Education Research Center
www.texaserc.utexas.edu

POLICY BRIEF

Evaluating the Transition to College Mathematics Course in Texas High Schools

James E. Pustejovsky
Associate Professor, University of Wisconsin – Madison, Educational Psychology Department
Megha Joshi
Graduate Student. The University of Texas at Austin, Educational Psychology Department
November 2020

What We Studied

Post-secondary education has become a gateway for economic and social mobility in U.S. society. While both federal and state policy has sought to broaden access to higher education, there remain substantial obstacles to expanding the more crucial objective of student degree completion. One challenge is that many students exit high school under-prepared for college-level work—particularly in mathematics. For instance, as of 2010, over half of students entering community colleges in the U.S. were deemed to be unprepared for college-level course-work in mathematics, while one third of students were deemed unprepared for college-level reading.[1] Students who are under-prepared for college-level course work are often referred to or required to complete developmental courses, which are intended to help them learn skills necessary to do well in college-level work. Large numbers of students begin such courses, and low-income students and minority students are disproportionately likely to take developmental coursework.[2] Although developmental courses are intended to help students succeed, research has suggested that they may actually have the effect of raising barriers to success in college, hindering credit and degree completion.[3–5] Evidence from a range of settings—including 2- and 4-year public institutions in Texas—indicates that participation in conventional developmental coursework does little to improve student persistence and credit completion, relative to immediately beginning college-level coursework.[5–8]

To address under-preparation of students for college-level course-work, Texas House Bill 5 (HB5) introduced a number of substantive changes to the state high school curriculum and graduation requirements. Among its provisions, HB5 created a requirement that school districts offer a college preparatory mathematics course for students not meeting college readiness standards in mathematics by the end of their third year of high school. It further required that the course be offered through a partnership with an institution of higher education—typically a community college—and that successful completion of the course must satisfy the partner institution's requirements for enrollment in college-level coursework.

One curriculum designed with the goals and requirements of HB5 is the Transition to College Mathematics Course (TCMC), developed by the Charles A. Dana Center. The Dana center developed TCMC as a model college preparatory math course, melding previously developed secondary-level course materials with strategies they had used to build college-level developmental courses. TCMC differs from conventional remedial math courses in several respects. First, the course content aligns with the multiple mathematics pathways framework[9,10] adopted by many Texas higher education institutions, providing a coherent sequence of work across the transition from high school to higher education. Second, the course involves novel material and instructional strategies, rather than repetition of content that students have already encountered. Third, the course incorporates evidence-based pedagogical approaches including

TEXAS Education
The University of Texas at Austin
College of Education

putting greater emphasis on richly contextualized applications, developing students' self-regulated learning strategies and productive persistence, and varying instructional activities. Taken together, these differences provide reason to expect that student participation in TCMC could have immediate and longer-term impacts on student outcomes.
In this project, we sought to evaluate the impacts of TCMC in its first and second years of implementation. Our guiding research question was: relative to taking typical high school coursework, what are the effects of participating in TCMC on high school graduation, post-secondary enrollment, and progress in college-level mathematics for twelfth grade students enrolled in TCMC?

How We Analyzed the Data

TCMC was offered at high schools in eight districts across central Texas during the 2016-17 school year and in thirty districts during the 2017-18 school year. Within high schools that offered the course, enrollment in TCMC was at the discretion of students and school staff. Most students who enrolled in the course were in twelfth grade. The main rule guiding enrollment was that students should not be college-ready at the beginning of twelfth grade. Schools could use a variety of approaches for determining college readiness, including college readiness tests, other standardized test scores, or grades. Schools did not follow any consistent approach for determining college readiness or which students should take the course, and advising practices differed from school to school.

