Appendix A – Robustness Checks

This appendix contains robustness checks for the main results presented in the paper. First, we examine the sensitivity of our analyses to the inclusion of school fixed effects, which we do not include in our main models. By comparing pathway participants to non-participants at their same schools, we remove the effects of school-level variation in CTE participation and outcomes from the estimates, though we argue at the cost of exacerbating the potential for bias from unmeasured student-level differences between participants and non-participants. We find negligible differences between the school fixed effects models, presented in Table A.1 (high school outcomes) and Table A.2 (postsecondary outcomes), and our main results shown in Tables 5 and 6 of the main text. This suggests that the array of school-level covariates we do include in our models (e.g., locale, county economic tier, school size) account for the major ways that school-level differences affect outcomes.

TABLE A.1 HERE

TABLE A.2 HERE

Next, we use the approach from Oster (2019) to estimate bounds for our main estimates. This approach estimates selection on observables based on how much our estimates change when we add control variables to the models relative to a simple baseline model. Based on varying assumptions about how much selection on unobservables compare to selection on observables we can obtain bounds for how our estimates may differ due to unobserved selection. Because the R-squared values in our models are typically small (close to 0.1), we have used an R-max of 0.3 and then also implemented the suggestion from Oster (2015) of using 1.3 times the observed R-squared. Second, economists including Altonji et al. (2005) suggest that the correct baseline model is one with an essential or parsimonious set of controls. Thus, our baseline model includes

controls only for students' baseline achievement and course-taking. We chose these controls because achievement and 9th and 10th grade coursetaking give a strong indication of student's likely postsecondary trajectory; it also accounts for the fact that access to advanced courses often differs by school setting. Table A.3 shows the bounds under varying assumptions for the maximum R-squared in the columns with the header Beta. For the most part, the bounds are not substantially different from our main treatment estimate, indicating that any selection bias remaining in our estimates should not substantially change our qualitative findings.

TABLE A.3 HERE

Last, we conducted a robustness check to explore whether excluding students for whom we imputed baseline GPA or economic disadvantage status altered our results. We did so because federal What Works Clearinghouse (WWC) standards require demonstrating baseline equivalence on a "broad, approximately continuous, and standardized measure of student academic readiness, knowledge, and skills," as well as two additional baseline measures one of which may be socioeconomic status (What Works Clearinghouse, 2022). Using unimputed data only for these key baseline covariate measures simplifies compliance with these WWC standards. We present these results in the tables below. Table A.4 replicates Table 1 from the main body of the paper and shows baseline characteristics of treatment and comparison groups composed of students not missing these baseline measures.[1] Table A.5 shows the baseline equivalence for the analytic sample for each outcome for a key subset of the covariates. Tables A.6, A.7, and A.8 replicate tables 3, 4, and 5 from the main report, displaying impact estimates overall and by subgroup for the restricted sample. Results are very similar to our main results for

[1] Table A.4 shows baseline equivalence for the full sample of students for whom we did not need to impute baseline GPA or economic disadvantage status. Analysis samples vary by outcome and baseline equivalence information for each outcome sample is available upon request. We did not need to impute race/ethnicity for any students.

the full sample that included students for whom we imputed baseline GPA and economic disadvantage when that information was missing.

TABLE A.4 HERE

TABLE A.5 HERE

TABLE A.6 HERE

TABLE A.7 HERE

TABLE A.8 HERE

Table A.1

Impact of Participation in CTE Pathway, High School Outcomes, Sensitivity Analysis Including School Fixed Effects in Outcome Models

Outcome	Treatment		Comparison		Impact	Effect
	Sample Size	Mean (SD)	Sample Size	Mean (SD)	Estimate (SE)	Size
Total # of CTE college credits earned via CCP	62,676	5.81 (6.14)	534,056	0 (0)	5.81*** (0.18)	2.9
Total # of transferable credits earned	62,676	4.65 (8.47)	534,056	1.49 (5.50)	3.17*** (0.14)	0.54
Final GPA (weighted)	62,546	3.24 (0.77)	528,076	3.23 (0.81)	0.011*** (0.002)	0.01
Final GPA (unweighted)	62,543	2.97 (0.59)	528,026	2.96 (0.62)	0.003* (0.002)	0.01
4-Year Graduation Rate	62,679	98.1% (13.4%)	534,477	96.0% (19.5%)	2.1 pp*** (0.1)	-

