sociological science

Supplement to:

Klugman, Joshua. 2017. "Essential or Expendable Supports? Assessing the Relationship between School Climate and Student Outcomes." Sociological Science 4: 31-53.

This supplement contains (a) various diagnostic analyses testing for various threats to the conclusions presented in the main article; (b) alternative specifications of the analyses (specifically analyses testing for nonlinear effects of school climate and for effects of school climate that depend on the year students experience them); (c) Table S.5 showing the sources of dropped cases; (d) Table S.6 showing an attrition analysis; and (e) Table S.7 showing the associations for each specific climate measure.

Threats to Validity

Exclusion of Within-CPS Transfer Students

There are a number of potential threats to the validity of these analyses. The most important one is the fact that the samples are approximately halved because only students who attended the same school in their fourth, sixth, and eighth years are retained. I reran the analyses retaining students who switched schools within CPS (presented in Table S.1). The school climate for a student in cohort c who attended school j in their fourth year, school k in their sixth year, and school l in their eighth year is calculated as:

$$measure_{jklc} = \frac{measure_{jt=c+1} + measure_{kt=c+3} + measure_{lt=c+5}}{3} \quad (1)$$

Among CPS students, there are over 40,000 combination of schools j, k, and l, many with only one student in them, making it impractical to run random or fixed effects for each combination. Instead, the between-within models are analogous to a fourth-year school fixed effect model. In essence, they account for student selection into schools by controlling for the school attended in the fourth year. Variation in school climate comes from schools changing over time (for students whose school j is equal to their schools k and l) and from students switching to schools with different climates.

The results are very similar to the original findings–modest positive associations between school climate and test scores, and virtually no associations with on-time 9th grade promotion and high school graduation.

Imputation of Test Scores

In the main analyses test scores (both as an outcome and as a key control variable) are imputed with test scores from other subjects and time points. The imputed values inevitably are more subject to measurement error than the non-imputed versions, and the effects, or lack thereof, shown in the main set of analyses could be an artifact of this imputation. However, even if only cases with non-imputed values are used, the results are still similar, as shown in Table S.1.

Including School-Cohorts With Only Two Years of Data

School-cohorts that have survey data for at least two years are included in the main analyses; but the main findings could be an artifact of measurement error caused by incomplete data. When analyses are limited to school-cohorts with the full set of three years of survey data (shown in Table S.1), the effects are a bit stronger, but the main conclusions still hold.

Endogeneity of School Demographics

School demographic variables are potentially endogenous; school improvement in climate could precipitate an influx of advantaged students and thus controlling for school demographics would suppress the effects of school climate. While the variance partitioning exercise suggests that at best there is a minor endogeneity problem (since there is not much selection into schools based on over-time changes in climate), this possibility cannot be dismissed out of hand. Lagging school demographic variables so they represent the state of the school two years before the student started their fourth year there produces very similar estimates (shown in Table S.1) to the main analyses.

Retaining the 2006 Cohort

During the 8th year of students in the 2006 cohort (2010-2011), CPS changed the use of the teacher and student surveys so that they would be made public (previously, survey results were disseminated only to schools). It is possible that including this data biases the results because within-school, over-time changes in climate measures may be artifacts of pressure on spring 2011 respondents (particularly teachers) to present their school in the most favorable light, out of concern their school may otherwise suffer because of school choice policies. Dropping the 2006 cohort in analyses presented in Table S.2 weakens the results a bit but the main conclusion stands.

Low Response Rates

As previously noted, response rates vary across school-cohorts, with some being quite low, which could bias the estimated effects of climate. A dummy indicator representing a median split in student and teacher response rates was included in separate models and interacted with student and teacher climate, respectively. The associations (presented in Table S.2) between student climate and math scores and graduation are more pronounced for school-cohorts with an above-median student response rate, but the effects of teacher climate remain consistent regardless of response rate. Taking into account response rates does not suggest any need to revise the conclusions from the main analysis.

