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Does Raising High School Graduation Requirements Improve Student Outcomes?

Technical Appendix

CONTENTS

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Appendix A. Additional Tables and Figures

TABLE 1

Districts with higher standards tend to enroll more high-need students and low performing students

	2 math	3+ math	2 science	3+ science
Student Demographics				
% Asian	12%	6.21%***	8%	6.6%*
% Latino	46%	57.8%***	54%	54%
% African American	4%	5.51%***	5%	5%
% Female	49%	49%	49%	49%
% FRPM eligible	51%	61.8%***	58%	59%
% English learners	10%	11.8%**	11%	11%
% with college educated parents	38%	30.4%***	33%	31%
Teacher Qualifications				
Average years of experience	13.8	13.6	13.8	12.95***
% with a master degree or higher	46%	46%	48%	39.2%***
School Characteristics				
% Urban	36%	35%	36%	35%
% Rural	12%	14%	12%	20.6%***
% math courses A–G approved	80%	76%***	77%	77%
% science courses A–G approved	85%	80.4%***	82%	81%
Student Outcomes				
Proficiency rates, 11th SBAC, ELA	64%	56.4***	59%	55.87***
Proficiency rates, 11th SBAC, math	38%	29.88***	33%	28.51***
AP exam rate (among 11/12th graders)	43%	41%	43%	34.8%***
SAT exam rate (among 11/12th graders)	41%	44.2%**	45%	36.8%***
A–G completion rate	50%	49%	50%	44.4%***
High school graduation rate	93%	90.6%***	92%	90.2%*
% students enrolled in advanced math courses	33%	34%	34%	30.7%***
% students enrolled in advanced science courses	17%	14.2%***	15%	15%
N high schools	312	694	813	194

SOURCES: Author's calculations. Districts graduation policies are obtained through web scraping, and other data are from the California Department of Education.

NOTES: Sample include regular high schools only. Students in alternative high schools and/or charter schools are not subject to the district's graduation policy. State policy is 2 years of science, 2 years of math. The stars indicate difference between districts requiring 3+ years of math (science) and districts requiring 2 years of math (science). *** p<0.01, ** p<0.05, * p<0.1. High school graduation rate is defined as the number of high school graduates divided by 12th grade enrollment. One regular high school/district is missing math requirement information.

