



Disentangling the Curriculum and Structural Effects of Math Pathway Reforms in Maryland Community Colleges

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Presented at the MLDC Center Research Series | Feb 20th 2026

Preview

- Background
- Research Questions
- Data
- Methodology
- Results
- Summary & Policy Discussion

Background

- In 2016, 60% of entering community college students in MD were identified as needing developmental education in math.
- **COMAR 13B.06.01.03 (before 2016):** General education programs of public institutions shall require one course in **mathematics at or above the level of college algebra.**

Background

Placement

Standardized Test: ACT, SAT,
Accuplacer, etc.

Developmental education

Non-credit-bearing
developmental course:
Intermediate Algebra; Geometry;
Trigonometry; etc.

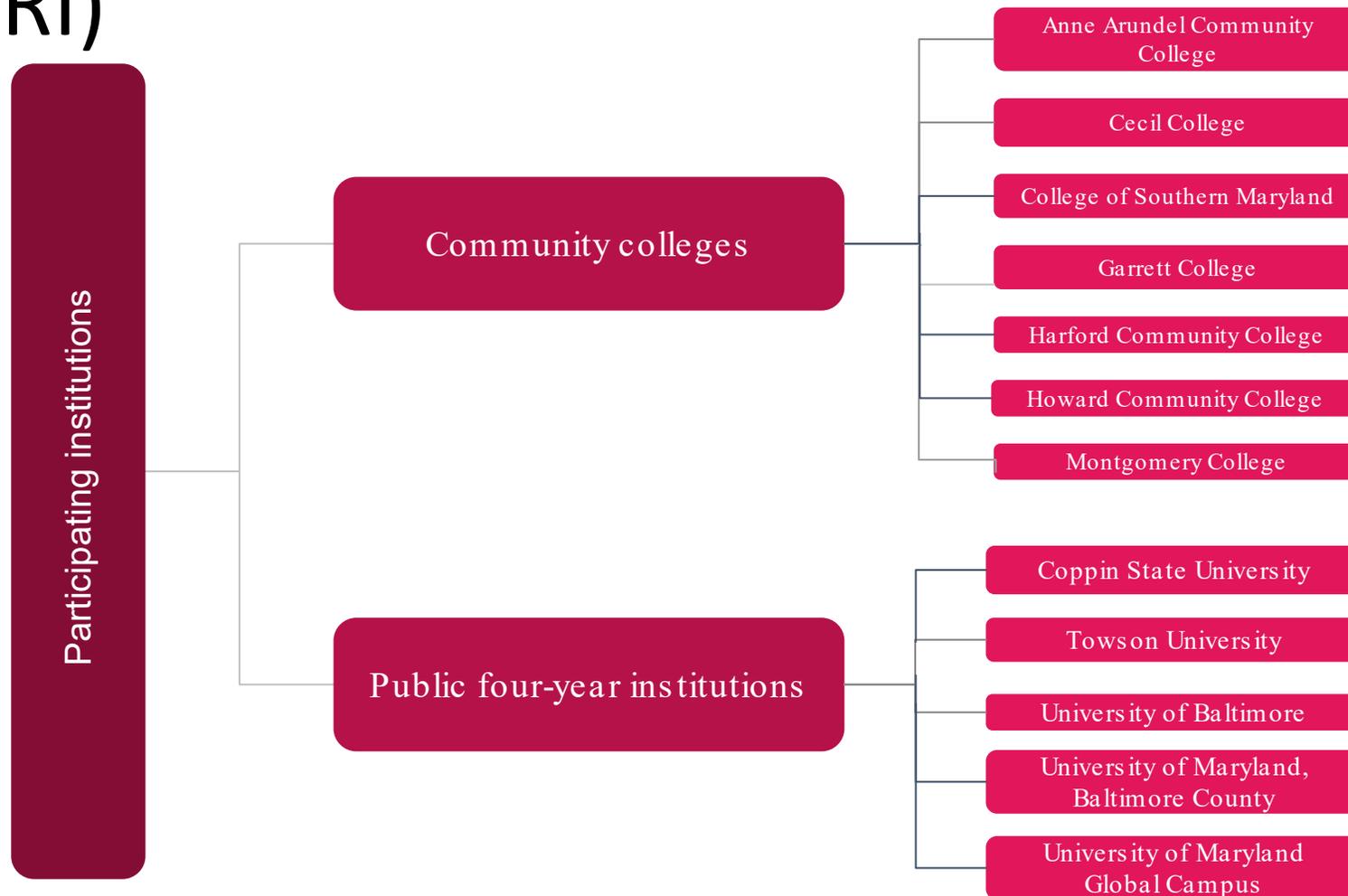
College gateway math

College gateway math:
College Algebra. Calculus,
etc.