Pooling Together Different Tests

This study pools together student scores on four different tests: the ITBS, the pre-NCLB ISAT, the post-NCLB ISAT, and for a very small fraction of students, the NWEA MAP. While student scores on these tests are standardized by grade and test, methodologists justifiably caution against pooling together different measures used in different years in longitudinal analyses, even if they are standardized (Singer and Willett 2003). As can be seen in Table S.3, there is a dramatic drop in cohorts' mean test score from 2000 to 2002, reflecting CPS's adoption of the post-NCLB ISAT test. Effects from analyses pooling these disparate measures together might be biased. Table A.5 addresses this concern by separating out students' scores on all of these tests (except for the NWEA MAP). The findings show more pronounced associations for the post-NCLB ISAT (which cohorts from 2002-2006 took), with weaker associations for the ITBS and pre-NCLB ISAT (cohorts 1996-2000). For example, overall climate's coefficient on the post-NCLB ISAT math test is .07, compared to .01-.02 for the ITBS and pre-NCLB ISAT math tests. One possible reason for why climate may have a modest association for the latter cohorts (as opposed to virtually no association for the earlier cohorts) is because the ITBS and pre-NCLB ISAT were "low stakes" tests and schools were not held accountable for their students' performance; perhaps strong school climates mobilize teachers to adapt (somewhat) to new accountability regimes.

Probing the Associations

Are The Associations Nonlinear?

The essential supports framework argues that in order for schools to benefit from strong organization, they need to be strong in a variety of different aspects of climate (Bryk et al. 2010). The implication of this argument is that the omnibus measures used in this study have nonlinear effects: the benefit of improved climate occurs for schools that already have high values on climate. To evaluate this possibility, the between-within models were rerun, with squared terms for the school mean and school-centered versions of the climate measures. The linear and quadratic terms were interacted with each other:

$$
\begin{aligned}
Y_{ijc} = {} & \beta(measure_{jc} - \overline{measure_j}) + \beta(measure_{jc} - \overline{measure_j})^2 \\
& + \beta(\overline{measure_j}) + \beta(\overline{measure_j})^2 \\
& + \beta(measure_{jc} - \overline{measure_j})(\overline{measure_j}) \\
& + \beta(measure_{jc} - \overline{measure_j})^2(\overline{measure_j})^2 \\
& + \beta(measure_{jc} - \overline{measure_j})^2(\overline{measure_j}) \\
& + \beta(measure_{jc} - \overline{measure_j})(\overline{measure_j})^2 \\
& + \sum \beta(X_{ijc} - \bar{X}_j) + \sum \beta(\bar{X}_j) \\
& + \sum \beta(W_{jc} - \bar{W}_j) + \sum \beta(\bar{W}_j) \\
& + U_j + e_{ijc}
\end{aligned} \tag{2}
$$

Because these are complex models, only graphical results will be shown. The association between improvements in school climate ($measure_{jc} - \overline{measure_j}$) and student outcomes is shown conditioned on the school climate mean ($\overline{measure_j}$) at its 25th, 50th, and 75th percentiles. Figures S1, S2, S3 show the associations for the overall, student, and teacher climate measures respectively. The only pronounced association is between overall climate and teacher climate, on the one hand, and test scores on the other. Contrary to Bryk et al. (2010), schools with weak climates benefit more from improving their climates than schools with average or superior climates. For example, a two SD improvement in teacher climate translates into 8th grade test scores improving by .15 SD for schools with a school climate mean at the 25th percentile; for other schools the benefit is about half that.

Do The Associations Depend on the Timing of the Measurement?

