NATIONAL CENTER for ANALYSIS of LONGITUDINAL DATA in EDUCATION RESEARCH
CALDER
RESEARCH FOR POLICY

Math Acceleration in Elementary School: Access and Effects on Student Outcomes

Steven W. Hemelt
University of North Carolina at Chapel Hill/CALDER

Matthew A. Lenard
Wake County Public School System

B. Aspacia Stafford
University of North Carolina at Chapel Hill

AIR®
AMERICAN INSTITUTES FOR RESEARCH®

Math Matters!

- Math is a core component of students' learning
- Math competence associated with national competitiveness
- More math in high school boosts later outcomes (educational and employment)

More Math – How? For whom?

- Early math → later math:
  - Early exposure to Algebra (in 8th or 9th grade)
    - Mixed findings
  - Universal versus targeted approaches to acceleration
  - Targeted acceleration in math for middle school students in Wake County
- Causal effects of early math acceleration on educational outcomes

Elementary School Math Acceleration

- Test-based approach began in spring of 2014 in WCPSS
- Acceleration process:

2013-14	2014-15	2015-16
2nd grader is nominated by teacher or parent for math acceleration; takes test in spring of 2014	Student is in 3rd grade: • If qualifying exam score >= 80%, then she takes 4th grade math • If score < 80%, she takes 3rd grade math	Student is in 4th grade and continues on accelerated math track (unless removed by parent)

Research Questions

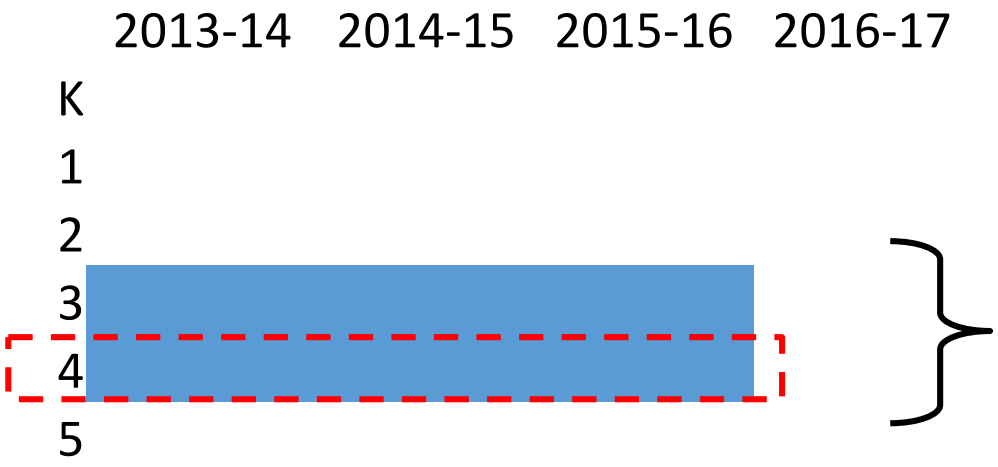
1) Are there gaps in nomination likelihood by gender, race, or ethnicity, conditional on measures of prior achievement?

2) What is the effect of acceleration in math during elementary school on...
   - Math, reading, and science performance
   - Non-test-score measures of effort, engagement, and plans
   - Corse-taking outcomes at start of middle school (6th grade)

Data and Analytic Samples

- Administrative data from Wake County Public School System (WCPSS) from 2013-14 to 2016-17

- Starting analytic sample:



