

College Openings, Mobility, and the Incidence of COVID-19 Cases

Additional Materials

eTable 1: Association of Reopening and Modality with Mobility and New Cases

	% change in visitors		Daily new cases per thousand				$R^2$
	Model 1	Model 2	Model 1	Model 2	Model 3	Model 4	Model 4
Open	0.457***		0.017*		0.016*		
	(0.048)		(0.007)		(0.007)		
	[0.362, 0.551]		[0.003, 0.030]		[0.003, 0.030]		
Open, Primarily online		0.328***		-0.001		-0.001	0.019***
		(0.045)		(0.010)		(0.010)	(0.005)
		[0.241, 0.415]		[-0.021, 0.018]		[-0.021, 0.019]	[0.010, 0.028]
Open, Primarily in person		0.539*** c		0.024** a		0.023** a	0.021***
		(0.057)		(0.008)		(0.008)	(0.004)
		[0.427, 0.650]		[0.008, 0.040]		[0.007, 0.038]	[0.013, 0.028]
Open x Student exposure					0.119***		
					(0.021)		
					[0.078, 0.160]		
Open, Primarily online x Student exposure					0.057*		0.011
					(0.028)		(0.017)
					[0.002, 0.111]		[-0.023, 0.045]
Open, Primarily in person x Student exposure					0.142*** a		0.010
					(0.025)		(0.014)
					[0.092, 0.192]		[-0.017, 0.037]

Notes: Sample includes 217,051 Census Block Group for 61 days (% change in visitors) and 3126 counties observed for 61 days for daily new cases per thousand. Student exposure is the change in the average of the log weekly incidence from July 15<sup>th</sup> to fourteen days before campus reopened, weighted by the change in movement from each county to each campus from the start of the Fall 2019 semester. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from open, primarily online P<0.05

b Difference from open, primarily online P<0.01

c Difference from open, primarily online P<0.001

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Table 2: Association of Reopening with Mobility, Cases, and Disease Transmission by Week

	Visitors	Daily new cases per '000	$R_t$
1-7 days before opening, primarily online	0.349***	-0.012	0.008*
	(0.037)	(0.008)	(0.004)
	[0.276, 0.422]	[-0.027, 0.003]	[0.001, 0.015]
1-7 days before opening, primarily in-person	0.563*** c	0.001	0.011***
	(0.037)	(0.006)	(0.003)
	[0.491, 0.635]	[-0.010, 0.012]	[0.005, 0.017]
Open for 0-6 days, primarily online	0.412***	-0.000	0.015***
	(0.049)	(0.011)	(0.004)
	[0.317, 0.507]	[-0.021, 0.021]	[0.006, 0.024]
Open for 0-6 days, primarily in- person	0.766*** c	0.008	0.016***
	(0.056)	(0.008)	(0.004)
	[0.655, 0.876]	[-0.006, 0.023]	[0.009, 0.024]
Open for 7+ days, primarily online	0.398***	-0.004	0.024***
	(0.052)	(0.012)	(0.006)
	[0.296, 0.499]	[-0.028, 0.019]	[0.013, 0.035]
Open for 7+ days, primarily in- person	0.633*** c	0.032** a	0.027***
	(0.061)	(0.010)	(0.004)
	[0.513, 0.753]	[0.012, 0.051]	[0.019, 0.036]

Notes: Sample includes 217,051 Census Block Group for 61 days (% change in visitors) and 3126 counties observed for 61 days for daily new cases per thousand. Standard errors account for first order serial correlation.