A common concept in education research is that of "critical period", a claim about path dependency where educational conditions, practices, and interventions at a certain developmental stage are alleged to direct children to either a good or bad path for academic success. Claims have been made about early (pre-K) childhood (Heckman 2013), the first and second grades (Entwisle, Alexander, and Olson 1997), the middle grade years (Kraft et al. 2016), and freshman year in high school (Allensworth and Easton 2005, 2007). Testing and adjudicating between these critical periods is outside the purview of this study, but the concept raises the possibility that exposure to strong school climates early on in one's school career has a larger influence on student outcomes than exposure in later years. To test this possibility, separate models were run for year 4, 6, and 8 climate measures, and are presented in Table S.4. There is not much evidence for a critical period argument; the general pattern being either a stepwise increase in the associations from year 4 to year 6 to year 8 (as seen for 8th grade math test scores), or an increase from year 4 to year 6 and no increase in year 8, as seen for 8th grade reading test scores. The AMEs for on-time 9th grade promotion are zero and the AMEs for high school graduation hover between zero and .01.

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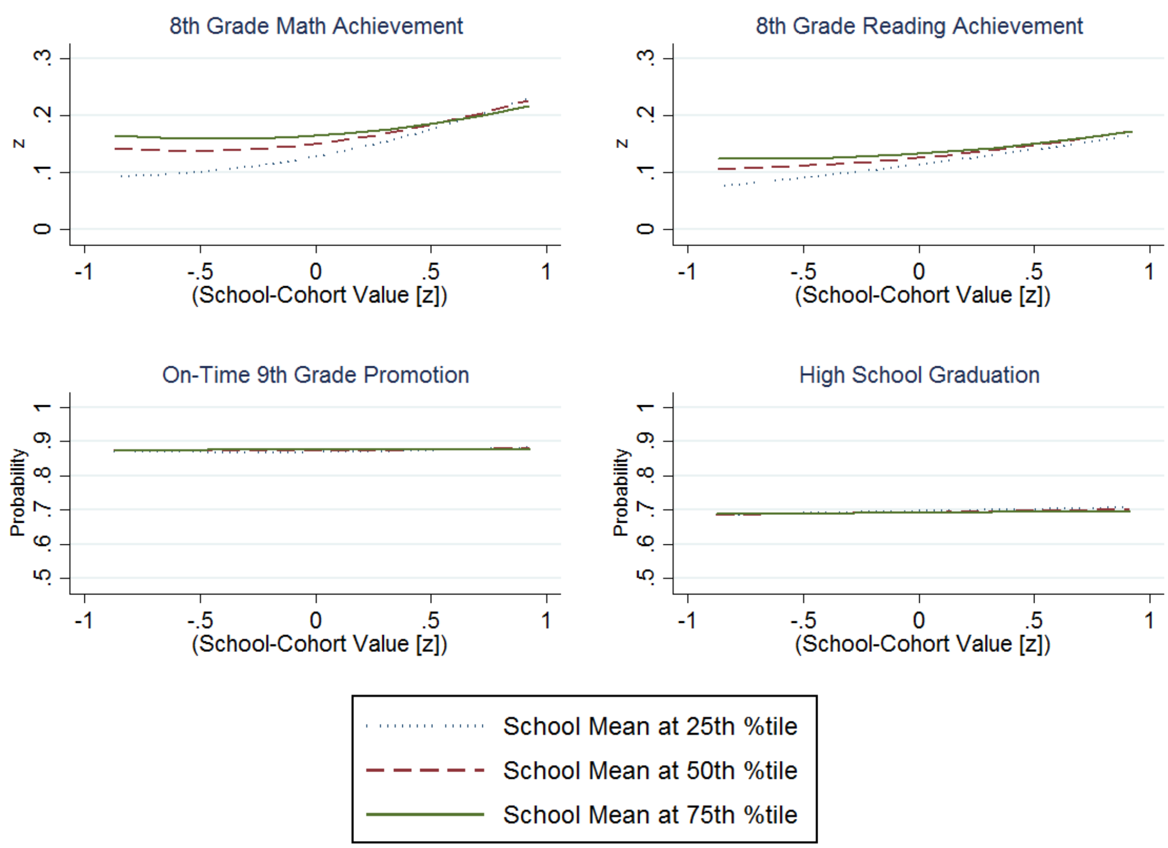