3rd and 4th graders

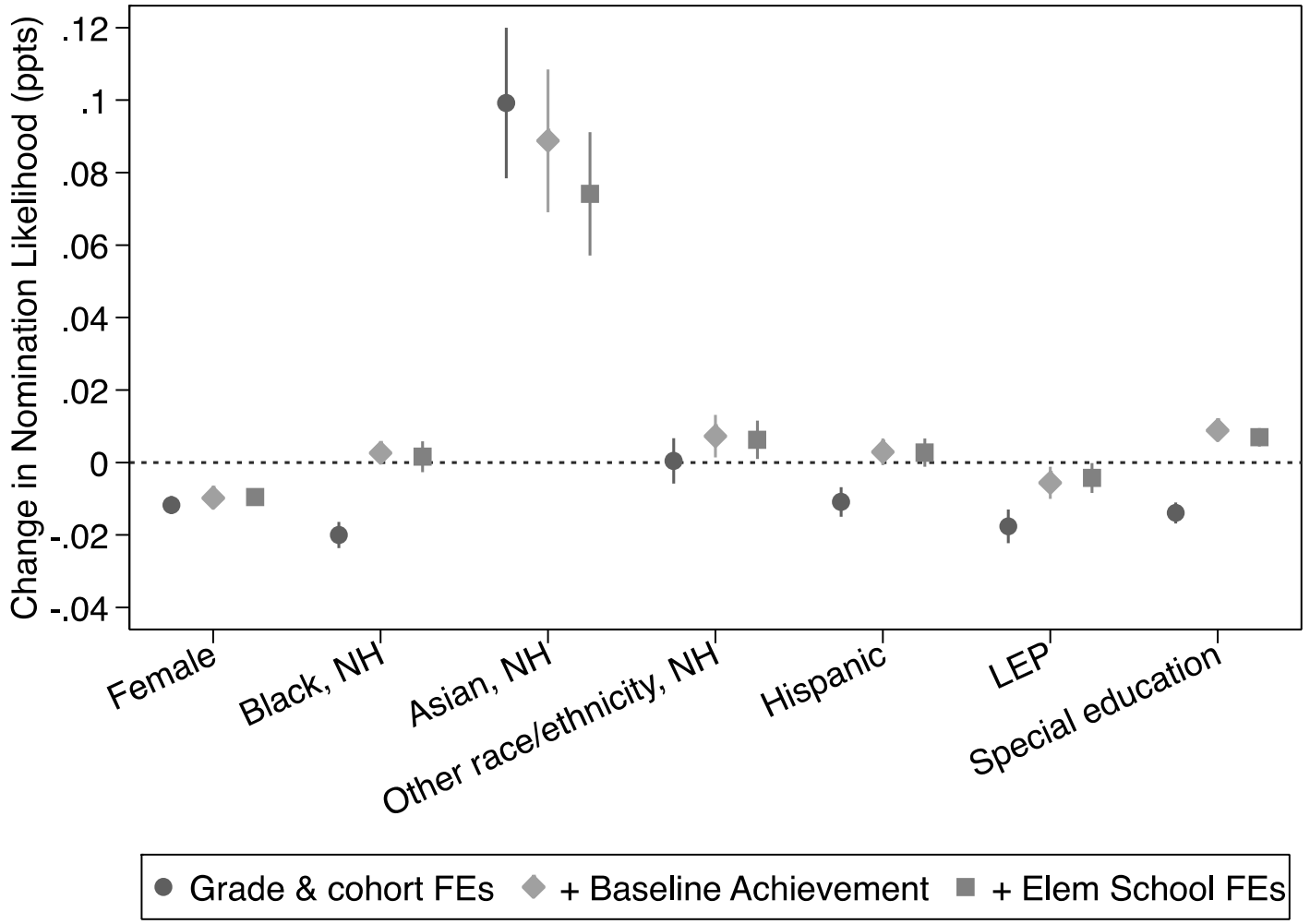
- Available measures of baseline achievement
- Observable short-run achievement outcomes (M + R)

More outcomes: Science test scores; non-test-score measures of engagement, grit, aspirations; course-taking at start of middle school

Descriptive Statistics

Variable	All 3rd & 4th Graders	Nominees	Qualifiers
Demographics			
Female	0.50	0.39	0.35
White, NH	0.48	0.51	0.46
Black, NH	0.22	0.05	0.02
Asian, NH	0.08	0.37	0.46
Hispanic	0.18	0.03	0.01
LEP	0.14	0.09	0.07
Special education	0.11	0.03	0.02
Baseline Achievement		*80-85th pctile of WCPSS distributions*	
Math EOG Score, std	0.009 (0.98)	1.12 (0.54)	1.51 (0.37)
Reading EOG Score, std	0.001 (0.99)	0.87 (0.60)	1.17 (0.47)
Accelerated	0.004	0.14	0.56
N(students)	70,773	1,792	416

