Abstract Title Page
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Title: Trajectories of Exposure to Racial School Segregation and the Transition to College

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Abstract Body
Limit 4 pages single-spaced.

Background / Context:

The *Brown v. Board of Education* decision ruled racial school segregation unconstitutional over 60 years ago. Although widespread desegregation followed initially, the past several decades have seen increasing resegregation, as evidenced by a decreasing proportion of black students in the average white students' schools and an increasing percentage of black students attending predominantly minority schools (Reardon & Owens, 2014). On average, students who attend minority-segregated schools are not receiving the same quality of education as those in majority-white schools with respect to school resources and achievement (Benson & Borman 2010; Betts, Reuben, & Danenberg, 2000; Boozer, Krueger, & Wolkon, 1992; Coleman et al., 1966; Crosnoe, 2005; Darling-Hammond, 2004; Gamoran, 1987; Palardy, 2013; Rumberger & Palardy, 2005). Research generally finds that attending black- or minority-segregated schools depresses individual student educational outcomes in the short and long term (Goldsmith, 2009; Hanushek, Kain, & Rivkin, 2009; Hoxby, 2002; R. C. Johnson, 2011; Mickelson, 2008; Mickelson & Nkomo, 2012; Wells & Crain, 1994; Yun & Kurlaender, 2004). But our understanding of the consequences of exposure to school segregation is limited by the fact that most studies of the impacts of school racial composition on student outcomes measure exposure to black- or minority-concentrated schools at a single point in time. This characterization is problematic because it ignores the possibility that students can experience different patterns of exposure to school segregation over time that may affect educational consequences. Even if students experience the same conditions of segregated schools over a number of years, it ignores the possibility that the duration of exposure matters. Because of these limitations, snapshot measures cannot yield a full understanding of how exposure to racial school segregation affects students.

Purpose / Objective / Research Question / Focus of Study:

This study examines the effect of different trajectories of exposure to school segregation during middle and high school on postsecondary education outcomes. I focus on the consequences of experiencing different timing, duration, and stability of exposure to black-segregated schools on enrollment in a 2- or 4-year college and completion of a 2- or 4-year degree.

The study defines segregated schools in this way because of the historical importance and contemporary relevance of black segregation. Although unequal educational opportunities between black and white students drove the *Brown* decision, residential and educational isolation continues to be more pronounced for black students than other minority students (Logan, Stults, & Farley, 2004; Orfield & Lee, 2005). Historic and current racial inequalities in this country mean that predominantly black schools on average have fewer school resources, less qualified teachers, higher proportions of economically disadvantaged students, and lower average academic achievement—all factors detrimental for educational outcomes (Logan et al., 2012; Rumberger & Palardy, 2005).

Setting:

The data are drawn from the National Longitudinal Survey of Youth, 1997 (NLSY97), which follows a sample of 8,894 students who were between 12 and 16 years old on December 31,

1996. The sample is representative of the civilian, non-institutional population living in the 50 states or the District of Columbia. Data from rounds 1 through 15, when the respondents were between 26 and 30 years old, are used in this analysis. The NLSY97 survey data contains parent retrospective responses about school history and family background, annual student responses on current and past schooling, and rich contextual information about youth and their families, including information on employment, family structure, program participation, behaviors, attitudes, and aptitude tests.

In order to calculate the racial composition of students' schools, data from the National Center for Education Statistics' Common Core of Data (CCD) and Private School Survey (PSS) were merged to NLSY97 student records using the school identification variable present in the NLSY97 data file for every school the student ever attended between 8th and 12th grade.

Population / Participants / Subjects:

The analytic sample includes 2,132 students from the NLSY97 and was restricted in three ways. First, only students who were currently enrolled in 8th grade or lower in 1997 were included to ensure complete data was available for key time-varying student characteristics, including academic coursetaking, behavior and substance use variables. Second, the sample includes respondents who were missing no more than one year of school racial composition data and who attended at least one school between 1997 and 2010. Third, the sample includes only those respondents living in metropolitan areas at baseline with a black population that was at least six percent of the total population. This restriction excludes students who have a zero or extremely low probability of attending a black-segregated school because of the small overall percentage of black students in their metropolitan area.