Background

- **College and Career Readiness and College Complete Act (CCR-CCA)** requires all Maryland public higher education institutions to ensure students enroll their credit-bearing mathematics and English general education courses within the first 24 credit hours of study.
- **COMAR 13B.06.01.03 (after 2016):** students were expected to complete *“one course in mathematics, having performance expectations demonstrating a level of mathematical maturity beyond the Maryland College and Career Ready Standards in Mathematics (including **problem-solving skills, and mathematical concepts and techniques** that can be applied in the student’s program of study)”*

Maryland's Mathematics Reform Initiative (MMRI)



Curriculum reform

Placement

Standardized Test: ACT, SAT, Accuplacer, etc.

Developmental education

Non-credit-bearing developmental course:
Algebra-track: Intermediate Algebra; Geometry; Trigonometry; etc.
Statistics -track: Pre-Statistics; Quantitative foundations; etc.

College gateway math

College gateway math:
Algebra-track: College Algebra. Calculus, etc.
Statistics -track: Statistics, Math literacy; etc.

Structural reform



Standardized Test: ACT, SAT,
Accuplacer, etc.
High school GPA
**Prior college credits (dual
enrollment)**

Non-credit-bearing developmental
course:
Algebra-track: Intermediate Algebra;
Geometry; Trigonometry; etc.
Statistic-track: Pre-Statistics;
Quantitative foundations; etc.

College gateway math:
Algebra-track: College Algebra.
Calculus, etc.
Statistics-track: Statistics, Math
literacy; etc.



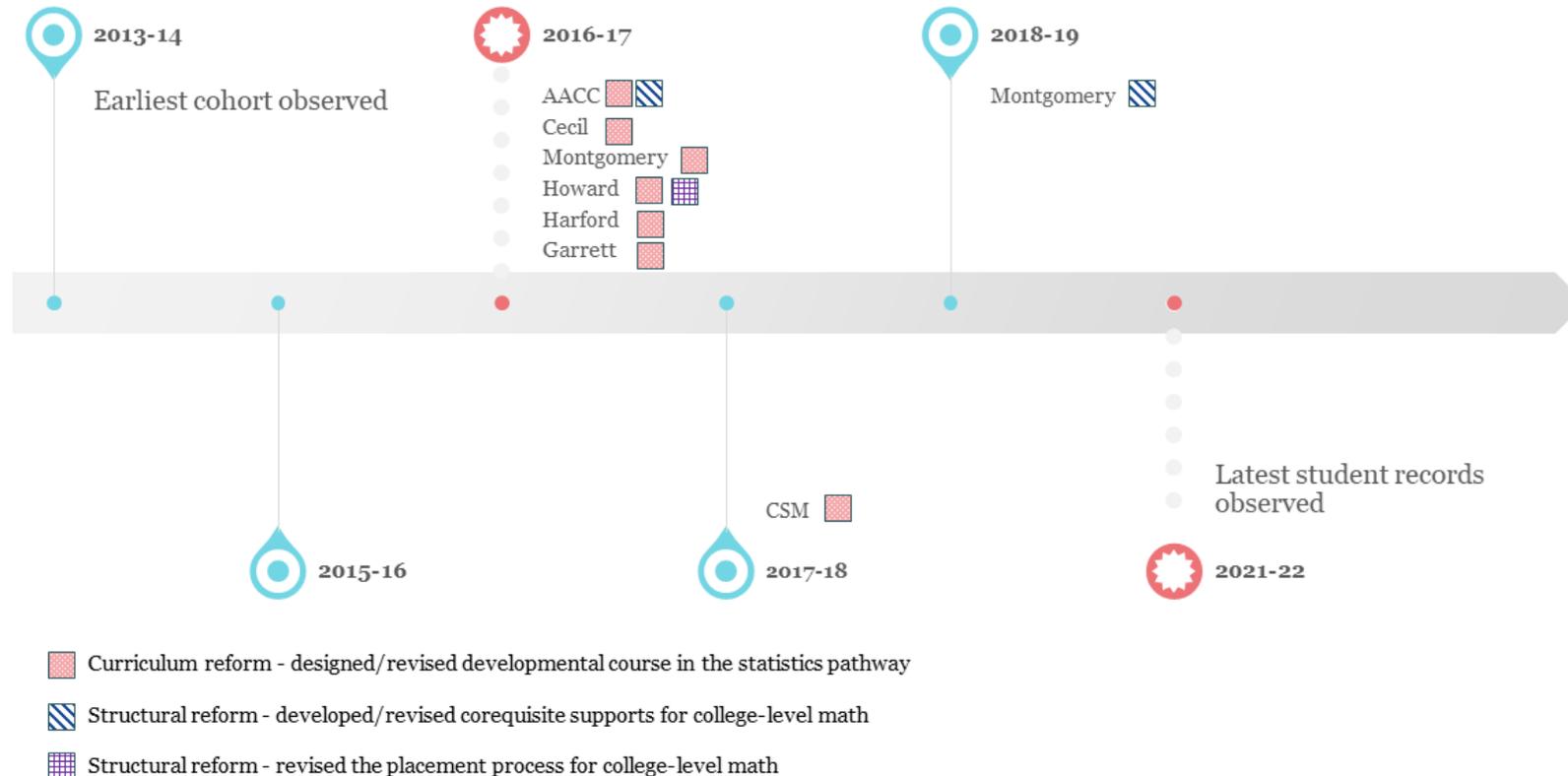
Standardized Test: ACT, SAT,
Accuplacer, etc.