To estimate the effects of participating in the course, we compared twelfth grade students who participated in TCMC to observationally similar twelfth grade students from the same cohort, but who did not enroll in the course.[†]
We aimed to create groups that were closely matched on background characteristics that may have influenced students to enroll in the course and that may be associated with later student outcomes. Using data from the Texas PK-20 Workforce Database, we identified matched comparison groups based on students' contemporaneous demographic and program enrollment status (e.g., Special Education, gifted programs), demographic history and past program enrollments, math course-taking history, and scores on the STAAR Algebra I end-of-course exam. Appendix Table S1 lists the full set of covariates used. We created the comparison groups using inverse propensity score weighting methods, with propensity scores estimated by generalized boosted regression models, a machine learning technique that is suitable for use with large sets of covariates.[12,13] After weighting based on propensity scores, the set of students in the comparison group was very similar to the set of students who took TCMC in terms of demographic characteristics, academic performance, and past math coursework.[‡]

To the extent that these background characteristics explain whether a student enrolled in TCMC, differences in outcomes between students who took TCMC and students in the comparison group can be attributed to the impact of the program. We assessed differences between TCMC participants and comparison students on outcomes related to students' post-secondary success. The main goal of the TCMC program was to improve student preparedness for college-level math. Thus, the primary outcomes of interest were enrollment and passage rates for college-level math courses. For completeness, we also examined enrollment and passage rates for developmental math courses at the post-secondary level. In order to affect post-secondary performance outcomes, however, students must first graduate and enroll in post-secondary education. Therefore, we also examined impacts on high school graduation and college enrollment rates as intermediate outcomes, including dis-aggregated college enrollment rates in community colleges, and public four-year colleges or universities. For all of the college-level outcomes, we examined cumulative rates for four semesters after the students' high school year (i.e., Fall, Spring, Summer, Fall).

To generate average effect estimates, we regressed each outcome on the covariates (listed in Table S1), indicators for each school, covariate-by-treatment interactions, and school-by-treatment interactions. Regressions used inverse propensity score weights. We then calculated a weighted average of the school-specific estimates, with weights based on the size of the TCMC group in each school.

[†] For the 2016-17 cohort, we also made comparisons between students who participated in TCMC and observationally similar students who were in twelfth grade during the 2015-16 school year, prior to when TCMC was offered.[11] This approach was not possible with the 2017-18 cohort because a substantial portion of the second cohort was implementing TCMC for a second year.
[‡] Appendix Figure S1 depicts the degree of similarity (or "balance") between the TCMC students and comparison students from the 2016-17 cohort. Appendix Figures S2 through S4 show the degree of balance for the 2017-18 cohort.

What We Discovered

In this brief, we focus on outcomes for the Fall semester one and two years after enrolling in the course. Table 1 reports rates for key outcomes among students who participated in TCMC and among students in the comparison group, in each of the two student cohorts. For each cohort, the columns labeled "Difference" are the estimated difference between the TCMC group and the comparison group, which represent our estimates of the effects of participating in TCMC.

Across both cohorts, students who participated in TCMC graduated from high school at higher rates than students in the comparison groups, with differences in on-time graduation rates of 3.1 percentage points (SE = 0.9) for the 2016-17 cohort and 4.7 percentage points (SE = 0.4) for the 2017-18 cohort. However, overall rates of college enrollment followed more complex and ambiguous pattern. For the 2016-17 cohort, TCMC students enrolled in college at somewhat lower rates than comparison students (43.7% versus 47.2% by Fall semester of Year 2). In the 2017-18 cohort, overall rates of college enrollment were similar, with a difference of 0.6 percentage points that was not statistically distinguishable from zero.

Possible differences in college enrollment rates appear to have been driven by reductions in enrollment at four-year colleges and universities and, potentially, partially or fully offsetting increases in enrollment at community colleges. By two years after start of their senior year, TCMC students in the 2016-17 cohort enrolled at four-year institutions at a rate 4.5 percentage points lower (SE = 1.3) than students in the matched comparison group of the same cohort, offset by a difference of 1.4 percentage points (SE = 1.8) in community college enrollment. For the 2017-18 cohort, the difference in enrollment rates at four-year institutions was smaller in magnitude (8.8% among TCMC students versus 11.3% among comparison students, a difference of -2.5 percentage points, SE = 0.7) and the difference in community college enrollment rates was larger and statistically distinguishable from zero (34.9% among TCMC students versus 30.9% among comparison students, a difference of 4.0 percentage points, SE = 1.2).

Participating in TCMC may have reduced college-level math course enrollment rates and passing rates. For both cohorts, students who enrolled in TCMC were somewhat less likely than students in the comparison groups to enroll in a college-level math course by the Fall semester of the

Table 1. Estimated average outcomes of TCMC students and comparison students for high school graduation, post-secondary enrollment, math course enrollment, and math course passage.