Figure S1: Associations of Overall Climate with Student Outcomes

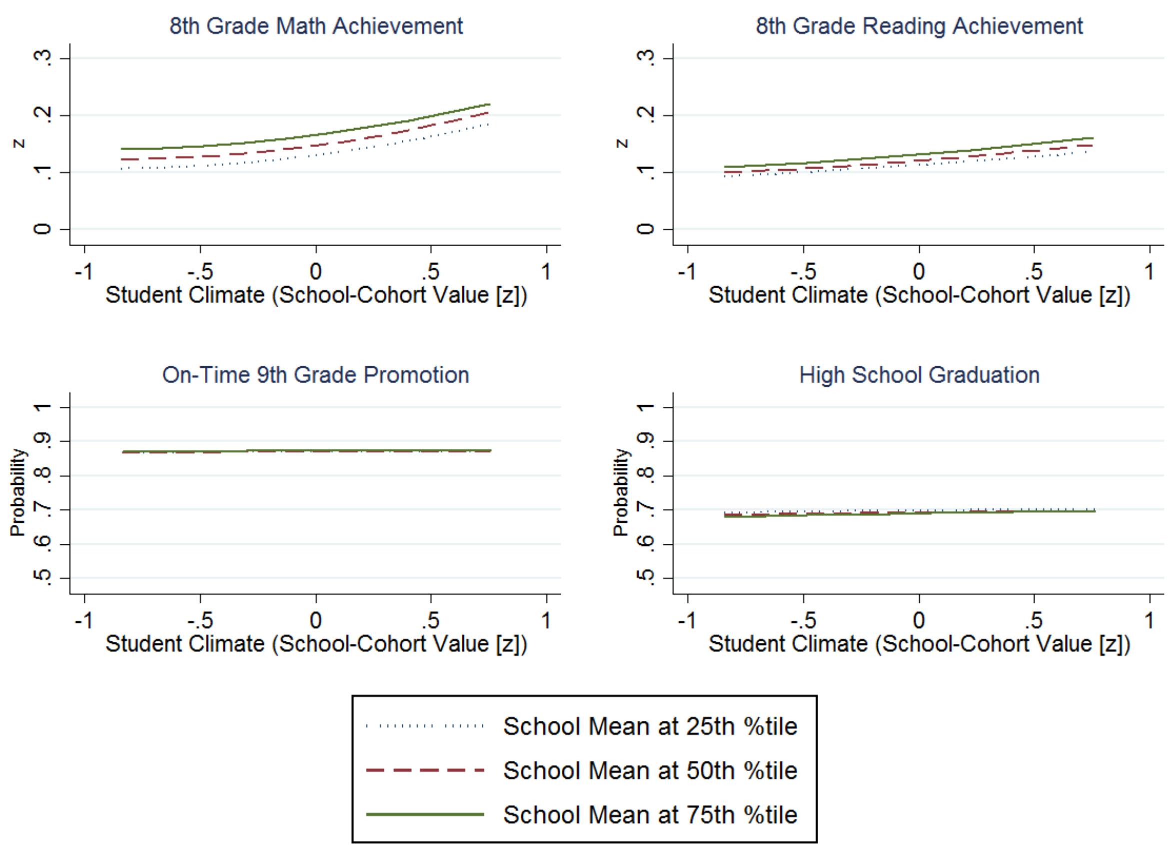

Figure S2: Associations of Student Climate with Student Outcomes

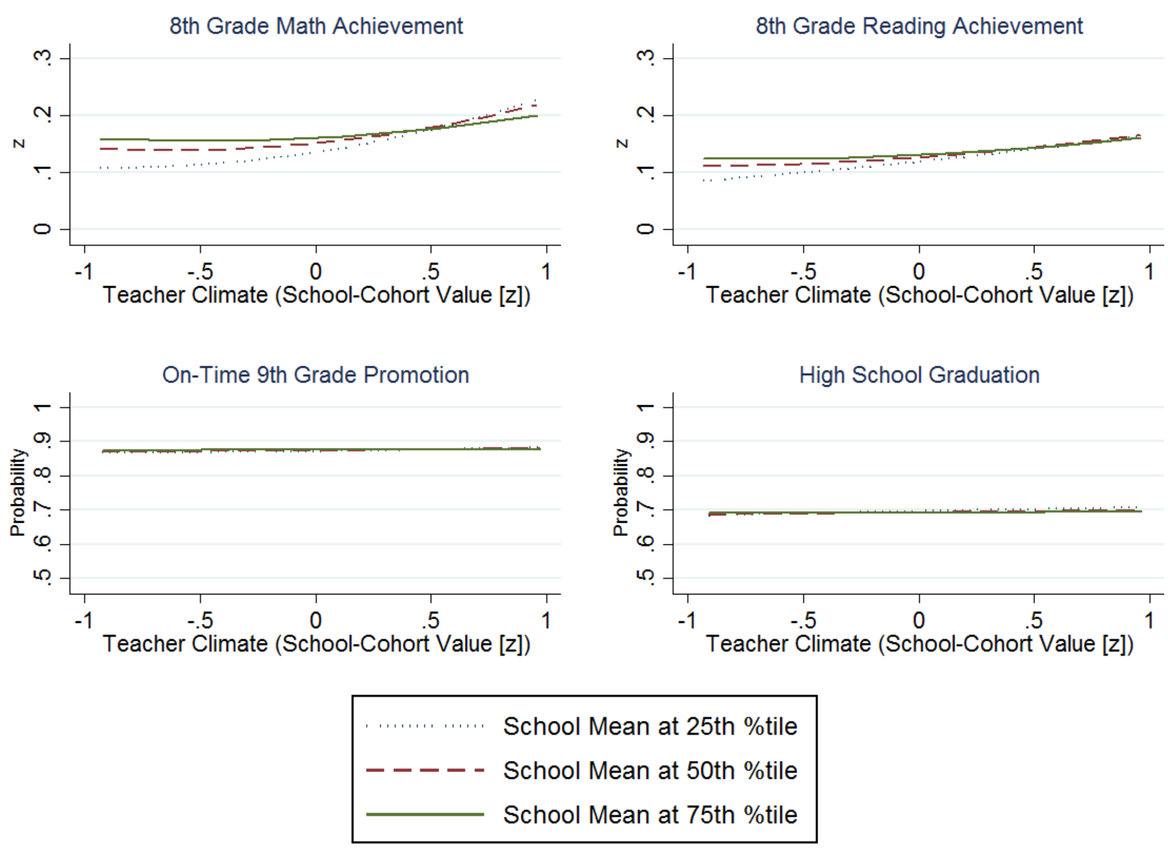

Figure S3: Associations of Teacher Climate with Student Outcomes

Table S.1: Results From Alternative Specifications

Climate Measure (z)	9th Grade Promotion (AME)	8th Grade Math (beta)	8th Grade Reading (beta)	Graduation (AME)
	Original Specification			
Overall	0.00	0.05*	0.04*	0.01*
	(0.003)	(0.004)	(0.005)	(0.004)
Student	0.00	0.05*	0.03*	0.01*
	(0.003)	(0.004)	(0.005)	(0.004)
Teacher	0.00	0.04*	0.03*	0.01
	(0.003)	(0.004)	(0.005)	(0.004)
	Including Students Who Transferred to Another CPS School			
Overall	0.00	0.04*	0.03*	0.00
	(0.002)	(0.003)	(0.003)	(0.002)
Student	0.00	0.03*	0.02*	0.00
	(0.002)	(0.003)	(0.003)	(0.002)
Teacher	0.00	0.04*	0.03*	0.00
	(0.002)	(0.003)	(0.003)	(0.002)
	No Imputation of Test Scores			
Overall	0.00	0.05*	0.03*	0.01
	(0.003)	(0.005)	(0.005)	(0.004)
Student	0.00	0.04*	0.03*	0.01
	(0.003)	(0.005)	(0.005)	(0.004)
Teacher	0.00	0.04*	0.02*	0.01
	(0.003)	(0.005)	(0.005)	(0.004)
	Only School-Cohorts With Three Survey Years			
Overall	0.00	0.07*	0.06*	0.01*
	(0.003)	(0.006)	(0.006)	(0.005)
Student	0.00	0.06*	0.04*	0.02*