Non-credit-bearing developmental
course:
Algebra-track: Intermediate Algebra;
Geometry; Trigonometry; etc.
Statistics-track: Pre-Statistics;
Quantitative foundations; etc.

College gateway math:
Algebra-track: College Algebra.
Calculus, etc.
Statistics-track: Statistics, Math
literacy; etc.

Timelines of Maryland Math Reform Initiative (MMRI)



Research Questions

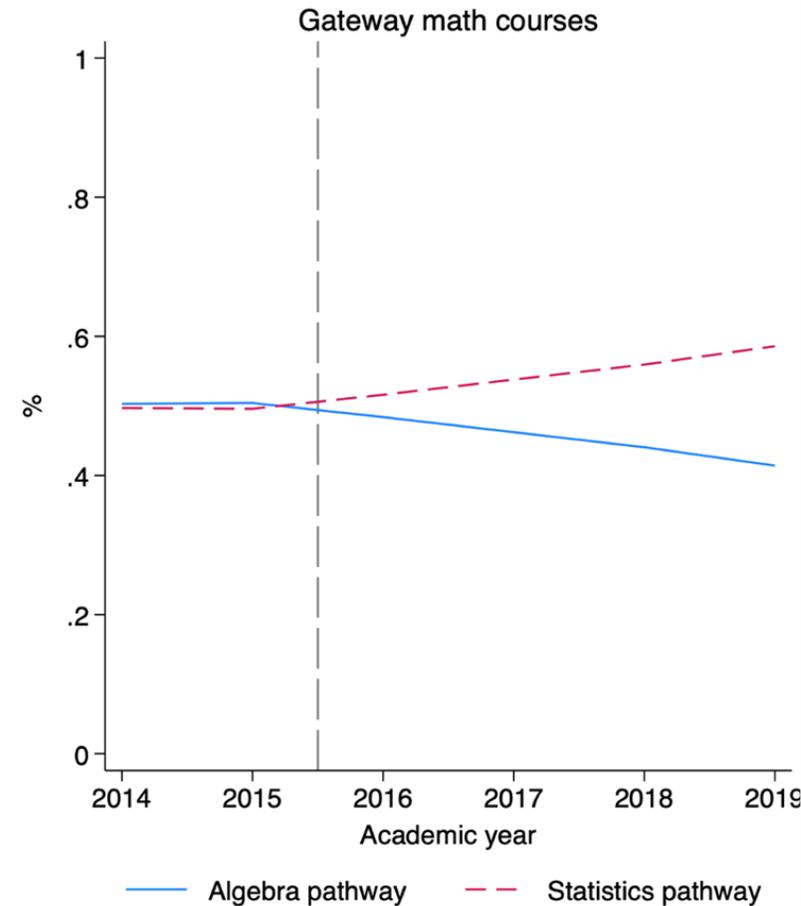
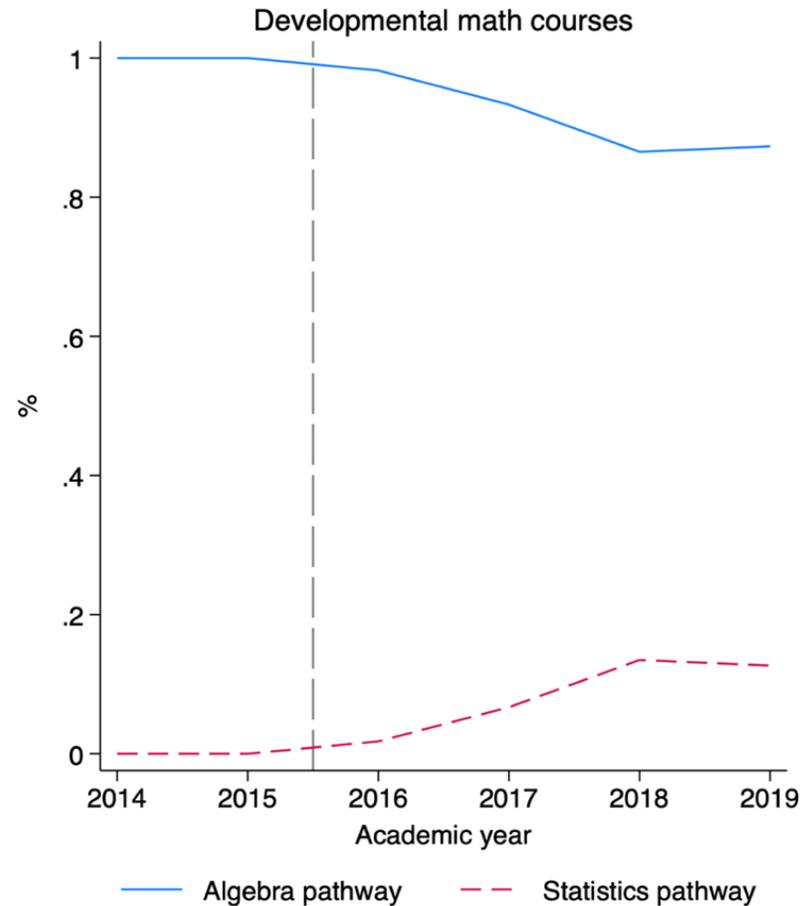
- What are the effects of Maryland's math reform (MMRI) on developmental and college-level math completion in Maryland community colleges?
- How do changes to math curriculum and other components influence these effects?
- How does MMRI affect students' likelihood of entering into or progression through STEM pathways?

Data

- MHEC administrative data 2014-15 to 2019-20
- 149,168 students who first entered one of community colleges in Maryland between 2014 and 2019 academic years.
- Data elements:
 - Demographics
 - Pre-college attributes: HS attended, HS GPA, standard test scores
 - Course enrollment and outcomes in Maryland community colleges
 - Program declared and degree attainment

Math Course Enrollments by Pathway

Significant increase in proportion of students enrolling in courses in statistics pathway since the MMRI reform



Methodology

Understand the overall effects of MMRI: Difference-in-Differences design

$$Y_{ijt} = \beta_0 + \beta_1 (MMRI_j * Post_{tj}) + \beta_k X_i + \theta_j + \pi_t + \mu_{itj}$$

- Y_{ijt} is the development or gateway math outcome for student i at college j of cohort t
- β_1 measures the overall effects of MMRI on outcome Y
- Control for student covariates (X_i), college-FE (θ_j), and cohort-FE (π_t)
- Heterogeneity-robust DID estimator as robustness check (Callaway & Sant'Anna, 2021)

Understand the effects of different reform components:

$$Y_{ijt} = \gamma_0 + \gamma_1 (Curri_j * Post_{tj}) + \gamma_2 (Struc_j * Post_{tj}) + \beta_k X_i + \theta_j + \pi_t + \mu_{itj}$$