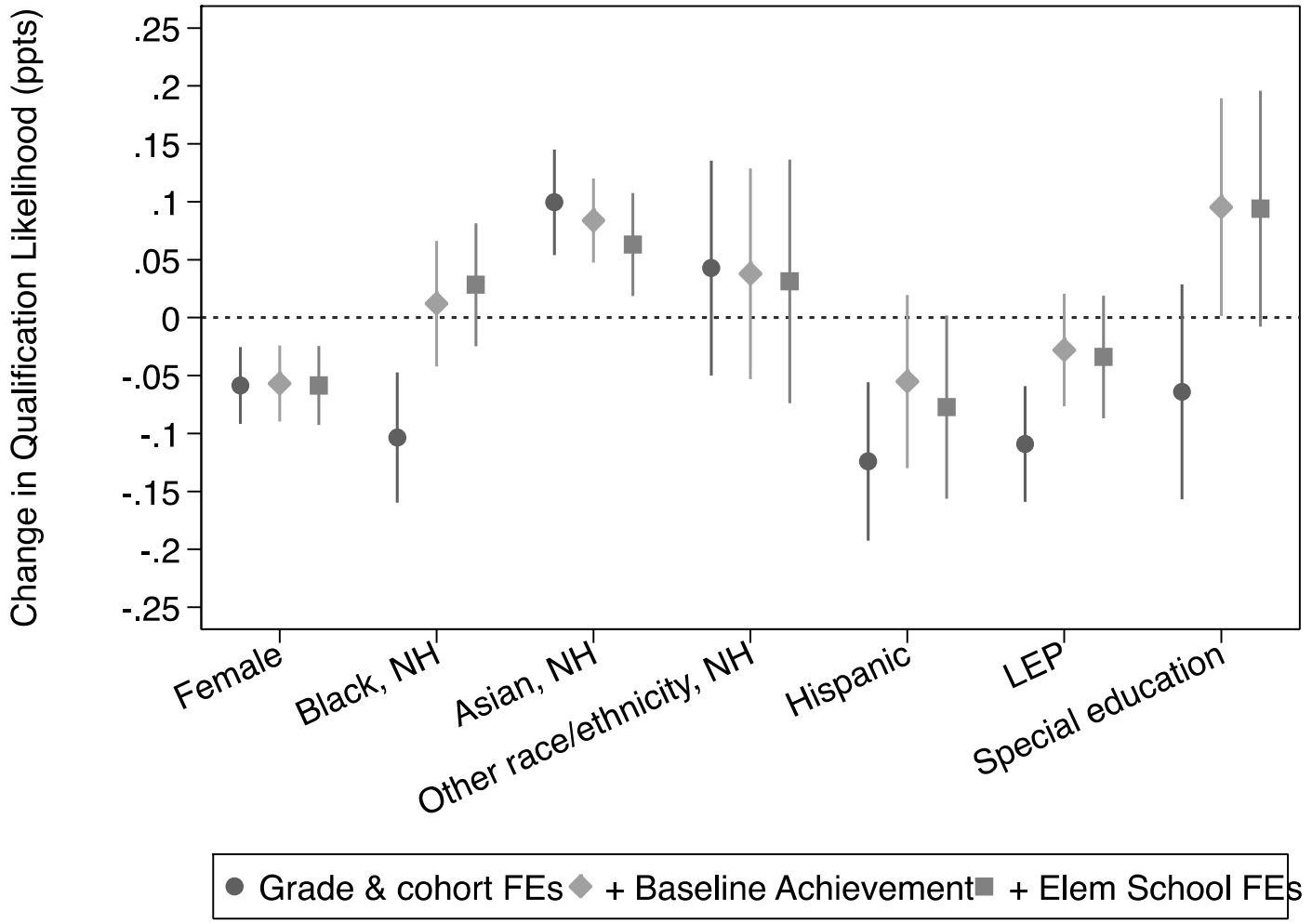
Nomination



0.025

Sample = 3rd & 4th graders, all cohorts; N = 70,773 students

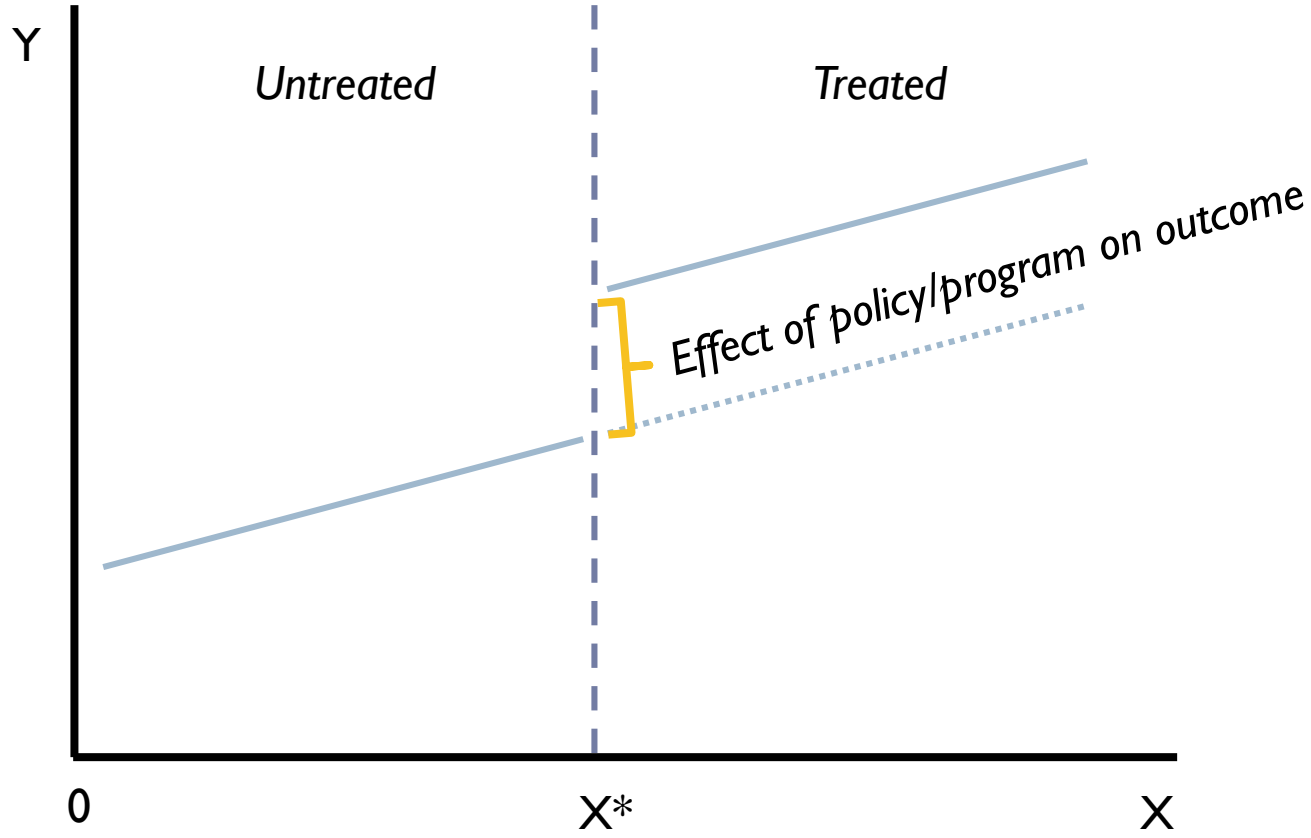
Qualification



0.232

Sample = 3rd & 4th grade nominees, all cohorts; N = 1,792 students