	(0.004)	(0.006)	(0.006)	(0.005)
Teacher	0.00	0.06*	0.05*	0.01
	(0.003)	(0.006)	(0.006)	(0.005)
	Using Lagged School Demographics			
Overall	0.00	0.05*	0.04*	0.01
	(0.003)	(0.004)	(0.005)	(0.004)
Student	0.00	0.04*	0.03*	0.01*
	(0.003)	(0.004)	(0.005)	(0.004)
Teacher	0.00	0.04*	0.03*	0.00
	(0.002)	(0.004)	(0.004)	(0.004)

* $p < .05$

Standard errors are in parentheses. All coefficients are for school-centered measures from separate between-within models with all student- and school-level controls.

Table S.2: Results From Alternative Specifications

Climate Measure (z)	9th Grade Promotion (AME)	8th Grade Math (beta)	8th Grade Reading (beta)	Graduation (AME)
		Original Specification		
Overall	0.00	0.05*	0.04*	0.01*
	(0.003)	(0.004)	(0.005)	(0.004)
Student	0.00	0.05*	0.03*	0.01*
	(0.003)	(0.004)	(0.005)	(0.004)
Teacher	0.00	0.04*	0.03*	0.01
	(0.003)	(0.004)	(0.005)	(0.004)
		Dropping 2006 Cohort		
Overall	0.00	0.03*	0.02*	0.01
	(0.003)	(0.005)	(0.006)	(0.005)
Student	0.00	0.03*	0.03*	0.01*
	(0.003)	(0.005)	(0.006)	(0.005)
Teacher	0.00	0.02*	0.02*	0.00
	(0.003)	(0.005)	(0.005)	(0.005)
		Comparison of Associations By Response Rates		
Student Climate				
Student Response Rate < 83%	0.00	0.04*	0.03*	0.01
	(0.003)	(0.006)	(0.006)	(0.005)