- γ_1 measures the effects of **curriculum** reform component (introducing statistics pathways)
- γ_2 measures the effects of **structural** reform components (changes to placement policies, corequisite support)

The reform improved completion of developmental math requirements

Outcomes	MMRI Overall (Regression Coefficient)
% Enrolled in Aligned Developmental-to-Gateway Sequence	0.108** (or 37% ↑)
% Completed Developmental Math Requirement by Year 1	0.075* (or 36% ↑)

** $p < 0.05$; * $p < 0.1$

Structural reform components increased gateway math completion

Outcomes	MMRI Overall (1)	Curriculum Reform (2)	Structural Reform (3)
% Enrolled in Gateway Math by Year 1	0.012	-0.003	0.052***
% Completed Gateway Math by Year 1	0.015	0.003	0.041***

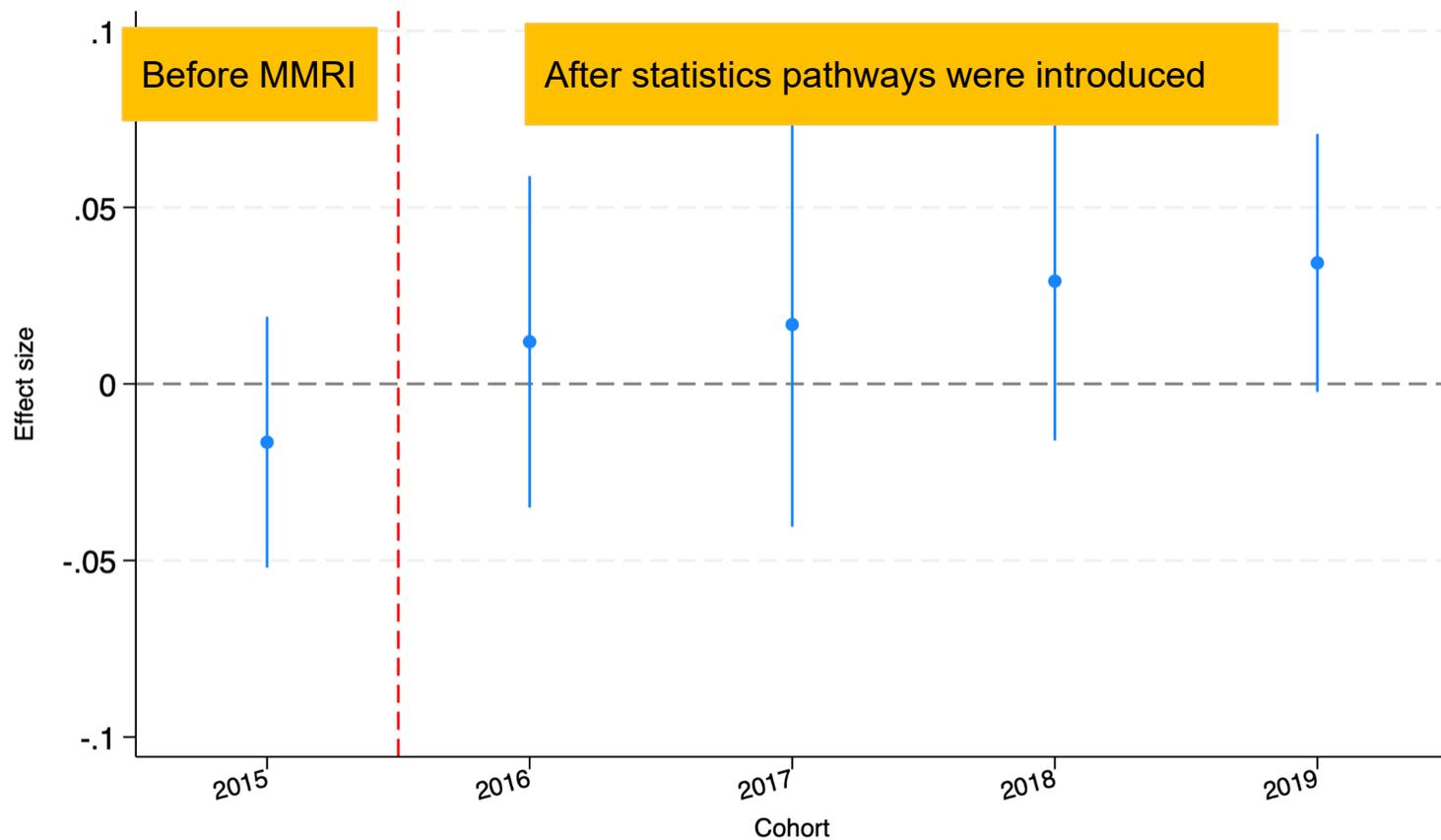
*** $p < 0.01$

Structural reform components increased gateway math completion

Outcomes	MMRI Overall (1)	Curriculum Reform (2)	Structural Reform (3)
% Enrolled in Gateway Math by Year 1	0.012	-0.003	0.052*** (24%↑)
% Completed Gateway Math by Year 1	0.015	0.003	0.041*** (27%↑)

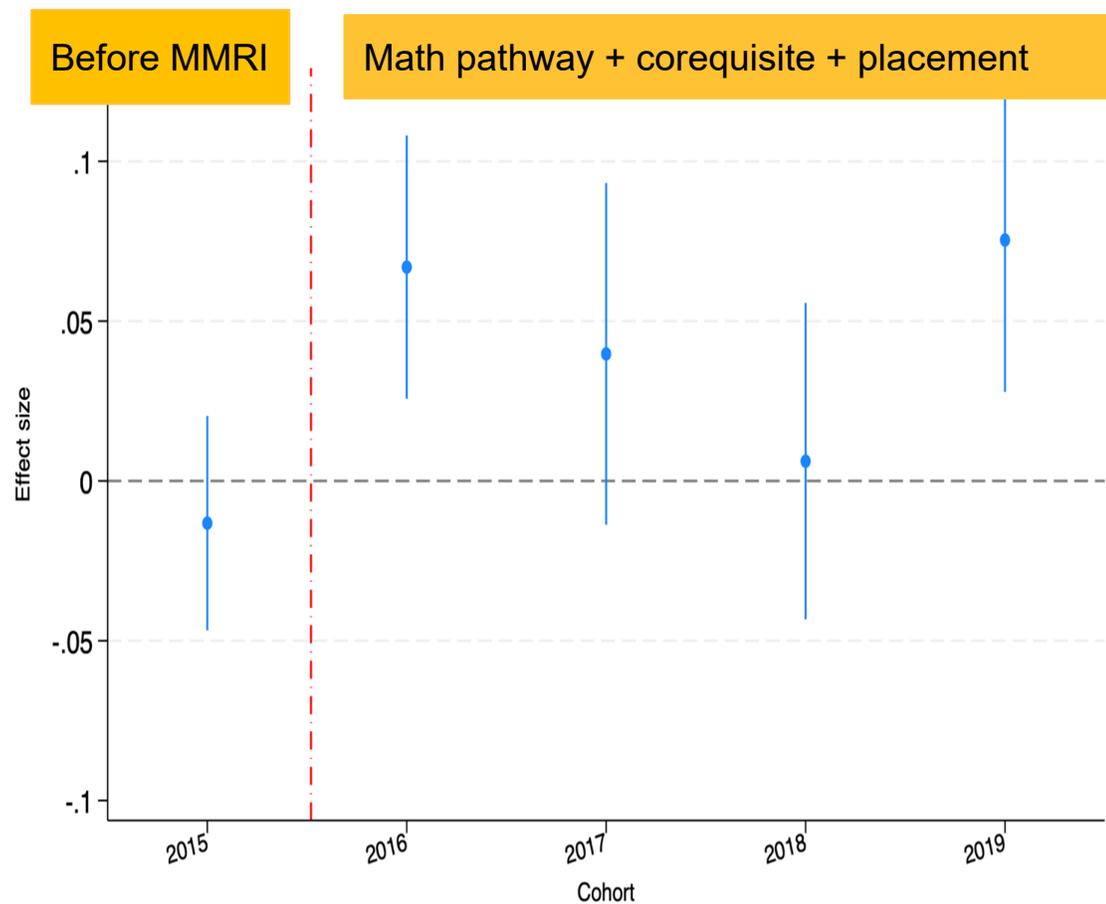
*** $p < 0.01$

Effects on gateway math completion (Curriculum reform only)