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

Table A.2

Impact of Participation in CTE Pathway, Postsecondary Enrollment, Sensitivity Analysis Including School Fixed Effects in Outcome Models

Outcome	Treatment Mean (SD)	Comparison Mean (SD)	Impact Estimate (SE)
Enrollment outcomes using NSC data[a]			
Enrollment in any postsecondary school within one year	68.0% (47.1)	64.3% (47.9)	3.8 pp*** (0.55)
Enrollment in four-year institution within one year	31.3% (45.9)	34.8% (47.6)	-3.6 pp*** (0.50)
Enrollment in two-year institution within one year	39.2% (48.7)	31.5% (46.4)	7.7%*** (0.57)
Enrollment outcomes using data from North Carolina Community College System and University of North Carolina System[b]			
Enrollment in NC public postsecondary school within one year	59.1% (49.1%)	48.8% (50.0%)	10.3 pp*** (0.4%)
Enrollment in UNC System school within one year	21.6% (41.6%)	21.4% (41.0%)	0.2 pp (0.3%)
Enrollment in NC community college within one year	39.8% (48.9%)	29.2% (45.4%)	10.7%*** (0.5%)

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

[a] Treatment sample size for NSC data: 20,916; comparison sample size: 235,334

[b] Treatment sample size for NC postsecondary institutions: 62,676; comparison sample size: 534,056

Table A.3. Estimates from Oster Bounding Approach

				R-max = 0.3		R-max = 1.3 R^2	
	PSW Treatment Effect	OLS Treatment Effect with Controls	OLS Treatment Effect with Controls + School FE	All Controls	All Controls + School FE	All Controls	All Controls + School FE
Total # of CTE college credits earned via CCP	5.780	5.738	5.713			4.401	4.273
Total # of transferable credits earned	3.310	3.473	2.850			-2.617	-5.239
Final GPA (weighted)	0.011	-0.001	0.003			0.033	0.009
Final GPA (unweighted)	0.003	0.012	0.002			0.070	0.045
4-Year Graduation Rate	0.020	0.023	0.028	0.043	0.058	0.030	0.040
Enrollment in any postsecondary school within one year	0.038	0.038	0.050	0.058	0.058	0.082	0.097
Enrollment in four-year institution within one year	-0.036	-0.062	-0.043			0.042	0.081
Enrollment in two-year institution within one year	0.077	0.104	0.100	0.221	0.128	0.085	0.094
Enrollment in NC public postsecondary within one year	0.103	0.100	0.115	0.186	0.264	0.132	0.154
Enrollment in UNC System school within one year	0.002	-0.027	-0.009	-0.007	-0.005	0.052	0.101
Enrollment in NC community college within one year	0.107	0.132	0.131	0.312	0.160	0.121	0.128

Notes: The baseline model includes controls for cohorts, baseline 8th grade test scores in math, reading, science, baseline high school test scores in biology, math and English, baseline GPA, and number of honors, AP, IP and CTE classes taken at baseline. Some values are blank because the maximum R-squared used to compute the bounds (and amount of selection) is smaller than the R-squared in the original regression so it is not possible to compute the bounds in these cases. In cases where 1.3 times the R-squared is greater than 1, an R-squared value of 1 is used for R-max. The Beta columns indicate the upper (or lower) bound of the treatment effect based on the observed amount of selection on observables and the noted maximum R-squared, under the assumption that delta is one. The first three columns indicate the treatment effect estimates from the propensity score weighting model, and OLS model with all the control variables, and OLS model with all the controls and school fixed effects. Where the Oster approach yields two solutions, we report the value that is smaller in absolute value. (In some cases, this leads to changes in the direction of the bounds for the different values of R-squared.)