TABLE 2

Full OLS results of higher math standards

VARIABLES	High school graduation rate	A–G completion rate	SAT exam rate	% students taking advanced math	Proficiency rates, SBAC, 11th, Math	High school dropout rate
3 or 4 years of math	-0.3537	2.8018*	5.3380**	4.1617***	-1.0553	0.4526
	(0.5869)	(1.6833)	(2.6347)	(1.0295)	(0.8796)	(0.4267)
% Asian	11.0423***	32.2568***	41.5463***	38.6409***	46.4425***	-3.5181***
	(2.2235)	(4.8005)	(5.5614)	(4.1869)	(3.4298)	(1.1222)
% Pacific Islander	-79.9791	-66.4938	-120.3141	-216.9530**	-165.0902*	-22.2889
	(56.3973)	(131.8369)	(170.0868)	(89.6635)	(88.1207)	(43.7906)
% Filipino	19.8877***	-13.7479	20.3085	-1.5435	-1.5093	-0.5760
	(5.4453)	(18.9114)	(20.9801)	(10.5087)	(9.9163)	(2.9207)
% Latino	8.4370***	10.8656**	35.7601***	12.7995***	-3.3460	-3.2915***
	(3.0695)	(4.8914)	(6.1337)	(4.5813)	(3.0500)	(1.1815)
% African American	2.2842	4.7329	52.6140***	14.3889*	-38.9638***	14.5088***
	(4.6663)	(10.9802)	(14.2387)	(7.7850)	(6.6383)	(2.1418)
% multi-race	-18.1185	-24.6056	-15.5055	41.6347*	12.4005	-0.1533
	(15.2935)	(39.9205)	(32.5860)	(22.6171)	(18.5272)	(6.3193)
% female	17.0433	42.9615*	14.7472	3.8566	34.0066	-25.4386***
	(12.6842)	(24.2124)	(30.5485)	(10.3636)	(21.5588)	(4.1847)
% free/reduced lunch eligible	-5.8117*	-26.6838***	-5.9101	-17.0985***	-33.3870***	4.9687***
	(3.2524)	(7.0857)	(9.0901)	(5.2961)	(3.7664)	(1.9086)
% limited English proficiency	-25.4895***	-26.7422**	-58.0856***	-0.7013	-23.8191***	19.8849***
	(5.2453)	(11.3415)	(13.6018)	(8.3290)	(8.2335)	(2.8678)
Teacher experience	0.2398**	0.1710	-0.1547	0.1247	0.2435	0.0832
	(0.0950)	(0.2389)	(0.3231)	(0.1528)	(0.1695)	(0.0511)
% teachers with advanced degrees	1.5860	20.5189***	12.4307**	12.9827***	12.2465***	-1.1822
	(1.8300)	(4.4311)	(5.1971)	(3.1148)	(2.5160)	(0.7842)
urban	-0.1051	3.5554**	4.2830*	1.2726	-0.1616	1.5328***
	(0.5799)	(1.6772)	(2.2942)	(1.0541)	(0.8241)	(0.4953)
rural	-0.3489	-1.7332	-0.8054	-0.5800	-3.0754***	0.0097
	(1.0679)	(1.9615)	(2.4575)	(1.1817)	(1.1075)	(0.4780)
% math courses A–G approved	0.1893	4.8295	7.6947	22.2503***	-5.4176**	0.9249
	(2.0045)	(5.4550)	(6.0050)	(4.8324)	(2.7353)	(0.9427)
% science courses A–G approved	4.4469**	13.6923***	19.6561***	4.2996	8.9322***	-0.5031
	(2.0088)	(3.8996)	(6.0320)	(6.3114)	(1.9016)	(1.4008)
% CTE courses	0.7012	-22.4827***	-22.7941***	4.3569	-2.4243	-2.1991**
	(3.5000)	(1.9181)	(3.2042)	(3.1378)	(1.5016)	(1.0796)

VARIABLES	High school graduation rate	A–G completion rate	SAT exam rate	% students taking advanced math	Proficiency rates, SBAC, 11th, Math	High school dropout rate
Observations	961	961	974	990	969	961
R-squared	0.172	0.434	0.304	0.523	0.819	0.454

SOURCES: Author's calculations.

NOTES: 1. Weighted by student enrollment. 2. Standard errors clustered at district level. 3. *** p<0.01, ** p<0.05, * p<0.1 4. The results are very close after excluding Los Angeles Unified School District in the sample.