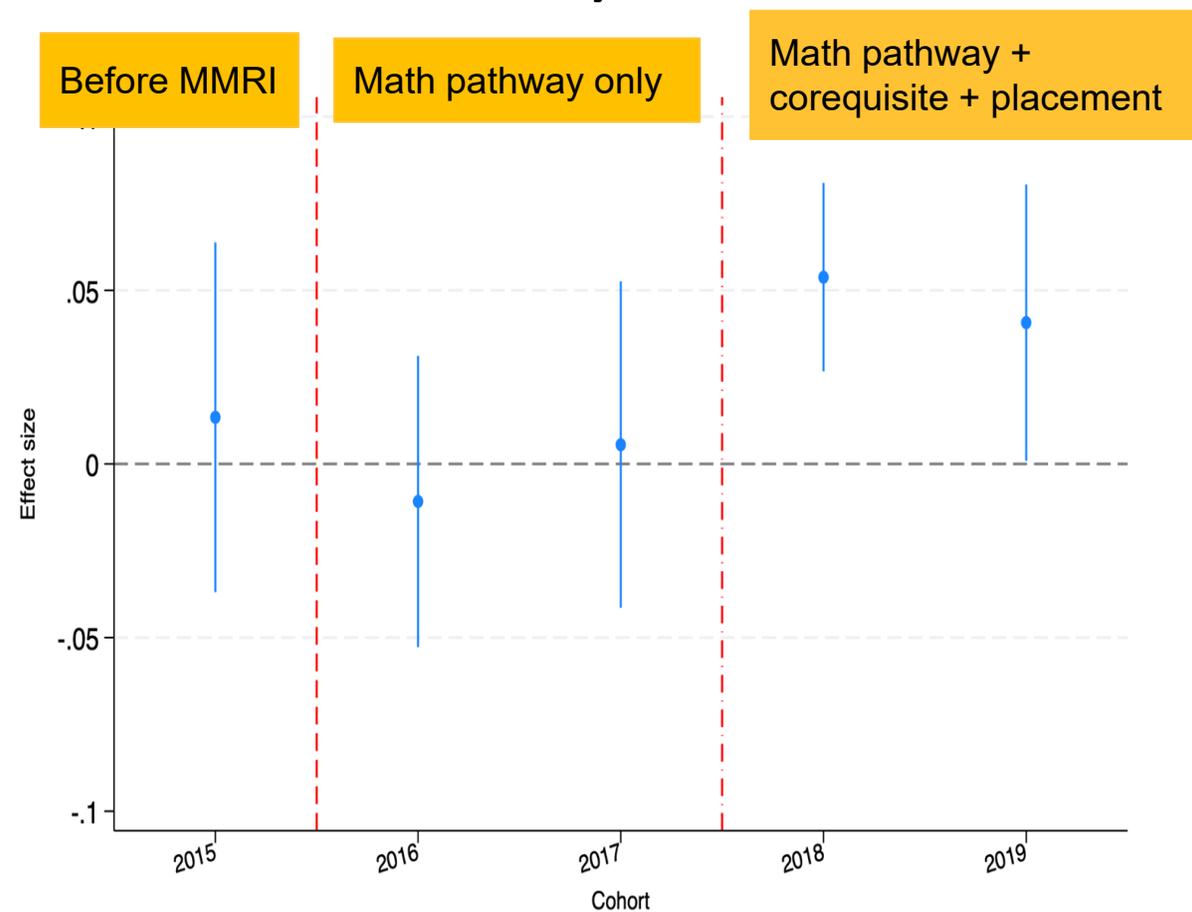