Table A.4

Baseline Characteristics of Treatment and Comparison Groups, Restricting Full Analysis Sample to Students with Baseline GPA and Economic Disadvantage Status

Variable	Treatment Mean (N=61,935)	Unweighted Control Mean (N=526,349)	Weighted Control Mean (N=526,349)	Weighted Standardized Effect Size
Female	53.9%	47.4%	52.8%	0.021
White	62.0%	50.6%	61.6%	0.008
Black	18.9%	27.1%	19.2%	-0.007
Asian	1.2%	2.9%	1.3%	-0.006
Hispanic	12.1%	12.5%	11.9%	0.004
Native American	1.0%	1.2%	1.0%	0.002
Multiracial	4.7%	5.7%	4.9%	-0.009
Mobility	8.8%	12.3%	9.3%	-0.018
Age	16.3	16.4	16.3	-0.009
Gifted	15.6%	16.0%	15.3%	0.010
Disability status	6.3%	11.9%	6.6%	-0.014
Economic Disadvantage	41.7%	44.8%	42.4%	-0.015
ELL	1.7%	3.5%	1.8%	-0.008
Absences	6.93	7.77	7.03	-0.016
Ever Out of School Suspension	5.8%	8.8%	6.0%	-0.008
Ever In-School Suspension	8.7%	10.4%	9.0%	-0.011
8th grade math	0.07	0.01	0.06	0.016
8th grade reading	0.08	0.00	0.07	0.016
Unweighted GPA	2.99	2.73	2.97	0.033
Honors courses	2.22	1.97	2.14	0.037
AP courses	0.09	0.15	0.09	0.007
High school CTE courses	1.58	1.23	1.59	-0.003

Table A.5

Baseline Characteristics of Treatment and Comparison Groups, Restricting Analysis Sample to Students with Baseline GPA and Economic Disadvantage Status, by Outcome Sample

Outcome and Sample Size	Variable	Treatment Mean	Unweighted Control Mean	Weighted Control Mean	Weighted Standardized Effect Size
Credits Earned and College Enrollment (NC institutions) (T=61,470, C=513,272)	Unweighted GPA	2.99	2.74	2.98	0.030
	Economic Disadvantage	41.6%	44.7%	42.4%	-0.015
	Black	18.9%	27.1%	19.3%	-0.010
	Hispanic	12.0%	12.5%	11.9%	0.003
	White	62.0%	50.5%	61.5%	0.010
HS GPA (weighted) (T=61,358, C=508,892)	Unweighted GPA	3.00	2.74	2.98	0.026
	Economic Disadvantage	41.6%	44.5%	42.3%	-0.014
	Black	18.9%	27.1%	19.3%	-0.010
	Hispanic	12.1%	12.5%	12.0%	0.003
	White	62.0%	50.5%	61.5%	0.010
HS Graduation (T=61,473, C=513,604)	Unweighted GPA	2.99	2.74	2.98	0.030
	Economic Disadvantage	41.6%	44.7%	42.4%	-0.015
	Black	18.9%	27.2%	19.3%	-0.009
	Hispanic	12.0%	12.5%	11.9%	0.003
	White	62.0%	50.5%	61.5%	0.010
College Enrollment (NSC) (T=20,496, C=226,408)	Unweighted GPA	2.93	2.73	2.97	-0.058
	Economic Disadvantage	44.1%	45.5%	43.0%	0.021
	Black	18.8%	26.8%	18.9%	-0.003
	Hispanic	10.0%	10.4%	9.7%	0.012
	White	64.3%	53.1%	64.5%	-0.004

Table A.6

Results of Participating in CTE Pathway, High School Outcomes, Restricting Analysis Sample to Students with Baseline GPA and Economic Disadvantage Status

Outcome	Treatment		Comparison		Impact Estimate (SE) -Preferred Model	Effect Size	Impact Estimate (SE)-School Fixed Effects
	Sample Size	Mean (SD)	Sample Size	Mean (SD)			
Total # of CTE college credits earned via CCP[a]	61,470	5.81 (6.15)	513,272	0 (0)	5.81*** (0.18)	2.9	5.83*** (0.18)
Total # of transferable credits earned[a]	61,470	4.82 (8.49)	513,272	1.49 (5.51)	3.33*** (0.15)	0.56	3.18*** (0.14)
Final HS GPA (weighted)	61,358	3.25 (0.77)	508,892	3.24 (0.80)	0.010*** (0.002)	0.01	0.011*** (0.002)
Final HS GPA (unweighted)	61,357	2.97 (0.59)	508,861	2.97 (0.62)	0.002 (0.002)	<0.01	0.003 (0.002)
4-Year HS Graduation Rate	61,473	98.2% (13.1%)	513,604	96.3% (18.8%)	1.8 pp*** (0.1)	-	1.9 pp*** (0.1)

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

How to read this table: CTE Pathway participants earned 5.81 CTE credits while the comparison students earned 0, an impact of 5.81, which was statistically significant. Notes: Comparison group means and standard deviations are weighted; effect sizes for continuous outcomes are calculated as the ratio of the impact estimate to the pooled (weighted) standard deviation.