Outcome	2016-17 Cohort TCMC (N = 1,066)	Comparison (N = 6,777, ESS = 2,452)	Difference	(SE)	p-value	2017-18 Cohort TCMC (N = 2,468)	Comparison (N = 20,854, ESS = 7,971)	Difference	(SE)	p-value
High school graduation (%)										
Year 1	95.5	92.5	3.1	(0.9)	<.001	98.7	94.0	4.7	(0.4)	<.001
Year 2	96.5	93.7	2.8	(0.8)	.001	99.2	95.4	3.8	(0.3)	<.001
Any post-secondary enrollment (%)										
Year 1	33.5	37.6	-4.1	(1.8)	.020	36.4	35.8	0.6	(1.2)	.603
Year 2	43.7	47.2	-3.4	(1.9)	.063	42.8	40.8	2.0	(1.2)	.093
Post-secondary enrollment at community college (%)										
Year 1	21.6	19.8	1.8	(1.6)	.257	27.9	24.6	3.2	(1.1)	.004
Year 2	34.0	32.6	1.4	(1.8)	.441	34.9	30.9	4.0	(1.2)	<.001
Post-secondary enrollment at partner community college (%)										
Year 1	11.6	11.8	-0.1	(1.2)	.916	21.3	19.4	1.9	(1.0)	.055
Year 2	17.8	18.5	-0.7	(1.4)	.604	26.9	24.8	2.0	(1.1)	.059
Post-secondary enrollment at 4-year public college or university (%)										
Year 1	10.5	15.9	-5.4	(1.2)	<.001	7.2	9.7	-2.5	(0.6)	<.001
Year 2	12.8	17.3	-4.5	(1.3)	<.001	8.8	11.3	-2.5	(0.7)	<.001
College-level math course enrollment (%)										
Year 1	14.7	17.2	-2.5	(1.4)	.066	4.4	6.0	-1.7	(0.5)	.001
Year 2	21.6	24.8	-3.2	(1.6)	.037	12.3	14.8	-2.4	(0.8)	.003
College-level math course passage (%)										
Year 1	8.0	12.5	-4.5	(1.1)	<.001	3.0	4.5	-1.6	(0.4)	<.001
Year 2	13.5	19.5	-6.0	(1.3)	<.001	7.6	10.0	-2.5	(0.7)	<.001
Developmental math course enrollment (%)										
Year 1	9.5	11.0	-1.4	(1.2)	.230	1.1	1.2	-0.2	(0.3)	.523
Year 2	12.8	14.7	-1.8	(1.4)	.178	3.5	3.4	0.2	(0.5)	.695
Developmental math course passage (%)										
Year 1	4.3	5.7	-1.5	(0.9)	.091	0.7	0.7	-0.1	(0.2)	.805
Year 2	6.2	8.7	-2.5	(1.0)	.015	2.0	1.9	0.1	(0.4)	.792

Notes: Difference = difference in percentage points between students who participated in TCMC and those that did not enroll. SE = Standard error of the difference. P-value = p-value for the null hypothesis of no difference between TCMC and comparison groups. N = total sample size of students. ESS = effective sample size, based on inverse propensity weights.

second year after high school graduation, with differences of -3.2 percentage points (SE = 1.6) for the 2016-17 cohort and -2.4 percentage points (SE = 0.8) for the 2017-18 cohort. Similarly, TCMC students were less likely than students in the comparison groups to have completed a college-level math course by the Fall of the second year after high school graduation. Regarding developmental coursework, TCMC enrollees and comparison students enrolled in developmental math courses at similar rates.

Policy Recommendations

Findings from this study suggest that participating in TCMC could have shifted some students who might otherwise have enrolled in four-year institutions towards enrolling in community college instead. This impact would be consistent with the incentive structure of the college preparatory course requirements created by HB 5, in that the successful completion of the course provided exemption from proficiency exams only at the partner institution. However, it is also possible that the pattern of results could be due to pre-existing differences between TCMC students and comparison students—particularly differences in aspirations or goals for attending four-year colleges—for which our analysis was not able to adjust.