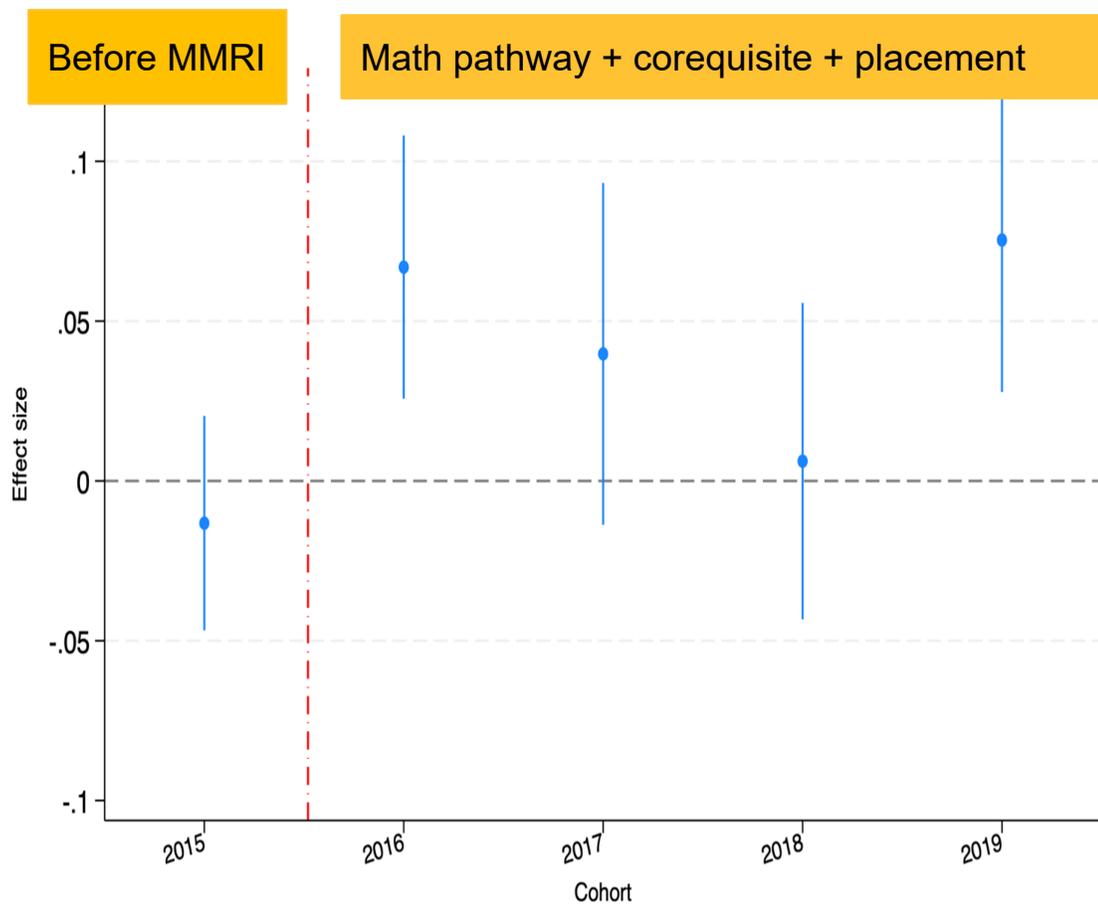