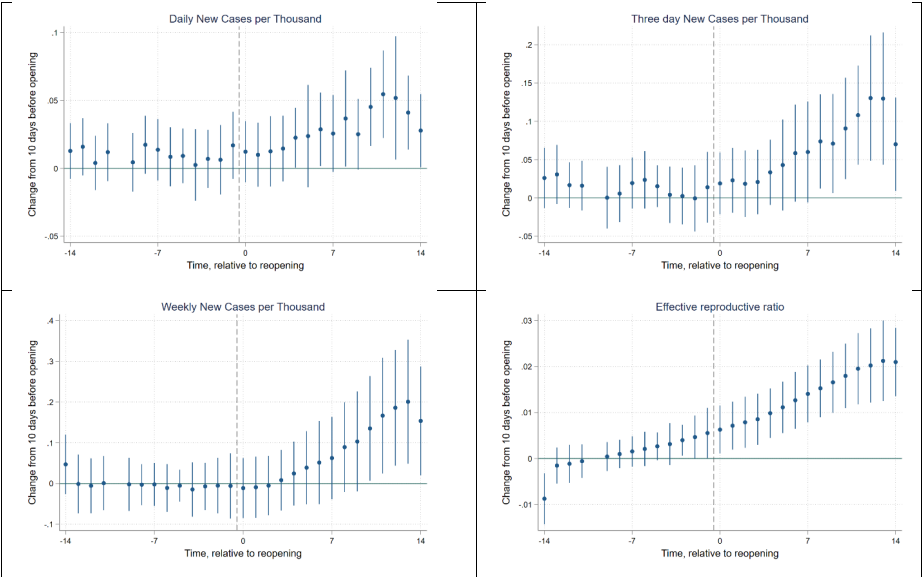
\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from open, primarily online P<0.05

b Difference from open, primarily online P<0.01

c Difference from open, primarily online P<0.001

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**Figure 1: Event studies**

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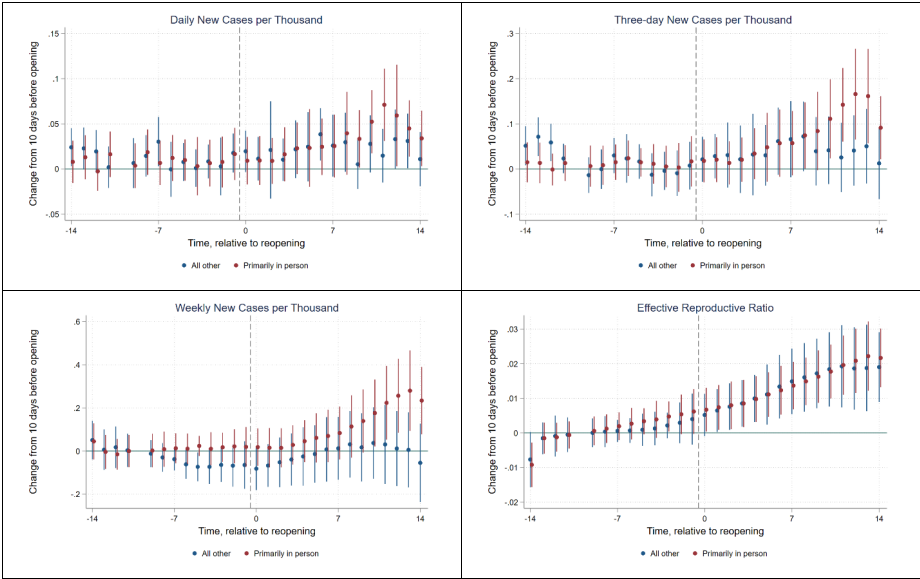
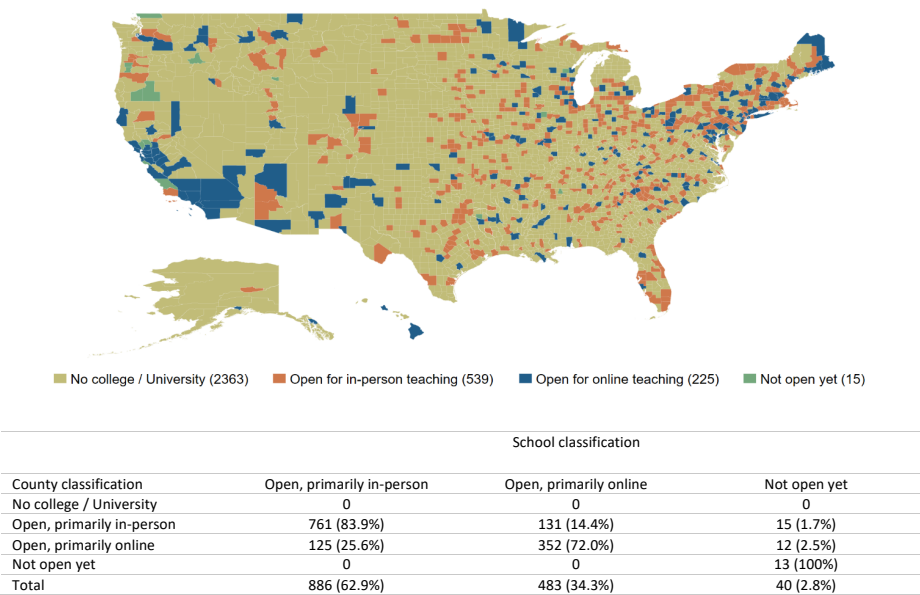


