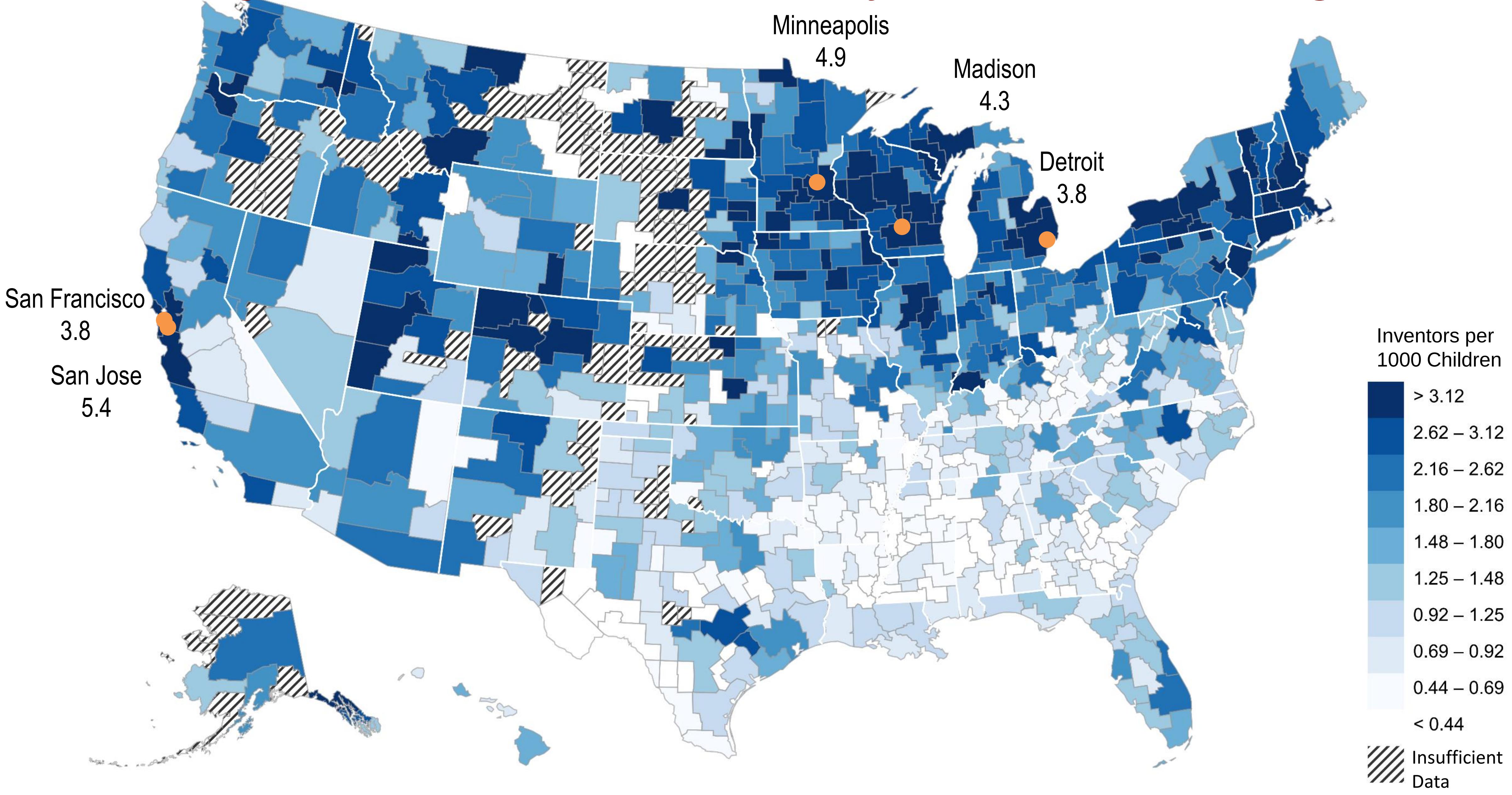
Distribution of Math Test Scores in 3rd Grade for Boys vs. Girls



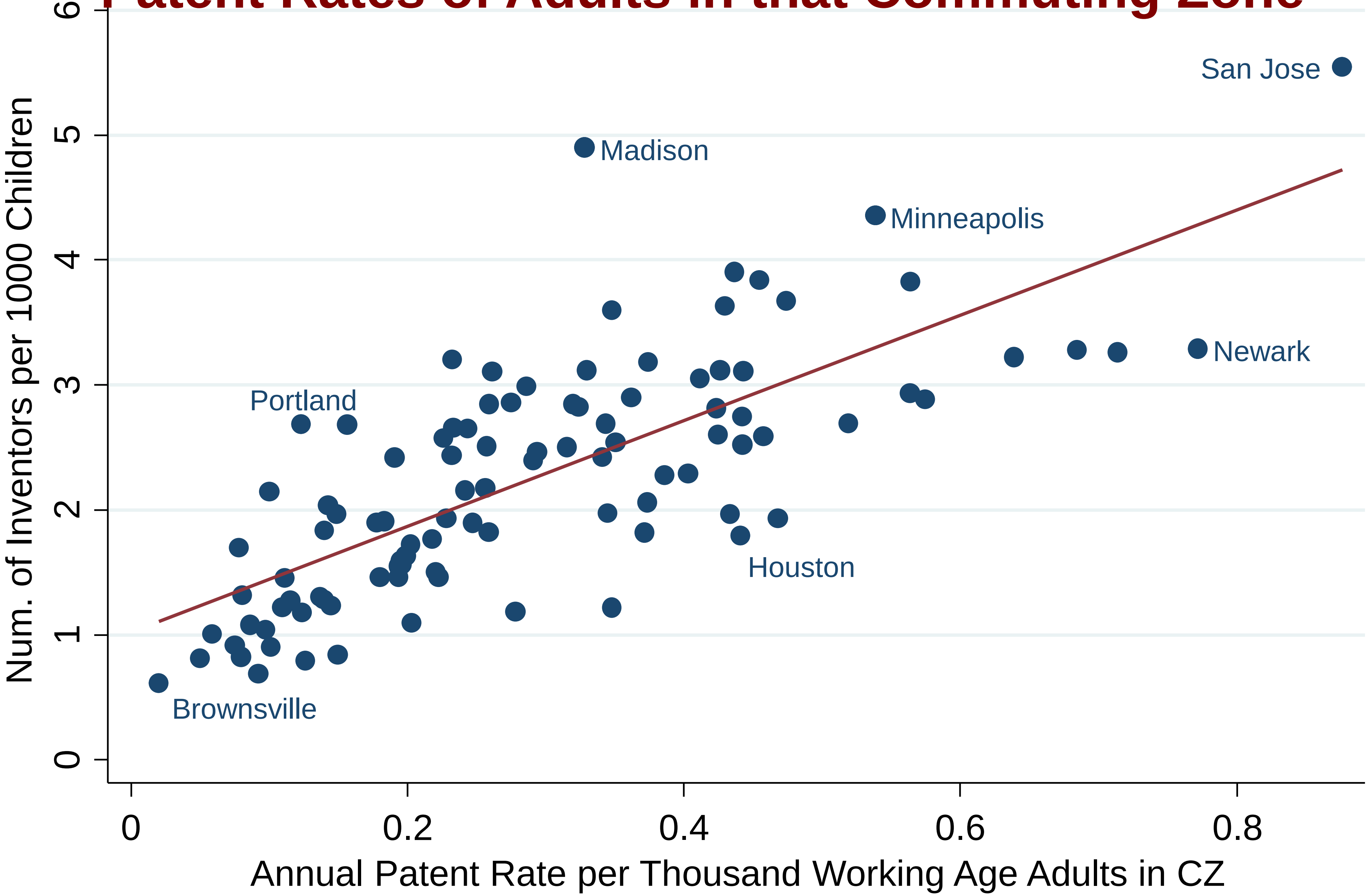
Patent Rates vs. 3rd Grade Math Test Scores by Race and Ethnicity



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^{th} and 5^{th} 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^{th} 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
- 3rd 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 quality). 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)