Intervention / Program / Practice:

The "treatment" is defined as the student's pattern of exposure to segregated schools throughout middle and high school. I investigate three temporal aspects of exposure. First, I examine the *timing* of students' exposure—whether they experienced early exposure by attending segregated schools in 8th or 9th grade, or experienced late exposure by attending a segregated school in 11th or 12th grade, regardless of total length of time exposed. Second, I investigate the consequences of the *duration* of students' exposure—i.e., the cumulative number of years that they were exposed to segregated schools—regardless of the timing of exposure. The third measure simultaneously describes the timing, duration, and stability of student segregation through exposure *trajectories*, constructed using longitudinal latent class analysis (Feldman, Masyn, & Conger, 2009; Muthén & Muthén, 2000). For each of the five years between 8th and 12th grade, students are counted as being exposed to a segregated school if they attended a majority-black school. The models identified four latent classes (exposure trajectories): consistently non-exposed to segregated schools, consistently exposed, entering segregated schools, and exiting segregated schools. Each students belongs to one of the four latent classes.

Research Design:

Estimating the effect of segregation exposure is problematic for two reasons. First, students can move in and out of the treatment (time-varying treatment); and second, student characteristics that are affected by prior treatment exposure and that predict subsequent treatment exposure as

well as college outcomes, can also vary over time (time-dependent confounders). Marginal structural models (MSM) use inverse probability of treatment weights (IPTWs) in order to account for time-varying treatment and time-dependent confounding, and obtain unbiased treatment effects in a way that studies using cross-sectional data or standard regression methods cannot (Hernan, Brumback, & Robins, 2002; Robins, 1999; Robins, Hernan & Brumback, 2000).

The effects of segregation exposure on postsecondary outcomes are estimated in a two-stage process. In the first step, I estimate each respondent's probability of attending a black-segregated school for every year between 8th and 12th grade using logistic regression. The model is a function of time-constant covariates, treatment status in the previous wave, and time-varying covariates in the current and previous waves. The inverse product of these five probabilities is the student's final IPT weight, which effectively removes the confounding between the treatment and prior measured covariates. (Characteristics of the IPT weights are presented in Table 3.) In the second step, the effect of treatment on college enrollment and completion is estimated in a logistic regression model that is weighted using the final IPT weights. Under the assumptions of no unmeasured confounding, the weights simulate an experiment in which individuals are randomized to treatment (segregation exposure) at each of the five waves. The coefficients from the weighted logistic regression model then recover the effect of segregation exposure on postsecondary outcomes.

Data Collection and Analysis:

I model two postsecondary outcomes separately – enrollment in a 2- or 4-year college and completion of a 2- or 4-year degree. Three weighted models are conducted for each outcome, focusing on timing only, duration only, and exposure trajectory, corresponding to equations (1), (2), and (3) below:

$$logit\ Pr[Y_{\bar{a}} = 1] = \beta_0 + \beta_1 a_1 + \beta_2 a_2 + \beta_3 a_3 + \beta_4 a_4 + \beta_5 a_5 \qquad (1)$$

where $Pr[Y_{\bar{a}} = 1]$ is the probability of college enrollment or completion given trajectory $\bar{a}$ (which is a function of exposure to black school segregation at five time points, $a_k\ for\ k = 1,2,3,4,5$);

$$logit\ Pr[Y_{\bar{a}} = 1] = \beta_0 + \beta_1 \sum_{k=1}^{K} a_k \qquad (2)$$

where $\sum_{k=1}^{K} a_k$ takes the values 0, 1, …, 5 and is modeled as a factor variable with zero years of exposure to black-segregated schools as the reference; and

$$logit\ Pr[Y_{\bar{a}} = 1] = \beta_0 + \beta_1 C \qquad (3)$$

where C is a categorical variable indicating membership in a given latent trajectory class.