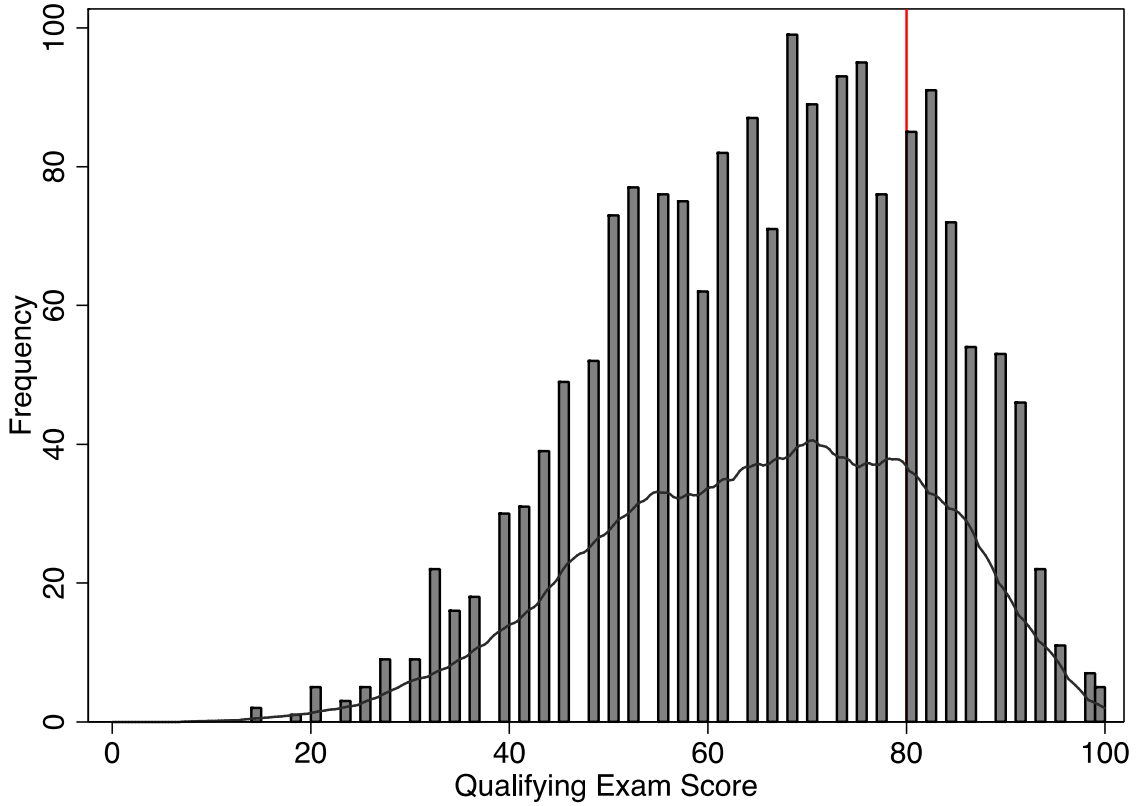
Effects of Math Acceleration on Educational Outcomes



Regression discontinuity (RD)

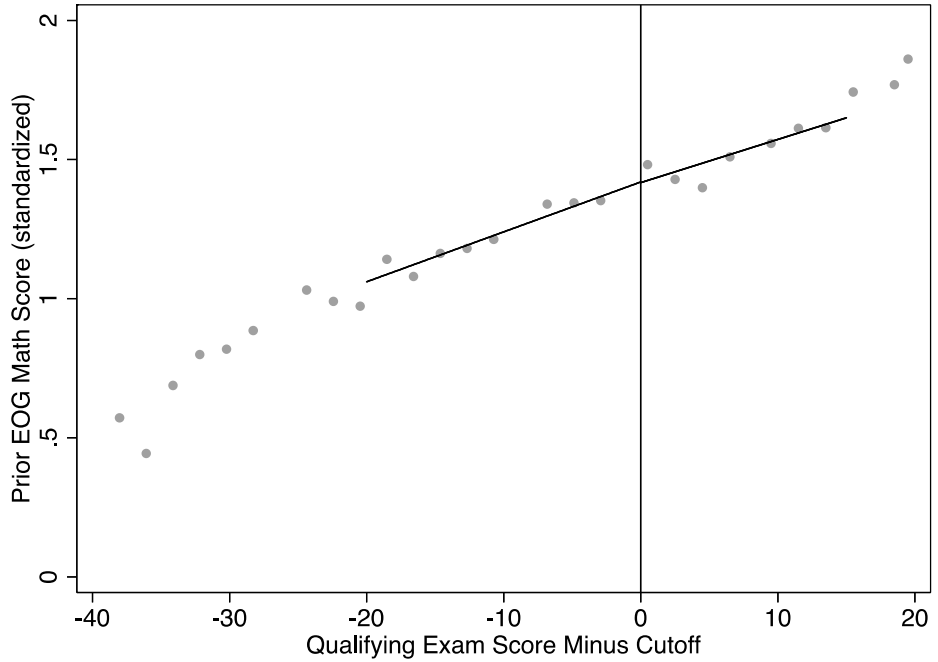
RD Assumptions Met?