Given the possibility of pre-existing differences between TCMC participants and comparison students, we urge caution in drawing any implications regarding the causal impact of participating in TCMC. The differences observed here could have resulted from our inability to fully adjust for initial differences in college readiness, college aspirations, or other potential confounders, at the start of students' senior year. Of particular concern is the possibility that the comparison group could have included some students who had already achieved college readiness by the start of senior year. Relative to students in TCMC, college-ready students in the comparison group could be expected to be more likely to apply to and gain admission into four-year colleges, which might explain the differences in four-year enrollment rates that we observed. In order to more effectively evaluate TCMC—and other similar programs—it will be critical to consider and account for students' college readiness status while students are still in high schools. Incorporating such data into the Texas PK-20 Workforce Database would enhance the capacity of the ERC research community for understanding the impacts of policy changes, programs, and other strategies aimed at improving student success across the transition between secondary and post-secondary education.

A final policy recommendation is to continue investigating the implementation of TCMC and other college preparatory math courses implemented in response to HB5. Further work should investigate how schools assess college readiness and determine whether students should take college readiness courses. It would also be valuable to investigate students' perspectives and experiences in such courses as they navigate the transition from high school to college.

Note: At the time that this project was conducted, Pustejovsky was assistant professor in the Educational Psychology Department at the University of Texas at Austin.

References

1. Bailey, T., Jeong, D. W. & Cho, S. W. Referral, enrollment, and completion in developmental education sequences in community colleges. *Econ. Educ. Rev.* **29**, 255–270 (2010).

2. Chen, X. *Remedial Coursetaking at U.S. Public 2- and 4- Year Institutions: Scope, Experiences, and Outcomes (NCES 2016-405)*. http://nces.ed.gov/pubs2016/2016405.pdf (2016).

3. Attewell, P. A., Lavin, D. E., Domina, T. & Levey, T. New Evidence on College Remediation. *J. High. Educ.* **77**, 886–924 (2006).

4. Levin, H. M. & Calcagno, J. C. Remediation in the Community College: An Evaluator's Perspective. *Community Coll. Rev.* **35**, 181–207 (2008).

5. Scott-Clayton, J. & Rodriguez, O. Development, discouragement, or diversion? New evidence on the effects of college remediation policy. *Educ. Finance Policy* **10**, 4–45 (2015).

6. Calcagno, J. C. & Long, B. T. The Impact of Postsecondary Remediation Using a Regression Discontinuity Approach: Addressing Endogenous Sorting and Noncompliance. (2008).

7. Martorell, P. & McFarlin, I. Help or Hindrance? The Effects of College Remediation on Academic and Labor Market Outcomes. *Rev. Econ. Stat.* **93**, 436–454 (2011).

8. Xu, D. Assistance or obstacle? The impact of different levels of English developmental education on underprepared students in community colleges. *Educ. Res.* **45**, (2016).

9. Charles A. Dana Center. *The case for Mathematics Pathways*. https://dcmathpathways.org/resources/case-mathematics-pathways (2016).

10. Charles A. Dana Center. *The Case for Mathematics Pathways - Updated*. https://dcmathpathways.org/resources/case-mathematics-pathways (2019).

11. Pustejovsky, J. E. & Joshi, M. *Evaluating the Transition to College Mathematics Course in Texas High Schools: Findings from the First Year of Implementation*. https://www.greatertexasfoundation.org/wp-content/uploads/2019/06/Pustejovsky-Final-2019.pdf (2019).

12. Lee, B. K., Lessler, J. & Stuart, E. A. Improving propensity score weighting using machine learning. *Stat. Med.* n/a-n/a (2009) doi:10.1002/sim.3782.

13. McCaffrey, D. F., Ridgeway, G. & Morral, A. R. Propensity score estimation with boosted regression for evaluating causal effects in observational studies. *Psychol. Methods* **9**, 403–25 (2004).

(See Appendix/Tables following this page)