Figure 2: Event studies including in-person interactions

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**eFigure 3: Mapping schools and counties. Top panel: US map with counties and schools. Bottom panel School classifications**

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eTable 3: Three-day new cases (main models)

	Model 1	Model 2	Model 3	Model 4
Open	0.044*		0.042*	
	(0.020)		(0.020)	
	[0.004, 0.083]		[0.002, 0.081]	
Open, Primarily Online		-0.009		-0.008
		(0.029)		(0.029)
		[-0.067, 0.048]		[-0.066, 0.049]
Open, Primarily in person		0.065** a		0.061** a
		(0.024)		(0.024)
		[0.019, 0.112]		[0.015, 0.108]
Open x Home state exposure			0.372***	
			(0.062)	
			[0.251, 0.494]	
Open, Primarily Online x Home state exposure				0.188*
				(0.079)
				[0.033, 0.344]
Open, Primarily in person x Home state exposure				0.442*** a
				(0.076)
				[0.293, 0.590]

Notes: Sample includes 3126 counties observed for 61 days. Student exposure is the change in the average of the log weekly incidence from July 15<sup>th</sup> to fourteen days before campus reopened, weighted by the change in movement from each county to each campus from the start of the Fall 2019 semester. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from open, primarily online P<0.05

b Difference from open, primarily online P<0.01

c Difference from open, primarily online P<0.001

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eTable 4: Weekly new cases (main models)

	Model 1	Model 2	Model 3	Model 4
Open	0.074		0.069	
	(0.047)		(0.047)	
	[-0.017, 0.166]		[-0.023, 0.161]	
Open, Primarily Online		-0.049		-0.046
		(0.065)		(0.065)
		[-0.177, 0.079]		[-0.174, 0.082]
Open, Primarily in person		0.125* a		0.113* a
		(0.055)		(0.055)
		[0.017, 0.233]		[0.005, 0.222]
Open x Home state exposure			0.928***	
			(0.142)	
			[0.649, 1.207]	
Open, Primarily Online x Home state exposure				0.489**
				(0.179)
				[0.139, 0.839]
Open, Primarily in person x Home state exposure				1.093*** a
				(0.175)
				[0.750, 1.437]

Notes: Sample includes 3126 counties observed for 61 days. Student exposure is the change in the average of the log weekly incidence from July 15<sup>th</sup> to fourteen days before campus reopened, weighted by the change in movement from each county to each campus from the start of the Fall 2019 semester. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from open, primarily online P<0.05

b Difference from open, primarily online P<0.01

c Difference from open, primarily online P<0.001

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Table 5: Effective reproductive ratio (main models)