Student Response Rate ≥ 83%	0.01	0.06*	0.03*	0.02*
	(0.004)	(0.007)	(0.008)	(0.006)
Teacher Climate				
Teacher Climate < 68%	0.00	0.04*	0.03*	0.01
	(0.003)	(0.006)	(0.006)	(0.005)
Teacher Climate ≥ 68%	0.01	0.04*	0.02*	0.00
	(0.004)	(0.007)	(0.007)	(0.006)

* $p < .05$
Standard errors are in parentheses. All coefficients are for school-centered measures from separate between-within models with all student- and school-level controls.

Table S.3: Associations Between School Climate and Specific 8th Grade Test Scores

	Original Specification		ITBS	
Climate Measure (z)	Math	Reading	Math	Reading
Overall	0.05*	0.04*	0.02*	0.02*
	(0.004)	(0.005)	(0.008)	(0.007)
Student	0.05*	0.03*	0.01	0.02*
	(0.004)	(0.005)	(0.008)	(0.007)
Teacher	0.04*	0.03*	0.02*	0.01*
	(0.004)	(0.005)	(0.008)	(0.007)
	Pre-NCLB ISAT		**Post-NCLB ISAT**	
Climate Measure (z)	Math	Reading	Math	Reading
Overall	0.01	0.02*	0.07*	0.04*
	(0.009)	(0.006)	(0.008)	(0.007)
Student	0.01	0.01*	0.06*	0.03*
	(0.008)	(0.006)	(0.007)	(0.007)
Teacher	0.01	0.01*	0.06*	0.03*
	(0.009)	(0.006)	(0.007)	(0.007)

$* \ p < 0.05$.
Standard errors are in parentheses. All coefficients are fully-standardized beta coefficients for school-centered measures from separate between-within models with all student- and school-level controls.