TEXAS Education
The University of Texas at Austin
College of Education

Appendix
Additional Tables and Figures

Table S1
Covariate definitions

Variable	Definition
Sex	Sex: male/female.
Race/Ethnicity	Race/ethnicity: Asian American, African American, Hispanic, American Indian, Pacific Islander, Multiracial, and White.
Economic disadvantage	Economic disadvantage status for the 12th grade year: free lunch status, reduced lunch status, no disadvantage or other disadvantage.
At risk for dropping out	Indicator for whether a student was at risk for dropping out of school according to state-defined criteria as of the beginning of the 12th grade year.
Giftedness	Indicator for whether a student participated in state-approved gifted and talented program during the 12th grade year.
Immigrant status	Indicator for whether a student was identified as an immigrant according to the definition in Title III of No Child Left Behind Act of 2001, as of the beginning of the 12th grade year.
Special education status	Indicator for whether a student participated in special education instructional and related services program or general education program using special education services, supplementary aids, or other special arrangements for the 12th grade year.
Limited English proficiency	Indicator for whether a student was limited English proficient as determined by Language Proficiency Assessment Committee (LPAC) as of the end of the 12th grade year.
Prior math course-taking	Indicators for whether a student passed, failed, or did not take Grade 8 Mathematics (four years prior), Algebra I (three and four years prior), Geometry (two and three years prior), Algebra II (one and two years prior) and Pre-calculus (one year prior).
Prior math performance	STAAR end-of-course exam score for Algebra I, completed between 2014 and 2017.
History of economic disadvantage, at-risk for dropping out, giftedness, immigrant status, and special education status	We tracked these variables from 2010 through 2017. Variables include (1) the number of years of available tracked data; (2) the number of years that a student was indicated as being in any of the categories for economic disadvantage and the number of years that the student was indicated as being in special education program, in gifted program, an immigrant, and at risk; (3) the proportion of years (the number of years the student was in the category divided by the number of years of record available) for the economic disadvantages categories; and, (4) if the student was ever indicated as being in special education program, in gifted program, an immigrant, and at risk.

Figure S1. Balance between TCMC group and comparison group in the 2016-17 cohort, before and after inverse propensity score re-weighting adjustment.