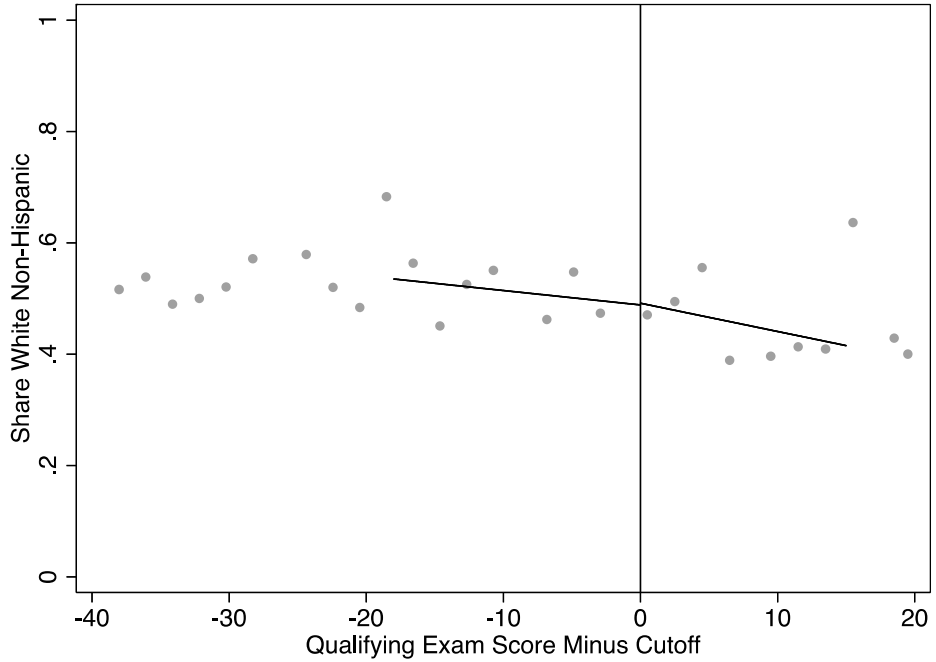
- Inability of students to precisely manipulate measure that determines treatment



RD Assumptions Met?

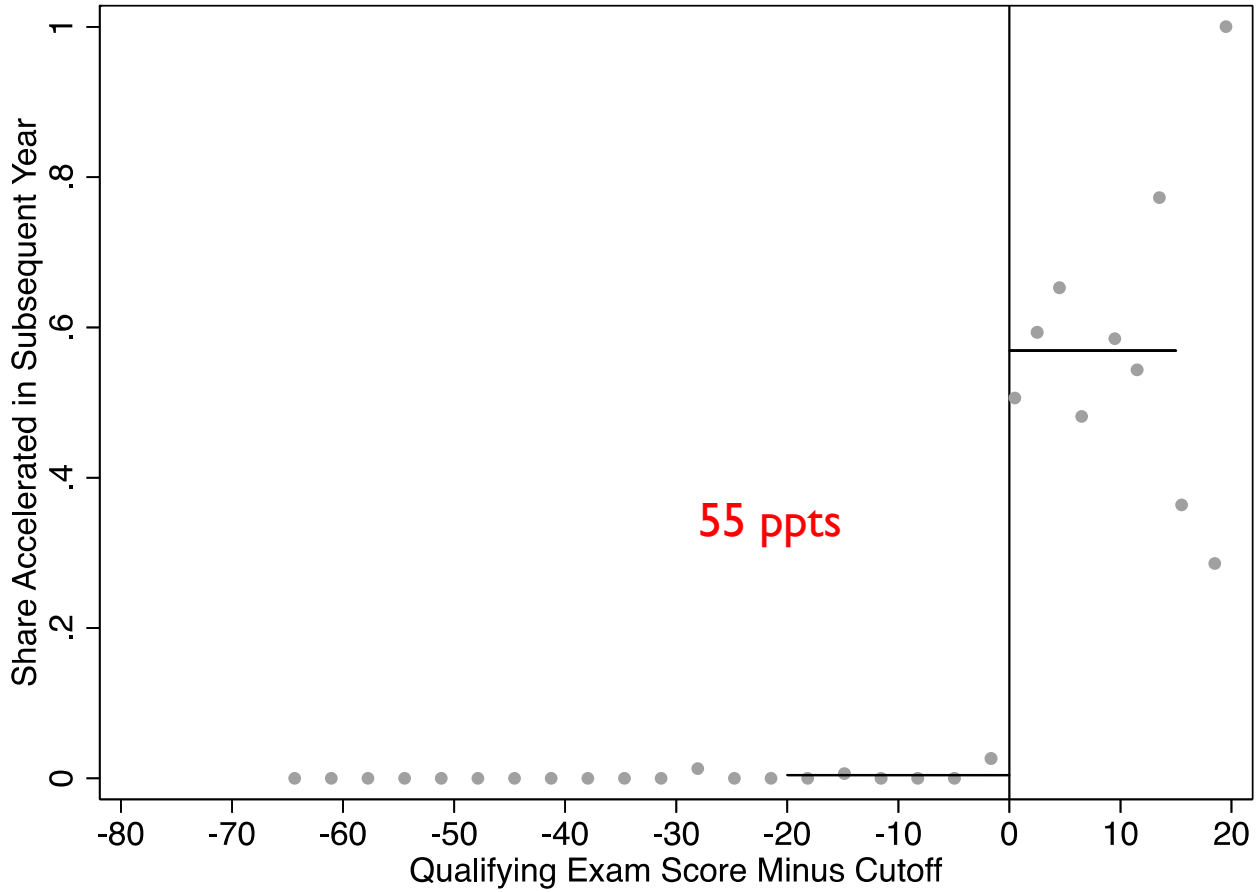
- Similarity of observations on each side of cutoff → only remaining difference is treatment itself