Table S.4: Associations Between School Climate and Student Outcomes, By Year

	9th Grade Promotion (AMEs)	8th Grade Math (betas)	8th Grade Reading (betas)	Graduation (AMEs)
Overall Climate (z)				
Year 4	0.00	−0.01	0.01	0.00
	(0.003)	(0.005)	(0.005)	(0.004)
Year 6	0.00	0.04*	0.04*	0.01
	(0.003)	(0.005)	(0.005)	(0.004)
Year 8	0.00	0.07*	0.04*	0.01
	(0.002)	(0.005)	(0.005)	(0.004)
Student Climate (z)				
Year 4	0.00	−0.03*	−0.01	0.00
	(0.004)	(0.006)	(0.007)	(0.006)
Year 6	0.00	0.05*	0.03*	0.01*
	(0.004)	(0.006)	(0.007)	(0.006)
Year 8	0.00	0.07*	0.04*	0.01
	(0.003)	(0.005)	(0.006)	(0.005)
Teacher Climate (z)				
Year 4	0.00	0.00	0.01	0.00
	(0.003)	(0.004)	(0.005)	(0.004)
Year 6	0.00	0.03*	0.03*	0.00
	(0.003)	(0.004)	(0.005)	(0.004)
Year 8	0.00	0.06*	0.03*	0.00
	(0.002)	(0.004)	(0.004)	(0.003)

* $p < .05$

Standard errors are in parentheses. All coefficients are for the school-centered measures from separate between-within models with all student- and school-level controls. School-level controls are averages of the year 4, 6, and 8 characteristics.

Table S.5: Sample Sizes

	9th-Grade Promotion	8th-Grade Test Scores	Graduation
Eligible Cohorts	1996-2006	1996-2006	1996-2006
Total Number of First-Time 3rd Graders Advancing to 4th Grade the Next Year	165,699		165,699
Total Number of First-Time 3rd Graders In CPS the Next Year		183,218	
Deleted Cases (listed in order of deletion)			
Non-CPS Transfers / Missing on Outcome (%)	34,085 (21%)	34,837 (19%)	51,214 (31%)
School(s) Surveyed Zero or One Years (%)	15,333 (9%)	15,001 (8%)	14,413 (9%)
Missing on Predictors (%)	2,017 (1%)	1,574 (1%)	1,722 (1%)
CPS Transfer	51,647 (31%)	59,452 (32%)	43,911 (27%)
No Variation in School	86 (0%)		6 (0%)
In Sample (%)	62,530 (38%)	72,354 (39%)	54,433 (33%)