TABLE 3

Full OLS results of higher science standards

VARIABLES	High school graduation rate	A–G completion rate	SAT exam rate	% students taking advanced science	Proficiency rates, CAST, all HS grades	High school dropout rate
3 or 4 years of science	-0.7027	-1.4219	-4.9195*	1.4661	-0.3088	-0.8698*
	(0.8225)	(2.1111)	(2.6077)	(1.2913)	(0.6252)	(0.4687)
% Asian	11.1997***	30.6602***	38.2947***	24.5552***	6.9146***	-3.8224***
	(2.2212)	(4.9649)	(5.6718)	(3.0050)	(2.3805)	(1.2010)
% Pacific Islander	-78.3487	-64.8791	-110.0978	-12.2923	-118.4219***	-21.5133
	(56.3363)	(126.3009)	(166.8166)	(87.2076)	(43.4463)	(43.8388)
% Filipino	18.7990***	-13.2848	18.5090	-20.4704**	10.2702	-1.1294
	(5.5661)	(18.8742)	(20.7675)	(10.2895)	(7.7525)	(2.8650)
% Latino	8.4862***	10.9690**	36.0293***	9.2915***	-7.7324***	-3.2319***
	(3.1053)	(4.8758)	(6.2049)	(3.4086)	(2.0131)	(1.1836)
% African American	2.1015	6.2575	55.2779***	6.8755	-28.7336***	14.7718***
	(4.6574)	(10.8492)	(14.3691)	(6.3728)	(4.3356)	(2.1307)
% multi-race	-18.8149	-27.2436	-24.7742	23.8732	-10.1524	-0.7878
	(15.3834)	(42.0405)	(34.3007)	(29.4887)	(14.4454)	(6.4464)
% female	16.7599	42.1354*	11.9007	9.8046	20.7248**	-25.7494***
	(12.3844)	(24.9999)	(30.7048)	(12.9639)	(9.4747)	(4.1896)
% free/reduced lunch eligible	-5.9956*	-26.2050***	-5.3789	-13.7221***	-13.1477***	4.9833**
	(3.3042)	(7.3147)	(9.3343)	(3.4991)	(2.0807)	(1.9260)
% limited English proficiency	-25.5201***	-28.0928**	-61.0141***	-7.8316	-16.6965***	19.5258***
	(5.2035)	(11.6932)	(13.9996)	(5.8179)	(4.4386)	(2.7863)
Teacher experience	0.2274**	0.1615	-0.1929	-0.4178***	0.1370	0.0714
	(0.0975)	(0.2370)	(0.3169)	(0.1522)	(0.0883)	(0.0487)
% teachers with advanced degrees	1.2821	20.5345***	11.5567**	16.8703***	1.5062	-1.4039*
	(1.8326)	(4.4680)	(5.5434)	(3.1270)	(1.7253)	(0.7820)
urban	-0.0880	3.6042**	4.4505*	0.6745	0.1174	1.5555***
	(0.5901)	(1.7603)	(2.3947)	(0.8379)	(0.4516)	(0.4954)
rural	-0.2832	-1.0307	0.7151	0.1988	-1.8565***	0.2269

VARIABLES	High school graduation rate	A–G completion rate	SAT exam rate	% students taking advanced science	Proficiency rates, CAST, all HS grades	High school dropout rate
	(1.0818)	(1.7381)	(2.3155)	(1.7156)	(0.7168)	(0.4415)
% math courses A–G approved	0.3329	4.7419	7.8760	4.4890	1.1715	1.0091
	(2.0030)	(5.3688)	(6.0417)	(3.9543)	(1.6687)	(0.9481)
% science courses A–G approved	4.4389**	13.1218***	18.2934***	6.0916**	0.6481	-0.6486
	(1.9829)	(3.7664)	(6.2448)	(2.5564)	(1.2800)	(1.3019)
% CTE courses	0.7653	-22.9004***	-23.4294***	-1.2624	-1.8632***	-2.2586**
	(3.4082)	(1.8765)	(3.0153)	(1.8412)	(0.6213)	(1.0488)
Observations	960	960	973	989	977	960
R-squared	0.172	0.429	0.293	0.342	0.694	0.457

SOURCES: Author's calculations.

NOTES: 1. Weighted by student enrollment. 2. Standard errors clustered at district level. 3. *** p<0.01, ** p<0.05, * p<0.1. 4. The results are very close after excluding schools in Los Angeles Unified School Districts in the sample.