	Model 1	Model 2	Model 3	Model 4
Open	0.020*** (0.003) [0.014, 0.027]		0.020*** (0.003) [0.014, 0.027]	
Open, Primarily Online		0.019*** (0.005) [0.010, 0.028]		0.019*** (0.005) [0.010, 0.028]
Open, Primarily in person		0.021*** (0.004) [0.013, 0.028]		0.021*** (0.004) [0.013, 0.028]
Open x Home state exposure			0.010 (0.011) [-0.012, 0.033]	
Open, Primarily Online x Home state exposure				0.011 (0.017) [-0.023, 0.045]
Open, Primarily in person x Home state exposure				0.010 (0.014) [-0.017, 0.037]

Notes: Sample includes 3126 counties observed for 61 days. Student exposure is the change in the average of the log weekly incidence from July 15<sup>th</sup> to fourteen days before campus reopened, weighted by the change in movement from each county to each campus from the start of the Fall 2019 semester. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from open, primarily online P<0.05

b Difference from open, primarily online P<0.01

c Difference from open, primarily online P<0.001

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## College Openings, Mobility, and the Incidence of COVID-19 Cases

**eTable 6: Weight counties by population**

	New cases per thousand			Reproductive ratio
	Daily	Last three days	Weekly	
Open, Primarily Online	-0.017	-0.052	-0.113	0.008
	(0.014)	(0.041)	(0.094)	(0.005)
	[-0.044, 0.009]	[-0.133, 0.029]	[-0.296, 0.071]	[-0.001, 0.018]
Open, Primarily in person	-0.018	-0.057	-0.157	0.005
	(0.014)	(0.043)	(0.097)	(0.004)
	[-0.046, 0.010]	[-0.141, 0.027]	[-0.348, 0.033]	[-0.002, 0.012]
Open, Primarily Online x Home state exposure	0.098**	0.311**	0.737**	0.037*
	(0.034)	(0.105)	(0.239)	(0.016)
	[0.031, 0.166]	[0.105, 0.516]	[0.268, 1.205]	[0.006, 0.068]
Open, Primarily in person x Home state exposure	0.162***	0.495***	1.219***	0.050***
	(0.032)	(0.095)	(0.232)	(0.011)
	[0.100, 0.224]	[0.309, 0.682]	[0.765, 1.674]	[0.028, 0.072]

Notes: Sample includes 3126 counties observed for 61 days. Student exposure is the change in the average of the log weekly incidence from July 15<sup>th</sup> to fourteen days before campus reopened, weighted by the change in movement from each county to each campus from the start of the Fall 2019 semester. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from open, primarily online P<0.05

b Difference from open, primarily online P<0.01

c Difference from open, primarily online P<0.001

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**eTable 7: Differential effects by week around reopening**

	New cases per thousand			Reproductive ratio
	Daily	Last three days	Weekly	
1-7 days before opening, primarily online	-0.012	-0.038	-0.100*	0.008*
	(0.008)	(0.021)	(0.041)	(0.004)
	[-0.027, 0.003]	[-0.078, 0.003]	[-0.180, -0.020]	[0.001, 0.015]
1-7 days before opening, primarily in-person	0.001	0.001	-0.016	0.011***
	(0.006)	(0.017)	(0.036)	(0.003)
	[-0.010, 0.012]	[-0.032, 0.033]	[-0.087, 0.055]	[0.005, 0.017]
Open for 0-6 days, primarily online	-0.000	-0.013	-0.077	0.015***
	(0.011)	(0.029)	(0.058)	(0.004)
	[-0.021, 0.021]	[-0.070, 0.044]	[-0.189, 0.036]	[0.006, 0.024]
Open for 0-6 days, primarily in-person	0.008	0.017	0.003	0.016***
	(0.008)	(0.022)	(0.047)	(0.004)
	[-0.006, 0.023]	[-0.025, 0.060]	[-0.090, 0.096]	[0.009, 0.024]
Open for 7+ days, primarily online	-0.004	-0.016	-0.061	0.024***
	(0.012)	(0.036)	(0.081)	(0.006)
	[-0.028, 0.019]	[-0.086, 0.053]	[-0.219, 0.098]	[0.013, 0.035]
Open for 7+ days, primarily in-person	0.032** b	0.088** a	0.177** a	0.027***
	(0.010)	(0.030)	(0.068)	(0.004)
	[0.012, 0.051]	[0.030, 0.146]	[0.043, 0.310]	[0.019, 0.036]