Table A.7

Impact of Participation in CTE Pathway, Postsecondary Enrollment, Restricting Analysis Sample to Students with Baseline GPA and Economic Disadvantage Status

Outcome	Treatment Mean (SD)	Comparison Mean (SD)	Impact Estimate (SE) –Preferred Model	Impact Estimate (SE)—School Fixed Effects
Enrollment outcomes using NSC data[a]				
Enrollment in any postsecondary school within one year	68.0% (47.1)	64.6% (47.8)	3.3 pp*** (0.53)	3.6 pp*** (0.56)
Enrollment in four-year institution within one year	31.6% (46.0)	35.0% (47.7)	-3.5 pp*** (0.51)	-3.6 pp*** (0.49)
Enrollment in two-year institution within one year	38.8% (48.7)	31.6% (46.5)	7.1 pp*** (0.56)	7.6 pp*** (0.58)
Enrollment outcomes using data from North Carolina Community College System and University of North Carolina System[b]				
Enrollment in NC public postsecondary school within one year	59.0% (49.1)	49.1% (50.0)	9.9 pp*** (0.4)	10.2 pp*** (0.4)
Enrollment in UNC System school within one year	21.7% (41.6)	21.5% (41.1)	0.2 pp (0.3)	0.2 pp (0.3)
Enrollment in NC community college within one year	39.6% (48.9)	29.3% (45.5)	10.2 pp*** (0.5)	10.5 pp*** (0.5)

*$p \leq .05$; **$p \leq .01$; ***$p \leq .001$

[a] Treatment sample size for NSC data: 20,496; comparison sample size: 226,408

[b] Treatment sample size for NC postsecondary institutions: 61,470; comparison sample size: 513,272

How to read this table: 59.0% of treatment students enrolled in any NC public postsecondary institution within the first year of leaving high school compared to 49.1% of comparison students. The impact was 9.9 percentage points and was statistically significant.

Table A.8

Impact Estimates by Subgroup, Selected Outcomes, Restricting Analysis Sample to Students with Baseline GPA and Economic Disadvantage Status

Outcome	Gender		Underrepresented Race/Ethnicity		Economically-Disadvantaged	
	Male	Female	Underrep.	Not underrep.	EDS	Not EDS
Total # of CTE college credits earned via CCP	6.4***	5.2***	5.6***	5.9***	5.9***	5.7***
Differential impact	1.2***		-0.3*		0.2	
Total # of transferable credits earned	2.3***	4.3***	2.7***	3.7***	2.4***	4.0***
Differential impact	-2.0***		-1.0***		-1.5***	
4-Year Graduation Rate	1.8 pp***	1.8 pp***	1.8 pp***	1.8 pp***	2.7 pp***	1.2 pp***
Differential impact	0.0 pp		0.0 pp		1.4 pp***	
Final GPA (weighted)	.01**	.01***	.02***	.01*	.02***	.00
Differential Impact	.00		.01**		.02***	
Final GPA (unweighted)	.005*	.000	.01	.00	.01***	.00
Differential Impact	.005		.00		.01***	
Enrollment in NC public postsecondary school within one year	9.2 pp***	10.5 pp***	10.8 pp***	9.4 pp***	11.1 pp***	9.1 pp***
Differential impact	-1.4 pp*		1.4 pp*		2.0***	
Enrollment in UNC System school within one year	-0.9 pp*	1.1 pp**	1.5 pp***	-0.6 pp	1.0 pp**	-0.4 pp
Differential impact	-2.0 pp***		2.0 pp***		1.4 pp**	
Enrollment in NC community college within one year	10.3 pp***	10.2 pp***	9.7 pp***	10.5 pp***	10.5 pp***	10.1 pp***
Differential impact	0.1 pp		-0.8 pp		0.4 pp	

How to read this table: The impact on the four-year graduation rate for males was 1.8 percentage points and for females, it was 1.8 percentage points. The difference in impacts between males and females was 0.0 percentage points and this difference is not statistically significant.
*p≤.05; **p≤.01; ***p≤.001