Table S.6: Attrition Analysis

	9th-Grade Promotion	8th-Grade Test Scores	Graduation
Average Essentials (z)	0.01*	−0.01*	0.00
Student Essentials (z)	0.02*	0.00	0.01*
Teacher Essentials (z)	0.01*	−0.02*	0.00
Race (omitted: Latino)			
Asian / White (0,1)	0.14*	0.09*	0.13*
Black (0,1)	−0.02*	0.03*	−0.02*
Other / Missing (0,1)	−0.09*	−0.12*	−0.13*
Avg Prop Asian / White (z)	0.06*	0.05*	0.05*
Avg Prop Black (z)	0.03*	0.05*	0.02*
Avg Other / Missing (z)	0.00	0.00	−0.01*
FRPL Status (0-1)	−0.17*	−0.06*	−0.11*
Avg School FRPL Status (z)	−0.05*	−0.03*	−0.04*
Neighborhood Disadvantage (z)	−0.04*	0.00	−0.02*
Avg School Neighborhood Disadvantage (z)	−0.02*	0.02*	−0.01*
Neighborhood Advantage (z)	0.03*	0.01*	0.02*
Avg School Neighborhood Advantage (z)	0.03*	0.02*	0.02*
Male (0,1)	0.02*	0.02*	0.02*
Bilingual Education Services (0,1)	−0.01*	−0.02*	−0.01
Cohort (omitted = 1996)			
1998	0.02*	−0.01*	0.08*
2000	0.03*	0.01	0.03*
2002	0.04*	0.00	0.00
2004	−0.05*	−0.04*	−0.04*
2006	−0.09*	−0.08*	−0.10*
Age in 3rd Grade (z)	0.00	0.02*	0.02*
3rd Grade Math & Reading Test Scores (z)	0.02*	−0.01*	0.00
Avg School 3rd Grade Math & Reading Test Scores (z)	0.01	−0.07*	−0.01
Prop Years in Charter School (0-1)	−0.01	−0.03	−0.04
Avg School Log Enrollment Size	0.11*	0.13*	0.09*

$* \; p < 0.05$
Average Marginal Effects (AMEs) shown from logistic regressions run separately for each predictor (or set of predictors).

Table S.7: Associations Between Student Outcomes and School Climate Experienced in 4th, 6th, and 8th Years on Student Outcomes

	9th Grade Promotion	8th Grade Math	8th Grade Reading	Graduation
Climate Measure (z)	Between-Within Model (AME)	Between-Within Model (beta)	Between-Within Model (beta)	Between-Within Model (AME)
Student Measures				
Engagement	0.00	0.03*	0.02*	0.01*
	(0.003)	(0.005)	(0.005)	(0.004)
Peer Relationships	0.00	0.05*	0.03*	0.00
	(0.004)	(0.006)	(0.007)	(0.005)
Academic Personalism	0.01*	0.04*	0.02*	0.01*
	(0.003)	(0.005)	(0.005)	(0.004)
Safety	0.00	0.04*	0.05*	0.01
	(0.003)	(0.006)	(0.006)	(0.005)
Teacher-Student Trust	0.00	0.04*	0.02*	0.01
	(0.003)	(0.005)	(0.005)	(0.004)
Teacher Measures				
Collective Responsibility	0.00	0.04*	0.03*	0.00
	(0.003)	(0.005)	(0.005)	(0.004)
Teacher Influence	0.00	0.03*	0.02*	0.00
	(0.003)	(0.005)	(0.005)	(0.004)
Innovation	0.01	0.05*	0.03*	0.01
	(0.003)	(0.005)	(0.005)	(0.004)
Instructional Leadership	0.00	0.03*	0.02*	0.00
	(0.002)	(0.004)	(0.004)	(0.003)
Program Coherence	0.00	0.04*	0.03*	0.00
	(0.002)	(0.004)	(0.004)	(0.004)
Quality Professional Development	0.00*	0.03*	0.02*	0.01
	(0.002)	(0.004)	(0.004)	(0.003)
Reflective Dialogue	0.00	0.02*	0.02*	0.01
	(0.003)	(0.004)	(0.005)	(0.004)
School Commitment	0.00	0.04*	0.03*	0.01*
	(0.003)	(0.005)	(0.005)	(0.004)
Teacher-Parent Trust	0.00	0.03*	0.04*	0.01*
	(0.003)	(0.005)	(0.005)	(0.004)
Teacher-Principal Trust	0.00	0.03*	0.02*	0.00
	(0.002)	(0.004)	(0.004)	(0.003)
Teacher-Teacher Trust	0.01*	0.02*	0.02*	0.01
	(0.002)	(0.004)	(0.004)	(0.004)

* $p < .05$

Standard errors are in parentheses. All coefficients are for the school-centered measures from separate between-within models with all student- and school-level controls.