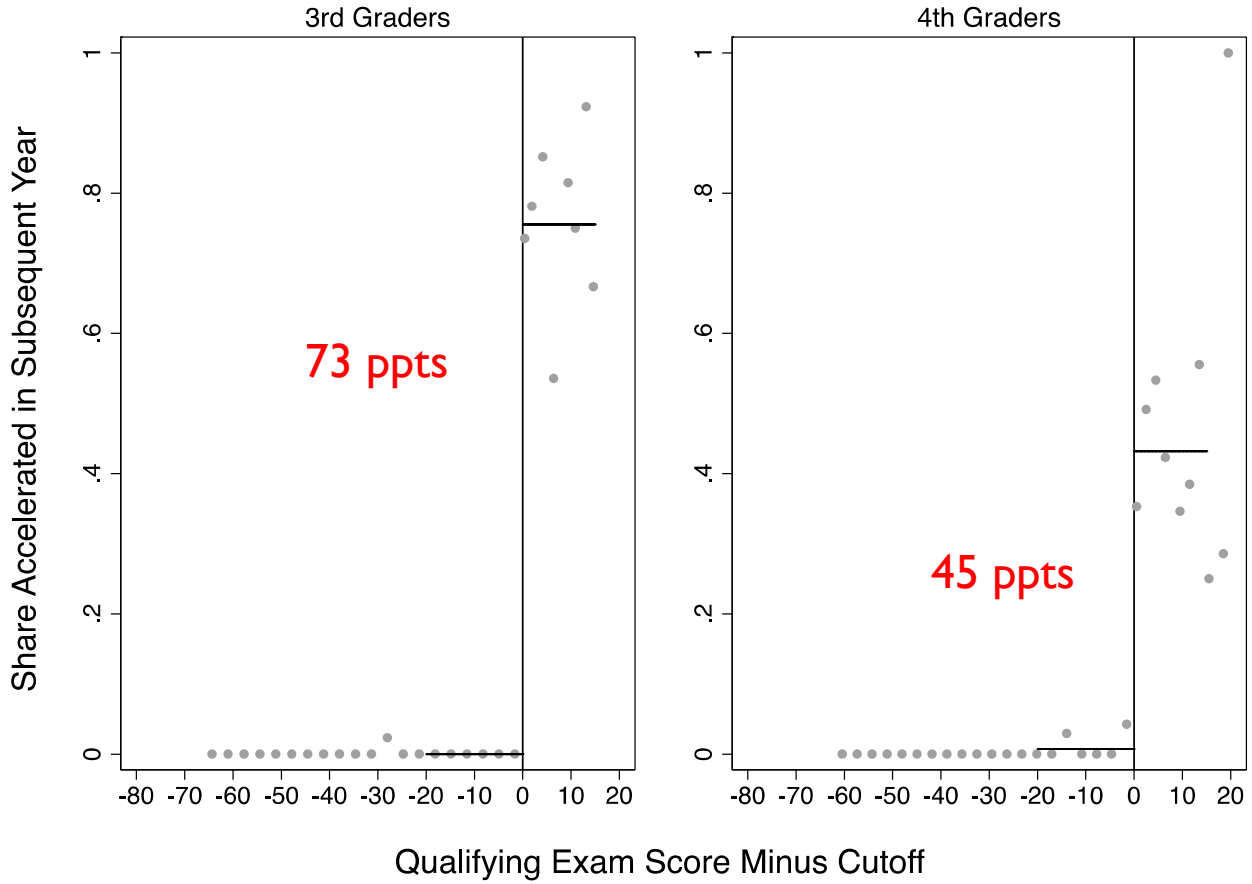
Qualification → Acceleration

- 3rd and 4th graders, pooled



Qualification → Acceleration

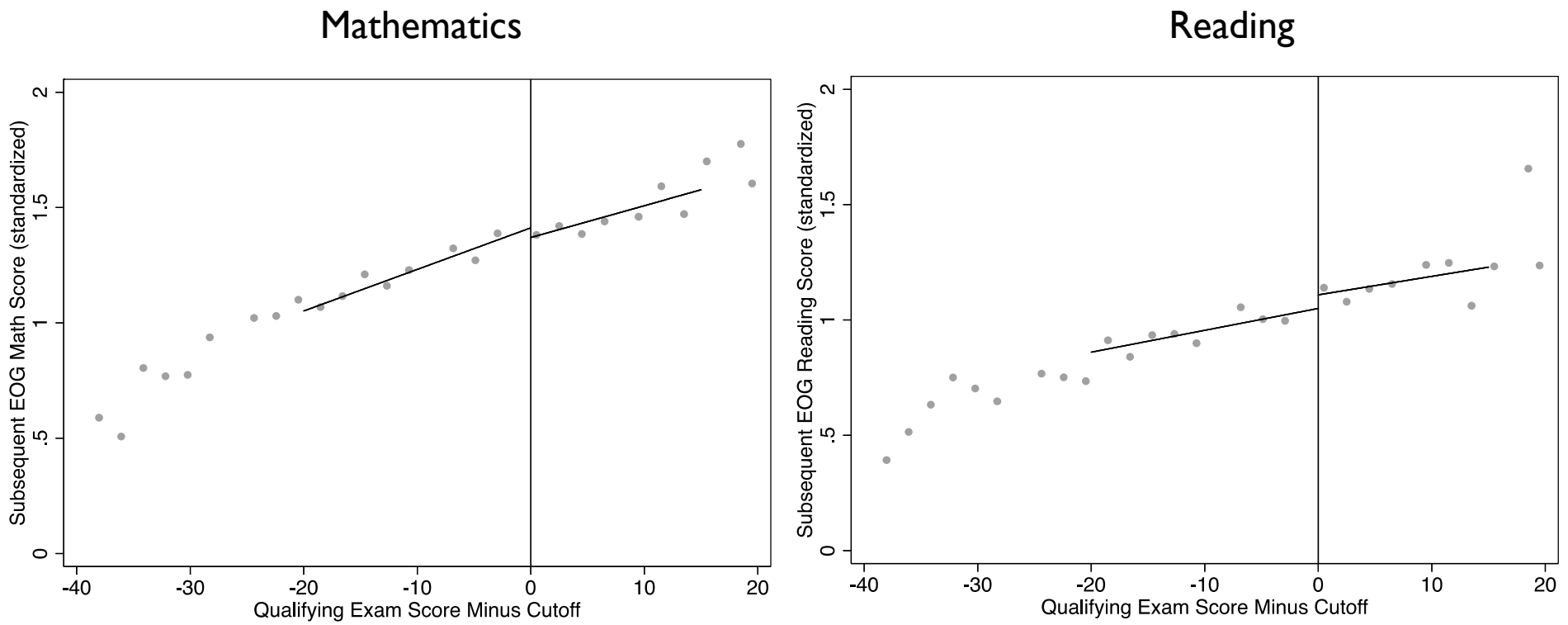
- Separate 3rd and 4th grade samples



"Treatment" differs

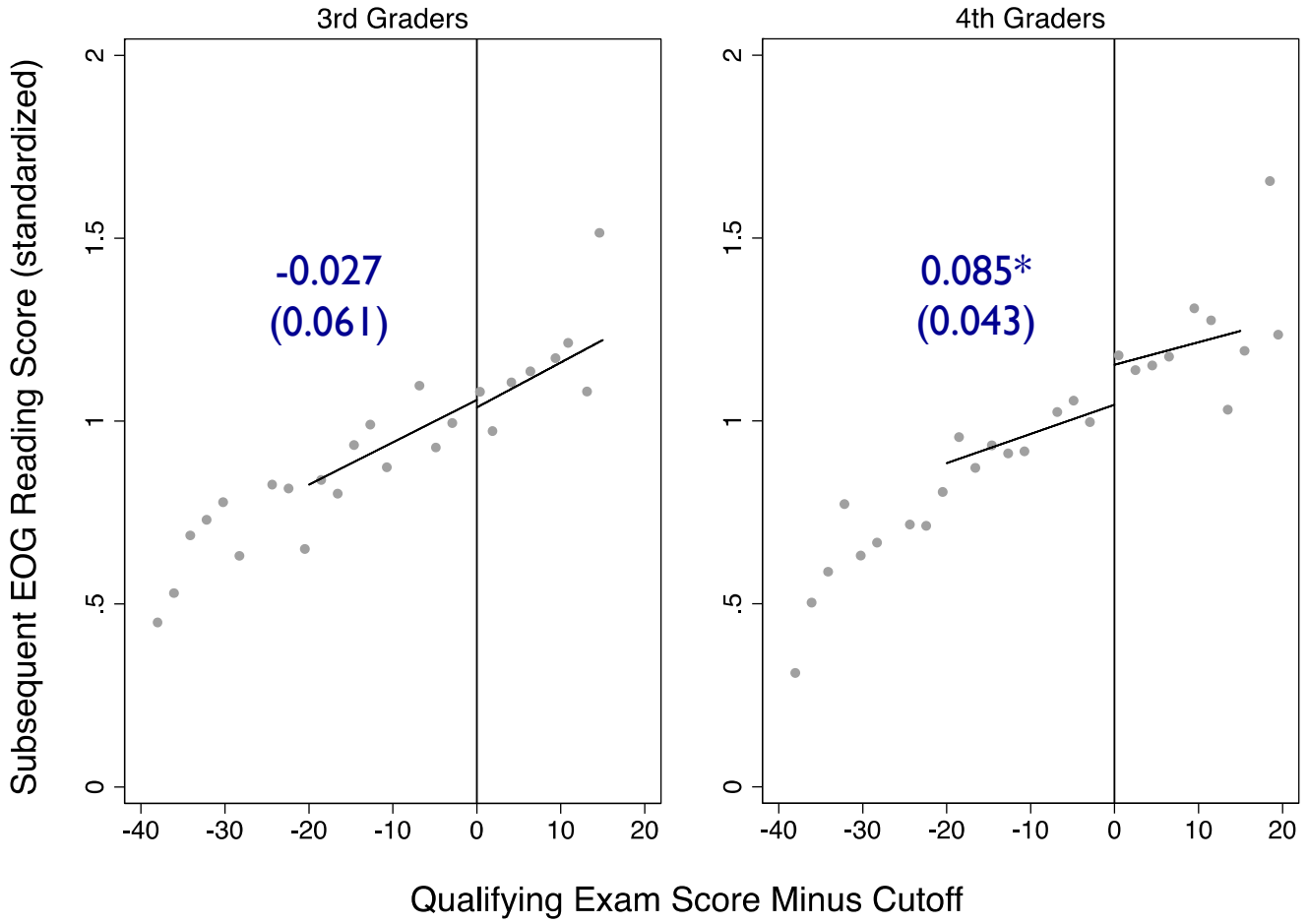
- 3rd grader who accelerates walks down hall to participate in 5th grade math during 4th grade
- 4th grader who accelerates takes *online* 6th-grade math while in 5th grade

Short-Run Achievement



- Accelerated students take EOG based on current grade level of enrollment (not material) → complicates interpretation of effects on math scores

Short-Run Achievement: Spillovers?



Effect of math acceleration on subsequent reading performance? (Fuzzy RD, IV estimates)

<u>3rd Grade Sample</u>
-0.036
(0.079)

<u>4th Grade Sample</u>
0.185*
(0.097)

~19% improvement over control-side outcome mean

Non-test-score Outcomes

- Analytic sample = 4th grade nominees
- Little clear effect of math acceleration on…
  - Grit scale
    - Nominee avg = -0.27 std; Qualifier avg = -0.24 std
  - Control and relevance of schoolwork (CRSW) index
    - "When I do well in school it's because I work hard."