TABLE 4

Association of higher graduation requirements and student outcomes, by school characteristics

	% students taking advanced math/science	A–G completion rate	Proficiency rates in math/science	SAT exam rate	High school graduation rate	Drop-out rate
Math						
All schools	4.1617***	2.8018*	-1.0553	5.3380**	-0.3537	0.4526
High need	4.1597***	3.2721	-0.8942	8.5282**	-0.339	0.4884
High poverty	4.9816***	2.3982	-1.1053	7.3624*	-0.3273	0.0896
High minority	3.0010*	2.6898	-2.0981	8.6944*	-1.3646	0.5356
CSI	3.6574*	2.821	-1.2939	4.1629	-0.1243	-0.4767
Urban	6.0653***	5.2242**	-0.2524	10.5339***	0.3823	0.3102
Rural	0.7089	-3.3866	-1.8103	-3.5059	1.1769	-0.2236
Science						
All schools	1.4661	-1.4219	-0.3088	-4.9195*	-0.7027	-0.8698*
High need	1.1619	-2.6905	-0.1420	-6.8342*	-0.155	-1.4157**
High poverty	3.9113*	-1.962	0.3216	-3.7936	1.8966*	-2.2627*
High minority	3.2121	-2.4398	0.7735	-2.3176	-0.6703	-1.6193*
CSI	1.5318	-1.3815	-0.1511	-7.9023	-1.1466	-1.6573*
Urban	3.1666	0.0596	-1.1065	-9.3716*	-1.3907	-2.4987***
Rural	-0.1116	-7.9160***	-0.0768	-5.5220*	1.4411	0.1457

SOURCE: Author's calculation.

NOTE: 1. Sample includes 1007 regular high schools in 2018-19 school year. 2. Students in alternative high schools and/or charter schools are not subject to the district's high school graduation policies. 3. The numbers represent OLS coefficients in a model that controls for student demographics (race/ethnicity, % free/reduced-price lunch), educational needs (% English learners), teacher qualifications (average experience, and % with advanced degree), school geographic location (urban, rural), % of math and science courses A–G approved. Standard errors are clustered at the district level.. 4. Math proficiency rates refer to % students proficient in 11th grade Smarter Balanced assessment; science proficiency refers to % students proficient in high school California Science Test. 5. . *** p<0.01, ** p<0.05, * p<0.1

TABLE 5

Average student outcomes, by school characteristics

	High school graduation rate	A–G completion rate	SAT exam rate	% students taking advanced math	% students taking advanced science	Proficiency rates, SBAC, 11th, Math	Proficiency rates, CAST	Dropout	N of schools	% of students
All	91	50	43	33	16	33	21	5	1075	
High need	90	44	44	31	13	22	15	7	626	54%
High poverty	89	46	48	31	13	19	13	8	346	29%
High minority	90	47	48	32	13	20	14	7	389	35%
CSI	89	43	42	31	13	23	16	8	198	21%
Urban	91	54	48	36	18	33	20	7	393	41%
Rural	90	39	35	26	10	26	19	4	147	6%

SOURCES: Author's calculations

NOTES: Sample include regular high schools only. Students in alternative high schools and/or charter schools are not subject to the district's graduation policy.

TABLE 6

Placebo tests: Association of higher graduation requirements and student enrollment

	(1)	(2)
	Enrollment	Enrollment
3 + math	-29.4091	
	(91.0470)	
3 + science		45.3886
		(107.1675)
Observations	990	989
R-squared	0.217	0.217

SOURCES: Author's calculations.

NOTES: 1. Weighted by student enrollment. 2. Standard errors clustered at district level. 3. *** p<0.01, ** p<0.05, * p<0.1 4. Sample includes regular high schools in 2018-19 school year. Students in alternative high schools and/or charter schools are not subject to the district's high school graduation policies. 5. The numbers represent OLS coefficients in a model that controls for student demographics (race/ethnicity, % free/reduced-price lunch), educational needs (% English learners), teacher qualifications (average experience, and % with advanced degree), school geographic location (urban, rural), % of math and science courses A–G approved.

TABLE 7

Overlap of disadvantaged schools

	High-minority schools	CSI schools	Rural schools	Urban schools
% high-need schools	98%	78%	56%	63%
% high-poverty schools	74%	50%	29%	36%
N. of high schools	389	198	147	393

SOURCES: Author's calculations.

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