**Notes:** Sample includes 3126 counties observed for 61 days. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from primarily online P<0.05

b Difference from primarily online P<0.01

c Difference from primarily online P<0.001

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Table 8: Interactions with more granular teaching classification

	New cases per thousand			Reproductive ratio	Visitors
	Daily	Last three days	Weekly		
Open, Primarily or Fully In-Person	0.028**	0.077*	0.152*	0.019***	0.525***
	(0.010)	(0.030)	(0.069)	(0.005)	(0.060)
	[0.008, 0.048]	[0.018, 0.136]	[0.016, 0.288]	[0.010, 0.028]	[0.408, 0.642]
Open, Hybrid or Hyflex	0.017	0.047	0.079	0.024***	0.555
	(0.011)	(0.031)	(0.073)	(0.005)	(0.069)
	[-0.003, 0.038]	[-0.015, 0.108]	[-0.063, 0.222]	[0.014, 0.034]	[0.419, 0.690]
Open, Primarily or Fully Online	-0.001	-0.009	-0.049	0.019***	0.328***
	(0.010)	(0.029)	(0.065)	(0.005)	(0.045)
	[-0.021, 0.018]	[-0.067, 0.048]	[-0.177, 0.079]	[0.010, 0.028]	[0.241, 0.415]

Notes: Sample includes 3126 counties observed for 61 days. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from primarily online P<0.05

b Difference from primarily online P<0.01

c Difference from primarily online P<0.001

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eTable 9: Interactions with (even) more granular teaching classification

	New cases per thousand			Reproductive ratio	Visitors
	Daily	Last three days	Weekly		
Open, Fully In Person	0.045 (0.027) [-0.008, 0.097]	0.127 (0.080) [-0.030, 0.284]	0.251 (0.187) [-0.117, 0.618]	0.029* (0.013) [0.003, 0.054]	0.295*** (0.054) [0.190, 0.400]
Open, Primarily In Person	0.026* (0.011) [0.005, 0.047]	0.071* (0.032) [0.009, 0.133]	0.140 (0.073) [-0.003, 0.283]	0.018*** (0.005) [0.009, 0.027]	0.545*** (0.062) [0.424, 0.667]
Open, Hybrid or Hyflex	0.017 (0.011) [-0.003, 0.038]	0.047 (0.031) [-0.015, 0.108]	0.079 (0.073) [-0.063, 0.222]	0.024*** (0.005) [0.014, 0.034]	0.555*** (0.069) [0.419, 0.690]
Open, Primarily Online	0.001 (0.011) [-0.020, 0.022]	-0.003 (0.031) [-0.063, 0.058]	-0.033 (0.068) [-0.167, 0.101]	0.020*** (0.005) [0.011, 0.030]	0.383*** (0.050) [0.284, 0.481]
Open, Fully Online	-0.016 (0.023) [-0.062, 0.030]	-0.058 (0.073) [-0.200, 0.085]	-0.161 (0.172) [-0.499, 0.176]	0.011 (0.012) [-0.014, 0.035]	0.125*** (0.038) [0.051, 0.199]

Notes: Student home case rate is the log Fall 2018-based enrollment weighted average increase in cases per thousand in home states, measured fourteen days before campus reopened. Standard errors account for first order serial correlation.

\*\*\* P<0.001, \*\* P< 0.01, \* P<0.05

a Difference from primarily online P<0.05

b Difference from primarily online P<0.01

c Difference from primarily online P<0.001