  - Future goals (FG) and aspirations index
    - "I plan to continue my education following high school."

Transition to Middle School

Q: What share of 4th graders initially accelerated in 5th grade remained on accelerated track at start of middle school?

- 86% of initial accelerators ("compliers") did so

- Males = 95%
- Females = 64%

Emerging Story

- Mostly little effect of targeted math acceleration for elementary school students on measures of short-run achievement

- Some evidence of positive spillovers on short-run reading performance:
  - Only for 4th graders who took online 6th-grade math as 5th graders
  - Suggests that mode (and content) of acceleration may shape achievement effects

- Persistence in advanced math at start of middle school
  - Overall rate = 86%
  - Male-female gap = 31 ppts

Next Steps

- Add additional cohort of 3rd/4th graders
- Effects on 6th grade math course grades?
- Use measures of peer/classroom characteristics to further characterize treatment-control contrast experienced by accelerated students
- More discussions with math specialists in elementary and middle schools across Wake County

Thanks!

Appendix: Citations for Motivation

- Math competence associated with national competitiveness
  - Hanushek & Woessmann (2012); Hanushek, Peterson, & Woessmann (2010); Hanushek & Kimko (2000)

- Increases in math course-taking (largely in high school) → boosts in downstream educational and employment outcomes
  - Long, Conger & Iatarola (2012); Cortes, Goodman, & Nomi (2015); Goodman (2012); Clotfelter, Hemelt, & Ladd (2018); Joensen & Nielsen (2009); Rose & Betts (2004)

Appendix: Details on Recent Math Acceleration Study

- Recent evidence from WCPSS focuses on targeted acceleration in math during middle school that began in 2010-11 (Dougherty et al., 2017):
  - Marginal student sits around the 20th percentile of district-wide achievement distribution
  - Focuses on 7th graders
  - No effects on short-run test scores
  - Moderate increase in share of middle-schoolers taking pre-calculus by 11th grade
  - Boost in share who want to attend college

Appendix: Citations for Non-Test-Score Outcomes

- WCPSS Student Engagement Survey dimensions:
  - Short Grit scale
    - Duckworth & Quinn (2009)
  - Control and relevance of schoolwork (CRSW)
  - Future goals and aspirations (FG)
    - Appleton, Christenson, Kim, & Reschly (2006)