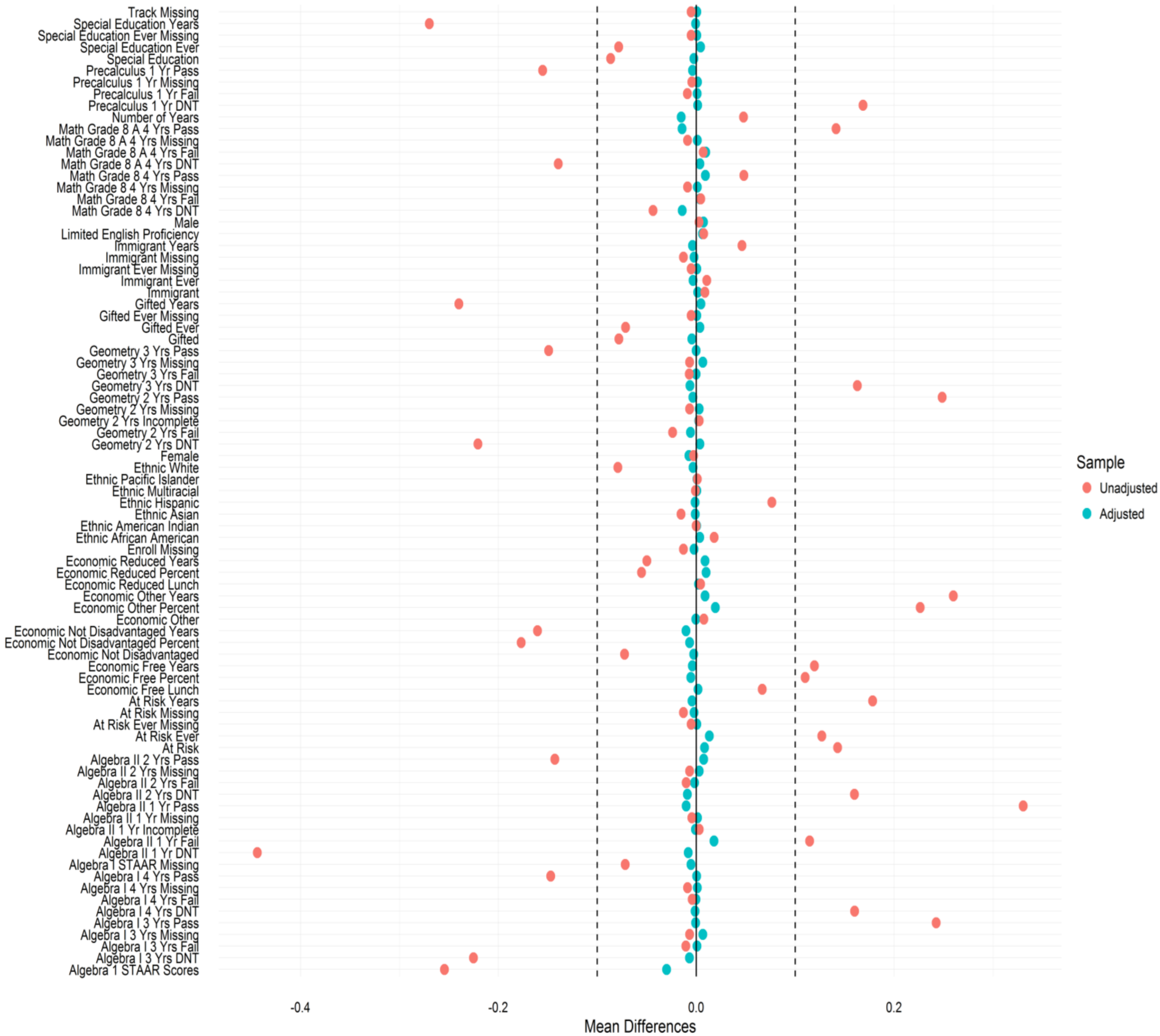


Figure S2. Balance between TCMC group and comparison group in the 2017-18 cohort on demographic characteristics and prior academic performance, before and after inverse propensity score re-weighting adjustment.