Findings / Results:

Table 1 presents the sample descriptive statistics for students overall and by race. Table 2 displays percentages of students attending segregated schools during each wave of follow-up, focusing on differences in timing, duration, and trajectory membership. The results from the MSMs (Table 4) find that exposure to segregated schools is generally negative for educational outcomes, but also provides additional insights into how segregation exposure over time affects college enrollment and completion. First, the timing of exposure matters. Exposure *later* in high

school reduces the odds of enrolling in and completing college. This is not the case for exposure *earlier* in secondary school, which is largely non-significant. Second, there does not appear to be a linear cumulative effect. Most years of exposure to segregated schools, regardless of when it occurred, are negative in direction suggesting it is detrimental to enrolling in or completing college. But the size of the effect is small and the standard errors large. Further, the effect does not monotonically increase with the number of years exposed. Third, and consistent with the findings about time, students who *enter* segregated schools over the course of secondary school have reduced odds of enrolling in or completing college relative to students who are consistently non-exposed. There is no significant effect for students who *exit* segregated schools. For most estimates, the standard errors are large, but the direction of the effects are largely consistent. Large standard errors are not uncommon with marginal structural models and have been noted by other researchers as a common issue with weighting strategies (Westreich, Cole, Schisterman, & Platt, 2012).

Conclusions:

The focus on effects of multiple temporal dimensions of segregation exposure in this analysis pushes the segregation literature forward in key ways. Although the study stops short of discussing the mechanisms responsible for the effects of segregated schools on future educational attainment, prior work on the socioeconomic composition of high schools finds that peer influences may be the primary mediator for the association between high school composition and educational attainment (Palardy, 2013). Some studies also indicate that the effect of peer influence peaks in the late teenage years, the period that corresponds to the final years of high school when students are making decisions about whether to continue into postsecondary education (Palardy, 2013; Patacchini, Rainone, & Zenou, 2011), and the period this study found to have the largest detrimental effect of segregation exposure. High schools may have very different college readiness activities, assistance for college application preparation, norms and expectations for college attendance, and may disseminate college information of various quality and quantity to students (Hoxby & Avery, 2012). These are all likely important aspects of school context that should be investigated in future research.

A college degree is widely seen as a prerequisite for joining the middle class, yet college degrees are unevenly distributed across students of different races, with minority students continuing to lag behind in college enrollment and completion (Fry, 2011). Recent educational policies including Race to the Top have focused on increasing college attendance and graduation, allocating billions of federal dollars to educational reforms (U.S. Department of Education, 2009). But policymakers have not yet attended to the role that racial school segregation plays in maintaining inequalities in college outcomes during these reforms. The analyses presented here provide evidence regarding the role racial school composition during secondary school has on the probability of enrolling in and completing college, and indicate that student composition should remain a topic for education policy. Student assignment and choice policies that create and maintain integrated schools may be an additional avenue for policymakers and practitioners to leverage in efforts to increase college-going and completion rates.

Appendices
Appendix A. References

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Appendix B. Tables and Figures

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Table 1.

Sample descriptive patterns for time-constant and time-varying covariates and college outcomes, overall and by race

Student and family characteristics	All Students (n=2132)			Black (n=691)			Non-Black (n=1441)		
Time-constant covariates									
Male	0.532			0.531			0.533		
Black	0.206			1.000			0.000		
Highest Parent Education > High school	0.535			0.363			0.580		
Living below poverty (1997)	0.194			0.406			0.139		
Teenage mother	0.231			0.392			0.189		
ASVAB (percentile score)	39.87			22.98			44.25		
Time-varying covariates	Gr. 8	Gr. 10	Gr.12	Gr. 8	Gr. 10	Gr.12	Gr. 8	Gr. 10	Gr.12
Reported any delinquent behavior	0.400	0.294	0.200	0.440	0.289	0.184	0.390	0.295	0.204
Reported any substance use	0.464	0.579	0.677	0.378	0.452	0.525	0.487	0.612	0.713
Suspended	0.102	0.063	0.004	0.171	0.079	0.013	0.084	0.059	0.001
2-parent family	0.686	0.678	0.621	0.411	0.433	0.412	0.757	0.741	0.671
Single parent family	0.263	0.264	0.227	0.456	0.430	0.401	0.213	0.221	0.186
Other family arrangement	0.051	0.058	0.151	0.132	0.137	0.187	0.031	0.038	0.143
Mean household size	4.46	4.31	4.08	4.47	4.37	4.10	4.46	4.29	4.07
Mean cumulative number of residences	1.58	1.91	2.29	1.80	2.33	2.69	1.52	1.81	2.19
Mean math and science course level (0-7)	1.64	4.30	5.28	1.61	4.16	5.14	1.65	4.34	5.32
College outcomes									
Ever enrolled in 2- or 4-year college	0.664			0.571			0.688		
Ever completed 2- or 4-year degree	0.349			0.210			0.385		