In colleges that introduced statistics pathway as the only reform component:
No significant improvements in gateway course outcomes

Effects on gateway math completion (Curriculum reform & structural reform)



Effects on gateway math completion (Curriculum reform & structural reform)



Gateway math completion vs. success rate

- Completion rate: the percentage of the **entire student cohort** that successfully passed gateway math.
 - It measures the reform's ability to move all incoming students through this academic milestone.
- Success rate: The percentage of **students who enrolled in gateway math courses** who successfully passed them.
 - It reflects how well the specific curriculum and instruction support those students once they are in the classroom.
- To improve gateway math **completion rates**, colleges must: increasing **access** (getting more students into the course) and improving the **success rate** (ensuring they pass once they are there).

Students in statistics gateway courses had higher course passing rates

Outcomes	Curriculum Reform (1)	Structural Reform (2)
Pass Rate of Gateway Math (All Courses)	0.032**	-0.012
Pass Rate of Gateway Math (Algebra track courses)	-0.006	0.035
Pass Rate of Gateway Math (Statistics track courses)	0.047*	-0.043

** $p < 0.05$; * $p < 0.1$

MMRI did not affect major selection

- Null effects on declaring a STEM major, total number of college-level math courses completed, or transfer rates
- MMRI colleges developed and standardized advising to prevent unintended consequences

Summary & Policy Discussion

- Alternative math pathway alone did not improve college-level math completion rates
 - Statistics pathways appear to boost students' performance for those in gateway math
- The positive effects on gateway math completion were mainly driven by the structure component of the reform
- Developmental education reform needs to address multifaceted issues
- Colleges should investigate the curriculum and instruction of *college-level* math

Read our paper at:

<https://mhec.maryland.gov/publications/Documents/Research/PolicyReports/MHECPolicyBriefVol5.pdf>



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