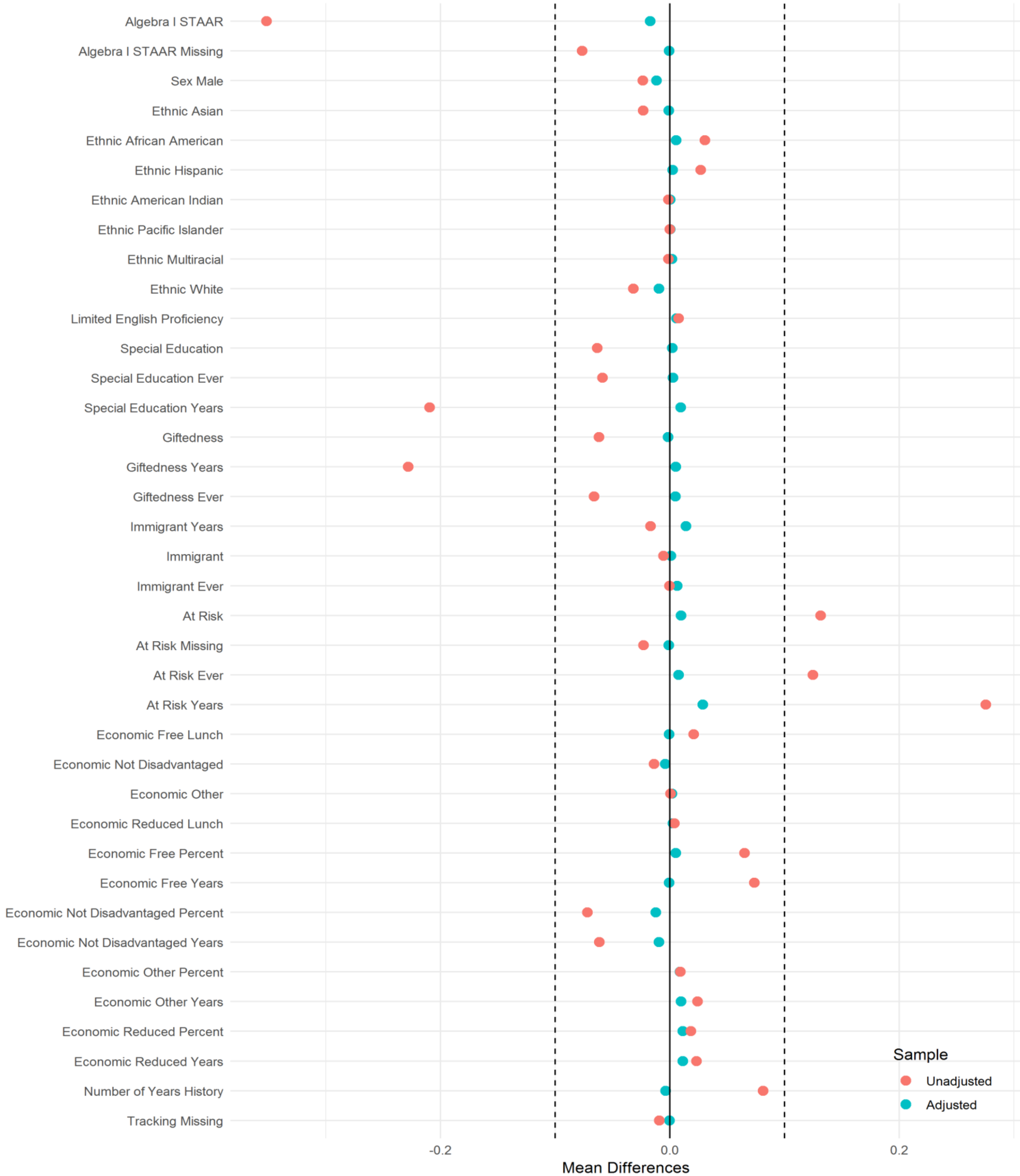
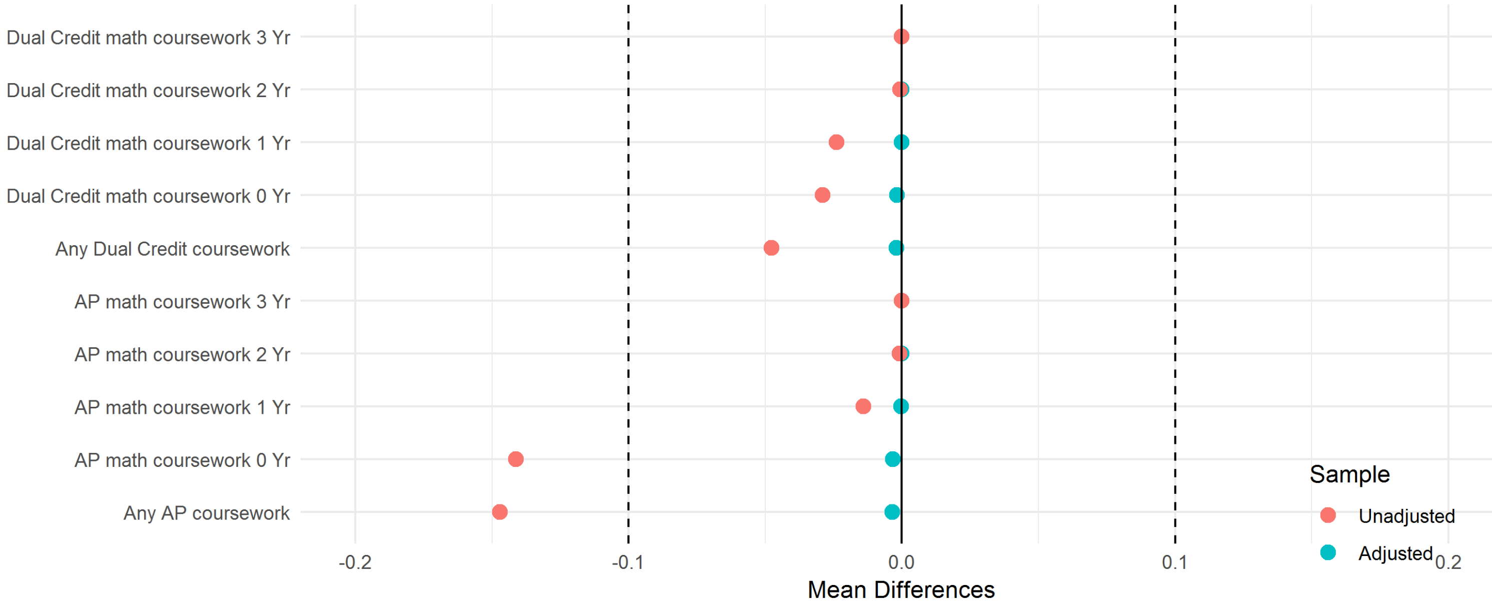


Figure S3. Balance between TCMC group and comparison group in the 2017-18 cohort on math course-taking patterns, before and after inverse propensity score re-weighting adjustment.

TEXAS Education
The University of Texas at Austin
College of Education

Figure S4. Balance between TCMC group and comparison group in the 2017-18 cohort on dual-credit and AP math course-taking patterns, before and after inverse propensity score re-weighting adjustment.



TEXAS Education
The University of Texas at Austin
College of Education