NOTE: ASVAB is the Armed Services Vocational Aptitude Battery. Results are presented for the first full imputed dataset and weighted with r1wgtcc.

Table 2.
Exposure to black-segregated schools, by race

	Treatment >50% Black		
	All	Black	Non-black
Attended black-segregated school			
8th grade	0.145	0.553	0.039
9th grade	0.139	0.527	0.039
10th grade	0.139	0.531	0.037
11th grade	0.137	0.517	0.038
12th grade	0.138	0.521	0.039
Ever attended black-segregated school	0.183	0.640	0.064
Total years attended black-segregated school			
0 years	0.817	0.360	0.936
1 year	0.027	0.060	0.018
2 years	0.017	0.050	0.009
3 years	0.019	0.049	0.011
4 years	0.019	0.061	0.008
5 years	0.101	0.420	0.019
Exposure Trajectory			
Exiters	0.022	0.065	0.011
Enterers	0.018	0.047	0.011
Consistently Exposed	0.119	0.469	0.028
Consistently NonExposed	0.841	0.419	0.950

NOTE: Exposure trajectory membership is based on the student's most-likely latent class.

Table 3.
Characteristics of IPT weights

	Mean	SE	Min	Max
50-100% Black				
Overall	0.99	0.02	0.10	7.68
Black	0.99	0.01	0.06	4.34
Non-Black	0.99	0.01	0.17	1.94

NOTE: Weights for overall sample were truncated at 1st and 99th percentile for treatment definition 50–100 percent black schools. Weights also truncated at 1st and 99th percentile for non-black sample with treatment definition of 33–100 and 50–100 percent black. The weights for the black sample are not truncated. Minimum and maximum values represent minimum and maximum values across all five imputed datasets.

Table 4.

Estimated effects of time-varying exposure to black-segregated schools on college enrollment and completion for all students (50–100 percent black)

	Enroll			Complete		
	Est		SE	Est		SE
Model 1: Timing Only						
Timing of Exposure						
8th grade	0.16		0.331	0.20		0.293
9th grade	-0.10		0.408	0.32		0.368
10th grade	0.54		0.492	0.25		0.613
11th grade	0.13		0.672	-1.40	*	0.743
12th grade	-1.10	**	0.535	0.32		0.523
Early (9th and 10th)	0.06		0.329	0.53		0.324
Late (11th and 12th)	-0.97	**	0.476	-1.08	*	0.630
Model 2: Duration Only						
Cumulative Years of Exposure						
(0 years as ref.)						
1 year	-0.27		0.327	-0.33		0.339
2 years	0.33		0.431	-0.12		0.450
3 years	0.20		0.470	-0.47		0.691
4 years	-0.45		0.458	-0.87		0.539
5 years	-0.40	*	0.242	-0.24		0.287
Model 3: Exposure Trajectory						
Latent class membership						
(Cons. Non-Exposed as ref.)						
Exiters	0.43		0.395	0.28		0.463
Enterers	-0.23		0.447	-1.65	**	0.623
Consistently Exposed	-0.39	*	0.219	-0.31		0.264

*p<.1, **p<.05, ***p<.01

NOTE: Coefficients are log odds. Models include the time-constant covariates and average values of the time-varying covariates: sex, race, parental education, student ASVAB percentile score, family poverty level at baseline, mother's age at first child's birth, delinquent behavior, substance use, coursetaking patterns, suspensions, family structure, household size, and residential mobility patterns.